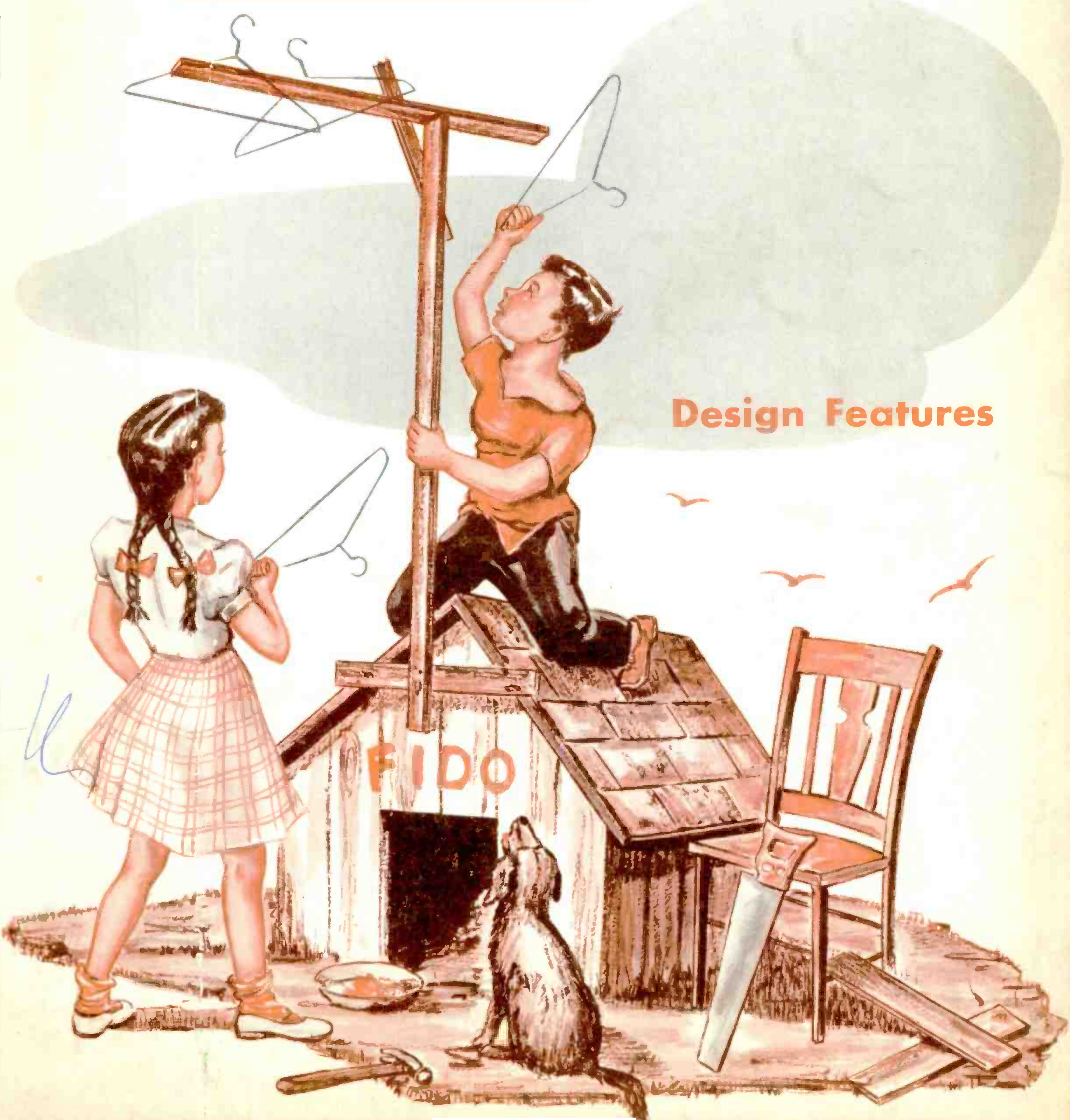
JULY • 1954

25 CENTS

PF INDEX

the monthly REPORTER for the Electronic Service Industry



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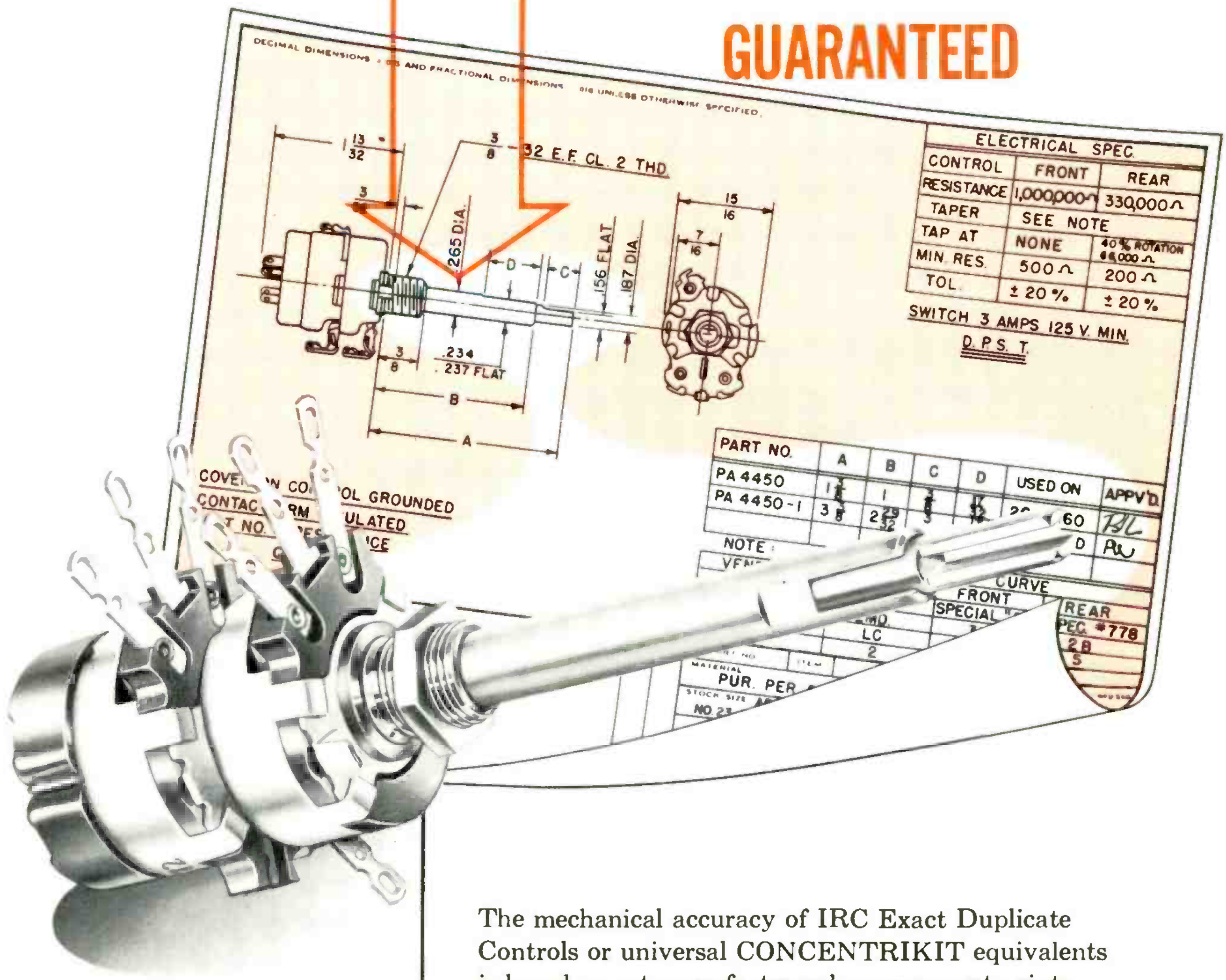

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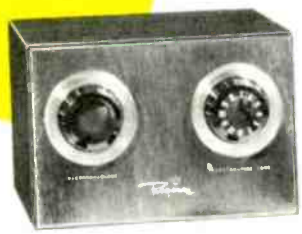

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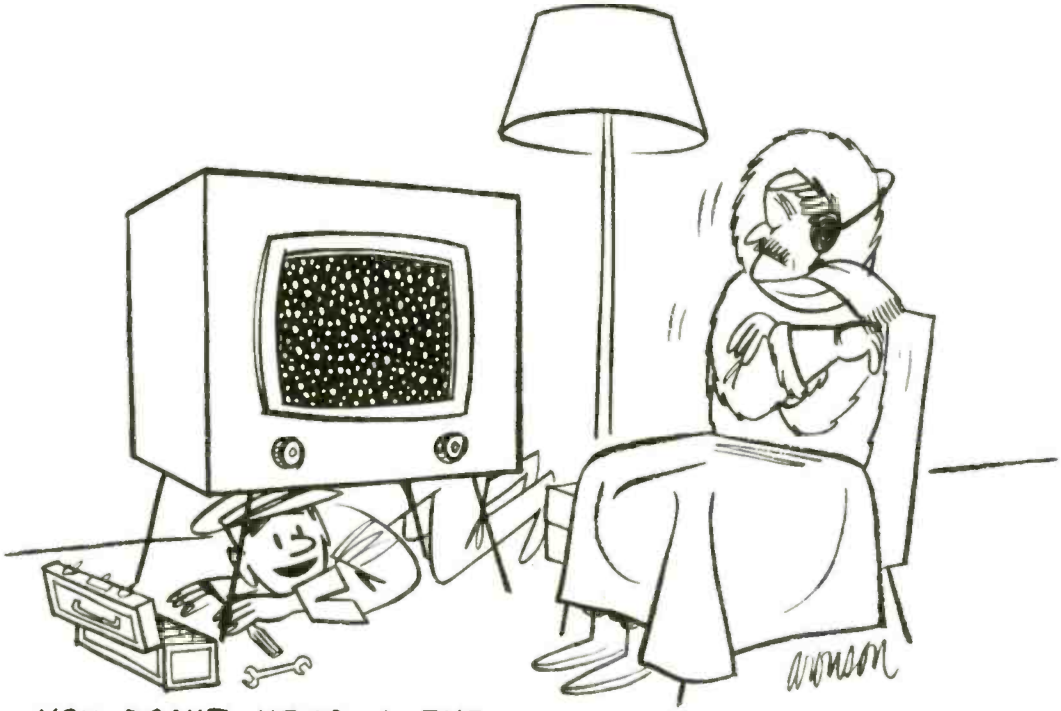

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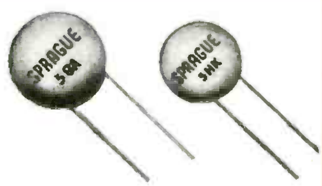

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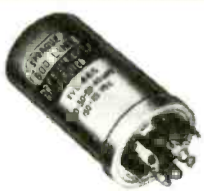

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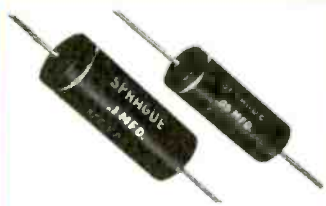

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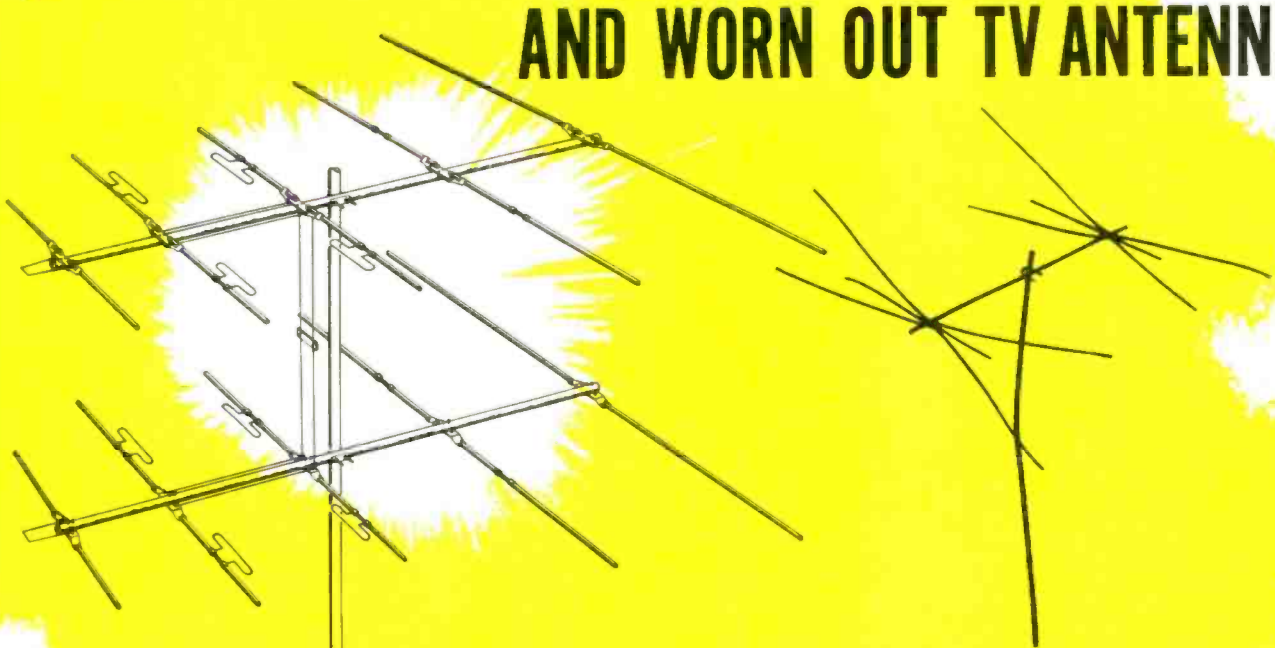

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Shop Talk

MILTON S. KIVER

President, Television Communications Institute

Wanted: Better Instruction Manuals

The commercialization of television has forced upon the service technicians a host of new test instruments. You may not need a VTVM, an oscilloscope, or a sweep generator to service successfully a radio receiver; but you do require these instruments for television servicing if you expect to do a competent job. Because of this, thousands of men have gone out and purchased suitable VTVM's, scopes, and generators. Mere possession, however, does not assure proficiency. As a result there are many service shops owning beautiful instruments which are seldom used because the men are frankly afraid of them. This is not physical fear, of course, but technical fear. The instruments may be too complex to use — perhaps there are too many dials to twist, knobs to turn, or switches to set. So far as accuracy, refinements, and design are concerned, the instrument may be the leader in its field. But if you find the unit too difficult to use, then all this accuracy, refinement, and design are of little avail.

The desire to own the best is a creed that has been instilled in us by the very devices we help to keep in operation. It is a commendable desire, but it must be tempered by the ability to use the instruments and to interpret what they tell. When you fail to understand them, they lose their intended usefulness.

Incidentally, many parts jobbers can offer you considerable assistance in becoming acquainted with a new instrument. There are some who will sell an instrument with the understanding that it can be returned (possibly in exchange for another unit), if you have any trouble working with it.

At the risk of offending some people in the industry, this writer would like to point out that in far too many instances the manual that comes with an instrument is more of an obstacle than a help in learning how to use the device. The manufacturer will look far and wide for a top-notch design engineer, and when he finds one he will give him full authority to design a really fine instrument. Research cost will run into the tens of thousands of dollars, and the engineer may do a truly tremendous job. Then, because it is a "necessary evil," the boss will tell Joe (the chief engineer) to go ahead and write the manual for his "baby." After all, who should know this gem better than Joe? "He designed it, didn't he?"

Joe can design, but the trouble is that he cannot write. In fact, he hates writing, and the manual he turns out only verifies it. Or, he may have one of his assistants do the job, begrudging every minute that the writing takes this man away from his engineering work. Whoever does it, the result is sometimes a $200 instrument with a 10¢ manual.

Exaggeration? Not so much as you think! Look at some of the so-called manuals you get with test instruments. Sometimes the sales department gets into the act, and then you get all kinds of modernistic designs. But the "meat" of the manual, the step-by-step instructions, remain sacredly untouched. This is Joe's work, and who is going to quarrel with Joe?

In no other phase of service work is the instruction manual so vital to the proper use of the instrument with which it comes. It is truly the bridge between the tinkerer and the artisan, between the man who gropes and the man who knows. Yet there are still many test-instrument manufacturers who do not recognize that technical writing is as much of a specialty as design engineering and that a good writer is as difficult to find as a good design engineer. You have to have a feeling for writing just as you have to have a special kind of sixth sense for design. The fact that you can speak English and know something of grammar no more signifies that you are a good writer than knowing a group of formulas qualifies you as an expert design engineer. Words or formulas are only the tools. It is then up to the individual to take these tools and fashion his product.

Mr. Manufacturer, this is a plea for better instruction manuals. If you have a good one, try to make it better just as you continually strive to improve the instrument itself. If your manual is poor, rework it with competent help.

Remember! the instrument frequently fares no better than the manual that comes with it.

Checking Signal-Generator Performance

A great deal of the usefulness of an AM signal generator lies in its accuracy. In this respect, most manufacturers indicate the accuracy of an instrument in the specification sheet. In moderately priced equipment, a common value is 1 per cent. This means that when the unit is properly calibrated, the output frequency as indicated on the generator dial will be within 1 per cent of the frequency of the voltage that appears across the output terminals. Thus, if the dial is set for 50 mc, the frequency of the output voltage will be within 1 per cent or ±.5 mc of this value.

The 1-per-cent figure, however, is no assurance that the frequency calibration will remain as set. In time, variations in component values, changes in tube emission, or fluctuations in voltage may cause the frequency of the oscillator to change and the 1-per-cent relationship will no longer hold. In fact, under some conditions you may find the frequency off by as much as 10 per cent or more.

* * Please turn to page 56 * *

COLOR TV TRAINING SERIES

PART II
THE COLOR PICTURE SIGNAL

by C. P. Oliphant and Verne M. Ray

The previous section (Part I) of this series dealt with the study of color. This section will discuss the make-up of the composite color signal. The requirements which must be met by the signal and the manner in which they are attained will be presented in a general manner first. Then a detailed coverage will be offered on each of the major processes which contribute to the make-up of the color signal. These major processes are interleaving, divided-carrier modulation, and color synchronization.

REQUIREMENTS OF THE SIGNAL

There are a number of requirements of the composite color signal; since not only must it carry color information, but it must be compatible with the long-established system of black-and-white television. In other words, the signal must be such that it can be received on a monochrome receiver in black and white without any modifications or additional adjustments in the receiver. In addition, the color information in the signal must be conveyed in such a manner that it does not appreciably affect the quality or type of picture reproduced by the monochrome receiver tuned to the color signal.

The signal must represent the scene according to its color, and the colors must be transmitted in terms of the three chosen primaries — red, green, and blue. By some means, the three physical aspects of brightness, hue, and saturation must be conveyed by the signal for each color in the scene, because the eye sees colors in terms of these aspects.

HOW THE REQUIREMENTS ARE ATTAINED

In order to make the color system compatible, the specifications of the standard black-and-white signal had to be retained. This meant that such things as the channel width of 6 megacycles, the aspect ratio of 4 to 3, the number of scanning lines at 525, the horizontal- and vertical-scanning rates at 15,750 cps and 60 cps respectively, and the video bandwidth of 4.25 mc had to remain the same within narrow tolerances. To these basic specifications, color information has been added.

Even though the same specifications were retained, the system would not be compatible if it did not contain information about changes in brightness. A black-and-white receiver needs this brightness signal in order to reproduce a picture; therefore, to satisfy this requirement, a signal which is representative of the brightness of the colors in the scene is transmitted together with the color information. This brightness signal is very much the same as the video signal in the standard black-and-white transmission, and it is referred to as the luminance signal. It is transmitted by amplitude modulation of the picture carrier in such a manner that an increase in brightness corresponds to a decrease in the amplitude of the carrier envelope.

Putting color information in the allotted channel of 6 megacycles created a difficult problem, since the chrominance signal had to be transmitted along with the brightness signal. Color had to be included without objectionable interference to the brightness signal. This was accomplished by proper placement of the color information in the video-frequency band and by limitation of the amount of color information to be transmitted.

The signal which carries the color information is called the chrominance signal. It is included within the 4.25-mc video band by interleaving it with the brightness signal. The energies in the black-and-white picture signal are grouped at certain intervals; therefore, when color information is added, it is placed between these groups by the interleaving process.

A subcarrier is employed to interleave the chrominance signal with the luminance signal. The frequency of the subcarrier was so chosen that the information it conveys falls in intervals between groups of brightness information which is carried by the video carrier. The subcarrier frequency is high enough in the video band that the color sidebands, when they are limited to a certain bandwidth, do not interfere with the brightness information. The interleaving process and the subcarrier will be covered in detail later in this discussion.

The color information has to be transmitted in terms of the primary colors — red, green, and blue. It cannot be transmitted by three separate signals each representing a primary color, because a channel of at least 12.75 mc would then be required. Since this would take away the idea of compatibility, the colors had to be represented by some other means.

This is done by combining the color information into two separate color signals. Three signals which represent red, green, and blue are first obtained; and then the brightness of these signals is taken for use in forming the luminance signal. This leaves what are referred to as color-difference signals. These color-difference signals are then proportionately mixed together to form the two color signals which are used to modulate the color subcarrier.

A method of modulation known as divided-carrier modulation may be employed in order to place two different signals upon the same carrier. Through the use of this method, the subcarrier is effectively split into two parts and each portion of the subcarrier is modulated separately. Then the two portions are combined into a resultant chrominance signal. This signal varies both in amplitude and phase, and it is one of those signals which modulate the transmitted picture carrier. A change in amplitude of the chrominance signal represents a change in saturation, whereas a change in phase represents a change in hue.

A reference signal of the same frequency as the subcarrier is transmitted in the composite color signal. This reference signal, called the color burst, is trans-

mitted at a fixed phase angle and is employed by the color receiver in order to detect properly the color information.

In analyzing the major portions of the composite color signal, we see that a signal which is representative of the brightness is transmitted. This signal is called the luminance signal. There is also a chrominance signal which contains only color information. A color-reference signal is transmitted along with the conventional blanking and sweep-synchronizing signals. Now, let us examine in greater detail the methods employed in making up the composite color signal.

THE INTERLEAVING PROCESS

The interleaving process, as mentioned previously, is employed in order to transmit the composite color signal within a channel no wider than that used for transmission of black and white. The use of this process was a great help toward formulating the compatible color system that was adopted by the FCC for the transmission of color information.

It was not known how to make the color system compatible until a discovery by Pierre Mertz and Frank Gray was taken into consideration.* Their studies concerning the scanning process used in telephotography and television proved that the energy produced by scanning an image concentrates at specific intervals in the frequency spectrum. It was further shown that these points of energy concentration occur at frequencies computed as whole multiples of the scanning rate. The actual proof of this phenomenon involves a series of complicated mathematical formulae not practical to reproduce here, but a more or less general idea of the reasons for such energy concentration is presented in order to help the service technician to understand the interleaving process.

A mathematical solution would show that any video signal produced by scanning an image contains an infinite number of pure sine waves. As an example, waveform E in Fig. 2-1 can be matched by combining waveforms A, B, and C. If the eighth harmonic is added to waveform E, the waveform shown at F will result. Note that each of the pure sine waves is either the fundamental or a harmonic of the recurring rate of waveforms E and F. Although more complex than waveform E or F, every video waveform contains an infinite number of pure sine waves each of which is the fundamental or is a harmonic of the recurring rate of the waveform.

The monochrome video waveform shown in Fig. 2-2 contains an infinite number of sine waves which are at multiples of the fundamental frequency of the entire waveform. Because this fundamental frequency is determined by the rate of scanning, it can therefore be stated that a video waveform produced by scanning an image at a constant rate will contain an infinite number of sine waves which are harmonics of the line-scanning frequency. If the waveform shown in Fig. 2-2 were followed through several successive scanning lines, there would be very little change in its composition. Thus, this waveform is a function recurring at the line-scanning frequency. It follows that for an image which is not moving rapidly, the waveform of a particular line will be repeated during the scanning of each successive frame; therefore, the wave-

* * Please turn to page 71 * *

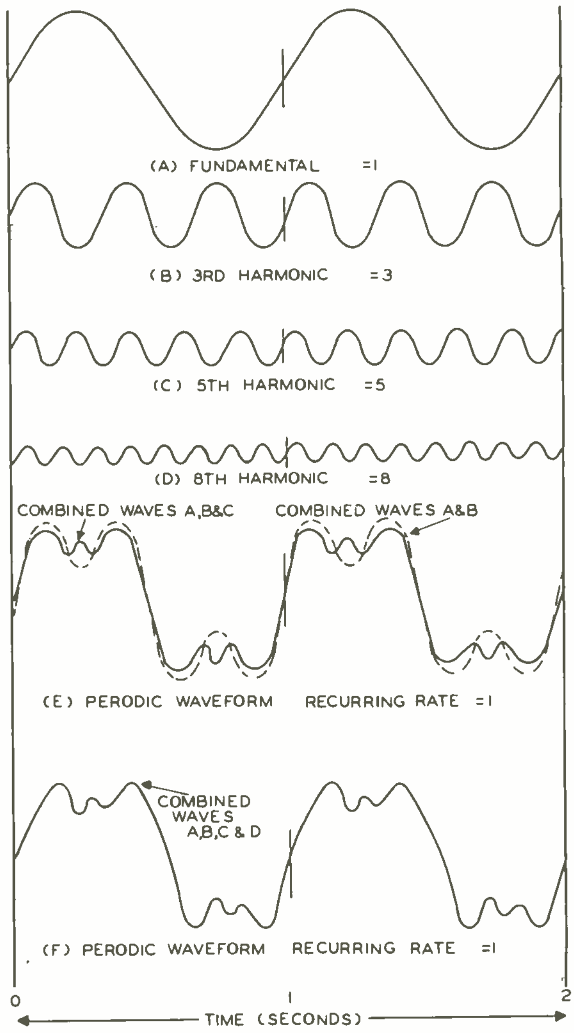

Fig. 2-1. Sine-Wave Components of a Periodic Waveform.

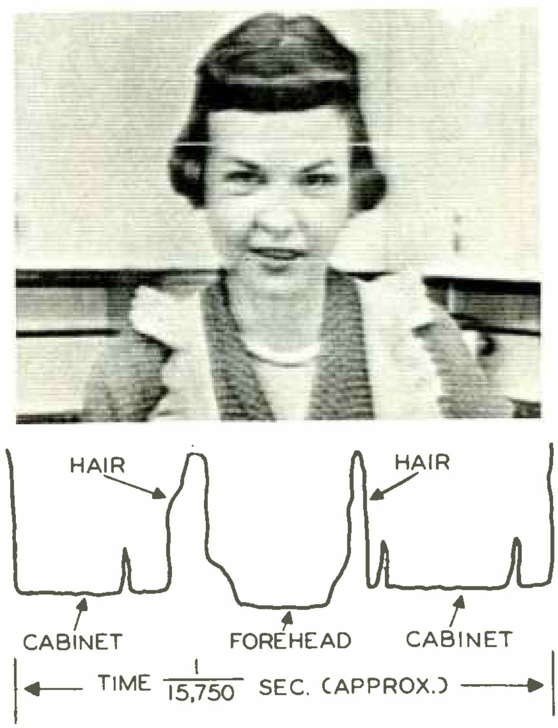

Fig. 2-2. Complex Waveform of Video Voltage Produced by Scanning One Line in the Televised Scene. (Photographed With Permission of WFBM-TV.)

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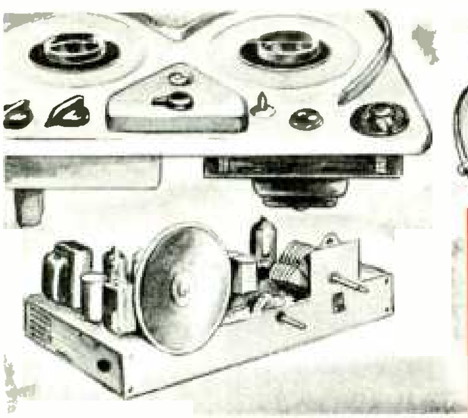
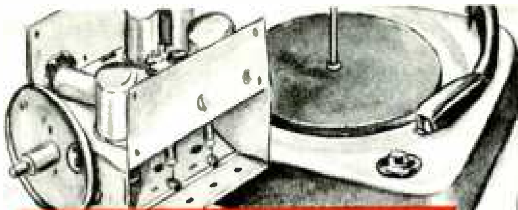
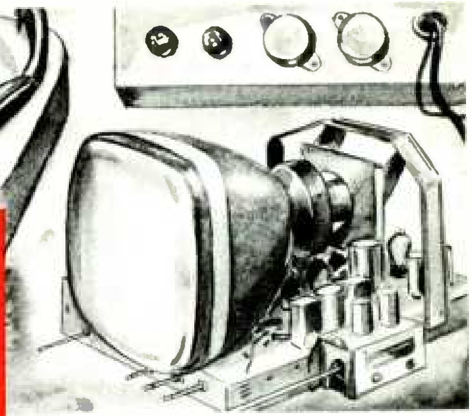
* Pierre Mertz and Frank Gray, "A Theory of Scanning and Its Relation to the Characteristics of the Transmitted Signal in Telephotography and Television," The Bell System Technical Journal, Vol. XIII, No. 3, July 1934.







Examining DESIGN Features

by DON R. HOWE

WESTINGHOUSE CHASSIS V-2260-14

Tuner

The Westinghouse Chassis V-2260-14, shown in Fig. 1, employs a 12-position turret type tuner V-12415 to cover the VHF channels 2 through 13. This tuner is mounted on the side of the chassis as in previous Westinghouse models. The RF amplifier may be either a 6BZ7 or a 6BQ7A. This tube is connected in a cascode circuit. AGC voltage is applied to the grid of the input stage and controls the amplification. The RF signal in the output of the RF amplifier is coupled to one of the triode sections of a 6J6 where it is mixed with the signal from the local oscillator. The other triode section of the 6J6 functions as the oscillator. The frequency of this oscillator is adjustable on each channel by means of a movable slug on the channel strips. This slug is accessible from the front of the receiver cabinet when the channel-selector knob is removed. The IF signal from the mixer is then coupled to the IF stages.

UHF strips may be installed in this tuner to provide operation on the UHF channels.

Video IF

There are three stages of video IF in this receiver. Each stage utilizes a 6CB6 as the IF amplifier. The input circuit to the grid of the first IF amplifier contains a 41.25-megacycle trap. This is the frequency of the sound IF. The output of the first stage is transformer coupled to the grid of the second amplifier. A trap which is resonant to the sound IF of the adjacent channel is connected between this grid and ground. The frequency of the sound IF signal of the adjacent channel is 47.25 megacycles. The over-all gain of the first and second IF stages is controlled by the level of AGC voltage that is applied to their grids. Double-tuned IF transformers are used for coupling between all stages of the IF strip. The output of the third IF amplifier is fed to the video detector. The general design of this section of the receiver follows the conventional line and does not depart appreciably from that used in former models.

Video

Video detection is accomplished by a CK706-1N64 crystal diode. This diode is placed in series with the signal path to the video amplifier. A pi-network is incorporated in the output of the video detector for purposes of RF filtering. Two peaking coils are contained in the grid circuit of the 6BK5 video amplifier. The value of the peaking coil in series with the grid is 50 microhenries. A 250-microhenry coil is placed between grid and ground. Peaking coils of 140 and 500 microhenries are inserted in the plate circuit of the video amplifier. The video signal is then applied to the cathode of the picture tube, a 17BP4 or a 17LP4, through the contrast control. A 4.5-megacycle trap is also placed in this circuit.

The brightness control and the focus control form a part of the picture-tube circuitry. All of these controls are available from the front of the receiver with the exception of the focus control which is located on the rear of the chassis.

Sound

The signal appearing at the plate of the video amplifier is fed directly to the FM detector through a 3.3-mmf capacitor. Detection of the FM signal is accomplished by a 6BN6 gated-beam discriminator. The resistance from the cathode of the 6BN6 to ground is adjusted by the "Quieting Control." This control determines the operating point of the tube and sets the limiting action for maximum rejection of amplitude modulation of the FM signal.

A 6BK5 provides the amplification necessary for driving the speaker.

Sync System

A composite video signal from the plate circuit of the video amplifier is fed to the grid of the sync separator. See Fig. 2. A 6AU6 is used in this stage. The sync pulses appearing in the plate circuit of this stage are fed to the sweep stages. Noise immunity is provided in conjunction with the sync separator. A triode section of a 12AU7 is used in this application and is connected as a

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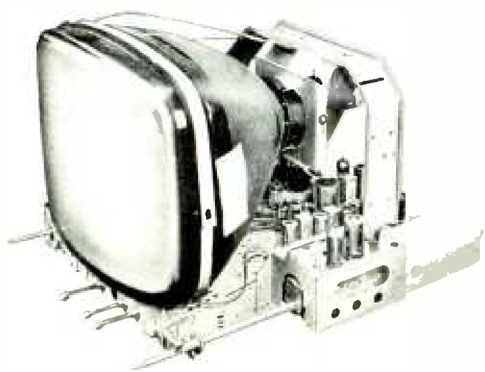

Fig. 1. The Westinghouse Chassis V-2260-14.

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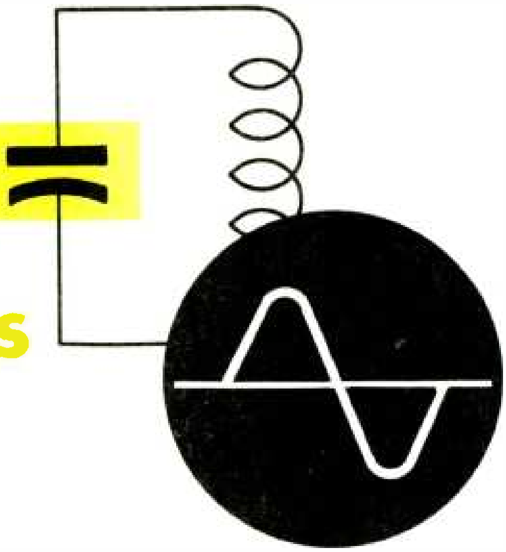


Part III

Alignment and Servicing Methods

by PAUL C. SMITH

Alignment of the sound IF portion of the television receiver can usually be considered as divisible into three distinct steps: (1) the sound take-off, (2) the IF strip, and (3) the detector. In many receivers where the sound take-off also serves as a sound IF trap in the video circuit, its function as a trap is considered first; and adjustment is made for minimum sound interference in the picture rather than for maximum sound output. Usually this adjustment is not critical, and correct adjustment for one condition will automatically result in satisfactory adjustment for the other.

It should be obvious that the use of good quality test equipment will make alignment easier and more accurate. The input impedance of oscilloscopes and VTVM's should be high enough to avoid loading of any tuned

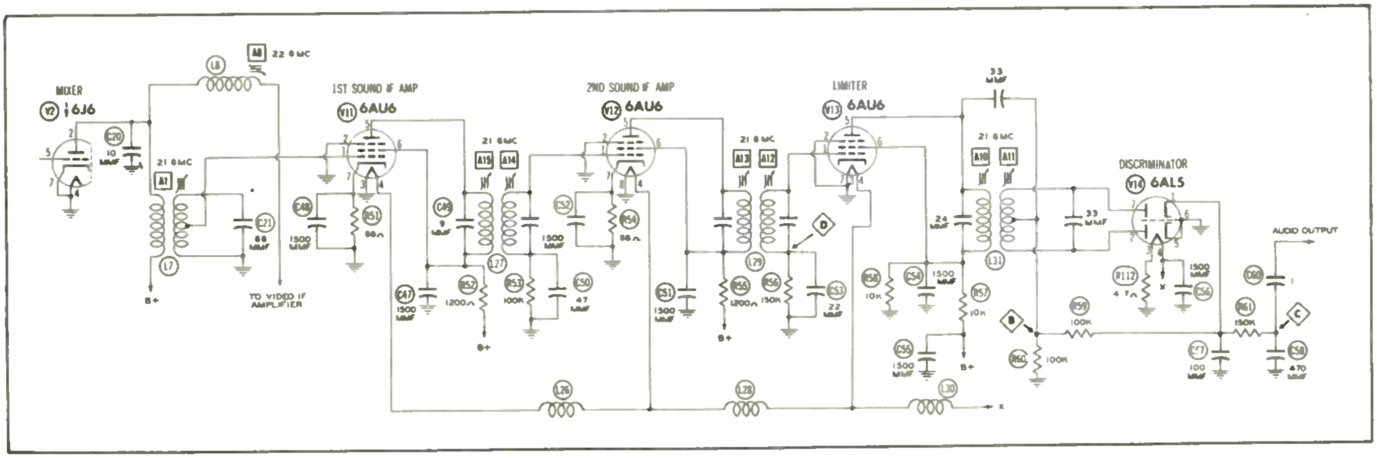


Fig. 10-20. Partial Schematic Showing Conventional Separate-Sound IF System.

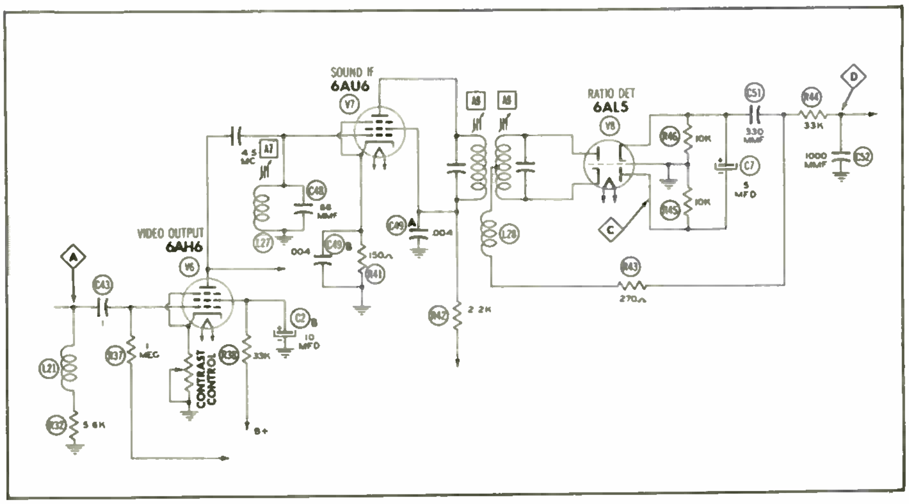


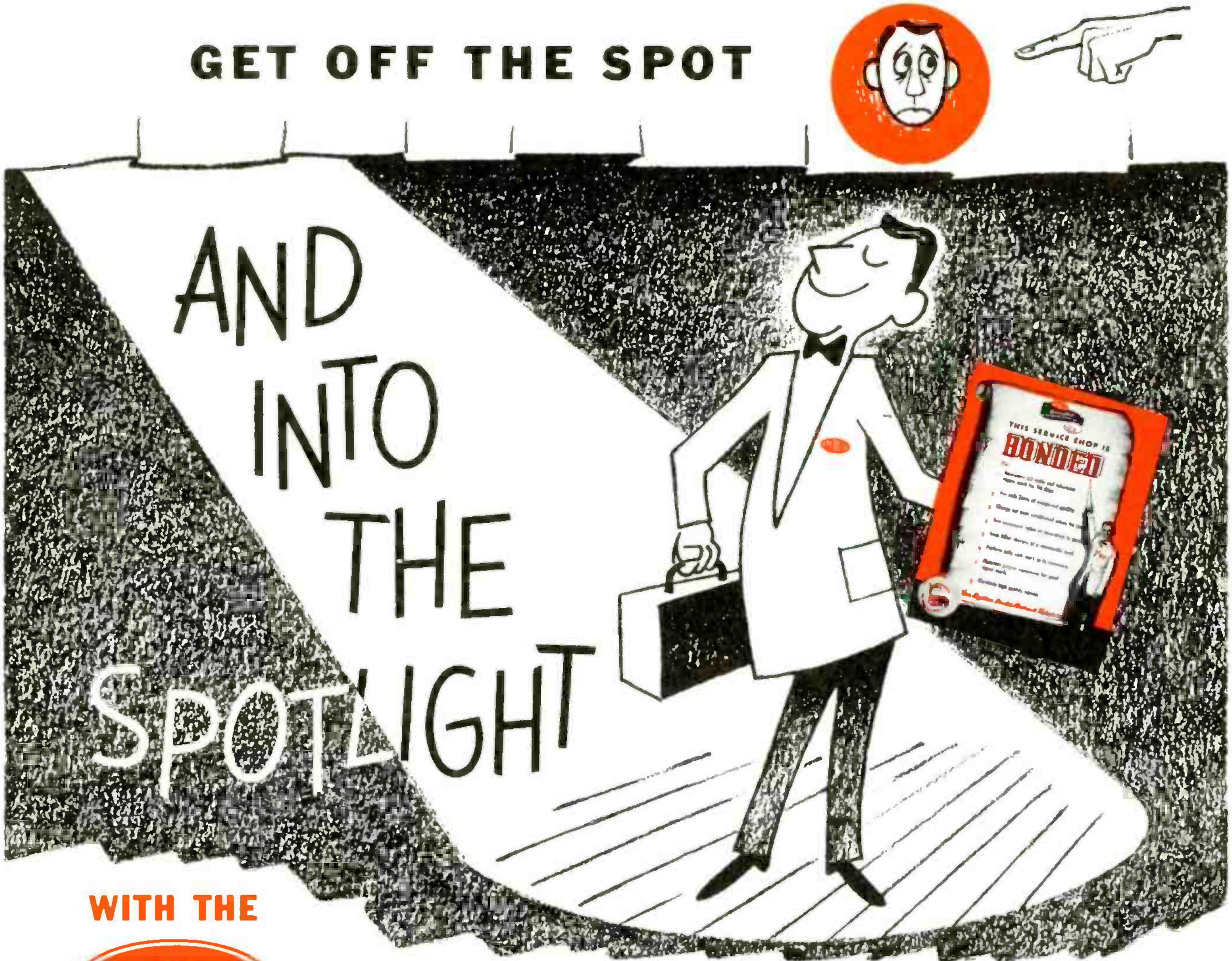
Fig. 10-21. Partial Schematic Showing Conventional Intercarrier Sound IF System.

circuits to which they might be attached; and, if necessary, the use of isolating networks is recommended.

Sweep and marker generators should provide the desired frequencies with a high degree of accuracy. If a strong, steady TV signal is available (such as a tone-modulated test pattern), a very satisfactory sound alignment can be performed on many receivers using this signal source.

Generator output levels should be kept low enough to avoid overloading amplifier stages because the resulting indications might be misleading and might prevent accurate alignment.

* * Please turn to page 41 * *



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Notes On TEST EQUIPMENT

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

by Paul C. Smith

Localizing Defects in Antenna Lead-Ins

The radio and television service technician can find many uses for that type of instrument commonly called the grid-dip meter. Operators of amateur radio transmitters have long been aware of its virtues; and such instruments can be useful to the service industry, as pointed out from time to time in published articles and in bulletins issued by manufacturers of this equipment. Faults in TV antenna leads or transmission lines can be easily located by the method to be described.

A long antenna lead may become shorted or open because of wear from exposure to the elements, or it may work loose at the antenna connections. An ohmmeter check may or may not give a conclusive indication, depending upon the type of antenna array in use. For example, when testing an installation employing an antenna having continuity between the driven elements of the array, an ohmmeter would show an open circuit in the lead-in but would give no indication of a short near the array. For the other case in which there exists no normal continuity, an ohmmeter check would indicate a short circuit but not an open circuit. The grid-dip meter will give an indication in either case, and the distance to the fault can be determined with reasonable accuracy without the necessity of taking down the antenna or climbing a tower. If the defect should prove to be located at the top of the installation, the technician would still have to take the time and trouble to reach and repair it: but if it is found to occur somewhere near the ground level, a great deal of unnecessary work may be avoided.

When a grid-dip meter is inductively or capacitively coupled to one end of a transmission line and the meter frequency is varied through a suitable range, a series of dips in the meter reading may be noted. If the other end of the transmission line is shorted, these dips will occur at frequencies at which the line is electrically one-half wavelength or some multiple thereof. If the other end of the transmission line is open, the dips will occur at frequencies at which the line is electrically some odd multiple of a quarter wavelength.

To give an example for each case, the dip readings for a shorted transmission line might read as follows: 5 mc, 10 mc, 15 mc, 20 mc, and so on. If the same transmission line were then shorted at the opposite end from the meter, the readings would be 2.5 mc, 7.5 mc, 12.5 mc, 17.5 mc, and so on. In both instances, the difference between any two readings is the same, namely 5 mc; and this difference is the frequency at which the line in question is electrically one-half wavelength. To obtain the physical length of the line, only a simple calculation is needed using the following formula:

$$D = \frac{V}{2(f_2 - f_1)} \qquad (1)$$

where

D = the distance to the end of the transmission line, if no defect exists,

V = the velocity of propagation along the transmission line,

f_1 and f_2 = any two successive dip readings of the meter.

If V is expressed in feet per microsecond and if f_1 and f_2 are in megacycles, the result D is in feet. The velocity of propagation of radio waves in free space is approximately 984 million feet per second, or 984 feet per microsecond. The value V (or VP, as it is commonly listed by manufacturers) for different types of transmission lines is a certain percentage of 984, and it is this percentage alone that is listed by the manufacturers with the understanding that it must be multiplied by 984 to obtain the true V for the line in question.

Assume that the readings quoted in the preceding example are for a line with a VP of 85 per cent. Substituting in the formula we obtain:

$$D = \frac{984 \times .85}{2 \times 5},$$

$$D = 83.64 \text{ feet.}$$

A number of experiments were conducted to determine the accuracy to be expected from this method. Several lines were measured through use of the grid-dip meter, and the results were compared with direct measurements of the same lines. Fig. 1 shows the method used to couple the meter to the line being measured. Several readings were taken, and the resulting differences between the readings were averaged, thus decreasing the chances for error.

In one experiment, a 35 1/2-foot length of tubular twin lead was

• • Please turn to page 60 • •

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TV COLORMATH

by HAROLD E. ENNES

The Mathematical Foundations Upon Which the Color TV System Operates

PART III

Bandpass and Delay Sections

Part of the FCC Standards specify that E_Y, E_Q, and E_I, and the components of these signals shall match each other in time to 0.05 microseconds.

These standards assume that a picture element is one-tenth microsecond. Thus, the relative timing of luminance and chrominance sideband frequencies is maintained within one-half a picture element, or 0.05 microseconds. This is for the range of frequencies close to the chrominance-subcarrier frequency. At frequencies in the spectrum approximately 0.6 mc away from the color-carrier frequency, a tolerance of one picture element (0.1 microsecond) is allowed.

From previous discussion, we know that the luminance and chrominance signals are transferred through circuits of differing bandwidths. The Y channel is wideband. The I channel is much narrower and employs the vestigial-sideband technique as does the Y channel. The Q channel is still narrower. Without compensation at both the transmitter and the receiver, the narrow-bandwidth signal components would lag behind the wider-band components, because filters delay the envelope of frequencies. Such misphasing results in poor transient response and causes color fringing on edges of colored objects. The effect is more apparent to observers of a color picture than is the case for monochrome.

This subject is illustrated by Fig. 10A. Since delay is a function of the associated bandpass filters at the sending and receiver ends, the I channel is delayed from Y, and the Q channel suffers the most delay. Delay lines are used in the receiver to bring all channels into time coincidence, as shown in Fig. 10A. (The locations of these delay lines are shown in a block diagram which will be presented later in our discussion.)

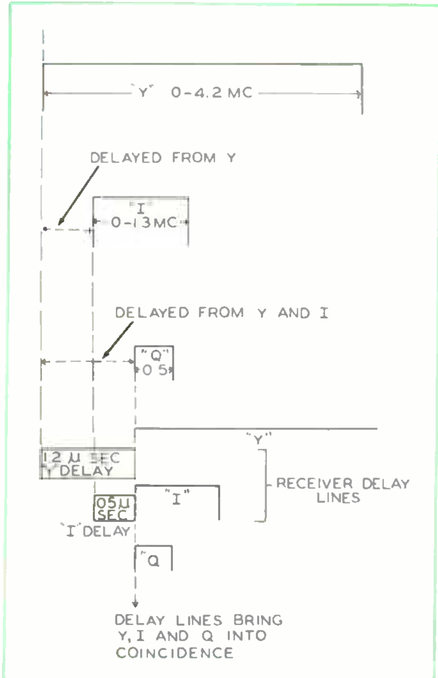

Fig. 10A. Time-Delay Requirements of the Y and I Delay Lines.

Delay lines consist either of lumped inductances and capacitances or a helix cable. The number of sections determines the amount of signal delay. The longest line is therefore found in the luminance (Y) channel. Amounts of delay shown by Fig. 10A are approximate, since they are a function of the particular receiver design. Delay lines must effectively delay the entire envelope of frequencies; hence, they must not offset frequency response of the band concerned.

The transmitter attenuation of the lower sideband (in vestigial-sideband transmission) and the receiver low-frequency cutoff (amplitude response which is 50 per cent of unity at video carrier frequency) result in envelope delay. Phase-correction circuits are incorporated at the transmitter to compensate for this source of phasing error.

The output of the video detector feeds both the luminance amplifiers and a chroma bandpass amplifier, as shown by Fig. 10B.* Detection is illustrated for green, red, and blue

* Many receivers drive the chroma bandpass amplifiers from the output of the first video amplifier stage.

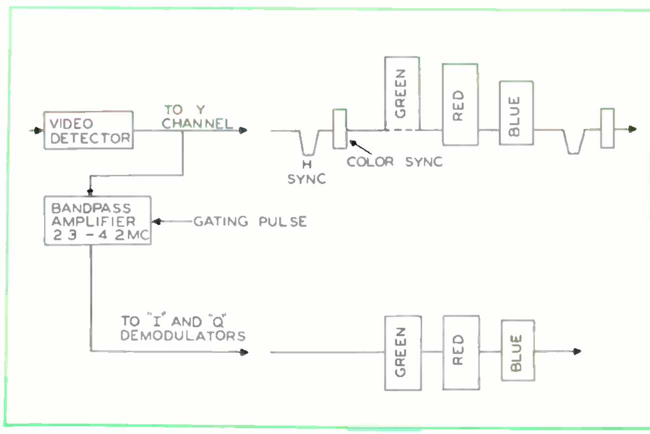

Fig. 10B. Filtering Action of the Bandpass Amplifier. H and V Sync Pulses Plus Low-Frequency Components Are Eliminated.

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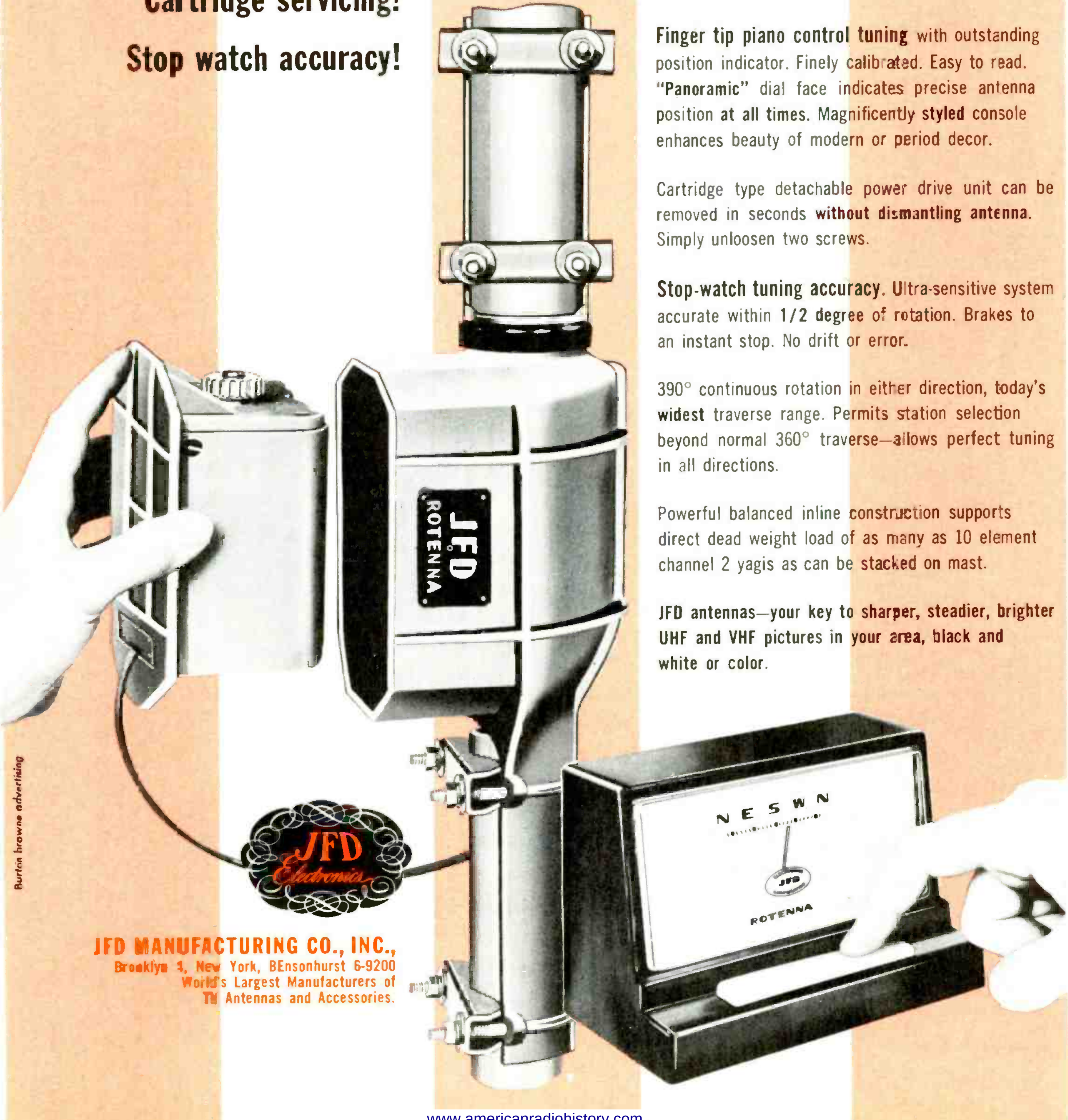

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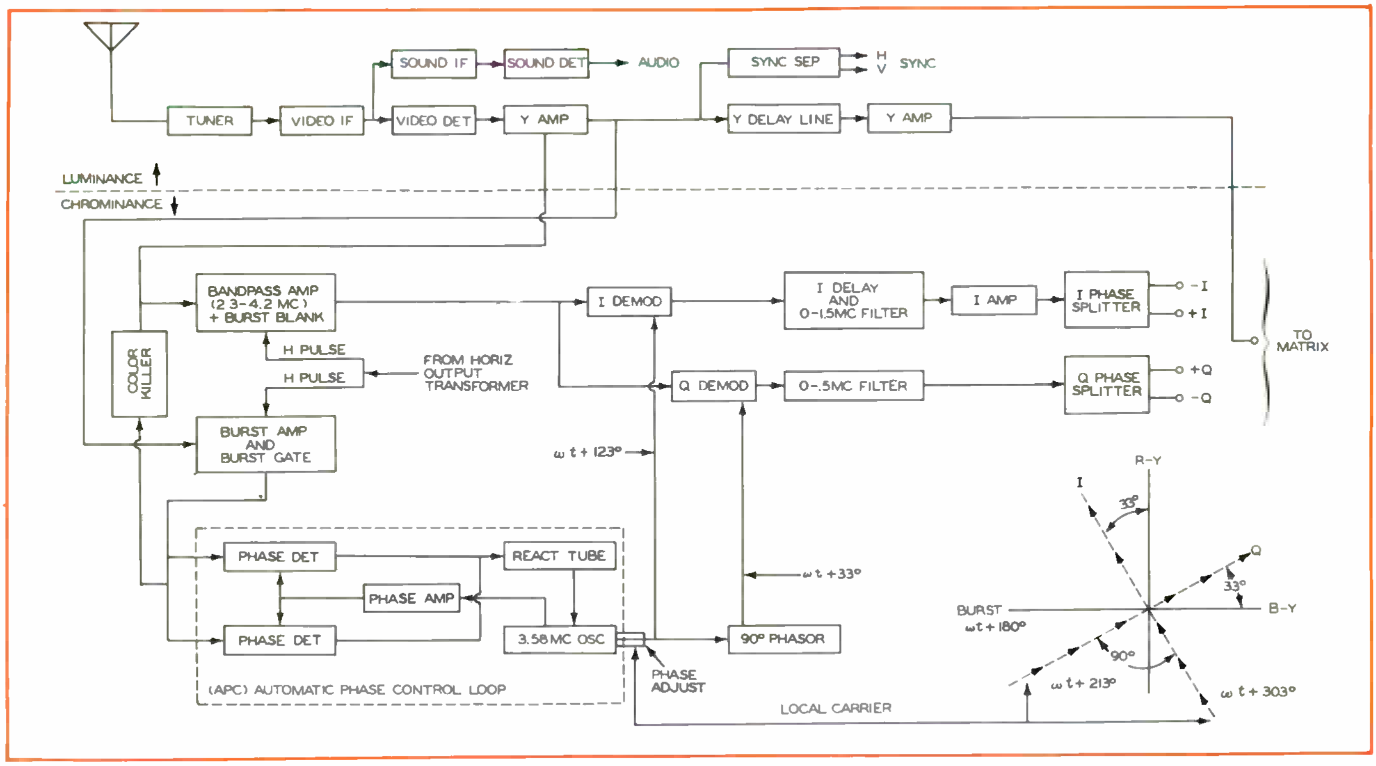

Fig. 11A. A Wideband Color Receiver Which Demodulates on the I and Q Axes.

color bars. The bandpass amplifier will pass those frequencies between approximately 2.3 mc to 4.2 mc. This eliminates the lower-frequency Y components including H and V sync pulses and passes the region around the chrominance-carrier frequencies, including the higher frequencies in the Y signal. The higher frequencies that are passed from the luminance channel are removed by filters in the load networks of the I and Q demodulators.

Chroma Demodulation

Figs. 11A and 11B show the two general types of color receivers analyzed in this section. Fig. 11A illustrates the blocks of a wideband (I and Q demodulation) receiver. Fig. 11B shows blocks of a narrow-band (R - Y and B - Y demodulation) receiver. We will analyze Fig. 11A first.

The blocks at the top indicate conventional monochrome receiver circuits. Two important differences exist in this section for a color receiver.

1. The video IF amplifiers should have a bandwidth to 4.2 mc. This is considerably greater than the nominal 3.5-mc bandwidth employed in monochrome receivers.

2. The sound signal take-off is from an IF amplifier stage. The signal is taken off at a point following video detection in monochrome intercarrier receivers.

The first difference is apparent in that color sideband information and color sync burst (3.58 mc) would be restricted with less bandwidth. In the bandpass amplifier for the chroma section, color receivers will employ peaking circuits as well as extended IF response.

The second difference is required in a color receiver to obtain sufficient sound signal voltage, since the ratio of sound carrier to picture carrier must be more greatly attenuated at the video detector* in color receivers than in monochrome receivers. The ratio of the video carrier to the sound carrier should be 40 db or more. This is necessary to minimize the 920-kc beat between the sound-carrier and the color-subcarrier frequencies. The presence of this beat influenced greatly the final choice for the color-subcarrier frequency. The rapid attenuation between 4.2 mc and 4.5 mc in the video amplifiers at the receiver then maintains freedom from this beat which would

* * Please turn to page 53 * *

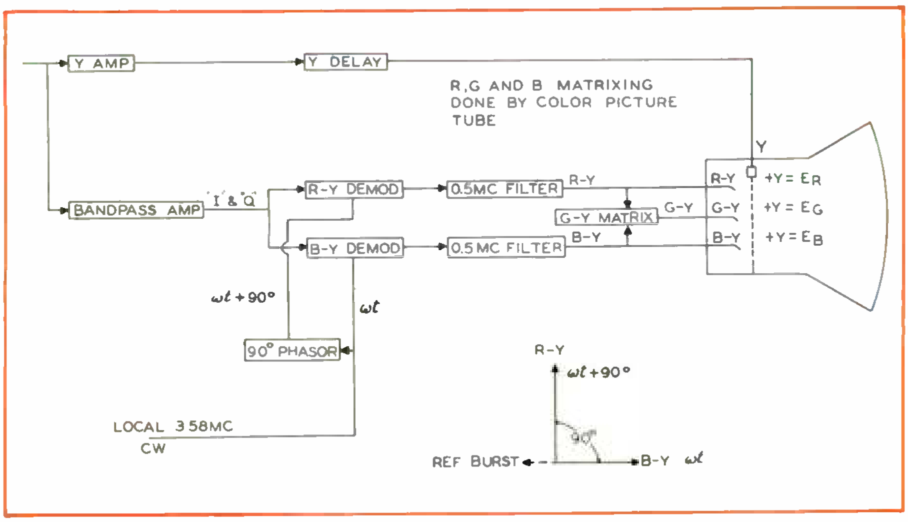

Fig. 11B. A Narrow-Band Color Receiver Which Demodulates on the R-Y and B-Y Axes.

* In some receivers, this attenuation takes place in the first video amplifier stage.


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The AMPEX TAPE RECORDER Model-350

DESCRIPTION OF CIRCUITRY AND MECHANISM

by
Robert B. Dunham

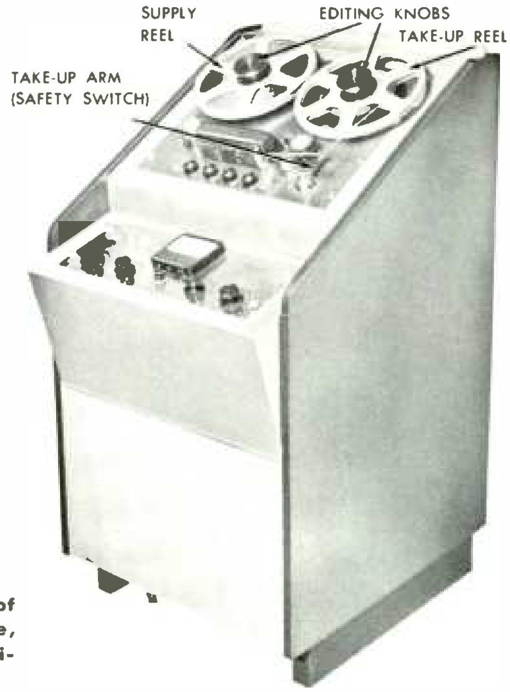

Fig. 1. Front View of Complete Console, With Tape in Position.

The Ampex Model 350 is a professional type magnetic-tape recorder capable of producing high quality results consistently with outstanding ease of operation. A description of the Model 350 and some discussion of its features should prove very interesting to both the professional and the amateur, for the qualities that make it an excellent professional tape recorder also make it particularly suitable for use by the high-fidelity enthusiast.

The specifications and operational characteristics of this unit are doubly interesting. They show why the unit is capable of producing high quality results and also illustrate some of the standards of performance and operation that must be met in order for the recorder to qualify as professional equipment. Some of the most important specifications are as follows:

1. Tape Speed.

The Model 350 is available in two tape-speed ranges:

a. One range with speeds of 15 and 7 1/2 inches per second.

b. The other range with speeds of 7 1/2 and 3 3/4 inches per second.

2. Half or Full Track.

The unit is available with either half- or full-track heads.

3. Frequency Response.

Frequency response at the different tape speeds is as follows. For a tape speed of 15 inches per second, the response is ±2 db from 30 to 15,000 cps. For a tape speed of 7 1/2 inches per second, two frequency response ratings are specified. They are ± 2 db from 40 to 10,000 cps and ±4 db from 30 to 15,000 cps. For a tape speed of 3 3/4 inches per second, the response is ±2 db from 50 to 7,500 cps.

4. Flutter and Wow.

The total flutter and wow are rated at not more than 0.2 per cent at a tape speed of 15 inches per second, not more than 0.25 per cent at 7 1/2 inches per second, and not more than 0.3 per cent at 3 3/4 inches per second.

5. Starting Time.

The tape attains full speed in less than 1/10 second, which can be considered as being instantaneous.

6. Stopping Time.

When operating at 15 inches per second, the tape moves less than two inches after the stop button has been depressed.

7. Accuracy.

Playback time is within ±0.2 per cent (or ±3.6 seconds) for a 30-minute recording.

8. Rewind Time.

A full 2,400-foot NARTB reel is rewound in approximately one minute.

9. Record Input.

Any low-impedance microphone (30 to 250 ohms) can be plugged directly into the input connector. A high-impedance microphone (if one must be used) can be plugged into the input, if the circuit is modified to accommodate it. Normal studio lines can be connected to the input connector as can high-impedance unbalanced sources such as radio tuners.

10. Playback Output.

The playback output connector will feed directly into a balanced or unbalanced 600-ohm line or can be connected to a high-impedance amplifier input, if the connecting plug is wired to accommodate it.

This is by no means a complete listing of specifications, but it does give some idea of the capabilities of the unit which will be described in more detail in succeeding paragraphs.

The Ampex Model 350 is available in three forms:

a. The Model 350C Console, as shown in the illustrations.

b. The Model 350R Rack Model on standard rack panels for mounting in a rack.

c. The Model 350P Portable Model contained in two cases.

The Model 350C will be discussed, but all models are basically the same with the exception that each

* * Please turn to page 33 * *

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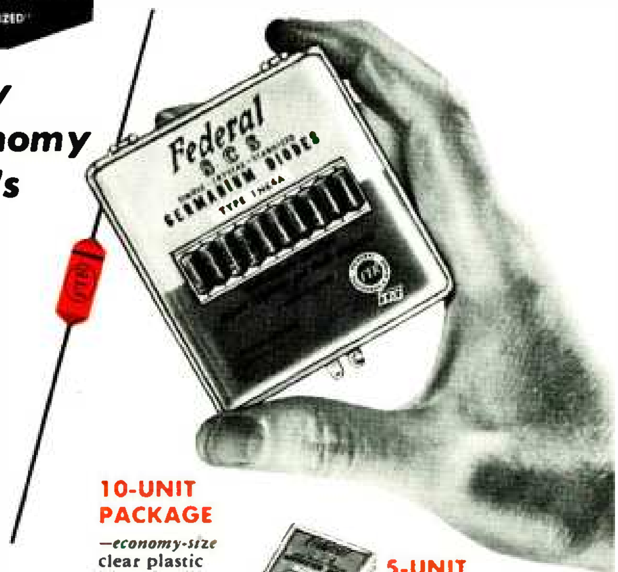

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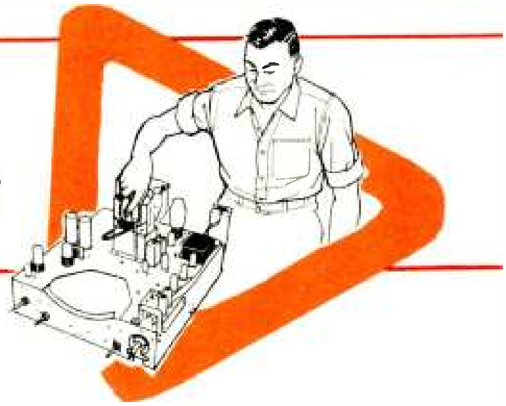

by **Henry A. Carter** *and* **Calvin C. Young, Jr.**

IN THE HOME

Selenium Rectifiers and Filament-Dropping Resistors

In an effort to reduce the cost of television receivers without sacrifice of picture quality or receiver sensitivity, many manufacturers have seen fit to employ a voltage-doubler type of low-voltage power supply using selenium rectifiers. The cost of the power transformer has thus been eliminated. Sometimes a small filament transformer is used to supply 6.3 volts AC to the filaments of the set, as in the case of some of the models of Crosley, Motorola, and Philco receivers. In other instances, series-filament strings have been employed. Where series-filament strings have been used, some manufacturers have incorporated negative temperature-coefficient resistors into the filament strings. These resistors serve a dual purpose. First, they protect the tubes against the surge current that occurs when AC power is first applied; and second, they act to reduce and equalize the voltage available for the filaments.

It has been this writer's experience that receivers which incorporate the aforementioned type of power supply and which have seen a considerable period of service may require the replacement of either the selenium rectifiers or the filament-dropping resistors; or, in some cases, both may have to be replaced.

Although the replacement of these units usually necessitates the removal of the chassis from its cabinet, the remainder of the operation is quite simple and requires only a short time and a minimum of equipment. At times it is convenient to perform this service job in the customer's home. The convenience factor is greatest when large consoles are encountered or when the customer's home is a considerable distance from the shop. In anticipation of this type of field service, some of the selenium rectifiers and filament-dropping resistors most often used were included in the basic tube-and-parts kit. These resistors plus the volt-ohm-milliammeter and drop cloth which are normally carried in the tube kit equip the technician for additional field servicing as cited in the following field experiences.

A recent service call comes to mind where the customer complained of a narrow and dim picture. The set involved was a Motorola that employed a voltage-doubler type of power supply and a small filament transformer. After the substitution of either the horizontal-output tube 6BQ6GT or the damper tube 6W4GT failed to correct the trouble, the B+ voltage was measured and found to be low.

The line voltage was measured next, and it was proved to be satisfactory. The resistance from B+ to ground was then checked to make sure no shorts existed. These tests narrowed the source of the trouble to the selenium rectifiers.

Replacement rectifiers of suitable value and size were selected from the parts kit. The drop cloth was laid over the floor, and the chassis was removed and placed on the cloth. A soldering gun was used for making the connections instead of an iron; it was used chiefly because the heating and cooling periods taken by a gun are shorter. The complete replacement operation required approximately 30 minutes.

In another field experience, the customer complained of no sound and no picture on a General Electric receiver. After removing the back and providing power to the set by means of a "cheater" cord, it was noticed that the filaments did not light. It was found by using the voltmeter that the filament-dropping resistor had opened. AC power was removed from the filament circuit, and the circuit was checked with the ohmeter to make certain no shorts existed. Since only the filament-dropping resistor had failed; a resistor of the proper value was selected from the parts kit and installed. As in the case of the rectifier replacement, a drop cloth was used to prevent dirt or hot solder from damaging the customer's rug.

Field replacement of selenium rectifiers and filament-dropping resistors calls for a wise selection of these units for inclusion in the parts kit. Table I is a list of the most frequently used selenium rectifiers.

The ratings of the filament-dropping resistors which are most often encountered are as follows:

1. Resistance 75 ohms, power rating 10 watts.

2. Resistance 20 ohms when hot, 250 ohms at room temperature.

3. Resistance 31 ohms when hot, 275 ohms at room temperature.

TABLE I

SELENIUM RECTIFIERS IN PARTS KIT

CURRENT RATING (ma)	FEDERAL	INTER-NATIONAL	MALLORY	RADIO RECEPTOR (SELETRON)	SARKES TARZIAN
300	1236	RS 300	6S300	6Q4	300
350	1238	RS 350	6S350	5QS1	350
400	1241	RS 400	6S400	5S2	400
450	1021	RS 450	6S450		450

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A LARGER AND EASIER READING SCALE FACE — The '120' gives you a new, extra-large 5¼" meter with full 4¾" extra-wide window for greater visibility.

SIMPLE, POSITIVE RANGE SELECTION — The '120' gives you an 18-position, positive-detenting, master range selector with low resistance, dependable, silver-plated contacts.

RUGGED, POSITIVE CONTACT JACKS and PLUGS — The '120' gives you specially designed, low resistance, solid brass, banana type plugs and jacks.

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★ **8 AC VOLTAGE RANGES:** 5,000 ohms per volt. 0-1.2-3-12-60-300-600-1200-6000 volts.

★ **8 AC OUTPUT RANGES:** same as AC volt ranges. With built-in 600 volts blocking capacitor.

★ **7 DC CURRENT RANGES:** 0-60-300 Microamperes. 0-1.2-12-120-600 Ma. 0-12 Amperes.

★ **5 RESISTANCE RANGES:** self-contained batteries. 0-200-2000-200,000 ohms. 0-2-20-megohms.

★ **8 DECIBEL RANGES:** from −20 to +77 DB. 0 DB = 1 Milliwatt, 600 ohms.

★ **EXTRA LARGE 5¼" RUGGED 'PACE' METER:** 40 microamperes sensitivity, 2% accuracy.

★ **1% MULTIPLIERS and SHUNTS:** wire-wound and high stability deposited-film types employed throughout.

★ **ONLY 2 PLUG-JACKS SERVE ALL STANDARD RANGES:** separately identified and isolated jacks provide for extra-high ranges.

★ **"TRANSIT" SAFETY POSITION:** on master range selector protects meter during transportation and storage.

★ **CUSTOM-MOLDED PHENOLIC CASE and PANEL:** set a new standard for compact, efficient, laboratory instrument styling. Deeply engraved panel characters afford maximum legibility throughout the life of the instrument.

MODEL 120: complete with internal ohmmeter batteries, banana-plug test leads and operating manual. Over-all case dimensions: 5⅜ x 7 x 3⅛" .... **Net Price: $39.95**

ACCESSORIES FOR THE MODEL 120

TV-2B — 30 kilovolt safety probe .... $14.75 net
LC-3 — Custom, leather instrument case .... 9.50 net
ST-1 — Snap-on foldaway tilt-stand .... 1.00 net

***PRECISION* Apparatus Company, Inc.**
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Export Division: 458 Broadway, New York 13, U.S.A. Cables: Morhanex
Canada: Atlas Radio Corp., Ltd., 560 King Street W., Toronto 28

4. Resistance 43 ohms when hot, 125 ohms at room temperature.

5. Resistance 19 ohms when hot, (room-temperature resistance is not listed).

The resistors listed under the foregoing items 1, 2, and 3 are most often used in General Electric receivers. The one listed under item 4 is used in some recent Crosley models, and that of item 5 is used in some Motorola models. Resistors under items 2, 3, 4, and 5 have negative temperature coefficients and are designed so that when cold they have a high resistance. When current is caused to flow through them, they heat up and their resistances decrease to the lower values indicated.

Some of the advantages that may be realized from the field replacement of selenium rectifiers and filament-dropping resistors can be listed as follows:

1. The time saved by the elimination of the trip to return the chassis will probably more than balance the time required to replace the units.

2. The time that would have been required to replace these units in the shop will be saved.

3. Customer relations are generally improved, since the set owner is not deprived of his set while it is undergoing repairs in the shop.

Special-Purpose Tools

While on a service call, have you ever experienced the annoyance of losing an oscillator slug in a Standard Coil tuner because you misjudged the tuning adjustment? The writer has had this happen to him, and consequently the discovery of a way to avoid this trouble was of considerable interest to him. The discovery was made in the showroom of a local parts distributor.

Walsco has produced an alignment tool which will not permit an oscillator slug to be turned far enough to become irretrievable. This tool (B in Fig. 1) has a main body with a diameter too large to enter the access hole of the tuner strip. The darker end of the tool has a small diameter and is just long enough to allow sufficient tuning range without exceeding the thread limits on the slug. If a slug cannot be backed out by means of the dark-colored end of the alignment tool, the other end may be employed since it is made longer for this purpose. The darker end should then be used to make the necessary adjustment. This alignment tool was not designed to retrieve slugs that

Fig. 1. Three Special-Purpose Tools. (A) Tube Extractor. (B) Oscillator Alignment Tool, Slug-Saver Type. (C) Oscillator Alignment Tool With Wide Slot.

have fallen through. There are tools on the market which are used for retrieving the slugs that happen to drop through. These tools, however, are somewhat larger and more expensive than the tool just described.

Two other very useful items are also illustrated in Fig. 1. Tool A is a tube puller made by the Worthington Products Company and known as a Raymer Tube Extractor. This device is very handy for removing those very hot low-voltage rectifiers and horizontal-output tubes that are often held in with metal clamps. The unit is designed to depress the retaining clamps and to extract the tube simultaneously. To operate this extractor, simply slip the jaws around the base of the tube to be removed; then with the thumb and forefinger, squeeze the grips together. The tube will be extracted and held in the jaws of the tube extractor. This tool should save a great deal of time, especially when extracting tubes from those tight places which are difficult to reach without getting burned.

Tool C illustrated in Fig. 1 is one for adjusting the "bull's eye" or local oscillator on current Zenith television receivers. Because of the construction of the adjustment slug, it is necessary to use a tool having an end with a wide slot. Tool C has such a slot.

There are on the market now several television receivers in which the VHF tuner is located far back from the front of the cabinet. In order to adjust the local-oscillator slugs on these receivers, it is necessary to have a long alignment tool — one about 18 inches long is usually satisfactory. These tools are readily available at your parts distributor, and it is recommended that one be carried in your tube kit.

IN THE SHOP

Horizontal-Output Stage and High-Voltage Supply

One portion of a TV chassis gives TV service technicians more headaches than any other. It actually consists of two sections which are closely allied in modern sets. These sections are the horizontal-output stage and the high-voltage supply. It is almost impossible to consider one of these without including the other because of their close relationship. The reason for this is the fact that the high voltage is a direct by-product of horizontal scanning.

The damper is another stage which is directly involved with the horizontal-output amplifier. If the damper is not functioning properly, the horizontal-output circuit cannot do its job satisfactorily.

As a voltage supply for the vertical-output stage, many sets obtain the boost B+ from the damper. If the boost voltage is therefore not up to what it should be, it may affect the shape of the waveform of the vertical-output voltage and thereby affect the raster vertically and cause reduced height.

The reasons that the horizontal-output and high-voltage stages are difficult to service have been discussed many times in other writings, and we will not attempt to go into them at this time. Instead, our approach to these stages will be to insert troubles into a chassis and note the effects upon the raster and picture. For this purpose, we will first use a chassis in which these circuits are relatively simple, and then we will do the same with a chassis which has a more complex circuit.

TEST RECEIVER No. 1.

The following conclusions were drawn from the results of tests on a chassis employing the relatively simple circuit which is shown in Fig. 2.

No Raster

If C1 becomes shorted, the plate voltage of the preceding stage is placed on the grid of the horizontal-output tube and causes it to draw a damaging amount of current. The horizontal-output tube no longer functions properly; and since the high voltage is a result of the horizontal output, it is naturally lost.

R1 being open causes the grid to float. This condition results in the build-up of a negative grid charge which cuts off the cathode current, and the high voltage fails.

If C2 shorts, the B+ line shorts to ground through R2; and R2 usually burns out. A loss of high voltage

* * Please turn to page 47 * *

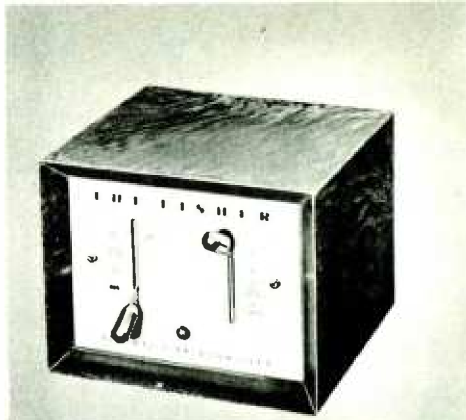
Audio-Facts

The Fisher

Preamplifier Model PR-5

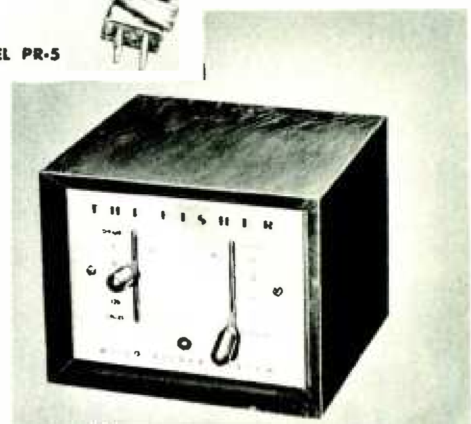
Preamplifier-Equalizer Model 50-PR-2

Hi-Lo Filter System Model 50-F



MODEL 50-PR-2
PREAMPLIFIER-EQUALIZER

FISHER MODEL PR-5
AMPLIFIER



MODEL 50-F
HI-LO FILTER SYSTEM

Fig. 1. Front Views of the Fisher Models PR-5 Preamplifier, 50-PR-2 Preamplifier-Equalizer, and 50-F Hi-Lo Filter System.

by Robert B. Dunham

The program material obtained from the usual recordings, radio broadcasts, and other sources possesses certain characteristics which must be considered and which require compensation in a music system for the home if the best sound reproduction is to be had.

Compensation for the characteristics of the pickup and equalization for the curve used when the recording was made are required when playing a record. Record surface noise and turntable rumble are often present in the reproduced sound and must be reduced or eliminated. Hiss, whistles, and sometimes an excessive amount of hum are encountered in some broadcasts; and their effects must also be reduced or eliminated.

The Fisher Models — PR-5 Preamplifier, 50-F Preamplifier-Equalizer, and 50-F Hi-Lo Filter System — are shown in Fig. 1. These are self-powered units designed to compensate for and to correct the aforementioned conditions conveniently and effectively.

MODEL PR-5 PREAMPLIFIER

The Model PR-5 Preamplifier (Figs. 1, 2, and 3) provides the necessary gain and compensation required for satisfactory operation of a magnetic pickup with the usual power amplifier. This small and well-shielded unit is not equipped with a cabinet, since in most cases it will be mounted close to or preferably on the amplifier with which it is being used. For this reason an output cable only 18 inches long is provided for connecting to the input of the amplifier, but a long cable can be used if a remote location is selected for the preamplifier.

Small units of this type have been used for some time and at present are being used for the preamplifier section of some of the "complete-in-one-cabinet," high-fidelity units now on the market.

With some slight modifications the Model PR-5 will function as a high-gain preamplifier for use with a low-level microphone.

Specifications.

(a) Over-all size.
Height 3 5/8 inches, width 3 5/8 inches, and length 3 5/8 inches.

(b) Power requirements.
105 to 125 volts AC, 50 to 60 cps, 4 watts at 117 volts AC.

(c) Tube.
6SC7, shock mounted.

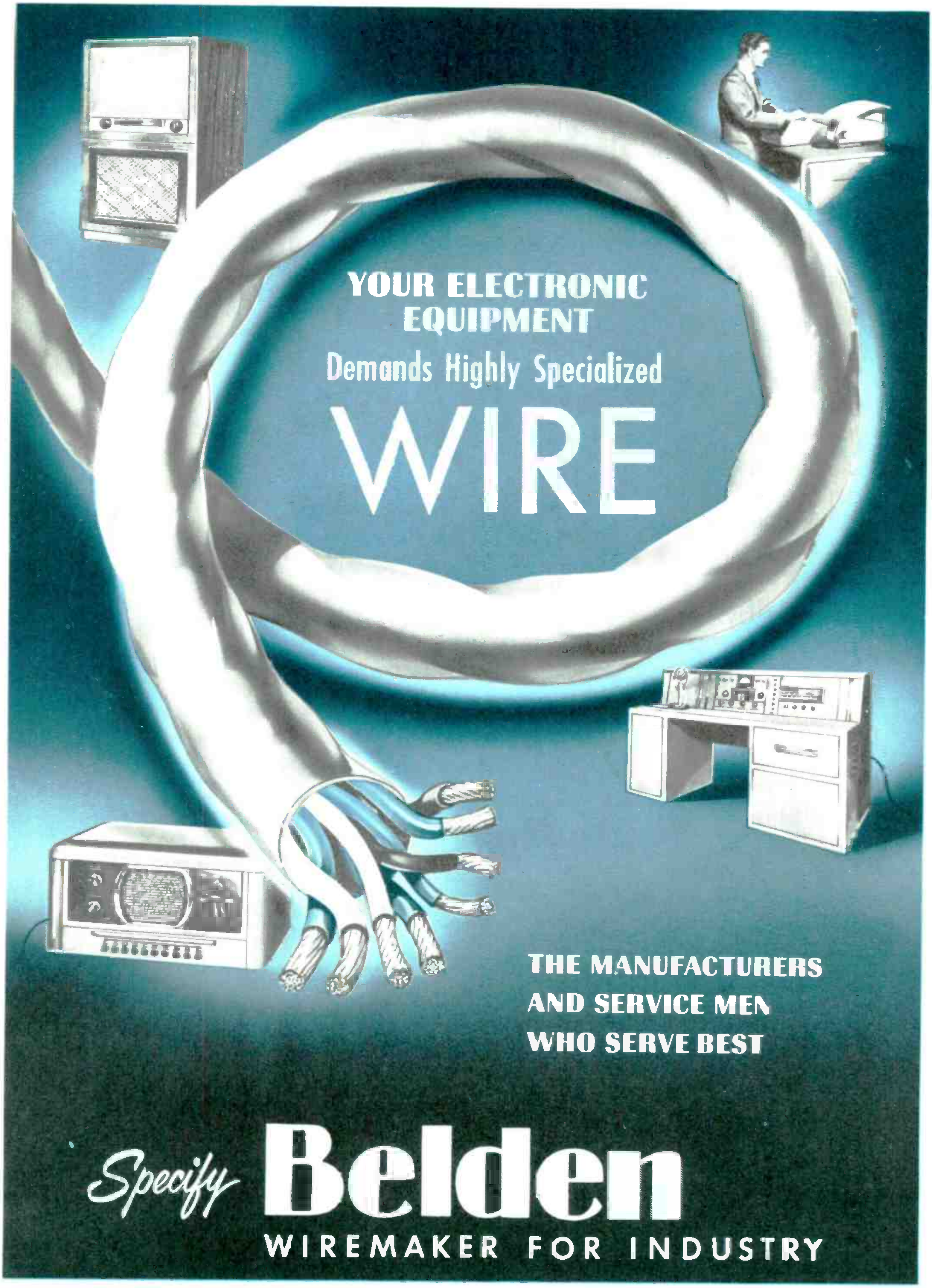
(d) Rectifier.
Selenium.

(e) Frequency response.
Within 2 db from 30 to 20,000 cps.

(f) Gain (phono).
Voltage gain of 100, 1-volt output with 10-millivolt input.

(g) Gain (microphone).
Voltage gain of 1,000, 1-volt output with 1-millivolt input.

* * Please turn to page 65 * *



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Servicing SPECIALIZED EQUIPMENT

Many Electronic Devices Can Provide Additional Business

by DON R. HOWE

In Part I of this series, it was pointed out that many pieces of specialized equipment consist of circuits that are familiar to the service technician. The Message Repeater was discussed and served as an example of such equipment.

Fig. 1. Soundview Projector and Amplifier. (Sample Courtesy of Automatic Projection Corporation.)

Soundview Projector and Amplifier

Another form of specialized equipment is exemplified by the Soundview projection equipment introduced by the Automatic Projection Corp. This equipment is shown in Fig. 1.

The projector is designed to accommodate 35-mm film strips or 2-inch by 2-inch slides. Provisions are made for automatic operation when using film strips. A mechanical arrangement, activated by a solenoid, is incorporated to advance the film. An external switch may be used to actuate the solenoid, or an entirely automatic advance is possible when using special records in conjunction with the film. This automatic operation is described in detail later in this article.

The audio amplifier consists of three stages utilizing a 12AU7 and a 50C5. A schematic diagram of the amplifier is shown in Fig. 2. The coupling network between the first and second stages contains a high-pass filter to attenuate frequencies below 100 cycles. This is necessary when one of the automatic-control units is used with the amplifier. Switch S1 on the tone control governs the application of power to the amplifier and the turntable motor. Switch S2 on the volume control permits the turntable motor to be shut off separately. If an automatic-control unit is not used in conjunction with the amplifier, a shorting plug is inserted into the socket on the ampli-

* * Please turn to page 39 * *

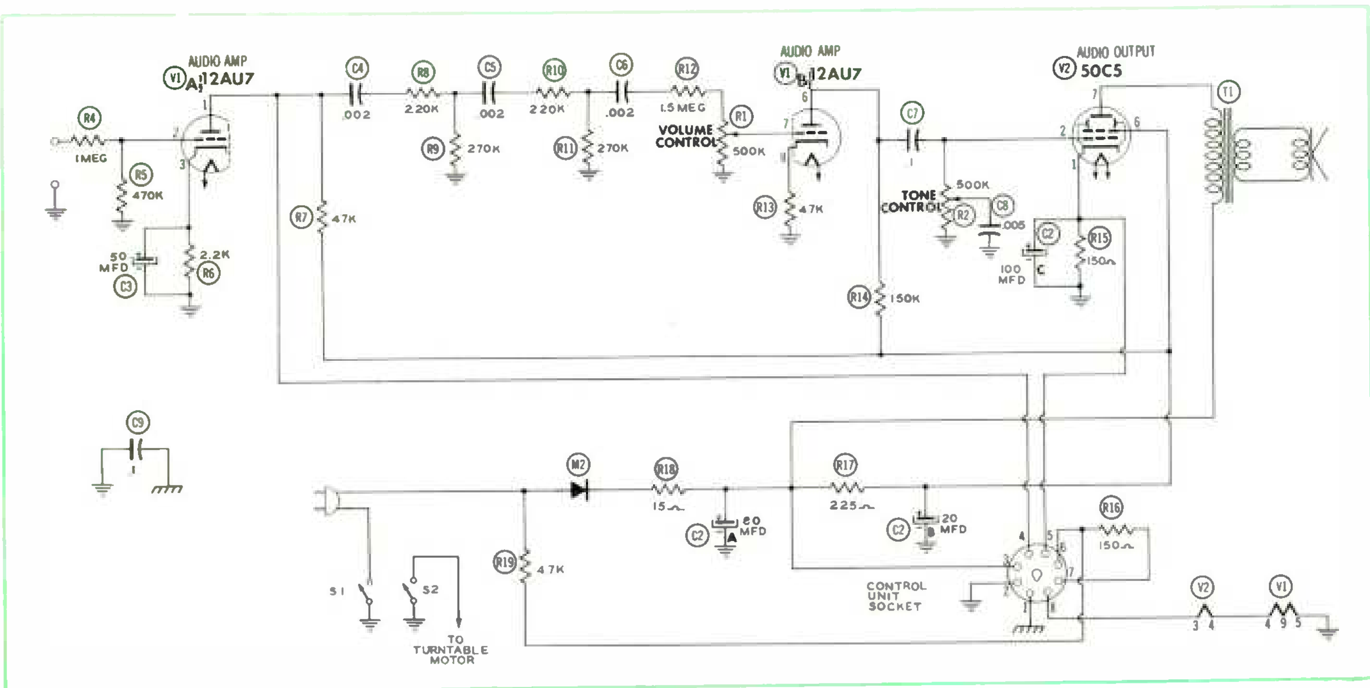
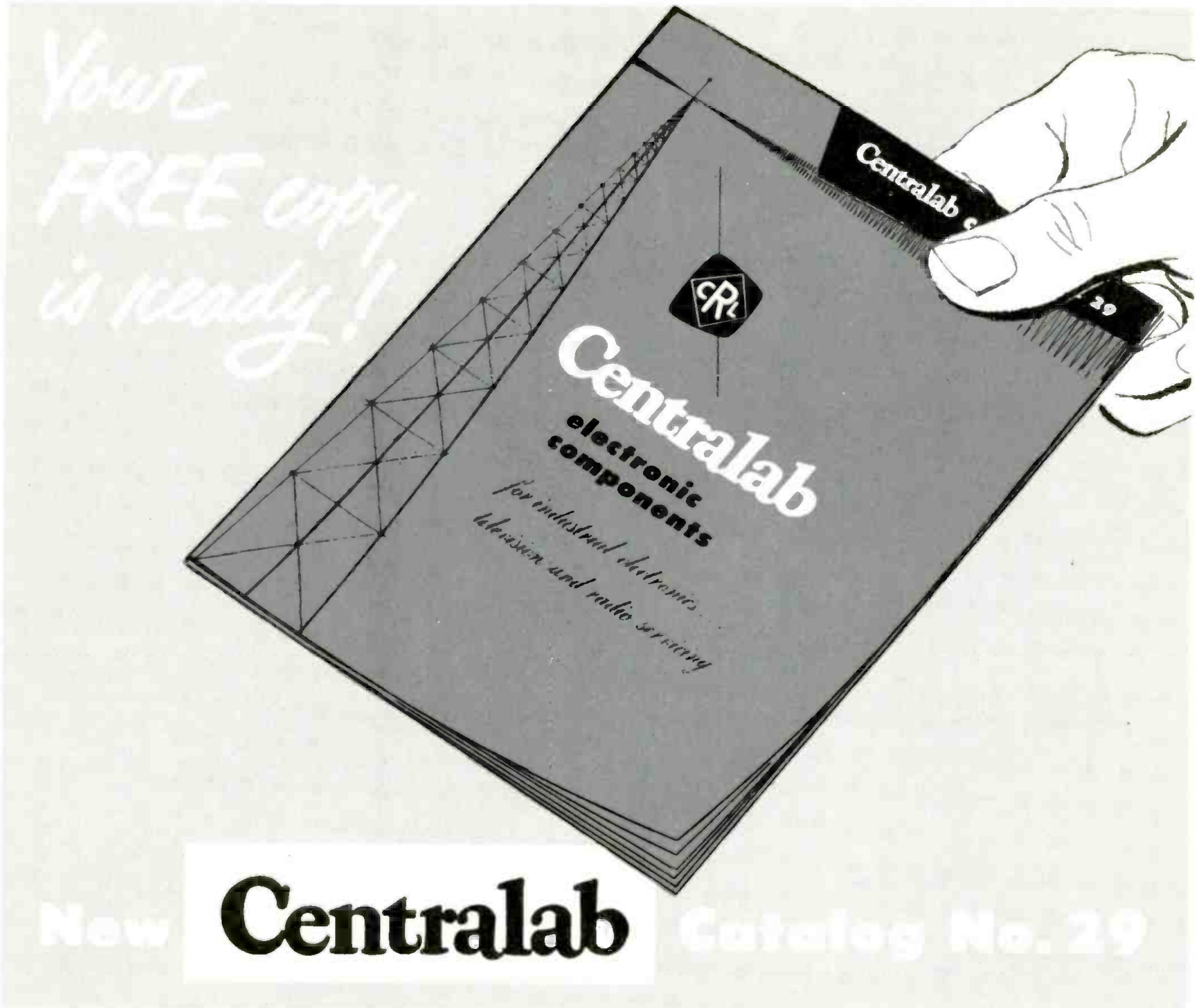


Fig. 2. Schematic of Soundview Audio Amplifier.



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Dollar and Sense Servicing

by *John Markus*

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

LOOKING HOURS. The average TV set is being viewed 5.2 hours per day, according to CBS president Frank Stanton. This adds up to 1,900 hours a year, which is far more than the 1,000-hour rated life that tubes used to have. It means that tube manufacturers are turning out better and better tubes, because many tubes in TV sets haven't been replaced in five years.

We suspect that a lot of the tubes which went bad in TV sets were the fault of the manufacturer's designers rather than the tube makers. From experience the designers have learned what can reasonably be expected from each tube type, so that now there are fewer failures due to overloading or other improper uses of tubes.

TELE CLUBS. With TV sets costing about $400 in France, or roughly the equivalent of four months' wages, this form of entertainment is as remote as the moon to most French peasants in the smaller towns. But slowly each town is now getting its own set, thanks to an idea that came into the head of a young Frenchman named Roger Louis. He initiated the plan wherein the people contributed toward the cost of a community set to be operated in the village school each evening.

In one town, 80 of the 115 families chipped in from $2.50 to $12.50 each, with the rich giving more than the poor. With the teacher in charge, shows were held each evening in the school for an admission fee of 20 francs or roughly one cent. Within a year, receipts were enough to pay everyone back his share for the set. Since then, the income has been used by the teacher to buy needed equipment for the school.

The school teacher there has a different opinion of television than do our own teachers. As quoted in John Crosby's column in the New York Herald Tribune, the teacher in France says, "Don't try to tell me that television makes the school children sluggish or lazy. This set has done wonders for them. It stimulates their imagination, increases their vocabulary, and makes them ask questions. You'd be surprised to see how it affects their play, too. The other day we saw a movie about a bullfight; now they're all playing matador. And we saw a baseball game once; since then they've invented some kind of game with a ball and stick."

At 8:30 on show nights the schoolhouse is filled with grizzled peasant farmers and their robust wives, along with teen-agers who find the Tele Club a great place for furtive necking. The television programs are pretty bad according to standards in the United States, but they get an awful lot of it for their 20 francs.

Now some 175 villages have community sets, with the numbers growing daily. Other countries have expressed lively interest in the idea, and UNESCO is studying its possibilities for promoting low-cost educational television in underdeveloped Asian and Latin-American countries. A retired American doctor in New York City is working on a similar plan for villages in his Italian homeland. Actually, the basic idea is rather old, for villages in India have had community radio sets for many years.

All this is a good discussion topic with your customers or even before community audiences. Point out that there are countries and even continents in this World that have never seen a television program, and tell about the little French TV shows. It'll make them appreciate our own television a lot more, and at the same time they will appreciate more what you do to keep their sets running.

BATTERIES. New types of batteries making news lately are not likely to be on the market for many years because of economic and practical drawbacks. With RCA's so-called atomic batteries that lose only half their power in 20 years, the chief drawback at present is high cost (around $25) and low power output (about a millionth of a watt). There are big hopes for the future though, particularly with the atomic-age metal tritium as the radioactive source.

The more recent Bell Telephone Laboratories version using special silicon strips that are activated by sunlight gives about 50 watts of power per square yard of sun-facing surface, but the sun itself is the chief drawback. It goes out of sight around the other half of the World once a day, and its energizing rays are all too often blocked by clouds. Furthermore, its relative position is always changing, so that a solar battery would have to follow the sun from east to west each day just like a sunflower, to get maximum battery efficiency.

Scientists calculate that a house roofed with these new photoelectric silicon shingles could supply enough energy to meet the entire electrical requirements of the house, provided that some "gimmick" could be devised to make the shingles turn like sunflowers. Huge storage batteries would be needed, however, to carry the occupants through the night. As yet, no one has come up with an answer to a long string of cloudy days.

When asked about this Bell Telephone Laboratories battery, you might point out that the idea has been in use for years in photoelectric exposure meters. The only thing new is a six-fold improvement in efficiency of converting light energy to electric power; the older photoelectric devices had an efficiency of 1 per cent, the new one 6 per cent.

* * Please turn to page 69 * *

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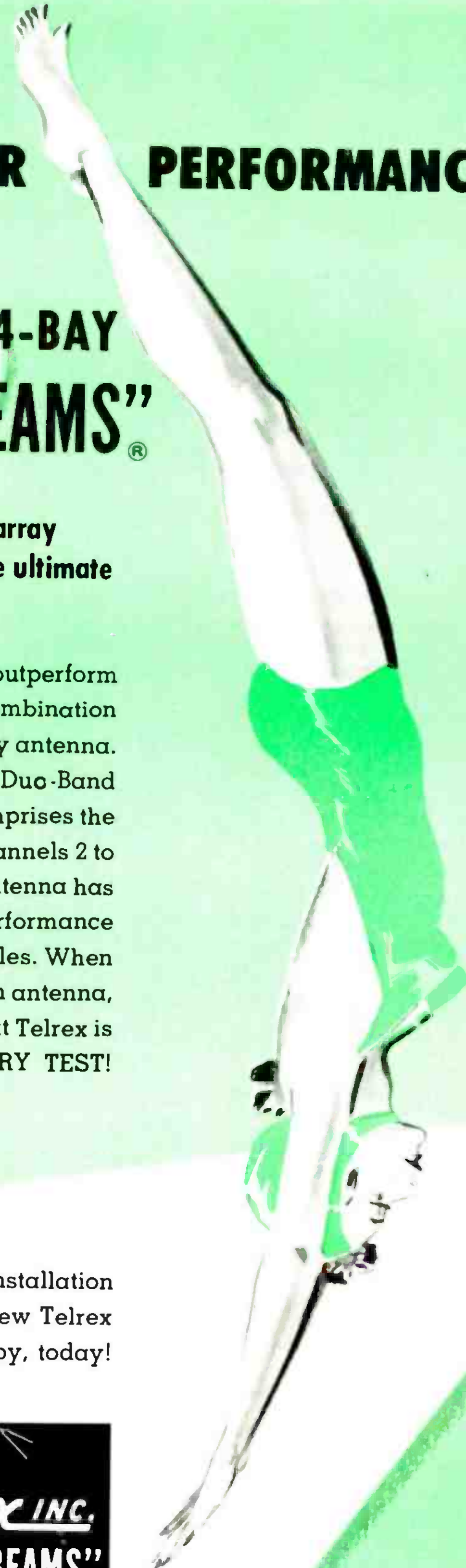

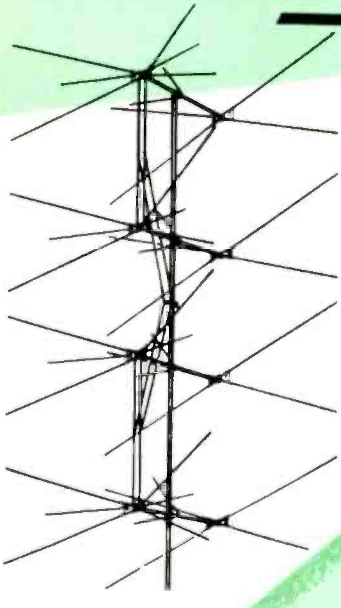

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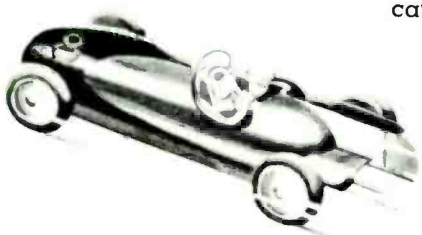

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The Ampex Tape Recorder Model 350

(Continued from page 21)

of the three housings (console, rack, or portable) are different.

The console model in Fig. 1 is intended for use in the studio. The height and angle of the panels place all controls within easy reach of the operator for added convenience when recording, playing back, or editing. The hinged tape-transport panel mount and the arrangement which allows the amplifier-and-control chassis to be lifted and locked into position are shown in Fig. 2. These features can be appreciated when routine checks are made or maintenance is required. The sliding, removable back shown in Figs. 3 and 4 provides access to the interior of the console. The complete recorder can be moved about very easily on its large casters.

TAPE-TRANSPORT MECHANISM

The tape-transport mechanism shown in Figs. 5 and 6 may give a first impression of being overly complicated. Actually it is a well engineered mechanism which is controlled by positive-acting relays and solenoids. In fact, the smooth and dependable service provided by this section contributes greatly to the ease of operation and maintenance already mentioned.

The editing knobs are used with NARTB reels, as shown in Fig. 1, which shows 10 1/2-inch reels in place with the tape properly threaded.

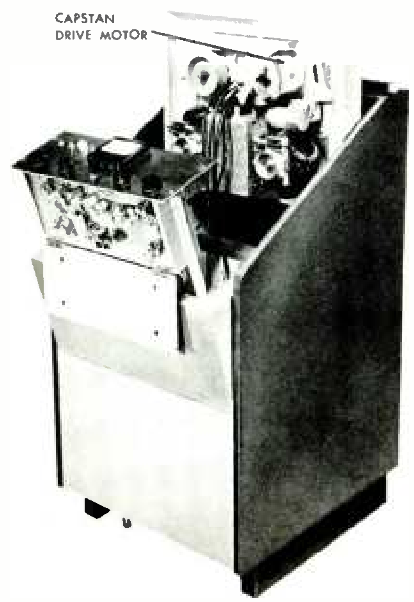

Fig. 2. Front View of Complete Console, With the Transport-Mechanism Panel Up. Control Chassis Is Up, With Bottom Cover Open.

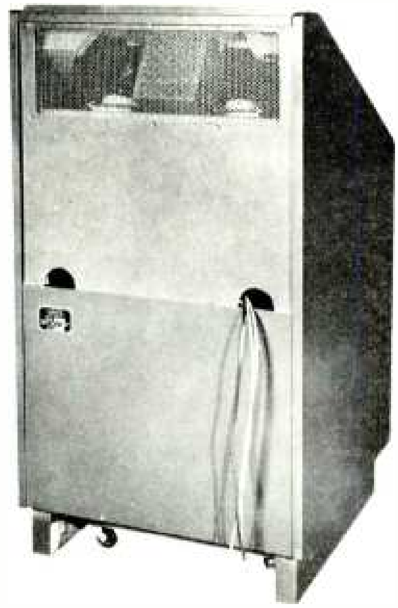

Fig. 3. Rear View of Complete Console, With Back in Place.

Standard RMA reels fit directly on the turntables. (See Fig. 5.)

Three separate heads (erase, record, and playback) are mounted in the plug-in assembly shown with the gate open in Fig. 5. The use of separate heads permits monitoring of the recorded tape during recording and also simplifies the switching and circuitry.

The reel idler (Fig. 5) with its flywheel (Fig. 6) runs so smoothly that it seems never to stop, and this tends to fascinate anyone observing its continued motion after the recorder has stopped. This action smooths out the motion of the tape and is particularly effective when the tape is first put into motion.

In order to maintain correct pressure on the tape against the capstan which drives the tape, the capstand idler (Fig. 5) is actuated by a solenoid during playback and record. The take-up tension arm is shown in its normal operating position in Fig. 1. If the tape should break, run off either reel, or unwind completely, or if a large loop is thrown, the take-up tension arm will fall back into the position shown in Fig. 5 where it will trip the safety switch (Fig. 6) and stop the mechanism. This safety feature is very worth while and is the most important function of the arm, since it operates as a result of the tension of the tape rather than solely for the purpose of maintaining tension on the tape.

The reel-size switch (Fig. 5) operates as part of the tape tension system. When this toggle switch is thrown to the left, correct tension is maintained for large-sized reels. When thrown to the right, the torque of the motors is adjusted by placing a resistor in series with them to obtain the correct tension for small reels. The tape-speed switch (Fig. 5) controls the speed of the tape by switching windings in the capstan drive motor.

Four push-button switches (rewind, fast-forward, stop, and play, as shown in Fig. 5) operate relays to control the tape movement. When either the rewind, fast-forward, or play push button is depressed, the correct relay will be activated to move the tape in the desired manner until one of the other buttons is depressed. When another button is depressed, the relay that was in control is deactivated and the one activated by the depressed button takes over the control of the tape. If the tape is in motion when the stop push button is depressed, all relays will be deactivated, the brakes will be applied on the take-up and supply motors, and the mechanism will stop. The capstan motor will continue to run (if the tape remains threaded properly and the motor is not stopped by the safety switch); but, since the pressure of the capstan idler is removed when the stop button is pushed, the capstan will no longer drive the tape.

The capstan drive motor has two speeds and is of the hysteretic, synchronous type. Its shaft is the capstan. The drive motor is hidden in Fig. 6 by the flywheel and fan. This high quality motor is important,

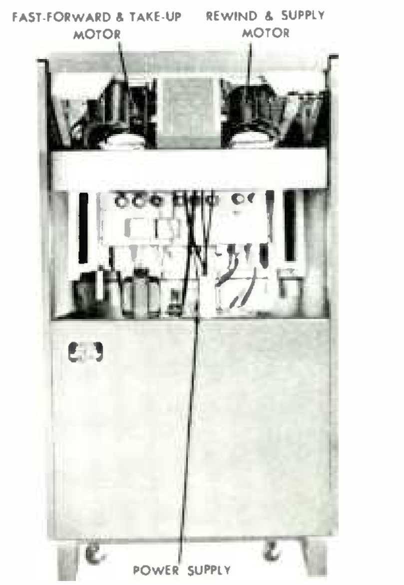

Fig. 4. Rear View of Complete Console, With Back Removed. Power Supply Is Shown.

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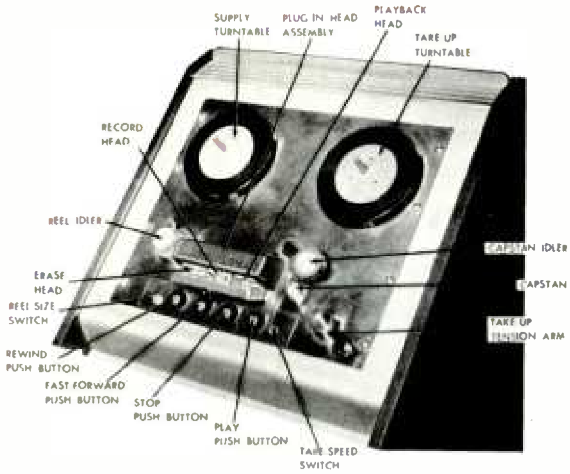


Fig. 5. Top View of Transport Panel.

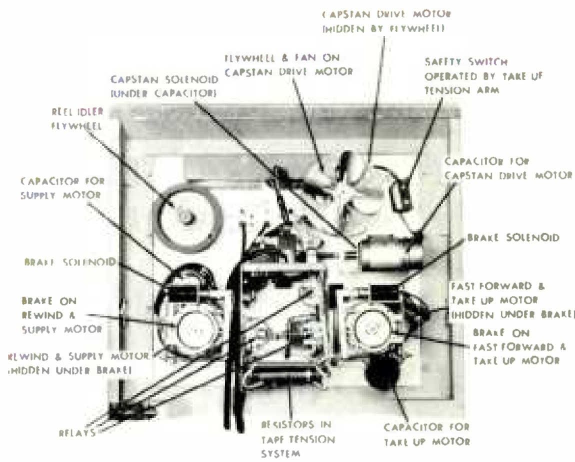


Fig. 6. Bottom View of Transport Panel, With Shield Removed.

since the quality of recording and playback depends so much upon its performance.

Separate induction motors (hidden by the brakes in Fig. 6) are used to drive the supply and take-up reels. Their rugged and simple brakes using conventional housing, drums, and shoes are operated by positive-acting solenoids. The use of separate motors for the drive, supply, and take-up functions provides positive and precise handling of the tape and simplifies the problems of electrical and mechanical control.

AMPLIFIER-AND-CONTROL CHASSIS

The amplifier-and-control chassis provides the necessary input, recording, playback, control, and output circuits required to handle any of the usual professional applications. The large VU meter is the eye-catching feature on the front panel of this section (Fig. 7). In fact, it is important because by its use, recording and playback levels can be adjusted and maintained and erase current and bias output can be read. The desired meter reading is selected by the meter-and-output switch.

Microphone, balanced-bridge, or unbalanced-bridge inputs can be selected by means of the three-position input transfer switch. The equalization switch has two positions — one provides correct high-frequency equalization when recording at high tape speed, the other corrects for low tape speed. The output of the unit can be monitored at any time by headphones plugged into the monitor jack on the front panel.

A push on the record button (a momentary contact push-button switch) while the recorder is operating in the play mode will activate the record relay which will light the neon lamp in the record indicator and change the operation of the recorder to the record mode. Recording will continue until the mechanism is stopped or until the rewind or the fast-forward push button is depressed. Either of the latter actions will release the record relay and will switch off the recording section.

Fig. 8 is a top view of the amplifier-and-control chassis showing the various adjustable controls, the input and output transformers, and the tubes. The tube line-up of five 12SJ7's, one 6F6, one 6C5/6J5, and one 6SN7GT might seem a little out-of-date to some readers; but these tubes find a great deal of use in commercial applications.

A selected 12SJ7 tube is used in the first stage of the playback section with another 12SJ7 used in the second stage. The 6F6 is employed in the third or output stage. The first stage of the record section uses a pentode-connected 12SJ7 with triode-connected 12SJ7's located in the second and third stages. The 6C5/6J5 is used in the fourth or output stage. The 6SN7GT is the bias-and-erase oscillator operating at a frequency of 100 kilocycles.

The shield covering the rear of the panel has been removed in the rear view of the amplifier-and-control chassis in Fig. 9. This illustration gives a good view of the sockets and connectors, all of which are of the locking type to prevent accidental disconnection. The line-termination switch must be in the ON position when the output is not feeding a 600-ohm line or is connected to a high-impedance load. This switch then properly terminates the output so that accurate readings of the VU meter can be obtained. The monitor jack on the rear of the chassis provides for monitoring by means of a conventional monitor amplifier.

The record relay (Fig. 10) is the only relay located in the amplifier-and-control chassis. The most noticeable feature of construction to be seen in the underside view of the chassis in Fig. 10 is the use of vector sockets. Six of these sockets are assembled on a shock-mounted sub-chassis.

The separate power supply is mounted on a shelf in the rear of the console, as can be seen in Fig. 4. The circuit is conventional with a 5Y3GT full-wave rectifier supplying plate power. A full-wave selenium rectifier provides 12.6 volts DC for the heaters of the 12SJ7's. For the rest of the tubes in the amplifier-and-control chassis, 6.3 volts AC are supplied.

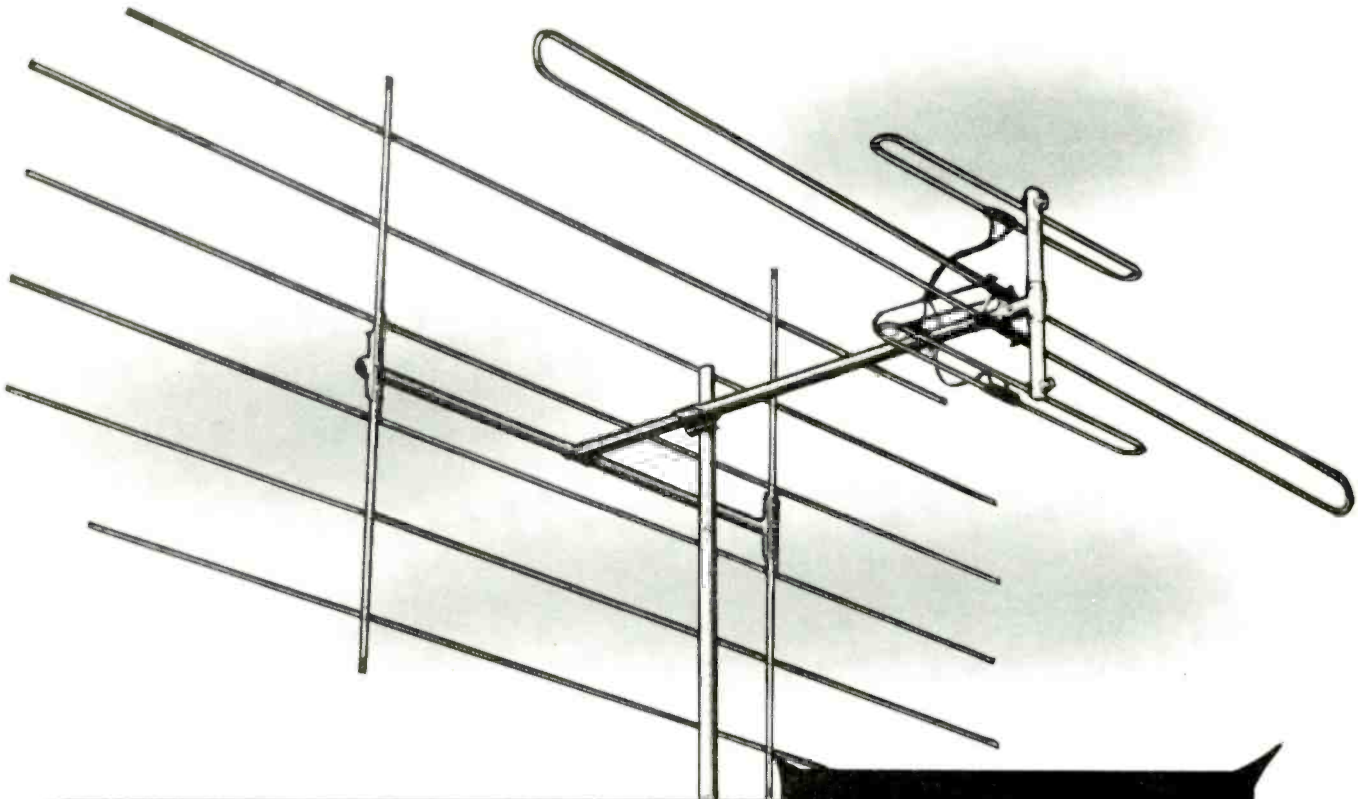
OPERATION OF THE RECORDER

Operation of the Model 350 whether recording, playing back, or editing is simplified because of the facilities provided by the features mentioned. Explaining how to operate in any of the modes is much more difficult than the actual operating procedure.

Playback

1. The reel of tape to be played back is placed on the supply turntable, with the empty reel placed on the take-up turntable and the tape threaded as shown in Fig. 1.

2. The system which is to be used for the playback is connected to the output.



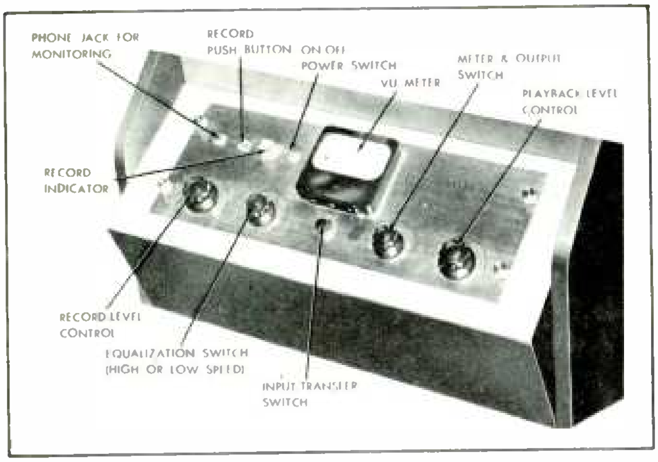


Fig. 7. Front View of Control Chassis.

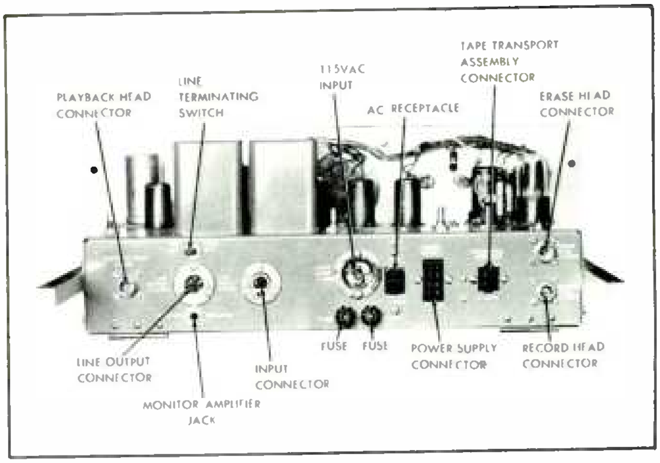


Fig. 9. Rear View of Control Chassis, With Shield Removed.

3. The AC power cord is plugged into the 117-volt AC line, and the power switch is turned on.

4. The tape-speed switch is set for the desired speed.

5. The equalization switch is set for the selected speed.

6. The reel-size switch is switched to large or small reels, whichever is to be used.

7. The meter-and-output switch is turned to the playback position.

8. Pushing the play push button will start the tape moving in the playback mode.

9. The desired playback level is set by means of the playback-level control.

Playback will continue until the stop push button is pressed or until the rewind or fast-forward switches are pushed to change the operation into the rewind or fast-forward mode. CAUTION: The play push button should not be pressed when the tape is moving in the rewind or fast-forward mode because of the risk of breaking the tape. Rewind or fast-forward can be started at anytime.

Record

1. The tape upon which the recording is to be made is placed on the recorder and threaded in the same manner as that for playback.

2. The desired signal source is connected to the input and the input-transfer switch turned to the proper position.

3. The play push button is pressed to start the tape in motion. Wait at least one-half second to prevent switching transients from permanently magnetizing the record head, and then push the record push button to start recording.

4. Recording level can be determined by switching the meter-and-output switch to record level and reading the amount shown on the VU meter.

5. The recording level is adjusted to the normal value of zero on the VU meter by turning the record-level control.

The program to be recorded can be monitored with phones with a monitoring amplifier, and the recording level can be set to the correct level before the tape is started in motion. These are both very convenient features.

Editing and Cuing

Editing and cuing can be accomplished very easily by holding down both the rewind and fast-forward push buttons simultaneously. This allows the tape to move very slowly; and by manipulating one or the other of the switches, its direction and speed can be controlled. When the correct point on the tape is found, the stop button should be held down until the rewind and fast-forward buttons are released.

Robert B. Dunham

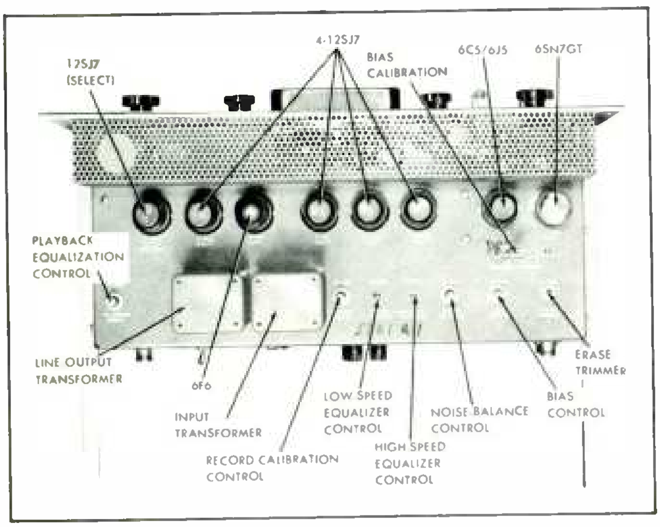


Fig. 8. Top View of Control Chassis.

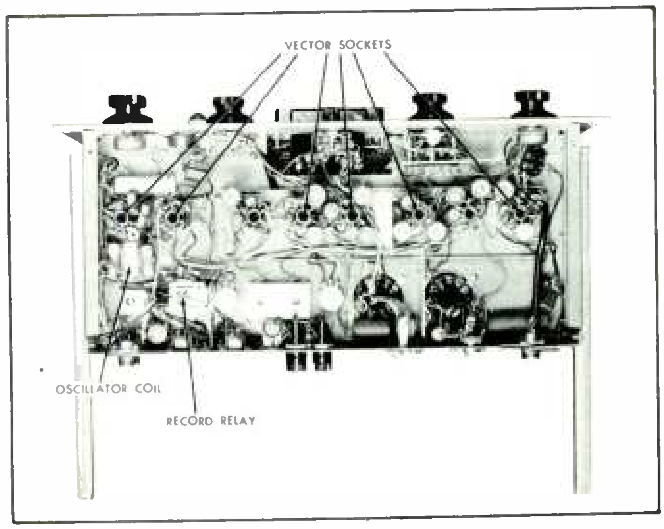


Fig. 10. Bottom View of Control Chassis, With Cover Removed.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Servicing Specialized Equipment

(Continued from page 29)

fier. This plug connects terminals 7 and 8 together.

When a film strip is used with an associated recording, completely automatic operation is possible. In this case, a control unit is plugged into the amplifier section. Two types of control units are available. One unit operates on a control signal of 30 cycles; the other one operates on a signal of 7 kilocycles. The recording used for automatic operation has a control signal impressed upon it at the time the record is made. The control signal may be either one of the aforementioned frequencies.

The low-frequency (30-cycle) control unit is shown schematically in Fig. 3. A sample audio signal from the audio amplifier is fed to the grid of the first stage in the control unit. After passing through this stage, the signal is fed to the next stage (V3B) where it is amplified. The input circuit of the third stage contains a selective filter which passes all frequencies except 30 cycles and feeds them back to the grid of the second stage. The feedback signals are 180 degrees out of phase with the signals from V3A. The over-all effect is to cancel all signals in the control unit except the 30-cycle signal. The trigger tube (V5B) is held at cutoff by the action of V5Q. The cathode of V5A is connected to one of its filament terminals. The applied AC signal is rectified and produces a negative voltage across R38. When the control signal appears on the cathode of the rectified tube V4B, the tube conducts and counteracts the voltage across R38. This causes the bias on the trigger tube to go in the positive direction, and the tube will conduct. Current is drawn through the relay, and it closes. The film-advancing solenoid in the projector is actuated, and the film is automatically advanced.

Resistor R39 and capacitor C18 in the grid circuit of the trigger amplifier form a time-delay network which requires a control signal having a minimum duration of .3 second before the trigger amplifier conducts. This circuit is designed to prevent extraneous 30-cycle signals of short duration from tripping the film-advance solenoid.

The control signal is prevented from going through the main audio amplifier by the high-pass filter between the first and second audio amplifier stages.

The high-frequency control unit, shown in Fig. 4, is designed for use with a record which provides a 7-kilocycle control signal. This unit is plugged into the audio amplifier in the same manner as the low-frequency unit. A schematic diagram of the high-frequency unit appears in Fig. 5.

The input circuit consists of a series-resonant circuit tuned to 7 kilocycles and is made up of capacitor C20 and inductance L1. Since this circuit appears in the plate of the first stage (V1A) of the audio amplifier, a very low impedance to ground is offered to a 7-kc signal. This keeps the control signal from proceeding through the audio amplifier. The 7-kc signal causes a voltage to be developed across inductance L1. The voltage thus developed is amplified by the triode section V6A and fed to the second stage V6B. Triode V6B is a

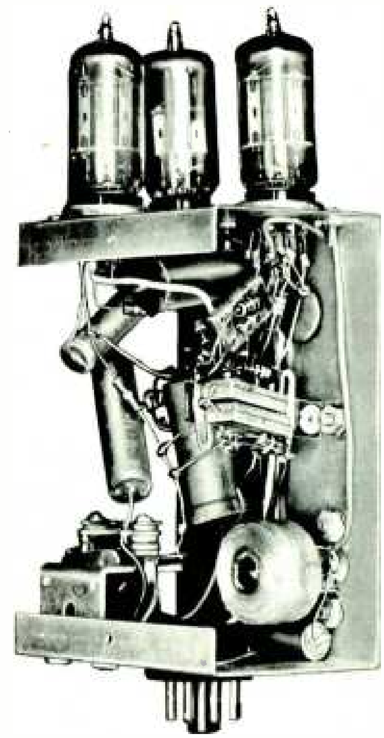


Fig. 4. High-Frequency Control Unit.

clipper which provides an almost constant output level for various values of signal input. The plate circuit of the third amplifier stage contains a frequency-selective network which bypasses all signals except 7 kc. The frequencies which are bypassed are fed back to the grid where they appear 180 degrees out of phase with the incoming signals. All signals, with the exception of 7 kc, are cancelled. The control signal is then fed to the rectifier V7B where it is rectified and coupled as a positive signal to the grids of the trigger tube. During the

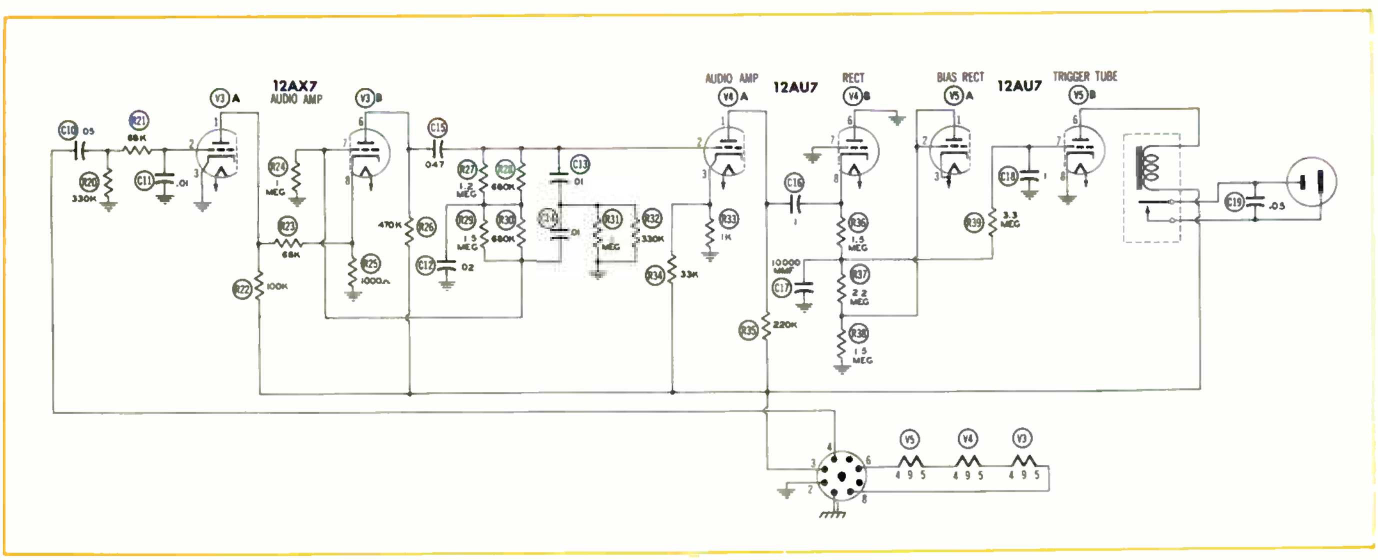
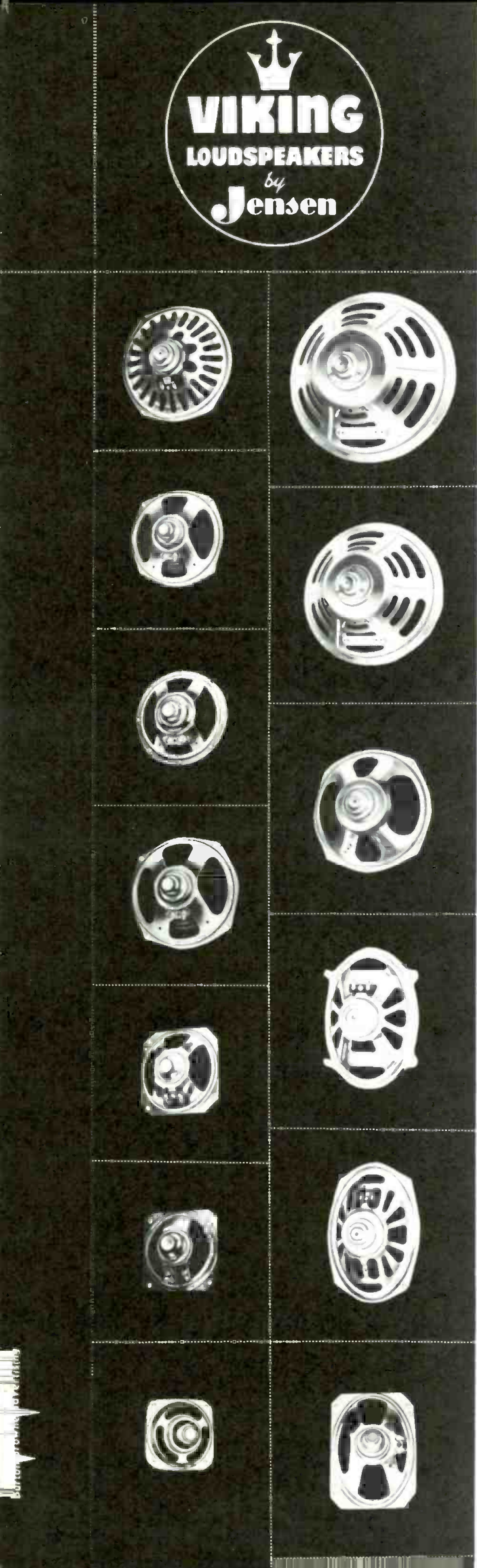


Fig. 3. Schematic of Low-Frequency Control Unit.



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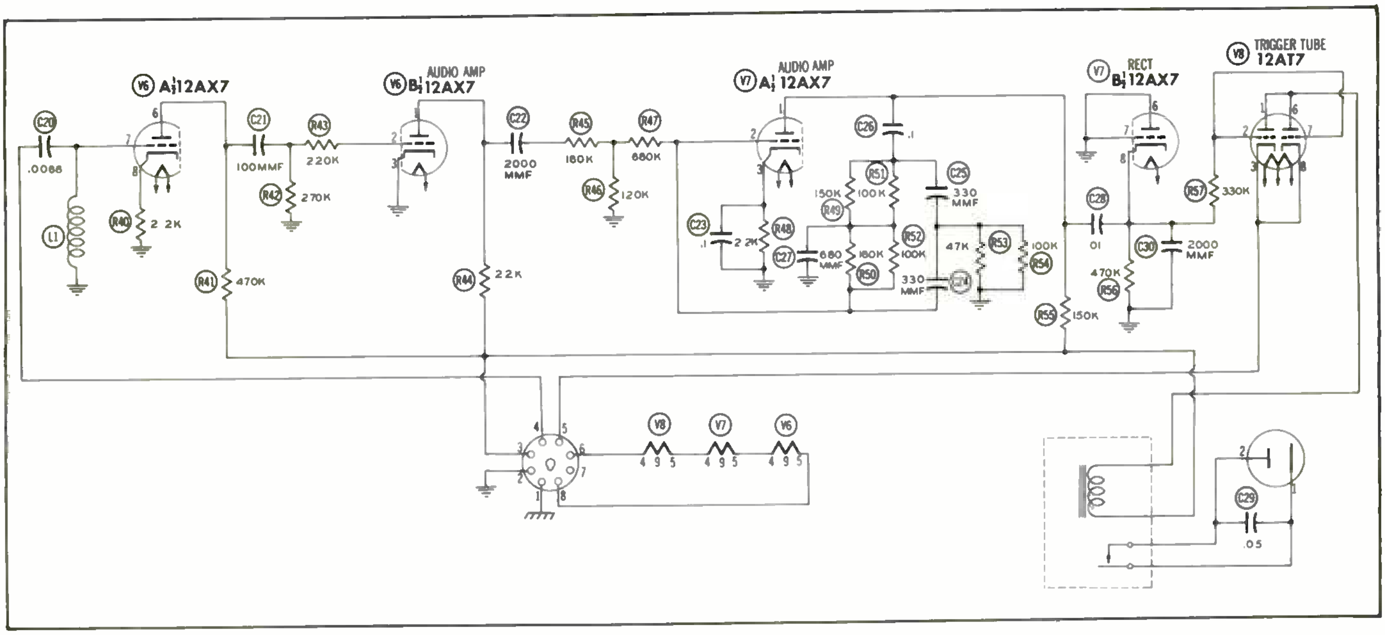

Fig. 5. Schematic of High-Frequency Control Unit.

period in which no signal is present, the trigger tube is held at cutoff by a bias voltage from the cathode circuit of the output tube V2 in the audio amplifier. When the positive control signal appears on the trigger-tube grids, the tube conducts and closes the relay in the plate circuit. This relay actuates the film-advancing solenoid.

Although the Soundview Projector is specialized in its use, it does not contain extremely complex circuitry. As a result, servicing of the unit should not be difficult with the use of conventional test equipment.

Don R. Howe

Television Sound IF Systems

(Continued from page 13)

In some cases where output is obscured by receiver noise, it is useful to ground the grid of the stage preceding the signal-injection point and eliminate the preceding stages as a source of noise.

Sound alignment procedures are given in Charts I and II for the two representative examples of separate-sound and intercarrier systems shown in Figs. 10-20 and 10-21. In both cases, it will be noted that a choice of either a scope or a VTVM alignment is offered, depending upon the alignment technician's preference or the test equipment he may have at hand.

Alignment of Separate-Sound System

For the separate-sound system, the sound intermediate frequency of 21.6 mc (as supplied by the generator) is coupled to the grid of the first sound IF amplifier tube. The sound take-off adjustment A1 was considered as part of the video alignment and was previously adjusted for minimum 21.6-mc indication at the video-detector load.

A blocking capacitor (.001 mfd) is placed in series with the generator output lead. Use of a capacitor in this manner is usually a good policy because it affords protection to the test equipment in case of accidental contact with B+ voltages, if the equipment is not already protected internally by a similar capacitor.

The VTVM is connected to point B and chassis or, in other words, across one-half the discriminator load. At resonance to the incoming signal, maximum signal voltage will be developed across the primary and secondary of L31 and across each half of the detector load; so A10 is adjusted for that indication.

Also at resonance with both diode circuits in balance, the voltages developed across the two load resistors R59 and R60 will be equal and opposite in polarity. The sum of their voltages will be zero at the junction of R61 and C57. A11 is adjusted for balance as indicated by zero reading at point C instead, thus taking advantage of the slight filtering action of the de-emphasis network R61 and C58.

The VTVM is then moved to point D across the limiter grid resistor, and A12 through A15 are adjusted for maximum indication.

For scope alignment, a frequency-modulated signal is used instead of the unmodulated RF signal of the VTVM alignment. A 47K-ohm isolating resistor is used to reduce loading of the tuned circuits by the input capacity of the scope. A 450-kc sweep deviation is more than enough to cover the bandwidth of the IF amplifier strip, therefore the response of the strip is seen at a glance. With the scope at point D, A12 through A15 are adjusted for maximum gain and symmetrical response at the intermediate frequency of 21.6 mc. The scope is then moved to point B, and A10 is adjusted for maximum gain and symmetry at the 21.6-mc marker. As mentioned previously it is important to keep the generator output low enough to avoid overloading, because the curve would then become distorted and improper alignment might result. The marker amplitude should also be kept at the minimum usable level for the same reason.

When adjusting the secondary winding of the discriminator, the scope is placed at point C; and A11 is adjusted to place the sound IF marker at the intersection of the crossover lines. If the internal sweep rate of the scope is 60 instead of 120 cycles per second, the scope pattern will be a single S curve and the marker should appear at the center of the straight-line portion of the curve.

A10 is retouched, if necessary, for maximum amplitude and straight-

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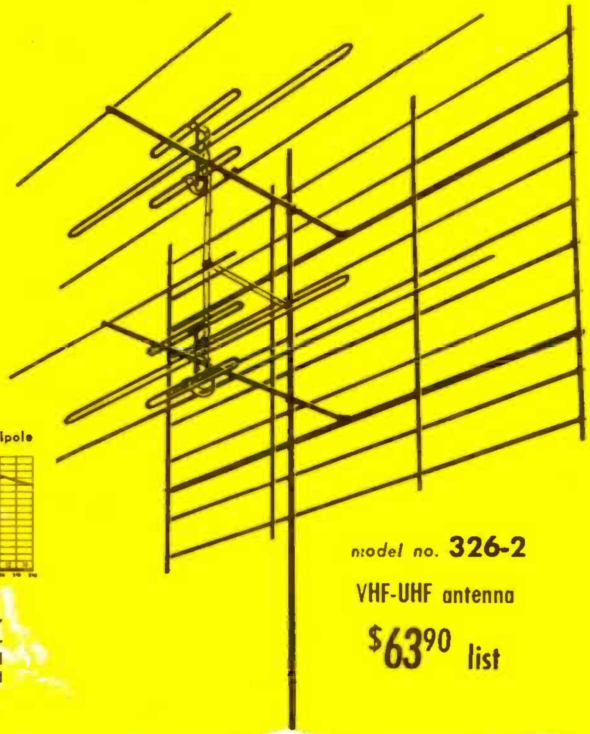

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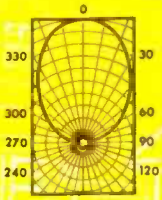
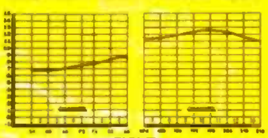
3	10:1
4	11:1
5	20:1
6	18:1

Only Low Band channels shown, since co-channel interference is not encountered on High Band channels.



Channel 5



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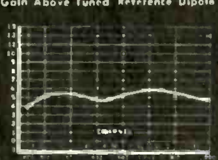

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CHART I

PHOTOFACT SOUND IF ALIGNMENT PROCEDURE FOR A TYPICAL SEPARATE-SOUND SYSTEM (Fig. 10-20)

SOUND IF ALIGNMENT USING AM SIGNAL GENERATOR AND VTVM

	DUMMY ANTENNA	SIGNAL GENERATOR COUPLING	SIGNAL GENERATOR FREQUENCY	CHANNEL	CONNECT VTVM	ADJUST	REMARKS
1.	.001MFD	High side to pin 1 (grid) of 6AU6 (V11). Low side to chassis.	21.6MC	Any	DC probe to point B. Common to chassis.	A10	Adjust for maximum deflection.
2.	"	"	"	"	DC probe to point C. Common to chassis.	A11	Adjust for zero reading. A positive and negative reading will be obtained on either side of the correct setting.
3.	"	"	"	"	DC probe to point D. Common to chassis.	A12, A13, A14, A15	Adjust for maximum deflection.

SOUND IF ALIGNMENT USING FM SIGNAL GENERATOR AND OSCILLOSCOPE

Use frequency modulated signal with 60∿ modulation and 450KC sweep. Use 120∿ sawtooth voltage in scope for horizontal deflection.

	DUMMY ANTENNA	SWEEP GENERATOR COUPLING	SWEEP GENERATOR FREQUENCY	MARKER GENERATOR FREQUENCY	CHANNEL	CONNECT SCOPE	ADJUST	REMARKS
1.	.001MFD	High side to pin 1 (grid) of 6AU6 (V11). Low side to chassis.	21.6MC (450KC Swp)	21.6MC	Any	Vert. Amp. thru 47KΩ to point D. Low side to chassis.	A12, A13 A14, A15	Adjust for maximum amplitude and symmetry.
2.	"	"	"	"	"	Vert. Amp. to point B. Low side to chassis.	A10	"
3.	"	"	"	"	"	Vert. Amp. thru 47KΩ to point C. Low side to chassis.	A11	Adjust A11 so that 21.6MC occurs at center of crossover lines. Retouch A10 for maximum amplitude and straightness of crossover lines.

CHART II

PHOTOFACT SOUND IF ALIGNMENT PROCEDURE FOR A TYPICAL INTERCARRIER SOUND SYSTEM (Fig. 10-21)

SOUND IF ALIGNMENT USING AM SIGNAL GENERATOR AND VTVM

	DUMMY ANTENNA	SIGNAL GENERATOR COUPLING	SIGNAL GENERATOR FREQUENCY	CHANNEL	CONNECT VTVM	ADJUST	REMARKS
1.	.005MFD	High side to point A. Low side to chassis.	4.5MC	Any	DC probe to point C. Common to chassis.	A7, A8	Adjust for maximum deflection.
2.	"	"	"	"	DC probe to point D. Common to chassis.	A9	Adjust for zero reading. A positive and negative reading will be obtained on either side of the correct setting.

SOUND IF ALIGNMENT USING FM SIGNAL GENERATOR AND OSCILLOSCOPE

Use frequency modulated signal with 60∿ modulation and 450KC sweep. Use 120∿ sawtooth voltage in scope for horizontal deflection.

	DUMMY ANTENNA	SWEEP GENERATOR COUPLING	SWEEP GENERATOR FREQUENCY	MARKER GENERATOR FREQUENCY	CHANNEL	CONNECT SCOPE	ADJUST	REMARKS
1.	.005MFD	High side to point A. Low side to chassis.	4.5MC (450KC Swp)	4.5MC	Any	Vert. Amp. to point C. Low side to chassis.	A7, A8	Disconnect stabilizer capacitor C7. Adjust for curve of maximum amplitude and symmetry.
2.	"	"	"	"	"	Vert. Amp. to point D. Low side to chassis.	A9	Reconnect capacitor C7. Adjust so that 4.5MC occurs at center of crossover lines. SLIGHTLY retouch A8 for maximum amplitude and straightness of crossover lines.

ness of the crossover lines or S curve. This is to compensate for any previous misadjustment of A10 caused by slight inequalities of the two load resistors R60 and R59, by an unsymmetrical condition of the two halves of the secondary winding, or by the difference of operation of the two diode sections. These inequalities would not be apparent at point B, since the response is taken from only one section of the discriminator.

If difficulty is experienced in determining the exact center of the marker on the response curve, a .001-mfd capacitor connected across the input terminals of the scope will serve to sharpen the marker indication. If a capacitor of too large a value is used, distortion of the curve is likely to occur.

Another method of making the marker indication easier to see is to amplitude modulate the marker at 400 cps. Most marker generators have internal circuits to provide this function. The 400-cps signal will appear superimposed on the response curve at the discriminator output. A zero or balance adjustment, the only point of operation where the discriminator does not respond to AM, will be indicated when the amplitude of the 400-cps signal on the response curve reaches a minimum.

Alignment of Intercarrier Receiver

In the alignment procedure for the intercarrier sound system, we find the 4.5-mc unmodulated RF signal being fed in at point A, which was also the take-off point for observation of the video IF response. The signal generator is effectively isolated from the first tuned circuit by the video-output tube V6.

The VTVM is connected to point C and chassis, across one-half the balanced detector load; and A7 and A8 are adjusted for maximum deflection which is an indication of resonance at the frequency of the incoming signal. Then the DC probe of the VTVM is moved to point D.

The voltage developed at this point should be zero when the FM sound carrier is unmodulated or at center frequency. This signal condition is represented by the 4.5-mc signal from the generator; consequently, A9 is adjusted for zero

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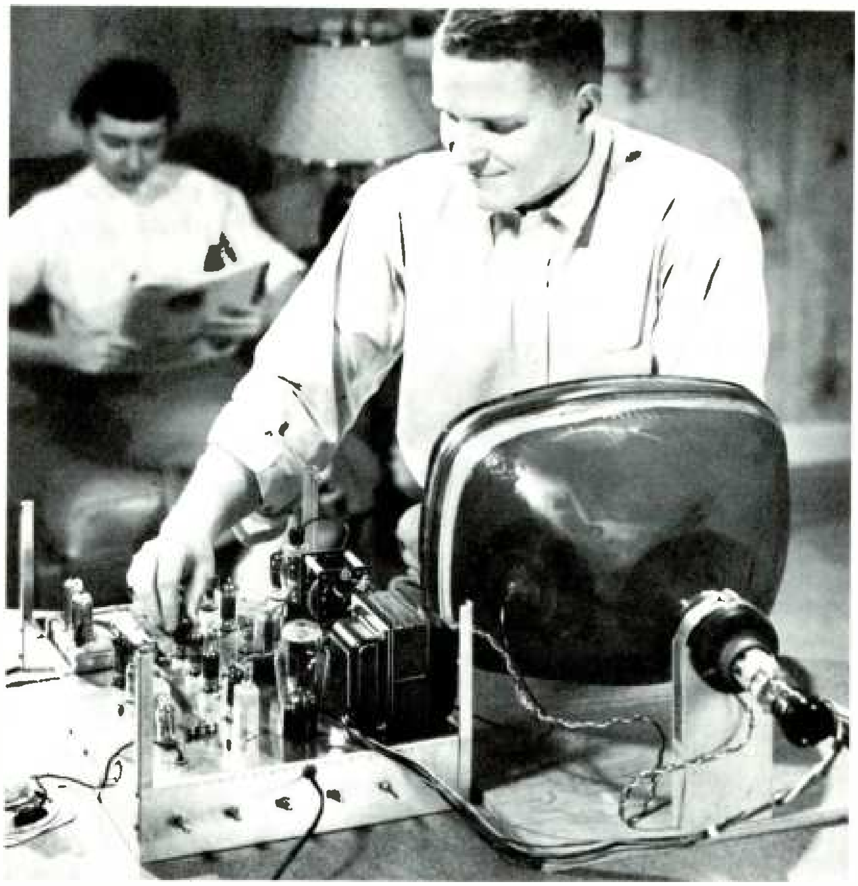

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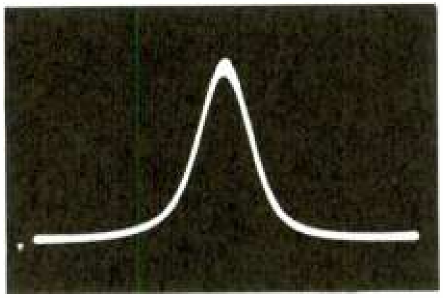

Fig. 10-22. Response Curve at Limiter Grid Resistor.

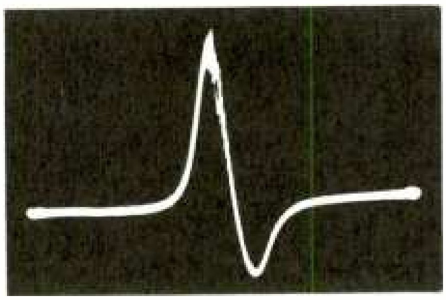

Fig. 10-23. Response Curve Indicating a Misaligned Discriminator.

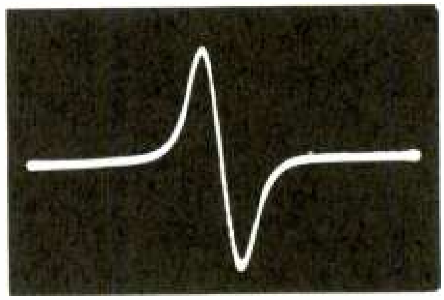

Fig. 10-24. Response Curve Indicating a Properly Aligned Discriminator.

indication on the VTVM at that frequency. When tuned to either side of 4.5 mc, a positive or negative voltage will be obtained.

Adjustment of the ratio detector is more exacting than that of the discriminator, since this adjustment controls the limiting action of the circuit; whereas, with the discriminator, limiting was obtained by a limiter stage or stages preceding the detector.

If the scope is used for alignment, it is connected from point C to chassis; and A7 and A8 are adjusted for maximum symmetrical response at 4.5 mc. The stabilizer capacitor C7 must be disconnected while making these adjustments, since its impedance is low enough to bypass the output signal (60 cps).

If the circuit were of the unbalanced type, the scope would be connected across the entire detector load, with C7 disconnected as in the foregoing.

The stabilizer capacitor is reconnected, and the scope is moved to point D. A9 is adjusted to place the 4.5-mc marker at the center of the crossover lines, and A8 is retouched slightly for maximum amplitude and straightness of crossover lines.

When making a VTVM alignment of the secondary in an unbalanced circuit, a pair of 100K-ohm resistors selected to match within ±1 per cent are connected in series across the diode load resistors; and the junction of the two matched resistors is used for the connecting point of the common lead of the VTVM. The DC probe of the VTVM should be connected to the output side of the de-emphasis network, and the secondary slug can be adjusted to obtain an indication of zero volts on the VTVM.

Figs. 10-22 through 10-26 are actual photographs of response curves obtained during alignment of a sound IF strip. Fig. 10-22 shows the curve obtained at the limiter-grid resistor. The curve obtained across one-half the load resistance of the discriminator is substantially the same. A curve representative of a misaligned discriminator is shown in Fig. 10-23, and the response indicative of correct alignment appears in Fig. 10-24. Fig. 10-25 shows the response curve obtained across the ratio-detector load, and Fig. 10-26 is the response at the audio take-off point. Both curves shown in Figs. 10-25 and 10-26 indicate proper alignment.

Gated-Beam Sound Alignment

Alignment of a 6BN6 sound system can be done using either test instruments or a signal from a TV station. If a TV signal is used, a modulated signal of steady tone such as that obtained when transmitting the station test pattern is preferred, although a normal program transmission could be used. Alignment using the TV signal would be as follows: Connect a variable attenuator in series with the receiver antenna, and adjust the attenuator to reduce the signal to a point below the limiting level of the 6BN6 limiter-detector. This point will be evidenced in the output by a hiss similar to that heard in superregeneration. The sound take-off coil, the sound IF coils, and the quadrature coil are then adjusted for maximum sound of best quality. The quadrature coil is connected to the quadrature grid, pin No. 6 of the 6BN6 tube. The buzz or noise control is adjusted for minimum buzz or noise. This control is found in the cathode circuit of the 6BN6, and its operation permits selection of the bias which will result in quietest operation of the 6BN6. If the signal strength rises during alignment to the point above limiting level, the attenuator should be readjusted until the hiss returns.

Alignment using test instruments would be quite similar to that of the preceding paragraph. A 4.5-mc frequency-modulated signal is introduced at a convenient point ahead of the sound take-off coil, and alignment proceeds with adjustment of the various coils as just described. If preferred, the output level can be indicated by an output meter across the voice coil rather than by relying upon the ears alone.

A few examples of unusual features sometimes found in the sound IF amplifier section are discussed in the following paragraphs.

Dynamic Limiter

Fig. 10-27 illustrates a feature described by the set manufacturer as a "dynamic limiter." A portion of the incoming IF signal is taken from the plate of V10 by C78 and applied to the diode plate of V11B for rectification. Capacitor C9 charges to the average value of the rectified signal. The diode plate is clamped at this level, and any positive peak at the plate of V10 must exceed this level before the diode conducts. This conduction shunts the peak to ground. Thus, any sharp amplitude peaks of the positive-going plate signal are

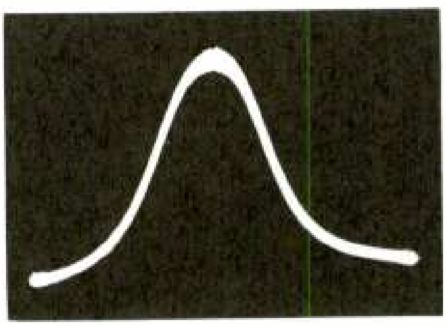

Fig. 10-25. Response Curve at the Load of a Properly Aligned Ratio Detector.

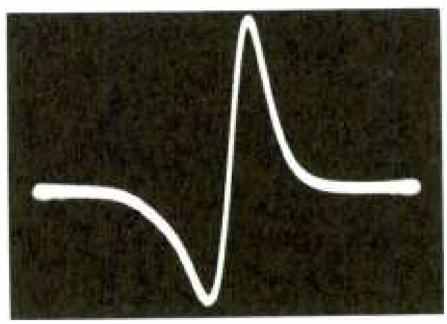

Fig. 10-26. Response Curve at the Audio Take-off Point in a Properly Aligned Ratio Detector.

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clipped or limited. These positive-going plate signals are produced by negative-going signals at the grid of V10. The positive grid signals are limited through the action of R55 and C75; therefore, the circuit gives a symmetrical limiting action by clipping both peaks of the signal.

AVC in the Sound IF

In Fig. 10-28, the voltage developed across the limiter grid resistor R48 is filtered by the action of R47, C44, R43, and C43; and it is applied to the grid of the first sound IF amplifier V9 as AVC voltage.

AVC is seldom applied to the sound IF strip in present-day receivers, because improved AGC circuits in intercarrier receivers effectively control both video and sound levels.

Before servicing the sound IF section, it should be determined, if possible, that the trouble lies in that section; since defects at other sections of the receiver can cause weakness, distortion, or total absence of sound. Usually the behavior of the receiver will give some indication which helps to localize the trouble. For example, if the sound is absent in an intercarrier receiver but the picture is normal, one would expect the sound IF to be at fault; but if both sound and video are absent, the trouble probably will lie at or before the video detector.

If distorted sound is noticed together with excessive contrast or indications of overload in the video section, that section should be eliminated first before proceeding to the sound IF strip. Weak sound, accompanied with sound bars in the picture, might indicate a misaligned sound take-off which was intended to function also as a sound IF trap. Weak, distorted, or missing sound can

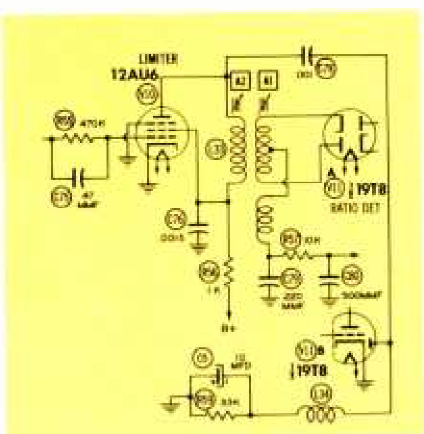


Fig. 10-27. Schematic of a Dynamic Limiter.

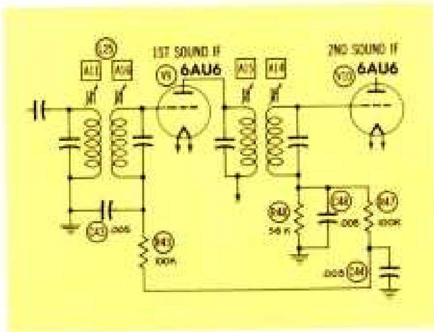


Fig. 10-28. AVC in a Television Sound System.

also be traced to the audio amplifier and output stages.

Since tube failure is the most common source of trouble, that possibility should be checked first by substituting tubes of known good quality or by means of a tube tester.

One should not resort to alignment immediately unless there is good reason to suspect that it is out of adjustment; however, adjustment of the ratio-detector or discriminator transformer in an intercarrier sound system is fairly easy and may be all that is necessary to cure a slight case of sound buzz.

Voltage and resistance checks would be next in order; and, that failing, one should try some method of signal tracing.

A strong, amplitude-modulated signal is injected at the input of the IF strip, and the generator is tuned to the sound intermediate frequency. A high-gain scope equipped with a demodulator probe is then applied stage by stage until the trouble is localized. The probe should be of the high-impedance type to prevent loading and detuning of the IF transformers.

If the IF strip employs a limiter stage, a demodulator probe will not be necessary at the grid of that stage or for the stages following, since the limiter also functions as an AM detector. Normally, the gain of a limiter stage is not great, being approximately five. If the limiter is not functioning as such, it will act as an amplifier to AM signals and the receiver will be noisy.

Open screen and cathode bypass capacitors will result in loss of gain due to degeneration. Open grid-lead capacitors in the limiter circuits will impair the limiting action.

Exaggerated high-frequency response giving a marked hissing effect to speech might indicate an open capacitor in the de-emphasis network.

PAUL C. SMITH

In the Interest of Quicker Servicing

(Continued from page 25)

results because of the fact that a pentode tube with no voltage on its screen has very little or no plate conduction.

Fuse M1 may open, in which case there is no plate voltage applied to the horizontal-output tube; hence, no high voltage is developed. There are any number of things which can cause the fuse to open. The first two things you might check are the damper tube and the horizontal-output tube, since these are the components which most often cause the fuse to blow. Sometimes the fuse blows from a surge in the line voltage.

If R3 opens, the high-voltage rectifier obviously has no filament voltage and therefore cannot produce the high voltage.

A breakdown within C3 causes a grounding of the 1B3GT cathode and produces an abnormally high plate-current flow through the tube. A breakdown of this kind very often causes the 1B3GT to become gassy, and a loss of high voltage results.

An open condition in R4 obviously causes a loss in the raster, because this condition blocks the passage of high voltage to the anode of the picture tube.

If C4 becomes shorted, a loss of the raster occurs because the 280-volt line is shorted to ground; and fuse M1 blows as a result.

If either C5 or C6 should become shorted, a loss of high voltage takes place because of the excessive load on the circuit. Fuse M1 can blow, or the horizontal-output transformer and the damper tube can be damaged.

The shorting of C7 in the yoke may cause loss of the raster by overloading the circuit.

Blooming

Blooming may be caused by any of the following tubes becoming weak: the horizontal-output tube, the high-voltage rectifier, the damper tube, or even the power rectifier. With some sets, a weak power rectifier does not cause blooming; but instead it brings about either a small raster or a dim one. Likewise, a weak damper does not always cause blooming; it sometimes produces a damped series of vertical shadow bars in the picture. Insufficient drive on the grid of the horizontal-output tube can cause blooming.

With age, R4 often increases in resistance and causes a great deal of blooming.

If the value of R3 increases, the filament of the 1B3 may not have sufficient voltage applied to it. Its emission becomes low, and may result in blooming.

Narrow Picture

A narrow picture may be caused by either the horizontal-output tube, the damper tube, or the power-rectifier tube becoming weak. It can also be caused by insufficient drive on the grid of the horizontal-output tube. If the drive does not appear to be what it should be, the preceding stage should be checked. This should be followed by a check of the components directly connected with the horizontal-output stage.

If C2 opens, the voltage on the screen of the 6BQ6GT decreases and consequently the output of this tube is reduced. The same effect results if the value of R2 increases.

Troubles in the damper can sometimes cause insufficient width. C4 may open and thus affect the operation of the damper and cause a change in the boost voltage.

Since this set does not contain a width or horizontal-linearity control, there is consequently no adjustment for correcting a narrow picture.

Horizontal Foldover

Before checking other components for failure, one would be wise to substitute first a new horizontal-output tube in an attempt to eliminate foldover. If this does not help, try substituting a new damper tube; this stage may also cause foldover. If C2 develops a high-resistance leak, a foldover in the center of the raster can occur. The reason for the foldover is that a leakage in C2 frequently produces a drastic change in the waveform of current through the horizontal-output tube.

A defective horizontal-output transformer or yoke can cause foldover. If you have one of the new instruments being manufactured for testing flyback transformers and yokes, the suspected units can be checked without removing them from the chassis.

Improper Horizontal Linearity

Since this set does not contain a horizontal-linearity control, linearity trouble must be caused by a

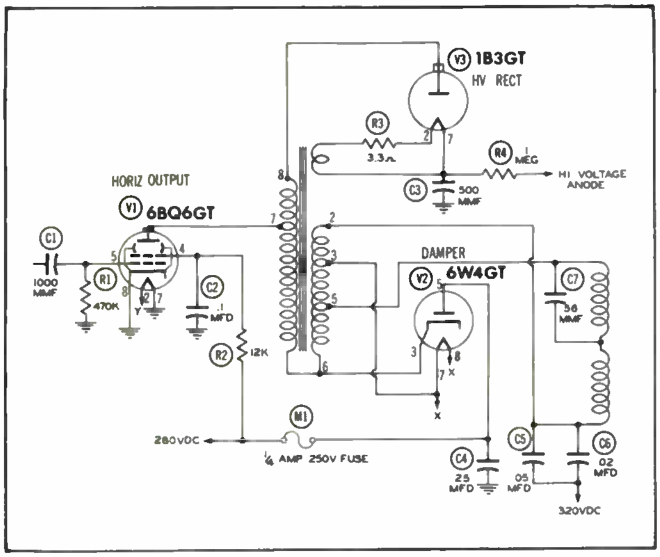


Fig. 2. Partial Schematic of Test Receiver No. 1.

failure or change in value of some part of the circuit. The best way to start on this problem is by substituting the horizontal-output tube and the damper tube, since weakness in either of these tubes can have an effect upon the linearity of the raster.

Check the waveform on the grid of the horizontal-output tube with an oscilloscope. If it is not satisfactory, check the coupling capacitor C1 and the grid resistor R1. Also check the components of the preceding stage.

Trapezoidal Raster

A trapezoidal pattern is almost always caused by a defective deflection yoke; therefore, when this trouble occurs, replace the yoke with a new one. There is one exception to this rule. If the horizontal-output transformer has just been replaced and a trapezoidal pattern is then noticed, it is entirely possible that a mismatch is causing the trapezoidal raster.

TEST RECEIVER No. 2.

Let us now consider the circuit shown in Fig. 3. This circuit is a little more complex. It contains a width control and a few other features which the other did not contain.

No Raster

In this receiver as well as in the simpler one, we found that defects in a variety of components could cause the raster to be lost; hence, the technician may have to make voltage and resistance measurements in order to isolate this trouble.

If C1 becomes open, leaky, or shorted, the set may lose sweep. If this capacitor is leaky or shorted, a positive voltage is placed on the grid of the horizontal-output tube, and the tube draws excessive current. If it is open there is no drive on the grid of the tube, no bias is developed, and excessive plate current flows. The tube can be damaged as a result.

If the grid resistor R1 increases in value or opens entirely, the grid goes negative, cuts off the plate current, and causes a loss of raster. The reason the grid goes negative when R1 is open is because of the presence of C1 and C2. These two capacitors allow a negative charge to accumulate and to bias the grid beyond cutoff.

If R2 opens, there is not enough capacity in the grid alone to permit the accumulation of a charge of sufficient value to cut off the tube; instead a high plate current flows and damages the tube.

If the drive control C2 becomes shorted, it grounds the sweep signal and causes a loss of raster.

There may or may not be a great deal of damage if C3 becomes shorted. The extent of damage depends upon whether or not the fuse blows. Since the fuse in this receiver is in the secondary of the power transformer, it may not blow in time to protect the components of the horizontal-output circuit. If the fuse fails to protect the circuit, the components which stand to be affected and possibly ruined are the deflection yoke, the horizontal-output transformer, and the screen-dropping resistor R3. If R3 opens, voltage is removed from the screen of the horizontal-output tube and the plate current is cut off.

If R4 opens, the B+ is removed from the horizontal-output circuit and loss of the raster occurs. If either R5 or R6 opens, the high current through the other resistor may cause it to open also. If this happens, the same effect as an open resistor R4 results.

If C4 becomes open, the horizontal sweep collapses, and the high voltage fails.

If the AGC winding of the transformer T1 (or any other portion of the transformer, for that matter) becomes shorted, the shorted condition throws a heavy load on the primary and may cause damage to the transformer or to the output tube.

At first glance, one would not expect C5 to cause a loss of high

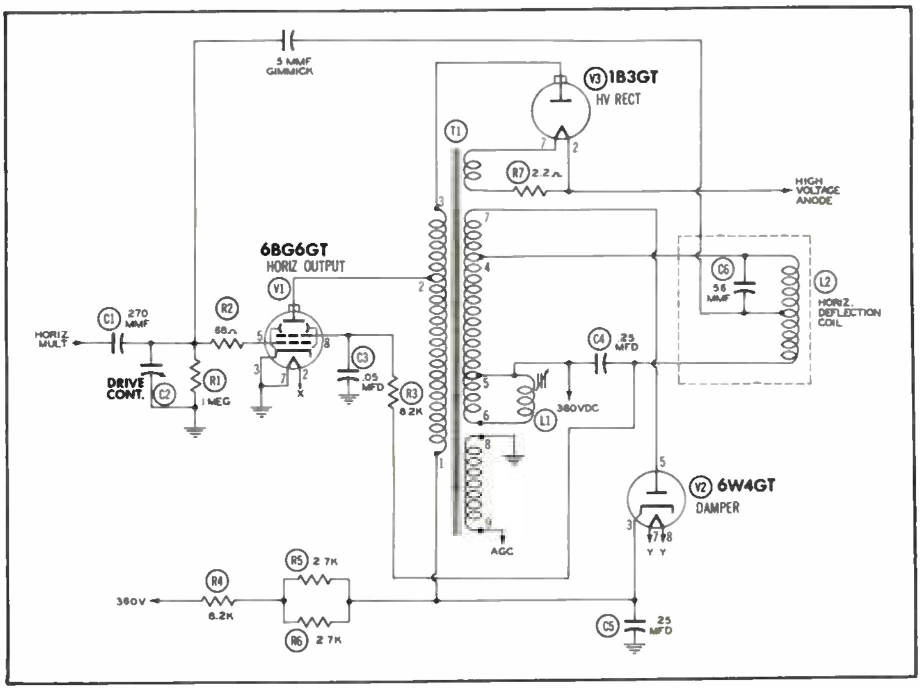


Fig. 3. Partial Schematic of Test Receiver No. 2.

voltage when it opens; but it can do exactly that, because no boost B+ is developed without C5 in the circuit. If C5 shorts, however, it either blows the fuse or burns R4, R5, or R6. With no B+, there obviously can be no sweep.

R7 may be open, in which case there is no rectification by the high-voltage rectifier and therefore no high voltage.

T1 may be tested in the same manner as the transformer in the other circuit we discussed. If L1 or L2 should become shorted, the heavy load on the circuit causes excessive plate current to flow in the horizontal-output circuit; and there is the possibility of permanently damaging the output tube. If L2 becomes open, it causes a loss of raster.

Blooming

Weak tubes are the most common causes of blooming. If C3 develops a leak or an open, either condition may cause reduced plate current in the horizontal-output tube and therefore cause blooming. Also check R4, R5, and R6 for increased resistance.

Narrow Picture

A weak output tube frequently causes a narrow raster. If C5 becomes leaky or if C3 becomes either leaky or open, these conditions also cause a narrow raster. If none of these defects are found, then check the horizontal-deflection coils.

Improper Horizontal Linearity

Poor linearity may be caused by C4 becoming leaky or shorted, since this condition affects the shape of the signal applied to the deflection coils. C6 can be open and cause the same effect, usually to a larger degree.

Trapezoidal Raster

A trapezoidal raster can be blamed almost exclusively upon the yoke.

Excessive Width

An open width control L1 may cause the raster to be too large and in a few instances slightly dimmer than normal. Adjustment of the width control does not affect the size of the picture when this trouble exists.

Henry A. Carter

and

Calvin C. Young, Jr.

Examining Design Features

(Continued from page 11)

diode. The cathode of the noise clipper is tied directly to the cathode of the sync separator. A composite video signal with a positive polarity is fed to the plate of the noise clipper through capacitor C1. When the video signal is applied to the 12AU7, the tube conducts; and two conditions result from this action. The first condition is the development of a positive potential on the cathode of the sync separator because of current flow through resistor R4. The second action is the charging of capacitor C1. This results in a negative voltage on the plate of the noise clipper, and the tube will cease to conduct. Capacitor C1 will then discharge through resistor R1. This discharge action is very slow because of the long time constant involved. A positive voltage sufficient to cause conduction of the sync clipper occurs only during the presence of a sync pulse from the video amplifier. The positive voltage developed at the cathode of the sync separator by the conduction of the noise clipper will occur only during a sync pulse and will be a very low value. When a noise pulse of large amplitude appears at the plate of the noise clipper, the tube will conduct more than during a sync pulse. This causes a greater voltage to be developed at the cathode of the sync separator. The noise pulse on the grid of the sync separator must overcome this additional bias and is thus made ineffective. This is the method by which noise immunity is provided in this receiver.

Sweep Section

The output from the sync separator is fed to an integrating network for use in the vertical-sweep system which uses the two triode sections of a 12BH7 as a multivibrator. Synchronization of the multivibrator is accomplished by feeding the pulse from the integrator network to the plate of one of the triode sections. The cathode circuit of this section contains the vertical-hold control. The other triode section is also used as the vertical output for feeding a pulse to the vertical-deflection coils. The cathode circuit of this tube contains the vertical-linearity control. A height control is also provided in the system. A pulse from the vertical-sweep section is also fed to the picture tube to provide retrace blanking.

Horizontal-Sweep System

The sync pulses from the sync separator are coupled to the horizontal-sweep section through a 150-mmf capacitor. A 6AL5 is used to provide horizontal AFC. A 12AU7 is connected as a cathode-coupled multivibrator. A more stable system is provided by the use of a ringing coil in the plate circuit of one section of the multivibrator. The horizontal pulses are applied to the grid of the 6BQ6G horizontal-output tube.

High-voltage rectification is accomplished by a 1B3GT. A 6AX4GT is connected as the damper. Controls in the horizontal-sweep system include those for horizontal hold, width, and horizontal linearity. The horizontal-hold control is the only one of these that is accessible from the front of the receiver.

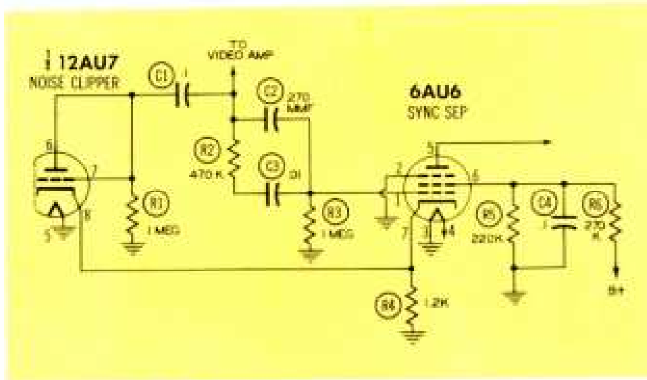


Fig. 2. Noise-Clipper Circuit.

AGC

A keyed AGC system is used in this receiver. A separate winding on the horizontal-output transformer provides the pulse necessary for operation of this system. The triode section of a 12AU7 is the AGC tube. There are two controls for the AGC system. The LOCAL-DISTANT switch is located in the cathode circuit of the 12AU7. When this switch is placed in the DISTANT position, it shorts out an 8,200-ohm resistor and raises the positive voltage applied to the cathode. A 750,000-ohm potentiometer is used to control the amount of AGC applied to the video IF amplifiers. This potentiometer is labeled "AGC CONTROL" and is located on the rear of the chassis.

Power Supply

The power supply in this receiver is conventional and requires little explanation. It contains a single 5U4G as a full-wave rectifier. The output of this supply is approximately 265 volts.

Mechanical Features

The safety glass on these receivers may be removed without removing the chassis. This provides easy access to the picture tube for cleaning purposes.

A dial light is also provided to indicate the channel that is in operation. If it becomes necessary to replace the picture tube, it should be noted that two pieces of electrician's tape are fastened to the corner that is nearest the tuner. Care should be taken to see that this tape is placed on the new picture tube for the purpose of eliminating reflections on the tube and safety glass from the dial light.

The mounting bracket for the picture tube is on the chassis. This permits the tube and chassis to be removed from the receiver as a single unit.

WESTINGHOUSE CHASSIS V-2260-12

The V-2260-12 chassis is the same as the V-2260-14, with the exception of the tuner. The tuner used

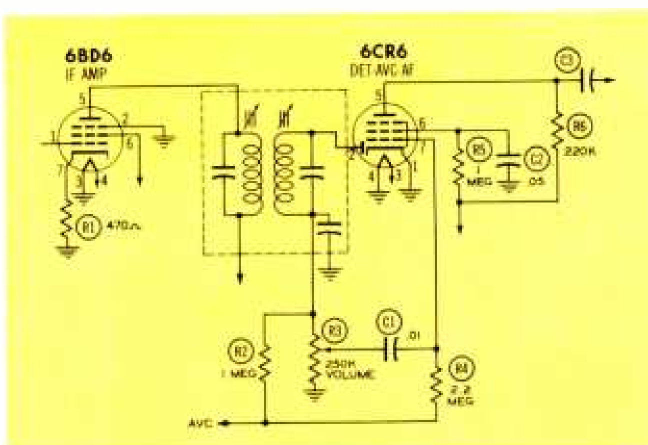


Fig. 3. A Schematic of the Motorola Volumatic Control.

in this model is a 16-position switch type and is designated V-12400-1. There is a socket on this tuner for connection of a UHF tuner. A 6X8 is used as the mixer and oscillator, and a 6BQ7A or 6BZ7 is used as the RF amplifier.

MOTOROLA VOLUMATIC CONTROL

Motorola has introduced a new feature into its line of automobile receivers. This feature is termed "Volumatic Control." Its purpose is to regulate the level of audio from the receiver under conditions of varying signal strength. These conditions may occur when tuning to different stations or may be attributed to the proximity of viaducts, bridges, tall buildings, and other objects which cause attenuation of the signal.

Volumatic control is provided in addition to the normal AVC in the receiver and is entirely automatic in its operation.

A new type of tube was developed specifically for use in this circuit. It is the 6CR6 which is a combination diode and pentode tube having a common cathode. The pentode section is a remote cutoff type and is used as the first stage of audio amplification.

The operation of this tube and its associated circuit may be more easily seen by referring to the schematic of Fig. 3 which is a partial schematic of the Motorola Model 404 receiver.

The diode section of the 6CR6 is used for detection and for development of the AVC voltage. The audio voltage from the volume control is fed to the control grid of the 6CR6 through the capacitor C1.

The departure from conventional systems occurs when the AVC voltage is also fed to the control grid of the 6CR6. A 2.2-megohm resistor R4 is used for isolation in this circuit. The operating point of the audio amplifier will then be determined by the level of AVC voltage.

If the incoming signal decreases in strength, this will be reflected in the amount of AVC voltage that is developed. The AVC voltage will then shift the operating point of the audio amplifier so that an increase in amplification occurs. The level of audio will increase to compensate for the loss in signal strength. At the same time the AVC voltage has increased the amplification of the IF stages.

DON R. HOWE

TV Colormath

(Continued from page 19)

cause shimmering sound-bar patterns on the picture tube.

The first chroma block is the bandpass amplifier. This circuit feeds the I and Q synchronous demodulators. In order to prevent the passage of the color burst through the bandpass amplifier, a gating pulse from the horizontal-output transformer is used to blank this burst OFF from the I and Q demodulator circuits. In some cases, this is done by applying the gate pulse in negative polarity to the suppressor grid of the bandpass amplifier. This cuts the tube OFF during the time of the color burst and prevents its transferal to the demodulator circuits. Although the burst occurs during the blanking interval and might seem to have no theoretical effect on chroma information, the presence of the burst is capable of affecting DC restorer action.

When no color sync burst exists, such as monochrome transmission, the color killer disables the bandpass amplifier by applying a high negative control-grid bias. Although no I and Q signals are transmitted for monochrome transmission (as detailed in previous sections), the higher frequencies in the Y channel and interference occurring around the color-carrier frequency would cause spurious chroma-section response if the bandpass amplifier were allowed to function.

The Y signal is also coupled to the burst amplifier. A burst gate is incorporated in this circuit. The purpose of this gate is to pass only the color sync burst which occurs approximately 0.4 microseconds after each horizontal sync pulse. One type

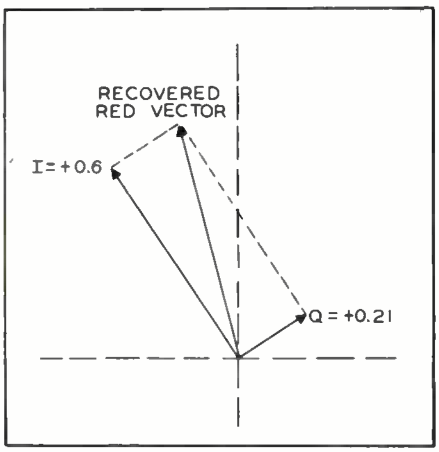


Fig. 11D. Recovery of the Red Vector in Terms of I and Q Instantaneous Voltages for a Red Transmission.

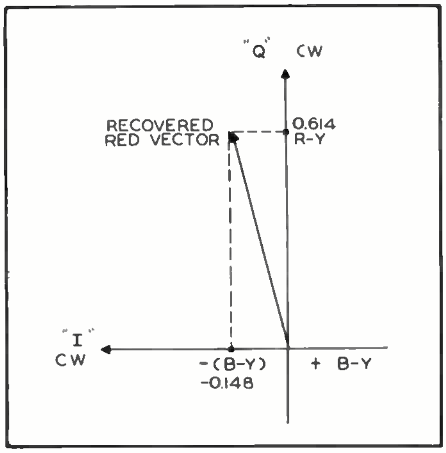


Fig. 11C. Recovery of the Red Vector in Terms of the R-Y and B-Y Color-Difference Signals.

of gate circuit holds the tube gain to zero by a negative suppressor-grid voltage. A pulse from the horizontal-output transformer is delayed 0.4 microsecond and is applied to this suppressor. This pulse gates the tube ON for the duration of the 8- to 10-cycle color sync burst which is applied to the control grid.

The burst amplifier feeds the APC (automatic phase control) loop which locks the local oscillator on frequency and on phase of this burst. Color fidelity depends greatly upon the accuracy of this portion of the receiver. Actually, a value close to 5 degrees (approximately 6 millimicroseconds) of the transmitted burst may be maintained in practical circuits. This phase accuracy is more than adequate for excellent color fidelity. The APC loop is further discussed later.

The 3.579545-mc local carrier feeds the I demodulator directly and the Q demodulator through a 90-degree phasing circuit. One typical design is to excite the suppressor grids of the demodulators with the CW signal from the local carrier, whereas the control grids receive the chrominance signals from the bandpass amplifier. The local carrier supplied to the I demodulator has the phase of t + 123°. Since the local carrier supplied to the Q demodulator is fed through a 90-degree phasor, the excitation is in quadrature to that of I and results in a phase of $\omega t + 33^\circ$.

As a specific example, we may examine the recovery of the red vector. This recovery is shown in Fig. 11C. For this specific example, the chrominance signal along the I axis is the B - Y component of the red signal. That along the Q axis is the R - Y component. The outputs of the I and Q demodulators then contain a vector corresponding to that of the transmitted red vector. Synchronous demodulators express an output amplitude which depends upon the phase angle with respect to the reference color sync burst and upon the instantaneous voltage. Instantaneous output is a product of signals applied to demodulator grids and are sometimes termed "product demodulators."

To become thoroughly familiar with the chrominance system, we may watch this action in terms of the actual I and Q vectors for a red signal. Although it is good practice for the reader to figure from the equation given earlier the values of color-difference signals and of the I and Q components for each definite color, Table I may be used.

Note that for a red transmission I = +0.6 and Q = +0.21. Placing these vectors along their respective axes, as in Fig. 11D, we again see that these respective amplitudes and the polarities of I and Q express the amplitude of the red vector.

For another example, consider magenta (red plus blue). From Table I, we note that values of I and Q for magenta are +0.28 and +0.525, respectively. Fig. 11E shows the recovery for the magenta transmission.

Fig. 11F shows the functions in terms of I and Q for all primary colors and their complements. Note that the quadrature system rotates through 360 degrees by simple amplitude relations in positive or negative values.

For frequencies up to 500 kc, double-sideband chrominance signals prevail. For this condition, the double sidebands of the I signal add together in the I demodulator, whereas the double sidebands of the quadrature (Q) signals cancel and produce no output in the I channel. Similarly, the

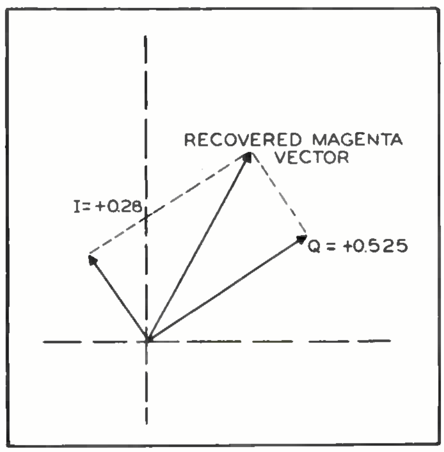


Fig. 11E. Recovery of the Magenta Vector in Terms of I and Q Instantaneous Voltages for a Magenta Transmission.

Q sidebands add in the Q demodulator, whereas I signals cancel and produce no output in the Q channel.

It is recalled that the I channel is wideband. For frequencies up to 500 kc, double sidebands prevail; but above this frequency up to 1.3 mc, the I carrier is single sideband. This type of modulation results in two sets of equal sidebands, one set in phase with the carrier and the other set in quadrature with the carrier. The quadrature components of the I channel will obviously crosstalk in the Q channel, since this is actually a quadrature component of the I channel.

This is the reason for the 0 to .5-mc filter in the block diagram of Fig. 11A. Crosstalk from the I channel into the Q channel occurs at frequencies above 500 kc. By limiting the response of this channel to its useful range of 500 kc, this interference is prevented. Since the Q sidebands are double, no crosstalk occurs from the Q to the I channel. The I-channel delay network also filters above 1.5 mc. Thus, the I-channel delay and filter and the Q filter eliminate the higher frequency Y-channel components passed by the chroma bandpass amplifier previously described.

The I and Q outputs are fed to phase splitters, so that positive and negative values of each are fed to the matrixer along with the Y signal.

While the wideband receiver just described gives 140 lines of resolution in the orange-cyan color areas, the narrow-band receiver of Fig. 11B is more economical and somewhat simpler in circuitry. Note that the locally injected carrier corresponds to the R - Y and B - Y axes instead of I and Q axes. The color-difference signals are then directly demodulated, and a single matrixer is used to extract the G - Y component.

This receiver must limit both color-difference channels to 500 kc to prevent spurious response. Since bandwidths are equal, the only delay line necessary is that for the Y channel.

The wideband receiver must use a matrixer to obtain the color-difference components. The receiver of Fig. 11B, since it obtains the color-difference signals directly from demodulation, needs no additional matrixer other than G - Y for this purpose. With R - Y voltage applied to the red cathode and Y voltage applied to the common grids, the grid-cathode voltage is E_R. A similar condition exists for the other two sections for their respective colors.

TABLE I

COLOR SYSTEM RELATIONSHIPS FOR PRIMARIES AND THEIR COMPLEMENTS

Transmitted Color	E_G	E_R	E_B	E_Y	G - Y	R - Y	B - Y	Q	I
Green	1	0	0	0.59	0.41	-0.59	-0.59	-0.525	-0.28
Yellow	1	1	0	0.89	0.11	0.11	-0.89	-0.31	+0.32
Red	0	1	0	0.3	-0.3	0.7	-0.3	+0.21	+0.60
Magenta	0	1	1	0.41	-0.41	0.59	0.59	+0.525	+0.28
Blue	0	0	1	0.11	-0.11	-0.11	0.89	+0.31	-0.32
Cyan	1	0	1	0.7	0.3	-0.7	0.3	-0.21	-0.60

E_G, E_R, and E_B are the green, red, and blue voltages, respectively, of the camera channel. Thus, yellow equals green and red minus blue, magenta equals red and blue minus green, and cyan equals green and blue minus red.

It was mentioned previously that color fidelity is influenced to a great extent by the accuracy of the APC loop. We are faced with two distinct characteristics of this portion of the circuitry:

1. AFC for pull-in to synchronization.

2. APC for phase stability after synchronization.

At the time of this writing, various circuits are being considered for this function. The service technician will probably encounter a greater variance in this circuitry of the receiver than in any other portion.

The merit of a color sync system is judged by its stabilization time. This factor is the sum of the two characteristics just given, the frequency pull-in plus the phase pull-in. When switching from one station to another, a frequency pull-in of one second or less is ordinarily considered satisfactory. Phase pull-in for a correctly functioning circuit is instantaneous after sync is established.

Consider the number of factors concerned in the color sync system. First, the conventional horizontal and vertical noise-immune sync control must be established. Then the color sync burst must be gated on, the width of this gate pulse being an important function. Then the AFC function must determine a frequency difference between the burst frequency and that of the local oscillator being controlled and must recognize it from noise. The APC must then lock the local oscillator phase with that of the color sync burst.

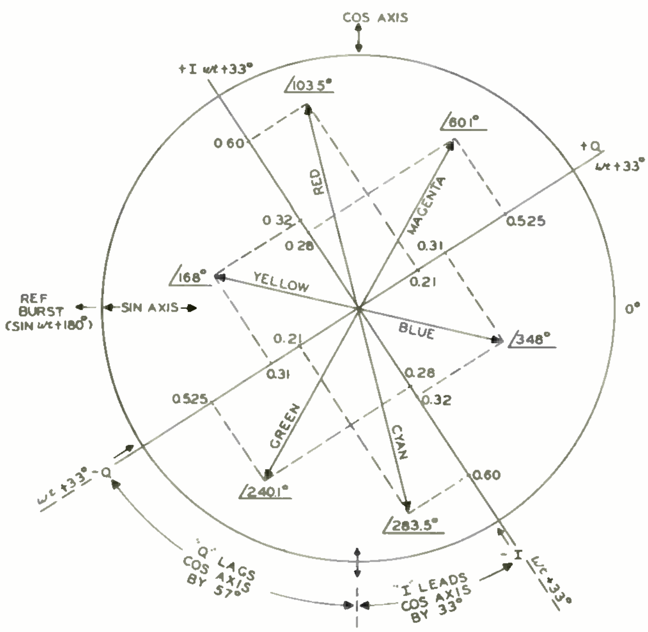


Fig. 11F. Functions of the Primary Colors and Their Complements in Terms of I and Q.

Let us consider what might seem at first a paradox. It is well-known that the ordinary AFC circuits with which the reader should be familiar work from a phase-difference principle. That is, two waves are compared with a discriminator circuit, and a frequency or phase difference results in an amplitude difference which appears as a DC correction voltage for the reactance tube. Frequency difference and phase difference are one and the same to this circuit. Therefore, the reader might argue that when frequency pull-in occurs, the phase of the local oscillator must also be correct.

This is to emphasize that timing information furnished by the sync burst consists only of a phase reference, since it is not possible to identify one cycle from another in a continuous sine wave. However, it is possible for the local oscillator to pull in yet be in phase error with resultant loss of color fidelity. One cause could be detuning of the color sync circuit. This shifts the phase in either direction, depending upon the direction of detuning. Another cause would be an aperiodic noise level such that the vector sum of burst and noise would change the effective phase angle. Echoes (the cause of ghost images) can have the same effect on the sync-burst phase. Improper width of the gating pulse or other gating-circuit troubles may result in phasing errors.

Therefore, the technician will encounter more elaborate circuits for local-oscillator control than those of conventional receivers. APC loop gain is ordinarily employed to discriminate better against noise. The burst is sometimes amplitude limited, then amplified and effectively time integrated. Time integration simply means that the sync-burst phase is averaged over a short period of time so that the loop functions as a result of past experience, minimizing the effect of tube thermal or other noise.

One type of circuit employs a crystal ringing circuit excited by the burst. It has a high Q-filter circuit, and has amplitude-limiting characteristics. Although APC circuits are initially more complex than heretofore, the stability is such that many receivers will have for the customer no hold control for the color sync. An over-all phasing control, however, will be found on the front panel in most cases, with separate controls on the chassis or rear panel. It will be important for the service technician to familiarize himself with tuning and adjustment procedures for this loop.

Harold E. Ennis

Shop Talk

(Continued from page 5)

Since significant frequency variations can be expected to occur in most moderately priced equipment, a useful standard to have available is a built-in crystal oscillator. With this, you can periodically check the accuracy of the indicating dial; and if frequency drift does occur, it can be corrected. In this writer's opinion, the ability to check dial calibration is of far greater importance than many of the so called extra features that are frequently stressed.

Also desirable in AM generators are large dials with many frequency markings plus, perhaps, a vernier dial. Very few of the frequencies that we use in television RF and IF circuits have whole values, such as 81 mc or 50 mc. Most are such odd combinations as 44.1 mc, 65.75 mc, or 21.25 mc; and since dials are calibrated in whole and half values, setting the dial to 44.1 mc can become a hit-and-miss proposition. Except in the very high-priced instruments, it is not feasible to provide line calibrations every .1 mc; but with a fairly large scale and a vernier dial, you can come quite close to this value.

A consideration that becomes more and more important as the frequency is raised is the level of the signal output. A common method of specifying this feature is for the manufacturer to state, "Output up to 0.1 volt." Seldom does this mean that you can obtain up to 0.1 volt at every generated frequency. What it usually indicates is that at some frequency or perhaps at a limited range of frequencies, an output of .1 volt will be obtainable. At all other frequencies, the maximum signal level will be less than .1 volt. Generally speaking, the output level falls off rapidly as the frequency is raised. This is a region, unfortunately, where high signal level is needed most.

You can, if you wish, check the variation in output level yourself. Place the generator in operation, and apply its output across terminals A and B of the circuit shown in Fig. 1. Resistor R1 should equal the output impedance (usually about 50 ohms) of the generator. Resistor R2 has a value of 500 ohms. R3 is variable, and initially it is set so that all of its resistance is in the circuit. Then the signal-generator frequency is varied from one end of its range to the other until the point where maximum output is obtained. At this frequency, R3 is adjusted until the meter reads full scale. The output at all other frequencies can then be compared to this maximum value.

Note that the foregoing method indicates only relative values, but these are all you need to know. When the output voltage is low, the meter indication will be lower than it should be (because of the square-law operation of the rectifiers at this low level); but this again is not overly significant when you are concerned only with relative values. Once set up, the circuit will work up to 100 mc, providing short leads are used. Beyond 100 mc, the results become less reliable because of other effects such as stray capacitance and lead resonance.

The output of a generator is sometimes checked by modulating its signal, detecting the modulated signal, and observing the audio note on a scope screen as the generator frequency is varied from one end of its range to the other. The fallacy in this

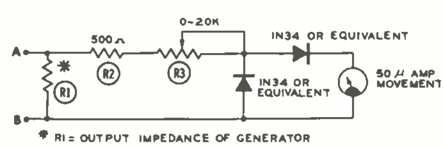


Fig. 1. Circuit for Checking Output Level of Signal Generator.

approach is that only the amplitude of the modulating audio signal is being checked. This is not a true indication of the amplitude of the RF signal, unless the precentage of modulation is maintained throughout the RF range. Since this is not done in most instruments, this procedure is not recommended.

No matter how good a generator may be, output level variations will be encountered. This is actually not your concern. What is important, however, is how low the maximum output goes, say at the high frequencies. Make sure you have enough signal with which to work.

It is said that one of the reasons for the rather high divorce rate in this country is the fact that you do not really get to know a person until you have lived with him or her. The same is true of instruments. When you have worked with an instrument for a while and have come to like it, try to fix in your mind those features of the unit that particularly suit you. It may be portability; ease of operation; a simple, uncluttered dial; accuracy; or extended range. Note these features carefully, and then use them as standards in choosing new equipment. Most people do this subconsciously; but if you do it knowingly, it is this writer's experience that you will be able to make definite decisions faster and more satisfactorily than you ever have before.

Review. Everybody knows what a fuse is and what it does. Undoubtedly, every reader of the PF INDEX has changed a fuse sometime in his life; but that is about as far as the general knowledge extends. Not so well known is the fact that there are three types of fuses for electronic circuits and that each has a specific application where it can best provide the protection that it is designed to give.

Two excellent articles on fuses have appeared recently. One was written by E. V. Sundt on "Proper Uses of Fuses," and the other was written by J. C. Lebens on "TV and Radio Chassis Protection." The first article appeared in the December 1953 issue of Electronic Design magazine, and the second was published in the February 1953 issue of Service magazine.

Electronic Design is published monthly by the Hayden Publishing Company, 127 East 55th Street, New York 22, N. Y. It is available without charge to design and development engineers on the engineering staffs of electronics manufacturers. Service magazine is published monthly by Bryan Davis Publishing Company, 52 Vanderbilt Avenue, New York 17, N. Y. Subscription rates are $2.00 yearly in the United States and Canada.

When properly installed, a fuse protects the equipment against overloads and burnouts and prevents unnecessary power interruptions caused by spurious current surges. The three types of fuses that one commonly encounters in electronic circuits and associated equipment are the high-speed type, the medium lag, and the Slo-Blo or Fusetron type. (The words Slo-Blo and Fusetron are registered trade names, the first one belonging to Littelfuse, and the second to the Bussman Manufacturing Company.)

The high-speed or fast-acting fuses do not have an appreciable time lag once their specified rating is exceeded. For all currents up to the indicated value, they will hold indefinitely. At 150 per cent of rated value, they will open up within 10 seconds. These units are designed to protect equipment where lag characteristics would be detrimental. Ammeters, milliammeters, and voltmeters fall within this category; hence, high-speed fuses would be employed in these circuits.

The medium-lag fuse has the greatest number of applications, being the type that is used normally in fusing the input power line to a piece of electrical equipment. Actually, what primarily needs to be protected in most instances is the power supply, since any current overload will generally affect the power transformer or the rectifier, or both. Table I lists the recommended fuse to use with various wattages. A power-line voltage of 115 volts is assumed.

The third type of fuse is the Slo-Blo or Fusetron fuse. These are designed primarily for circuits in which there occur periodic or transient current surges not harmful to the equipment. In these circuits, high- or medium-speed fuses would open and cause a nuisance difficulty. One logical application of a long-time-lag fuse would be in motors which have high-starting-current surges. Another place where these units would be especially useful would be in intermittent systems in which the current rises and falls rather sharply. The slight expansion and contraction of a fuse element many hundreds of thousands of times can cause cyclic fatigue with subsequent failure of the fuse element, and time-delayed elements give better service under these conditions.

TABLE I

SIZES OF MEDIUM-LAG FUSES FOR VARIOUS POWER REQUIREMENTS ON 115-VOLT AC LINE

Power Required (watts)	Fuse Rating (amperes)
40-65	1
65-100	1 1/2
100-150	2
150-250	3
250-350	5
350-450	6

Underwriters' specifications for medium- and long-time fuses state that they must be capable of carrying 110 per cent of their rated current continuously when installed in a single fuse holder. Under these same conditions, the fuse must open at 135-per-cent load within 60 minutes and at 200-per-cent load within 2 minutes. On this basis, a 1-ampere fuse listed by the Underwriters' Laboratories will carry 1.1 amperes indefinitely, will open at 1.35 amperes in 60 minutes, and will open at 2 ampers within 2 minutes. UL has established that this is safe performance, and any fuse meeting these requirements will not create a fire hazard if applied properly. Actually, a medium-lag fuse will blow in about 2 or 3 seconds at 200-per cent overload and a long-time-lag fuse in 5 to 10 seconds. The additional time represents the basic difference between these two types of fuses.

Fuses are rated by voltage as well as by current. Thus, glass-tube fuses are rated at 32 volts or less, 125 volts or less, and 250 volts or less. The 32-volt fuse is designed primarily for battery-operated and auto radios; the higher ratings are for fuses used in AC and DC power lines. The inclusion of a voltage rating may seem superfluous, since fuses are current-operated devices.

However, once a fuse element melts, the full circuit voltage appears across the fuse and the fuse must be capable of extinguishing the arc established by the voltage. A moment's consideration will reveal that the higher the circuit voltage, the greater the arc and the more difficult it is to clear the circuit. For this reason, voltage ratings represent the upper limit for the fuse. Voltages are established by actual tests. Underwriters' Laboratories establishes the voltage rating of low-voltage fuses on a DC circuit capable of delivering 10,000 amperes at the voltage for which the fuse is rated. They surround the fuse with surgical cotton; and when a fuse is blown on such a system, the fuse must remain intact and open the circuit without emitting sufficient flame or molten metal to ignite the cotton.

Rating a fuse in this manner gives the average application a greater safety factor, since in no radio or TV receiver will currents of 10,000 amperes ever be encountered. It is because of this fact that we can use fuses of less than 1-ampere rating in circuits in which the voltages go as high as 500 volts. The latter application occurs in the plate circuit of the horizontal-output rectifier and is the only place where UL will approve of the use of a fuse in a circuit possessing a voltage higher than that of the fuse.

In replacing fuses, always use one which has the approval of the Underwriters' Laboratories. This organization is sponsored by the National Board of Fire Underwriters and tests and determines the compliance of material with the National Electrical Code. Its principal interest and sole reason for existence is safety. It is concerned only in determining whether a product will create a fire hazard, not whether the product has any commercial value.

Fig. 2. Snap-on Fuse Holder

In a television receiver, fuses appear in two general places: in the AC power line and in the plate circuit of the horizontal-output amplifier. The power-supply rating of the set in watts for 115 volts and the medium-lag fuse that would be used are given in Table I.

In the horizontal system, the average fuse value is 1/4 ampere at 250-volt rating. For the most part, these fuses come with pigtail leads that are soldered into the circuit. For the technician who does not want to be bothered with soldering replacement fuses in place, snap-on fuse holders are available. See Fig. 2. One side of the holder is snapped onto the blow fuse, and the replacement fuse is inserted into the other side of the holder. Replacement in this manner is readily accomplished without soldering or pigtail cutting. Cost of the holder is less than 25 cents.

MILTON S. KIVER

Notes on Test Equipment

(Continued from page 15)

used. The VP factor was not at hand, so it was calculated using formula 1. The length of the line D was known, and $f_2 - f_1$ was obtained from meter readings. Substitution of these values in the formula gave a VP of .815. To form a test case, a short was then introduced at a distance of 31 feet from one end. Measurement with the meter at this end should then verify this distance of 31 feet to the short. Dip readings were taken by coupling the meter across a loop at this end, and these readings are as follows:

Dip Readings (mc)	Difference $f_2 - f_1$ (mc)
91.2	
	13.0
78.2	
	12.7
65.5	
	13.5
52.0	
Average Difference	13.1

By using the foregoing figures to solve formula 1, we find that:

$$D = \frac{984 \times .815}{2 \times 13.1}$$

$$D = 30.6 \text{ feet (calculated).}$$

The actual measured distance to the short was 31 feet, so the error by the meter method was only .4 foot.

When making measurements by this method, certain precautions should be observed. The coupling loop at the end of the transmission line should be kept small, and the meter should be coupled to it as loosely as possible while still obtaining satisfactory dip indications. If an unshielded line is allowed to loop or double back on itself, some very confusing indications may be obtained.

Fig. 1. Grid-Dip Meter Being Used to Measure Electrical Length of Transmission Line.

This method cannot be used satisfactorily to determine the length of unshielded line on a spool, but it works very well on coaxial cable. A small roll of RG 59/U line was measured in this manner. The calculated length was 35 feet. Actual measurement showed the line to be 35 feet 2 inches long.

Returning to the subject of antenna lead-ins, there are some instances in which a conclusive indication of the condition of the antenna system may not be obtained by the grid-dip method of measurement. For example, readings may indicate that the total length of the lead-in is intact up to the antenna itself where an open condition is indicated. The same indications can be obtained with a lead-in in perfect condition but with an improper impedance match at the antenna. Since the results of the test discount the possibility of a defect at a point appreciably removed from the antenna and since the antenna system is still suspected, the trouble is localized to a point near or at the antenna itself; so, the aforementioned limitation of the method is not a serious one.

For the technician who wishes to save himself some time and avoid any unnecessary tower or roof climbing, the foregoing method should prove useful. When he becomes familiar with the use of the grid-dip meter in this manner and notes the ease with which it is operated, he may wish to explore further the possibilities of this instrument in other applications.

A Closer Look at an Old Acquaintance—Your Voltmeter

Constant daily association with his test instruments may lead the technician to accept their performance as a matter of course; yet many interesting principles may be involved in some of the simplest applications of these instruments. The voltmeter is one of the most frequently used instruments of any on the test bench, and its indications are usually accepted without question; however, when it is improperly used, its indications can be far from correct.

The accuracy of a voltmeter reading depends upon several factors such as the accuracy of the meter movement itself, the loading effect of the meter on the circuit involved, or the type of signal being read.

Meter Input Impedance

The loading effect of the meter on the circuit under test is one of the most important considerations. This loading is dependent upon the input impedance of the meter and the impedance of the circuit to which it is applied. Fig. 2 is a simplified diagram showing a voltmeter connected to a circuit to make a voltage reading. E_S is the voltage source and could be either a DC supply or an AC signal. $R_L + R_O$ constitutes the load across E_S when the meter is not connected. The internal resistance of the source is in series with the external load and can be lumped with R_L. The voltage which should appear across R_O would be

$$E_S \left(\frac{R_O}{R_L + R_O} \right)$$

Actually, when the meter is applied to measure the voltage across R_O, the meter resistance is in parallel with R_O and their combined resistance will be less than R_O alone. Thus, the loading upon E_S is changed and a reading is obtained that is lower than the calculated theoretical voltage.

The meter reading taken across R_O will be less than the voltage present when the meter is disconnected. The percentage of error in the reading will be greater for the following conditions:

1. When the meter resistance is decreased.

2. When R_O is increased.

3. When R_L is increased.

This shows why it is important to use a high-impedance meter when working with high-impedance circuits.

You may wish to conduct the following experiement. Obtain several meters with a variety of input impedances such as a VOM, a VTVM, and any others at hand. Use these meters to check the voltage of a fresh battery such as a 22.5-volt B battery. Use the lowest meter range consistent with safety. Since the internal resistance of a fresh battery such as the one mentioned should be very low compared to the meter impedances, all the meters should indicate very nearly the same, 22.5 volts. Then connect a resistance to one battery terminal, and measure the voltage across the free end of the resistor and the other battery terminal, using each meter in turn. This arrangement is the same as in Fig. 2 when R_O = infinity. Try several values of resistors such as 10K ohms, 470K ohms, and 2.2 megohms. In all cases, the meters will indicate lower voltage as R_L is increased. In addition, the meters with lowest input impedances will show the lowest readings. The readings obtained in this manner when R_L = 2.2 megohms will vary considerably, from approximately 6 volts when using a meter rated at 20,000 ohms per volt to approximately 19 volts when using a VTVM having an input impedance of 11 megohms.

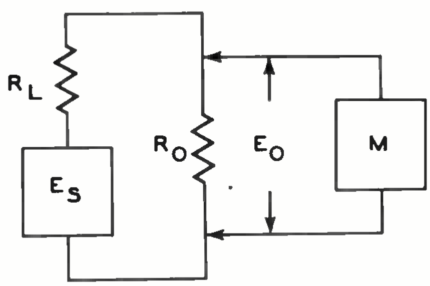


Fig. 2. Simplified Diagram Showing Use of Voltmeter.

Meter-Impedance Variation With Range

An interesting point of difference between conventional multimeters and VTVM's should be noted here. The input impedance of the multimeter varies with the range in use; whereas with most VTVM's it is constant at some value determined by design, usually 10 or 11 megohms. It is common practice to rate the input impedance of multimeters at so many ohms per volt. For example, a meter might be rated at 20,000 ohms per volt, meaning that on a range which reads 10 volts at full scale the input impedance is 10 x 20,000 or 200,000 ohms; or on a 100-volt range, the impedance would be 2 megohms. These impedance values are the sums of the resistance of the meter movement plus the multiplier resistors for the ranges mentioned, and it is this sum which the meter places in parallel with the circuit when a voltage reading is made. Therefore, in order to load any circuit the minimum amount, the highest multimeter range which permits a convenient deflection should be used.

The careful technician will protect his multimeter by setting it to a voltage range that he is sure is more than adequate for the voltage being measured, and he will then reduce the range setting step by step until the pointer deflection is easily read. While following this procedure, it is not uncommon to find that the pointer remains at nearly the same position on the scale through all ranges even down to the lowest range. This is a positive indication that the meter impedance is too low and is loading the circuit.

AC Voltages

Since the meter movement responds only to DC, some type of rectifier must be used in conjunction with it in order to measure AC voltages. The meter input impedance to AC will then depend upon the type of rectifier and the sensitivity of the meter movement used with it. Most multimeters will use rectifiers of the dry-disc type, whereas most VTVM's will use a diode of some sort, although some VTVM's do employ the disc type of rectifier. Sometimes, in the case of the VTVM, the rectifier will be external to the instrument and in the form of a probe that uses either a crystal diode or a diode tube. The AC input impedance commonly found with multimeters is 5,000 ohms per volt or less because of the use of the disc rectifier. The internal capacity of this type of rectifier is appreciable so that the higher audio frequencies are bypassed, resulting in a reading that is lower than normal at these frequencies. In addition, the response of this type of rectifier is different for low voltages than for higher voltages; therefore, a separate AC scale is necessary for accurate calibration. In many cases, a separate scale will be provided for the lowest AC range.

The AC input impedance of VTVM's usually is much higher than that of the meter employing a dry-disc rectifier. The main limiting factor of the latter type of meter is the shunting effect of its input capacity at high frequencies. The probe type of rectifier tends to reduce the input capacity of the meter and therefore is more useful at higher frequencies.

Other Loading Effects

The simplest loading effect is the one mentioned in the opening paragraphs. The meter resistance is shunted across the voltage to be measured, causing added current drain and a lower reading as a consequence. With certain types of circuits, the loading may cause other effects. For example, when measuring the voltage at an oscillator grid, the loading may be sufficient to weaken the oscillations greatly or to cause the oscillator to quit entirely so that an incorrect reading or no reading at all will be obtained. The capacitance of the meter leads together with the capacitance of the meter input stage may have some detuning effect when applied to tuned circuits. This effect is reduced by the 1-megohm isolating resistor usually found in the DC probes of VTVM's and by the use of low-capacity AC probes.

When working with high-gain or critical circuits, the added capacity of the meter leads may be enough to cause the system to break into oscillation. A little judicious routing of the leads may help in this case; and in some cases, an external isolating resistor may be necessary, with connections being made as short and direct as possible. The addition of the isolating resistor naturally introduces some error in the value of the reading, and this fact brings up the point that sometimes the technician does not require an exact voltage indication. We refer to instances in which the technician is interested in comparative values only or in determining only if voltage is present at the points in question. The first case is illustrated by a VTVM alignment of a video IF strip. In such a case, the adjustments are made for maximum or minimum deflection of the VTVM without much concern about the absolute value of the readings. The second case could be illustrated by the use of signal-tracing methods in locating a receiver fault. In this case, the technician is primarily concerned with the point at which a signal appears or disappears, although relative strength of the signals is of some importance.

RMS and Peak-to-Peak Measurements

An important factor to be considered when making AC voltage readings is whether the rectifier circuit of the meter is properly designed to measure the AC waveform in question. Commonly, the meter circuit is designed to give a reading that is proportional to either rms or peak values of a sinusoidal waveform. An explanation of the terms peak, rms, and average may be found in books on alternating-current theory; and an indication of their relative amplitudes is shown in Fig. 3. In this figure, one-half cycle of a sinusoidal waveform is shown, covering from 0 to 180 degrees. Using a peak value of 1 as a reference, the rms value is .707 and the average value is .636. These latter two values are, more exactly:

$$\frac{1}{\sqrt{2}} \quad \text{and} \quad \frac{2}{\pi}$$

The rectifier circuit of the AC voltmeter can be either a half-wave

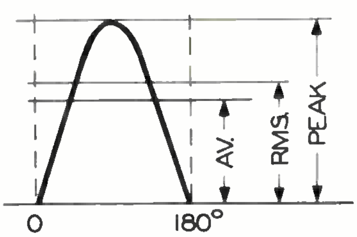
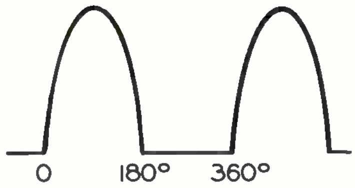
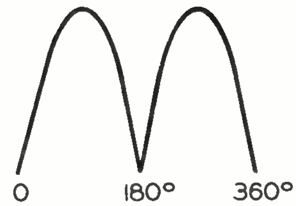


Fig. 3. Peak, RMS, and Average Values of a Sine Wave, One-Half Cycle.



(A) With Sine-Wave Input to a Half-Wave Meter Rectifier.



(B) With Sine-Wave Input to a Full-Wave Meter Rectifier.

Fig. 4. Voltage Waveforms Across Meter Movements.

rectifier or a full-wave rectifier. A sinusoidal voltage was fed to the input leads of an AC meter of the first type, and the voltage waveform across the meter terminals was viewed on an oscilloscope. The resultant waveform is shown in Fig. 4A. Since the waveform is the same as that shown in Fig. 3 for one-half of the cycle but zero for the other half, the average will be .636 ÷ 2 or .381 of the peak value. Fig. 4B illustrates full-wave rectification with an average value of .636 for the full cycle. The voltage across the meter terminals is pulsating DC in either case, but the inertia of the meter movement results in a smooth indication by the pointer at approximately average value. Since the peak, rms, and average values all bear a definite fixed ratio to each other, the meter can be calibrated with scales to read any or all three types of values, provided that the voltages measured are sinusoidal. Any departure of the signal from this sinusoidal waveform will introduce an error in the readings (except in the case of Fig. 4B, if the scale is calibrated for average values).

A diode-rectifier circuit can be designed to yield peak-to-peak values by using a voltage-doubler circuit. The load resistor and shunt capacitor should be of such value that the RC constant is large compared with the period of one cycle of the AC voltage being measured. Provisions for measuring peak-to-peak voltages are becoming increasingly prevalent in meters of recent design because of the usefulness of such readings in television servicing. Some meters have provisions for switching to either rms or peak-to-peak functions; and in that case, readings should be accurate, if the proper function is used for the waveform under consideration. Other meters operate on the peak-to-peak principle on all AC measurements. The scale, however, is calibrated so that both rms and peak-to-peak values are indicated. The technician should bear in mind that a meter of this type will give accurate rms readings only on sinusoidal waveforms.

Fig. 5 illustrates a type of waveform which would be correctly indicated on a meter which measures true peak-to-peak values. The measurement of this waveform would result in an incorrect indication on a meter designed to respond to rms values.

In summary, the main points to remember for best results in using voltmeters are:

1. Use a high-impedance meter with high-impedance circuits.

2. Use the highest satisfactory range when using a meter with impedance that varies with the range.

3. When measuring AC voltages, use a peak-to-peak range for peak-to-peak voltages and an rms range for rms voltages.

4. Use low-capacitance probes and short leads in critical circuits.

Sprague Model TO-4 Tel-Ohmike

The Sprague Model TO-4 Tel-Ohmike Analyzer, which is shown in Fig. 6, combines in one moderately sized instrument provisions for making a wide variety of tests of capacitors and resistors.

The instrument employs an AC bridge for measurement of capacitance, power factor, and resistance. Scales are large, and the divisions are clearly marked and easily read. A magic-eye tube gives visual indication of bridge balance.

Capacitances from 1 mmf to 2,000 mfd and resistances from 2.5 ohms to 25 megohms may be checked. Certain applications employ capacitors rated in impedance rather than

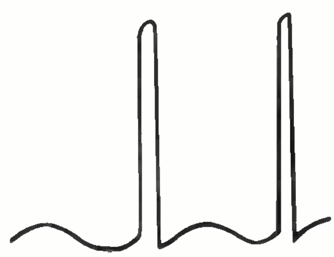


Fig. 5. Example of a Waveform Which Must Be Measured in Peak-to-Peak Values.

Fig. 6. Sprague Tel-Ohmike Model TO-4 Capacitor-Resistor Analyzer.

in microfarads, and a special scale is provided for their testing. This scale is calibrated so that the impedance reads from 2 to 60 ohms at 60 cycles per second. A low capacitance range covers from 1 mmf to 100 mmf in steps of 1 mmf.

All capacitance and resistance ranges are overlapping. These ranges are selected by means of front-panel pushbuttons. In addition, other pushbuttons are provided for the functions of measurement of insulation resistance and electrolytic leakage. Another pushbutton provides for fast charging of large capacities. Release of all pushbuttons automatically discharges any capacitor under test.

Insulation resistance and electrolytic leakages are read directly on a front-panel meter. The meter is calibrated to read insulation resistances between 150 and 20,000 megohms and electrolytic leakage up to 60 ma. A toggle switch provides for full-scale readings of electrolytic leakage of either 60 ma or 6 ma.

Any polarizing voltage from 0 to 600 volts may be applied to electrolytic capacitors and metered on the front-panel meter.

Three power-factor ranges are provided: 0 to 20, 20 to 40, and 40 to 55 per cent.

All controls are clearly labeled, and operating instructions on the front panel make possible a minimum number of references to the operating manual once the technician becomes familiar with the use of the instrument.

Over-all size of the Model TO-4 is 8 7/8 inches high by 15 5/8 inches wide by 6 1/8 inches deep.

Net weight is 12 1/2 pounds.

The tube complement consists of one each of the following tubes: 12J5GT, 1619, 1629.

PAUL C. SMITH

Audio Facts

(Continued from page 27)

(h) Hum and noise level (phono).
60 db below 1-volt output.

(i) Hum and noise level (microphone).
70 db below 1-volt output.

(j) Equalization.
For the RIAA (Record Industry Association of America) curve: 500-cps crossover frequency and high-frequency roll-off determined by the value of loading resistor R1 and by the characteristics of magnetic pickup used.

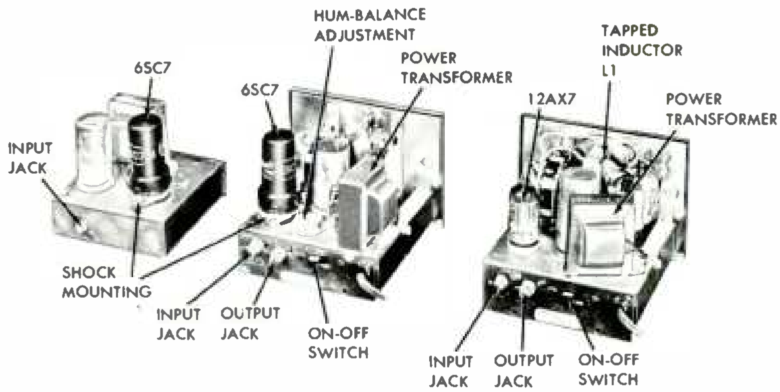
(k) Output impedance.
Operates normally when connected to an amplifier with an input impedance of 100,000 ohms or higher. A long output cable with a maximum length of 50 feet can be used without loss of high frequencies.

Circuit

The circuit shown in Fig. 4 is simple but very complete considering that this is a self-powered unit of very small size.

As mentioned before, the value of the loading resistor R1 determines the amount of high-frequency roll-off. The recommendations specified by the manufacturer of the pickup that is being used should be followed when selecting the value of this resistor.

The desired amount of roll-off can be obtained by substituting various values of resistors for R1 until the right effect is achieved. This value should be kept within the limits of 3,300 to 22,000 ohms.



MODEL PR-5 PREAMPLIFIER   MODEL 50-PR-2 PREAMPLIFIER-EQUALIZER   HI-LO FILTER SYSTEM MODEL 50-F

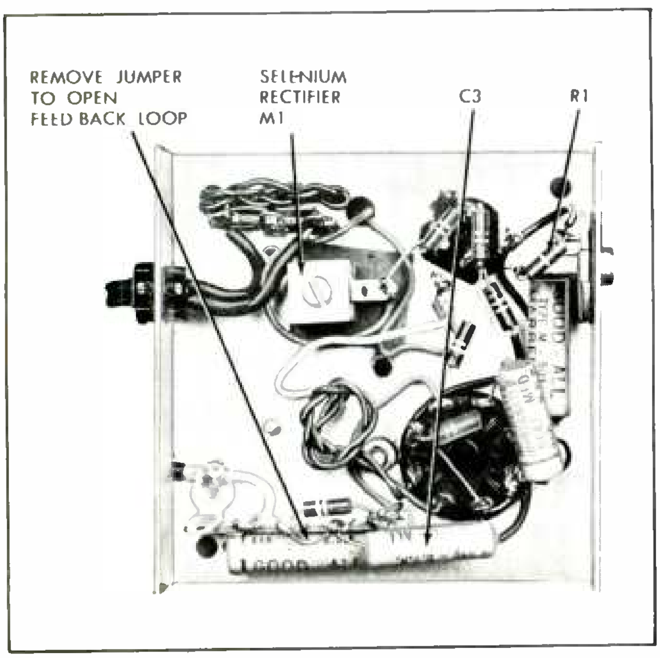
Fig. 2. Rear Views of the Fisher Models PR-5, 50-PR-2, and 50-F (Cabinets Removed From Models 50-PR-2 and 50-F).

Low-frequency compensation, with the crossover at 500 cps, is furnished by the feed-back circuit composed of capacitor C3 and resistor R4. This compensation corresponds to the RIAA curve (similar to the RCA Orthophonic curve) which is becoming the standard of the recording industry. It is also very close to being a happy medium of the many recording curves used in recent years. Therefore, it is possible to get satisfactory reproduction from most any record with the Model PR-5, with any small adjustments in response being made by means of whatever tone controls are included in the system.

Used as a Microphone Preamplifier

If the equalization circuits in the Model PR-5 are eliminated, it will serve as a very satisfactory high-gain preamplifier for a low-level microphone. Disconnecting R1 from the circuit will remove the high-frequency roll-off. The low-frequency compensation can be removed by opening the feed-back circuit at the point marked with an X in the schematic. The jumper which is opened at this point is shown in the bottom view of Fig. 3, and on the chassis it is painted red for identification.

If the high gain (which is obtained when all negative feedback is taken out of the circuit) is not needed or desired, feedback without low-frequency equalization can be had by allowing R4 to remain in the circuit and shorting across C3 with a jumper. With R4 connected directly between pins 2 and 5 of the 6SC7 tube, the benefits of negative feedback will be kept and gain will be reduced by the feed-back action.

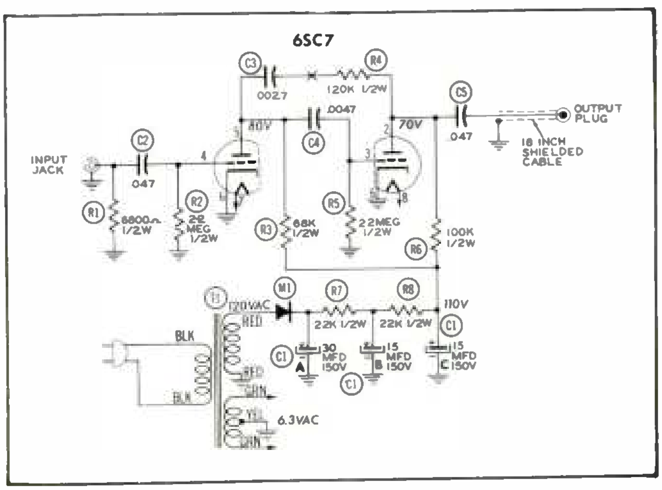


(Left)

Fig. 3. Bottom View of the Fisher Model PR-5.

(Below)

Fig. 4. The Fisher Model PR-5 Preamplifier.



MODEL 50-PR-2 PREAMPLIFIER-EQUALIZER

Basically the Model 50-PR-2 Preamplifier-Equalizer (Figs. 1, 2, and 5) is similar to the Model PR-5. A 6SC7 tube is used in the same basic circuit, but this unit is more elaborate and flexible than the PR-5. Many of the general specifications also apply to the Model 50-PR-2 and will not be repeated, but its added features will be discussed.

The Model 50-PR-2 has a neat and very substantial plastic cabinet which is 4 7/16 inches high, 5 3/8 inches wide, and 5 inches deep. The metal front panel contributes much to the attractive appearance of the unit.

Flexibility of operation is provided by the lever type of controls seen in the front view. A pilot light is also visible on the front panel. A slide type of ON-OFF switch is located on the back of the chassis, and a hum-balance adjustment can be seen above it beside the power transformer in Fig. 2.

Circuit

The method used to obtain the flexibility of control featured in this unit can be seen in the schematic shown in Fig. 6.

A 470,000-ohm resistor R1 is connected across the input to match it to a GE or Fairchild pickup. The instructions enclosed with the preamplifier recommend that an additional loading resistor should be connected across the input to equalize the response when some other makes of pickups are used. For instance, a 470,000-ohm resistor is recommended for loading an AUDAK pickup, and a 27,000-ohm resistor is used for a Pickering pickup.

Larger resistors than are called for in the Model PR-5 are used to load the input, because additional roll-off is provided in this unit by the high-frequency roll-off control which will be described later.

Low-frequency compensation (bass boost) is obtained, as in the Model PR-5, by a frequency-discriminating feed-back circuit connected between the two sections of the 6SC7 tube; but in this unit, the compensation is made adjustable by means of the four-position crossover switch M2.

Various combinations of capacitors and resistors are switched into the feed-back network to obtain low-

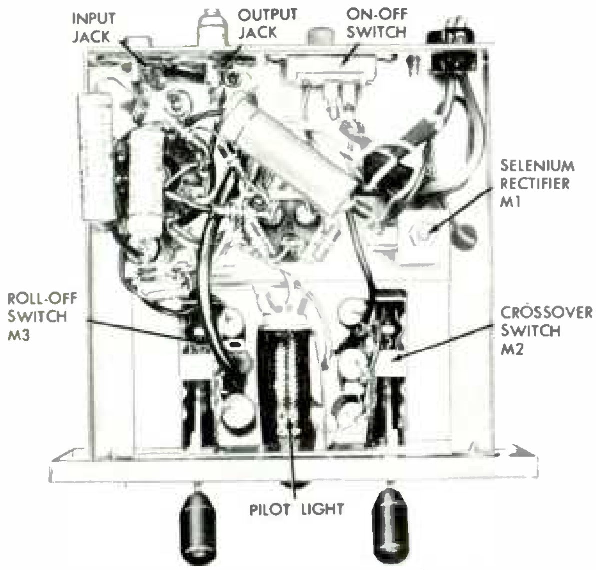


Fig. 5. Bottom View of the Fisher Model 50-PR-2.

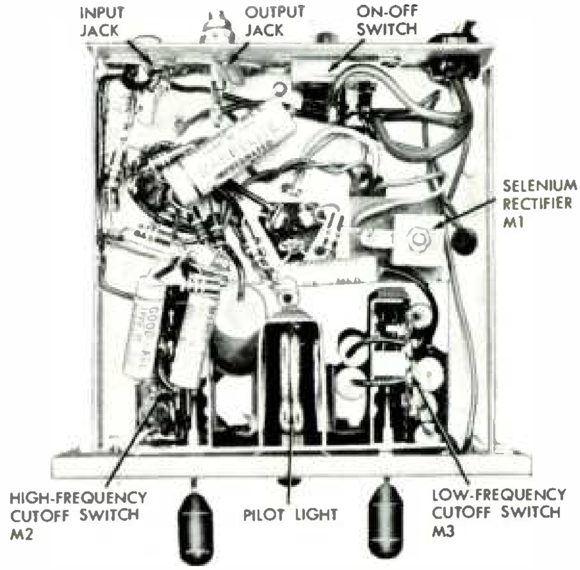


Fig. 7. Bottom View of the Fisher Model 50-F.

frequency equalization following the curves listed:

SWITCH POSITION	CURVE
No. 1	AES
No. 2	NARTB, Ortho
No. 3	LP
No. 4	Crossover at 800 cps

High-frequency roll-off is accomplished by switching either capacitor C9, C10, or C11 across the output. The switch settings listed below provide the various amounts of attenuation at 10,000 cps:

SWITCH POSITION	ATTENUATION
No. 1	0 db (flat)
No. 2	8 db
No. 3	12 db (for AES or Ortho)
No. 4	16 db (for NARTB)

As an example, position 3 results in an attenuation of 12 db at 10,000 cps, which follows the AES and NARTB curves very closely.

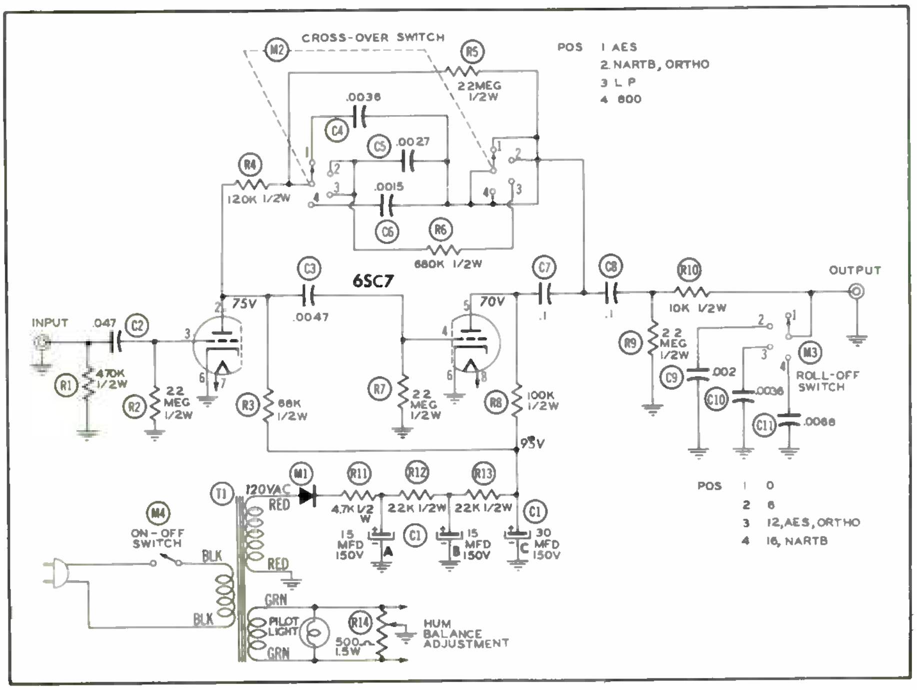


Fig. 6. The Fisher Model 50-PR-2 Preamplifier-Equalizer.

Most any playback curve can be duplicated by using the large number of combinations possible with these two switches. A list of the proper switch settings to be used when playing the records issued by the various manufacturers is furnished with the Model 50-PR-2.

The hum-balance adjustment potentiometer R14 is a worth-while feature in this high-gain, wide-range preamplifier and is a good example of the quality of this well-designed unit.

No provisions are made for converting this preamplifier for use with a microphone.

MODEL 50-F HI-LO FILTER SYSTEM

The Hi-Lo Filter System Model 50-F (Figs. 1, 2, and 7) is very similar in both appearance and cabinet construction to the Model 50-PR-2 Preamplifier-Equalizer. The similarity ends there, because it is not a preamplifier but serves a very different purpose.

The Model 50-F is a small, self-powered unit featuring variable cutoff filters designed to reduce or eliminate many of the disturbances present in so much of the program material reproduced by the usual home music system. Many of the annoying things we do not wish to hear, such as turntable rumble, hum, record-surface noise, tape and FM hiss, and AM whistles are located in either the low or the high end of the audible frequency range. If enough of these extreme ends of the audio spectrum are removed by sharp cutoff filters like those in the Model 50-F, much of the objectionable noise can be eliminated without disturbing the desired portions of the signal.

Tone controls cannot produce the same results because their use produces a more gradual roll-off which affects the middle frequencies enough to destroy the fidelity of reproduction.

The high-input and low-output impedances of the Model 50-F make it possible to add it to most any audio system which does not have sharp cutoff filters in its circuit. The Hi-Lo Filter is usually connected between the preamplifier and power amplifier because of its normal input requirements of 1 or 2 volts for best operation. A signal input of .5 volt is specified as being the minimum allowable amount with 5 volts given as the maximum.

The fact that the Model 50-F has no insertion loss adds to its adaptability.

Sharp cutoff filters, especially the adjustable ones, have often been thought of as being too complicated and bulky to be practical. No doubt there is a great deal of truth in the thought, but a look at the photographs in Figs. 1, 2, and 7 and at the schematic in Fig. 8 reveals how well the situation has been handled in this small unit.

The input section is conventional and has provisions made to bias correctly the first section of the 12AX7 high-mu triode when the maximum signal of 5 volts is fed into it.

High-Frequency Cutoff Section

A low-pass filter composed of the tapped iron-core inductor L1; capacitors C4, C5, C6, C7, C8, and C9; and the four-position switch M2 make up the adjustable high-frequency filter. The method of switching sections of the inductor and different capacitors into the network to change the cutoff frequency can be seen in the schematic. In position No. 1, the complete network is switched out of the circuit.

Even though the attenuation figures do not make it apparent, the low-pass circuit provides very sharp roll-off characteristics and is remarkably effective in operation. The approximate attenuations that are obtained in the different switch positions are as follows:

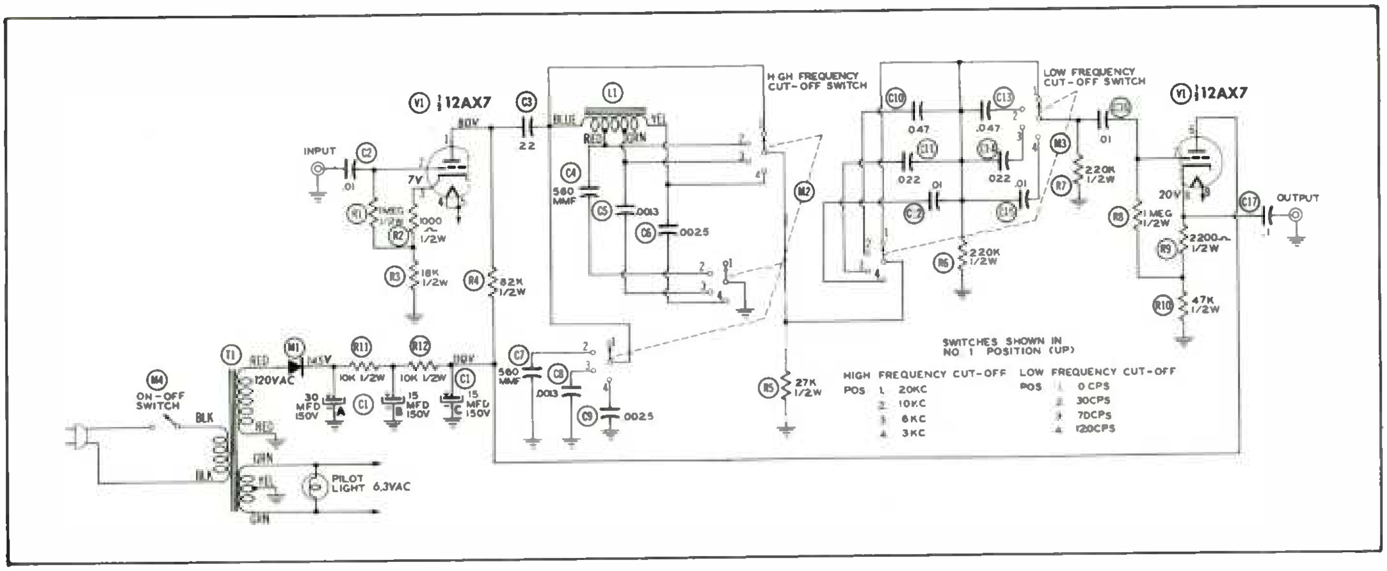


Fig. 8. The Fisher Model 50-F Hi-Lo Filter System.

SWITCH POSITION	ATTENUATION
No. 1	0 db at 20 kc
No. 2	30 db at 20 kc
No. 3	20 db at 10 kc
No. 4	15 db at 5 kc

Low-Frequency Cutoff Section

Resistors R5, R6, and R7; capacitors C10, C11, C12, C13, C14, and C15; and the four-position switch M3 form the high-pass network which serves as the adjustable low-frequency cutoff filter. The switching sequence and layout of the filter are shown in the schematic.

The switch positions are marked with the following cutoff frequencies:

SWITCH POSITION	CUTOFF FREQUENCY
No. 1	0 cps
No. 2	30 cps
No. 3	70 cps
No. 4	120 cps

The approximate attenuation at 50 cps at the various switch settings are as follows:

SWITCH POSITION	ATTENUATION
No. 1	0 db
No. 2	2 db
No. 3	6 db
No. 4	11 db

The attenuation provided by the low-frequency cutoff filter is not so sharp as that obtained with the high-frequency cutoff filter, but it is still rather abrupt and found to be very effective during operation.

A cathode follower is used in the output stage and provides low-impedance output characteristics. The second section of the 12AX7 tube provides this function.

Very complete installation information and operating instructions are furnished with each of these units; and since they are very simple to use, no complications whatsoever should be encountered.

ROBERT B. DUNHAM

Dollar and Sense Servicing

(Continued from page 31)

REPLACEMENTS. By 1957 the TV replacement market will amount to at least 7,000,000 sets a year, says Admiral's sales vice-president W. C. Johnson. That sure brings up the problem of what to do with the old sets. One local service technician, who dropped out of servicing recently to concentrate on a more lucrative phono record business, just loaded the basement accumulation of 10-inchers on a truck and hauled them to the dump, tubes and all.

Cost of rehabilitating these oldies is the chief deterrent to any program for shipping them en masse to television-poor parts of the World. After just so many years of operation and just so many parts replacements and circuit changes, the cost of putting a 10-incher into nearly-like-new operating condition and then crating and shipping it somewhere far away would be terrific — probably way more than the cost of a new 17-incher. Old radios end up on junk heaps, generally after a prolonged period of idleness in an attic or basement; so it looks as if TV sets will have to go the same way.

SLIP-ONS. Cabinets in the new Raytheon Challenger line of TV sets feature slip-on jackets that come in eight different decorator colors to match various color schemes in homes. After a housewife gets a redecorating job done on the walls, she may now call the service technician to change the color of her set!

Who's gonna come out with a clear plastic TV cabinet having slots into which you can slip pieces of wallpaper exactly like that used in the room, for perfect color matching?

PEEPIE CREEPIE. British equivalent of "Walkie Lookie." This is a miniature portable TV camera that is light enough to be carried by one man and used for on-the-spot televising of news events.

PREDICTIONS. Ten million color TV sets will be sold in the next 5 years, predicts NBC research chief Hugh Beville. To set the stage for this, he estimates that some 180 stations will be ready to transmit color programs by the end of the year. Right now about 50 stations can do it.

For still higher figures, see the survey results in the March issue of Fortune; these pinpoint the sales year by year. They say 200,000 color sets will be made this year, but they won't even guess at sales. In 1955, one million sets will go at retail for an average of $700 each. In 1956 there'll be 2.5 million sales, and the average price will drop to $540. For 1957, 4 million will sell at $450. For 1958, 5.3 million should sell at $400. For 1959, 5 million will be sold at $350. Was it a good crystal ball? Time will tell!

POWER OF TV. Installation of television receivers on a trial basis in mental hospitals in England brought amazing results. Patients who formerly showed not the slightest interest in their surroundings sat staring at TV programs for hours, almost as if glued to the screen.

Few mental hospitals in this country have surplus funds to use for TV sets. Even old small-screen sets would therefore be appreciated, particularly if accompanied by an offer of free service. There is no better feeling deep down inside than knowing a lot of unfortunate people are happier each day because of you.

NUJOL. We thought the days of Nujol-filled magnifiers for 10-inch screens were gone forever. (Ours got knocked down and sprung a leak — wot a mess!) But from Hollywood comes word that Mary Pickford uses five gallons of it in some sort of transparent compartment that fits in front of her 30-inch picture tube to give the effect of a supercolossal 40-inch picture. Quoting from New York columnist John Crosby's report on this, "The set is so good, Miss Pickford claims, that movies made 25 years ago look brand new...." That we gotta see!

TRANSISTORS. Today over 90 per cent of all hearing aids are being made with transistors. Some 200,000 of the nation's hearing-aid wearers, out of a total of 1.25 million, have changed over to transistorized aids and are now saving over $5,000,000 in battery-replacement costs per year. Battery costs per user have dropped from $40 to $80 a year to as low as $2 to $5, according to Raytheon vice-president Norman B. Krim.

Rate of failure for transistors is about 1 per cent yearly, as compared to 0.5 per cent for high quality subminiature tubes formerly used; this means transistors are as yet failing about twice as often as tubes, but there's plenty of hope that they'll be better than tubes soon. He goes on to predict that some portable radios will use transistors late in 1955, and by 1958 they'll even start appearing in TV sets.

ALLOCATIONS? One big tube manufacturer warned in April that receiving tubes may go on allocation this summer because inventories were allowed to run down earlier in the year. A drop in tube buying caused layoffs in tube plants, which cannot get back into production overnight on all tube types at once. Regardless, it's always a good idea to keep a good well-balanced stock of new tubes on hand to meet servicing requirements.

FAULTS. When you find yourself critizing nearly everybody and finding fault with them, stop and think. Ten to one there's something wrong within yourself. Whether it's physical or mental, correct it; and then see if your picture of others doesn't change. It's a smart man who knows when to close up shop and go fishing for a day.

FREE MOVIES. Kinerecordings of King Richard II, the widely acclaimed two-hour Hallmark-sponsored TV show starring Maurice Evans on the NBC network last January, are being made available free to schools and colleges in 16-mm prints.

John Markus

(Continued from page 9)

form is also a function recurring periodically at the frame rate. As a result of repeated scanning, a number of recurring functions at the frame frequency and at the line-scanning frequency are produced.

Since the total signal wave is comprised of recurring functions at the frame and line frequencies and since these functions contain an infinite number of waves which are harmonics of these frequencies, the signal spectrum contains a concentration of energy at each harmonic. This means that bands of energy in the video signals appear at whole multiples of the frame and line frequencies. The energy bands appearing at multiples of the line-scanning rate are much greater in amplitude than those appearing at multiples of the frame rate because of the greater number of successive waves at the line frequency.

Thus, it was found that present-day monochrome transmission follows this principle of energy distribution. An illustration of the concentration of energy at these distinct intervals is presented in Fig. 2-3. It may be noted that nearly half of the video spectrum is unused and would be ideal for transmitting color information in the same channel with luminance information.

Since the scanning rates for color information and for luminance information are equal, the bands of energy produced by both are spaced at equal intervals. It is feasible, therefore, that the energy representing color information could be moved halfway between the energy bands of the luminance signal. As seen in Fig. 2-4, the spaces to be occupied by the color energy are at odd multiples of one-half the line frequency. Therefore, a frequency computed as an odd multiple of one-half the line-scanning frequency can be employed as a subcarrier for the color information. Choosing a subcarrier at such a frequency will result in an interleaving of the color and luminance signals.

Development of the Subcarrier Frequency

Most of us are familiar with the nature of a carrier. We know it to be an oscillation in which some feature — amplitude, frequency, or phase — may be made to vary in accordance with the intelligence that is being transmitted.

In radio transmission and in black-and-white television, this intelligence can be recovered by a simple detection process. In color television, however, a portion of the modulation on the video carrier performs by itself the functions of a carrier. This modulating frequency is called a subcarrier. After being detected and separated from the video carrier, the subcarrier must undergo further demodulation before the intelligence on the subcarrier can be obtained.

The frequency of the subcarrier used to interleave the color and luminance information is governed by several factors. The subcarrier frequency must be high enough above the video carrier to keep interference at a minimum in either monochrome or color receivers. If a frequency near the upper limit of the video band is used, it will undergo attenuation in the relatively narrow band-pass circuits of a monochrome receiver; and moreover, if this frequency does reach the picture tube, the dot structure it produces will be very fine and not too objectionable. On the other hand, the subcarrier frequency must be low enough so that its upper sidebands will fall within the useful limits of the video band. Color-signal specifications state that the upper limit of the subcarrier sidebands shall be 0.6 mc above the frequency of the subcarrier. It follows that a frequency as high as 3.6 mc can be used as the subcarrier frequency, if we consider that the practical video bandwidth for color transmitters and receivers has been established as approximately 4.2 mc.

We have shown that the signal energy which is produced by scanning an image will concentrate around the harmonics of the frame and line frequencies, leaving nearly half the space between the harmonics of these frequencies unused. This is another determining factor for the subcarrier frequency, since its harmonics must interleave in these spaces. A frequency which is an odd multiple of one-half the line frequency must be used to produce this interleaving effect. A tentative subcarrier frequency f_S can be computed as:

$$f_S = \frac{15{,}750 \times 10^{-6}}{2} \times 455$$

$$= 3.583125 \text{ mc.}$$

The multiple 455 is used to keep the frequency close to 3.6 mc above the video carrier.

This frequency was not adopted for the color-transmission standards because of an objectionable feature which may be described as follows. Monochrome receivers which employ an intercarrier type of sound system develop a 4.5-mc signal at the video-detector output. When this 4.5-mc signal beats with the color subcarrier, a difference frequency of approximately 900 kc is produced. Experiments were conducted; and it was found that when the aforementioned color-subcarrier frequency was used, the beat frequency created a distracting pattern on the screen of a monochrome picture tube. Further experimentation in this direction proved that the beat frequency

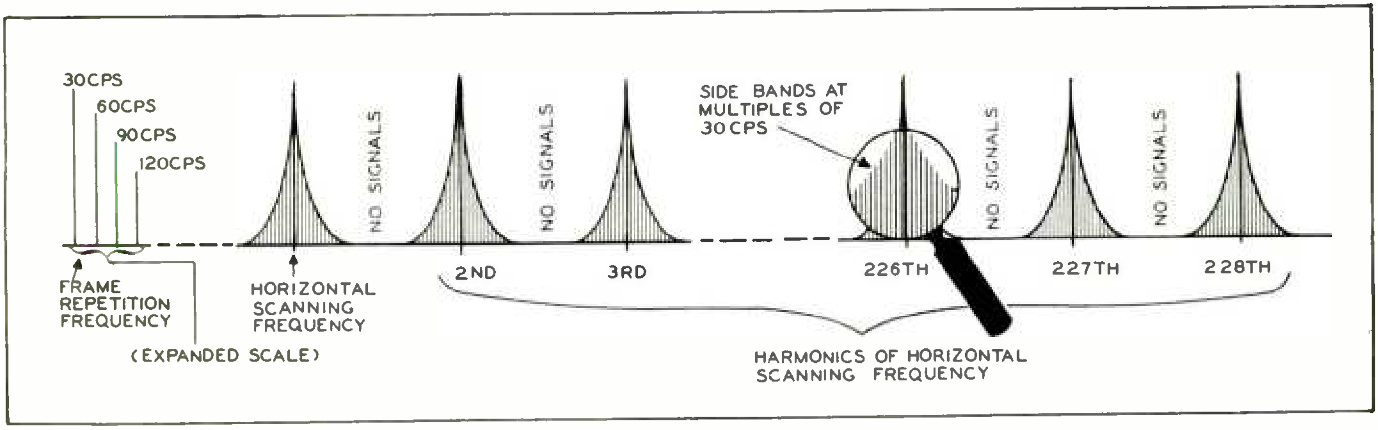


Fig. 2-3. Distribution of Energy in the Frequency Spectrum of a Standard Monochrome Signal.

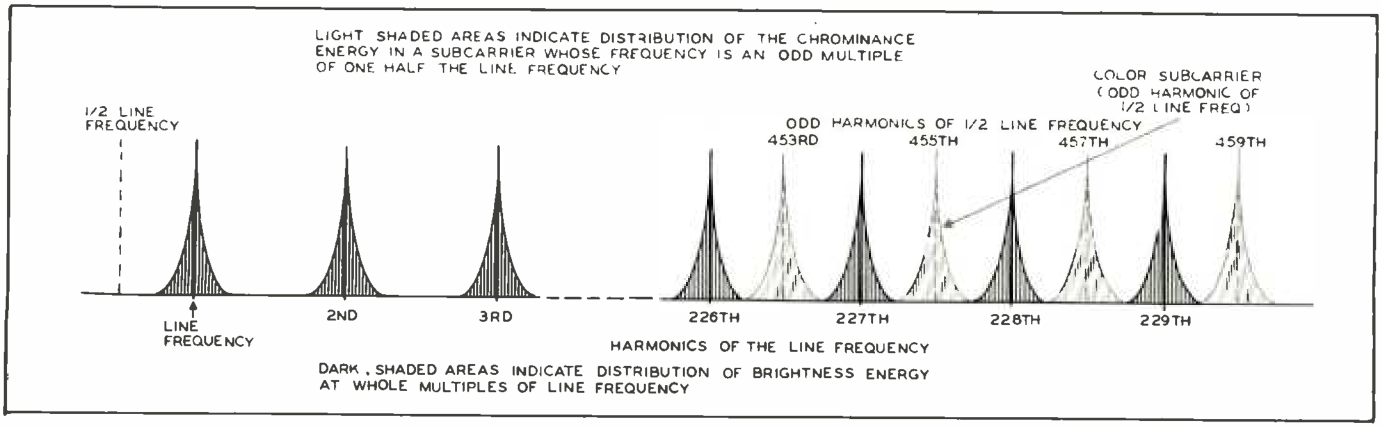


Fig. 2-4. The Interleaving of Brightness and Color Information in the Frequency Spectrum.

would be less objectionable if it could be made an odd multiple of one-half the line frequency.

Naturally, it would be impractical to change the 4.5-mc intercarrier frequency which is accepted as standard in so many existing receivers. This made it necessary to select a color-subcarrier frequency slightly lower than the tentative value given. Consequently, the line and field frequencies had to be reduced by the same ratio in order to retain their frequency relationship to the subcarrier.

In the determination of the new line and field rates, it was desired to have the frequency differences between the video carrier and the subcarrier, as well as those between the subcarrier and the sound carrier, at odd harmonics of one-half the line rate. Since adding two odd harmonics of one-half the line rate yields a whole multiple of the line rate, the separation between the video carrier and the sound carrier must be defined as a whole multiple of the new line frequency. Using 15,750 cps as a basis for determining this multiple, it was found that the 286th harmonic would be at a frequency of 4.504500 mc.

This new line frequency f_L can be computed as:

$$f_L = \frac{4.5 \times 10^6}{286} = 15{,}734.264 \text{ cps.}$$

Thus, the 286th harmonic of the new line frequency is equal to the 4.5-mc picture-to-sound separation.

Since 525 lines per frame are maintained, it follows that the new field frequency f_F can be computed as:

$$f_F = \frac{f_L}{525} \times 2 = 59.94 \text{ cps.}$$

Now the subcarrier frequency f_S becomes

$$f_S = \frac{455}{2} \times f_L = 3.579545 \text{ mc.}$$

Note that the new scanning frequencies used for color transmission are slightly below the nominal values used in black-and-white receivers; however, this change is still within the 1-per-cent tolerance allowed and will fulfill the requirements for compatibility in black-and-white reception.

For purposes of maintaining close synchronization of color receivers, the tolerance for the subcarrier frequency is set at ±.0003 per cent, or around ±10 cps; and the rate of change cannot be more than 1/10 cycle per second per second. The same percentage of tolerance applies to the field and line frequencies; and in actual practice, all of these frequencies are developed from the same source in such a manner as to minimize variations from the established figures.

Chrominance Cancellation Effect

From the standpoint of compatibility, how does color transmission affect monochrome reception? It has been stated that the frequency of the color subcarrier was established at 3.579545 mc and that the upper sidebands containing color information extend 0.6 mc above the subcarrier. The lower sidebands extend 1.5 mc below the subcarrier. Fig. 2-5 shows the positions which the luminance and chrominance signals occupy in the video spectrum. Note that a portion of the chrominance signal falls within the bandpass limits of existing monochrome receivers, which ordinarily have good frequency response to approximately 3.5 mc. The fact that the color subcarrier was set at a frequency which is an odd harmonic of one-half the line-scanning rate results in a cancellation effect if any portion of the chrominance signal modulates

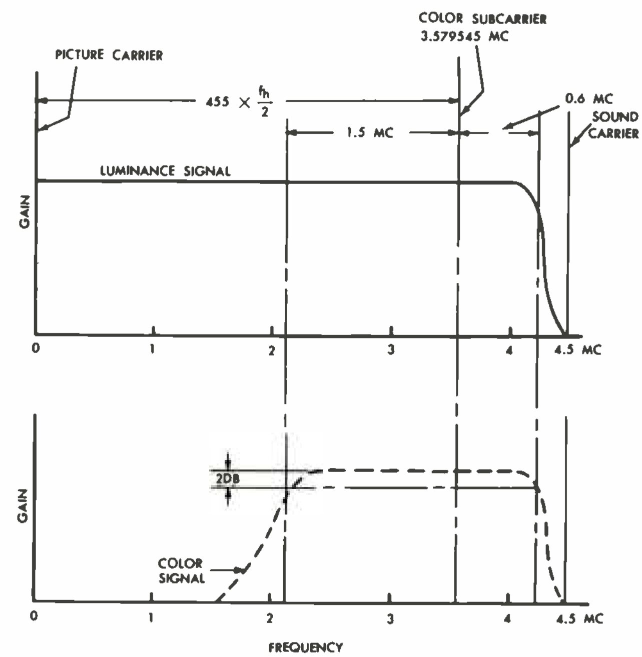
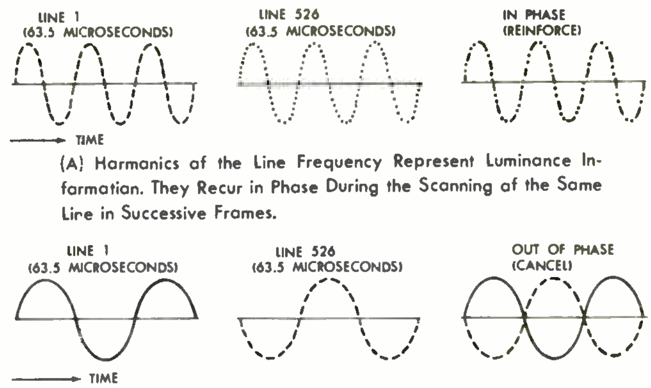


Fig. 2-5. The Complete Video Spectrum of a Standard Color Transmission.

the picture tube in a monochrome receiver. The explanation of this phenomenon is given in the following discussion.

It has been shown that video signals can be broken down by analysis into many sine waves and that the brightness variations produced along any given scanning line by each of these waves is of a sinusoidal nature. These characteristics are true of the chrominance signal as well as of the luminance signal. An important difference does exist, however. Since it has been established that all of the sine-wave components of the luminance signal are harmonics of the line and frame frequencies, the brightness variations produced by these components go through a whole number of cycles during the scanning of any given line or frame. This means that in the next line or frame, the variations recur in phase. A reinforcing effect is produced as illustrated in Fig. 2-6A.

In the case of the chrominance signal, however, the opposite condition exists. The sine-wave components of the chrominance signal are odd harmonics of one-half the line frequency and of one-half the frame frequency. The brightness variations which these components produce on the picture tube of a monochrome receiver go through one-half of a cycle more than a whole number of cycles, as illustrated in Fig. 2-6B. This means that in the next line and in the next frame, the brightness variations produced by the chrominance signal recur 180 degrees out of phase. A cancellation effect occurs as a result of this condition; and despite considerable fluctuation and change in the color information carried by the chrominance signal, very little of this information appears on the screen of the monochrome receiver. Thus, a satisfactory black-and-white reproduction of the color picture signal can be achieved.



(A) Harmonics of the Line Frequency Represent Luminance Information. They Recur in Phase During the Scanning of the Same Line in Successive Frames.

(B) Odd Harmonics of One-Half the Line Frequency Represent Chrominance Information. They Recur Out of Phase and Cancel.

Fig. 2-6. Effect of Luminance and Chrominance Signals on the Screen of a Monochrome Receiver.

DIVIDED-CARRIER MODULATION

It has been pointed out that for purposes of color transmission, a chrominance signal is required. Moreover, the chrominance signal must represent two color signals separable from each other. One subcarrier at a frequency of 3.579545 mc above the picture carrier is available to convey both color signals. Consequently, some method of modulating one carrier with two signals must be utilized at the transmitter.

As can be seen in Fig. 2-7, a fundamental block diagram illustrates the manner in which this is done. A subcarrier generator produces a sine wave of constant frequency and amplitude. This subcarrier is then applied to two doubly balanced modulator circuits represented by blocks A and B. The subcarrier coupled to the modulator in block B has been subjected to a 90-degree phase shift. One of the two modulating signals is applied to modulator A, and the other is applied to modulator B.

In order to show what occurs in each of the balanced modulator circuits, a simple schematic representing the modulator in block A is presented in Fig. 2-8. The modulating signal is passed through a phase-splitter circuit; as a result, two signals of opposite polarity are produced. This causes the signal at the grid of tube No. 1 to be 180 degrees out of phase with the signal arriving at the grid of tube No. 2. The subcarrier also goes through a phase-splitting process as a result of the transformer action, and the suppressor grids are fed with signals of equal amplitude but of opposite polarity.

When the signal at the grid of tube No. 1 is in the positive portion of its cycle, a subcarrier signal of increased amplitude is produced. As the signal at the grid goes through the negative portion of its cycle, a subcarrier signal of lower amplitude is produced in the output. The waveform produced by this action is shown at the plate of tube No. 1. A similar operation takes place in tube No. 2, except that it is in reverse; that is, the subcarrier voltage with the lower amplitude appears first, and that with the higher amplitude appears next. The waveform produced by this action is shown at the plate of tube No. 2.

The operation of the entire circuit is dependent upon the fact that the plate circuits of tubes Nos. 1 and 2 are tied together. The waveforms shown at the plates do not exist separately but are actually combined because of the common plate circuit. By noting the two waveforms shown in the illustration, one at the plate of each tube, it can be seen that the signals are 180 degrees out of phase. Because the plates are tied together, the output sidebands will consist of a combination of the output waveforms produced by the two tubes. Since these output waveforms are always 180 degrees out of phase, a cancellation effect occurs. The amplitude of the output sidebands becomes the difference in the amplitudes of the components. In addition, the phase of the output sidebands agrees with the phase of the component having the greatest amplitude. It can be seen that if the signal information applied to the grid of the phase splitter is increased in amplitude, then the amplitude of the output sidebands will also increase. The phase of the output sidebands will also change 180 degrees when the polarity of the signal information is reversed. Consequently, the output sidebands represent the modulating signal in terms of the phase and amplitude of the subcarrier frequency. If no signal is applied to the

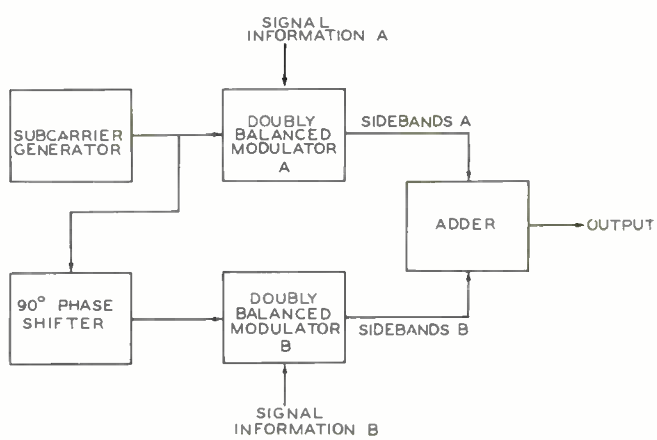


Fig. 2-7. Block Diagram of Divided-Carrier System of Modulation.

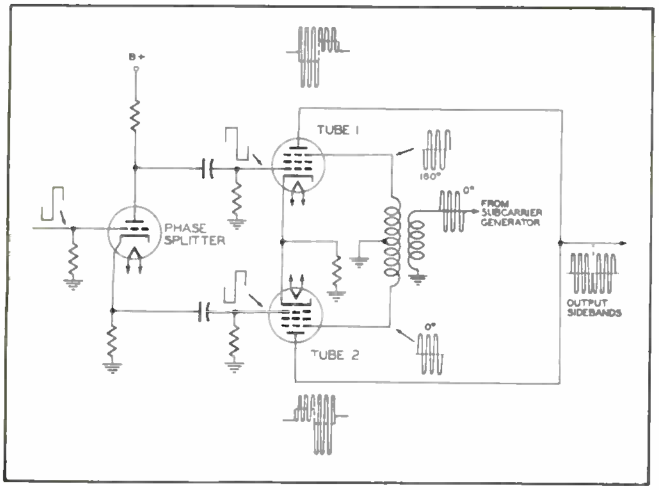
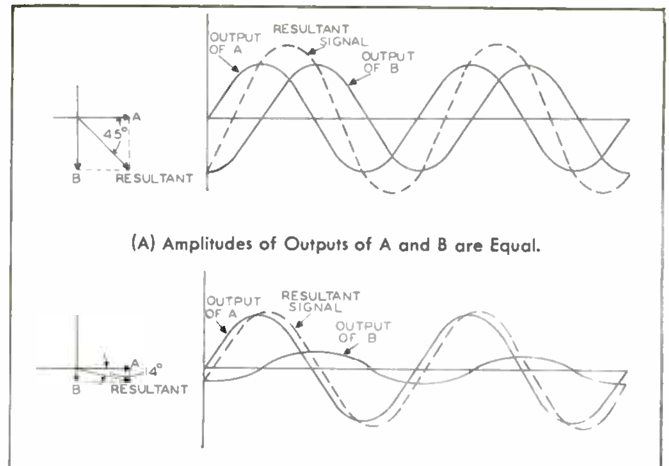


Fig. 2-8. Schematic of a Doubly Balanced Modulator.



(A) Amplitudes of Outputs of A and B are Equal.

(B) The Output of B Has One-Fourth the Amplitude of the Output of A.

Fig. 2-10. Voltages Resulting From the Addition of Two Output Sidebands Separated in Phase by 90 Degrees.

grids of tubes Nos. 1 and 2, no signal will appear in the output because both tubes will conduct equally and the result will be complete cancellation.

In Fig. 2-7, there are two blocks representing doubly balanced modulators. The modulator in block B operates in the same manner as that described for the one in block A, with the exception that the subcarrier input is delayed 90 degrees. This delay causes the output of modulator B to be displaced 90 degrees in phase with reference to the output of modulator A. In this respect, it should be remembered that the output of modulator B can either lead or lag that of modulator A by 90 degrees, depending upon the instantaneous polarity of the signal information introduced into each balanced modulator circuit.

Consider a particular case in which the output of modulator A is equal in amplitude to the output of modulator B but leads the latter output by 90 degrees. See Fig. 2-9. Since the instantaneous values of both of these signals are continuously changing and since the signals are displaced in phase, it is easier to analyze their relationship through the use of vectors. Thus, we can consider both signals as vectors rotating at the same speed but with one leading the other by 90 degrees.

The first pair of vectors in Fig. 2-9 are shown at zero time. The vector representing the instantaneous value of A leads that of B by 90 degrees because their circular motion is considered to be counterclockwise. At zero time, the instantaneous voltage of A is zero; whereas, the instantaneous voltage of B is at a maximum negative value. The resultant signal at zero time is equal to the instantaneous value of B. This can be seen in the vector diagram as well as in the sine-wave representation of the signal at time zero.

If we allow the vectors to rotate another 45 degrees, they will appear as shown in the vector diagram for time No. 1 in Fig. 2-9. Note that at time No. 1, the vector of A has reached an amplitude of 70.7 per cent of the positive peak, and the vector of B is 70.7 per cent of the negative peak. The resultant signal has an amplitude of zero. In the sine-wave diagram, these values are shown at time No. 1. The positions of the vectors at times 2, 3, and 4 indicate that the instantaneous voltages in the vector diagrams are equal to those on the sine-wave diagram at their respective times.

If the rotating vectors in Fig. 2-9 were analyzed at every degree throughout their complete cycle, the waveforms which are represented by these vectors could be traced as shown in the sine-wave diagram. The length of each vector equals the peak amplitude of the signal it represents.

In the foregoing discussion, the outputs of modulators A and B were considered to be of equal amplitude; and they produced a resultant signal shown by the dotted line in Fig. 2-10A. The associated vector diagram is drawn for the vector positions at zero time. In actual practice, the output from each of the doubly balanced modulators will vary in amplitude and undergo a 180-degree phase shift from time to time. As an illustration of this condition, Fig. 2-10B shows the manner in which the two outputs combine when the output of B is one-fourth the output of A. Notice that the amplitude of the resultant signal is less than its amplitude in Fig. 2-10A. Moreover, a phase shift in the resultant signal is indicated by the fact that in this figure the resultant signal lags the output of A by 45 degrees; whereas, in Fig. 2-10B it lags by only 14 degrees.

The combining of voltages resulting from the outputs of modulators A and B takes place in the adder stage

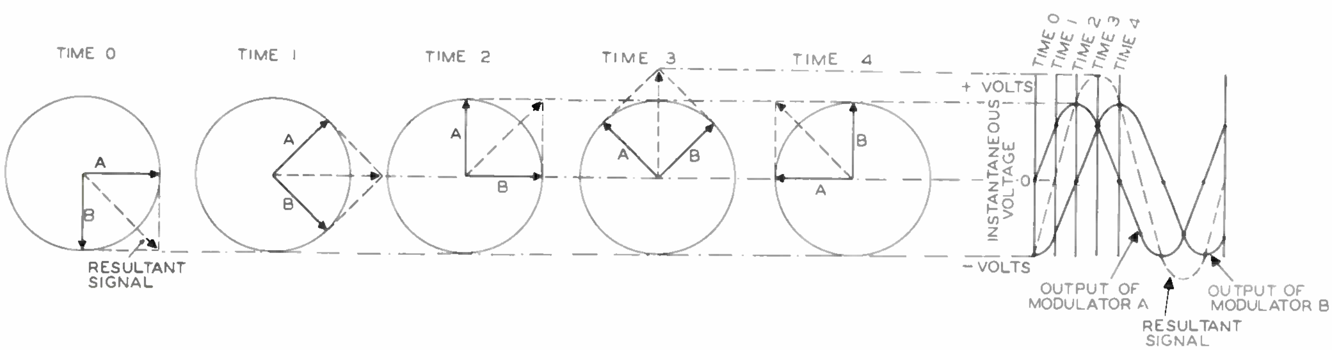


Fig. 2-9. Vector Representations of Instantaneous Voltages at Various Times.

NOTES

1. The radiated signal envelope shall correspond to the modulating signal of the above figure, as modified by the transmission characteristics of specification number 6.
2. The burst frequency shall be the frequency specified for the chrominance subcarrier. The tolerance on the frequency shall be ±0.0003% with a maximum rate of change of frequency not to exceed 1/10 cycle per second per second.
3. The horizontal scanning frequency shall be $\frac{2}{455}$ times the burst frequency.
4. Burst follows each horizontal pulse, but is omitted following the equalizing pulses and during the broad vertical pulses.
5. Vertical blanking 0.07 to 0.08V.
6. The dimensions specified for the burst determine the times of starting and stopping the burst, but not its phase.
7. Dimension "P" represents the peak-to-peak excursion of the luminance signal, but does not include the chrominance signal.

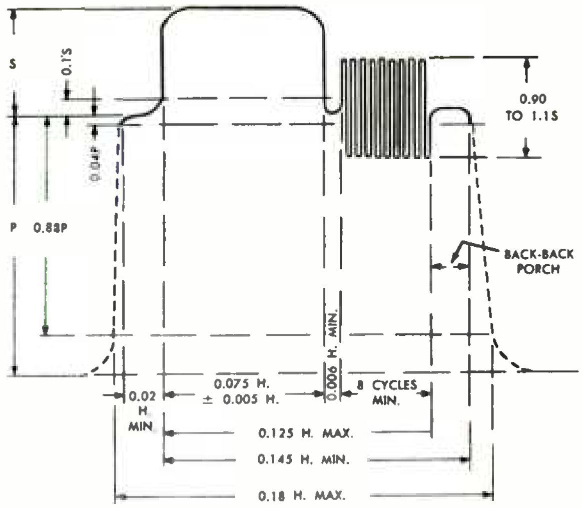


Fig. 2-11. Specifications for the Color Burst.

(see Fig. 2-7), and the output is a single waveform which varies in amplitude and phase as a result of modulation by the signal information introduced to modulators A and B. Thus, two modulating signals are impressed upon a single subcarrier, and these two signals can be recovered by reversing the modulation process at the receiving end.

COLOR SYNCHRONIZATION

The chrominance signal changes phase with every change in the hue of the color it represents, and the instantaneous phase difference between the chrominance signal and the output of the subcarrier generator identifies the particular hue at that instant. When the chrominance signal reaches the receiver, the receiver must have some means of comparing the phase of the signal with a fixed reference phase which is identical to that of the subcarrier generator at the transmitter. This reference phase is provided in the receiver by a local oscillator which is synchronized with the subcarrier generator by means of a color burst signal that is transmitted during the horizontal blanking period. The color burst consists of a minimum of eight cycles at 3.579545 mc.

As shown in Fig. 2-11, the color burst is placed on the back porch of the horizontal blanking pedestal. Because the horizontal systems used in existing receivers are designed to be immune to any noise or pulse for a short time after they have been triggered, the burst when located at this point will not affect the operation of the horizontal-oscillator circuits. In addition, a greater portion of the color burst is above the black level of the composite video signal and will not produce unwanted brightness on monochrome receivers. Located at a lower level, the burst would produce spurious picture-tube light during the retrace period.

A color receiver is designed to extract the color burst from the transmitted signal. This reference signal is used to synchronize the color section of the receiver in much the same manner as the horizontal and vertical pulses are used to synchronize the horizontal and vertical sweep sections.

In summarizing the material in this installment of the training series, we would like to point out that three major processes are employed for the transmission of the composite color signal. These are the interleaving process, divided-carrier modulation (sometimes called quadrature modulation), and the use of a color burst for purposes of color synchronization.

In the next issue, the actual make-up of the color picture signal will be explained in detail, and the reader will be able to see the manner in which the foregoing processes are put to use.

Here are a few questions, the answers to which were given in this discussion. Test yourself — see if you are able to answer satisfactorily all of the questions.

1. How was the frequency of the subcarrier selected so that interleaving takes place?

2. What is meant by the cancellation effect of the chrominance signal?

3. What happens to the output signal of a doubly balanced modulator when the polarity of the input signal is reversed?

4. What is the nature of the resultant signal produced by the addition of output signals from two doubly balanced modulators when the output signals are of different amplitude?

5. What purpose does the color burst serve?

C. P. Oliphant and Verne M. Ray

GLOSSARY

CHROMINANCE CANCELLATION. An effect caused by the out-of-phase condition of chrominance modulation on consecutive lines in any one field and on the same line in consecutive frames.

CHROMINANCE SIGNAL. That portion of the composite color signal conveying variations of hue and saturation.

COMPOSITE COLOR SIGNAL. The complete signal used for the modulation of a color transmitter. The signal includes luminance and chrominance information, vertical and horizontal sync pulses, vertical and horizontal blanking pulses, and the color sync burst.

DIVIDED-CARRIER MODULATION. A process by which two signals can modulate two subcarriers of the same frequency but in phase quadrature and by which the addition of the two subcarriers can produce a resultant subcarrier signal variable both in amplitude and phase.

INTERLEAVING. Placing between. As applied to color transmission, the concentrations of energy of the chrominance signal are interleaved or placed in the spaces between the concentrations of energy of the luminance signal.

SUBCARRIER. As applied to color television, a portion of modulation on the video carrier, which portion performs by itself the functions of a carrier.

PF INDEX REPORTER

INDEX TO ADVERTISERS
July, 1954

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.

+ More or Less —

It is the lot, often happy sometimes not, of the editorial directors of a publication such as ours, to receive many comments, suggestions, criticisms and questions regarding editorial policy and content. We appreciate them, try to be guided by them, and occasionally seek to inform our readers of existing policies which have a bearing on questions representing general interest and our reasons for establishing such policies.

One question that has been asked on several occasions concerns the appearance of new product releases. The PF INDEX has never since its inception carried a department or column for this feature, in view of the following considerations.

We have conceived that our obligation to PF INDEX readers is to provide them with the greatest amount possible of material primarily concerned with successful technical operations of their electronic service work — that it be authentic, accurate, purposeful and timely — presented in an impartial manner.

First, with regard to impartiality and timeliness. The number of individual new product or publicity releases received per day ranges from three to ten. Attempting to produce all of them fully is a physical impossibility, unless all editorial personnel devoted their efforts to this task and all editorial content of the publication were similarly dedicated. Cutting content of the releases (still not practical from total space requirement) or arbitratily including some while rejecting others, immediately runs afoul of the impartiality and currency policies.

With respect to accuracy and authenticity, each product manufacturer takes a rightful pride in the features or application of his product, and certainly we would not have it otherwise. However, this same pride and the stress of competition very often combine to produce releases which leave a little to be desired from the standpoints of objective reporting, proven claims, and definite technical contribution to the field we serve.

A final consideration involves our relationship with present or potential PF INDEX advertisers. We have not, and we will not use a new product review as a come-on for the solicition of advertising, and as a corollary, we are not willing to accept any obligation for the inclusion of such material as an implied qualification of advertising arrangement.

We have no quarrel with the product or publicity release activity. Quite to the contrary, we think it quite helpful in supplying to the mediums of dissemination the cogent points of product design. In our own case these releases are studied and evaluated towards the purpose of providing material or guidance in the preparation of general editorial content. This practice, we believe, constitutes the most useful and highly regarded application of the release data.

As a matter of fact, a good portion of text coverage in the features "In the Interest of Quicker Servicing" and "Examining Design Features" which appear in each issue of PF INDEX has resulted from product developments first called to our attention through publicity releases. Additionally, a lot of the information presented in the continuing series on test equipment, and on the servicing of specialized equipment had its start from the same source.

We hope that the foregoing clarifies our position on the subject and if there are any further questions, fire away.

J.R.R.

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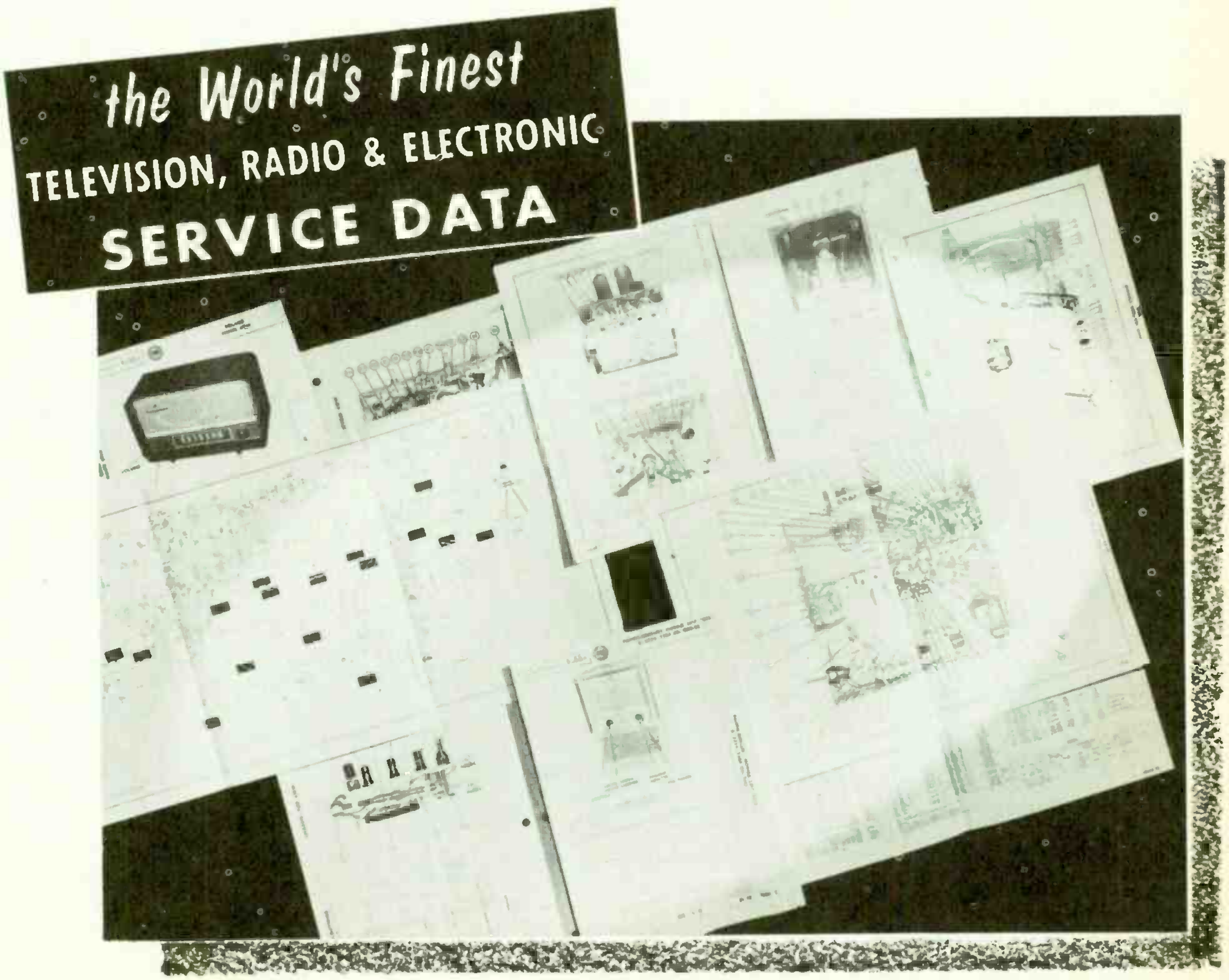

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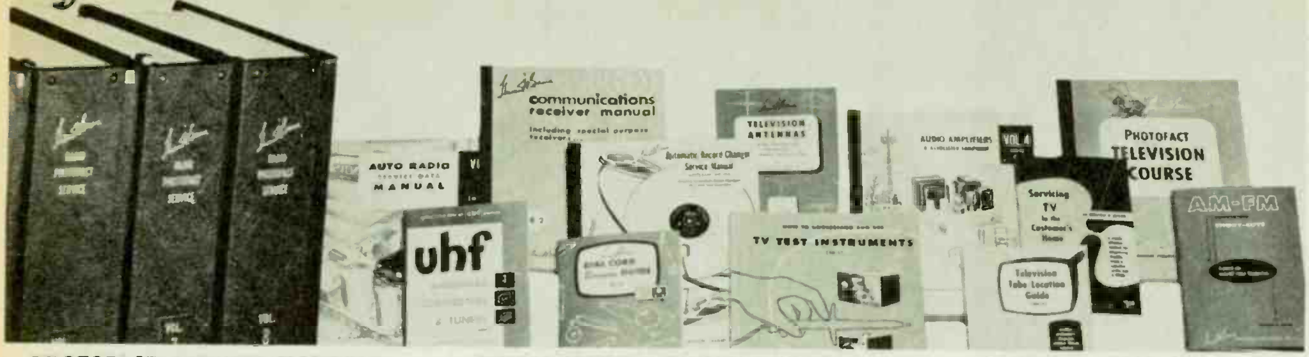

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IMPORTANT—1. The letter "A" following a set number in the Index listing, indicates a "Preliminary Data Folder." These folders were designed to provide immediate basic data on TV receivers. Many of these were later superseded by regular Photofact Folders. 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.)

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NOTE: PCB denotes Production Change Bulletin

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NOTE: PCB denotes Production Change Bulletin

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NOTE: PCB denotes Production Change Bulletin

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49-1076 (Code 123), 49-1077 (Code 122) Tel. Rec.... **92**—5
49-1100 .... **47**—19
49-1101 .... **55**—17
49-1150 (Codes 121 and 123) Tel. Rec. .... **70**—6

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49-1150 (Codes 122, 124) Tel. Rec. .... **92**—5
49-1175 (Codes 121 and 123) Tel. Rec. (Code 121). .... **70**—6
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
49-1278 (Code 122) Tel. Rec. .... **93A**—11
49-1278 (Code 123), 49-1279 (Code 122), 49-1280 (Code 121) Tel. Rec. .... **92**—5
49-1401 .... **45**—21
49-1404 (See Model 49-1405—Set 54-24)
49-1405 .... **54**—24
49-1450 (Codes 121A or B, 123A or B, 123T A or B) Tel. Rec. **77**—8
49-1475 (Codes 121A, B, 123A, B, 123T A, B) Tel. Rec. .... **77**—8
49-1480 (Code 121A, B, 123A, B, 123T A, B) Tel. Rec. .... **77**—8
49-1600 .... **50**—13
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49-1602, 49-1603, 49-1604, 49-1605 .... **55**—18
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49-1615 .... **64**—9
50-T701 (Code 121), 50-T702 (Code 122) Tel. Rec. .... **140**—7
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
50-T1432 (Code 122) (See PCB 29—Set 154-1 and Model 50-T1104—Set 114-9)
50-T1432 (Code 124) Tel. Rec. .... **115**—8
50-T1443 (Codes 122, 123) Tel. Rec. .... **94**—7
50-T1476, 50-T1477, 50-T1478, 50-T1479 Tel. Rec. .... **128**—11
50-T1481, 50-T1482 Tel. Rec. .... **128**—11
50-T1483 Tel. Rec. .... **93A**—12
50-T1484 Tel. Rec. .... **128**—11
50-T1600 Tel. Rec. (Code 121) .... **91A**—10
50-T1600 (Code 122) Tel. Rec. .... **110**—10
50-T1606 (Code 131) Tel. Rec. (See Model 50-T1600, Code 121—Set 91A-10)
50-T1630 Tel. Rec. .... **99A**—8
50-T1632, 50-T1633 Tel. Rec. .... **91A**—10
50-T1632, 50-T1633 (Code 122) Tel. Rec. .... **110**—10
50-520, 50-520-1 .... **73**—9
50-522, 50-522-1, 50-524. **78**—11
50-526 .... **96**—8
50-527, 50-527-1 .... **80**—11
50-620 .... **85**—11
50-621 .... **89**—11
50-920, 50-921, 50-922.... **88**—8
50-925 (Code 123) 50-926 **99**—12
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50-1721, 50-1723, 50-1724 **98**—9
50-1725 .... **93**—8
50-1726 .... **91**—9
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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
51-T1601, T, 51-T1602 (Code 121) (Ch. 33, C1) Tel. Rec.. **138**—7
51-T1601, T, 51-T1602 (Code 122) (Ch. 32, C1) Tel. Rec. .... **138**—7
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)

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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
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
51-530 .... **122**—7
51-532 .... **122**—7
51-534 .... **122**—7
51-537, 51-5371 .... **126**—10
51-629 .... **136**—13
51-631 .... **106**—12
51-632 .... **136**—13
51-930, 51-931, 51-932.... **153**—11
51-934 .... **102**—10
51-1330 .... **130**—11
51-1730, 51-1730 (L).... **140**—8
51-1731, 51-1732 .... **124**—7
51-1733, 51-1733 (L). 51-1734 .... **137**—9
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)

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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)
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

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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)
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)
52-540, 52-540-1, 52-541, 52-541-1, 52-542-1 .... **154**—10
52-544, 52-544-1, 52-544-W .... **163**—9
52-640, 52-641 .... **153**—12
52-643 .... **161**—7
52-940, 52-941, 52-942. **156**—9
52-944 .... **169**—12
52-1340 (Codes 121, 122). **160**—8
53-T1824 (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (Also see PCB 83—Set 224-1) .... **201**—7
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

NOTE: PCB denotes Production Change Bulletin

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53-T2228 (Code 128) (Ch. 91, J-2) Tel. Rec. (See PCB 66—Set 203-1, PCB 82—Set 223-1 and Model 53-T1853—Set 185-10)
53-T2255 (Code 133) (Ch. 81, H1) Tel. Rec. ... 201—7
53-T2260 (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (Also see PCB 83—Set 224-1) ... 201—7
53-T2260 (Code 125) (Ch. 42, G2) Tel. Rec. ... 186—10
53-T2262 (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (Also see PCB 83—Set 224-1) ... 201—7
53-T2262 (Code 125) (Ch. 42, G2) Tel. Rec. ... 186—10
53-T2264 (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (Also see PCB 83—Set 224-1) ... 201—7
53-T2264 (Code 125) (Ch. 42, G2) Tel. Rec. ... 186—10
53-T2266, L (Code 126) (Ch. 91, J-1) Tel. Rec. (Also see PCB 66—Set 203-1) ... 185—10
53-T2266, L (Code 128) (Ch. 91, J-2) Tel. Rec. (See PCB 66—Set 203-1, PCB 82—Set 223-1 and Model 53-T1853—Set 185-10)
53-T2268 (Code 126) (Ch. 91, J1) Tel. Rec. (Also see PCB 66—Set 203-1) ... 185—10
53-T2269 (Code 126) (Ch. 91, J1) Tel. Rec. (Also see PCB 66—Set 203-1) ... 185—10
53-T2269 (Code 128) (Ch. 91, J-2) Tel. Rec. (See PCB 66—Set 203-1, PCB 82—Set 223-1 and Model 53-T1853—Set 185-10)
53-2270 (Code 126) (Ch. 91, J1) Tel. Rec. (Also see PCB 66—Set 203-1) ... 185—10
53-T2270 (Code 128) (Ch. 91, J-2) Tel. Rec. (See PCB 66—Set 203-1, PCB 82—Set 223-1 and Model 53-T1853—Set 185-10)
53-T2271 (Code 126) (Ch. 91, J1) Tel. Rec. (Also see PCB 66—Set 203-1) ... 185—10
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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)
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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)
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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)

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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-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)
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NOTE: PCB denotes Production Change Bulletin

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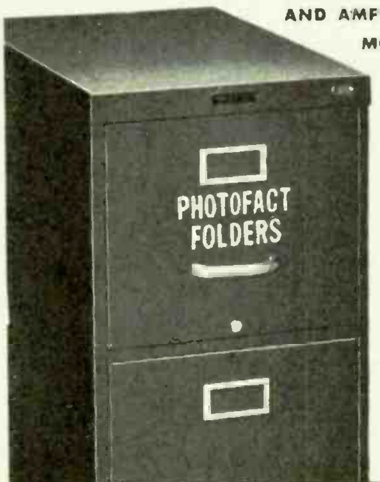

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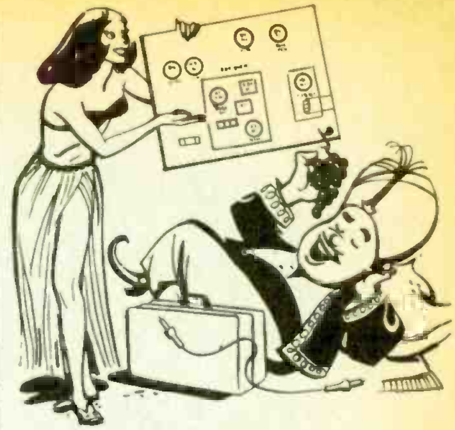

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