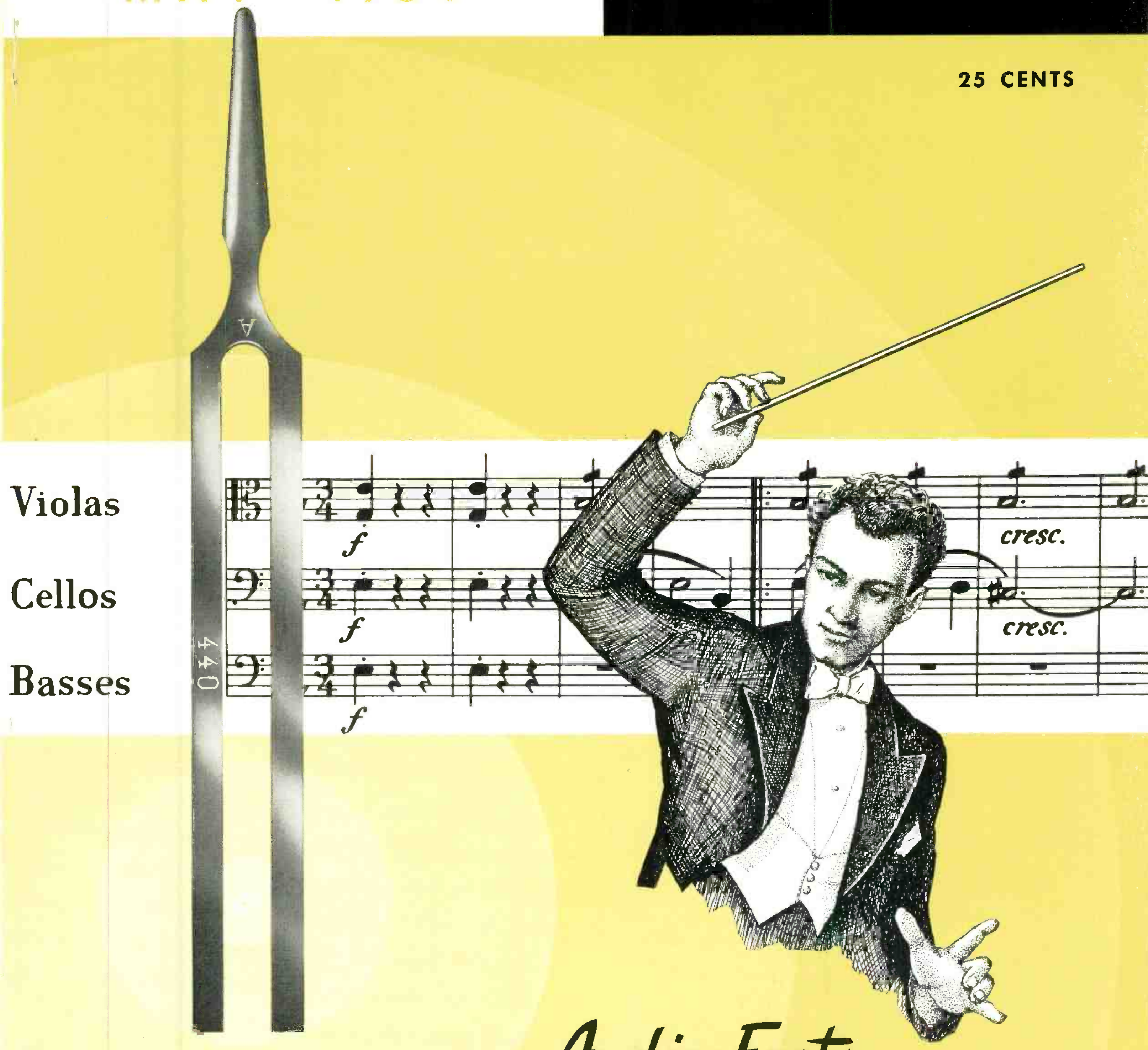
Howard W. Sams

PF PHOTOFACT® **INDEX**

MAY • 1954

the monthly REPORTER for the ELECTRONIC SERVICE INDUSTRY

25 CENTS



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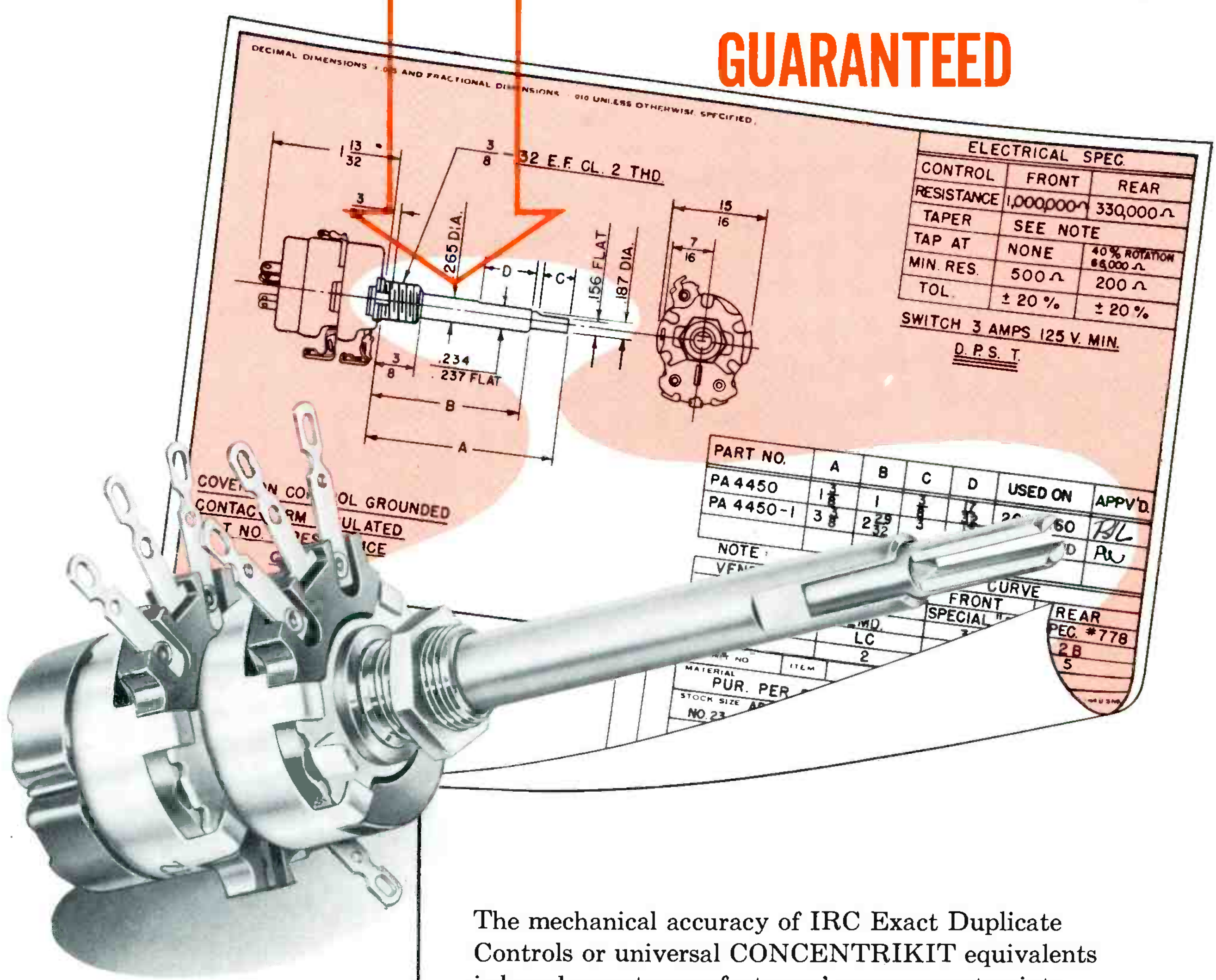

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SUBJECT REFERENCE

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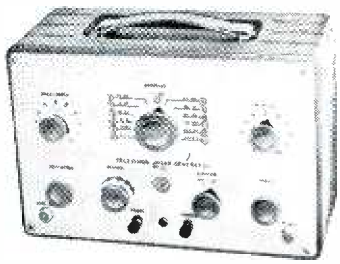
YOUR BEST BET for BLACK & WHITE and COLOR TV



RCA WR-59C
Television Sweep Generator

RCA WR-89A
Crystal-Calibrated
Marker Generator

RCA WV-97A
Senior VoltOhmyst®

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

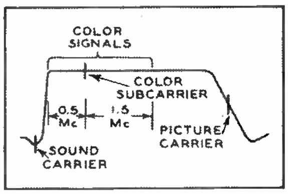


Fig. 1. RF-IF Response

The rf-if amplifier must be aligned correctly to provide flat response for modulating frequencies up to 4.1 Mc. *The RCA WR-59C Sweep Generator and WR-89A Marker Generator provide the flatness of sweep output and crystal accuracy that are essential for aligning color circuits.*

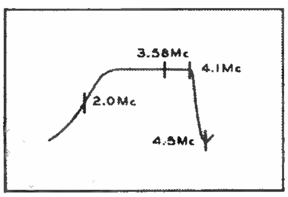


Fig. 2. Bandpass Filter Response

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

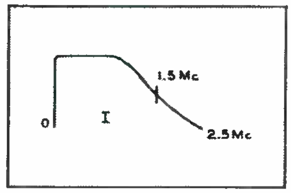


Fig. 3. I Channel Response

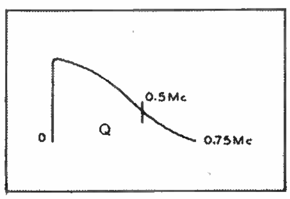


Fig. 4. Q Channel Response

REMEMBER that the high voltage (up to 30,000 volts and more) must be set to the specified value before adjusting purity or convergence. The RCA VoltOhmysts can be used with the RCA High Voltage Probe (WG-289 and WG-206 Multiplier Resistor) to measure dc voltages up to 50,000 volts.

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Shop Talk

MILTON S. KIVER

President, Television Communications Institute

Now that the FCC has authorized a color television system with which most engineers seem happy, the barrage of literature on color television fundamentals and operation is in full swing. Each passing month brings with it more and more information, and it is to our advantage to get into the swim of things as quickly as possible or else we may soon find ourselves in the position of shoveling sand against the tide.

Color television, both from a theoretical and from a practical standpoint, is not a subject that one grasps on first contact. That it seems to affect practically everyone in the same way was borne out by the results of learning tests which we at the Television Communications Institute conducted among our own students and on practicing service technicians who were not students.

It was also revealed that a method which we call the "general to the specific" enables the student to grasp, remember, and apply what he has read better than any other system of learning which we have tried. Since color television is the concern of every service technician, this writer felt that the readers of the PF INDEX might be interested in learning more about this successful method of learning.

The best approach we found is to forget at the outset all about color television circuitry. If you are approaching the subject for the first time, read articles on the operation of the tri-gun picture tube and on color fundamentals. Concentrate on these two subjects until you feel that you know each so thoroughly that you can talk, even argue about them with your fellow workers.

At this point, it may not be amiss to interject several thoughts on black-and-white television. Color TV is actually an extension of black-and-white TV, and it stands to reason that you cannot qualify yourself as an expert color man until you become proficient with black-and-white receivers. So while you are learning color fundamentals, pull out your texts on black-and-white TV and do a little reviewing.

PREDICTION: You will be amazed at how much you've forgotten about the sets you work with everyday.

Your next step is to concentrate on the color signal, what it is supposed to do, how it is formed, and exactly what differences there are between its components: I, Q, R-Y, and B-Y. This is a particularly rough section to overcome; but if you read enough different accounts of the signal formation (and there are a great many articles on this score), then you will soon develop at least a reading acquaintanceship with these quantities.

This step, we have found, is the most critical in your entire color study. Clear this hurdle and the rest can be smooth sailing; but if you form only a hazy idea, everything you do from this point on will be clouded.

This might appear to be a rather strong statement, and it is meant to be. You will find that the diagram shown in Fig. 1 will be one of your handiest tools in servicing the color circuits of a color television receiver. The diagram may be labeled in a variety of ways, but the name we prefer is "color-phase diagram." On it we see the location of the I, Q, R-Y, and B-Y signals. More important, however, is the presence of the various colors around the diagram; for these tell us what colors are directly concerned with each of the I, Q, R-Y, and B-Y vectors. If we find that a color picture is defective in magenta and green, then we know that the trouble is somehow tied up with the Q-channel in the receiver. If we lose our pastel shades of yellow and cyan (blue-green), then the I-channel is at fault. These are but two of the many applications of this diagram, but to understand it fully requires that you know something about the I and Q (or R-Y and B-Y) signals that form the color signal.

The foregoing study will have taken you through the color system

* * Please turn to page 51 * *

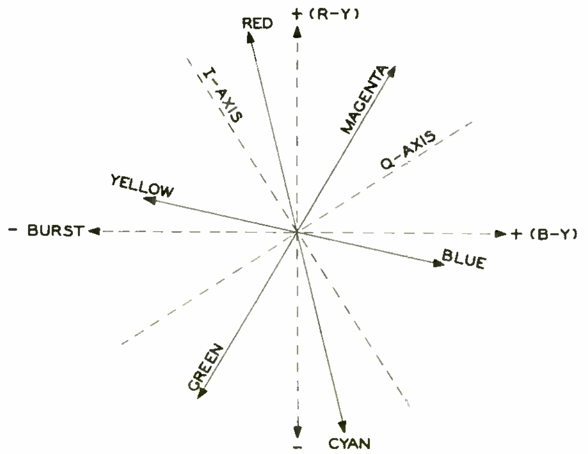

Fig. 1. A Color-Phase Diagram.

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Audio-Facts

Installation of REK-O-KUT LP-743 Turntable With Dual Transcription Arms, GE A1-501 and Livingston Universal

by Robert B. Dunham

Although some mention was made of the turntable and the two pickup arms installed in the cabinet discussed in Audio Facts in the March 1954 PF INDEX, no details were given concerning them or their installation. There were two reasons for the lack of specific data: (1) it was not the purpose of the article to present details about any certain part of the system and (2) the motor board in use at that time was a temporary one, and some changes were to be made when a permanent board was prepared and installed.

Some information concerning the preparation of the new motor board (shown in Fig. 1) and the installation of the three-speed REK-O-KUT LP-743 turntable, Livingston Universal transcription arm, and the General Electric A1-501 transcription arm may be interesting and helpful to anyone considering making such an installation.

A piece of one-inch-thick solid birch, cut to the dimensions of 15 3/4 inches wide and 22 1/8 inches long to fit the opening in the top compartment of the cabinet, was obtained from a local planing mill. Birch plywood 3/4-inch thick would have been preferred, but none could be found on hand that had not already warped. A warped motor board should not be used because of the strain it imposes on the turntable mounting plate. It is also difficult to adjust a pickup arm to swing parallel to the top surface of the turntable if the motor board is not flat. The piece of solid birch which was selected was well seasoned and flat.

Some of the very complete templates and mounting information furnished with the turntable and arms are shown in Fig. 2A. The template for the GE A1-501 arm and its rest are shown in this illustration at their correct positions on the board. The correct positions for the arms, arm rests, and the turntable spindle were found by use of the appropriate templates and then marked on the board.

In Fig. 2B, the template for the REK-O-KUT LP-743 turntable is shown held in place by two pieces of masking tape. The correct location was found by matching the spindle position on the template with the one marked for it on the board. A piece of paper, which had been prepared by partially covering one side with lead applied with an ordinary pencil, was slipped under the template for use as carbon paper; and the markings were then traced as shown in Figs. 2B and C. Regular carbon paper sometimes has a tendency to smear, which makes its use unsatisfactory because such smears are difficult to remove.

The opening for the turntable was cut out with a keyhole saw, and the holes for the arms and GE arm rest were made with wood bits. Pilot holes for the wood screws used in mounting the turntable, Livingston arm, and the rest for the Livingston arm were made with a drill bit. The board ready for finishing is seen in Fig. 2D.

The board was finished with walnut stain and two coats of clear varnish to match the cabinet. After being sanded between coats of varnish and sanded and rubbed after the final coat, it was ready for the mounting of the turntable and arms, as shown in Fig. 3.

The underside of the precision-made turntable with its large-sized bearing shaft can be seen in Fig. 3. The bearing shaft fits into the well for the shaft on the mounting frame and turns on a single ball bearing. The motor and idler wheels, also visible in the illustration, drive the balanced turntable very quietly and

Fig. 1. REK-O-KUT Three-Speed Turntable, Livingston Universal Transcription Pickup Arm, and General Electric A1-501 Transcription Arm.

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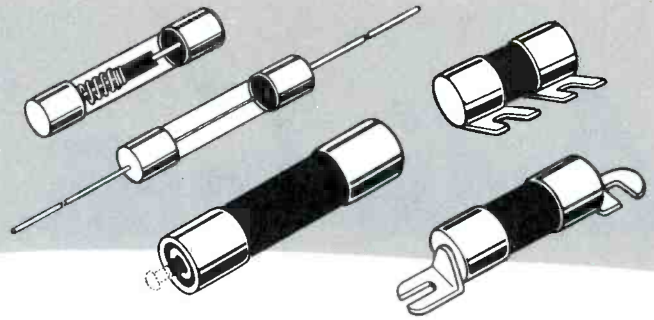

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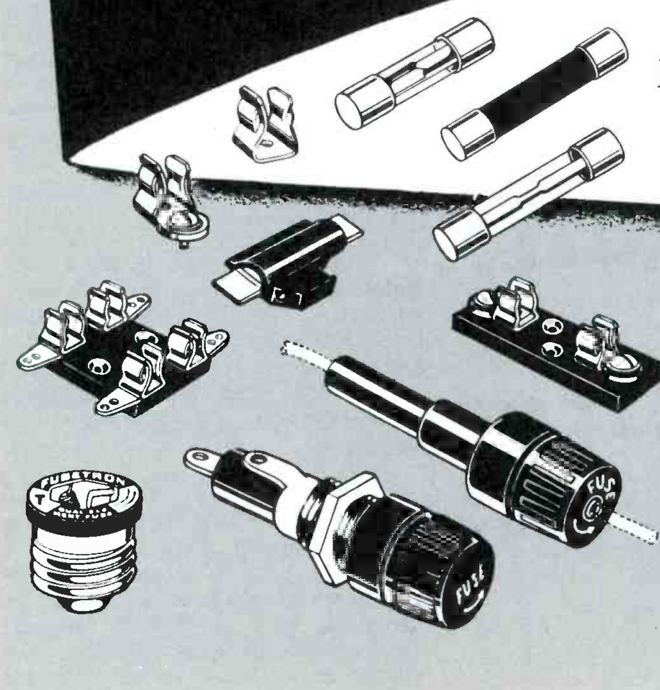

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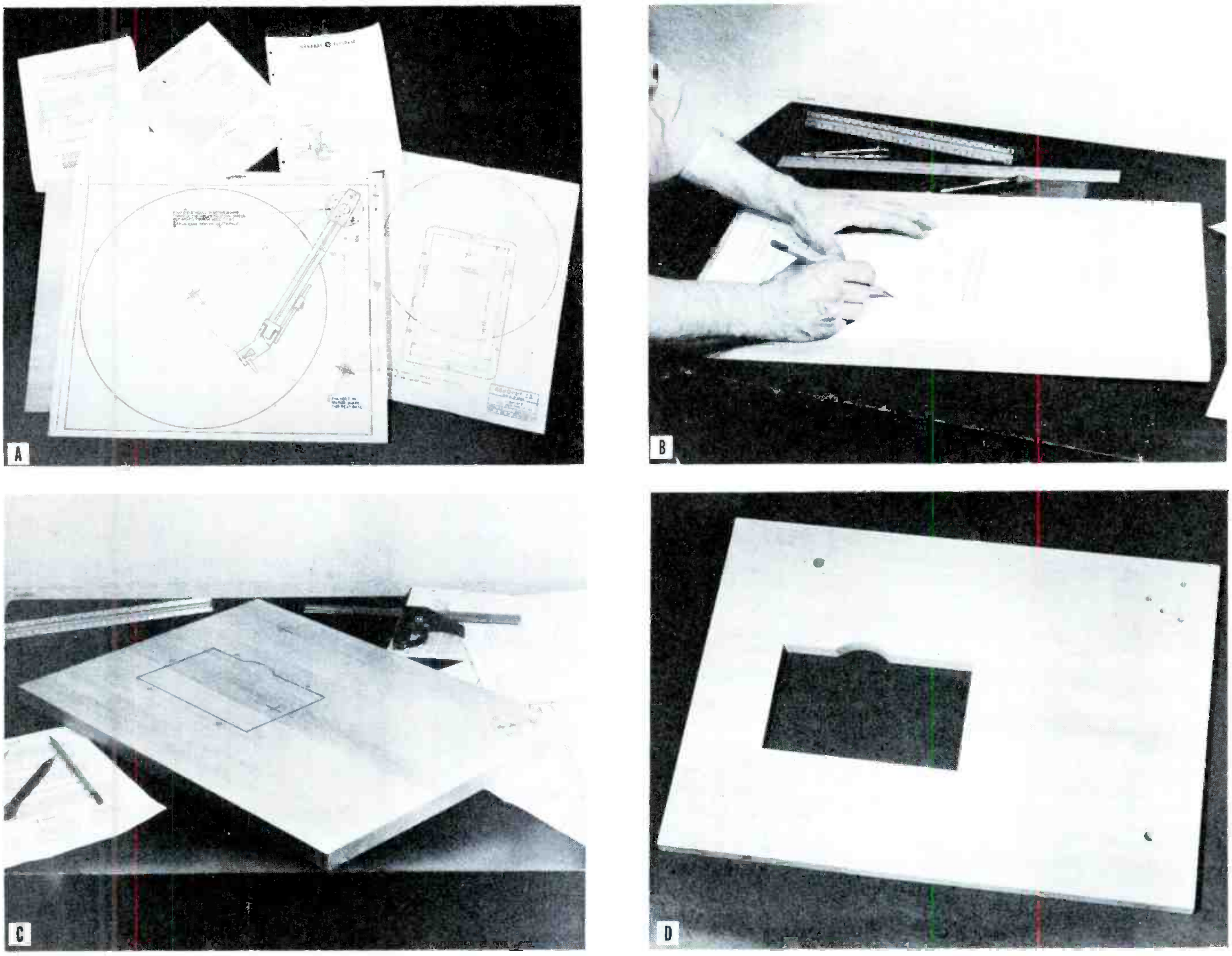


Fig. 2 (A.) Instruction Sheets and Templates Furnished With Turntable and Arms. (B.) Marking Position for Turntable on Board. (C.) Board Marked and Ready for Cutting. (D.) Board With Opening and Holes Cut, Ready for Finishing.

smoothly at all three speeds of 33 1/3, 45, and 78 rpm.

The Livingston Universal arm, equipped with a GE triple-play cartridge, lies on its side at the right of the turntable drive assembly; whereas the GE A1-501 arm (with its two plug-in cartridge slides, rest, and pressure plate) can be seen in the right foreground of Fig. 3.

Some structural details of the GE A1-501 and the manner in which it is mounted are revealed in Fig. 4A. Three machine screws inserted in the holes in the base of the arm pass through the holes drilled for them in the motor board, and they thread into the pressure plate to hold the pickup arm in place. The twisted leads from the cartridge terminals pass through the hole provided for them in the base, motor board, and pressure plate; and they are soldered to the terminals on the strip mounted on the plate. Shielded cable should be used to connect from the terminals on the strip to the input of the preamplifier or amplifier employed.

An Allen-head set screw (located under the end of the tail piece and visible in Fig. 4A) is provided for making height adjustments of the arm. The arm rest is shown secured in position by a nut and washers.

In Fig. 4B, the arm is being leveled so it will swing parallel with the top of the turntable. Inspection will show that the bottom surface of the base is round. Leveling can be accomplished by adjusting the tension of each one of the mounting screws that pass through the base and motor board into the pressure plate.

The Allen wrench (furnished with the arm) is being used in Fig. 4C to adjust the height of the arm. The arm can be slid up and down on the spindle when the set screw is loosened. After the correct position is found, the set screw is tightened.

* * Please turn to page 83 * *

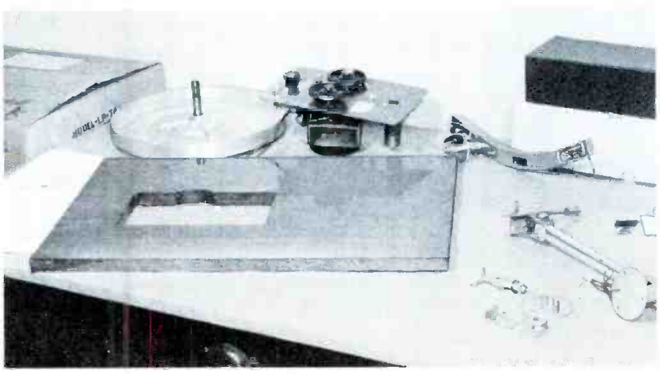


Fig. 3. Finished Motor Board Ready for Mounting of Turntable and Arms.

COLOR TV

EDITOR'S NOTE:

This training series is primarily directed to service technicians who have knowledge of the fundamentals of black-and-white television. The purpose of the series is to familiarize the technician with the background, development and practical operation of color television equipment, so that problems of installation and maintenance or repair may be approached with understanding and reasonable confidence.

The acquisition of this familiarity will not be a short process and it undeniably will have its difficult moments. To achieve it, studies of color, color signal makeup, color receiver circuit design and new servicing techniques will be involved. Even so, it's nothing to get frightened about. No matter how complex a system or piece of equipment may be, it still can be reduced to individual circuit principles of oscillation, detection and amplification known to all.

Each successive PF INDEX will contain an installment until the series is complete. The length of each section will be governed by the type of discussion it contains. A section covering a difficult phase of the subject will be shorter than one containing material on a less complicated phase. By so doing, we hope to present the complete series as quickly as possible, but at the same time we plan to present no more data than can be readily absorbed and fully understood in the period between each installment.

The section which follows is intended to serve as an introduction to color television and the series. As always, your comments and suggestions about the series will be welcomed. Good luck.

An Introduction to Color Television

"Color television is one of the greatest technical achievements of our age. It represents outstanding progress and another important contribution of the electronics industry to our American way of life."

The foregoing is a quotation from Dr. W. R. G. Baker who served as chairman of the National Television Systems Committee. This quotation serves to express the feelings of a great number of people, whether they are in the electronics industry or not, that the development of color television is an outstanding achievement which reflects the ingenuity and diligence of the American people.

WHY COLOR TELEVISION?

When two pictures of the same scene, one in color and one in black and white, are placed side by side, the version in color receives the greater attention. This is only natural, because as we view objects around us in nature the response is in color.

This does not mean to imply that all pictures must be in color to be enjoyable. There are many types of pictures and illustrations that are as much if not more effective in black and white as they would be in color. Applied to TV programming, for example, news or sports commentaries, panel shows, and certain types of sporting events would seem to benefit little through use of color.

Fig. 1. RCA Victor Model CT-100 Color Receiver.

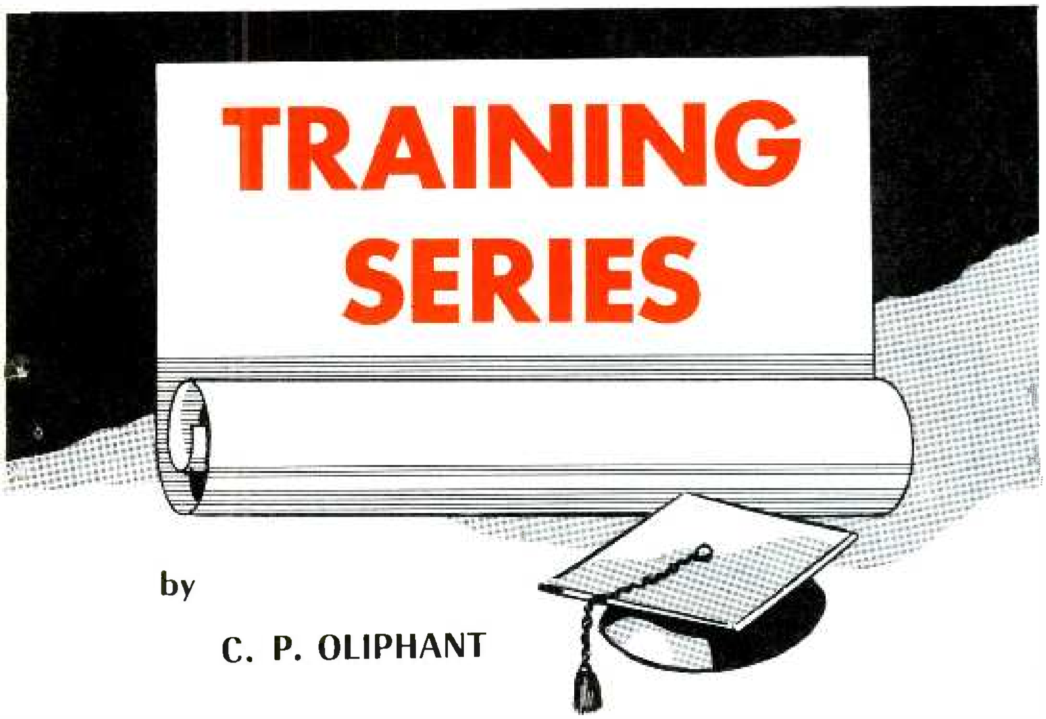
On the other hand, there are certain types of programs which would be enchanced by the addition of color. Examples here would be variety shows and special outdoor telecasts such as the Pasadena Rose Parade on New Year's Day. These presentations could rely heavily on the use of color for entertainment value.

Another advantage offered by color television lies in the presentation of commercials. Sponsors like to present their products in the best possible manner, and it would seem that the addition of color would help a great deal since many products are distinguished by their color or by the colors of their containers. The color scheme on a container is often selected by the producer to serve as a guide for the buyer. With capability of product display in full color on TV commercials, sponsors should certainly be interested in the potential of color television.

Number of Color Programs

A portion of the public is under the impression that in time the entire schedule of television programs will be in color. This will probably not be true because of the lack of need for color in certain programs and because of the higher cost of color programming. Another contributing factor would be the number of color receivers in a given area. If the color program does not reach a large number of consumers, the sponsor would not likely contract for the higher cost of color programming.

A question which is asked quite often in areas where color TV is not yet available is, "Why isn't color televised over our local station?" This question can best be answered by discussing some of the things



TRAINING SERIES

by

C. P. OLIPHANT

which must be done at the transmitter before color can be televised.

The simplest way that any station can televise color is accomplished by having the color signal fed from some other originating point to the transmitter. This process is certainly not new, because network distribution of television programs has been carried on for several years. The nature of the color signal, however, is such that it places certain requirements on any distribution system over which it is carried. To better understand why this is so, let us consider one of the characteristics of the color signal.

Since the color signal contains considerably more information than the black-and-white signal, it is only natural to suspect that the color signal would require greater bandwidth; and such is the case. As a comparison, the black-and-white video signal can be very successfully carried over connecting links having a bandpass of three megacycles. The color signal, however, must be carried over links having a bandpass of 4.1 megacycles; otherwise, serious degradation of this signal will result. The transmitter must also be capable of transmitting a signal having this broader bandpass. In order to do this, most of the existing stations will require certain modifications. The network facilities will also have to fulfill the previously mentioned requirements before the signal can be carried.

Assuming that these two qualifications are fulfilled, an existing station will be able to transmit color programs which are available from the networks. Later in the training series, the study of the color signal will make clear why these more stringent requirements must be met. The point is mentioned here in the hope that this information will help in answering any questions which your customers might ask on the subject.

Cost of Color Receivers

The number of color receivers in the hands of the consumers will be largely dependent upon cost. At the outset of color-TV production, receivers were offered at retail prices ranging from \$1000 to \$1300. This price generally places the color receiver in the classification of a luxury. Until such time that the price is reduced so that the receivers will be purchased by a greater number of people, color programming is likely to be limited.

Fig. 2. Westinghouse Model H-840CK15 Color Receiver.

Figs. 1 and 2 show two color receivers which were among the first commercially available units after the FCC approval of the present color television system.

COLOR TV DEVELOPMENT

The development of color television has been going on for several years. Actually, it would be difficult to estimate even an approximate date for the beginning of the development work. Before the acceptance of the present system, there were many other systems being considered. Since these systems did not satisfy the FCC or the industry, they were not acceptable. However, the present system is an outgrowth of some of these earlier systems.

The standards for the present color television system were formulated by the NTSC (National Television System Committee). The design of the transmitting and receiving equipment was left to the discretion of the electronics manufacturing industry.

There were two requirements that a color television system had to meet. These were: first, the system had to be compatible and second, it had to be all-electronic. A compatible television system is one that provides a signal of such a nature that the existing black-and-white receivers are able to accept this signal and produce a picture in monochrome without modifications or additional adjustments to the receiver. The task of developing specifications for a signal which would conform to these requirements was undertaken by the NTSC. Let us take a brief look at the history of the NTSC and what has been accomplished by it.

The first NTSC was formed in 1940 for the purpose of obtaining a set of standards which could be used in the commercialization of monochrome television. The standards for monochrome television that we now have are the results of the first NTSC. Because of the approved work of the first NTSC, the second NTSC was organized and ultimately produced the accepted color standards.

This committee was authorized by the board of directors of the Radio Television Manufacturers' Association with members who represented organizations in the electronics field and who were interested in the re-

* * Please turn to page 43 * *

Servicing SPECIALIZED EQUIPMENT

Many Electronic Devices Can Provide Additional Business

by DON R. HOWE

There are many kinds of electronic equipment designed for special applications. The electrical circuits in many of these devices are not far different from those employed in radios, television receivers, and audio amplifiers; therefore, the servicing problems connected with them should not be particularly difficult for the experienced service technician. Specialized equipment appears strange principally because of the varied mechanical arrangements usually employed. These devices are received for repair with hesitancy on the part of the service technician who is not aware of the electrical similarities which exist between them and the sets he services every day.

Such opportunities for additional sources of revenue should not be missed. Hence, it is our purpose to point out and discuss examples of specialized equipment so that the service technician may better understand how to go about analyzing and servicing these units.

Message Repeater.

The Mohawk Business Machines Corporation has recently introduced a device which should find wide acceptance in a great number of applications. This device, shown in Fig. 1, is termed the Message Repeater and is a combination tape recorder and playback machine. Fig. 2 is a photograph of the unit with the cover removed.

The Message Repeater will repeat a previously recorded message whenever the unit is activated by an external switching device and will automatically stop at the end of the tape. The switching may be accomplished by push buttons, floor mats, electric eyes, electric timers, or similar devices.

Practically unlimited uses are possible for such a machine. An example might be for sales promotion in an appliance store where the opening of a refrigerator door will actuate the Message Repeater. The recorder could then relate some of the main features of the refrigerator. Another use might be for safety purposes in a factory where the unit would be activated by a floor mat placed near a potential source of accidents. The machine could then repeat a message to warn of the potential danger. The specific applications of such a device are limited only by the user's imagination and needs.

It is not improbable that the service technician may eventually be asked to repair these units. It will therefore be helpful to have a working knowledge of the Message Repeater. For this reason, the following information is given.

The tape used in this machine is plastic with a coating of red oxide. The tape is formed in an endless loop which is housed in a rectangular cartridge. The cartridge can be seen behind the opening in the upper left-hand corner of the unit shown in Fig. 1. These cartridges provide tapes designed to carry messages up to two minutes in length. They are easily removed from the machine so that other cartridges with different messages may be substituted.

A 12AX7 and a 50B5 are used to provide three stages of audio amplification. See Fig. 3. These stages are used for recording and for playback. An additional 50B5 is used as the bias oscillator which is required for conventional tape or wire recording. The bias oscillator is inoperative during playback.

When the switch S3 is closed, power is supplied to the rectifier M1 and the filament string. The high-voltage rectifier M1 supplies voltage to the B+ circuits through resistor

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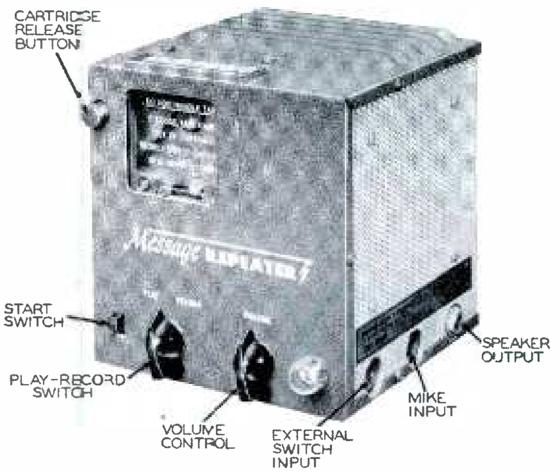

Fig. 1. Message Repeater. (Sample Courtesy of Mohawk Business Machines Corporation.)

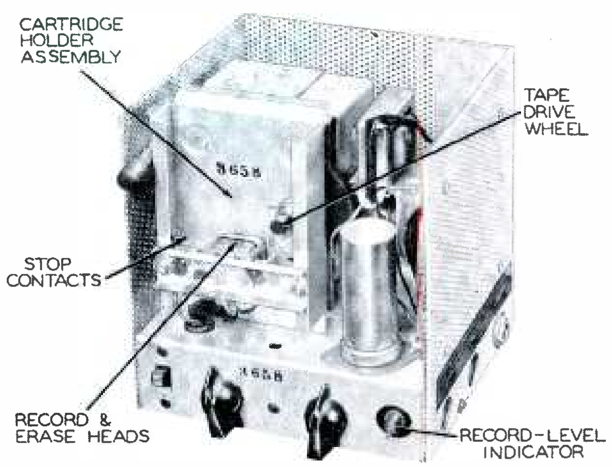

Fig. 2. Message Repeater With Cover Removed. (Sample Courtesy of Mohawk Business Machines Corporation.)

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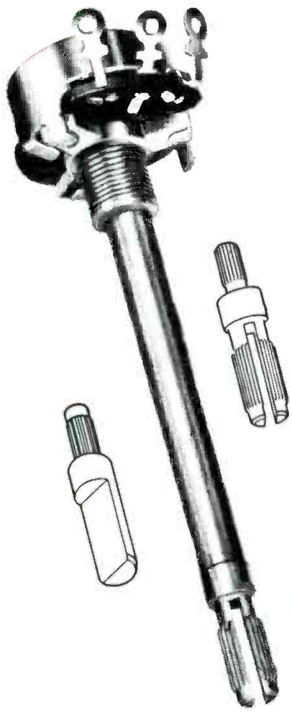

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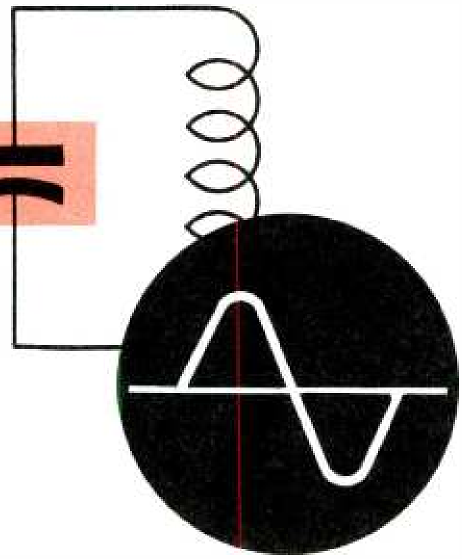

PART 1 Analysis of Several Circuits Used in Intercarrier and Nonintercarrier Receivers

by PAUL C. SMITH

The standard television sound signal in the United States consists of a carrier which is frequency modulated by the audio signal. The maximum deviation is 25 kilocycles on each side of center frequency for 100 per cent modulation. This FM carrier frequency is maintained very accurately by the transmitting station at 4.5 megacycles above the video carrier frequency.

It is the function of the sound IF amplifier of the television receiver to accept this FM signal after conversion to the sound intermediate frequency in the converter stage of the receiver and to supply any amplification necessary for proper operation of the sound-detector stage and succeeding audio stages. The final audio signal should contain a minimum of distortion and extraneous noise.

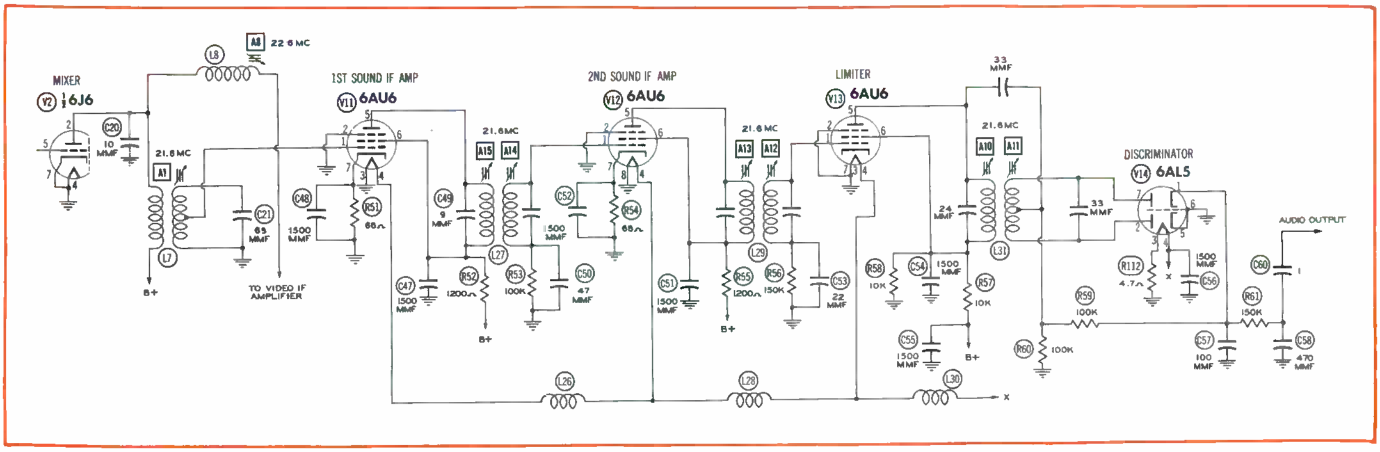

Fig. 10-1. Partial Schematic Showing Conventional Separate-Sound IF System.

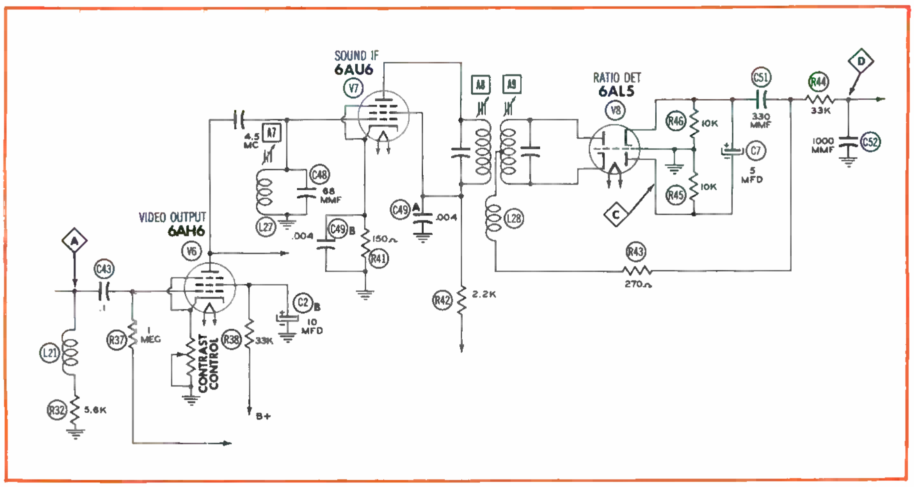

Fig. 10-2. Partial Schematic Showing Conventional Intercarrier Sound IF System.

The original modulation is impressed on the carrier at the broadcasting station as a frequency variation only, whereas the carrier amplitude is held constant. Atmospheric and man-made electrical disturbances may alter the signal reaching the TV receiver, but these disturbances are evident mainly as sharp peaks in amplitude. A well-designed receiver will respond only to the frequency variations, and the result is the static-free reception characteristic of FM.

Other factors contributing to reduced noise are (1) the use of pre-emphasis of the higher audio frequencies at the transmitter and of

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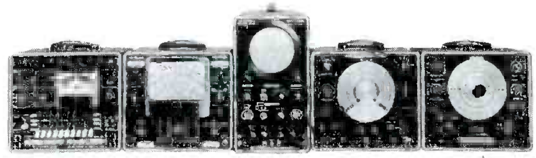

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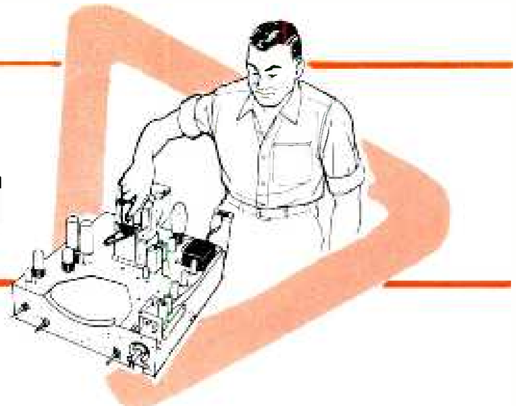

by HENRY A. CARTER

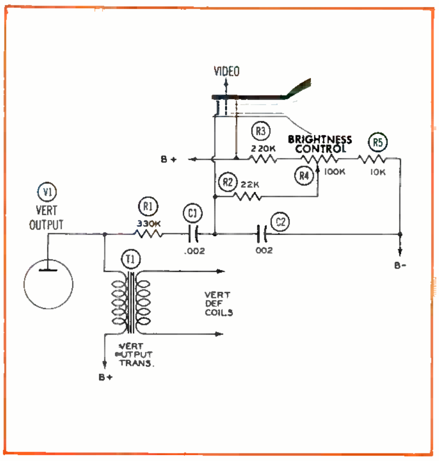

Fig. 1. Blanking Pulse Fed to the Cathode.

Vertical-Retrace Blanking

Almost all television sets now being manufactured employ some means whereby the vertical-retrace lines are blanked out so that they are not visible in the picture at any time. There are two reasons why the need for this has come about.

1. Many films which are used for television programming were not made for TV. These films often contain many night scenes, the transmission of which results in a low video level. Receivers not incorporating a DC restorer circuit will not function properly under these conditions, as will be explained later.

2. As the picture tube becomes weak, it is necessary to increase the setting of the brightness control in order to obtain sufficient brightness. This action usually results in visible retrace lines.

You may be wondering why there is any need in a set for a circuit to eliminate vertical-retrace lines when the video already contains a vertical-blanking signal. The absence of a DC restorer makes this blanking signal less effective. Very few present-day receivers employ a circuit for DC reinsertion. With no DC reinsertion, the blanking level will change as the video level is changed and will thereby make the vertical-retrace lines visible during night scenes or when the picture is blacked out at the originating studio. On the other hand, sets which do contain circuits for DC reinsertion have very little need for special retrace-blandking circuits.

There are many ways to obtain vertical-retrace blanking. Some are more elaborate than others; however, they are all fundamentally alike. A pulse is taken from the vertical-deflection circuit and applied to one of the elements of the picture tube. This pulse cuts off the current flow in the picture tube during the time the pulse is present. The pulse used for this purpose is actually the resultant voltage developed by the collapsing action of the magnetic field in the vertical-deflection circuit during vertical-retrace time.

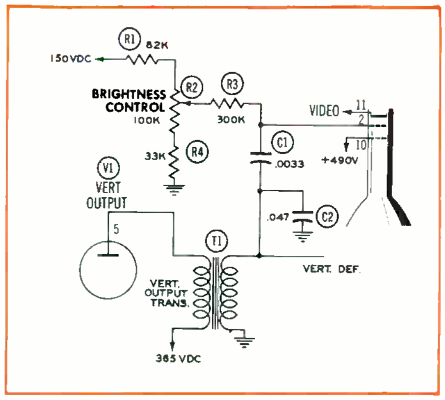

Fig. 3. Blanking Pulse Fed to the Picture-Tube Grid From the Vertical-Output Transformer.

One of the simplest methods of coupling the pulse to the picture tube is shown in Fig. 1. In this arrangement, only two additional components are required. They are a 330K-ohm resistor (R1) and a .002-mfd capacitor (C1). The pulse taken from the plate of the vertical-output amplifier and having a positive polarity is applied to the cathode of the picture tube to cut off the beam current. In circuits which have the blanking pulse applied to the accelerating anode or to the grid (as illustrated in Fig. 2), the pulse must have a negative polarity. In order to obtain a negative pulse, the signal is taken from the grid of the vertical-output tube (Fig. 2) and fed to the grid of the picture tube through a .0005-mfd coupling capacitor C4.

Fig. 3 shows another method whereby a negative blanking pulse is obtained for application to the grid of the picture tube. For this system, the signal is taken from the secondary of the vertical-output transformer. In order for a set to use this method with an auto type of vertical-output transformer, it may employ a setup similar to the circuit shown in Fig. 4.

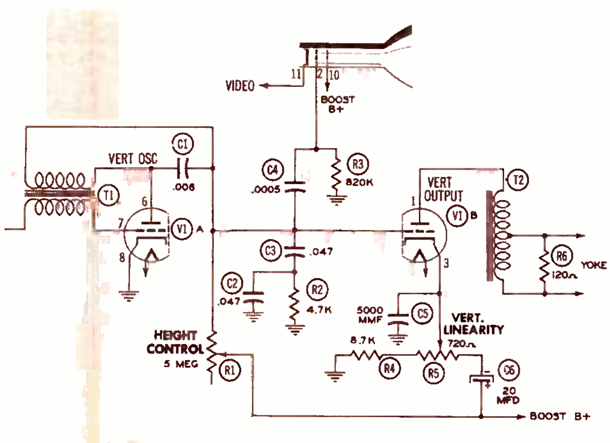

Fig. 2. Blanking Pulse Provided by the Vertical-Output Grid.

* * Please turn to page 85 * *

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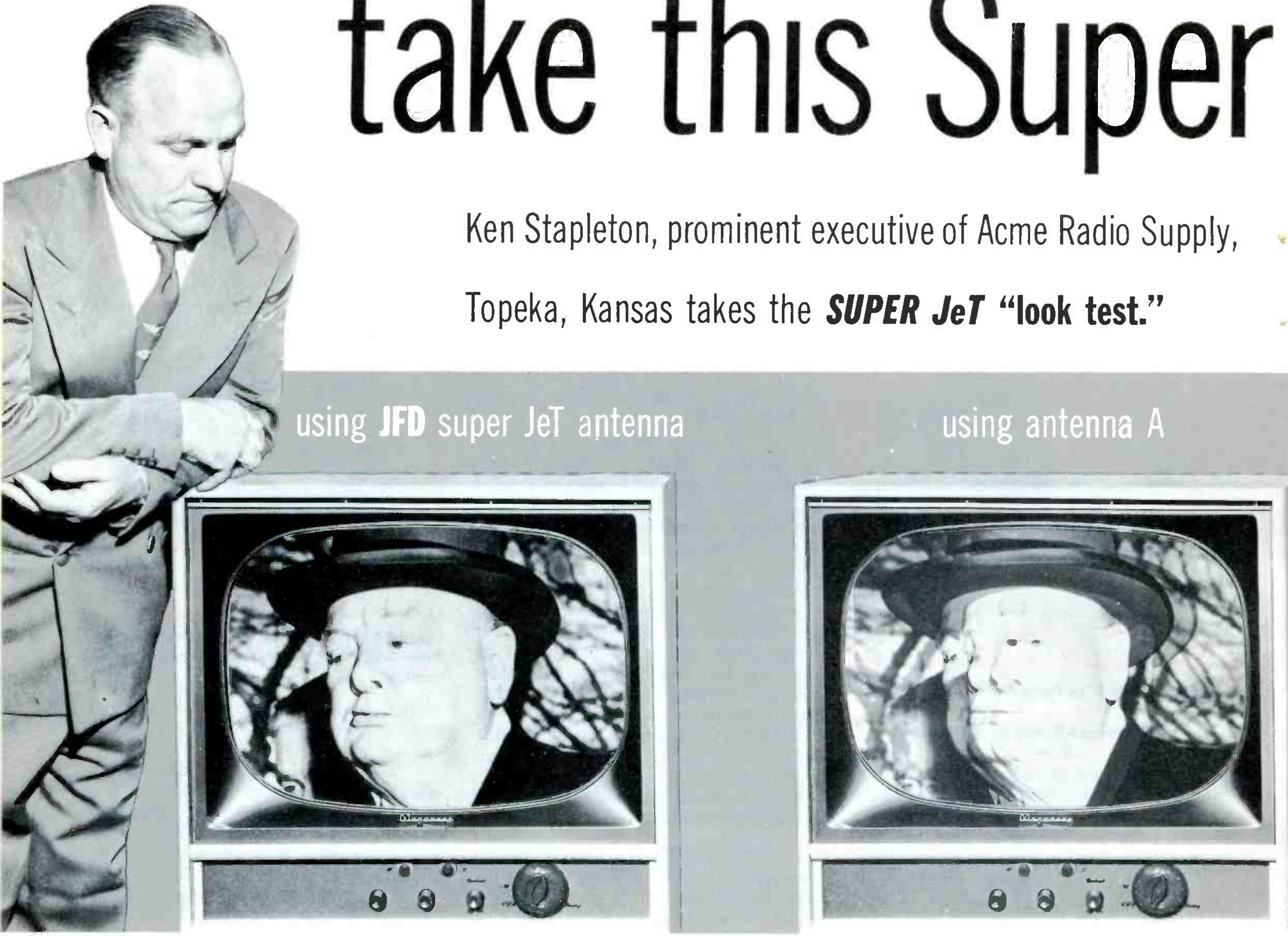

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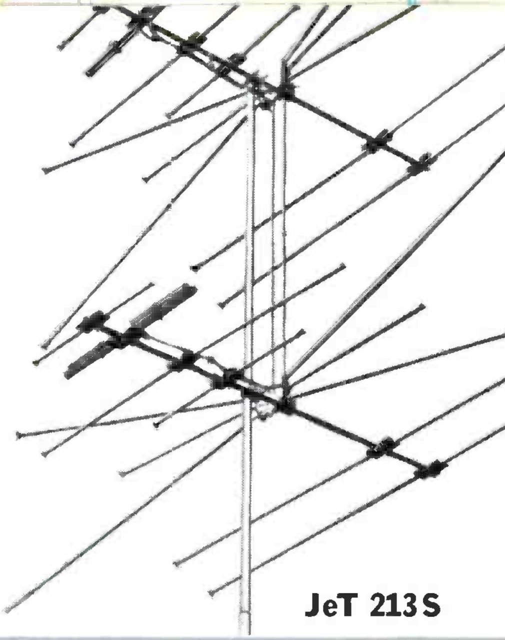

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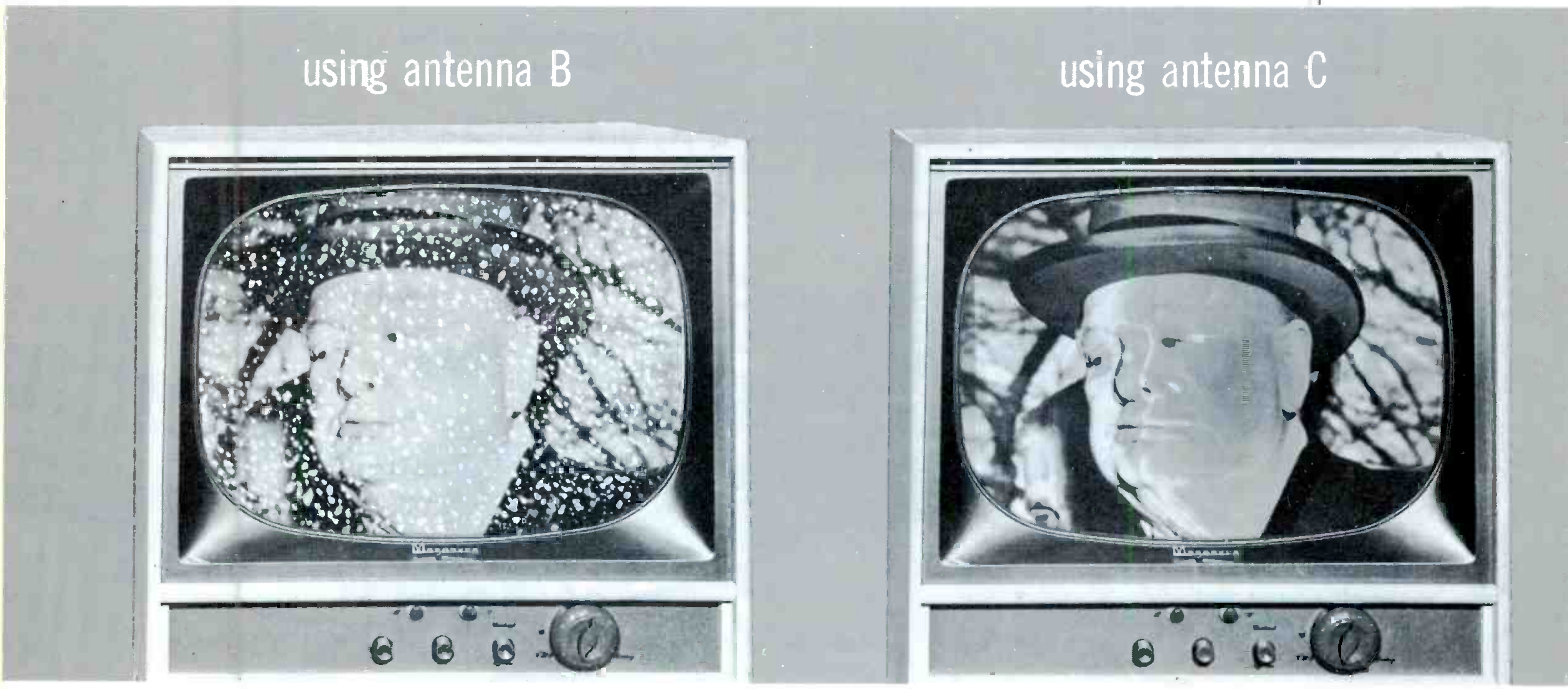

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Competitor B Radar Screen with 2 dipoles (2-bay) Not Assembled	$34.95	0.75	3.25	4.5	3.5	3.5	6.0	7.0	6.5	7.75	8.0	7.5	6.0
Competitor C Bedspring (4-bay) Pre-Assembled	$55.00	4.0	5.0	7.0	6.25	5.0	5.25	6.0	5.25	7.25	9.25	6.5	7.0
JFD Superjet Model JeT 213 S (2-bay) Pre-Assembled	$38.35	6.5	7.5	9.5	8.5	8.5	11.0	11.0	12.0	12.0	11.25	11.75	12.0

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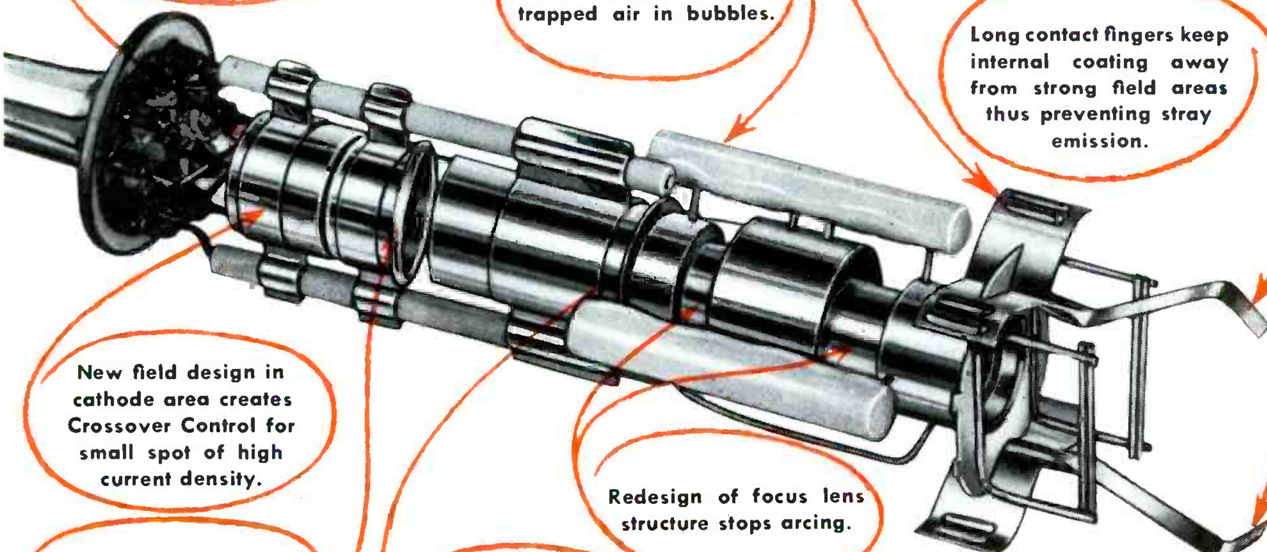

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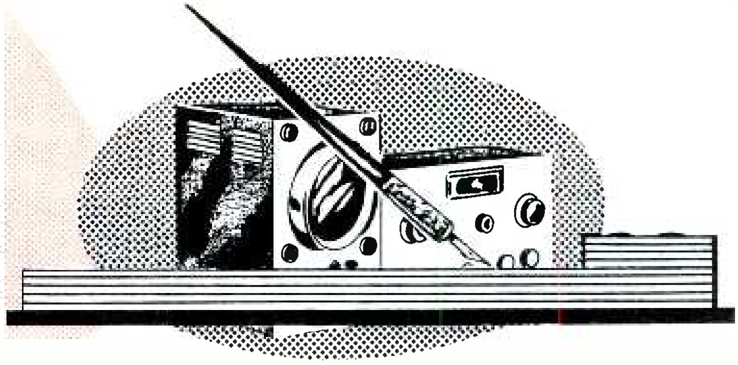


TEST EQUIPMENT

by **PAUL C. SMITH**

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

OSCILLOSCOPE CALIBRATORS

The oscilloscope is certainly one of the most useful test instruments a service technician may possess. It can be made even more valuable through the use of the scope calibrator. Without some means of calibration, the scope will give only a relative indication of signal amplitude. A large signal will give a greater deflection than a small signal — if the signal is twice as large, the deflection will be twice as great (providing the scope is not overloaded).

Sometimes this relative indication is all that the service technician will require at the moment. But there are instances when comparison of the amplitude of signal output of a stage with the normal value of output indicated on the schematic will be the only means of determining whether the stage in question is operating properly. This is particularly true of TV receivers, because the varied waveforms encountered in them make the oscilloscope a natural choice. With it, the technician is able to compare both waveform shape and amplitude at the same time. With the common AC meter he cannot view the shape of the waveform, and any indication of relative amplitudes may be inaccurate because of irregularities in shape.

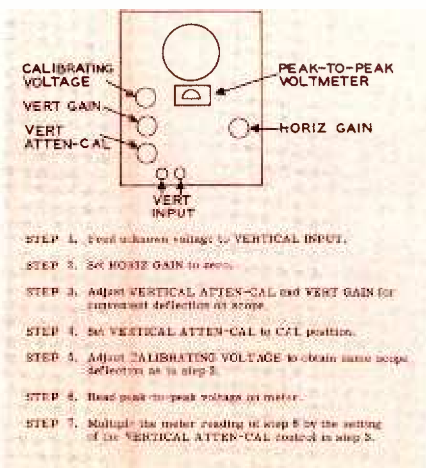


Fig. 1. Procedure for Measuring Waveform Amplitude With Scope Having Built-in Calibrator.

One of the simplest provisions for scope calibration is the inclusion of a test jack or binding post on the panel of the scope. This terminal is connected internally to some point of the scope circuit where an AC signal of small value can be tapped without disturbing the normal operation of the scope. The service technician merely touches the vertical-input probe to this point and obtains a deflection on the scope to represent that voltage value. The vertical attenuators are adjusted to make this reference voltage of convenient height for comparison with the unknown signal voltage.

Instead of bringing the test signal to an external point, it may be connected to a front-panel switch so that at one position of the switch it is fed directly to the vertical-amplifier input. This arrangement is employed in the Jackson CRO-2 oscilloscope. In this model, one position of the SYNCHRONIZING INPUT CONTROL switch is labeled VERT CAL 10V P TO P. Turning the switch to this position results in a vertical deflection of 10 volts peak to peak on the scope screen. The vertical trace obtained in this manner is adjusted to convenient height by means of the vertical-attenuator controls; then the SYNCHRONIZING INPUT CONTROL is returned to normal position for viewing the unknown signal voltage. Comparison of the height of the two traces gives a direct indication of the value of the unknown voltage. For example, assume that the attenuator controls have been set for a one-inch deflection of the 10-volt calibration signal and that the signal to be measured results in a three-inch trace. This indicates that the unknown voltage is 30 volts, peak to peak. Much larger or smaller voltages may require a change in the step-attenuator position to obtain a deflection of convenient size. This change in attenuation ratio must then be considered when calculating the unknown voltage.

In some scopes, the calibrating voltage is applied to its own step attenuator and is separate from the vertical step attenuator. The Hickok Model 640 oscilloscope utilizes this arrangement. A four-position calibration switch allows the operator to select a calibration signal of either .1, 1, 10, or 100 volts peak to peak.

A calibrating meter may be mounted on the front panel of the scope, as in the Triplett Model 3441. In this model the meter is calibrated with two scales, 0 to 3 volts peak to peak and 0 to 10 volts peak to peak. The desired scale is selected by one of the positions of the vertical-attenuator switch, and then the adjustment of the calibrating voltage control selects any calibrating voltage within the range of the scale. A step-by-step outline of a procedure which can be used in measuring an AC voltage with the Model 3441 is shown in Fig. 1.

* * Please turn to page 70 * *

HORIZONTAL

Operation of the Phase Detector in Controlling a Multivibrator

by WILLIAM E. BURKE

One of the most popular methods used to obtain automatic frequency control of the horizontal sweep in television receivers is by means of the phase-detector and multivibrator combination. A typical system is illustrated in the schematic of Fig. 1. Waveform numbers on the schematic identify points at which significant waveforms can be observed. The operation of the system may be explained through an analysis of these waveforms and the phase relationships between them.

In order to provide a suitable means of comparison between the various waveforms, the oscilloscope was synchronized externally with the saw-tooth voltage which is present at the grid of the horizontal-output tube. A 500,000-ohm resistor was included in series with this external sync connection so that receiver operation would not be disrupted by loading of the circuit. By synchronizing the oscilloscope in this manner and by maintaining the frequency and amplitude of the horizontal sweep of the scope at constant values, we have shown all waveforms with reference to approximately the same time base. Then, by placing associated waveforms one above the other, any change in either the frequency or the phase of these waveforms is made apparent. In addition, an isolation probe was used to prevent the input capacity of the scope from affecting receiver performance.

Sync Phase Inverter.

Starting at the sync phase inverter (V1 on the schematic of Fig. 1) we find two voltage waveforms, W1 and W2, which are pictured in Fig. 2. These voltages are produced by the horizontal sync pulse which is derived from the received signal and which is applied with a positive polarity to the grid of the sync phase inverter. Since resistors R1 and R3 are of equal resistance values, the voltages developed by these resistors are approximately equal in amplitude. Because one resistor is in the cathode circuit of the tube and the other is in the plate circuit, the polarities of the two voltages are opposite. The cathode resistor produces a positive sync pulse, and the plate resistor develops a negative sync pulse. Capacitors C1 and C2 couple these pulses to the phase-detector tube V2.

Sweep Output Voltage.

The phase detector requires a third item of information, namely a sample of the voltage which provides sweep energy to the horizontal deflection coils. Specifically, this sample must accurately depict the frequency and phase of the sweep output voltage. Very often the sample is obtained from a winding on the horizontal-output transformer and has the form of positive pulses like those of waveform W12 in Fig. 2. The three waveforms W1, W2, and W12 in Fig. 2 are those which are supplied to the circuit of the phase detector, and they are observed under conditions where the horizontal oscillator is synchronized with the sync pulses. If the receiver were out of synchronization, the frequency and phase of W12 would not coincide with those of waveforms W1 and W2.

Phase Detector.

A properly operating phase detector responds to and neutralizes

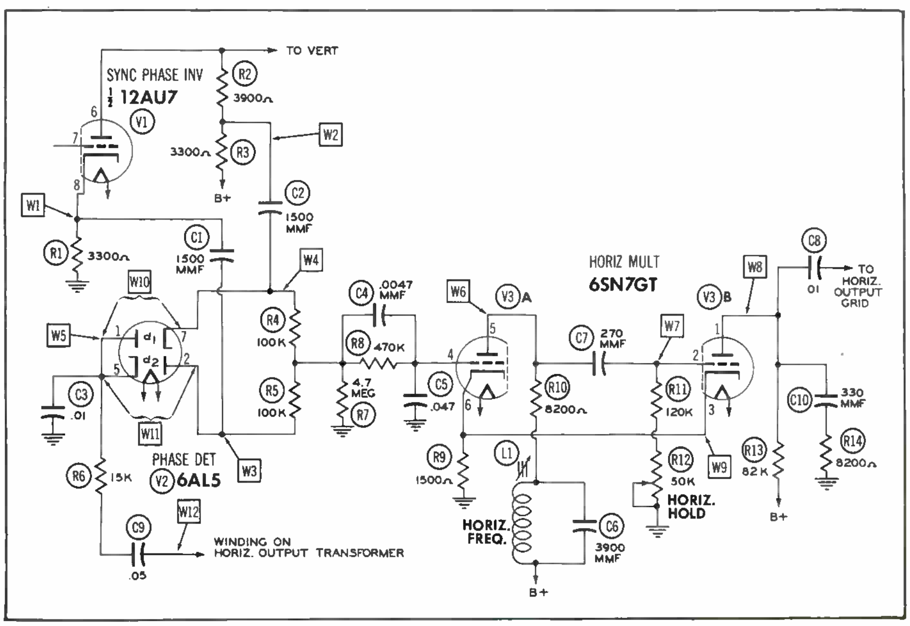
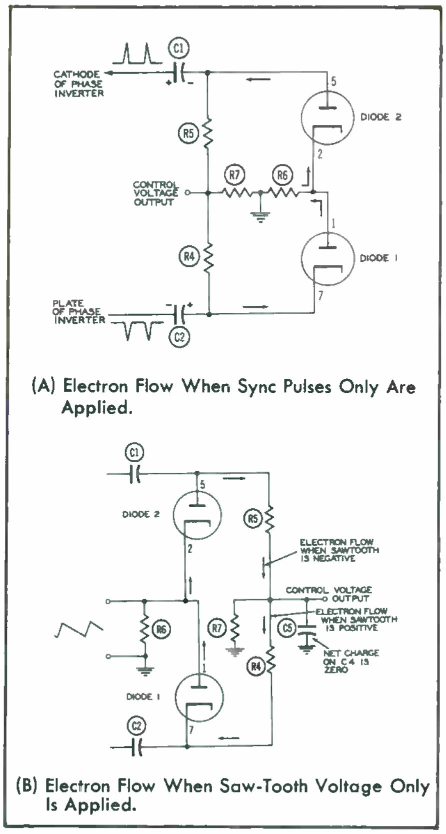


Fig. 1. Schematic of Phase Detector and Multivibrator.

AFC Circuits

any tendency for the horizontal-sweep oscillator to change frequency. It does this by a comparison of the waveforms W3, W4, and W5 which are shown in Fig. 3. These waveforms are derived from those of Fig. 2; W3 and W4 picture W1 and W2 as they are applied to the diodes of the phase detector. Waveform W5 is the saw-tooth wave which results from an integration of waveform W12. The waveforms in Fig. 3 are observed under conditions of horizontal synchronization; the sync pulses coincide in frequency with the saw-tooth voltage. The vertical lines connecting the various waveforms in Fig. 3 mark off identical time intervals; and a comparison of W3, W4, and W5 will reveal that the sync pulses occur while the saw-tooth wave is passing through its AC axis during retrace time.

The phase detector of Fig. 1 can be redrawn as in Fig. 4A to present a clearer picture of its operation. The action of the sync pulses on the circuit will be considered first. The positive sync pulse from the cathode of the sync phase inverter is applied to the plate of diode 2. Electron flow is from ground, through R6 to the cathode of diode 2, through the tube to the plate, and then to the detector side of C1. The excessively large number of electrons makes this plate of the capacitor negative, as marked. The cathode circuit of the sync phase inverter completes the circuit back to ground. The cessation of the sync pulse leaves C1 charged as shown, and as a result diode 2 does not conduct because of the negative bias on the plate.



(A) Electron Flow When Sync Pulses Only Are Applied.

(B) Electron Flow When Saw-Tooth Voltage Only Is Applied.

Fig. 4. Phase-Detector Circuit Redrawn to Show Electron Flow.

During the same time, the negative sync pulse from the plate circuit of the sync phase inverter is applied to the cathode of diode 1. Electron flow is from ground through the plate circuit of the phase inverter to capacitance C2. The electrons leave the detector side of C2, flow through diode 1 and R6, and return to ground. Capacitor C2 is charged as shown, and diode 2 is cut off at the end of the sync pulse.

Between sync pulses, capacitor C1 discharges through resistors R5 and R7; and C2 discharges through R4 and R7. Currents of equal amplitude but opposite polarity flow through R7, the net voltage across

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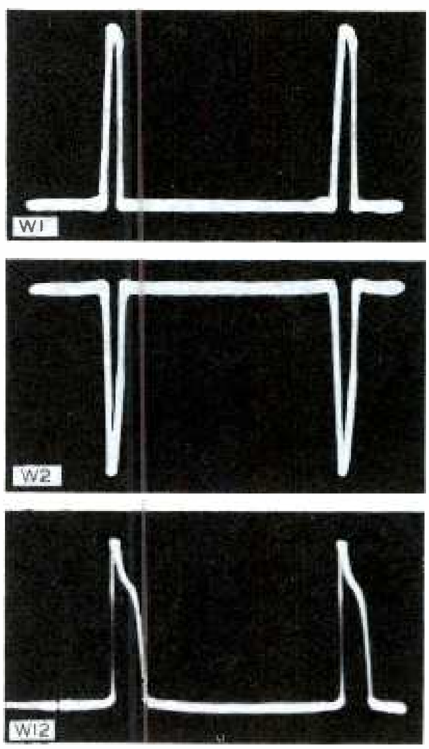

Fig. 2. Horizontal Sync Pulses and Sweep Sample.

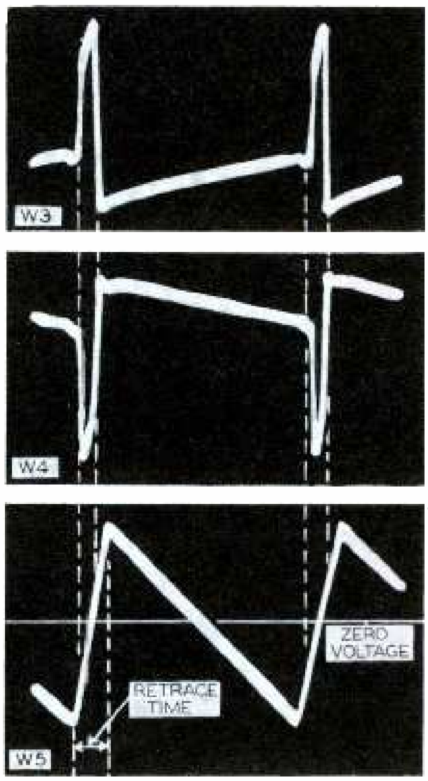

Fig. 3. Comparison Between the Horizontal Sync Pulses and the Saw-Tooth Voltage Applied to the Phase Detector.

Mr. Ed. Lombard, *of Dealer's Wholesale Supply, Ventura, Calif. states:*

"We have tested almost every all-channel antenna, to find the *best* antenna for our Dealers!"

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"With many manufacturers claiming top superiority in their antennas, we were not sure which one to choose. We therefore tested antenna after antenna right on our own roof, and had our dealers try and test antennas to see which brought in clearer, sharper pictures and the least interference on all channels.

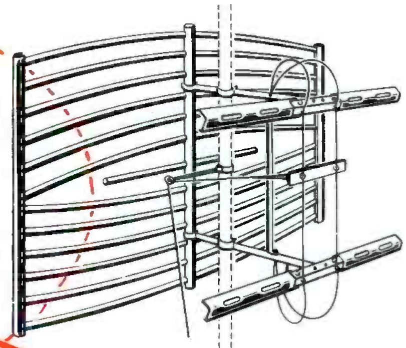
"Dealers in our area have chosen Davis Super-Vision antennas, because our test and their test have proven outstanding results in every area.

"There are many similar antennas, but our Dealers demand Davis from the results it gives."

A Tough Reception Area...

but the DAVIS SUPER-VISION antenna in the Ventura test received all these channels: nos. 2, 4, 5, 7, 9, 11 and 13 from Los Angeles, 75 miles away, over mountainous terrain...nos. 6, 8 and 10 from San Diego, 160 miles away...no. 3 from 24-miles-distant Santa Barbara, despite terrific co-channel interference ...no. 10 from Bakersfield, 90 miles away.

Every dealer has heard antenna manufacturers claim top performance. Davis alone backs its claim with a money-back offer. The Davis Super-Vision antenna is factory-guaranteed to give the maximum reception obtainable. Try one... judge it ...and you too will standardize on the Davis.



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TV COLORMATH

by HAROLD E. ENNES

The Mathematical Foundations Upon Which the Color TV System Operates

EDITOR'S NOTE:

The article which follows is the first of a series prepared by the author, Harold E. Ennes. Mr. Ennes is already well known to most readers as the author of several books dealing with problems and techniques of radio and television broadcasting. The organization became associated with the author through the production of his most recent book, "Principles and Practices of Telecasting Operations," currently enjoying wide-spread acceptance in commercial and educational television applications.

Through this association, the idea occurred that a discussion of color fundamentals and the makeup of the signal at the transmitter, for presentation in the PF INDEX, might well serve a dual purpose. Its apparently primary interest to studio engineers and technicians tends to obscure its virtually equal value to all who desire a basic understanding of color television principles. The service technician, in whose interests this publication is guided, normally concerning himself only with factors of installation, maintenance, and repair, may find the different approach helpful in clarifying operational concepts through familiarity with the complete system.

An unprecedented rush is underway in the television world to cope with the latest addition to the sense of transmission; namely, color. Enthusiasm is warranted, as attested by the few who have witnessed a color telecast; but the optimistic claims of networks that there will be immediate large-scale activity in color should not precipitate the service technician into a helter-skelter approach to this all-important but complex subject. As always, it is advisable to take time to think.

To point up the mood of this treatment, the reader should analyze the purpose of his familiarity with Ohm's law. Is it to be able to figure voltage, current, or resistance from known variables? Not primarily, since any nontechnical person can be taught to measure these values by teaching him the operation of a volt-ohm-milliammeter. Actually, his grasp of Ohm's law not only enables him to set up and solve equations but to arrive at a sensible procedure in analyzing faults when the readings are not normal. He is able to visualize circuits in action.

TV colormath, the mathematical foundation upon which compatible color systems work, enables the technician to visualize the added color circuits in action. When he has this visualization, he can undertake the study required to find sensible procedures in analyzing color-circuit faults.

The math required of the technician is no more advanced than that of conventional monochrome transmission, there is simply more of it. It is of vital importance since, at the transmission end, the color coding, which the receiver must correctly decode, is achieved by means similar to and as accurate as electronic computing machines.

Luminance to Chrominance Proportions

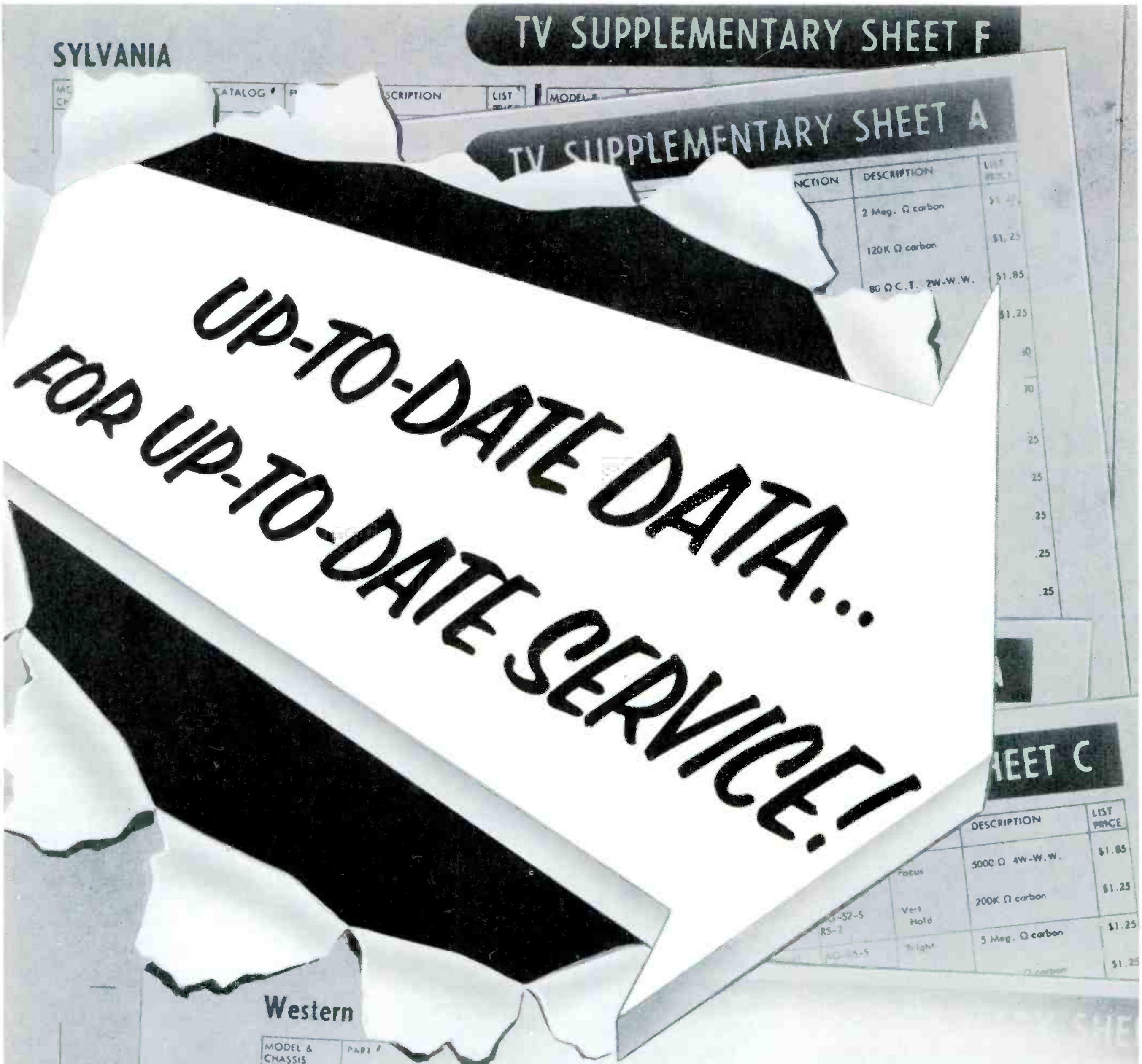
Luminance may be considered essentially a measure of brightness. Conventional monochrome transmission is a translation of the scenic grays and colors into corresponding brightness in the picture tube. The values of brightness are represented by numerical values relating to depth of modulation at the transmitter and to the corresponding amplitude of picture-tube beam current at the receiver.

In the color TV system, the luminance signal contains this brightness translation and carries the fine detail of the picture in its 4.18-megacycle bandwidth. The only difference from conventional monochrome is that the luminance signal is formed from the combined outputs of the three primary color channels at the camera, instead of a single pickup tube. No direct color information is included in this luminance signal; and monochrome receivers may reproduce a color telecast in regular black and white, ignoring information being transmitted on a color subcarrier. Of prime importance for color receivers, however, is the fact that the luminance signal must correctly interpret the relative brightness of the color components in the televised scene. This is assured by special treatment at the camera to complement the characteristics of the phosphor color dots in the color picture tube at the receiver.

The three primary colors (Fig. 1A) are red, green, and blue. The red, green, and blue are assumed to be pure hues, highly saturated, undiluted with white light. Red plus green produces yellow. Red plus blue produces a bluish red, termed magenta. Blue plus green produces a bluish green, termed cyan. A combination of red, blue, and green produces white. Also a combination of cyan, magenta, and yellow contains all three primaries, and will produce white (all colors). Black denotes lack of any color. The three primaries allow any given color to be closely matched by proper mixtures. For example, a greater proportion of red to green produces orange rather than yellow; a greater proportion of green to red results in a greenish yellow, termed "lemon yellow."

The properties of color are termed chrominance. The color brightness is transmitted on the luminance channel. The chrominance channel then concerns only two prop-

* * Please turn to page 63 * *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Examining DESIGN FEATURES

by DON R. HOWE

Familiarity with the features employed in a particular line of receivers is often the keynote to efficient servicing of these receivers. An advance knowledge of unusual circuits or designs is extremely beneficial because of the time saved when these features are encountered. For this reason, an analysis of a complete chassis is provided in the following text. Additional makes of TV receivers will be covered in future articles so that the service technician may become better prepared to service these units.

RCA VICTOR CHASSIS KCS84C AND KCS84E

Tuner

RCA Victor Models 24-T-420 and 24-T-435 employ the KCS84C chassis shown in Fig. 1. This chassis contains a KRK22C tuner which provides reception on all of the VHF channels. The KRK22C tuner is the switch type commonly used by RCA Victor. The input section to the tuner contains the familiar elevator coils used for matching either a 300-ohm or 72-ohm lead-in to the unbalanced input of the RF amplifier. The input circuit also contains three parallel-resonant traps. One of the traps is tuned to 41.25 megacycles, which is the sound IF. Another trap is resonant to the video IF of 45.75 megacycles. The third trap is tuned to prevent interference from stations operating in the FM broadcast band.

A 6BQ7A tube is used in a cascode circuit to provide RF amplification. This stage is controlled by the AGC voltage developed in the receiver. The converter tube is a 6X8 with its output link-coupled to the first video IF stage.

The oscillator adjustments for channels 2 through 12 are accessible from the front of the cabinet by removing the station-selector knob and escutcheon. The channel-13 adjustment is on the side of the tuner.

The U suffix on Models 24-T-420U and 24-T-435U indicates that these models cover the UHF channels in addition to the 12 VHF channels. The chassis used in these receivers carry the designation KCS84E. The use of two tuners, KRK29A and KRK27, constitutes the major difference between chassis KCS84C and KCS84E. The VHF tuner (KRK29A) is very similar to the KRK22C; however, an additional input is provided for connection to the UHF portion of the tuner.

When the tuner is tuned to the UHF position, the VHF oscillator is disabled and the 6AF4 UHF oscillator is placed in operation. The UHF tuner contains a 1N82 crystal diode which is used as the mixer. The output of this mixer is at the video IF of 41 mc and is fed to the RF amplifier in the VHF tuner where it is amplified. The signal is then fed to the 6X8 mixer which acts as an additional stage of amplification. The output of the mixer is coupled to the video IF stages.

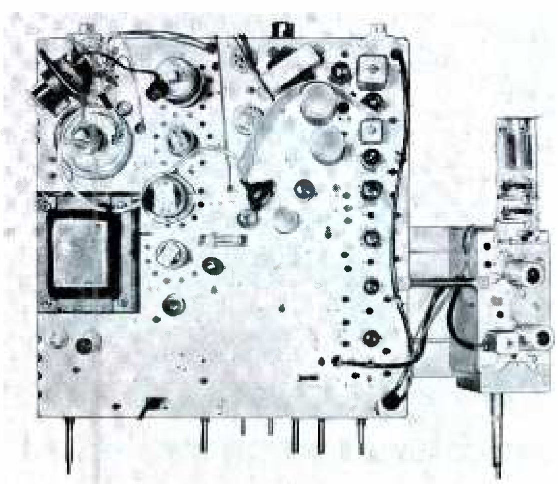

Fig. 1. The RCA Victor KCS84C Chassis.

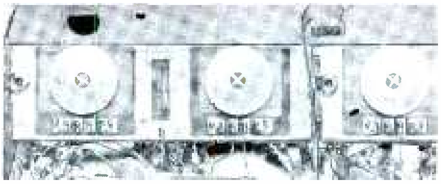

Fig. 2. The Printed-Circuit IF Transformers Used in the RCA Victor Chassis KCS84C.

Video IF

The circuitry employed in the three stages of video IF does not differ greatly from previous models, but the physical construction does depart somewhat from former models. The unique IF transformers illustrated in Fig. 2 are the focal point in this section of the receiver. They are printed-circuit transformers contained on the same base. Tuning of these transformers is accomplished by means of aluminum discs. The proximity of these discs to the coils determines their tuning. These discs are readily accessible from beneath the chassis.

Two 6CF6 tubes constitute the first and second IF amplifiers. The third amplifier is a 6CB6. The gain of the first two stages is controlled by the application of the AGC voltage.

Video Detector

The video detector consists of a triode section of a 12AU7. The grid and cathode form the diode section used for detecting purposes. A schematic diagram of the video-detector circuit appears in Fig. 3. A negative voltage, derived from the grid circuit of the horizontal-output tube and from the AGC circuit, is applied to the plate of the video detector. The negative voltage on the plate exercises some control over the amount of current that will flow in the grid circuit. With a fixed value of signal input to the detector, less grid current will flow as the voltage on the plate is made more negative. This action permits the operating

* * Please turn to page 49 * *


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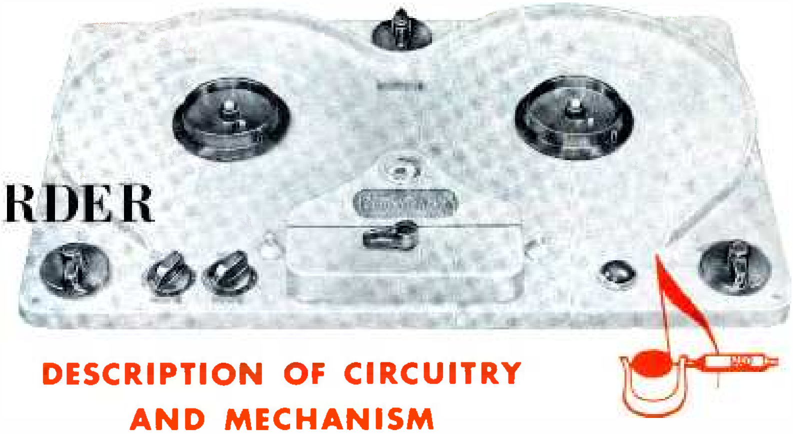
The Concertone TAPE RECORDER Model 1401S



by Robert B. Dunham

DESCRIPTION OF CIRCUITRY AND MECHANISM

Recording on magnetic tape has become practically indispensable to the professional and certainly very popular with the high-fidelity enthusiast, the experimenter, and the casual user who plays with it only for fun. Consequently, many types and models of tape recorders are now available and range from the large complex systems such as those used in large recording studios to the small and comparatively simple units intended for occasional use by the strictly nonprofessional.

The design and final form of a tape recorder are determined chiefly by the purpose for which it is to be used. Therefore, it is possible to group recorders in certain broad classifications such as:

(1) Studio console models for the highest quality recording of music.

(2) Portable professional type of units capable of quality recording comparable to that obtained with studio models.

(3) Dictating and interviewing equipment for recording voice only. These are usually portable, and in some cases they are spring-motor and battery operated.

(4) Units designed for recording music and voice for fun.

The Concertone 1401S Basic Recorder shown in Fig. 1 must be classed as a professional type. Although it is portable, it is sturdily constructed to insure consistent operation. A discussion of some of its features and specifications will reveal why this recorder produces professional results and is very suitable for use by the serious amateur and high-fidelity enthusiast.

Tape Speeds

The 1401S has tape speeds of 7 1/2 and 15 inches per second. Either speed can be selected at any time by turning the speed control knob. The speed of 15 inches per second is necessary when recording music to make it possible to obtain the desired wide frequency response.

Standard and NARTB Reels

Standard 5- and 7-inch reels fit directly on the RMA hubs. The NARTB 10 1/2-inch reels make use of the usual NARTB reel adapters. A full 10 1/2-inch reel of tape provides approximately 32 minutes of recording time at a tape speed of 15 inches per second, or more than one hour at 7 1/2 inches per second. A 7-inch reel holds enough tape for only one-half of the recording time provided by the 10 1/2-inch reel.

Three Separate Heads

Separate erase, record, and playback heads are used. The use of separate heads in this manner allows monitoring of the signal being recorded on the tape. All heads are of the single-track type.

* * Please turn to page 55 * *

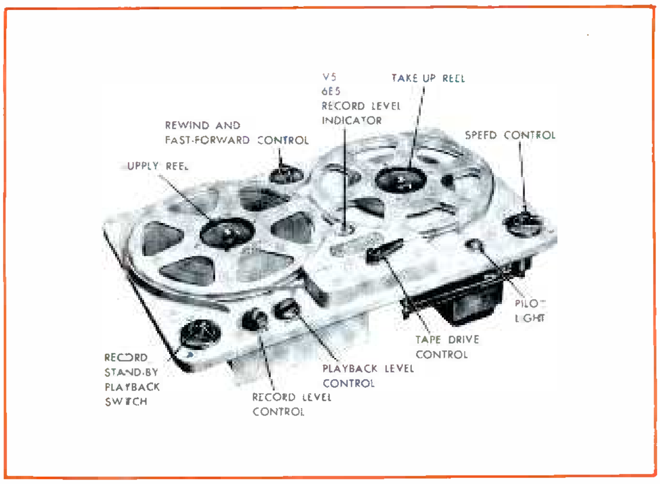


Fig. 1. Concertone Tape Recorder Model 1401S.

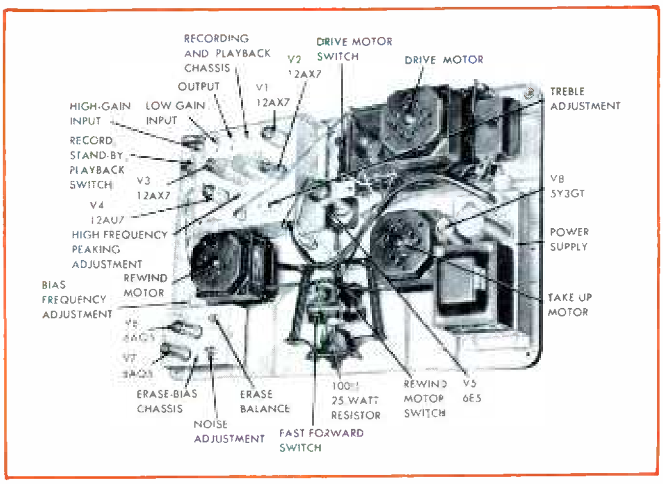


Fig. 2. Underchassis View Showing Individual Chassis and Tape Control System.

Dollar and Sense Servicing

by *John Markus*

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

COLOR BLINDNESS. A color-perception test is given to Admiral's field engineers and distributor service engineers who are prospects for their color TV training school. Those found to be color-blind will have to confine their future service activities to black-and-white TV.

About 5 men out of a hundred have some form of color blindness. Most of these don't know it until they take a perception test, because of the skill with which they utilize brightness and position clues in judging color of objects. The tests require special equipment, which most eye specialists have.

Commonest form of color blindness is dichromatism, in which all colors can be matched by mixtures of two elementary stimuli instead of three. A service technician having this could conceivably turn down one color completely when adjusting a color TV set and balance the other two colors to give what to him seems a perfectly normal picture.

Service technicians everywhere are showing intense interest in color TV developments. Over 850 attended an RCA Service Company course in Washington, D.C.; and other classes throughout the country have likewise attracted maximum attendance. Many of the large manufacturers are planning to make lessons available on color TV circuitry, and servicing publications are giving last-minute developments along with articles on basic theory. For those service technicians who prepare now, the first few years of color TV can be the most profitable of their entire career.

RCA Service Company has announced that a color-service contract would cost a minimum of $180 for the first year as compared to a $60 contract for a black-and-white set. Other factors pointed out are that sets may require up to 60 minutes to warm up properly before making critical back-of-set adjustments during service calls. It is not expected that indoor antennas will be satisfactory for color sets. This can mean more antenna installation business for the trade as well.

BANKING. Best way to endorse checks that you plan to deposit is, "For deposit only," followed by your name. This protects you completely if the checks are lost or stolen, because with such an endorsement your own account is the only place in the World where that check is any good.

We'd been worrying about whether in some far-off city an account could be opened in our name with such an endorsed check and the money drawn out a few days later after the check had cleared, but our local bank says it won't work. The for-deposit-only endorsement means that the account already exists. For maximum safety on big checks, endorse them this way as soon as you get them. Trying to have payment stopped on a check that got out of hand is one big headache and doesn't always succeed.

FAILURES. There's a lot to be learned from the mistakes of others. The Dun & Bradstreet report on 210 business failures in 1952 among appliance, radio, and TV retailers is well worth studying. The four major causes of these failures were: incompetence, 38.1 per cent; unbalanced experience in sales, finance, purchasing, and production, 17.6 per cent; lack of experience in the line, 16.2 per cent; lack of managerial experience, 13.8 per cent. These underlying causes for failure resulted in inadequate sales, difficulties with inventory, weakness in meeting competition, and difficulties in collecting bills.

Actual fraud on the part of principals caused only 9 per cent of the failures; this chiefly involved irregular disposal of assets, false financial statements, and premeditated overbuys. Neglect of business due to bad habits, poor health, or marital difficulties was the only other appreciable cause of failure and amounted to 4.3 per cent.

Summarizing this information, we find that difficulties in collecting accounts and in buying merchandise accounted for some 30 per cent of the apparent causes of failure. Watch these two danger points, if you're selling as well as servicing.

ITV STUNTS. Two novel uses for industrial TV cameras in Chicago's Belden-Stratford Hotel merit mention this month. One camera was focused on the clerk's desk and connected to room TV sets in such a way that a guest could see the person calling him on the lobby phone. Another camera was placed in the hotel kitchen, so that guests in their room could see what the chef was cooking for dinner.

DIVERSION. Kansas City's Sheriff Owsley bought a dozen TV sets for the county jail to keep his wards from thinking about who they're going to rob when they get out.

* * Please turn to page 86 * *

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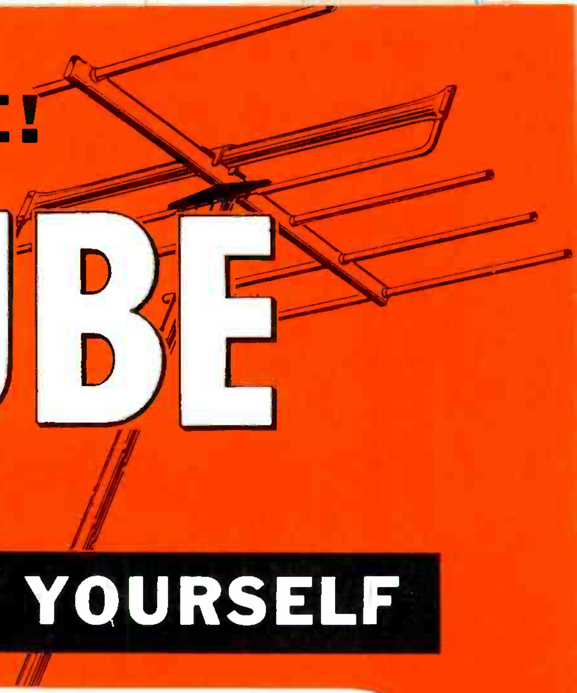

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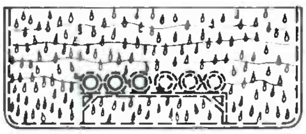
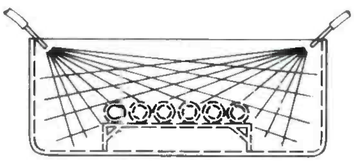
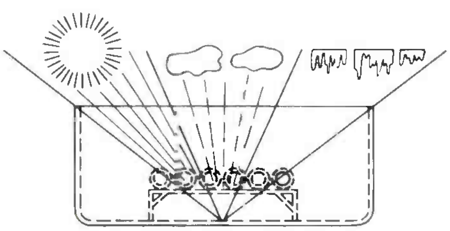
EXPOSURE TEST	NEPCO TENNATUBE	BEST COMPETITIVE MASTING OF THE MANY TESTED
 HUMIDITY TEST 100% Humidity 120° F.	500 Hours NO BREAKDOWN	500 Hours VERY POOR APPEARANCE
 SALT SPRAY TEST—20% at 95° F.	215 Hours NO CHANGE	215 Hours VERY PRONOUNCED RUSTING
 WEATHEROMETER	300 Hours NO CHANGE	300 Hours BEGINNING TO DETERIORATE

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Television Sound IF Systems

(Continued from page 15)

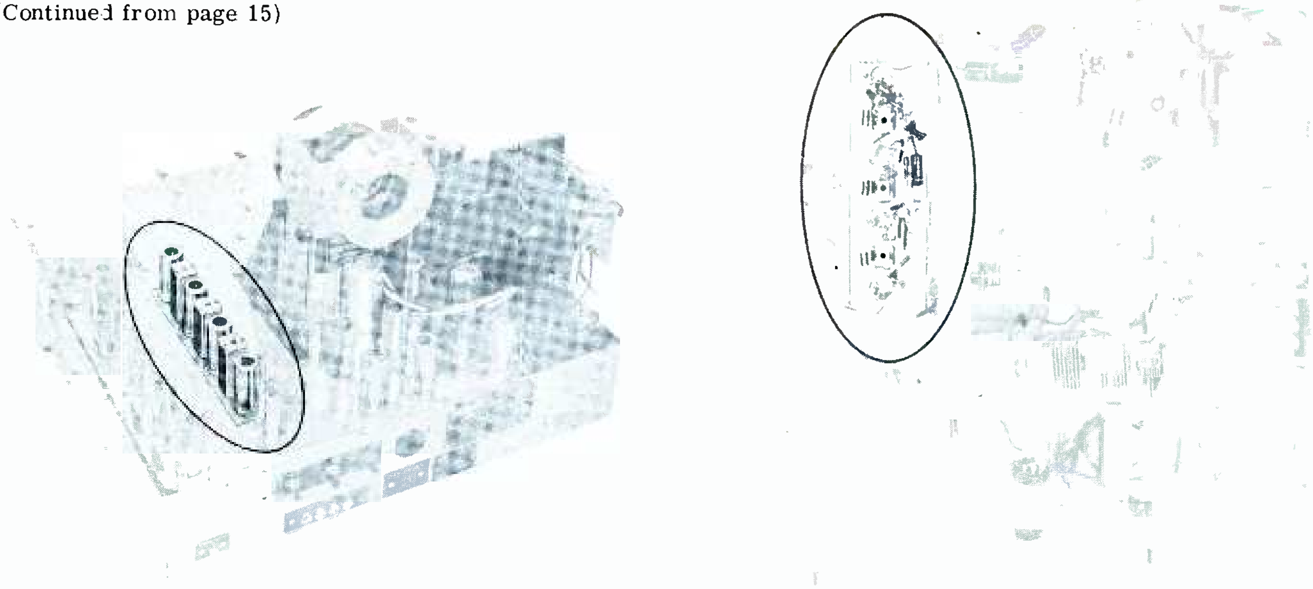

Fig. 10-3. Top and Bottom Views of Portion of Receiver Covered by Schematic of Fig. 10-1.

compensating de-emphasis at the receiver and (2) the fact that the modulation can be increased without increasing the power output of the FM transmitter, thus resulting in a better signal-to-noise ratio.

Another advantage of the FM sound system as applied to TV appears in intercarrier receivers where separation of the sound and video signals is simplified because of the difference in modulation methods of each.

Two Sound Systems

Current models of television receivers employ two types of sound IF systems commonly referred to as "separate sound" and "intercarrier sound." Fig. 10-1 is an example of a separate-sound system, and Fig. 10-2 illustrates an intercarrier system. Figs. 10-3 and 10-4 are photographic illustrations showing the appearance of the sections of receivers represented by the schematics of Figs. 10-1 and 10-2.

Each type is easily identified by the take-off point. In the separate sound system, take-off may be made anywhere between the mixer and the video detector but is usually found in the converter plate circuit or in the first two video IF stages. By referring to the schematic of Fig. 10-1, it can be seen that the sound take-off point is in the mixer plate circuit.

Intercarrier sound depends for its operation upon the resultant frequencies obtained when two signals having different frequencies are impressed on a nonlinear device such as the conventional video detector. One of these resultants will be the difference frequency. In the intercarrier system the combined sound and video IF signals are impressed on the video detector, and the resultant 4.5-mc FM signal is available at the output of the detector. This signal may be either taken off and applied to the

Fig. 10-4. Top and Bottom Views of Portion of Receiver Covered by Schematic of Fig. 10-2.

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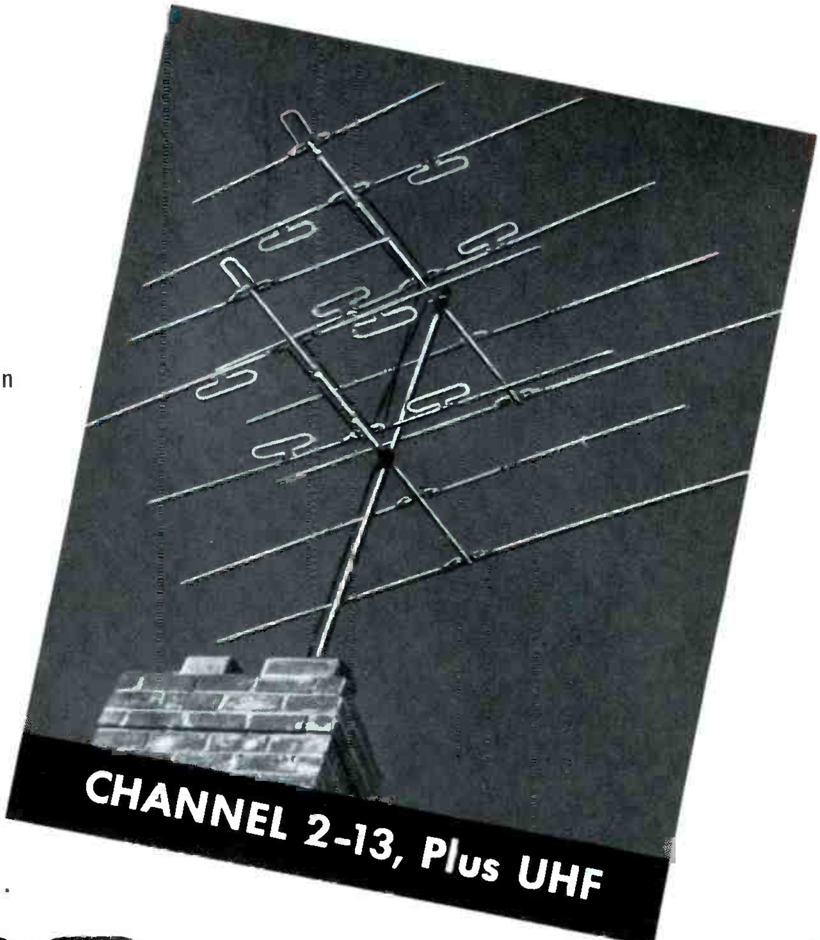

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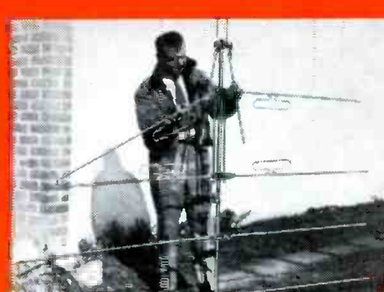

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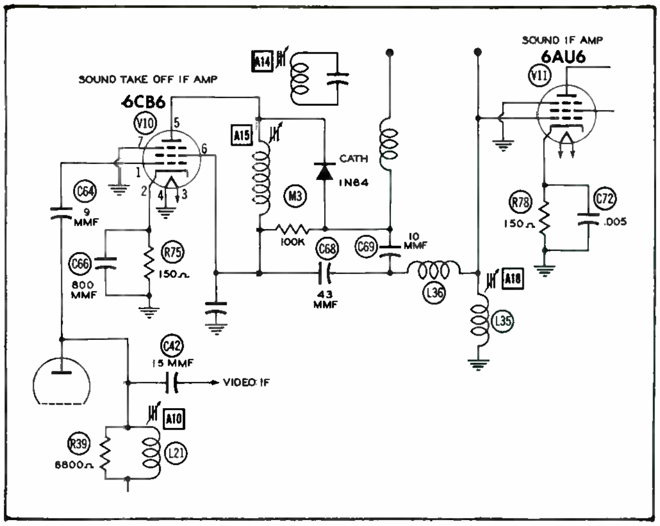

(Left)

Fig. 10-5. Unusual Type of Sound IF Take-Off in Intercarrier Receiver.

sound IF amplifier or passed on to the video amplifier section to receive further amplification before being fed to the sound IF amplifier section.

The response of the video IF amplifier must be kept low in the sound IF region to avoid excessive amplitude modulation of the 4.5-mc sound IF carrier. Usual recommendations are that sound IF response should not be more than five per cent of the total over-all response of the video IF strip.

Since the sound IF signal is removed in the early stages of the video IF amplifier, one advantage of the separate sound system is the fact that design requirements of the rest of the video IF amplifier are not so critical with respect to response in the sound IF region. The intercarrier system on the other hand is not so susceptible to variations in fine tuning or to oscillator drift, since the video and sound carriers are maintained at the constant 4.5-mc difference in frequency at the television station. Thus, the 4.5-mc difference is available at the video detector output regardless of considerable adjustment of the fine tuning or oscillator drift.

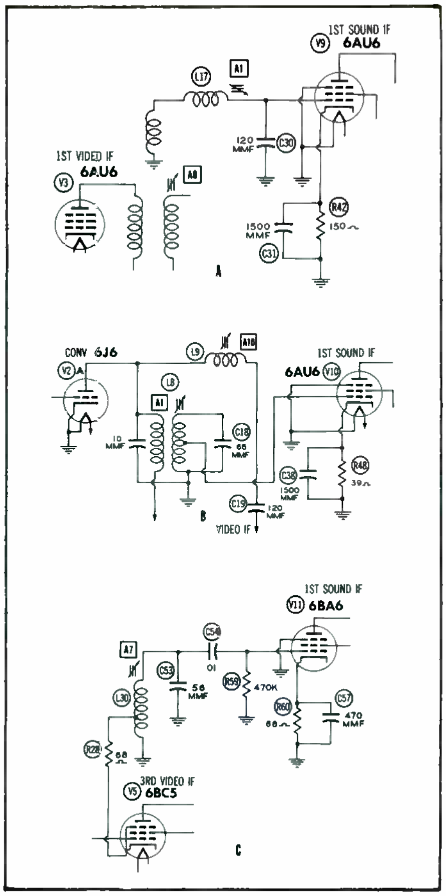

Fig. 10-6. Three Examples of Sound IF Take-off in Separate-Sound Receivers.

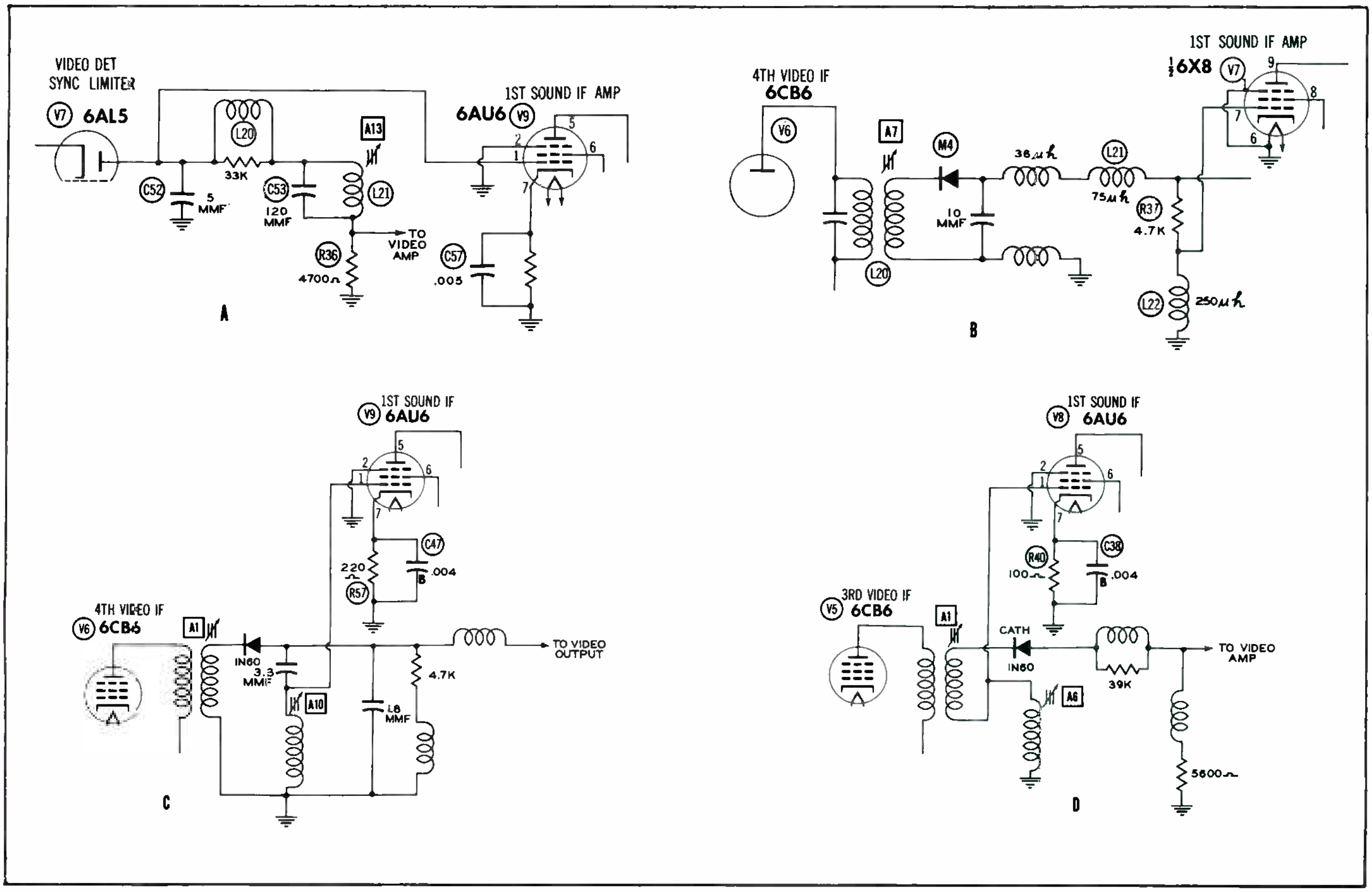

Fig. 10-7. Four Examples of Sound IF Take-off in Intercarrier Receivers.

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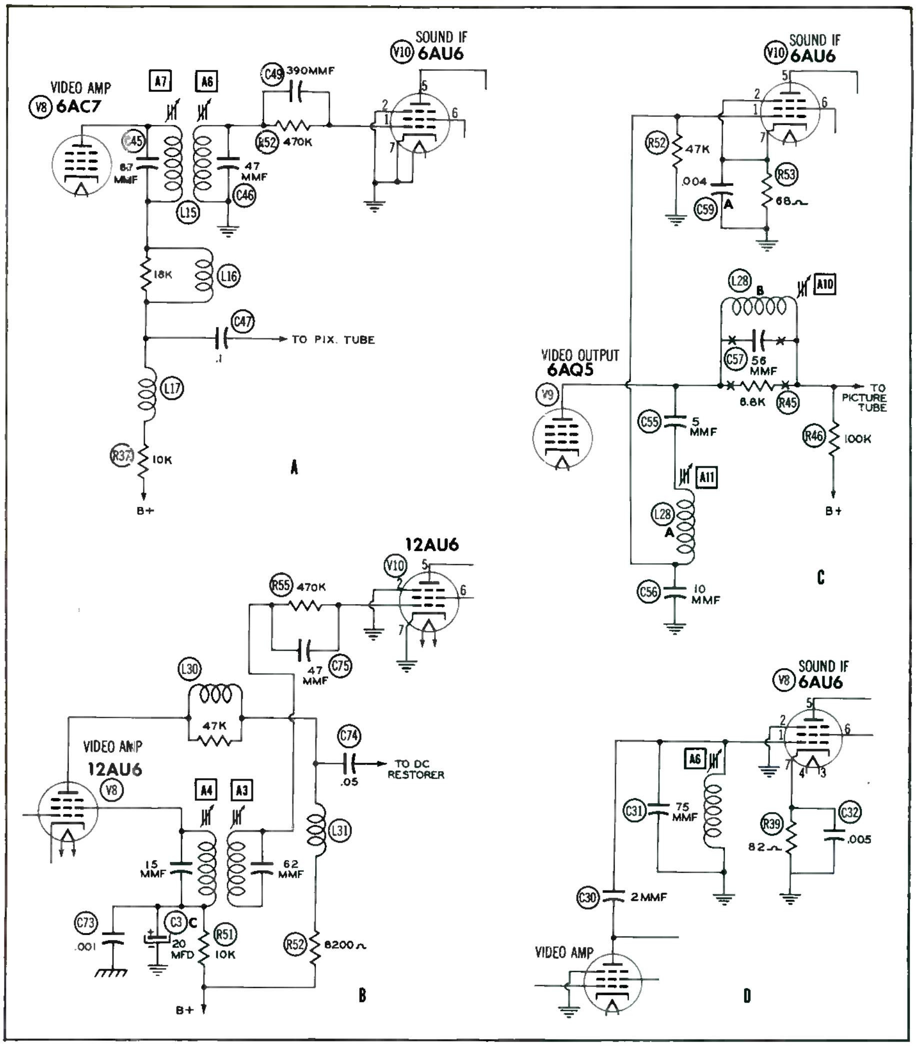

Fig. 10-8. Four Examples of Sound IF Take-off From Video Amplifier Circuits.

Take-off Points

Since the sound IF signal of the intercarrier system is taken off at a point farther from the antenna, it receives more amplification than it would in a separate-sound system. Consequently, because less amplification is necessary in the sound IF strip, then fewer stages are needed in the receiver, and economy of manufacture results.

Fig. 10-5 shows an interesting example of sound take-off which at first glance appears to be a separate-sound system, since the take-off point occurs at the plate circuit of the second video IF amplifier. Further study shows, however, that it is really an intercarrier system because the IF signal receives an additional stage of amplification after which it is then put through a detector that makes the 4.5-mc sound IF signal available for input to a conventional sound IF amplifier.

Some of the variations in the manner of take-off of the sound IF are shown in Figs. 10-6 (A through C). Fig. 10-6A shows that the signal is taken off by inductive coupling from the plate circuit of the first video IF amplifier. The signal is fed through a tunable choke to the grid of the first sound IF amplifier V9. The choke and coupling coil serve as the grid return for V9. In Fig. 10-6B, the secondary of the converter-plate transformer is tapped for sound take-off and also serves as a trap at the sound IF. The take-off point may appear in the cathode circuit as in Fig. 10-6C where a tapped choke again functions as a combined sound trap and sound take-off.

In the majority of receivers of the intercarrier sound type, the sound take-off point will be somewhere in the video detector circuit. Figs. 10-7 (A through D) show several ways in which this is accomplished.

In Fig. 10-8A, the sound is taken off by a transformer in the plate circuit of the video amplifier. Fig. 10-8B is a similar circuit, but the transformer is connected in the screen circuit of the video amplifier stage. An example of sound take-off in the plate circuit of the video output stage appears in Figs. 10-8C and 10-8D. In this manner, full advantage is taken of the amplification afforded by the video IF and video amplifier sections of the receiver; thus, less amplification is necessary in the sound IF section.

Sound IF Strip

The sound IF strip may consist of several stages, usually with mutual inductance coupling; and this strip is followed by a limiting stage, if a discriminator is used for detection. In many cases, only a limiting stage is used and is followed by the detector; or if previous amplification is adequate, a detector such as the limiter-detector type 6BN6 may be all that is required.

A limiter stage is sometimes used ahead of a ratio detector, although its use is not so necessary as with the discriminator type of receivers. The reason for this will be discussed in Part II dealing with FM detection.

Although 100 per cent modulation of the sound carrier would mean a maximum frequency deviation of 50 kc, the sound IF bandwidth of the receiver is made much greater than this (about 200 kc at 3 db down from peak response) to allow for frequency drift in the local oscillator. This precaution is more necessary with separate-sound receivers; but it is also useful in intercarrier sound systems, since any drift in the alignment of the sound IF system cannot be corrected by receiver tuning.

Limiters

The 4.5-mc sound IF signal available at the video detector or succeeding video stages contains a certain percentage of AM video signal and of other AM signals introduced by electrical disturbances of various kinds.

Some type of amplitude-limiting circuit is used to reduce these amplitude variations without distorting the FM signal component. One such type of circuit is shown in Fig. 10-8A. This is commonly referred to as a grid-circuit or grid-leak limiter. Such circuits usually start limiting action with signal inputs of 2 to 5 volts. When a positive portion of the signal is applied to the grid, it attracts electrons; and this action charges the capacitor C49. As the signal reverses to negative polarity, C49 discharges through R52 and develops a voltage drop across R52 so that the grid is driven negative and so that the operation point on the E_g-I_p curve of the tube moves down near cutoff. Screen and plate voltages of the tube are purposely kept low so that rela-

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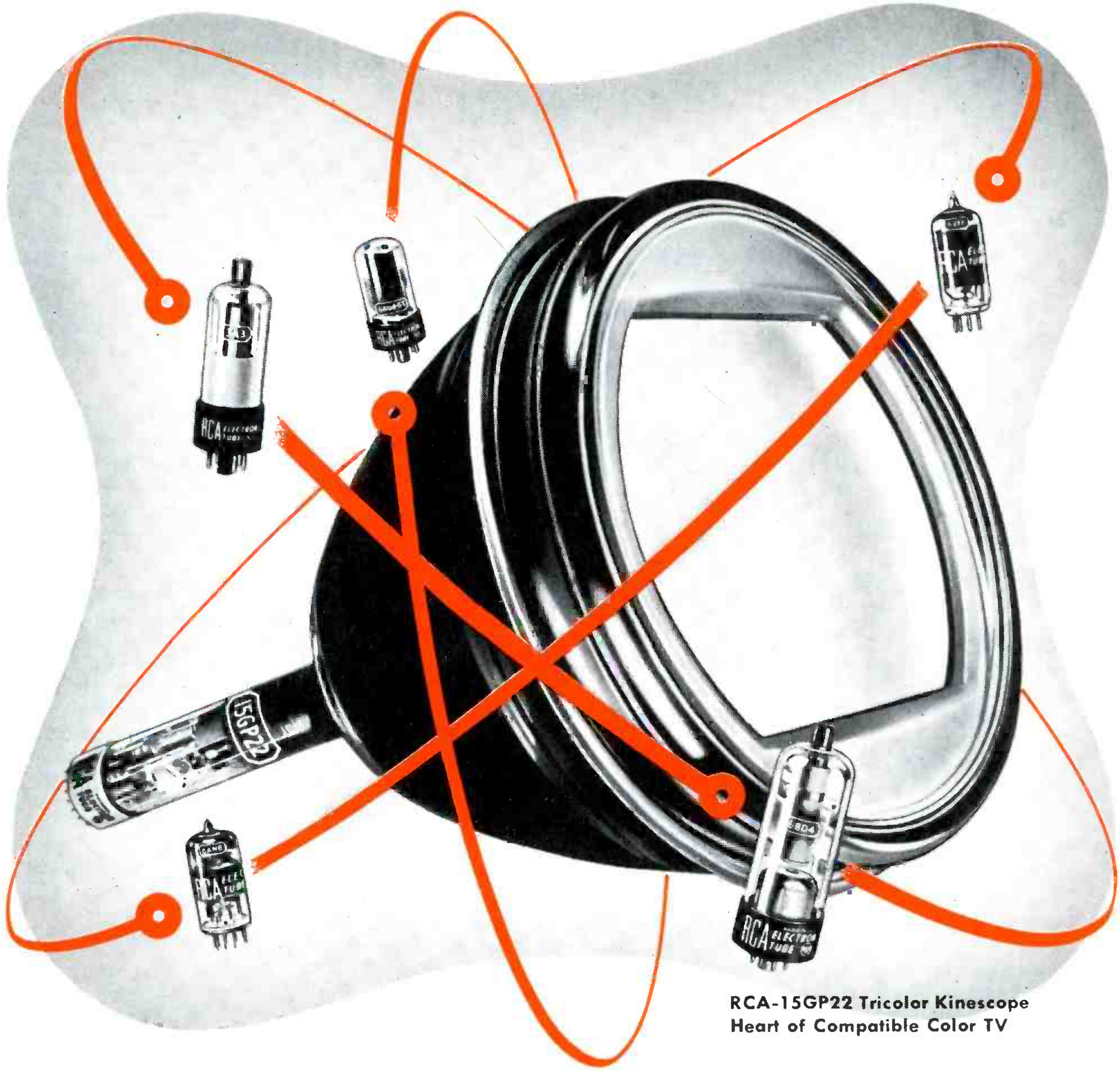

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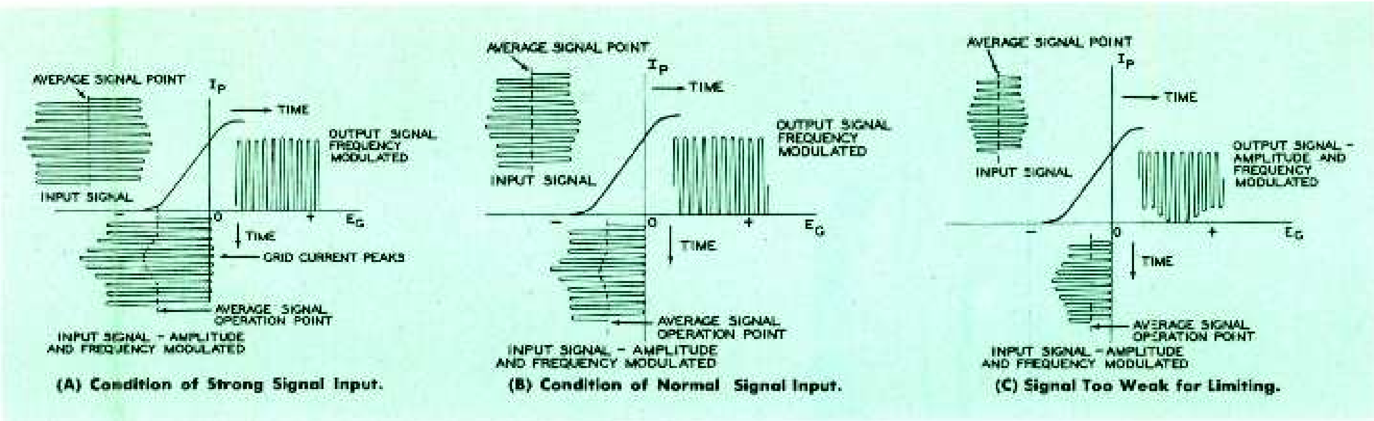

Fig. 10-9. Grid-Voltage—Plate-Current Characteristic Curves.

tively small signal inputs drive the tube to cutoff. The use of a sharp cutoff tube aids in attaining this result.

Fig. 10-9A is a graph of the foregoing action for strong signal input. As the peaks of the signal input vary in amplitude, the operation point on the E_g-I_p curve varies in corresponding manner so that the positive signal peaks are effectively held just above the point of grid current. The negative peaks fall below the cutoff point of the tube, and that portion of the signal is clipped from the signal output of the tube.

The time constant of R52 and C49 (Fig. 10-8A) must be such that the grid bias can follow the AM portions of the signal. If the time constant is too long, the grid bias will not react quickly enough to follow the AM envelope. If it is too short, the positive peaks are not effectively held at the same point on the curve and limiting is not complete.

Fig. 10-9B shows the limiter action for a signal input just slightly greater than necessary for limiting. In this case, the amplitude of signal is not great enough to force the operation point far down on the characteristic curve, and as a result small amounts of opposite peaks are clipped from the response.

If signal input is too small for limiting, we have the result as shown in Fig. 10-9C. All points of the signal fall on the straight-line portion of the characteristic curve. This type of operation does not provide proper clipping action, and noise and AM signals are passed on to the detector circuit together with the desired FM signal.

In both instances shown by Fig. 10-9A and 10-9B, the square wave in the signal output is modified to a closer approach to a sine wave by the flywheel effect of the tuned circuit of the detector input.

Interstage Coupling

Where the sound IF strip comprises more than just limiter and detector, the method of interstage coupling usually is one of two methods; a tuned choke or a double-tuned transformer. Both methods are combined in the circuit, shown in Fig. 10-10, which is taken from the circuit of a current model receiver.

The shunting effect of R48 lowers the Q of the tuned circuit, which is composed of L28 and its associated capacitors, and thus increases the bandpass of the stage. The signal is coupled to the grid of the next stage through C68. R48 may be absent in some variations. Whether or not R48 is used depends upon the design requirements of the manufacturer. Other variations use a resistor for the plate load of V11, and L28 appears in the grid return of V12 with C68 as the coupling capacitor, as in the preceding example.

In the next stage the bandwidth is determined by the degree of coupling between the primary and secondary of L29 or, as in the preceding stage, by a resistor of the proper value shunted across either winding of the transformer.

L28 and both windings of L29 are shunted by capacitors to obtain parallel-resonant circuits, but in many receivers the capacitors are absent and the interelectrode capacitance of the associated tube is sufficient to attain the desired resonance. The latter condition is true in receivers which employ separate sound systems and which therefore operate at frequencies in the 20- or 40-megacycle range. Lumped capacity in the form of actual capacitors is used generally to achieve resonance in sets which employ intercarrier sound at a frequency of 4.5 megacycles.

Part II of this discussion about television sound IF systems will deal with the methods of FM detection commonly employed in television receivers. These are: (1) slope detection, (2) the Foster-Seely discriminator, (3) the ratio-detector, and (4) the gated-beam tube.

Paul C. Smith

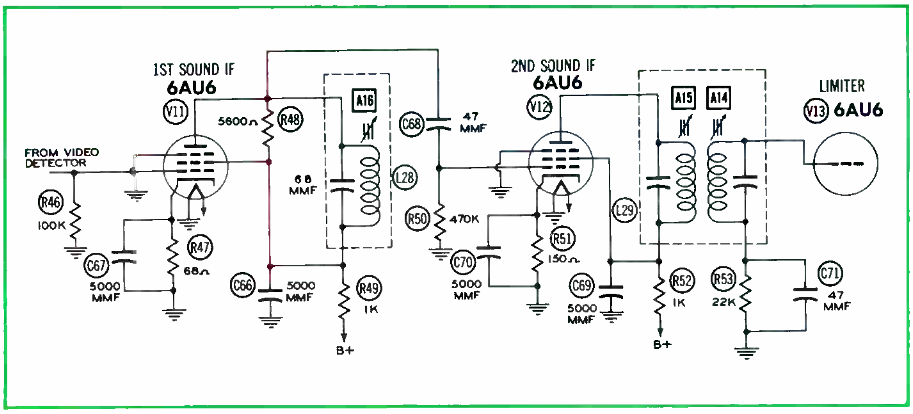

Fig. 10-10. A Sound IF Strip Illustrating Two Common Methods of Interstage Coupling.

Color TV Training Series

(Continued from page 11)

search and development of color television. In addition, some members were qualified engineers who were not associated with any particular organization. All members were appointed by the chairman of the Radio Television Manufacturers' Association with the concurrence of the vice chairman.

Within the organization, panels were set up and certain projects were assigned to them. The members of each panel were selected regardless of affiliation with any company, association, or organization according to each member's recognized ability and interest in the particular project. Upon the completion of an assignment, the members of the panel submitted a detailed report on their work and findings to the committee.

After extensive research and field testing, standards for compatible color television were set up by the committee and were prepared for submission to the FCC for approval. These standards were submitted July 23, 1953 and approved December 17, 1953.

WHY IS COLOR TV SO COMPLICATED?

One of the major questions being asked is, "Why is color TV so complicated?" Certainly when compared to black-and-white television, it is complicated, or perhaps complex would be more fitting. In trying to give an answer to the reasons why color television is so complex, a number of points must be taken into consideration.

Three factors were most difficult to overcome in the color television system. They were (1) the need for compatibility, (2) the requirement for an all-electronic system, and (3) the achievement of color reproduction.

In order to make the system compatible, the NTSC realized that the present standards for black-and-white transmission had to be retained in the color signal so that monochrome receivers would be capable of utilizing the color signal without any adjustments or conversions. As a result, the standards for black-and-white transmission are included, with minor changes, in the specifications for the color picture signal. Thus, the following standards were retained:

1. The same aspect ratio of 4 to 3.

2. The same number of scanning lines.

3. Approximately the same horizontal and vertical scanning rate.

4. The same alloted channel bandwidth of 6 megacycles.

5. The transmission of sound in the same manner.

6. All video information transmitted within the video band of 4.25 megacycles.

7. A signal representative of the brightness included in the composite signal.

To these specifications the color information was added in such a way that it does not disturb the operation of a black-and-white receiver. How this was accomplished will be shown in subsequent installments of this training series.

By an all-electronic system, it is meant that the receiver must not depend upon the use of any mechanical attachments, such as a color wheel, for operation. The use of a color picture tube makes an all-electronic system possible.

The achievement of color reproduction is a major process by itself. To gain a better understanding of the process, let us take a look at some of the characteristics of color.

Hue, Saturation, and Brightness

When viewing a colored object, three physical aspects of that particular color are either consciously or subconsciously recorded. These three physical aspects are hue, saturation, and brightness. Hue is defined as the name of a color, such as red, green, or blue. Saturation is defined as the degree to which white light is absent in a particular color. Brightness is that attribute which makes an area appear to emit more or less light. In order to reproduce color properly through the use of a television system, these three attributes must be conveyed.

The brightness can be handled in the composite color signal by using the same method as is used in black-and-white transmission. The hue and saturation, however, must also be included in the signal. One of the main things which made it possible to do this within the allotted video band of approximately 4.25 megacycles were the characteristics of the human eye.

Human Vision

Seeing is a dual process, occurring partly in the eye and partly in the brain. The eye acts as the receiving unit for the light rays which enter it. The optic nerve is stimulated and conveys impulses to the brain. The brain accepts these impulses and registers them as conscious sensation. As has been mentioned before, color is perceived by the human eye in terms of hue, saturation, and brightness. The hue distinguishes one color from another, such as red or blue. The saturation distinguishes strong colors from pale colors of the same hue. The other physical aspect, brightness, tells the intensity of the light being given off or being reflected by an object. The eye is capable of sensing these attributes of color.

Tests were conducted to determine how much color information is utilized by the eye. Through experimentation it was found that the eye is not able to detect colors in fine detail. The present color TV system makes use of this fact because it permits a great reduction in the required bandwidth for color transmission.

During the process of determining the extent to which color should be conveyed by television, large-area vision and small-area vision were taken into consideration. Knowing how the eye responds while viewing different sizes of colored areas greatly helped in setting the parameters of the color television system.

It is known fact that every person does not see color in the same manner; however, by taking a large number of tests with different viewers, data for an average viewer can be obtained.

Large-Area Vision

In order to represent color in large areas, it has been determined that lights of three primary colors are needed. The requirements of color primaries are that each primary must be different and that no two primaries when mixed together are capable of producing the third primary. Red, green, and blue are primary colors which fulfill these qualifications and have been chosen for color-TV applications. A viewer can more closely match colors in large areas than in small areas. As an example, a large area of blue can be readily distinguished from a large area of blue-green. However, when these areas are reduced in size, it becomes more difficult to distinguish

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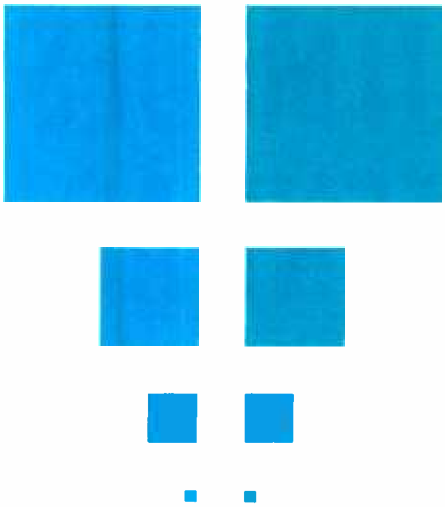

Fig. 3. Blocks Illustrating Color Perception in Large Areas.

between the two colors. Fig. 3 illustrates this characteristic when viewed at arm's length. This brings us to the matter of small-area vision.

Small-Area Vision

Experiments have been made using sheets of multicolored paper cut in various sizes. A number of things were discovered as these pieces were reduced in size and viewed at a distance. Listed below are the findings.

1. Blues become indistinguishable from grays with equivalent brightness.

2. Yellows also become indistinguishable from grays. In the same size range where this happens, browns are confused with crimson and blues with greens; reds remain clearly distinct from blue-greens; colors with pronounced blue lose blueness; whereas colors lacking in blue gain blueness.

3. A further decrease in size results in reds merging with grays of equivalent brightness, and blue-greens become indistinguishable from grays.

When viewing extremely small objects, the ability to identify color is lost and only response to brightness remains. Fig. 4 shows clusters of colored dots of three different sizes. Note that a decrease in dot size makes color identification more difficult. (Hold page at arm's length.)

It can be seen that several factors have contributed to the complexity of the color television system. Not only must the system meet the requirements of compatibility and all-electronic operation, but it must also compensate for certain characteristics of human vision. The present color television system conforms to all these requirements.

THE COLOR RECEIVER

It stands to reason that the color receiver performing more functions that its monochrome predecessor ends up as a more complex unit. It contains all the stages for monochrome reception plus the additional stages necessary to extract color information from the color signal and apply it to control and reproduce the color picture image. However, no matter how complex the color receiver might seem, it still employs the old familiar components — tubes, resistors, capacitors, and inductors; and these parts are designed into the basic circuits of oscillation, amplification, and detection — none of which need to frighten or confuse. Fig. 5 shows a color receiver chassis indicating the greater number of components which must be employed.

One of the new sections of the color receiver is used for color synchronization. This section is in addition to the normal deflection sync circuits employed in the monochrome receiver and performs an entirely different function. The color sync section is incorporated to enable the color receiver to detect the correct color information from the signal.

Another new section is the color-decoding section. This section consists of detectors and amplifiers arranged in a predetermined order and designed so that they are capable of detecting and amplifying the color information which is fed to the color picture tube.

Any picture tube has the task of accepting a varying electrical signal and producing the picture which that signal represents. The monochrome picture signal varies only in respect to the change in light content of the transmitted signal; thus, the monochrome picture tube has only to follow this one variation. The signal applied to the color picture tube is a combination of the brightness signal and the three selected primary color signals. Each of the color signals varies according to the color present in the televised picture, and the color picture tube must reproduce the proper proportion of the individual colors and the correct brightness content.

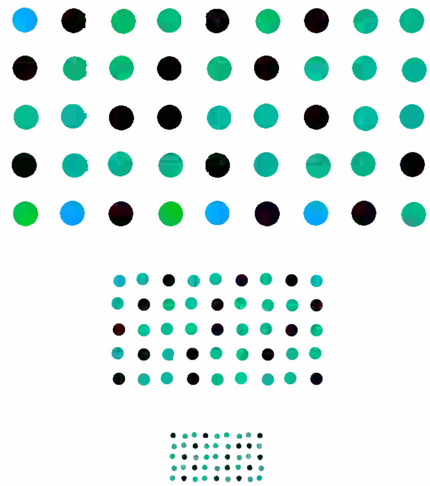

Fig. 4. Dot Clusters Illustrating Poor Color Perception in Small Areas.

To fulfill the standards of a compatible system, the color picture tube must also be capable of producing a black-and-white picture when only the monochrome signal is present. It is evident, then, that the picture tube in a color receiver must necessarily be a much more compli-

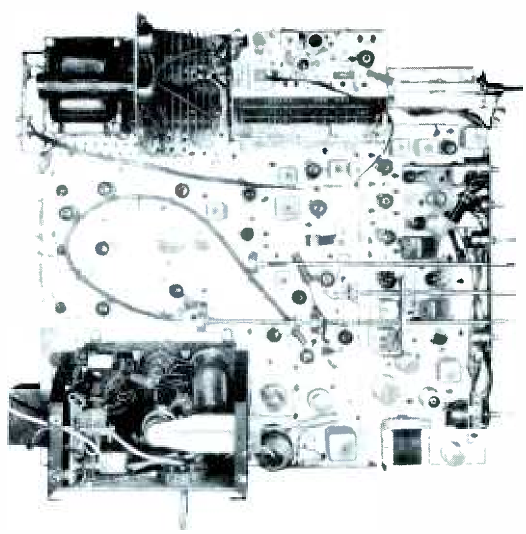

Fig. 5. Top Chassis View of the RCA Victor Model CT-100 Color Receiver.

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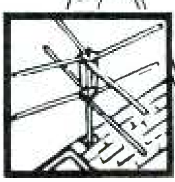

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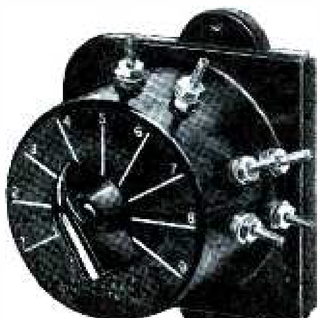

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cated device than its monochrome counterpart.

Servicing Color Receivers

After a study of the technical aspects of color television, the technician will probably feel that the servicing job will be quite difficult in comparison with what confronts him in monochrome television. This is true to a certain extent, because the color receiver is a more complex unit than the monochrome receiver; however, with a thorough understanding of the operation of the color receiver, the servicing should ultimately fall into fixed patterns. Through experience and training, the problem of servicing the color receiver should become easier.

At this point in the training series, it is not our intention to discuss in great detail the subject of servicing the color receiver. The time for such a discussion will come after the technical aspects are understood; but in order to answer some of the questions which might be in the minds of many service technicians at the present time, the following discussion may be of help.

The procedure for installation of the color receiver follows very closely the method employed with monochrome receivers. When the set is received from the manufacturer, it is uncrated and the initial setup is performed in the service shop. The set is checked for proper operation, and any necessary adjustments made. Some manufacturers are shipping the color receiver with the picture tube dismounted and packaged in a separate carton. This means that the picture tube and its external components must be installed in the cabinet at the time of the initial setup. Other manufacturers are shipping their receivers with the picture tube already mounted on the chassis, a practice popular in shipping monochrome receivers. Fig. 4 shows a color receiver which has the tube so mounted.

Now let us assume that the initial setup has been performed in the shop and the set has been delivered to the customer's home. The procedure for installing the color receiver there follows the same pattern as that of installing a monochrome receiver. First, a check is made to see whether the receiver is operating properly. A few adjustments might be necessary, since transporting the set to the home might have affected some of the initial adjustments.

At the time of installation, the customer should be familiarized with the operation of the controls. He must be shown which controls are available for his operation and how they are used to obtain the proper results. If a good job of instructing the customer about the operation of the controls on the color receiver is done, the number of nuisance callbacks will be cut down considerably. Of course, the same thing is true when a monochrome receiver is being installed, but it is of even greater importance in the case of the color receiver.

The color receiver has the same basic operator's controls that are present on the monochrome receiver. It is interesting to note, however, that the adjustment of the fine tuning control in a color receiver is much more critical than in a black-and-white receiver. Improper adjustment of this control in the color receiver results in improper color rendition. In addition to these basic controls, there are from one to three additional controls which are available to the operator. In the event only one additional control is available, it is usually called a chroma or saturation control. By adjusting it, the saturation of the colors in the picture can be changed to whatever degree is most pleasing to the viewer. Other receivers have the chroma control, plus hue and convergence controls.

Antennas for Color TV

Antenna requirements are generally the same for color and monochrome reception. If the antenna installation results in a clean, sharp picture in black and white, it should provide equally satisfactory results in color. The things to consider when making an antenna installation for color are bandwidth, directivity, and gain. Most of the conventional broadband antennas which are used for monochrome have an adequate bandwidth for use in color reception. If there are sharp dips in the response of the antenna at certain frequencies, the color set performance on some channels may be affected.

The directivity of an antenna is important in some monochrome installations and will be equally or more important in color reception work. If reflections are present, they will show up as different hues and shades in the colors of the picture. If the directional antenna is too sharply tuned to the video carrier, a degradation of the picture will result.

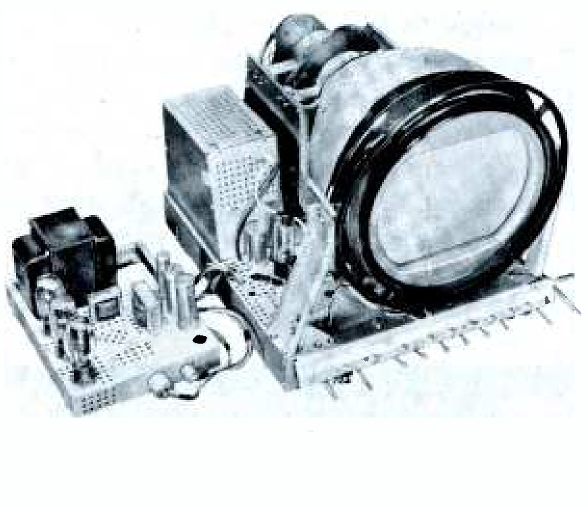
A television picture might be deemed satisfactory as long as synchronization is maintained, even though it may have considerable noise or snow in the picture. If synchronization is lost, the picture is completely unsatisfactory. Since the operation of the color sync section in a color receiver is quite critical and is apt to lose synchronization before the sweep section does (as the signal level is reduced), it is important for the antenna system to be properly installed to provide sufficient signal pickup to assure proper operation.

Test Equipment

Most of the basic equipment (signal generator, marker generator, vacuum-tube voltmeter, and scope) now being used for servicing monochrome receivers can be used to some extent for servicing color receivers. It appears that it will be necessary to have additional pieces of test equipment to supply color information. Such units are being developed and should be available shortly.

A high-voltage probe will be needed along with the vacuum-tube voltmeter for checking the high voltages which are present on the picture tube. The second anode requires approximately 20 kv for proper operation.

Fig. 6. Chassis View of the Westinghouse Model H-840CK15 Color Receiver Showing the Chassis Mounting for the Color Picture Tube.



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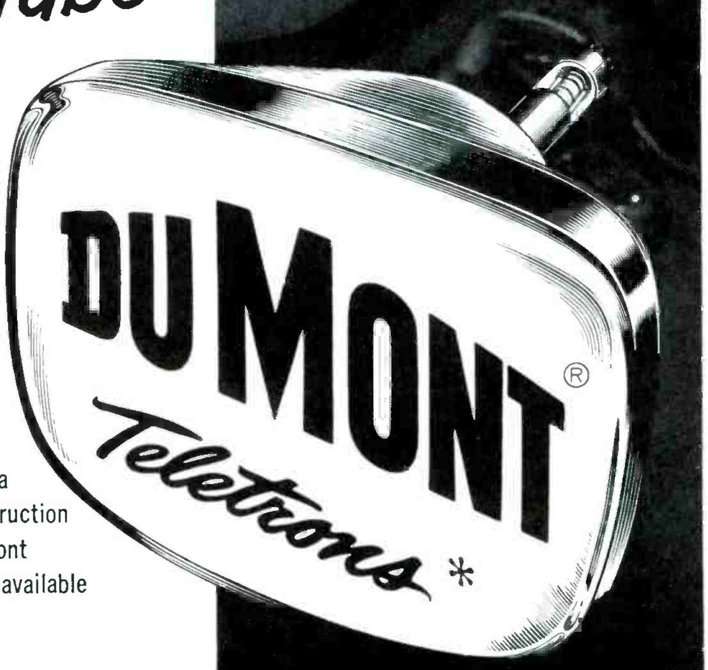

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The scope should be of the wideband variety for color servicing. It should have good phase and frequency response, with the frequency response flat up to 4 megacycles. It should have a minimum loading effect because some of the circuits are rather critical in the color receiver. There are a number of scopes on the market which meet these requirements.

Two pieces of new equipment which should be very helpful in color-receiver servicing are a dot-pattern generator and a color-bar generator. The dot-pattern generator can be used during the initial setup procedure, and the color-bar generator can be used to test the ability of the receiver to reproduce given colors correctly. Several methods have been devised to supply a certain amount of color information during regular transmission of black and white. If any of these plans are adopted it will enable the service technician to check the operation of the color receiver at times when no color broadcast is available.

The next installment of the Color Television Training Series is scheduled to appear in the June issue of this publication. It will be concerned with the subject of colorimetry, the science and practice of determining and specifying colors.

C. P. Oliphant

Examining Design Features

(Continued from page 27)

point of the detector to be shifted slightly by varying the plate voltage. Since the negative voltage is partially derived from the AGC circuit, its value will vary in accordance with the strength of the received signal. The over-all effect is to provide a more linear system of detection.

Video Amplifier

The first stage of video amplification consists of one-half of a 6X8. The grid-input circuit contains a parallel-resonant trap tuned to 4.5 megacycles. One section of a 12AU7 constitutes the second video amplifier which is also the video-output stage. This stage feeds the grid of the picture tube. The contrast control is contained in the cathode circuit of the video-output tube.

Sound

A sound take-off is provided in the output circuit of the video detector. The 4.5-megacycle sound signal is coupled to the first sound IF amplifier where it is amplified and fed to the second IF stage. Coupling between

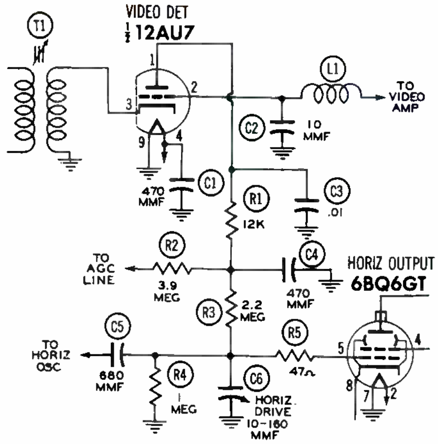


Fig. 3. Video-Detector Circuit.

the two stages is accomplished by means of a single-tuned resonant circuit with RC coupling. A conventional ratio detector is used. The detected signal is fed to a 6AV6 audio amplifier. The 6AV6 is also used as an AGC clamper. A 6AQ5 audio-output tube replaces the 6K6GT tube used in most of the previous models.

AGC

The keyed AGC system is a straightforward circuit. A keying pulse from the horizontal-output transformer is applied to the plate of the AGC tube. This permits the tube to conduct only during retrace time. Horizontal sync pulses from the cathode of the horizontal sync separator are applied to the grid of the AGC tube. The amplitude of these sync pulses varies with signal strength and causes the peak conduction of the AGC tube to vary accordingly. The AGC voltage developed by this circuit is determined by the peak current flowing through the AGC tube. The bias for the AGC tube can be set by adjusting the AGC control. This adjustment permits the receiver to operate with optimum sensitivity over a wide range of signal strengths.

Sync Separator

This receiver employs individual sync separator tubes, one for the vertical sync and a second for the horizontal. A partial schematic of the sync separators and sync amplifier is shown in Fig. 4. One-half of a 12AU7 is used as the horizontal sync separator. A triode section of a 6X8 is used as the vertical sync separator. A composite video signal is fed to these tubes from the first video amplifier. The outputs of the sync separators are fed to a sync amplifier. The grid of the sync amplifier is coupled through a 1.5-megohm resistor to the plate circuits of the first two video IF amplifiers. The plate voltage present on these two tubes will be partially dependent upon the magnitude of AGC voltage controlling them. This means that the bias on the sync amplifier will also be dependent upon the AGC voltage. The end effect is to place the tops of the sync pulses at the cutoff point of the sync amplifier. Noise pulses having a greater amplitude than the sync pulses will be clipped in this stage.

Sweep

A multivibrator circuit is used in the vertical-sweep section. The 6AQ5 vertical output functions as a part of the multivibrator. An auto-transformer is used in the output of this section.

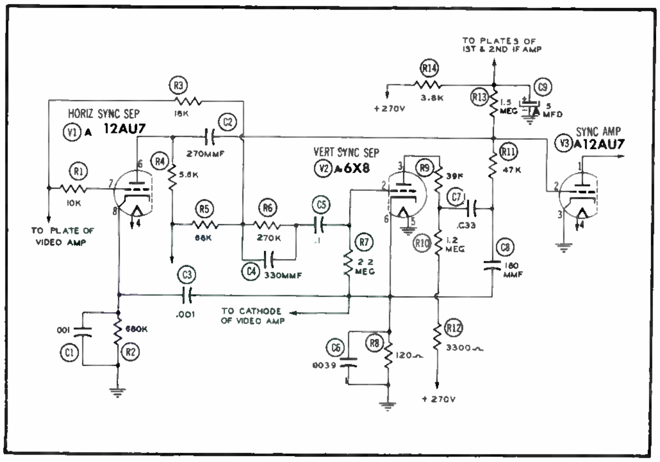
The horizontal-sweep system employs the RCA synchroguide circuit. The horizontal-output tube is a 6CD6G, and the damper tube is a 6AU4GT.

In order to provide sufficient current from the low-voltage power supply, a 5U4G is used in parallel with a 5Y3GT.

The 24CP4A picture tube is mounted in the cabinet by four supporting rods. By mounting the picture tube separately, it is possible to remove the chassis and permit the picture tube to remain in the cabinet.

Don R. Howe

Fig. 4. Sync Separators and Sync Amplifier.



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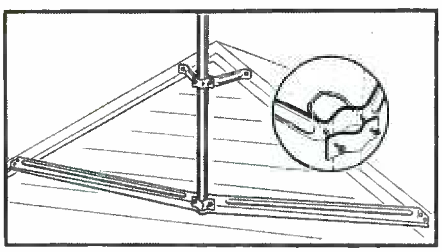

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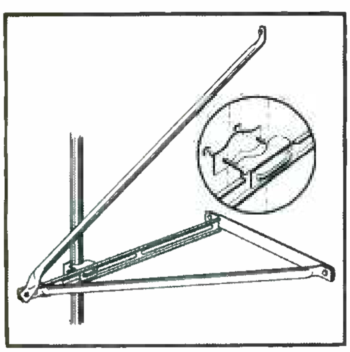

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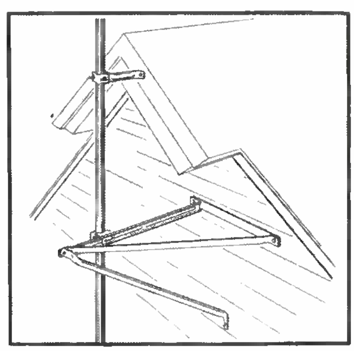

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Shop Talk

(Continued from page 5)

fundamentals, and you are now ready to consider the color television receiver — but in block-diagram form only!! Avoid circuits like the plague. Fortunately, we can do so at this time because the need for servicing color television sets may still be a number of months off. Compare these block diagrams with those of black-and-white receivers to see what new sections have been added.

For example, a master block diagram of a color television receiver such as we would desire at this point in our educational process might appear as shown in Fig. 2A. When we compare it with a similar diagram of a black-and-white receiver (Fig. 2B), we can see that a color set requires three new sections. These are: a color sync section, a chrominance section, and a block labeled "convergence amplifier." Otherwise, we have approximately the same arrangement that we find in a black-and-white receiver. Since the new sections represent only three blocks out of a total of ten, apparently we are more or less familiar with seven-tenths of the circuits in a color set. And whether you appreciate it or not, this simple fact alone will take much of the sting out of the complexities of a color television receiver. From a purely psychological standpoint, you can conquer or have already conquered seven-tenths of the circuitry in a color television set; and this is not being overly optimistic.

The next step along the line is to find out in a general way what the new sections do. If you have read the material written in other magazines or in the PF INDEX, then you have determined that these sections do the following things.

The color sync section generates a 3.58-mc wave (the color subcarrier) which possesses the proper phase. The signal is provided in two components 90 degrees out of phase with each other, and these two components are recombined with the incoming color sidebands in order to permit the color portion of the signal to be demodulated. This is the principal function of the color sync section. As a side function, this section also provides a biasing voltage which renders the entire chrominance section inoperative when no color signal is being received.

The foregoing is, in essence, all we need to know about the color sync section at this stage of our learning. We are not concerned with the manner in which the job is accomplished. All we desire to know is what this section does in the general scheme of things.

The chrominance channel, another of the new blocks, has as its function the conversion or transformation of the color sidebands into the color signal voltages. In a sense it is the detector for the color portion of the signal; it extracts from the incoming signal the color information required by the color picture tube. The output of the chrominance section is combined with the output of the brightness channel and then fed to the color picture tube.

The final new block in Fig. 2A is the one labeled "convergence-amplifier." This block is situated between the vertical- and horizontal-sweep systems and the tri-gun color picture tube. The position of this block tells us that it must somehow transfer a voltage from the sweep systems to some point in the picture-tube circuit which is not associated with the deflection yoke. At this point of our study, a suitable explanation of the convergence block is that it supplies a parabolic wave to the focus and convergence electrodes of the picture tube in order that the electron beams will possess the proper convergence and focus at all points of the phosphorescent screen. The only new thought in this explanation is the idea of convergence, and this should have been thoroughly understood when the operation of color picture tubes was studied previously.

Thus far then we have proceeded gradually, in a step-by-step process, in becoming familiar with the operating principles of color television sets, with each new step resting upon a firm foundation built through the assimilation of prior knowledge. The continuation of the method beyond this point is now clearly indicated and would first include the use of a more detailed block diagram, such as that shown on page 41 of January 1954 issue of the PF INDEX. After this, each block would be replaced by its specific circuit; and this would actually be the first time that any contact would be made with such components as the resistors, capacitors, or tubes of the set.

This system of learning, labeled by the author as going from the general to the specific, has been extensively tested and found to be extremely effective for the acquisition of any knowledge — whether it is about television servicing or automobile mechanics. We have employed it at Television Communications Institute with considerable success. There is no valid reason why it cannot benefit every service technician irrespective of how much or how little he knows.

Try it and see.

Review An article dealing with the servicing of UHF tuners and converters appeared in the December 1953 issue of Radio & Television News magazine. The author of the article was Walter H. Buchsbaum, and the title of the article was, "Trouble-shooting the UHF Tuner."

Radio & Television News magazine is published monthly by the

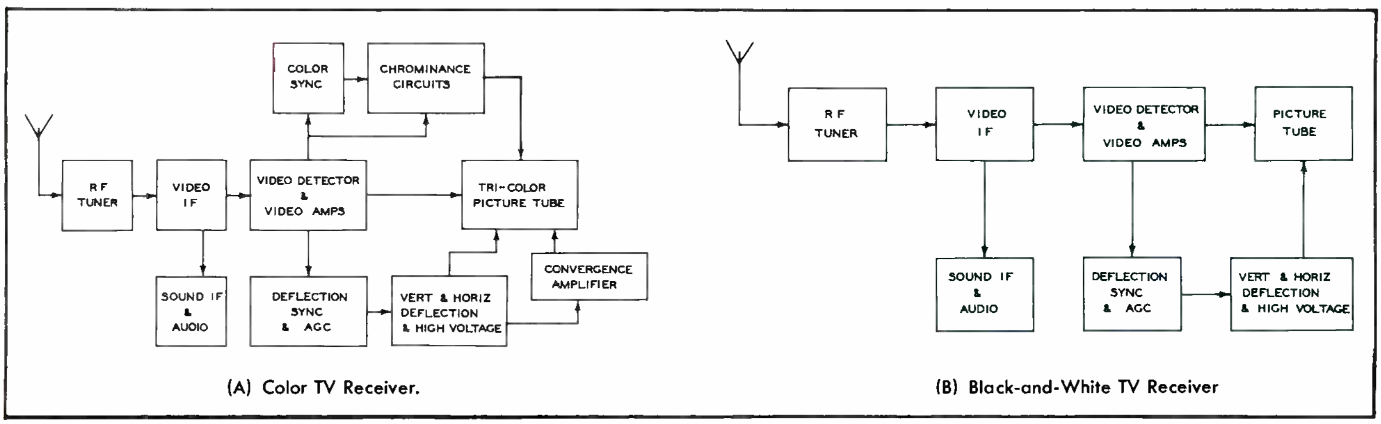

Fig. 2. Master Block Diagrams.

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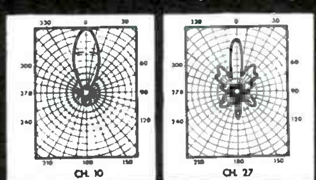

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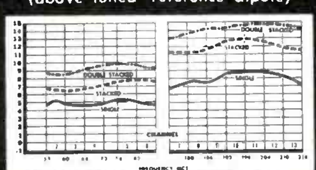

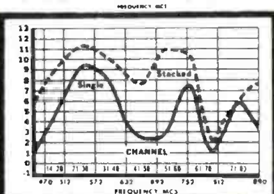

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At the time of this writing there are about 130 UHF television stations on the air. If you examine the FCC allocation chart, you will find very few areas that will not in time possess at least one UHF station. Hence, if you have not already had occasion to install or service a UHF receiver, you know that someday in the foreseeable future you will. Thus, the servicing of UHF television equipment is very much a part of your useful store of knowledge.

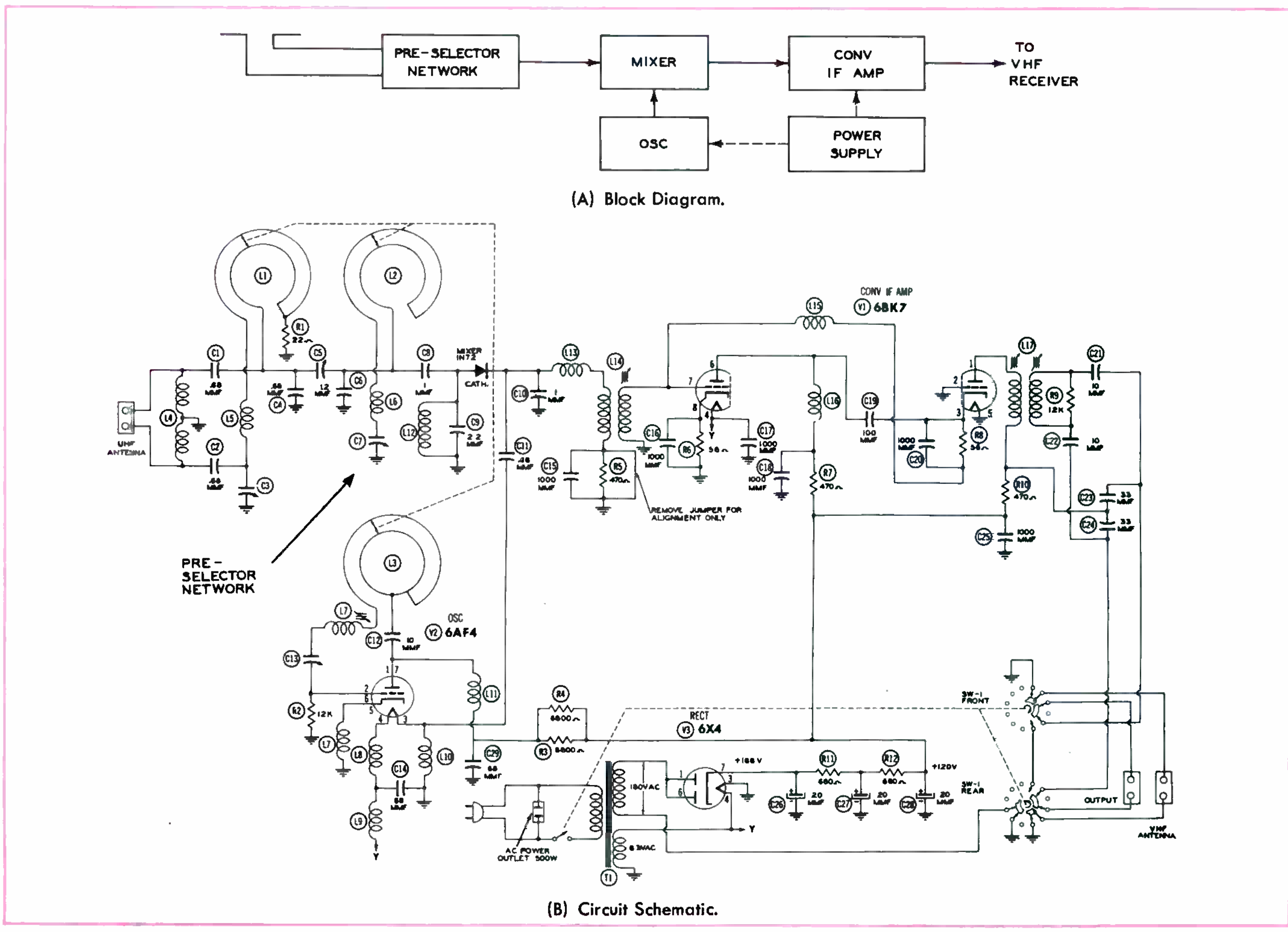
Although official approval of the use of the ultra-high-frequency channels for television broadcasting is now almost two years old, the UHF tuner or converter is still very much an adjunct to the normal VHF receiver. In very few instances are you compelled to purchase a receiver with the UHF tuner. The unit is almost always optional, and the additional cost to the purchaser is generally about $20 to $50.

Conversion of a VHF receiver to UHF reception takes one of three forms. Simplest to use is the UHF converter; this merely requires a short length of twin lead between the converter output terminals and the receiver antenna terminals. A second approach to the problem of UHF reception is the use of strips for turret tuners, such as the Standard Coil tuner. Finally, a number of manufacturers have made available UHF tuning assemblies which can be mechanically or electrically coupled to an existing VHF tuner. Station selection is achieved either by a single over-all control or by a separate knob. In this general classification could also be included Standard Coil's 82-channel UHF-VHF tuner. This is basically the familiar Standard Coil VHF turret with a separate UHF tuning assembly mechanically and electrically joined to the VHF section.

In this article, Mr. Buchsbaum discusses trouble shooting of the UHF tuner and the UHF converter. No mention is made of the UHF strips. He points out that the difference between a UHF tuner and a converter is one of physical location rather than of electrical characteristics. The converter is mounted in a separate cabinet atop the TV set, whereas the tuner is placed alongside the VHF tuner on the main receiver chassis. Since the circuits of both types of units are similar (if not identical), we would expect to encounter the same troubles in both.

The basic ingredients of a UHF tuner or converter are an input resonant circuit known as a preselector, a crystal mixer, an oscillator, and generally one or more IF stages. These IF stages are tuned to one of the VHF channels. An alternate approach is to have the UHF tuner reduce the received signal directly to the video IF frequency of the VHF receiver itself. This output signal would then go directly to the IF section of the receiver, bypassing the VHF tuner entirely.

The circuits of UHF tuners and converters are seldom more complicated than that shown in Fig. 3, limiting the number of electrical defects that one might normally encounter. Mechanical defects are important, too, especially since the tuning devices of many UHF tuners employ



(A) Block Diagram.

(B) Circuit Schematic.

Fig. 3. Typical UHF Converter.

sliding contacts of one form or another. Furthermore, movement of these sliders is frequently achieved by dial cords similar to the dial cords in AC-DC radio receivers. The restringing of a broken dial cord can easily consume the better part of an hour, as this writer found out recently. Thus, while a mechanical defect may be readily detected, its repair can be as time-consuming as any electrical breakdown.

Defective UHF tuner operation can be broken down into four categories. These are (1) no UHF reception, (2) weak reception, (3) intermittent operation, and (4) interference. Let us consider each in turn.

1. No UHF Reception

Inability to receive any UHF signals, even though such signals are definitely known to be present, indicates a defect at one of three general points: the antenna, the UHF tuner, or the VHF receiver. A field-strength meter is an excellent check on the antenna. In the absence of such an instrument, the next best approach is to connect a UHF generator to the input of the UHF tuner and modulate the UHF signal with a 400- or 1,000-cycle voltage. If both UHF tuner and VHF receiver are functioning, dark bars will appear on the picture-tube screen when the tuner is set at the generator frequency. Such bars will also point the finger of suspicion at the antenna.

Suppose, however, that the trouble is situated in one of the receiving units, either in the UHF tuner or in the VHF set. To narrow the trouble down to one of the units, switch the VHF receiver to a local VHF channel, if a station is available. (You can also use a VHF signal generator.) If you receive the station, the trouble lies in the UHF tuner; if the VHF signal cannot be received, turn your attention to the VHF receiver.

Let us suppose that the UHF tuner is defective. The first step is to inspect it visually for any physical or mechanical defects. The next step is to check all of the tubes, particularly the oscillator tube. After this, many manufacturers suggest a check of the mixer crystal, either by replacement (which may not be simple if the crystal is soldered in) or by measuring the current flowing in the mixer circuit. The minimum limit of this current is generally indicated in service literature; and as long as this value is exceeded, the crystal may be considered satisfactory.

Now, if the reading obtained exceeds the minimum value, then two things are indicated. First, it reveals that the crystal is functioning. Second, it tells you that the injection voltage from the local oscillator is also where it should be. Thus, you "kill two birds" with one measurement.

Suppose, however, that the crystal current is either zero or below the minimum figure. Where does the trouble lie now? Is the oscillator weak or dead, or is the crystal defective?

Most of the time, a quick measurement can be made of the grid bias voltage of the oscillator. This reading normally ranges between -3 and -10 volts DC. Absence of such a voltage would definitely indicate that the oscillator was not working, and this would account for the lack of crystal current. If the oscillator grid bias voltage is within its specified range, then the crystal should be changed.

When lack of oscillation is indicated, an initial check might be the measurement of B+ voltage available at the plate of the oscillator tube. With power off, also check the coils for continuity and the capacitors for opens or shorts.

An inoperative UHF tuner may be caused by a defective preselector circuit. Here continuity checking is useful, as is signal injection with a UHF signal generator. The latter is performed by injecting an AM signal at the crystal mixer and noting on the receiver screen whether the signal is getting through. If it is, move the signal lead back to the antenna input terminals. If no bars appear on the screen, you know that the signal is not getting through the preselector circuit.

When the RF network, mixer, and local oscillator are all found to be operating satisfactorily, attention should be directed to the IF stages in the tuner or converter. Tubes should have been checked initially. Next, B+ is measured at the plates and screen grids, if the latter are present. Signal injection at the IF frequency is also an excellent servicing tool.

2. Weak Signals.

When the output from a UHF tuner is weak, the trouble may be caused by low B+ voltages, low tube emission (particularly in the oscillator), a defective mixer crystal, or circuit misalignment. For the latter, the preferred approach is with a UHF sweep generator and an oscilloscope, according to the manufacturer's instructions. Where no precise alignment data is available, tune the bandpass for maximum amplitude at the weakest station.

A frequent cause of weak output is insufficient oscillator injection voltage. Most manufacturers' instructions indicate what the lowest permissible crystal-mixer current is, and this should be carefully checked. Too little current can be taken as a definite indication that the injection voltage is too low (if the crystal is all right). Try a new oscillator tube, then check the oscillator injection circuit.

3. Intermittent Operation.

One type of intermittent operation occurs on every channel and can be produced by tapping, squeezing, or jarring the tuner. Such a defect is due to a bad solder joint, broken lead, or faulty component; and it can frequently be located by mechanical inspection. The second type of intermittent operation occurs only at certain points in the band, especially when the tuning mechanism is used. From this description noisy contacts, corroded wipers, or shorted capacitor plates are probably the trouble. Again the defect can be repaired by mechanical means.

4. Interference.

Many of the current UHF tuners and converters radiate a considerable amount of oscillator signal. Although interference between two receivers is rare in most UHF areas because of the channel allocations and the higher IF frequencies, it is possible to run into this trouble. Some of the tuners operate the oscillator directly at the proper mixing frequency, while others employ harmonics of the local oscillator. Interfering beats due to other UHF equipment appear in the same manner on the screen as VHF or IF interference. The remedies are the same — shielding of the offending tuner, orienting the antenna and transmission line for minimum interference, and (as a last resort) relocating one or both antennas.

In addition to oscillator radiation, strong VHF stations sometimes ride through the UHF tuner and beat with the output of the UHF section; or they interfere directly as a superimposed picture. The only remedy for this is the use of an efficient high-pass filter in the input of the UHF tuner and the use of a shield on the connection to the VHF tuner when an external UHF converter is used.

Milton S. Kiver

The Concertone Tape Recorder

(Continued from page 29)

Recording-Level Indicator

A 6E5 electron-ray tube operates as the recording-level indicator. If the recording-level control is set at the level which allows the eye barely to close but not overlap at the highest peaks, the maximum allowable signal will be recorded on the tape.

Stand-by Position

The stand-by position provides monitoring of the incoming signal when the switch marked RECORD, STAND-BY, PLAYBACK is in the stand-by position.

Other Features

The 1401S possesses other features such as easy threading of tape, fast forward, high-speed rewind, tape-pressure release during fast forward and rewind, and interlocked controls for prevention of accidental erasure of recorded material.

The separate recording and playback chassis, erase-bias chassis, and power supply are visible in the bottom view (Fig. 2) of the recorder. Most of the tape control system with its switches and mechanical levers and interlocks can also be seen.

Circuit

The complete circuit is shown in the schematics in Figs. 3, 4, 5, and 6. The circuit for each chassis is shown separately. All switches, connectors, and heads which are not mounted directly on the chassis are shown on the schematics as being on extended leads or cables.

Playback Section

The playback head which is mounted in the head assembly is connected through the shielded cable to the grid (pin No. 7) of tube V1 on the recording and playback chassis. The playback circuit using V1 and V2 is conventional with some low-frequency compensation being provided by the 10K-ohm resistor and .1-mfd capacitor in the plate circuit of V1A. One-half of V2 is not used, but its 12.6-volt heater is connected in series with the heaters of the two other DC-heated tubes V1 and V3. Adjustable high-frequency peaking is furnished by the network in the circuit connecting V2 to the grid (pin No. 2) of V1B. The treble adjustment (trimmer

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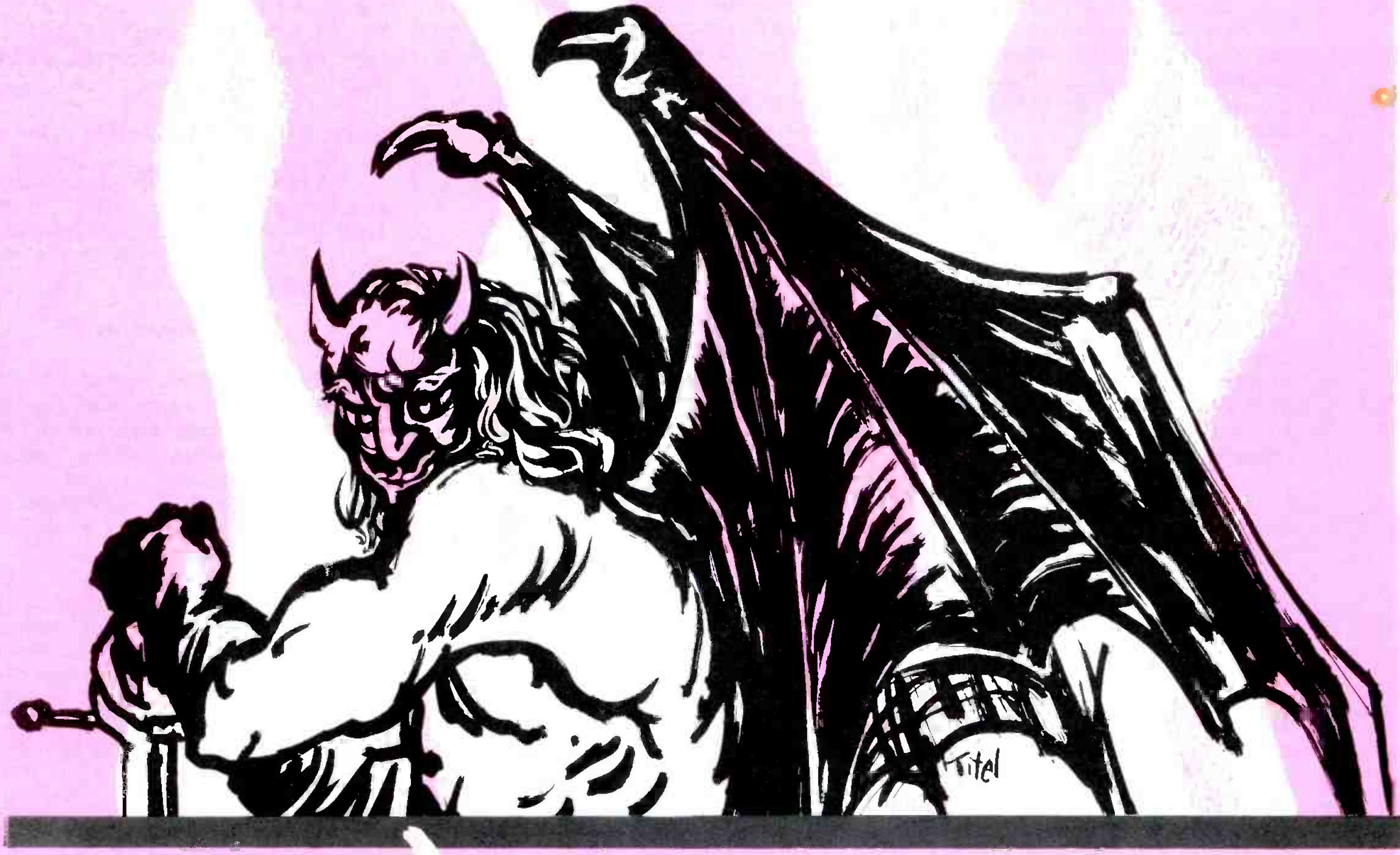

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The Concertone Tape Recorder

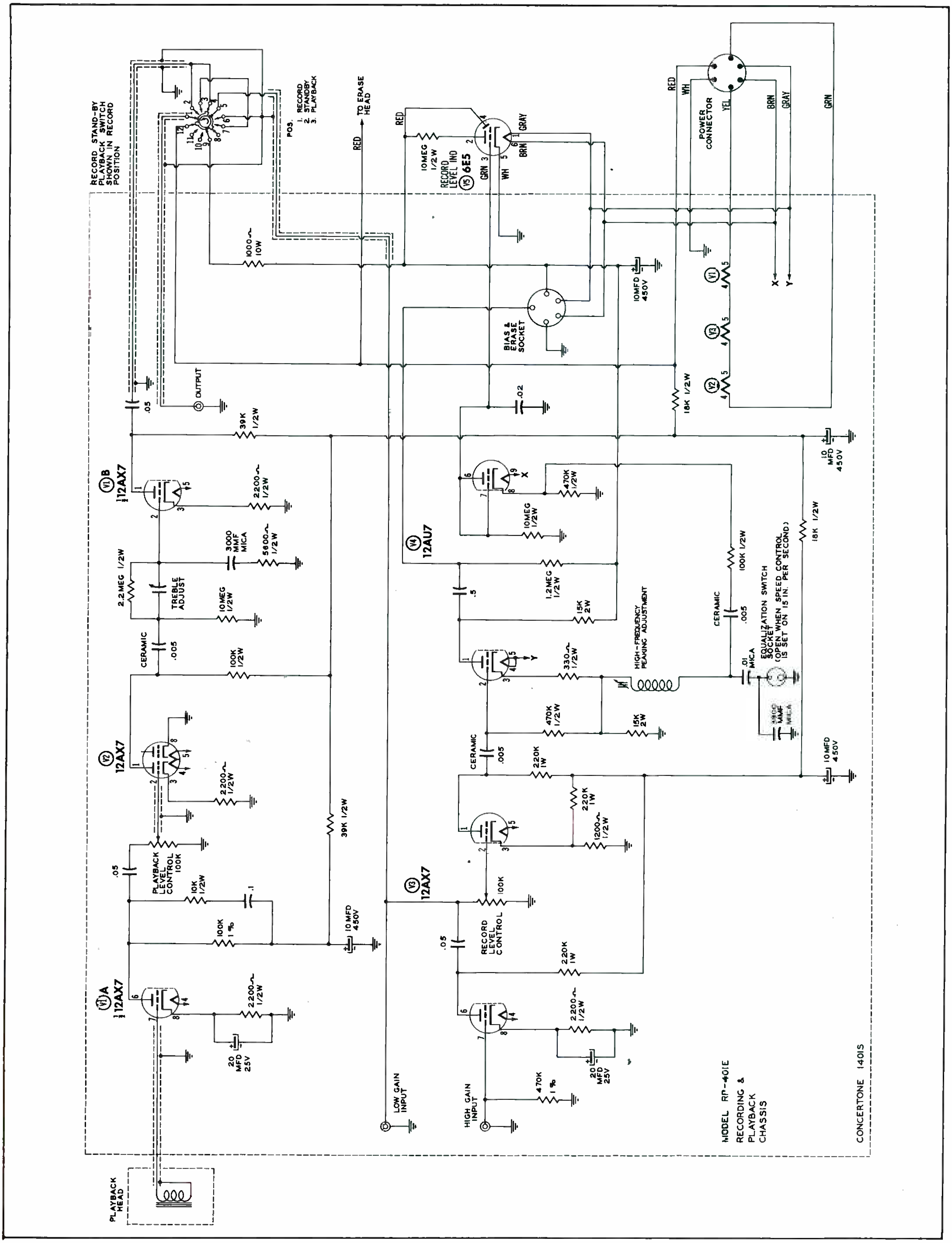

Fig. 3. Recording and Playback Circuits.

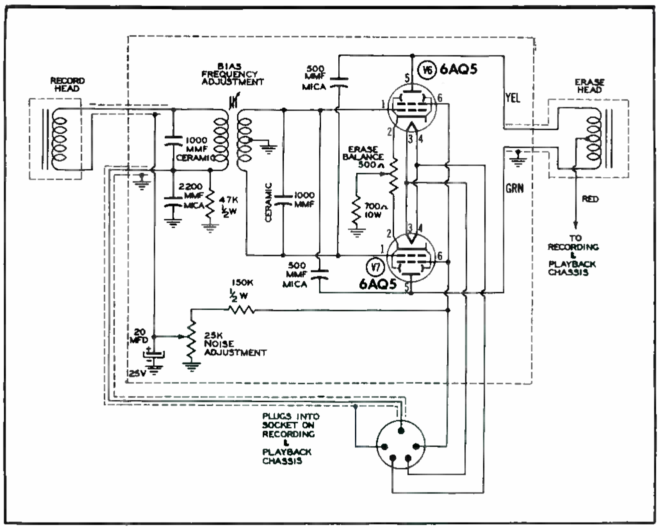

Fig. 4. Erase-Bias Oscillator Circuit.

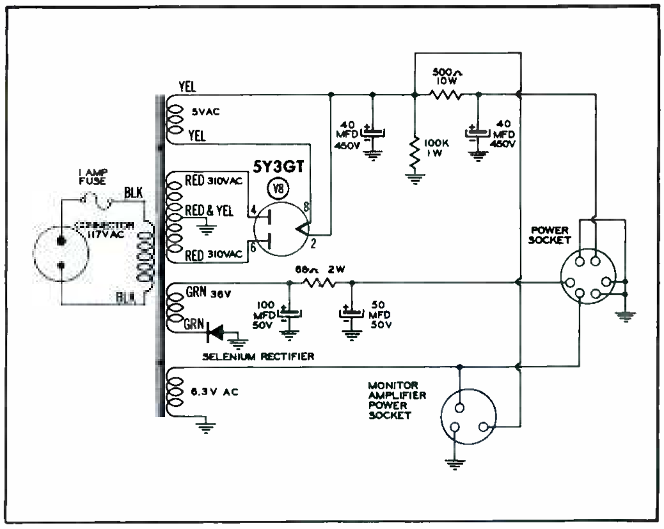

Fig. 5. Power Supply for Concertone Recorder.

capacitor) is adjusted for the most uniform frequency response in the range from 1,000 to 15,000 cps.

The output is fed through a shielded cable to the switch marked RECORD, STAND-BY, and PLAYBACK. The switch is shown in RECORD position which connects the output of the playback section to the output jack.

Record Section

The high-gain input connects directly to the grid (pin No. 7) of V3. The output of the first stage is coupled to the top of the RECORD-LEVEL control through a .05-mfd capacitor. The low-gain input connects directly to the top of the same control. Note that no capacitors are used in either input circuit. This fact should be kept in mind when connecting a signal source to either input circuit. Should a DC voltage be applied, the bias of the stage would be affected.

The 220K-ohm resistor connected between the cathode (pin No. 3) of V3 and B+ provides additional stability to this high-gain triode stage. The network in the cathode circuit of the third stage (first section of V4) provides adjustable high-frequency compensation. The correct frequency response is automatically maintained by the equalization switch when the tape speed is changed. The switch is open when the speed control is set for a speed of 15 inches per second. With the control set at 7 1/2 inches per second, the switch is closed and the 3,900-mmf capacitor is shunted out of the circuit. The high-frequency peaking adjustment is made by setting the speed control at 15 inches per second and adjusting the tuning slug in the high-frequency peaking coil for maximum signal output at 15 kc.

The output signal is fed from the plate of V4 to the bias and erase chassis. The signal for the recording-level indicator is taken from the cathode circuit of the first section of V4 and fed to the cathode (pin No. 8) of the second section which operates as the rectifier for the indicator tube V5.

When the RECORD, STAND-BY, PLAYBACK switch is in the stand-by position, the low-gain input is connected straight through to the output jack. The high-gain input is also connected to the output jack, but through the first section of V3.

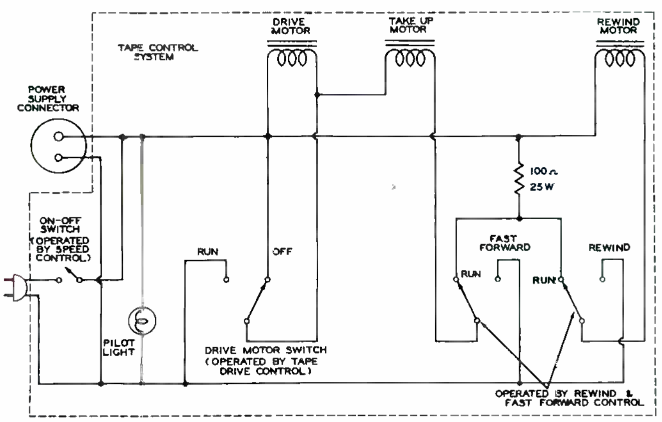

Fig. 6. Tape Control System.

Bias and Erase

Most of the features of the bias and erase chassis are indicated on its schematic shown in Fig. 4. This section operates only when the RECORD, STAND-BY, PLAYBACK switch is in the RECORD position. The signal output from the plate (pin No. 1) of V4 on the recording and playback chassis feeds through the transformer to obtain bias for the record head.

A certain amount of positive DC voltage is applied to the record head through the noise adjustment control, which is the variable portion of a voltage-divider network. When the correct voltage adjustment is made by means of this control, a minimum amount of noise will be recorded on the tape.

Power Supply

The power supply (Fig. 5) is conventional. DC for the heaters of V1, V2, and V3 is supplied by the half-wave selenium rectifier.

Tape-Control System

The schematic (Fig. 6) of the tape-control system illustrates how simple the basic circuit really is. All switches are microswitches controlled by the mechanical system visible in the bottom view of the recorder. Correct sequence of operation and the necessary interlocking action are provided by this mechanical network when the tape-drive, rewind, and fast-forward controls are moved.

Robert B. Dunham

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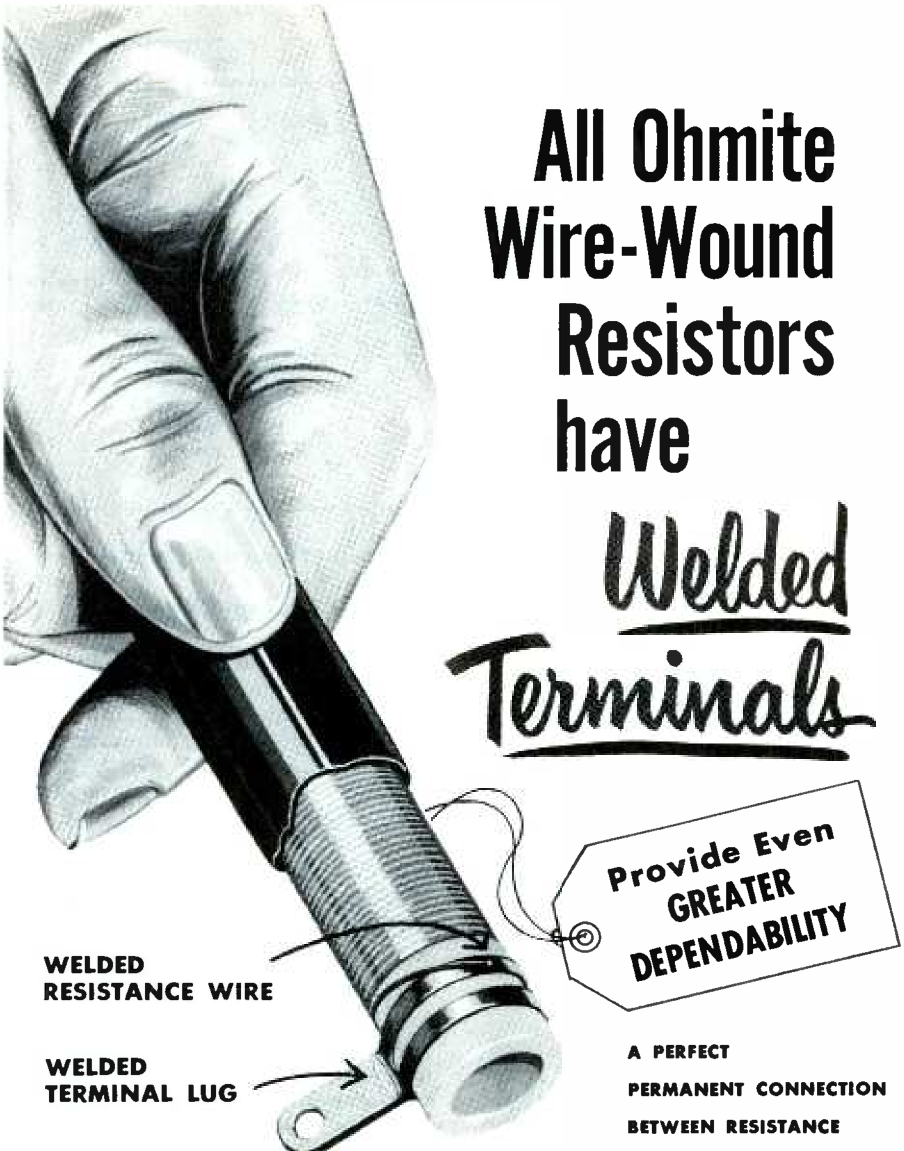

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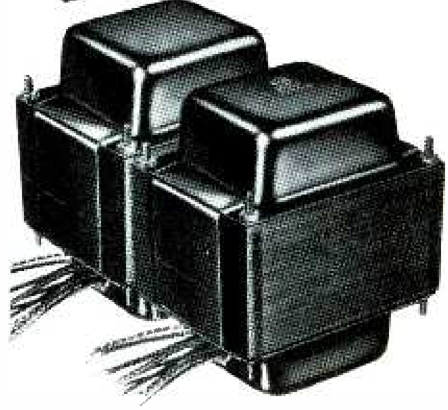

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(Continued from page 13)

R18. Because of the voltage drop across this resistor, the voltage applied to the tubes will be decreased. Relay RY1 remains open because insufficient current is being drawn through it. Power is not supplied to the drive motor until the relay closes.

If the PLAY-RECORD switch S1 is placed in the record position, the microphone input is connected to the grid of the first audio amplifier. The audio output is connected to the recording head through capacitors C13 and C14 and through resistor R11. Resistors R9 and R10 and capacitors C8 and C9 make up a feedback network to decrease the response at the middle frequencies. A neon bulb M4 is used as record-level indicator.

The PLAY-RECORD switch also connects the cathode of the bias oscillator V3 so that it will operate at a frequency of approximately 38 kilocycles upon the application of proper plate voltage. The bias-oscillator circuit operates in conjunction with the erase head. When the starting switch S2 is closed, resistor R18 is shorted. This raises the level of B+ voltage on the tubes so that they may operate. The audio-output tube V2 will conduct and draw current through relay RY1. The relay will close and apply power to the motor. An additional set of contacts closes and keeps resistor R18 shorted when switch S2 is released. The unit will then record the message picked up by the microphone.

A small band of silver paint is applied to the tape to activate the stop mechanism. When the tape has reached the end of its cycle, the silver paint will short the contacts labeled M3. This causes a negative voltage from the rectifier M2 to be applied to the grid of V2. The negative voltage cuts off V2, and the current flowing through relay RY1 becomes less. The relay opens and removes power from the drive motor. By the time the tape stops, the shorting band has passed the contact switch M3, and the negative voltage has been removed from the grid of V2. The short across R18 is also removed, and the B+ potential drops in value. This quiescent condition exists until the starting switch is closed again.

When the PLAY-RECORD switch is placed in the play position, the record head is connected to the first audio amplifier and the audio output is connected to the speaker. The switch S1C in the cathode circuit of the bias oscillator is opened in order to make this stage inoperative. The start-stop circuits function in the same manner as for recording.

The Message Repeater is an example of electronic equipment which may appear to be quite specialized in design. An analysis of the operation, however, has shown that the circuit is quite conventional and the procedure for servicing does not differ widely from that employed with a conventional recorder.

Don R. Howe

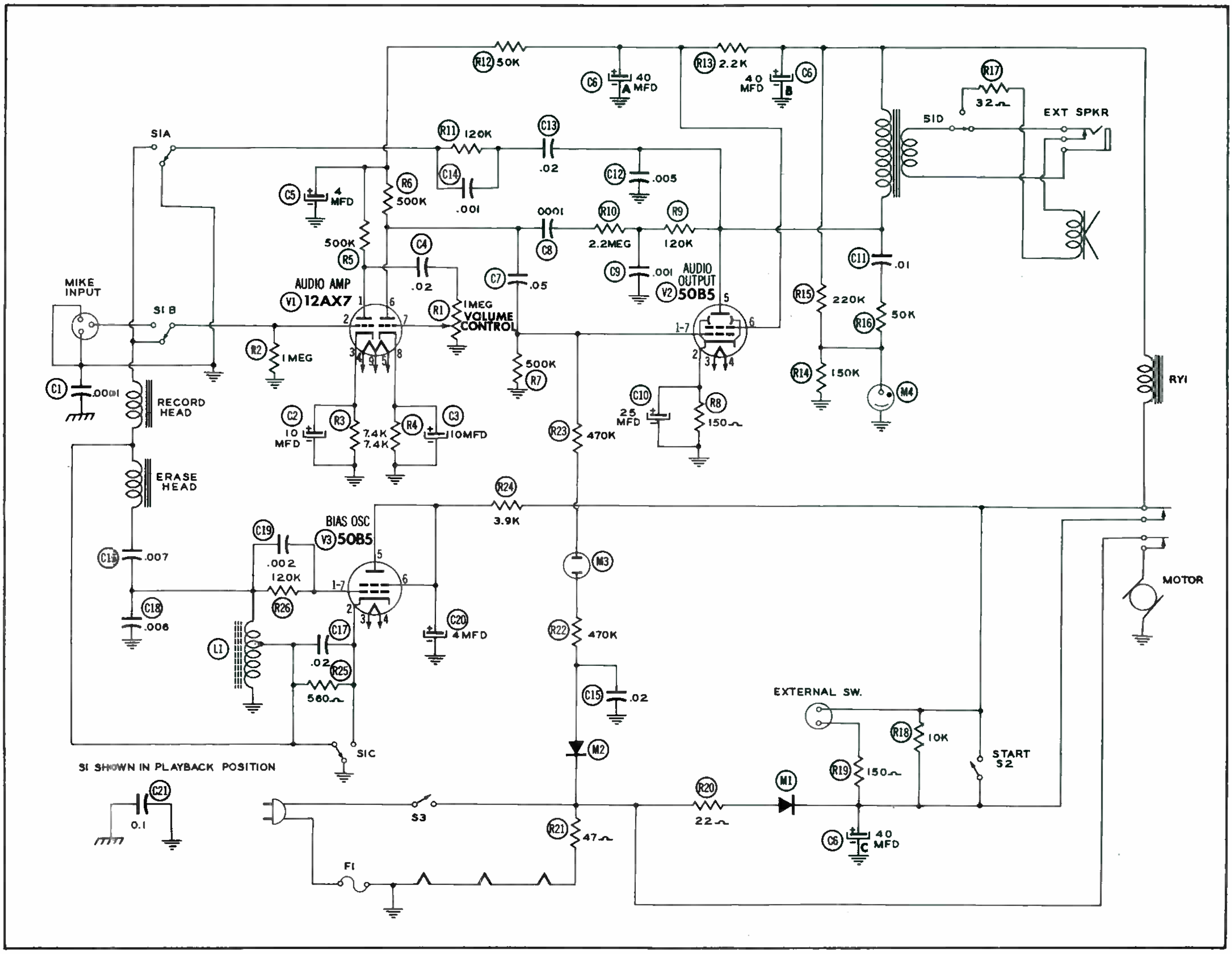

Fig. 3. Schematic of Message Repeater.

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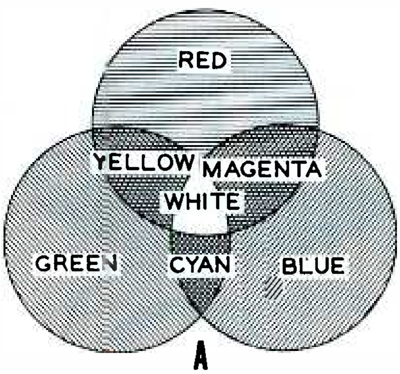
TV Colormath

(Continued from page 25)



R+B=MAGENTA
R+G=YELLOW
G+B=CYAN
R+G+B=WHITE
C+M+Y=WHITE

(above)

Fig. 1A. Chrominance Primaries.

(right)

Fig. 1B. Hue and Dominant Wavelength.

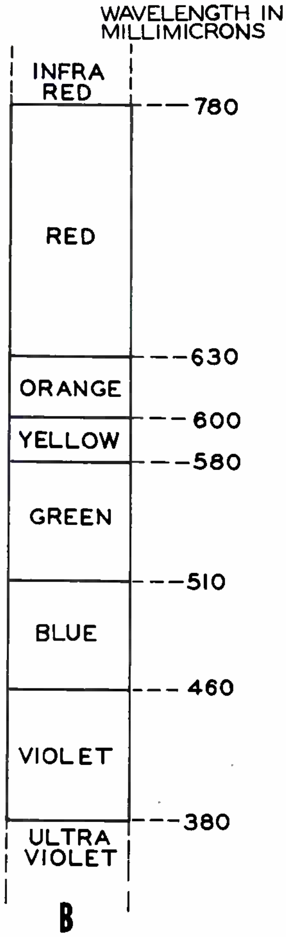
erties of color information: (1) the hue, and (2) the purity, or saturation.

The hue of an object or image is what the layman usually refers to as color. Hue depends upon the dominant wavelength, as shown by Fig. 1B.

The saturation of a color must also be represented electrically to specify completely the needed information. This is the degree of mixture with white. Note from Fig. 1B that variation of the dominant wavelength has nothing to do with purity (saturation). The difference between a deep red and a pastel pink is in the degree of saturation of the dominant wavelength representing red. A high degree of saturation indicates a pure color containing very little contamination with white. As white is added in greater amounts, the degree of saturation becomes less, and a deep color is changed to a pale shade of the same color.

Purpose of a Chromaticity Diagram

A chromaticity diagram illustrates relationships (hue and saturation) in such a way as to establish a numerical relationship. Terminal equipment (transmitting and receiving ends) may then be made to match a given numerical value. For artistic effects, the program producer may depart from an assumed standard at the receiving position by utilizing reliable numerical variations.



The basic idea in a chromaticity diagram is shown by Fig. 2. Note that the saturated red and green each have a numerical value of unity (or one) on their respective axes. In this basic example, saturated blue is given a value of z. Using only two specifications, x and y, all hues may be represented along the boundary and any degree of saturation may be represented within the area of the triangle. Following the RG line, as red approaches green the gamut of colors goes through red, orange, yellow, and green. Where equal amounts of red and green occur (x = 0.5 and y = 0.5), yellow results. The same line of reasoning follows for cyan and magenta.

Note that the point W designates "equal-energy white." As a line recedes from the boundary (as does the dotted line along the yellow-white axis in Fig. 2), it designates mixtures with white or a less saturated condition. In this example, the numerical value of W is:

x = 0.333 and y = 0.333.

The axes of X and Y are recognized as right-angle components that make up any value in the system in terms of their individual amplitudes. This is termed a system of rectangular coordinates, where any third value is automatically fixed by the two other values.

To illustrate this point, think of the triangle as a dynamic rather than a static form. Suppose you could shape your triangle in any dimension providing the total of x + y + z equals unity or one. Obviously, if you made x = 1, then y and z must be zero. If you made y = 1, then x and z must be zero. If you made x = 0.5 and y = 0.5, then z must be zero. To follow Fig. 2, if R = 0.5 and G = 0.5 we get a unit of yellow, and blue is zero. (Yellow contains only red and green minus blue.) Similarly, any point in the area bounded by the sides of the triangle may be defined in terms of x and y. Since x and y in this case are less than one, z will have a numerical value, indicating that all three colors are present. The resulting hue is less saturated.

Three primaries or their mixtures and degrees of saturation may be specified by only two coordinates, x and y. Instead of using x and y, we may represent this equal-energy white as:

r = 0.333 and g = 0.333.

Now it is obvious that for equal-energy white, all primaries must be represented and be equal in amount, as apparent from Fig. 1A. Since the diagram in Fig. 2 is a system of rectangular coordinates in which x + y + z = 1, then:

r + g + b = 1

and blue (b) is therefore available as:

b = 1 - (r + g)

= 1 - 0.666

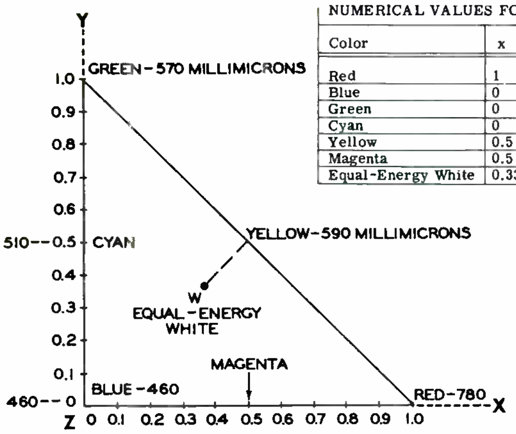
= 0.333

and all three primaries are of equal energy and produce white.

The Color TV Triangle

The TV chromaticity diagram is based upon color-matching tests made by the CIE* using a device known as a colorimeter. This device takes the exact primaries (red, green, and blue) and combines them so that it may be determined what amount of light flux, in lumens, of each primary is needed to match a given number of lumens of each hue in the visible spectrum. A large number of tests were made with a large number of different observers, and the mean

* "Commission Internationale de l'Eclairage" (CIE) is sometimes referred to as ICI (International Committee on Illumination). It should be understood that the CIE or ICI system is one and the same, CIE having been designated as the preferred term by IRE Standards.



NUMERICAL VALUES FOR THIS EXAMPLE

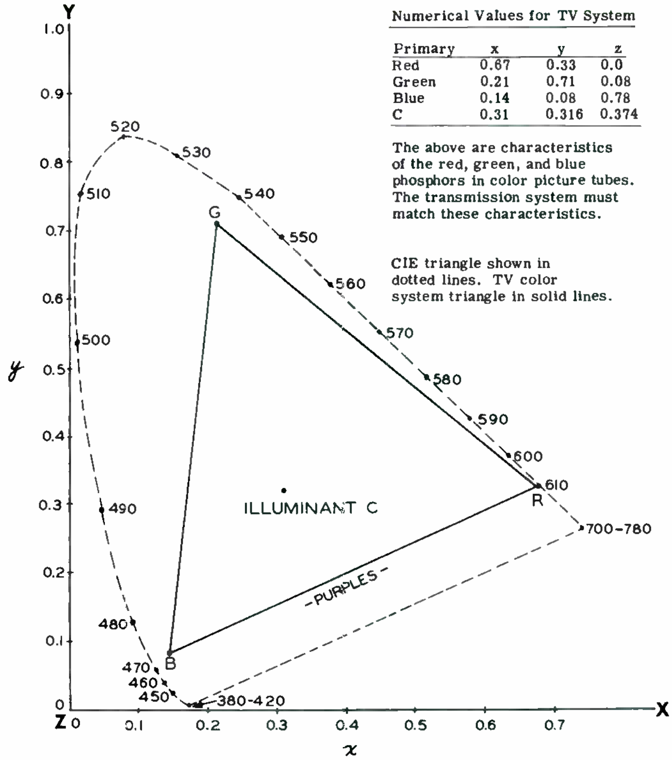
Color	x	y
Red	1	0
Blue	0	0
Green	0	1
Cyan	0	0.5
Yellow	0.5	0.5
Magenta	0.5	0
Equal-Energy White	0.333	0.333

(above)

Fig. 2. Basis of Numerical Specification of Hue and Saturation.

(right)

Fig. 3. XYZ Values of RGB, With Dominant Wavelengths in Millimicrons and Value of Reference White (Illuminant C).



Numerical Values for TV System

Primary	x	y	z
Red	0.67	0.33	0.0
Green	0.21	0.71	0.08
Blue	0.14	0.08	0.78
C	0.31	0.316	0.374

The above are characteristics of the red, green, and blue phosphors in color picture tubes. The transmission system must match these characteristics.

CIE triangle shown in dotted lines. TV color system triangle in solid lines.

value of observed quantities was used as the value for the "average CIE observer." Numerical values of hues and saturations given in the color TV system are largely based upon the CIE observations.

Fig. 3 shows the CIE triangle in dotted lines and the color TV system triangle (based on the spectral response of phosphors used in color kinescopes) in solid lines. This gamut of colors (solid lines) departs from the more highly saturated primaries of the CIE triangle, particularly in the green and blue regions. Also, the contrast range is reduced. Color telecasting must remain within the 30-to-1 contrast ratio for optimum results, just as conventional monochrome brightness should be kept within this range.

In the television transmission system, characteristic white is taken as "illuminant C" designated as point C on the diagram. Note that this has a value of x = 0.310 and y = 0.316. At this value, the chrominance signal is so proportioned that it disappears; and white, contributed entirely by the luminance channel, occurs on the kinescope.

Note that R, G, and B at any degree of saturation may all be defined in values of x and y. We may term this triangle an RGB diagram. The manner in which the transmission system encodes these relative values for the entire color gamut and the manner in which the receiver decodes this information comprises the entire study of color television systems.

The uses of this diagram for visualization of the numerical specifications of the system are discussed more fully in following sections.

Reason for Gamma-Corrected Signals

The phosphors in the color picture tube not only have x and y specifications in chromaticity, but they also have a nonlinear response to changes in the beam current which excites them; that is, the brightness increases in greater proportions than corresponding increases in beam current. The luminosities of these phosphors have approximately a square-law relationship to beam current. This means that the brightness increases about as the square of the change in beam current. The actual average

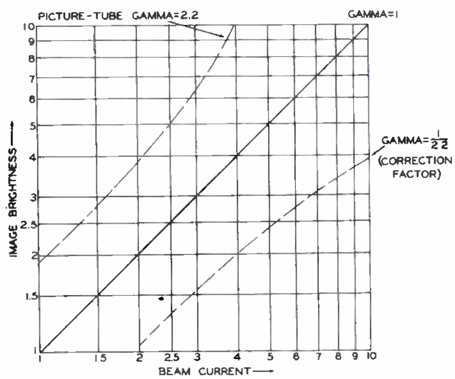


Fig. 4. Gamma-Correction Factors.

exponential value is 2.2. Without compensation, this relationship would distort the signal. Due to the fact that such compensation must be considered in certain transmission characteristics, it was decided to incorporate this correction at the transmission end rather than in the receiver. The receiver technician, however, must be familiar with this factor of the over-all system.

Fig. 4 illustrates the point in question. A gamma of unity or one, shown by the solid line, illustrates linear reproduction of image luminosity. The upper dotted curve illustrates the power-law function of the picture tube. This is analogous to operating the tube at too high a brightness setting which would result in severe compression, particularly in shadow portions of the picture. The lower dotted curve shows the function of gamma correction; that is, the camera amplifiers shape the amplification curve to the reciprocal of 2.2, or 1/2.2. The product of 2.2 (receiver-tube characteristic) and 1/2.2 (camera characteristic) is unity or one, achieving the unity gamma curve of linear reproduction.

It should not be inferred that a linear (gamma = 1) relationship is always established. For artistic reasons, departure may be made at the studios. It may be desirable at times even to depart from illuminant C as reference white, for the same reason. In order to provide a sensible basis from which to judge such departure, it should be realized that

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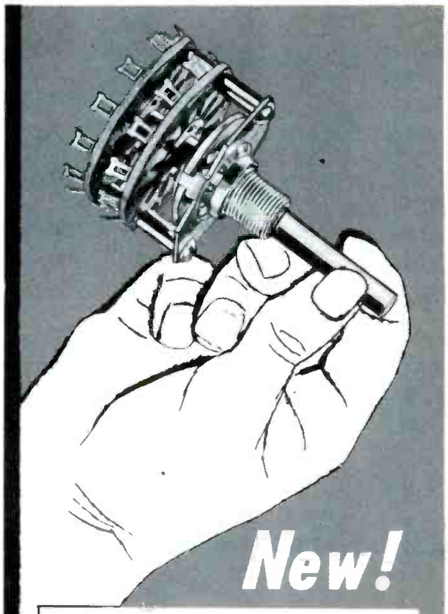

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such practices are a departure from standard operation upon which the system is based.

To achieve satisfactory color rendition in the receiver, the bias voltage at the color picture tube should be adjusted at cutoff on the reference-black level of the transmitted video. Accurately functioning DC restorers, usually of the driven-clamp type, are used for this purpose. If gamma correction were left to the receiver, it would make easier the possibility of absorbing the transmitter-setup voltage (difference between maximum picture black and blanking level). This could be done by making the necessary adjustment of the bias voltage of the receiver picture tube. Such a manner of operation, however, results in inaccurate chromaticity of the colors reproduced. Therefore, gamma correction is performed at the transmission end. The proper setting of receiver-channel gains for accurate luminance and chrominance reproduction hinges upon these factors.

Color Signal Proportions for Illuminant C

As noted in the section on "Luminance to Chrominance Proportions," the three primary channels of the color-camera output are combined to form the regular luminance signal. The individual primary color signals are also fed to a separate system to derive corresponding electrical signals relative to chrominance only. See Fig. 5A.

Since the eye is most sensitive to detail in the green region, less in the red region, and still less in the blue region, the Y (luminance channel) is proportioned accordingly. As shown in the drawing, we are considering the proportions when transmitting a white signal. In this case, R = G = B = 1

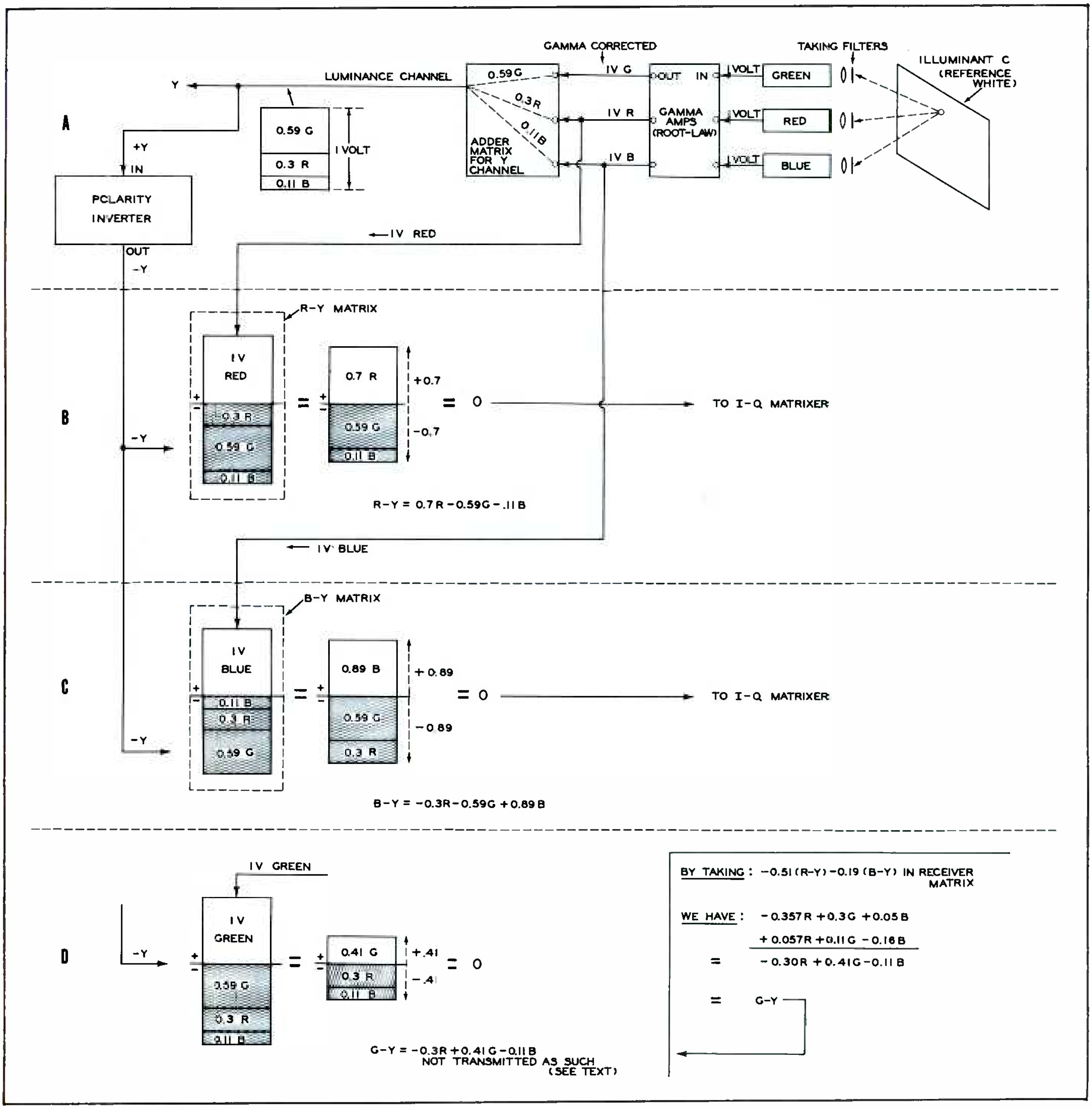


Fig. 5. Standard Signal Proportionment for Illuminant C.

the unity value of one volt being used arbitrarily to show signal proportions. It should be understood that channel outputs may vary anywhere between zero and unity, depending upon hue and intensity. For white (illuminant C), the voltage outputs from the initial amplifiers of the cameras are equal.

After passing through the adder matrix for the Y channel, one volt of luminance is made up of 0.3R, 0.59G, and 0.11B. The division of energy, made in accordance with the proportionate detail needed, conserves bandwidth and allows narrow-banded chrominance information to be conveniently interleaved within the luminance channel. The resulting one volt of luminance corresponds to the one volt of video on station monitors when a white signal is being transmitted.

Now each of the primaries must contribute to the color subcarrier only information relative to the chrominance, that is, hue and saturation minus the brightness information contained on the luminance (Y) channel. This is desirable for a number of reasons, chief of which is the fact that any interference occurring around the color-carrier frequency will cause only a hue change which is far less noticeable to the eye than interference which affects brightness.

The chrominance takeoff is following the gamma amplifiers and before the Y-adder matrix. (Figs. 5A and 5B.) Fig. 5B illustrates the manner in which the red-difference signal (R - Y) is obtained. The Y signal is fed through a polarity inverter to obtain a -Y signal. Note that the output of the R - Y matrix contains +0.7 and -0.7 units; the luminance (Y) signal is therefore zero. The R - Y color-difference signal is then:

$$R - Y = 0.7R - 0.59G - 0.11B \qquad (2)$$

The same function is performed to obtain the B - Y signal (Fig. 5C).

$$B - Y = -0.3R - 0.59G + 0.89B \qquad (3)$$

Note carefully that each color-difference signal (signal containing only chrominance information) includes all three color primaries. This permits the use of only a two-phase color carrier instead of a three-phase one for the information of three color primaries. Only the R - Y and B - Y signals modulate the color carrier in quadrature; hue information is represented by the phase, and saturation information is represented by the amplitude. The receiver can then combine the color-difference signals to obtain the G - Y component. See Fig. 5D.

Now remember we are at present studying the signal proportions on a transmission of a reference-white picture. This sets two conditions:

1. The color-carrier sidebands disappear.

2. The luminance channel contributes this reference white referred to in our study as unity or one volt, and this indicates maximum depth of modulation of the video carrier.

The second of the foregoing conditions is obvious from Fig. 5A. The luminance channel has an amplitude of one volt and is composed of 0.3 volt of red signal, 0.59 volt of green signal, and 0.11 volt of blue signal. These signals are in the proper proportions to produce reference white.

Now consider the chrominance signal which actually consists of three color-difference signals, only two of

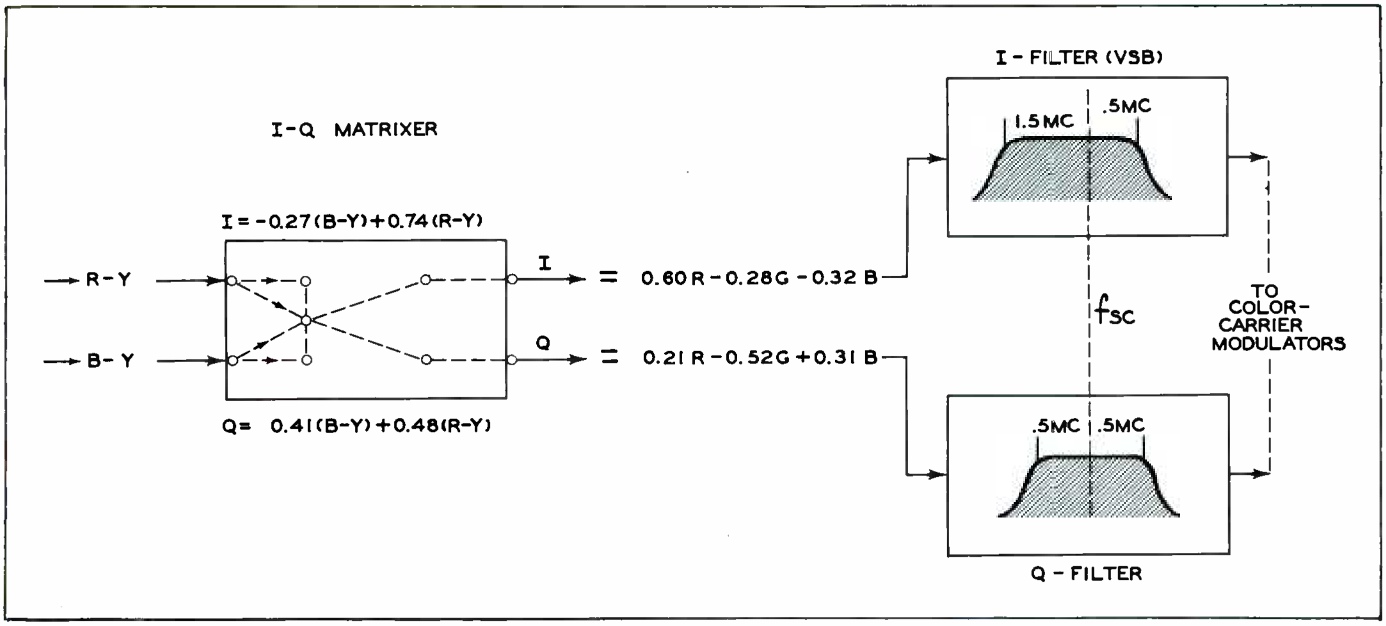


Fig. 6. I and Q Transmission Channels

which are used for modulating purposes. As can be seen in Figs. 5B and 5C, the R - Y and B - Y signals are both fed to the I-Q matrixer where they are converted to I and Q signals prior to the modulation process. Since the R - Y and B - Y signals both equal zero, no modulation occurs; therefore the subcarrier sidebands disappear.

From the foregoing, you will note that we have specified that the subcarrier is modulated only by R - Y and B - Y components. The G - Y signal is extracted in the receiver. This is true and brings up the following point: that we have considered only chrominance primaries from the camera. These chrominance primaries are placed in the form of transmission primaries so that only a two-phase color carrier is required, but the proportionment is still such that color-carrier sidebands disappear on reference white.

Transmission Primaries (I and Q Channels)

Note from Figs. 5B and 5C that the B - Y and R - Y signals are fed to an I-Q matrixer, where their form is changed. The color information must be placed in a form that (1) causes zero modulation of the chrominance channel to occur on illuminant C, (2) permits the extraction in the receiver of the G - Y signal from the B - Y and R - Y signals, and (3) permits the use of a two-phase demodulator for obtaining the three chrominance primaries.

Fig. 6 shows the action of the I-Q matrixer The I channel combines a -0.27 of B - Y with a 0.74 of the R - Y to obtain:

$$I = 0.60R - 0.28G - 0.32B \quad (4)$$

and the Q channel combines 0.41 of B - Y with 0.48 of R - Y:

$$Q = 0.21R - 0.52G + 0.31B \quad (5)$$

and, since we are still considering conditions for reference white:

$$I = 0.60 - 0.28 - 0.32 = 0.6 - 0.6 = 0$$

$$Q = 0.21 - 0.52 + 0.31 = 0.52 - 0.52 = 0$$

and modulation of the color carrier is zero. The luminance transmission primary is still

0.3 + 0.59 + 0.11 = 1 volt (Fig. 5A).

The I and Q channels are fed to separate filters before modulation of the color subcarrier. (Fig. 6.) The I channel is broad-banded but has vestigial-sideband characteristics. The bandwidth below the subcarrier frequency (f_{SC}) is single sideband for frequencies higher than 500 kc. Frequencies up to 500 kc are double-sideband on both the I and Q channels as shown. Such operation allows two types of receiver action: (1) the receiver may utilize the extra color information in the wideband I channel, or (2) cheaper receivers may ignore this extra information and reproduce only chrominance detail supplied up to 500 kc.

Now let us consider what happens when a black-and-white picture is transmitted at points other than reference white.

Continue to consider that this reference white will occur at maximum depth of modulation — one volt in our example. Consider now that the scanned point in question is a gray between maximum black and maximum white. Since no specific color exists, the output of the camera pickup tubes (Fig. 5A) will still be equal. Since the luminance is not so great from gray as it is from white, the amplitudes are reduced accordingly. For example, assume the amplitudes as 0.5 volt each.

Now this 0.5 volt in the Y channel will be made up of 30 per cent from the red, 59 per cent from the green, and 11 per cent from blue channels. The resulting 0.5 volt will reproduce gray on the receiver picture tube, since the depth of carrier modulation is one-half that of reference white. This is conventional monochrome action.

As long as the outputs of the initial channels are equal, the combined chrominance proportions (Figs. 5B, 5C, and 5D) will all add up to zero as in the case for reference white. The color carrier is therefore not modulated for any condition of monochrome transmission, and no sidebands occur. The receiver picture tube then reacts only from the brightness information in the Y channel.

Part II of "TV Colormath" will discuss chrominance modulation and modulation levels of the composite color signal.

Harold E. Ennes

Notes on Test Equipment

(Continued from page 21)

Sometimes it is necessary to get the output of a signal source, such as an audio signal generator, to a predetermined level for a testing operation. The procedure outlined in the foregoing could be used in a somewhat reverse manner to achieve that end. First the VERTICAL ATTEN-CAL switch should be set to either the 3-volt or 10-volt calibration position, whichever is more appropriate. Then the CALIBRATING VOLTAGE control is adjusted to obtain a meter reading which, when multiplied by one of the attenuation ratios of the VERTICAL ATTEN-CAL switch, will result in the desired signal level.

Next the VERT GAIN control is adjusted to obtain a vertical trace of convenient reference size. The VERTICAL ATTEN-CAL switch is then set to the previously determined attenuation position, and the output control of the signal source is adjusted to obtain a vertical trace of the same height as the reference trace.

Several manufacturers supply separate self-contained units which can be used to calibrate any scope. A representative group of such units is pictured in Fig. 2. They are the Du Mont Type 264-B, the Hickok Model 630, the Simpson Model 276, and the Sylvania Type 300 scope calibrators.

All of these units have certain similarities of operation and application. Each obtains its operating power or signal from the standard 115-volt AC source. Each unit is a source of AC signal to the scope, this signal being either a square-wave, clipped sine-wave, or a sine-wave signal. Each unit provides both step and vernier attenuation of the signal. In the Du Mont and Sylvania instruments, the vernier attenuation control is calibrated directly on the panel; while with the Hickok and Simpson instruments, vernier calibration is obtained through use of the front-panel meters.

In operation, the unknown signal voltage is applied to the input terminals of the calibration unit, and the output terminals of the unit are connected directly to the vertical input of the scope. At one position of a switch, the signal to be measured can be fed directly through the calibrating unit to the vertical input of the scope. Another position of the switch disconnects the unknown signal and connects the internal signal of the calibrating unit to the scope.

Since the operation of any one of these units is similar to that of the others, an outline of operating procedure will be given for only one. The outline that follows in Fig. 3 shows the procedure for determining the peak-to-peak voltage of an unknown voltage waveform using the Simpson Model 276 scope calibrator. One point in which this unit differs from the other three mentioned is that a continuous rotation of the calibration switch alternately selects first a calibration signal and then the externally applied signal. Thus, there are six calibration positions each separated by a position which provides direct coupling of the signal under test.

Several points not previously mentioned may help the technician to obtain the most accurate indications. Although the input capacitance of most calibrators is small, it may be sufficient in combination with the input capacitance of the scope to distort the waveform or change its amplitude, particularly when high-

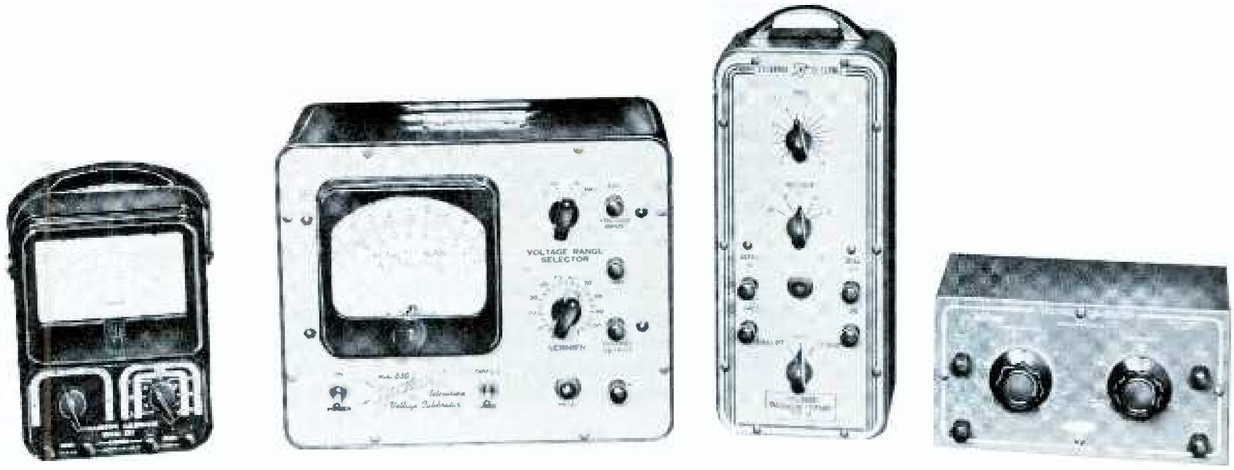


Fig. 2. Representative Group of Oscilloscope Calibrators.

frequency signal components are present. In that case, the calibrator could be bypassed and the scope input could be connected directly to the signal take-off point. If necessary, a low-capacitance scope probe could be used for minimum loading and distortion. After the scope controls are adjusted for a convenient reference deflection, the scope input can then be connected to the output of the calibrator and the calibration can then proceed normally.

Another precaution to observe is that the scope amplifiers are not overloaded at any time during the calibration. If the calibrator output is a square wave or a clipped sine wave, it would be well to expand the trace horizontally for examination before adjusting the vertical size for a reference trace. With some scopes, some tilt of waveform may be noticed, as in Fig. 4. In this figure, the distance h is the true measure of the height of the calibrating waveform and is the portion that should be used as a reference. If the horizontal

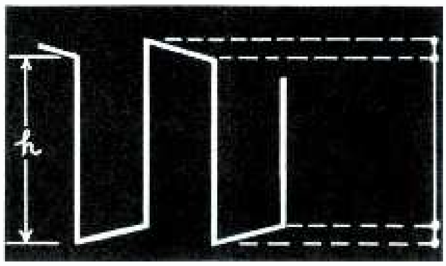


Fig. 4. Correct Reference Height of Calibrating Voltage.

deflection is reduced to zero, the waveform takes on the appearance of the vertical line at the right of the figure. Use of the entire length of this vertical trace for a calibration reference would result in a voltage indication slightly less than the true value. Therefore, it would be advisable to make this check for possible tilt before setting the vertical reference trace.

Fig. 5 shows an oscilloscope and calibrator being used to measure the peak-to-peak voltages in the horizontal AFC circuit of a television receiver. This is an example of just one of the many applications of a scope and a calibrator in waveform measurements in receiver servicing or adjustment.

THE SWEEP GENERATOR

The sweep generator is widely used among service technicians, because it is very useful for alignment of FM receivers and practically a necessity for TV alignment. Yet occasionally one hears a comment or a question which indicates that the nature of the sweep signal or the exact manner in which it functions during alignment is not fully understood by the operator. This does not

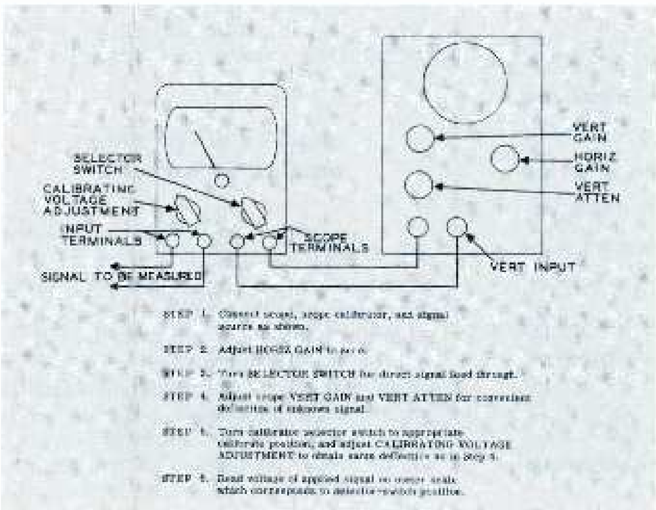


Fig. 3. Procedure for Measuring Amplitude of Waveform With Scope and External Calibrator.

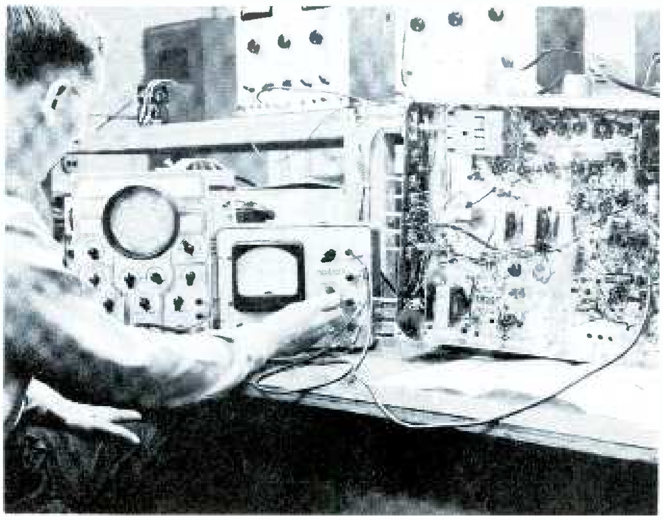


Fig. 5. Oscilloscope and Calibrator Employed in Typical Service Operation.

prevent him from performing a perfectly satisfactory alignment, but it is axiomatic that the better a service technician understands his instruments the more useful they are to him. With that in mind, let us see if we can clear up some of the mystery of the sweep generator and its use.

It was stated previously that the sweep generator is practically a necessity for TV alignment procedure. Actually, it would be possible to align and view the response of a video IF strip of a TV receiver using an RF generator and a VTVM, but it would be a time-consuming operation. Such an alignment might proceed like this: the signal from the RF generator is introduced at the mixer stage of the tuner, and the detected signal is measured across the video-detector load with the VTVM. Many IF alignments actually start in that manner. Any trap adjustments are made for a minimum indication on the VTVM at the frequencies specified by the manufacturer.

So far so good, but the next step can be quite tedious. In many alignment charts the next step is an over-all response check, with perhaps a bit of retouching of the individual IF adjustments for the optimum response curve, as indicated in Fig. 6. In order to obtain this curve with an RF generator and VTVM, the technician must take many readings on the VTVM over a range covering the sound and video intermediate frequencies, plus perhaps a few extra readings if traps are used in the circuit. These readings are plotted on a graph showing relative amplitude versus frequency, and the final result is a response curve similar to the one he would have obtained with the scope and sweep generator. If the response curve departs too far from the desired response, he must decide which adjustments need be changed and to what degree; and then after these readjustments, a new set of readings must be taken and plotted.

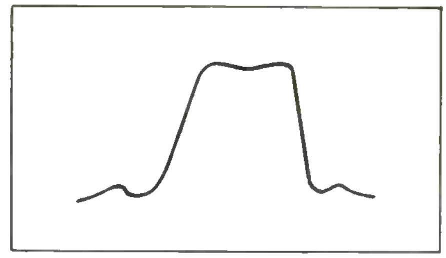


Fig. 6. Typical Video IF Response Curve.

How much simpler and easier it is merely to substitute a sweep generator for the RF generator and view the response curve directly on the scope! The effect of any adjustment can then be seen immediately without any voltage readings or graph plotting. The sweep generator is actually doing electronically what the technician did manually as he set the RF generator at the various frequencies. It is doing a much better job of it, too. The technician was limited in the number of readings he might take (depending on time and patience), but the sweep generator covers almost instantaneously all the frequencies within the extremes of its sweep width.

Methods of Obtaining the Sweep Signal

In order to understand better the exact nature of the signal furnished by a sweep generator, let us examine the way this signal is obtained in some generators. In Fig. 7, L1 is an inductance in the resonant tank circuit of the sweep-oscillator stage of the generator. The letter D represents a light-weight metallic disc (seen edgewise in the figure) which is driven back and forth in the direction indicated by the double arrow in much the same manner as the cone of a loudspeaker is driven. L1 is wound in the form of a flat spiral

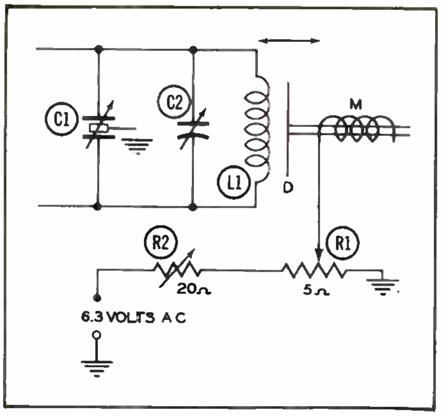


Fig. 7. A Common Method of Sweep Modulating an Oscillator.

so that the flat side of disc D can be made to approach it quite closely. As the distance between L1 and the disc varies, the inductance of L1 also varies. This action is similar to that obtained when the brass slug of a tuning wand is inserted into a tuned coil, and as a result the resonant frequency is raised. When the disc is closest to the coil, the sweep oscillator operates at its highest frequency; then the oscillator goes lower and lower in frequency as the disc moves away, reaching its lowest frequency when disc and coil are farthest apart. With no driving voltage applied to the dynamic motor M, the disc will be at rest and the oscillator will operate at the sweep center frequency.

With most sweep generators of this design, the driven voltage for M is obtained from a low-voltage winding on the power transformer. This would result in a sweep varying in a sine-wave manner at the line frequency of 50 or 60 cycles per second. Resistor R1 is the sweep-width control. As the potentiometer arm moves toward the high side of the applied voltage, more voltage is applied to the dynamic motor M; and a greater sweep width results, that is, the sweep oscillator swings through a wider range of frequencies about the center frequency.

A graphic illustration of the relation between the motor-driving voltage, the position of the disc, and the sweep frequency is shown in Fig. 8. The lower portion represents the motor-drive voltage and takes the form of a sine wave. The middle portion shows the corresponding position of the motor-driven disc with respect to L1, and the upper portion represents the variation in frequency output of the sweep oscillator. Let us assume that the sweep generator is in operation and that the motor-drive voltage is at point A. Also assume that the voltage at point A is of the proper polarity to drive the disc towards L1 and that the response in movement of the disc

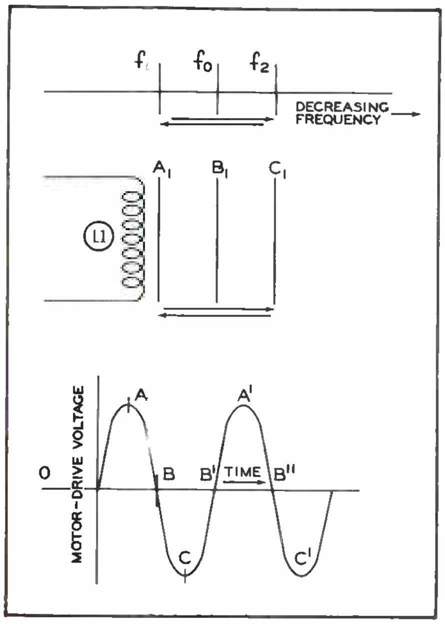


Fig. 8. Sweep-Driving Voltage and the Effect It Produces on the Sweep Oscillator.

is instantaneous. Then the disc will be at point A_1, the nearest position to L1, and the frequency of the sweep oscillator will be f_1, the upper limit of its sweep. As the drive voltage falls toward B, the disc will move toward the mid-position B_1 and the output frequency will approach the center frequency f_0. When the drive voltage reaches C, the disc will be at C_1 and the output frequency will be f_2, the lower frequency limit of the sweep. Thus, the output of the oscillator is swept through all frequencies between the limits of f_1 and f_2.

At C the direction of voltage change is reversed, and the disc retraces its former path but in reverse order, thus reversing the sweep. What we have then is an output signal much the same as that of an RF generator, except that the signal frequency is constantly changing from one instant to the next between the upper and lower frequency limits. In the example we have been discussing, this change from upper to lower frequency and back again to the upper frequency all takes place during one complete cycle of the driving voltage; and in this case, we say that the sweep rate is 60 cycles per second (the usual power-line frequency in this country).

Thus far we have discussed only one method of obtaining the sweep signal, but several other methods are in use. Instead of driving a disc, as we have shown, the dynamic motor may drive one side of a variable capacitor in the sweep oscillator circuit; or a reactance-tube modulator may be used. One laboratory type of sweep generator obtains its sweep from the application of a saw-tooth voltage to the repeller element of a reflex-klystron oscillator. It is reported that some recently developed sweep generators operate on the principle of a varying incremental inductance in the sweep oscillator circuit. Regardless of the means of obtaining the sweep signal, the end result or the signal itself is essentially the same in its nature and application.

Extending the Range of Sweep-Signal Coverage

The previously mentioned methods of sweep generation provide a signal which varies in frequency about a center determined by the values of components in the tuned circuit of the sweep oscillator. Provision is made for varying this center frequency through as wide a range as can be easily obtained under the design limitations of the sweep circuit.

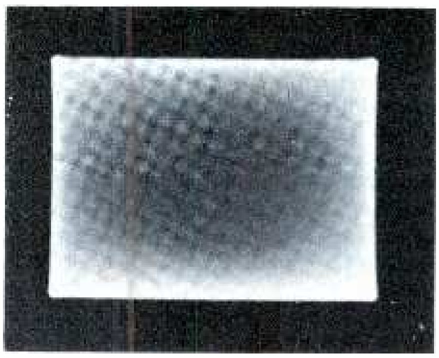


Fig. 9A. Output of Sweep Generator As Seen on an Oscilloscope.

In order to extend the range of output frequencies, most generators employ either one or both of the following methods: (1) harmonics of the sweep oscillator can be used; (2) a fixed oscillator can be beat against the sweep oscillator, and the resulting sum and difference frequencies can be utilized. Thus, sweep frequencies are obtained over a range which would not be possible with a sweep oscillator stage alone without expensive modifications in design.

The Sweep Signal

A sweep signal was applied directly to an oscilloscope and the resultant waveform photographed. The sweep center frequency was kept low in order that the sweep frequency extremes might fall within the response of the vertical amplifier of the scope.

The waveform appears in Fig. 9A. The sweep generator was set at a center frequency of 3 megacycles, with a sweep width of 150 kilocycles (75 kc each side of center). At this frequency, the waveform contains some 25,000 alternations which blend into one continuous tone, as shown in the illustration. With the equipment at hand, it was not possible to expand the photograph a very small section of this waveform to show the individual alternations; so the same effect has been accomplished by making the diagram of Fig. 9B. The spacing between alternations indicates that the generator signal is continuously changing frequency between a lower frequency at one extreme and a higher frequency at the other.

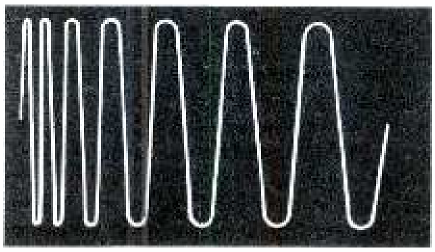


Fig. 9B. Greatly Expanded Drawing of Small Portion of Fig. 9A.

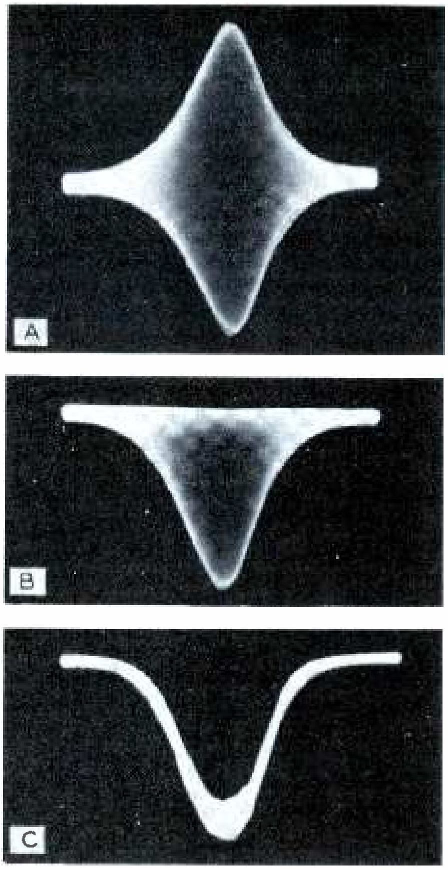


Fig. 10. Effect on a Sweep Signal When It Is Applied to Tuned IF Stages of a Radio Receiver.

Fig. 10A illustrates the response of a tuned circuit to a signal like that shown in Fig. 9A. Center frequency of the sweep was set at 455 kc, the intermediate frequency of a conventional AM receiver. The sweep signal was introduced at the converter grid of the receiver, amplified by two IF stages, taken off the plate circuit of the last IF stage, and applied to the oscilloscope. It can be seen that the receiver IF strip has maximum response at the resonant frequency of the IF transformers (455 kc) and falls off rapidly on either side of this frequency.

Fig. 10B was obtained with the scope at the same point in the circuit; but a simple rectifier circuit consisting of a blocking capacitor, crystal diode, and load resistor was inserted to rectify the signal. The rectifying action eliminated one-half of each cycle from the signal.

To obtain the photograph shown in Fig. 10C, the oscilloscope input lead was connected to the volume control. Before reaching this point, the sweep signal which was introduced at the converter grid has been subjected to the amplification and selectivity of the IF stages and has been rectified by the detector stage of the receiver. In addition, the filtering action of the detector stage has removed most of the RF portion of the signal. What remains is actually a graph plotted across the screen of the oscilloscope. The horizontal sweep from left to right represents the change in frequency of the signal; the vertical amplitude of the trace represents the relative amplitude response of the receiver IF system to each frequency within the sweep.

Necessary Oscilloscope Response

It is not entirely clear to some technicians just what the frequency-response characteristics of an oscilloscope must be in order to use it for sweep alignment. The line of reasoning seems to be as follows: since the sweep signal used during a TV alignment contains frequencies of 4.5 mc, 20 mc, 40 mc, or higher, the vertical-amplifier response of the scope should be equally high. This would be true if one wished to view a response similar to those shown in Figs. 9A, 10A, and 10B. However, the sweep signal is practically always subjected to detector action before viewing with the scope. The most common points for sweep viewing in a TV receiver are the mixer grid, the video detector, the FM sound limiter (if it is present), and the sound detector. These points all provide some form of detector action. The tuned circuits preceding these points provide selective amplification of the sweep signal, and the resulting signal is amplitude modulated in a manner similar to that shown in Fig. 10A. The detector action in the circuit then results in a signal similar to Fig. 10C. This signal is received at the generator sweep-frequency rate (usually 60 cycles) and is easily viewed by a general-purpose scope providing it has good low-frequency response. If it is desirable to view the response at some point other than a detector stage, then a detector probe can be used with the scope and the same results obtained as those in the foregoing. It can be seen from the previous discussion that the scope is not required to respond to the sweep center frequency of the signal generator but to the sweep rate.

Synchronization and Phasing

In order to synchronize the sweep generator and oscilloscope, a signal of the same frequency as the generator sweep is applied to the horizontal-deflection circuit of the scope. If the frequency is other than the power-line frequency, the signal is usually taken from some point in the generator sweep circuit; if it is at line frequency, it can be obtained either from the generator or from

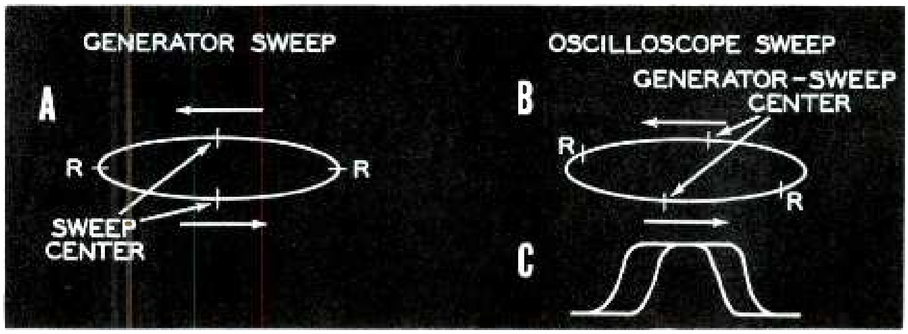


Fig. 11. Diagram Showing Out-of-Phase Condition Between Sweep Generator and Oscilloscope.

the internal circuit of the scope itself.

The most common source of the synchronization signal, when the sweep is of line frequency, is some point in the filament circuit of either the sweep generator or the oscilloscope. Since both instruments are being operated at the same line frequency, synchronization will be exact; however, some provision for correct phasing between the generator sweep and the horizontal sweep of the scope will be necessary. Fig. 11 will serve to show what happens when generator and scope are not exactly in phase. For clearer illustration, parts A and B of Fig. 11 are drawn with the return half of the sweep slightly above the initial half. In Fig. 11A, the generator sweep is shown with sweep centers indicated and with points R indicating sweep reversal points. Fig. 11B is drawn to indicate that the synchronization signal applied to the scope is retarded in phase with respect to the generator sweep. Then at the instant of sweep reversal shown by R in Fig. 11A, the scope sweep in Fig. 11B will continue and will reverse a little later as shown. The generator sweep centers will be displaced a corresponding amount, and the resultant response curve of an amplifier might appear as in Fig. 11C. Proper adjustment of the phase control will bring the two traces together to appear as one trace.

Fig. 12 shows the sweep-driving circuit of Fig. 7 with horizontal sweep take-off and phasing control added. The value of R5 is determined in production to set the range of R3 within the proper limits.

Fig. 13 illustrates a condition sometimes encountered in practice. The response of a tuned circuit, such as an IF strip, may be slightly different (as the sweep frequency goes from low to high) than its response as the signal swings in the other direction. In this case, two curves are obtained which are mirror images of each other; and no amount of adjustment of the phasing control or of the tuned circuits can make the two curves coincide. The difference is usually small and can be disregarded.

Blanking

Some sweep generators are provided with a blanking control for blanking the return sweep. When the blanking control is in operating position, the generator output is reduced to zero during the return sweep, thus providing a zero-reference base line and eliminating one-half of the double response curve normally obtained without blanking. However, the phasing control should be adjusted for near coincidence of the two response traces before blanking is applied. This will help prevent a confusing indication which might occur if the phasing control is very far from the correct setting.

Sweep Generator Applications

Only a few of the many applications of the sweep generator can be mentioned in an article of this length. Perhaps the most common of its uses, as far as the service technician is concerned, is in checking and aligning the RF and video IF stages of TV receivers. It is useful in adjusting

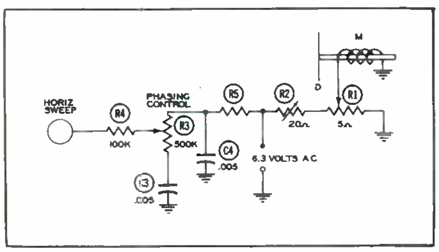


Fig. 12. Phasing Control Circuit of a Sweep Generator.

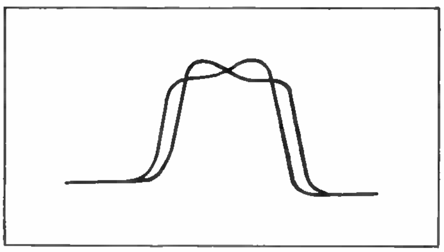


Fig. 13. Mirror-Image Effect Sometimes Encountered During Sweep Alignment.

wideband IF amplifiers in both AM and FM receivers and in aligning FM detectors. Some unusual applications are: its use in measuring standing-wave ratios on transmission lines and the velocity of propagation in a transmission line. In practically all of its applications, it is used in conjunction with an oscilloscope.

There are a few points which it would be well to remember when using the sweep generator. Misleading indications or damage to the instruments involved may thus be avoided.

1. Use an isolation transformer when working on AC-DC receivers.

2. Avoid connecting the generator to a point of DC voltage without the use of a blocking capacitor. The terminating network of the generator is usually of low resistance value and might be damaged by excessive current.

3. Terminate the generator output cable with the proper impedance network to avoid reflections on the cable.

4. Use plenty of grounding straps between test instruments. If the response curve changes shape when instruments or chassis are touched, more grounding straps are needed.

5. Avoid overdriving the circuit under test. A change in response-curve shape as the signal level is changed indicates overdriving.

6. Correct adjustment of the phasing control may clear up some peculiar and confusing wave shapes.

7. Keep marker signal strength low to avoid distorting the response curve.

NEW OSCILLOSCOPE HANDBOOK

A new 24-page handbook of cathode-ray oscilloscopes has been announced by the Hickok Electrical Instrument Company.

The handbook contains an explanation and illustrations of the basic characteristics of the oscilloscope and the manner in which it works. Tips are included on some of its more general uses. Also listed are specifications on many models from three-inch portable scopes to large bench models and laboratory type scopes.

This handbook is available without charge from the Hickok Electrical Instrument Company, 10566 Dupont Avenue, Cleveland 8, Ohio.

Paul C. Smith

Horizontal AFC Circuits

(Continued from page 23)

R7 is zero, and no control voltage can be applied to the horizontal oscillator. Capacitors C1 and C2 will not completely discharge between sync pulses because of the long time constant in the circuit. The partial discharge of these capacitors forms the exponential portions of waveforms W3 and W4 and causes them to appear slightly different from waveforms W1 and W2.

The action of the saw-tooth waveform on this circuit can now be considered. This saw-tooth voltage is applied between ground and the diodes as shown in Fig. 4B. When the saw-tooth voltage is above its AC axis, or is positive, diode 1 will conduct; when the saw-tooth voltage is below its AC axis or is negative, diode 2 will conduct. The conduction of diode 1 will charge capacitor C5 positive with respect to ground. Conduction of diode 2 will reverse this action and charge C5 negatively. The net charge on C5 for one cycle of saw-tooth voltage will then be zero, and no output voltage will appear.

It has been shown that neither the sync pulses nor the saw-tooth voltage alone can produce an output voltage from the phase detector. It is necessary to apply them simultaneously in order to make the phase detector function properly. Consider one instant of time where the horizontal oscillator is operating in the exact center of its synchronization range. Both the frequency and the phase of the feedback signal coincide with the received sync pulses. Because of this coincidence, the sync pulses arrive at the phase detector at the instant when the saw-tooth voltage is passing through its AC axis during retrace time. This is effectively a point of zero potential for the saw-tooth wave; and, therefore, the saw-tooth voltage can produce no current flow in either diode. The two sync pulses of equal amplitude produce equal but opposite currents, and the output voltage from the phase detector is zero.

If at any time the frequency or phase of the oscillator were to vary, the saw-tooth waveform would arrive at the phase detector either before or after its previous time of arrival. As a result, the sync pulses would arrive at a time when the voltage at the connection between the diodes was not zero but of some positive or negative value. This condition would unbalance the circuit, because one diode would have more voltage applied to it than the other would have.

The waveforms in Fig. 5 are presented to show the voltages existing across each of the diodes for three settings of the horizontal hold control. These waveforms were obtained by connecting the oscilloscope directly across each diode with the ground lead

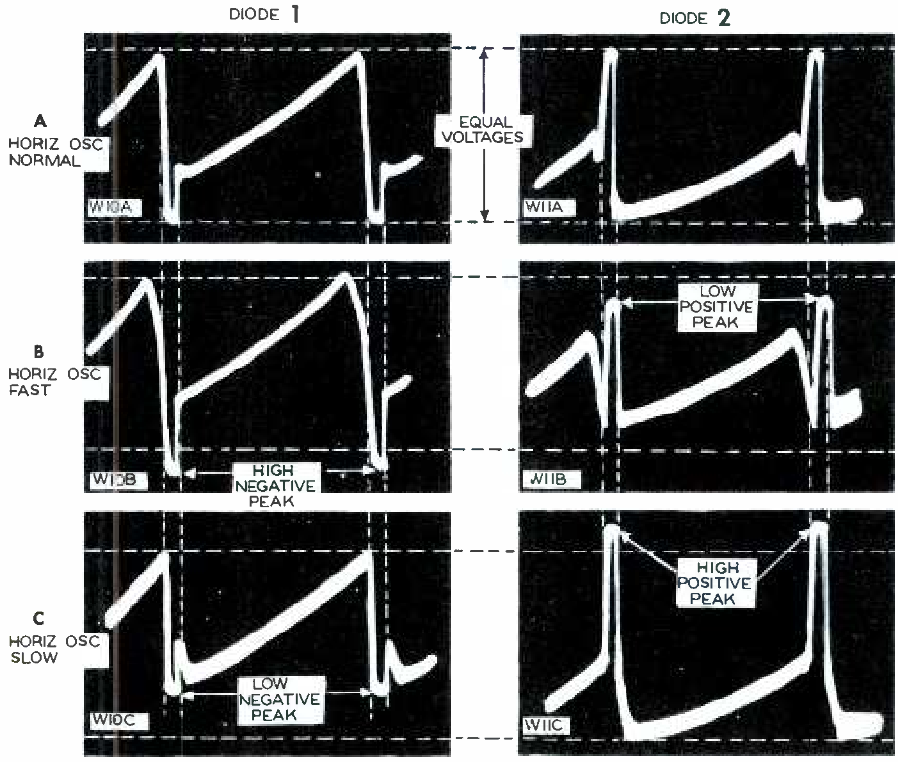


Fig. 5. Comparison Between the Waveform Across the Two Diodes When the Setting of the Horizontal Hold Control Is Varied.

of the scope connected to pins 1 and 2 of the phase-detector tube socket in both cases. The two waveforms W10A and W11A in Fig. 5A show the conditions (previously described) when the oscillator is operating at the frequency and phase of the sync pulses. It can be seen that the sync pulses appear at the center (AC axis) of the retrace portion of the saw-tooth wave, and equal voltages are applied to the two diodes.

The two waveforms W10B and W11B in Fig. 5B show the conditions existing when the oscillator tends to operate slightly fast in relation to the sync pulses. A comparison of the two waveforms will reveal that the negative sync pulse in W10B appears at a time when the saw-tooth waveform is below its AC axis (or is negative) and thus the amplitudes of the two will add. In W11B, the positive sync pulse also appears when the saw-tooth voltage is negative, but in this case the two amplitudes will subtract. Diode 1 thus has more applied voltage, and it will conduct more than diode 2. The resulting control voltage under these conditions will be positive.

The two waveforms W10C and W11C in Fig. 5C show the voltages on the phase detector when the oscillator is running slow. A comparison of the two waveforms will reveal that the sync pulse appears on the upper or positive side of the saw-tooth wave for both diodes. Since diode 2 has the positive sync pulse applied, it will therefore have the highest applied voltage and will conduct more than diode 1. The control voltage will be negative. With normal operation, the control voltage will always be of the correct polarity to return the sweep oscillator to synchronism with the incoming sync pulse.

One variation of this phase-detector circuit is in fairly common usage. In this circuit a current waveform, instead of a voltage waveform,

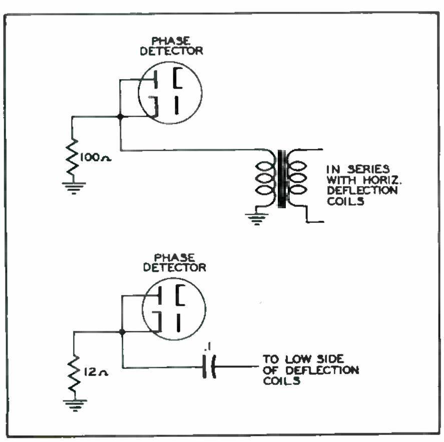


Fig. 6. Variations in Method of Obtaining Saw-Tooth Waveform.

is derived from the horizontal deflection coils and is applied to the phase detector. Since this waveform is representative of the current through the horizontal coils, it already has the form of a saw-tooth pattern and the integration circuit associated with the phase detector is not needed. Two circuits of this type are shown in Fig. 6.

The number of components actually used in a phase-detector circuit is small, hence the possible causes of trouble are few. The chief offenders when trouble is encountered are usually the capacitors C1, C2, and C9. These parts have fairly high voltages applied and are prone to failure. Capacitors C4 and C5 are subject to a loss of value occasionally but are seldom found open. The resistors in this circuit do not dissipate appreciable amounts of power, hence they do not often cause trouble. Checking the resistors should consist only of measuring resistance values.

Multivibrator.

The cathode-coupled multivibrator using a ringing coil is a circuit very commonly used for generating the horizontal-sweep frequency. The waveforms shown in Fig. 7 are those which can be found at the indicated points on the schematic of Fig. 1 and should serve to clarify the operation of the oscillator.

To explain the operation, we shall first assume that the plate current of V3B is increasing. The increasing current flow through the cathode resistor R9 will increase the bias on V3A to the cutoff point where plate current ceases in V3A. The resulting increase in plate voltage on V3A is coupled to the grid of V3B by C7; the change in grid voltage is shown at point 1 on W7. This positive voltage will cause the grid to draw current. The flow of grid current results in the charging of C7. Meanwhile, because of the positive grid voltage (point 2 on W7), the plate current of V3B has reached its maximum value and immediately begins to decrease because of the lowered plate voltage. The feedback through R9 drops to the point where it can no longer hold the bias on V3A at cutoff, and plate current flows in this tube. The resulting decrease in plate voltage on V3A drives the grid of V3B below the cutoff level (point 3 on W7), and plate current in V3B ceases. The high negative charge on C7 then holds the grid below cutoff while the capacitor is discharging through resistors R11 and R12. The current flow during discharge drops exponentially to a level where the voltage across R11 and R12 is insufficient to hold V3B at cutoff, V3B begins to conduct, and the cycle is repeated. That portion of waveform W7 between points 3 and 4 shows the potential on the grid of V3B while C7 is discharging. If the ringing coil L1 were not in the circuit, this portion of the waveform would display the exponential discharge waveform associated with the capacitor C7 and would be an almost straight line connecting points 3 and 4. The addition of the ringing coil, however, results in the coil being shock-excited by the rapid decrease of plate current through V3A and in an oscillation occurring in the coil and capacitor combination. The voltage introduced into the circuit by the coil is a sine wave which is superimposed upon the exponential discharge waveform of C7. The main advantage of the ringing coil is that the voltage change on the grid of V3B approaches the conduction level much more abruptly than if the waveform were exponential during this period. The multivibrator is made much less sensitive to random operation due to noise pulses. When the grid of V3B attains the conduction level, the grid potential begins to go

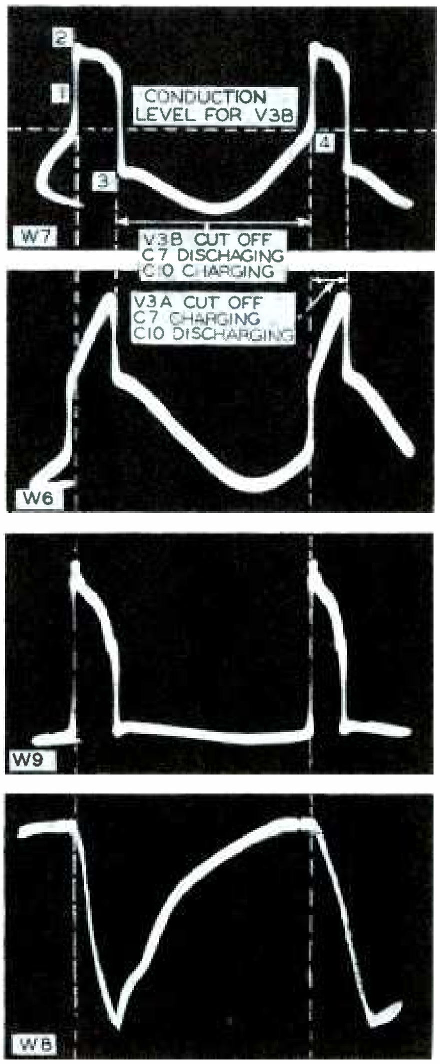


Fig. 7. Waveforms Obtained in Multivibrator Circuit (Compared With Respect to Common Time Base).

positive again and the first cycle is repeated.

During the interval in which V3B is cut off, capacitor C10 charges through R13 and R14. The variation in voltage across C10 forms the trace portion of the saw-tooth waveform W8. When the grid of V3B attains the conduction level, plate current begins to flow and capacitor C10 is rapidly discharged through the tube. This discharge forms the rapid retrace portion of the saw-tooth output voltage.

It may be noted that waveform W8 does not have a perfect saw-tooth shape. The discrepancies are corrected by the output tube and transformer. In some cases, it is actually necessary to predistort this waveform in order to compensate for non-linearity in the output tube and associated circuits.

The waveforms in this circuit are formed by the action of the multivibrator only; the pulses which are present in the multivibrator circuit are not formed in any way by the action of the sync pulses applied to the phase detector. The frequency of the multivibrator is controlled by the DC voltage from the phase detector; this voltage either aids or opposes the feedback voltage to V3A and thus changes the frequency of the multivibrator

The most common cause of trouble in a multivibrator circuit of this type is tube failure. Fig. 7 shows that V3B is conducting only during retrace time, while V3A conducts for the entire trace time. Because of this imbalance of operational time, one-half of the tube (represented by V3A) will usually fail while the other half is still in good condition. Replacement of the tube is the only solution for this trouble.

Sometimes it is difficult to tell whether the cause for multivibrator failure lies in the multivibrator or in circuits ahead of it. A simple check can be performed by shorting the control grid of V3A to ground and noting if the multivibrator operates at its free-running frequency and if the frequency can be adjusted by means of the horizontal hold control. If the foregoing events occur, the trouble probably lies somewhere ahead of the multivibrator; if they do not occur, check the multivibrator for defective components.

The ringing coil L1 and capacitor C7 present a combination that occasionally fails to function properly. If this is the case, a check of the waveform W7 at the grid of V3B should reveal that the sine wave is absent; that the sine wave has an incorrect frequency; or that the sine wave has an amplitude which is insufficient to drive the grid of V3B to conduction at the proper time.

All the resistors and capacitors are subject to the common faults involving these components, and they should be checked if trouble does occur in the multivibrator.

William E. Burke

Audio Facts

(Continued from page 9)

The arm height is correct when the bottom of the head (not the cartridge) is parallel with the surface of a record on the turntable as the cartridge stylus is resting in a groove of the record.

The arm rest should be adjusted so that when the sliding weight on the counterbalancing arm is held down (as in Fig. 4D) and when the pickup arm is swung over the arm rest, the head (which has been automatically lifted from the record grooves) will strike the right side of the arm rest and drop into place on it when the pressure on the weight is removed. The preceding explanation of the action might sound complicated; but actually it is a simple way of lifting the pickup head from the record without causing damage, because any pressure on the counterbalancing weight lifts the stylus clear of the record grooves. The finger lift on the head should always be used when placing the stylus on a record.

Fig. 4E illustrates how the pickup head pivots and tilts upward on the arm which is rigid in the vertical direction and will swing only horizontally on its spindle. This tilting action is convenient for checking and cleaning the stylus and for easy insertion and removal of the plug-in cartridge adapters.

A Fairchild 215A cartridge is shown plugged into the head in Fig. 4E. A GE triple-play cartridge can be seen in the adapter lying on the motor board. No soldering is required when a cartridge is mounted in one of the plug-in slides.

The counterbalancing arm is calibrated directly in grams for use with GE cartridges. Some adjustments may be necessary when other makes of cartridges are used, since cartridge weights vary. When the correct stylus pressure is found, the sliding weight is locked in position with the thumb screw. The position of the weight shown in Fig. 4B has proved satisfactory with the Fairchild 215A cartridge.

Figs. 1 and 4E illustrate how three wood screws fasten the mounting flange of the Livingston Universal transcription arm to the motor board. Some of the features of this arm and more details concerning its installation can be seen in Figs. 5A and 5B.

The view from below in Fig. 5A illustrates how the hollow spindle of the arm extends through the motor board and carries the shielded lead coming from the cartridge.

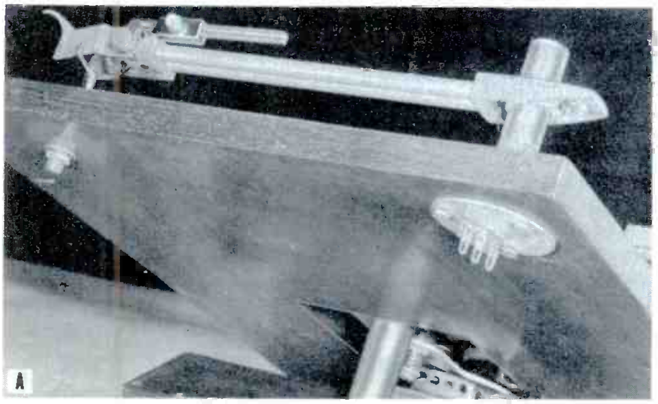
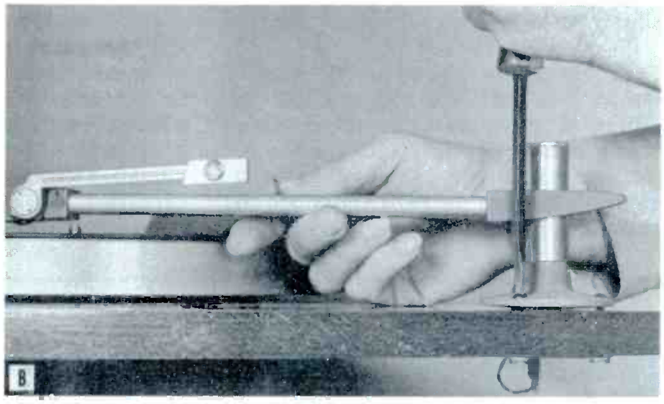
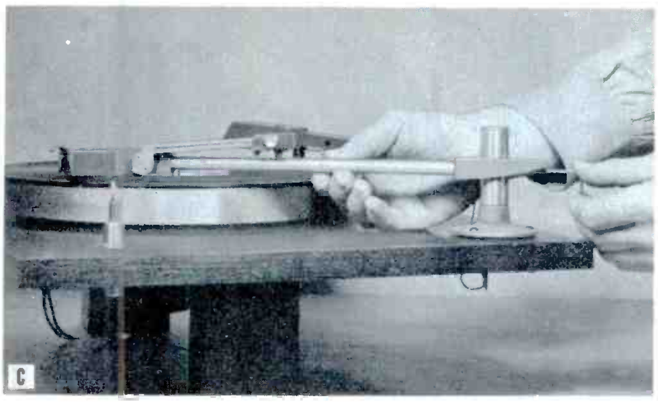
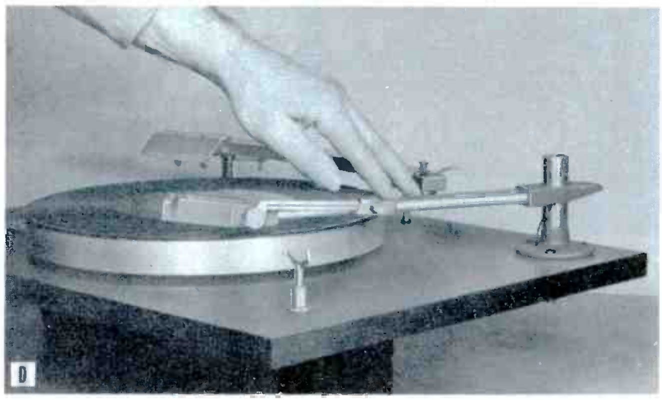






Fig. 4 (A.) GE A1-501 Arm and Rest. (B.) Leveling GE A1-501 Arm. (C.) Adjusting Height of GE A1-501 Arm. (D.) Swinging GE A1-501 Arm Into Position on Arm Rest. (E.) View of Turntable and Arms; Cartridges in GE Plug-In Slides.

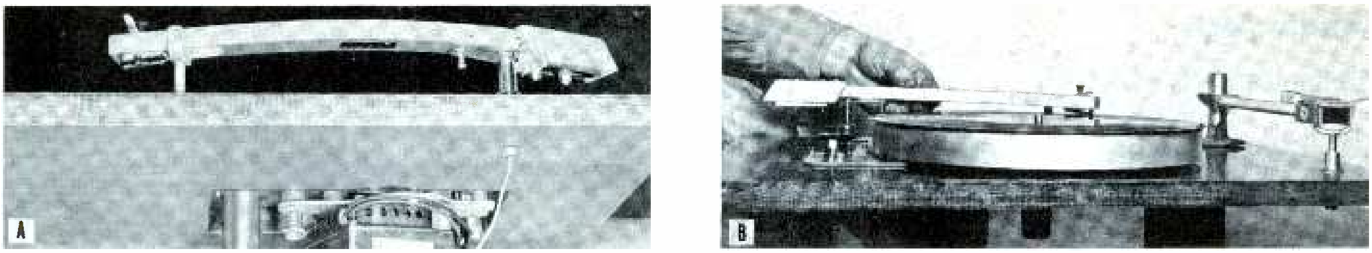


Fig. 5 (A.) Livingston Universal Arm. (B.) Adjusting Height of Livingston Arm.

Two slotted counterbalancing weights, a light one for use with cartridges requiring comparatively heavy stylus pressures and a heavier one for use with microgroove cartridges, are supplied with the Universal arm. Fine adjustment of stylus pressure is made by sliding the weight being used forward to increase and rearward to decrease the stylus pressure. The heavier weight is shown in place under the tail piece of the arm in Figs. 5A and 5B and is positioned correctly for the GE triple-play cartridge, also visible in the illustrations.

To adjust the arm for height (as in Fig. 5B), the arm spindle is slid up or down until the bottom edge of the arm is parallel with the top of the turntable; the set screw in the mounting flange is then tightened to lock the spindle at this correct height.

The Livingston Universal arm pivots vertically only at the spindle. All bearings move freely and smoothly, resulting in very satisfactory tracking.

The arm rest shown with the Livingston arm was made out of some aluminum scraps and is secured in place by a long wood screw running down through the upright piece into the motor board.

Both arms are furnished with the necessary hardware and fittings to make possible the mounting of most any standard cartridge. Along with the previously mentioned feature of a wide range of stylus pressure adjustments, this makes these arms excellent for all-round use and experimental work.

Both arms are long transcription arms and track very well. Of course, the usual precaution of making certain that the motor board is level must be taken in order to obtain the most satisfactory operation.

Two arms allow many tests to be made and are found to be very convenient to anyone engaged in any form of experimental audio work. A person who has never used a turntable or pickup arms of such high quality as these may not realize the improvement that can be brought about by them in the reproduction of music. High-fidelity reproduction depends upon every part of the audio system operating as it should and doing its part well. The turntable and pickup arm must be recognized as being very important units in the music system.

Robert B. Dunham

In the Interest of Quicker Servicing

(Continued from page 17)

The circuit of Fig. 4 is very similar to that of Fig. 3, the big difference being in the design of the vertical-output transformer. The transformer in Fig. 4 is wired as an autotransformer and produces the same results as the transformer in Fig. 3, with only one exception. The secondary is not isolated from the primary; therefore, the possibility of a breakdown between the primary and secondary (due to the high potential difference between the two) is greatly reduced.

The circuit shown in Fig. 5 is a variation of the one shown in Fig. 2. The significant difference is that the one in Fig. 5 incorporates a vertical-discharge tube and the pulse is taken off across the wave-shaping resistor R2. R2 actually serves two purposes in this circuit. It functions as a wave-shaping resistor, and in addition it acts as the grid return for the picture tube. By taking off the signal at this point, the manufacturer accomplishes two desired objectives. First, a negative pulse is obtained for driving the picture-tube grid to cutoff; and second, the number of necessary components is reduced to a minimum.

When a vertical-output stage uses an autotransformer connected as shown in Fig. 6, there is no inversion of the applied signal. For this reason, the signal taken from anywhere on the output transformer in this circuit must be applied to the picture-tube cathode in order for the positive pulse to achieve cutoff. This particular circuit contains a small coupling network between the vertical-output transformer and the picture-tube cathode. The network acts to integrate and shape the pulse somewhat before applying it to the cathode. This network is comprised of R1, C2, and C3. The remaining portion of the circuit is more or less conventional.

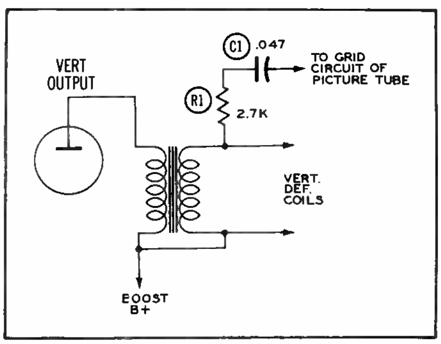


Fig. 4. Variation of Fig. 3.

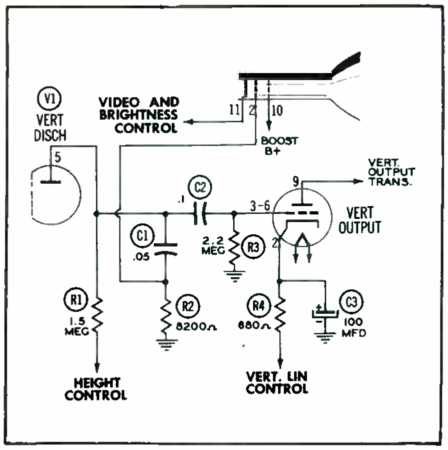


Fig. 5. Blanking Pulse Taken From the Wave-Shaping Network.

The purpose of this discussion has been to acquaint the reader with the many ways in which a TV receiver may incorporate vertical-retrace blanking. It was also intended to point out certain things which must be considered when installing a circuit for vertical-retrace blanking in a set which does not already have one. One such consideration is the polarity of the required pulse. This choice depends upon the picture-tube element selected for application of the pulse. The cathode requires a positive pulse, and the grid or accelerating anode requires a negative pulse. Another consideration is the voltage source for the pulse. Although most retrace-blanking circuits draw very little power, their loading effects may still be appreciable if they are attached to some frequency-determining circuit such as the vertical oscillator. It is therefore essential that loading effects be considered in the selection of a voltage source for the pulse.

Many of the television set owners will consent to the installation of a vertical-blanking circuit if it is pointed out to them just what effect it has on the picture. This brings up the question of cost for this circuit.

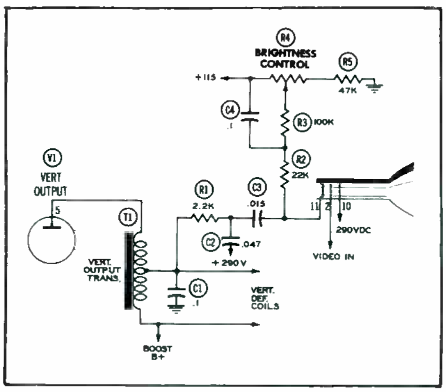


Fig. 6. Blanking Pulse Taken From the Auto-Output Transformer and Fed to the Picture-Tube Cathode.

Fig. 7. ELIM-A-TRACE Used for Eliminating Vertical Retrace.

If the chassis has to be removed for repair, the circuit can be wired in at very little extra cost if one of the simpler circuits is used. However, if the chassis does not have to be removed for some other repair, it will be much less trouble to use one of the accessory units which have recently appeared on the market. An example of these units is the ELIM-A-TRACE (shown in Fig. 7) which is produced by Vidaire Electronics Corp. This unit was designed in the interest of quicker servicing because it does not require the removal of the chassis for installation and may be installed in less than two minutes. For this reason, the time saved more than offsets the extra cost of the unit. The ELIM-A-TRACE has been tested and found to work out satisfactorily in every set in which it has been tried.

The ELIM-A-TRACE is available in two models. Model TE-1 is designed for installation in sets which inject the video into the grid of the picture tube. Model TE-2 is designed for those sets which are cathode driven. This makes it possible to install these units in all sets.

In order to illustrate just how simple it is to install the ELIM-A-TRACE, we are including at this point the installation instructions which are provided with the unit:

1. Shut off the television set.

2. Remove the picture-tube.

3. Install the ELIM-A-TRACE between the picture tube and the socket.

4. Remove the vertical-output tube from its socket, and insert the lug (long wire) from the ELIM-A-TRACE on the plate pin of the tube.

5. Reinsert the tube in its socket.

WARNING: Make sure that the lug (long wire) does not touch any other pin of the tube or the chassis.

6. Connect the lug (short wire) to a convenient point on the chassis.

7. Turn on the television set. If the retrace lines still appear, either

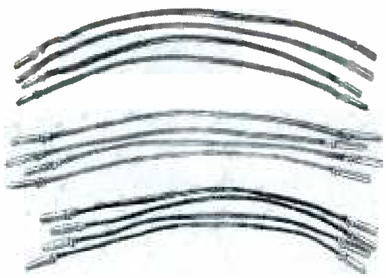


Fig. 8. Jumper Leads for Use When Working on Combinations.

the lug has been connected to the wrong pin of the vertical-output tube or the wrong model of ELIM-A-TRACE has been used.

There are other units on the market which will serve the same purpose as the one being discussed, and they are probably just as easily installed. However, this was the only one that was available locally when we made out tests and is therefore the only one we had the opportunity to try out.

Jumpers

A great deal of time is often lost putting all the jumpers into a TV chassis which has been removed from a combination TV, radio, and phonograph. Most of these sets do require at least one or two jumpers. How do you go about putting in these jumpers? You probably do as most of us do. You reach for the solder and start cutting it up into short lengths; then you bend a piece into a U-shape and plug it in, hoping that it will make fairly good contact. If the piece of solder does not make good contact, you then start the ritual of twisting the solder this way and that. Wouldn't it be much simpler to have jumpers already made up, so that they could be plugged into the socket and produce a positive connection?

Shown in Fig. 8 is a group of jumpers we made by removing the pins from old tube bases and soldering them to six-inch leads. By using the pins from various types of tubes, we obtained jumpers with three different sizes of pins. Different sizes are required for various types of connector sockets.

The small pins that we used came from a discarded 6V6 tube; however, any octal tube would have worked as well. The pins of medium and large size were taken from two 57's, one 75, and one 6D6.

Another advantage of these jumpers is the ease with which they are removed from the chassis when the repair is finished.

Henry A. Carter

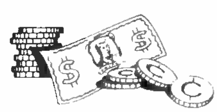
Dollar and Sense Servicing

(Continued from page 31)

ALARM. An ultrasonic burglar alarm using the Doppler principle, wherein reflection of sound from a moving object causes a change in frequency, is manufactured by Alertronic Corp., Long Island City, N.Y. One or more loudspeakers connected to a 19,000-cps oscillator generate a sound wave too high-pitched for normal human ears, so the burglar hears nothing. When everything is motionless in the room, the microphones pick up exactly the same 19,000-cps reflected sounds and nothing happens. When anything moves, the reflected frequency is altered and this frequency change is detected by highly selective filter circuits which trigger the alarm.

Initially, sensitivity was so high that frisking mice would set off the alarm. Instructions for final adjustment of an installation might therefore read thus: Take toy mouse from tool kit, wind up with key provided, let mouse run across room, and reduce sensitivity control step by step until mouse no longer triggers alarm. If cats are likely to stray through room at night, borrow cat somewhere and repeat adjustment. If cat won't cooperate, open can of sardines and make smear trail back and forth across floor.

But we just gotta lift our eyebrows at Time magazine's closing sentence about this alarm: "It lets mice frisk undetected, but their delicate ears can hear its high-pitched sound, and the uproar frightens them so much that they die of a heart attack."



ATOMIC BATTERY. A battery that takes 20 years to drop to half its rated voltage has been developed by RCA engineers and has received plenty of publicity lately, despite the fact that it delivers only a millionth of a watt and costs quite a pile of money. Strontium-90 is used as a radioactive source that bombards a semiconductor crystal wafer with beta rays to cause electron emission. The resulting free electrons flow across the semiconductor junction to produce a voltage. The possibilities are intriguing, but commercial feasibility is still a long way off.

EXECUTIVE. "An executive is good when he can make a smoothly functioning team out of people with the many different skills required in the operation of a modern business," says DuPont's president, C. H. Greenwalt. "His most important function is to reconcile, to coordinate, to compromise and to appraise the various viewpoints and talents under his direction, to the end that each individual contributes his full measure to the business at hand . . . .The more effective an executive, the more his own identity and personality blend into the background of his own organization.

"In earlier days, business units were small and technology was simple; the proprietor of any enterprise could hold all the reins firmly in his own hands. Then we began to require more and more the services of specialists and technicians. Business became increasingly a team effort, in which the contributions of each individual and each group had to be integrated with the contributions of others. In this way, the executive came into being."

The advent of television with its increasing complexity brought the executive into the servicing picture, with precisely the same duties and responsibilities as the head of a big industrial empire. The important thing is that these duties definitely do not include being able to fix TV sets; much as he'd like to, the head of a business should resist the temptation to pick up a soldering gun and should concentrate on ways and means of keeping other hands busy with all the soldering guns. If you've got men working under you and are responsible for their pay checks each week, read the speech quotes over again word by word. They say a lot.

AUCTION. If you've got a business where trade-ins and uncalled-for sets pile up to the point where you can hardly turn around, give a thought to auctioning them off some Saturday afternoon. Set up a mike and a PA system, and line up a few helpers — one as cashier and two more to bring the sets up to you one by one and then take them out to the buyers. If your shop isn't big enough, go behind it on a vacant lot or in a parking lot, because auctions draw crowds. The mike will give you confidence and eliminate need for shouting. Let the first few sets go for a very low price — knock them down even before bidding has stopped. You'll soon have the crowd warmed up to the point where bidding will take care of itself.

Sell the sets on an as-is basis; demonstrate those that work, and admit frankly what the potentialities are for each set in turn. Boys, and even men, like to buy these old sets just for experimenting. Some of these sets may even come back to you as repair jobs; in fact, in auctioning dead sets you might even quote the repair estimate on a few of the simpler jobs to give the crowd the idea that the sets can be fixed.

If you're timid about running the auction yourself and have no limelight-loving friends, consider turning the whole batch over to a professional auctioneer in your locality. His standard fee is 20 per cent of total sales. And he does get good prices; we've seen old, beaten-up, table-model radio sets go for as much as $5 each and prewar consoles for $25 or more when the crowd was in just the right mood. Our conclusion is that at auctions people buy chiefly what they don't need, and that's where you can profit. Even that old tube tester will bring a few bucks from some radio-happy lad.

COMPUTER. This year, GE will demonstrate a production machine that turns out a complete radio set or electronic subassembly from a punched negative. The machine uses an electronic computer to actuate the various punch presses, parts-positioning machines, and dip-soldering machines involved. The engineer merely works up a layout diagram on which dimensions are given from left and top. A girl takes this diagram and converts it into a punched negative on a machine similar to a typewriter. This in turn is placed in a photoelectric or electric reading unit for the computer. Design changes merely involve punching a new negative and making sure that the correct new-parts values are in the bins feeding the parts-placing machines.

First unit in the system already demonstrated controls a Wiedeman turret punch press that puts holes in an etched-wiring plate or a chassis at the exact positions called for, with an accuracy of a thousandth of an inch. The Signal Corps is footing the bill for this research, with the goal of being able to produce small quantities of complex military electronic units in a hurry while making frequent changes in design.

SQUEAKS. Some service shops spend hundreds of dollars giving their counter and workbench that new look, then fail to repair a front door that squeaks or sticks when a customer attempts to get in.

Tomorrow morning, pretend you're a customer as you walk into the shop, and note the things that catch your eye as you step inside to "case the joint." For this test, take the viewpoint of a prospect who rates going to a service technician on a par with going to a dentist. Then get to work. That old calendar, the sun-faded posters in the window, the loose linoleum on the floor, the nicks in the furniture — things like those don't inspire confidence in anyone.

SPLITTER. An unverified report says that nut growers in the Pacific Northwest are considering the use of an electronically controlled 65-kv jolt for shelling filberts. In early experiments, the bolt of man-made lightning neatly separated walnut meats from their shells. The technique is quite plausible, for we actually saw it being used for splitting wood at the Franklin Institute in Philadelphia.

TOO BIG. Out in California, distributors are offering out-of-this-world deals on 24-inch and 27-inch sets to get them moving; but dealers are having little to do with them, according to Howard Emerson in Electrical Merchandising. The public out there is not going for big-ticket TV until it can get sets that glow in all the colors promised. One dealer says "I'm selling top brand but lowest priced models in 21-inch size to many old and new customers who have either the cash or the credit to buy the more expensive $600 to $800 merchandise. They tell me that when color comes they'll have to pay plenty for a set, and they don't want too much sunk into a black-and-white receiver. They know that the 21-inch set can always be used as a second set."

TIP. One of the surest ways to succeed at selling TV sets, radios, or service is to make a real effort to like people who don't appeal to you.

John Markus

PF INDEX

INDEX TO ADVERTISERS
May, 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 –

The March 1954 Issue of the PF INDEX contained an article entitled "Deflection Components for Color TV", by C. P. Oliphant. Included in the writeup were several color component illustrations. An oversight here caused omission of proper credit and identity information on these illustrations.

We hope the following serves to answer questions of our readers and provide suitable acknowledgment to RCA, the very cooperative source for the sample units pictured. Particularly, may we express our thanks to A. G. Petrasek, Manager of Electronic Components Sales for RCA, who went to considerable trouble to help, and who has undoubtedly been on the receiving end of some questions in the matter.

The figure below includes the components covered in the original article. Although they were in developmental status at the time of original preparation, they have since been announced as commercially available products and type numbers assigned them are included in the following description.

Upper Left (A)
Vertical Output Transformer for Color Receivers (RCA Type #243T1)

Upper Right
Purifying Coil, Beam-Positioning Magnets, and Neck-Shield Assembly (RCA Type #224D1)

Second Row Left
Horizontal Dynamic-Convergence and Dynamic-Focus Transformer (RCA Type #242T1)

Second Row Center
Vertical Dynamic-Convergence and Dynamic-Focus Transformer (RCA Type #241T1)

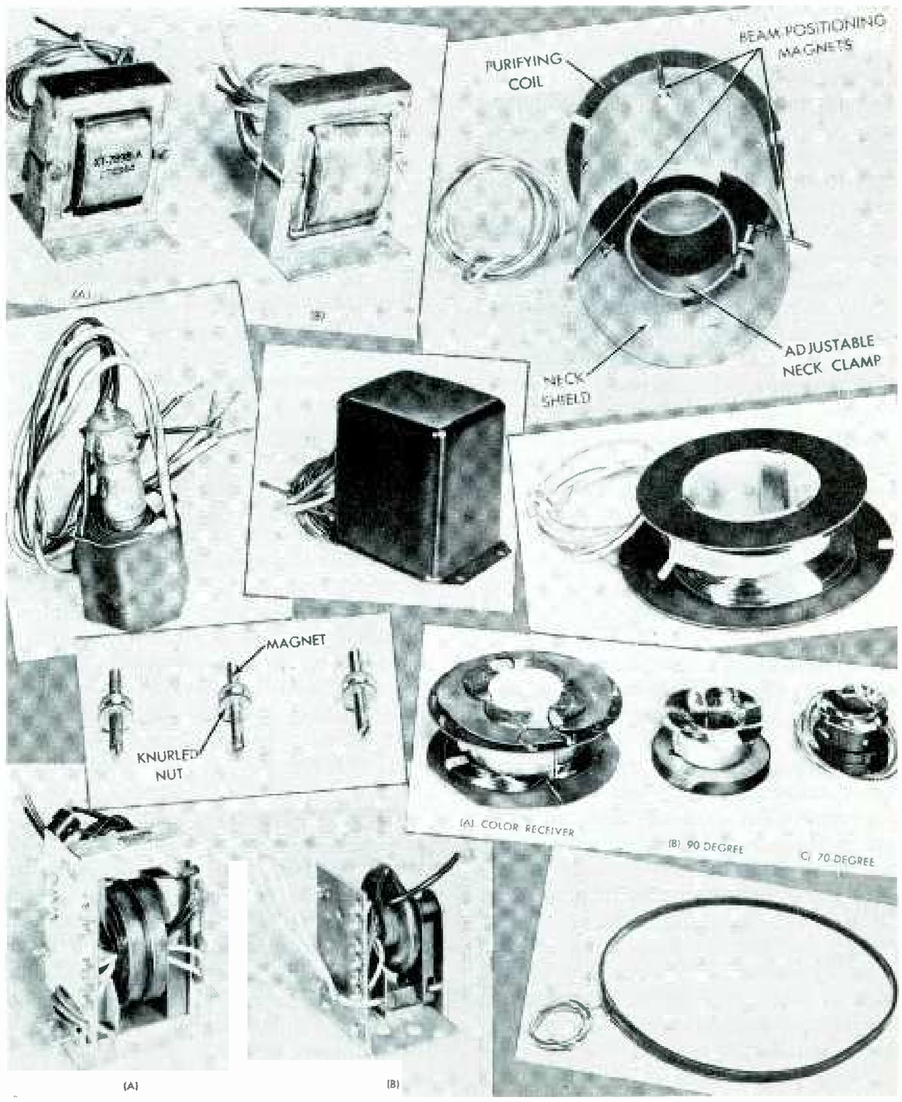
Second Row Right
Purifying Coil (Part of assembly shown at upper right)

Third Row Left
Beam-Positioning Magnets (Also part of assembly at upper right)

Third Row Right
Deflection Yokes for Color and Monochrome Receivers (Color Receiver Unit at "A" RCA Type #223D1)

Lower Left (A)
Horizontal Output-High Voltage Transformer for Color Receiver (RCA Supersedence Type #240T1)

Lower Right
Field-Neutralizing Coil for Color Picture Tube

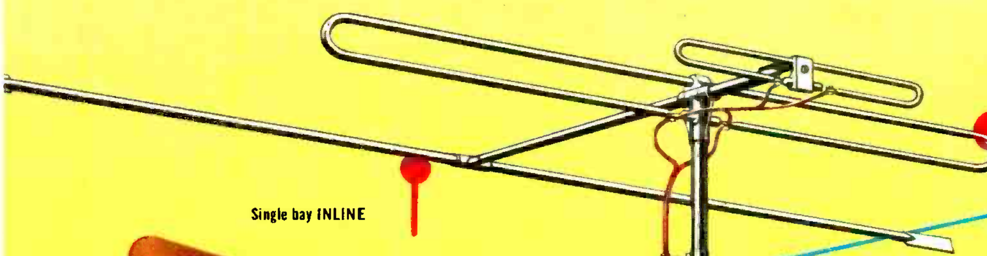


"Color Television Components. All photographs from samples Courtesy of RCA."

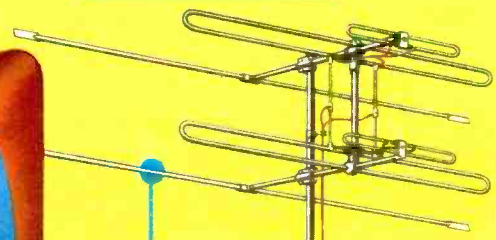
best (black and white) picture quality

with the Amphenol

INLINE *



Black & white or color, the Amphenol INLINE assures the finest audio/video quality on any TV set.



The INLINE color advantages are also available to fringe areas with 2 or 4 bay Stacked Arrays.

... and best for COLOR too!

Set owners have their color television antenna *right now* if they have an Amphenol INLINE! Because the very features that make the INLINE the outstanding buy for black & white television are the same that have been listed as *requirements* for color television!

For *fidelity* color reception the antenna must have these characteristics:

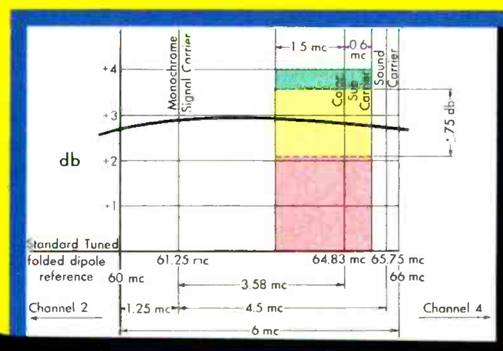
1. Antenna gain must be flat, no gain or loss greater than 1.50 db within 1.5 mc below and 0.6 mc above the color sub-carrier. *The INLINE gain (see charts at right) fully meets this condition.*
2. Antenna gain must be held down across the FM frequencies, 88 mc to 108 mc. *The INLINE gain has been engineered for a sharp cut-off at the end of Channel 6—for rejection of FM signals.*

Gain variation over the color modulation band for each VHF channel should not exceed ±.75 db; the following table gives figures for the INLINE on all channels.

Channel	*Gain Variation/db*	*Channel*	*Gain Variation/db*
2	±0.40	8	±0.08
3	±0.06	9	±0.04
4	±0.12	10	±0.03
5	±0.27	11	±0.20
6	±0.20	12	±0.30
7	±0.20	13	±0.30

Gain chart showing ±0.06 db variation over color modulation band for INLINE, Channel 3

*Reissue U.S. Pat. No. 23,273



AMPHENOL

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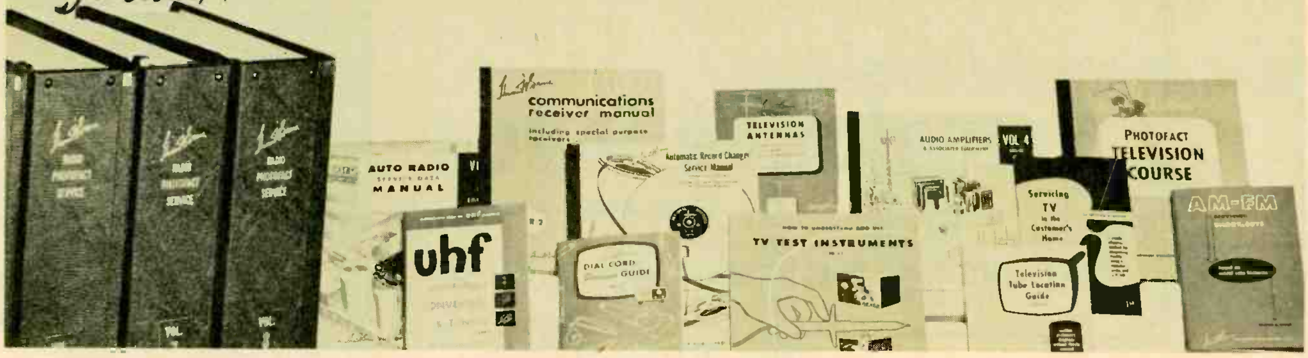

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No. 44 · Covering Folder Sets Nos. 1 through 239 · World's Finest Electronic Service Data

HOW TO USE THIS INDEX

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

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

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

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

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A-T1816, L (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (See PCB 83—Set 224-1 and Model 53-T1824—Set 201-7)
A-T1816 (Code 129) (Ch. 81A, D-81) Tel. Rec. ... 227—10
A-T1817, HM (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (See PCB 83—Set 224-1 and Model 53-T1824—Set 201-7)
A-T1818 (Code 128) (Ch. 91A, J-2) Tel. Rec. (See PCB 66—Set 203-1, PCB 82—Set 223-1 and Model 53-T1853—Set 185-10)
A-T1856, HM, L, W (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (See PCB 83—Set 224-1 and Model 53-T1824—Set 201-7)
A-T1856W (Code 129) (Ch. 81A, D-81) Tel. Rec. ... 227—10
A-T1858 (Code 128) (Ch. 91A, J-2) Tel. Rec. (See PCB 66—Set 203-1, PCB 82—Set 223-1 and Model 53-T1853—Set 185-10)
A-T2230, L (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (See PCB 83—Set 224-1 and Model 53-T1824—Set 201-7)
A-T2230 (Code 129) (Ch. 81A, D-81) Tel. Rec. ... 227—10

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52-T1802 (Code 124) (Ch. 71, G1) Tel. Rec. (Also see PCB 57—Set 191-1) ....179—9
52-T1804 (Code 122) (Ch. 32, C2) Tel. Rec. (See Model 51-T1800—Set 148-13)
52-T1804 (Code 123) (Ch. 37, C2) Tel. Rec. (See Model 51-T1800—Set 148-13)
52-T1808 (Code 121) (Ch. 41, D1, D1A) Tel. Rec. (See PCB 56—Set 190-1 and Model 52-T2106—Set 171-9)
52-T1808 (Code 122) (Ch. 33, C2) Tel. Rec. (See Model 51-T1800—Set 148-13)
52-T1810M (Code 122) (Ch. 33, C2) Tel. Rec. ....148—13
52-T1810L, M (Code 123) (Ch. 37, C2) Tel. Rec. ....148—13
52-T1812 (Code 122) (Ch. 33, C2) Tel. Rec. ....148—13
52-T1812 (Code 123) (Ch. 37, C2) Tel. Rec. ....148—13
52-T1820 (Code 121) (Ch. 41, D1, D1A) Tel. Rec. (See PCB 56—Set 190-1 and Model 52-T2106—Set 171-9)
52-T1821, 52-T1822 (Code 124) (Ch. 71 G1) Tel. Rec. (Also see PCB 57—Set 191-1) ....179—9
52-T1831 (Code 122) (Ch. 33, C2) Tel. Rec. (See Model 51-T1800—Set 148 13)
52-T1839 (Code 121) (Ch. 41, D1, D1A) Tel. Rec. (See PCB 56—Set 190-1 and Model 52-T2106—Set 171-9)
52-T1839 (Code 122) (Ch. 33, C2) Tel. Rec. (See Model 51-T1800—Set 148 13)
52-T1839 (Code 123) (Ch. 37, C2) Tel. Rec. (See Model 51-T1800—Set 148-13)
52-T1840 (Code 121) (Ch. 41, D1, D1A) Tel. Rec. (See PCB 56—Set 190-1 and Model 52-T2106—Set 171-9)
52-T1840 (Code 122) (Ch. 33, C2) Tel. Rec. ....148—13
52-T1840 (Code 123) (Ch. 37, C2) Tel. Rec. ....148—13
52-T1841L (Code 121) (Ch. 41, D1, D1A) Tel. Rec. (See PCB 56—Set 190-1 and Model 52-T2106—Set 171-9)
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. 3P2, 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 191-1) ....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

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52-T2150, W, 52-T2151, L (Code 124) (Ch. 71, G1) Tel. Rec. (Also see PCB 57—Set 191-1) ....179—9
52-T2151 (Code 121) (Ch. 41, D1, D1A) Tel. Rec. (See PCB 56—Set 190-1 and Model 52-T2106—Set 171-9)
52-T2157 (Code 125) (Ch. 42, G2) Tel. Rec. ....186—10
52-T2175 (Code 124) (Ch. 35, F-2 and Radio Ch. RT-6) Tel. Rec. (For TV Ch. see Model 51-T2102—Set 132-10, for Radio Ch. see Set 159-2A)
52-T2176 (Code 124) (Ch. 35, F-2 and Radio Ch. RT-6) Tel. Rec. (For TV Ch. see Model 51-T2102—Set 132-10, for Radio Ch. see Set 159-2A)
52-T2182 (Code 121) (Ch. 44, D-4, D-4A and Radio Ch. RT-6) (For TV Ch. see PCB 57—Set 191-1 and Set 181-9, for Radio Ch. see Set 159-2A)
52-T2224 (Code 121) (Ch. 41, D1, D-A) Tel. Rec. (See PCB 56—Set 190-1 and Model 52-T2106—Set 171-9)
52-T2244 (Code 121) (Ch. 41, D1, D1A) Tel. Rec. (Also see PCB 56—Set 190-1)
52-T2245 (Code 121) (Ch. 44, D4, D4A) Tel. Rec. (Also see PCB 57—Set 191-1) ....181—9
52-T2252 (Code 121) (Ch. 41, D1, D1A) Tel. Rec. (See PCB 57—Set 191-1) ....181—9
52-T2252 (Code 124) (Ch. 71, G1) Tel. Rec. (Also see PCB 57—Set 191-1) ....179—9
52-T2253 (Code 121) (Ch. 44, D4, D4A) Tel. Rec. (Also see PCB 57—Set 191-1) ....181—9
52-T2254 (Code 121) (Ch. 41, D1, D1A) Tel. Rec. (See PCB 56—Set 190-1 and Model 52-T2106—Set 171-9)
52-T2256 (Code 121) (Ch. 41, D1, D1A) Tel. Rec. (See PCB 57—Set 191-1 and Model 52-T2106—Set 171-9)
52-T2258 (Code 121) (Ch. 41, D1, D1A) Tel. Rec. (See PCB 56—Set 190-1 and Model 52-T2106—Set 171-9)
52-T2259 (Code 121) (Ch. 41, D1, D1A) Tel. Rec. (See PCB 56—Set 190-1 and Model 52-T2106—Set 171-9)
52-T2282, 52-T2283 (Code 121) (Ch. 44, D-4, D-4A and Radio Ch. RT-6) (For TV Ch. see PCB 57—Set 191-1 and Set 181-9, for Radio Ch. see Set 159-2A)
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53-T1824 (Code 124) (Ch. 71, G1) Tel. Rec. (Also see PCB 57—Set 191-1) ....179—9
53-T1825 (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (Also see PCB 83—Set 224-1) ....201—7
53-T1825 (Code 124) (Ch. 71, G1) Tel. Rec. (Also see PCB 57—Set 191-1) ....179—9
53-T1826 (Code 123) (Ch 81, H-1, H-1A) Tel. Rec. (Also see PCB 83—Set 224-1) ....201—7
53-T1826 (Code 124) (Ch. 71, G1) Tel. Rec. (Also see PCB 57—Set 191-1) ....179—9
53-T1827, -F, -HM (Code 126) (Ch. 91, J-1) Tel. Rec. (See PCB 66—Set 203-1 and Model 53-T1853—Set 185-10)
53-T1827, -F, -HM (Code 128) (Ch. 91, J-2) Tel. Rec. (See PCB 66—Set 203-1, PCB 82—Set 223-1 and Model 53-T1853—Set 185-10)
53-T1852 (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (Also See PCB 83—Set 224-1) ....201—7
53-T1852 (Code 124) (Ch. 71, G-1) Tel. Rec. (See PCB 57—Set 191-1 and Model 52-T1802—Set 179-9)
53-T1852F (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (Also See PCB 83—Set 224-1) ....201—7
53-T1852HM (Code 123) (Ch. 81, H-1) Tel. Rec. (See Model 53-T1824—Set 201-7)
53-T1852L (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (Also See PCB 83—Set 224-1) ....201—7
53-T1852L (Code 124) (Ch. 71, G-1) Tel. Rec. (See PCB 57—Set 191-1 and Model 52-T1802—Set 179-9)
53-T1853, L (Code 126) (Ch. 91, J1) Tel. Rec. (Also see PCB 66—Set 203-1) ....185—10
53-T1853, L (Code 128) (Ch. 91, J-2) Tel. Rec. (See PCB 66—Set 203-1, PCB 82—Set 223-1 and Model 53-T1853—Set 185-10)
53-T1854, L (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (Also see PCB 83—Set 224-1) ....201—7
53-T1883 (Code 125) (Ch. 44, G4) Tel. Rec. ....196—11
53-T1884 (Code 125) (Ch. 44, G-4 and Radio Ch. RT-9) Tel. Rec. (TV Ch. Only) ....196—11
53-T1886, L (Code 125) (Ch. 44, G-4 and Radio Ch. RT-9) Tel. Rec. (TV Ch. Only) ....196—11

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53-T2124, L (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (Also see PCB 83—Set 224-1) ....201—7
53-T2125, L (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (Also see PCB 83—Set 224-1) ....201—7
53-T2125, L (Code 124) (Ch. 71, G1) Tel. Rec. (See PCB 57—Set 191-1 and Model 52-T1802—Set 179-9)
53-T 2126 (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (Also see PCB 83—Set 224-1) ....201—7
53-T2126 (Code 125) (Ch. 42, G2) Tel. Rec. ....186—10
53-T2127 (Code 126) (Ch. 91, J1) Tel. Rec. (Also see PCB 66—Set 203-1) ....185—10
53-T2152, L (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (Also see PCB 83—Set 224-1) ....201—7
53-T2152, L (Code 124) (Ch. 71, G1) Tel. Rec. (See PCB 57—Set 191-1 and Model 52-T1802—Set 179-9)
53-T2183 (Code 125) (Ch. 44, G-4 and Radio Ch. RT-9) Tel. Rec. (TV Ch. only) ....196—11
53-T2225, L (Codes 123 and 133) (Ch. 81, H-1, H-1A) Tel. Rec. (Also see PCB 83—Set 224-1) ....201—7
53-T2226 (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (Also see PCB 83—Set 224-1) ....201—7
53-T2227 (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (Also see PCB 83—Set 224-1) ....201—7
53-T2228 (Code 126) (Ch. 91, J1) Tel. Rec. ....185—10
53-T2228 (Code 128) (Ch. 91, J-2) Tel. Rec. (See PCB 66—Set 203-1, PCB 82—Set 223-1 and Model 53-T1853—Set 185-10)
53-T2255 (Code 133) (Ch. 81, H1) Tel. Rec. ....201—7
53-T2260 (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (Also see PCB 83—Set 224-1) ....201—7
53-T2260 (Code 125) (Ch. 42, G2) Tel. Rec. ....186—10
53-T2262 (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (Also see PCB 83—Set 224-1) ....201—7
53-T2262 (Code 125) (Ch. 42, G2) Tel. Rec. ....186—10
53-T2264 (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (Also see PCB 83—Set 224-1) ....201—7
53-T2264 (Code 125) (Ch. 42, G2) Tel. Rec. ....186—10
53-T2266, L (Code 126) (Ch. 91, J-1) Tel. Rec. (Also see PCB 66—Set 203-1) ....185—10
53-T2266, L (Code 128) (Ch. 91, J-2) Tel. Rec. (See PCB 66—Set 203-1, PCB 82—Set 223-1 and Model 53-T1853—Set 185-10)
53-T2268 (Code 126) (Ch. 91, J1) Tel. Rec. (Also see PCB 66—Set 203-1) ....185—10
53-T2269 (Code 126) (Ch. 91, J1) Tel. Rec. (Also see PCB 66—Set 203-1) ....185—10
53-T2269 (Code 128) (Ch. 91, J-2) Tel. Rec. (See PCB 66—Set 203-1, PCB 82—Set 223-1 and Model 53-T1853—Set 185-10)
53-2270 (Code 126) (Ch. 91, J1) Tel. Rec. (Also see PCB 66—Set 203-1) ....185—10
53-T2270 (Code 128) (Ch. 91, J-2) Tel. Rec. (See PCB 66—Set 203-1, PCB 82—Set 223-1 and Model 53-T1853—Set 185-10)
53-T2271 (Code 126) (Ch. 91, J1) Tel. Rec. (Also see PCB 66—Set 203-1) ....185—10
53-T2271 (Code 128) (Ch. 91, J-2) Tel. Rec. (See PCB 66—Set 203-1, PCB 82—Set 223-1 and Model 53-T1853—Set 185-10)
53-T2272, L (Code 123) (Ch. 81, H1) Tel. Rec. ....201—7
53-T2273 C, M (Code 126) (Ch. 91, J1) Tel. Rec. (Also see PCB 66—Set 203-1) ....185—10
53-T2273, C (Code 128) (Ch. 91, J-2) Tel. Rec. (See PCB 66—Set 203-1, PCB 82—Set 223-1 and Model 53-T1853—Set 185-10)
53-T2274 (Code 123) (Ch. 81, H-1, H-1A) Tel. Rec. (Also see PCB 83—Set 224-1) ....201—7
53-T2285, L (Code 126) (Ch. 94, J-4 and Radio Ch. RT-8) Tel. Rec. ....213—5
53-T2285, L (Code 128) (Ch. 94, J-5 and Radio Ch. RT-8) Tel. Rec. (See PCB 85—Set 226-1 and Model 53-T2285—Set 213-5)
53-T2285S (Code 126) (Ch. 94A, J-4 and Radio Ch. RT-8) (See Model 53-T2285—Set 213-5)
53-T2285S (Code 128) (Ch. 94, J-5 and Radio Ch. RT-8) Tel. Rec. (See PCB 85—Set 226-1 and Model 53-T2285—Set 213-5)
53-T2286 (Code 126) (Ch. 94, J-4 and Radio Ch. RT-8) Tel. Rec. ....213—5
53-T2287 (Code 126) (Ch. 94, J-4 and Radio Ch. RT-11) Tel. Rec. (TV Ch. only) ....213—5
53-T2287 (Code 128) (Ch. 94, J-5 and Radio Ch. RT-11) Tel. Rec. (For TV Ch. See PCB 85—Set 226-1 and Model 53-T2285—Set 213-5)
53-U1827, HM (Code 126) (Ch. 91, J-1) Tel. Rec. (See PCB 66—Set 203-1, PCB 82—Set 223-1 and Model 53-T1853—Set 185-10)
53-U1827 (Code 128) (Ch. 91, J-2) Tel. Rec. (See PCB 66—Set 203-1, PCB 82—Set 223-1 and Model 53-T1853—Set 185-10)

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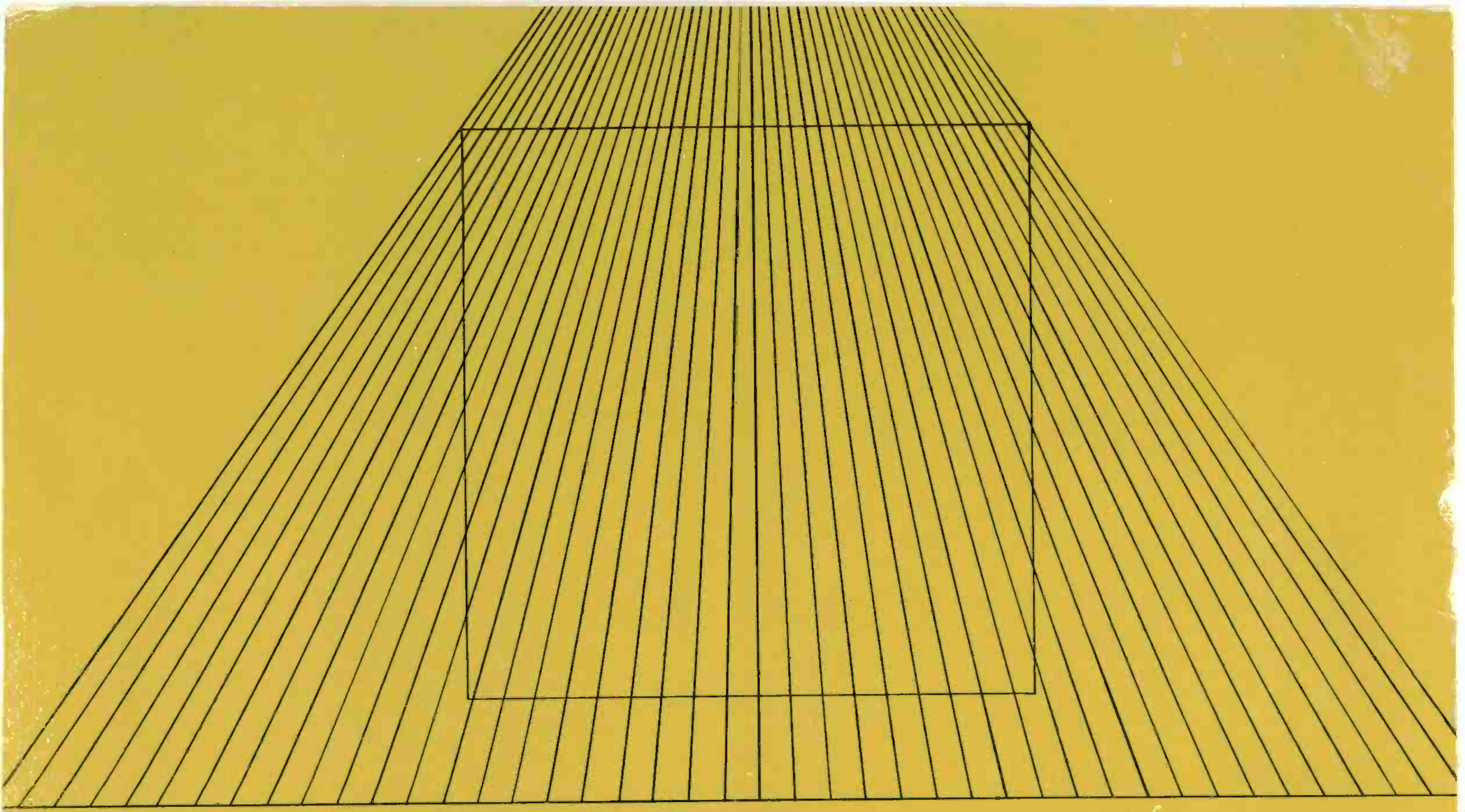

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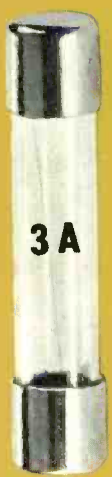

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