Howard W. Sams

PF REPORTER

for the Electronic Service Industry

JULY • 1956
25 CENTS

QUICKER SERVICING
Summer Servicing

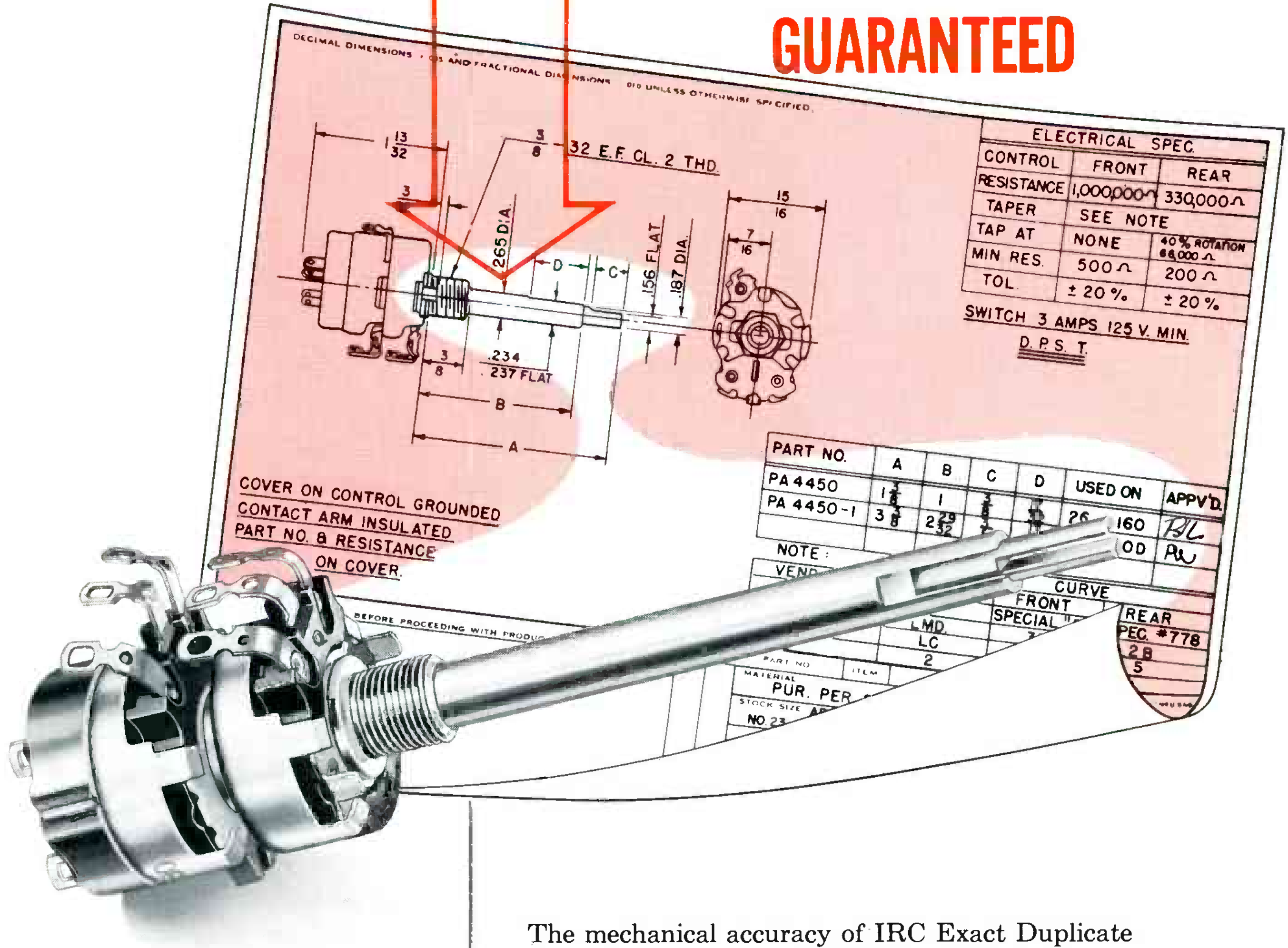
• • •

SHOP TALK
Auto Radio

• • •

AUDIO FACTS
Feedback in Amplifiers

HERE'S WHY IRC EXACT DUPLICATES ARE DOUBLE-MONEY-BACK GUARANTEED



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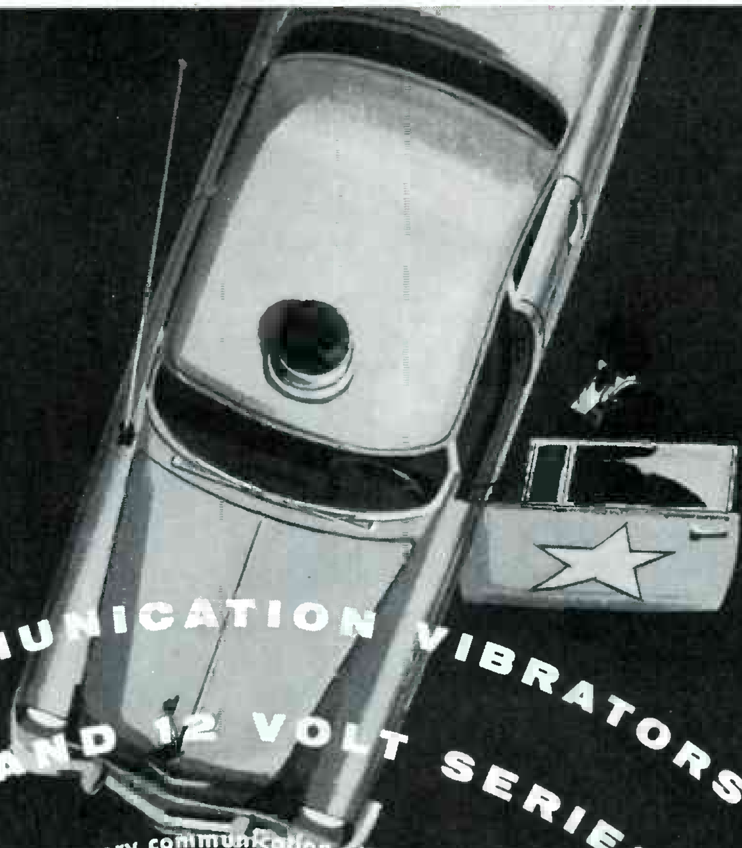

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★	5722	6722
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5620	5820	6820
5621	5821	6821
5622	5822	6822
★	5824	6824

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for the Electronic Service Industry

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ABOUT THE COVER

(Specially posed photograph)

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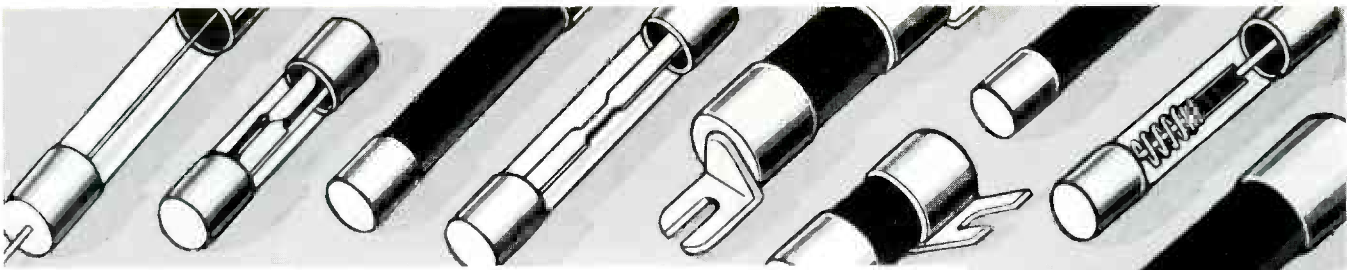

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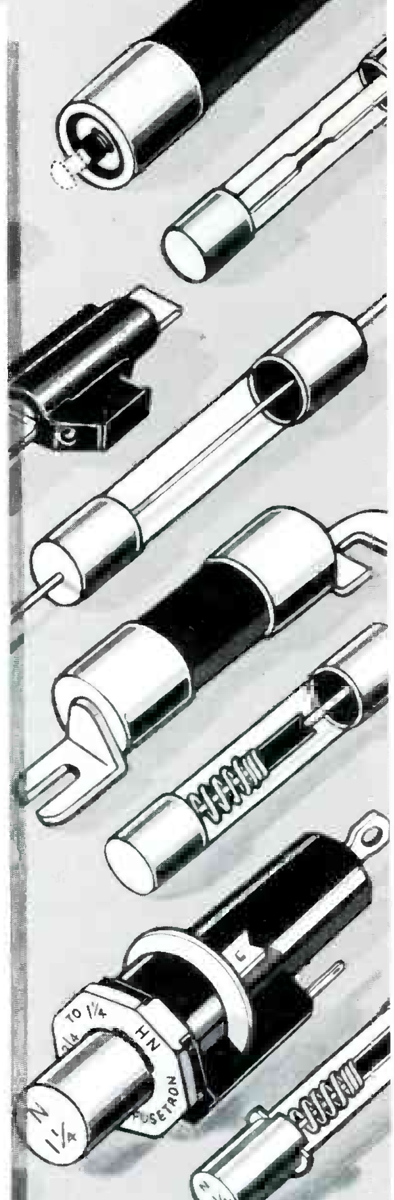

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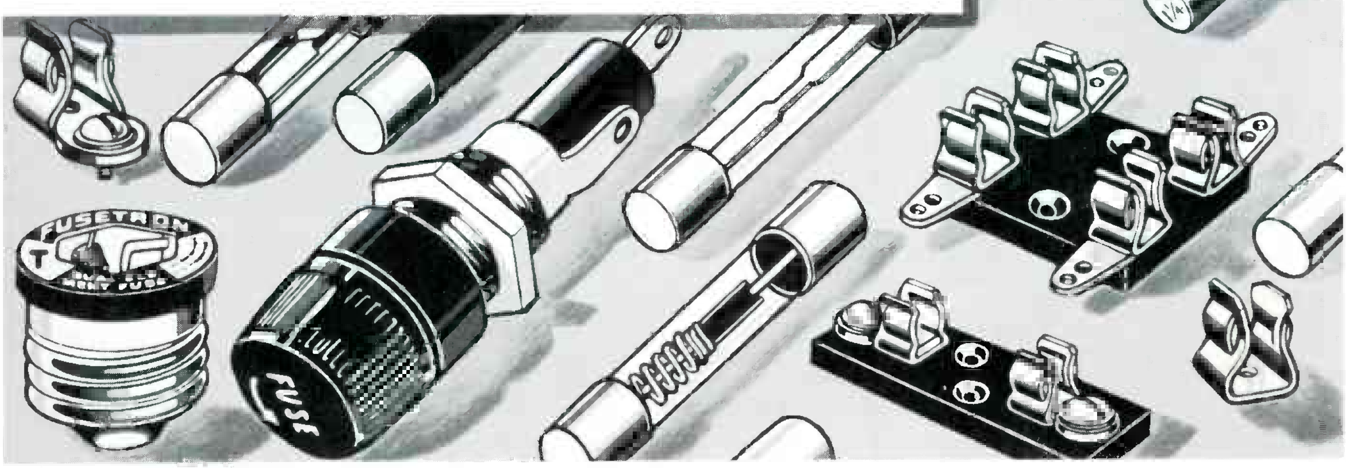

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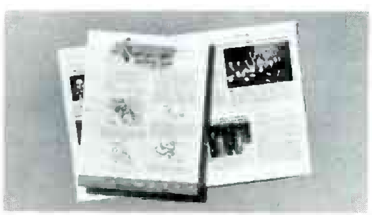

LATEST SERVICE INFORMATION—The "Testing Tips" bulletin is another Delco service to the electronics industry. This handy information sheet keeps you up to date on parts revisions and common service problems—besides keeping you posted on interesting current events in the electronics industry.

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LETTERS to the EDITOR

Dear Editor:

As a suggestion, why couldn't you people compile a complete book on TV troubles—something similar to the series of articles which Leslie D. Deane and Calvin C. Young, Jr., have in the *PF REPORTER?* . . . I believe this would help a service man to the *n*th degree, and I believe you could sell many copies. There are a few [such books] on the market I understand, but they are nothing like you are running in the *PF REPORTER*.

W. E. Gloeb,
The Gloeb's
Fort Crook, Nebraska

* * *

The series of articles to which Mr. Gloeb refers have been compiled, and a Sams book based on the articles will soon be available from your parts distributor.—Editor

Dear Editor:

I wish to take this time to tell you how much I think of your publication, the *PF REPORTER*, and all the wonderful information compiled in your magazine. . . . I am more than satisfied since subscribing to the *PF REPORTER*.

Sherman N. Ross,
Ross Electronics
Danville, Illinois

Dear Editor:

It is not clear to me (in the article "Time Constants" in the March 1956 issue) how the writer develops a positive pulse from the trailing edge of a serration. Any positive-going square wave being differentiated develops a positive pulse from its rising or leading edge.

Tell me please if I missed something in reading this article.

Maxim Tzytovitch
San Francisco 21, California

* * *

Mr. Tzytovitch is correct. A positive-going square wave which is being differentiated develops a positive pulse at its leading edge; however, the make-up of the sync signal is such that the serrations (the narrow notches) in the vertical pulse may be considered as negative-going square waves. The positive-going trailing edge of each serration would cause a positive spike to be developed.—Editor

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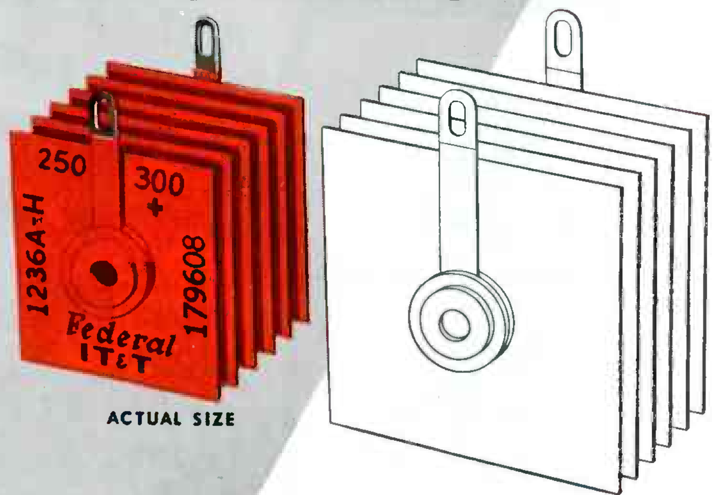

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Shop Talk

MILTON S. KIVER

Author of . . .
How to Understand and Use TV Test Instruments and Analyzing and Tracing TV Circuits

AN AUTO RECEIVER WITH A TRANSISTOR OUTPUT STAGE

Transistors are a foremost consideration in every new electronic device and particularly so when the design is directed toward mobile or portable equipment; however, even though transistors appear to be a "natural" for such applications, there are certain disadvantages that stand in the way of their exclusive use. These include frequency response (particularly in the RF and IF stages), gain at the higher frequencies, and cost. Until the transistor is able to compete successfully with vacuum tubes in all these respects, we will probably see combinations of tubes and transistors being used.

One such arrangement is employed in a recent auto receiver developed by Motorola. A glance at the schematic diagram in Fig. 1 reveals that there are a considerable number of unusual features, not the least of which is the fact that the B+ voltage for each of the tubes is obtained directly from the car battery! There is no vibrator, power transformer, nor power rectifier in the receiver.

Plate Voltages of Only 12 Volts

"How is this possible?" you may ask. It is made possible by the development of tubes which operate satisfactorily with B+ voltages of approximately 10 to 12 volts. According to a letter from one of the commercial engineers of Tung-Sol Electric Inc., (the company that was instrumental in developing these tubes in conjunction with Motorola), most of these tubes are not new in their design or basic principles. Except for the 12K5, they are older types which have been re-evaluated and rerated for 12-volt operation. For instance, the 12AC6 is fundamentally the existing type 12BD6 rerated, the 12AD6 is a slightly modified type 12BE6, and the 12F8 is essentially the type 12CR6 with the addition of one diode.

The rerating of the older types has been accompanied by modifications which have appeared necessary. For example, the elements have been positioned closer together and each control grid has been formed with a greater number of turns. Furthermore, every tube has been made with selected materials and modified methods of processing in order that stability of contact potential over the wide excursion of heater voltage will be achieved. (The voltage of a 12-volt car battery may range anywhere from 10.5 to 16.0 volts during the course of operation. These new tubes must be capable of coping with such variations; otherwise, receiver behavior will be erratic.) When we employ a B+ potential of one hundred or more volts, a small change in cathode-to-grid contact potential will have only a slight effect upon the operating point of a tube; but at a B+ potential of 12 volts, the same change can alter circuit operation markedly. It becomes highly important, therefore, to stabilize this contact potential so that any variations that do occur will be limited in range.

The characteristic curves and operating data for these tubes offer some important clues as to their applications. For example, the pentode section of the 12F8 passes a plate current of 1.0 milliampere and a screen-grid current of .38 milliampere when both the plate and screen elements are operated at 12.6 volts. These currents are about one tenth or less of the normal currents found in conventional pentodes operated at higher voltages. One result is a lowered transconductance.

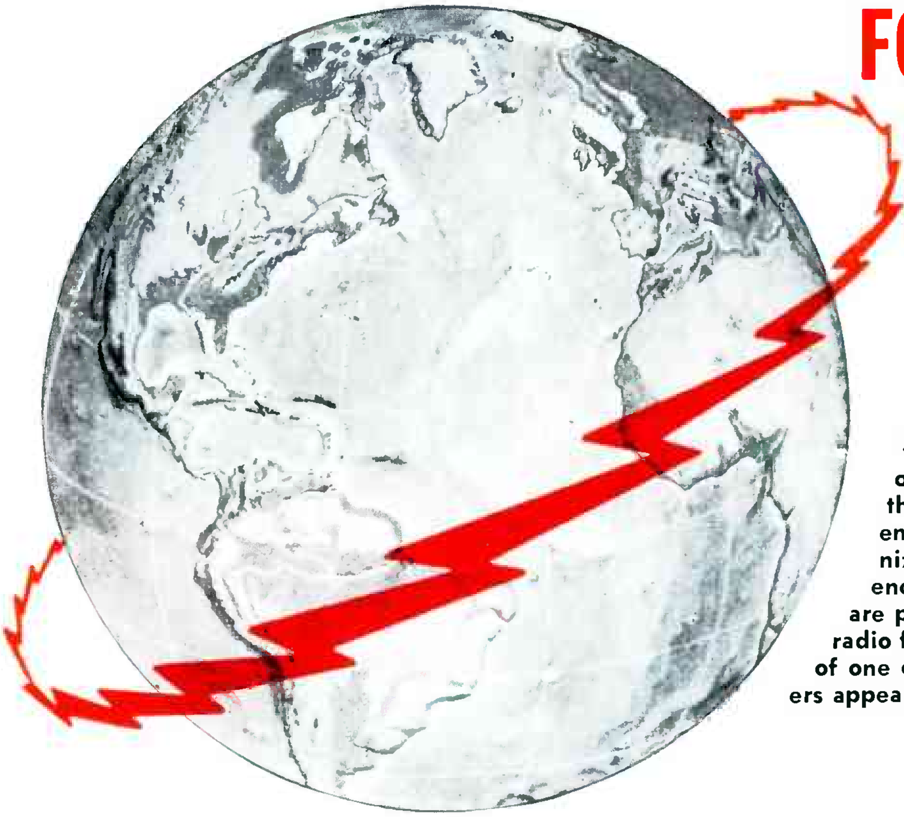
Another effect of these lower operating voltages is clearly reflected in the characteristic curves. For example, in the E_pI_p curves of Fig. 2, the plate current becomes independent of plate voltage at about 20 volts or less, depending on the value of control-grid bias. In the E_gI_p curves of Fig. 3, the extent of the linear portion of the curve in the negative grid region is restricted, being scarcely more than 1 volt wide. Beyond -1 volt, the characteristic curve drops sharply and is essentially at cutoff at -3 volts. The use of these tubes must be more or less limited to those stages of a receiver in which the signal level is low. This does not necessarily need to be a disadvantage, since power transistors can be used in the audio stages in which the signal level becomes relatively high. This is in line with the designed purpose of these tubes—to operate in those stages where they can outperform transistors both in frequency response and in cost.

Incidentally, the low ratings for plate and screen currents in the new tubes may lead to shortened tube life if the tubes are tested in

• *Please turn to page 39*

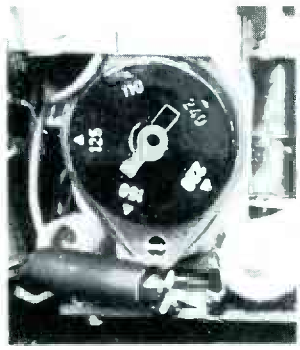
Let's Take a Look at Some Components in

FOREIGN-MADE RADIOS



by C. P. Oliphant

A large number of the components used in foreign-made receivers differ in appearance from those used in our receivers. In order to familiarize the reader with some of these differences so that he will be able to recognize these components if and when he encounters them, the following pictures are presented. We used the TELEFUNKEN radio for these pictures because it is typical of one of the types of foreign-made receivers appearing on our national market.



Line-Voltage Switch

The power-line voltages used in the different parts of Europe have many different values. This switch permits the use of any of them.

Battery

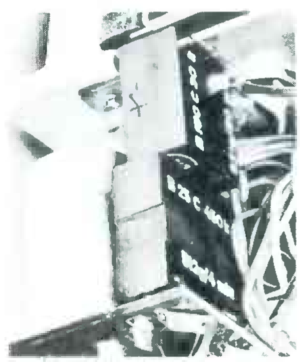
A nickel-cadmium battery is used for the filament supply when the receiver is being used as a portable. A circuit is included in the receiver to charge this battery.

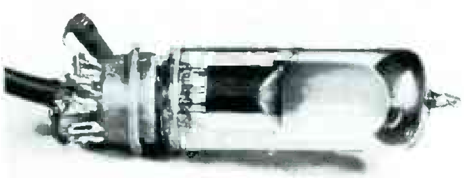
Rectifier Can

Four selenium rectifiers which are part of the power supply are housed in this unit that resembles an electrolytic capacitor can.

Diodes

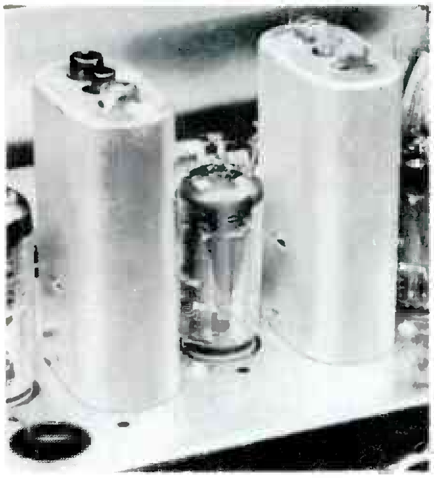
These are two germanium diodes. Notice the physical size and shape and the symbol for the crystal.





Tuning-Eye Tube

A tube provides for visual tuning of the receiver. The tuning eye shows through the side instead of the top of the tube.

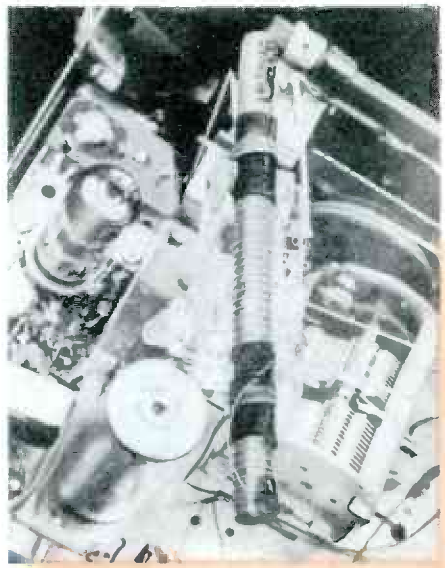


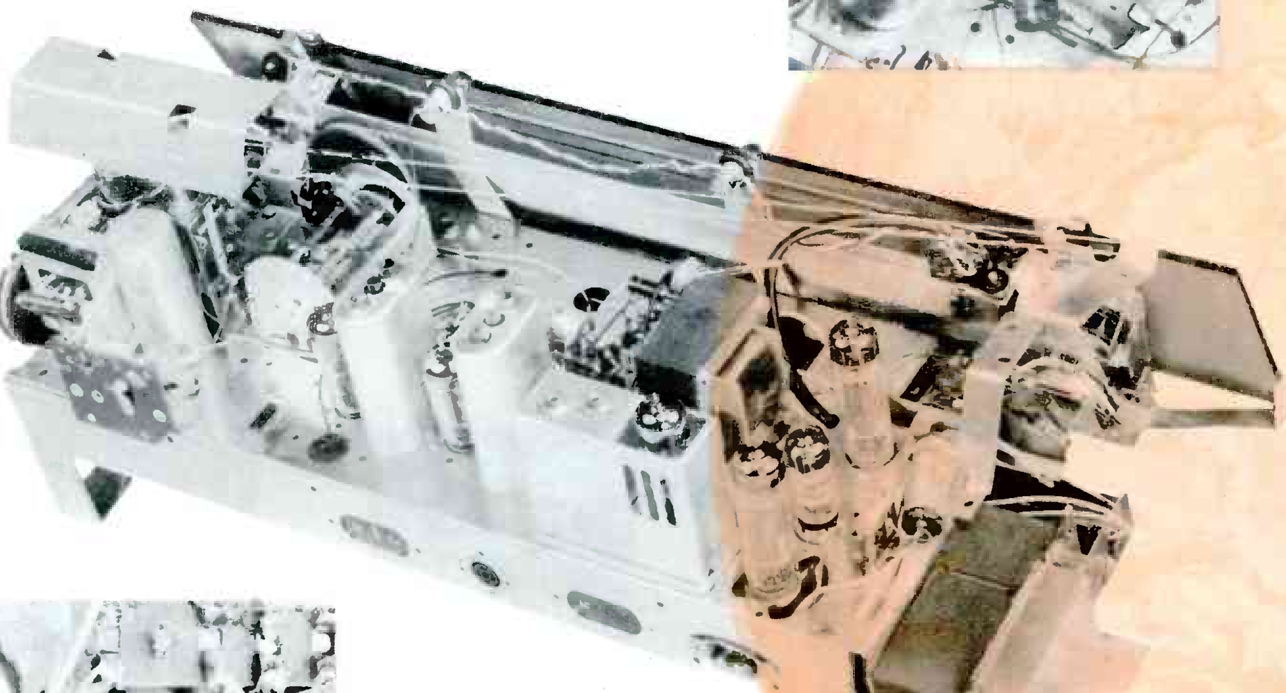
IF Cans and Tubes

Pictured here is the IF section. Notice the appearance of the transformer cans.

Antenna

The unique feature of this antenna assembly is that it can be rotated by turning a knob on the front panel. A ferrite core is used in the coil.





Molded Capacitor

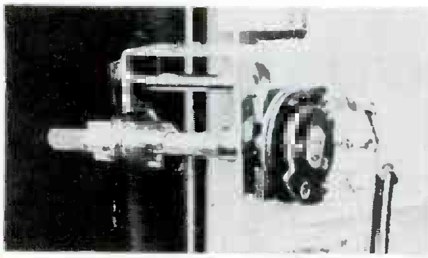
This is a molded capacitor with a rating of 2,200 pf (micromicrofarads) at 500 volts. The case appears to be made of Bakelite or a similar material.

Toroidal Coil

The toroidal coil is used a great deal in industrial electronics in our country, but so far it has not been used in our radio or television receivers.

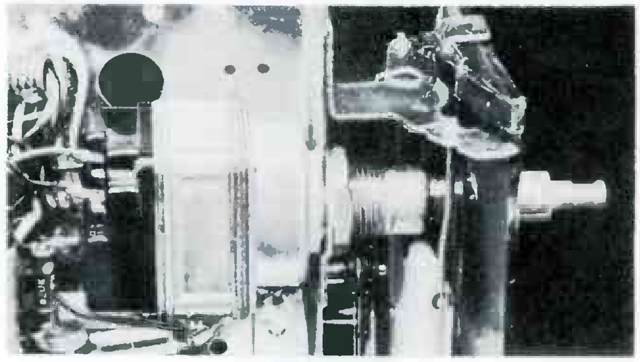
Fuse

This is a ceramic-cased fuse which has a rating of .8 ampere. It is a miniature fuse 13/16 inch long and .202 inch in diameter.



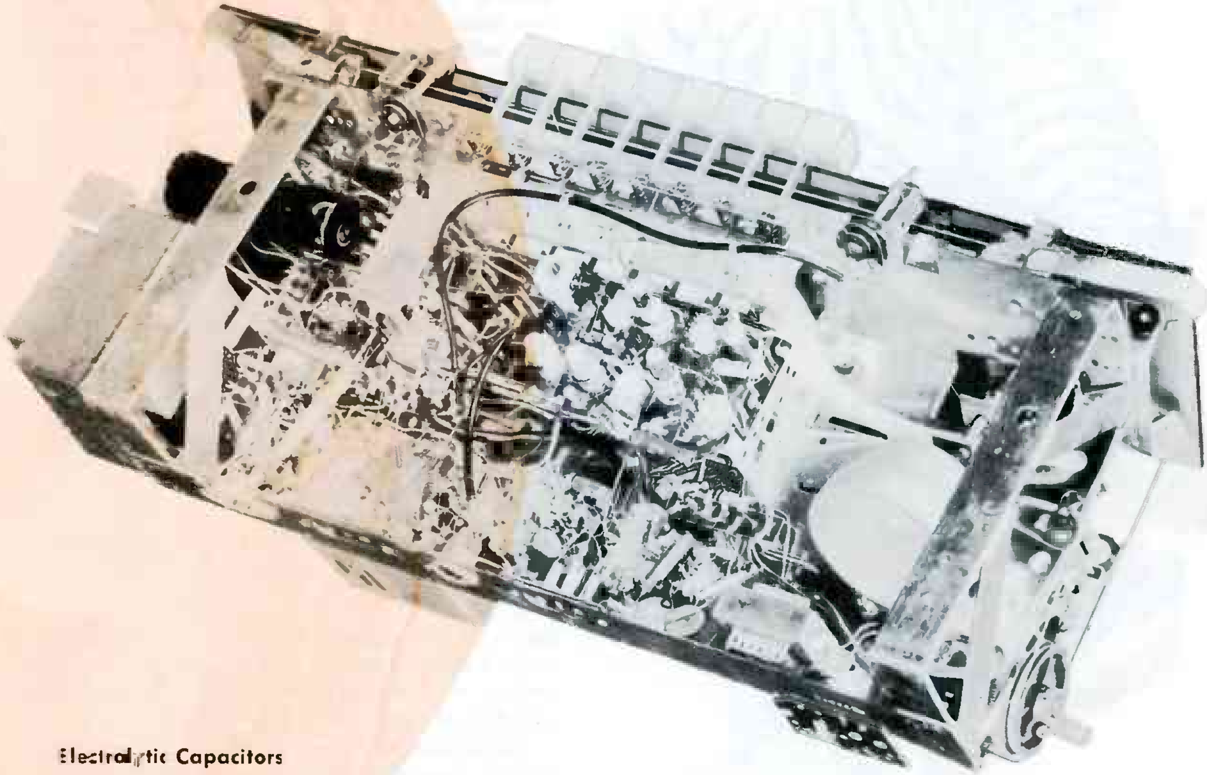
Potentiometer

This potentiometer is used as a tone control. Notice the absence of a cover.



Sealed Controls

This unit comprises the ON-OFF switch, volume control, and tone control. It is rather large in physical size and appears to be hermetically sealed.



Electrolytic Capacitors

One of these electrolytic capacitors has a rating of 2 mfd at 350 volts and the other has a rating of 100 mfd at 15 volts. Notice their unique shape.

Polystyrene Capacitor

This capacitor has a dielectric of polystyrene. Its rating is 1,500 pf (micromicrofarads) at 125 volts. It has a tolerance of 10 per cent.

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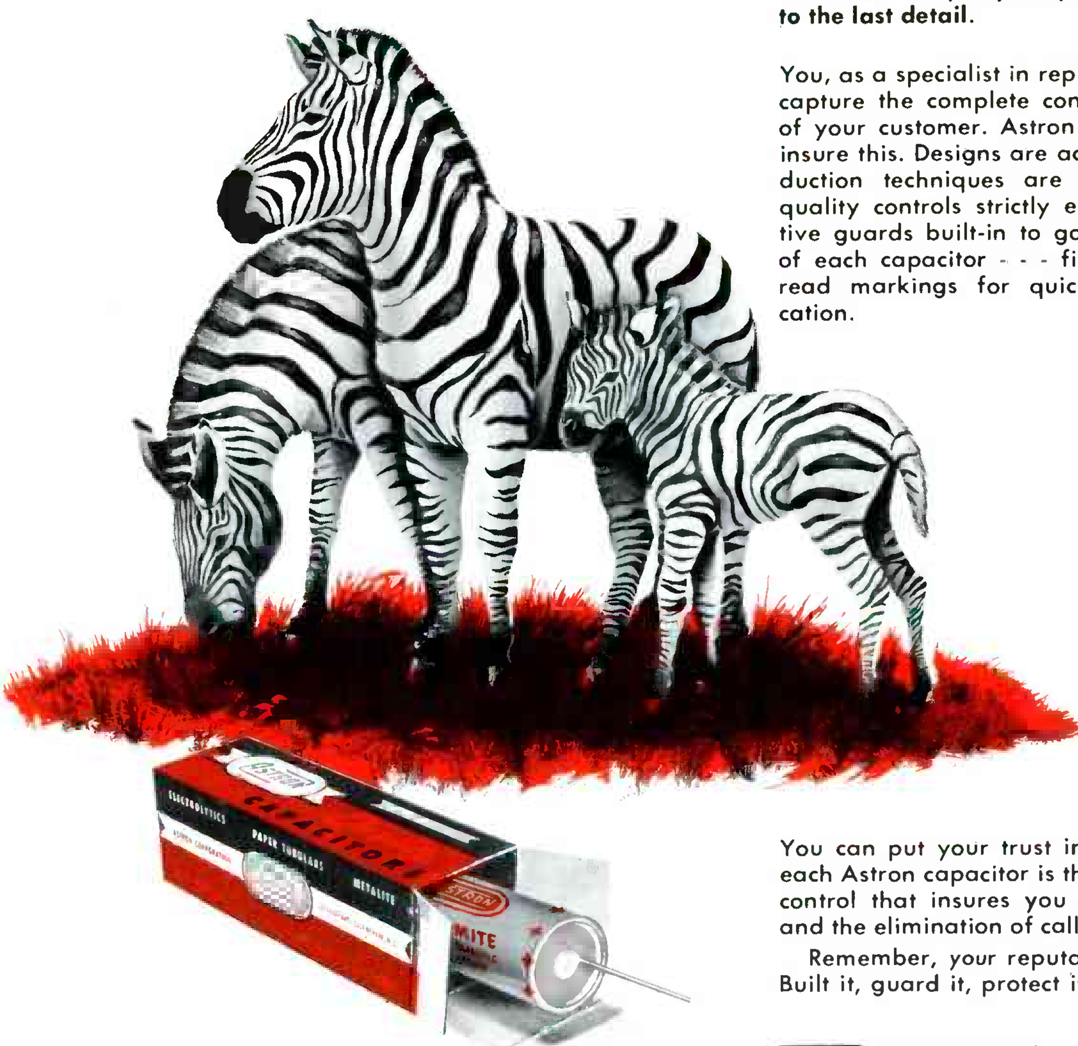

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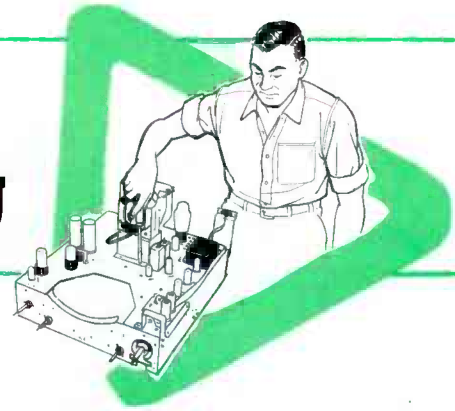


by **Calvin C. Young, Jr.**

Summer Business Slump

Warm weather brings complaints from many service-shop owners that business is poor. The biggest reason for this seasonal business slump is that people do not stay inside to watch television as much during the warmer months and that consequently the television receivers do not fail as often. Portable radios and auto radios are in use more during the summer, and service work on these units can be expected to increase and to counteract the slump in television servicing.

Many shops specialize in television service because the shop owner may feel that he cannot afford to waste time on radios. This condition sometimes makes it difficult for the potential customer to locate a shop which will repair his radio. Owners of phonographs, recorders, and auto radios also have this difficulty.

If a shop actively campaigns for service work on phonographs, recorders, radios, and auto radios, the lull in the number of requests for television service work can be offset by an increase in work on these other units. It would be well to point out that there are more than three times as many radio receivers as there are television receivers in use in this country. This large number of radios (125 million plus), along with recorders, phonographs, and other electronic devices create a large potential servicing market.

One good way to obtain radios, phonographs, and recorders for servicing is to inform the customer on each television service call that you are equipped to service the other units as well. Your business could be increased all year long if you asked the customer on each television service call whether he has any radios or other electronic devices that need repairing and if you remind him to think of you for future servicing of these devices.

Direct-mail advertising to your regular customers could stress radio, phonograph, and recorder servicing and should bring a rewarding amount of service work to be done.

Spot commercials on radio and TV are other successful methods which could be used to promote radio or any other type of servicing. The use of attractive window displays that emphasize radio repair is another method of bringing to the attention of the public the fact that you are ready to service these units.

Adding Radio Servicing to Your Business

If you are planning to include the servicing of radios and other types of small electronic or electrical devices in your business operation or if you are already doing radio servicing, it is a good practice to have a separate bench equipped with the proper tools, equipment, and parts for these repairs. This would make it possible to repair these devices in the least possible time without interference with television servicing operations.

Tools and Equipment

An RF signal generator with a built-in 400- or 1,000-cycle tone generator and a VTVM are about the only pieces of test equipment required for radio servicing. The RF signal generator should have provisions so that the audio signal could be used to check the operation of the audio stages in a radio or other device. The same tube tester that is used to test television tubes can be used to test radio tubes. If you do not have a tube tester, it would be a good idea to get one for radio service work. Testing radio tubes in a tube tester is often the fastest method of locating the trouble.

An assortment of tools such as a soldering iron or gun, diagonal cutters, long-nosed pliers, screwdrivers, nut drivers, and Phillips screwdrivers should be available at the bench for radio work. This would mean a duplication of the small hand tools, but the cost of these would be small; consequently, this would not be an impractical step from a financial standpoint.

Tubes and Parts

Very few tubes and parts in addition to the ones normally stocked for television service are required for complete radio service. The addition of about 40 types of tubes would ensure almost complete coverage for radio service work. Those normally found in radio receivers are listed in Chart I. The ones preceded by a dagger are also used in television receivers and should, for that reason, already be included in your tube stock.

The tubes listed in Chart I cover those used in most of the radios produced in the last 3 or 4 years. Radios produced prior to that may use some different ones. If you find

· *Please turn to page 52*

OPERATION OF KEYED AGC SYSTEMS

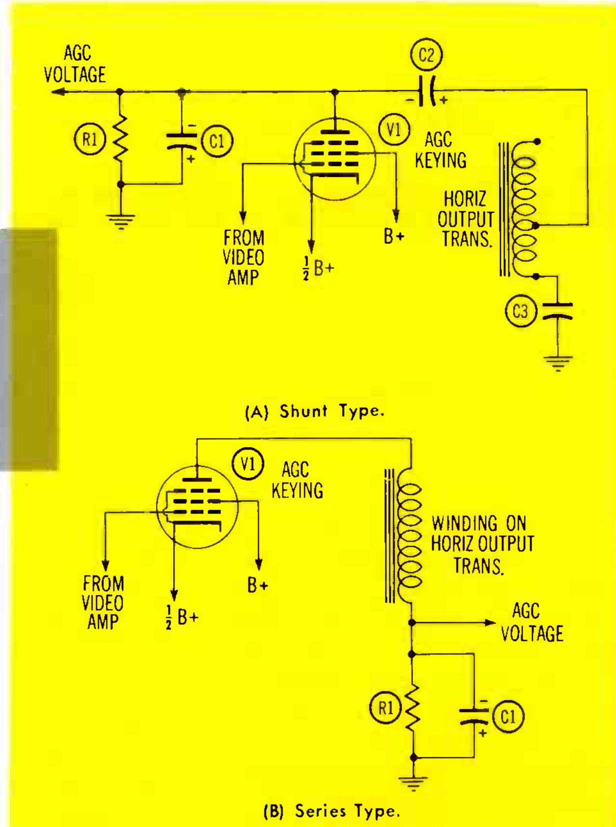


Fig. 1. Simplified Schematic Diagrams of Keyed AGC Systems.

EDITOR'S NOTE: The material in this article was taken from the book, *Servicing AGC Systems*, by Henry A. Carter and Thomas A. Lesh. This book is a 1956 publication of the Howard W. Sams & Co., Inc.

Keyed AGC is the most complex form of automatic gain control which is used in TV receivers, and it is also the most efficient. In this article, the theory of operation of keyed AGC circuits is discussed in detail.

The AGC keying tube which is used in these circuits is typically a pentode, but it may be a triode. It requires two input signals. A composite video signal which contains positive-going horizontal sync pulses is applied to the control grid, and positive pulses of high amplitude are coupled to the plate from a winding on the horizontal output transformer. The conduction of the tube depends upon the arrival of a pulse at the plate at the same time that a horizontal sync pulse arrives at the grid. Since the plate pulses are timed by the horizontal oscillator, they have the same frequency and phase as the sync pulses if the receiver is correctly synchronized.

A short burst of conduction occurs 15,750 times each second in response to the arrival of each pulse. Since the level of the sync tips determines the bias of the keying tube during the burst of conduction, the amount of conduction that occurs during the pulses depends upon the DC level that is reached by the tips of the horizontal sync pulses at the grid. The level of the sync tips in turn depends upon the strength of the incoming signal. The keying tube is cut off between pulses, and the plate voltage assumes a negative value which is proportional to the amount of conduction that takes place during the pulses. The greater the conduction, the more negative the average plate voltage. The plate voltage is passed through an RC filter, and the resultant DC voltage is applied to the RF amplifier and to one or more IF amplifiers as grid bias.

Since the keying tube is cut off in the interval between horizontal sync pulses, noise and video in the input signal cannot affect the production of AGC voltage. In addition, the keyed AGC circuit does not respond to the vertical sync pulses. The keying tube conducts only during alternate equalizing and serration pulses. This amount of conduction is not sufficient to cause a periodic rise in AGC voltage at the vertical rate of 60 cps. Such a rise is a characteristic of other AGC systems. The AGC filter in the keyed circuit, unlike the filters in other AGC circuits, does not have to be designed to remove vertical pulses from the output voltage. The time constant of the filter is therefore appreciably shorter in a keyed circuit than it is in other circuits. This is a desirable feature because it tends to make the keyed circuit largely immune to airplane flutter.

A keyed AGC system is of the shunt or series type according to whether the pulse winding and the AGC filter are connected in shunt or in series from the plate of the keying tube to ground. Simplified schematic diagrams of these two basic varieties are shown in Fig. 1.

In the shunt circuit shown in Fig. 1A, the pulses are coupled to the plate of the keying tube through a capacitor. In this case, the pulses may be taken from a tap on the horizontal output transformer. The capacitor isolates the AGC circuit from the transformer, and a special AGC winding on the transformer is not required. In spite of this fact, an isolated winding is often used. The conduction of the keying tube causes C2 to charge in the polarity shown in Fig. 1A. Between pulses, C2 discharges and maintains a charge on the filter capacitor C1. The voltage across C1 is supplied to the various controlled stages as AGC bias.

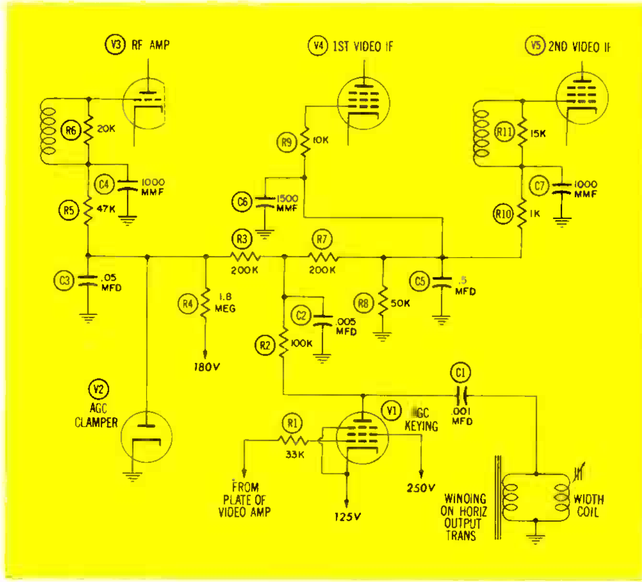
The series type of keyed AGC uses direct coupling of the keying pulses to the plate of the tube and is shown schematically in Fig. 1B. Since the AGC winding of the horizontal output transformer is tied directly to the AGC bias line, this winding must be isolated from other transformer windings which might carry high voltages. Capacitor C1 is charged to a degree which is determined by the amount of conduction through the keying tube, and the time constant of C1 and R1 is long enough to maintain the charge on C1 at a value which is very close to the peak value of the charge.

In both of the circuits which are shown in Fig. 1, the keying tube is kept cut off between keying pulses for the reason that the negative AGC voltage is the only voltage that is applied to the plate of the tube.

The DC cathode voltage is made several volts more positive than the average DC grid voltage in order that the keying tube will be correctly biased during the period of conduction. The difference between the grid and cathode voltages is more important than their absolute values.

These two voltages have high positive values in most actual circuits. Regardless of this fact, the tube conducts normally because the keying pulses on the plate have a much higher positive value. The reason behind the use of a positive grid voltage is that the grid of the keying tube must be directly coupled to the stage which supplies an input video signal to the AGC system. Frequently, the signal source is the plate circuit of a video amplifier; and the high voltage which is present at the amplifier plate also appears at the grid of the keying tube. Direct coupling is used because the variations in grid voltage which occur in response to changes in the DC level of the sync pulses are fundamental to the operation of the AGC system. This reference level would be lost if a capacitor were inserted in the input lead to the grid of the keying tube.

Fig. 2. Schematic Diagram of a Typical Keyed AGC System.



An isolating resistor is included in the grid circuit. This resistor limits the amount of current in the circuit in case the grid draws current. The impedance of the resistor isolates the input capacity of the keying tube from the video circuit, and therefore the loading effect of the AGC circuit on the video circuit is greatly reduced.

Recall that the amount of conduction through the tube is determined by the peak amplitude of the sync pulses. If the video signal is weak, the positive voltage on the grid of the keying tube is relatively low. The difference between the grid voltage and the cathode voltage is great, and the heavily biased tube passes less than average current. Little AGC voltage is produced under these conditions because the charge on the capacitors in the circuit is comparatively small. On the other hand, a strong video signal develops a high grid voltage which is closer to the value of the cathode voltage. The bias on the tube is low in this case, conduction through the tube is heavy, and considerable AGC voltage is produced in the plate circuit.

CIRCUIT DESCRIPTION

Fig. 2 is a more detailed schematic diagram of a shunt type of keyed AGC circuit which contains features that are most typical of commercial circuits. The plate receives pulses through the coupling capacitor C1. In this circuit, the AGC winding of the horizontal output transformer is separate from all other windings. The cathode of the keying tube is returned to a source of 125 volts. The video signal which is developed in the plate circuit of the video amplifier is used as an AGC input signal. It is passed through the isolating resistor R1 to the grid of V1. The DC voltage on the grid varies according to the strength of the incoming signal, but it is about 100 volts.

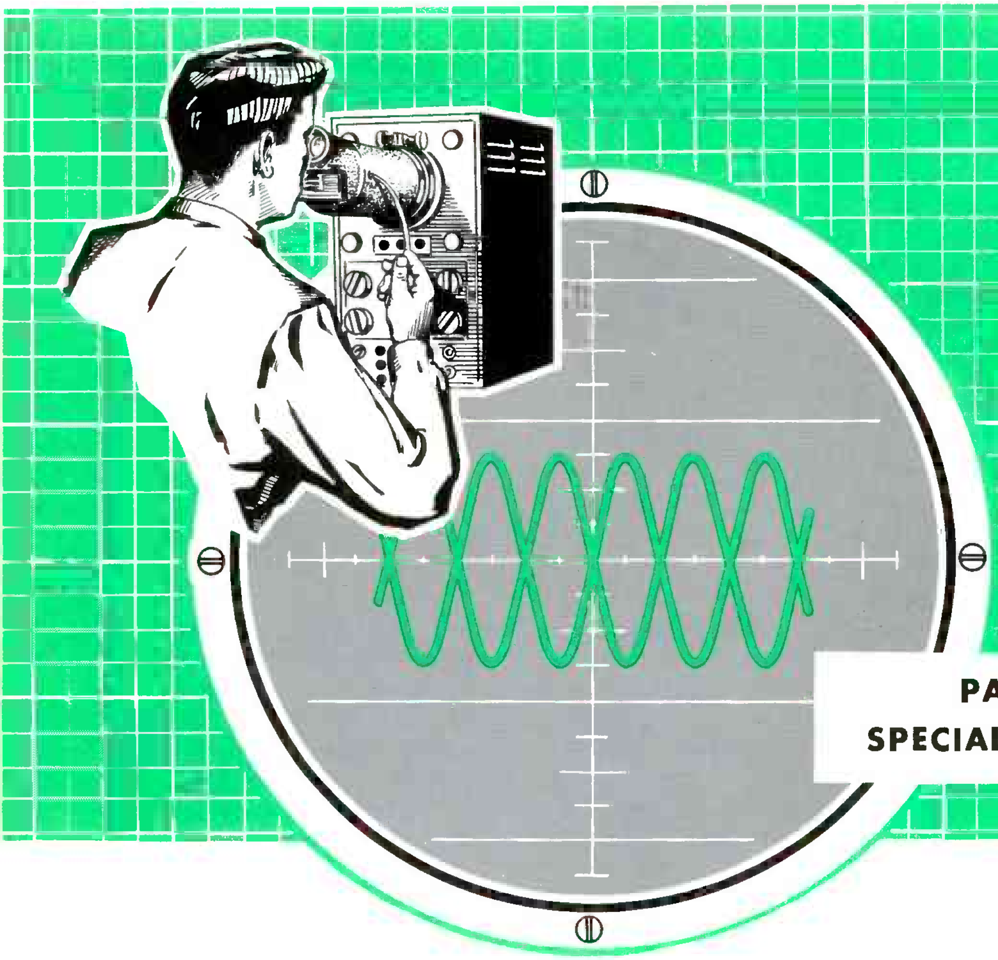
The process by which the output of V1 is converted to a DC bias voltage is fairly complicated in the circuit of Fig. 2. The plate voltage of the tube is partially filtered by R2 and C2 before the AGC line splits into RF and IF branches. The incompletely filtered voltage which is present at the junction of R2, R3, and R7 has a sawtooth waveform of relatively low amplitude.

The aforementioned junction is at the negative end of a voltage divider from which the bias voltage for the IF stages is derived. Only a portion of the voltage which is present at the junction is needed as IF bias, and this portion is tapped off across R8. The IF voltage is filtered by the RC circuit made up of R8 and C5. Since the time constant of this filter is only .025 second, this circuit is able to respond to quick changes in signal strength.

Delayed AGC for RF Stage

Even the weakest usable input signal develops some AGC voltage

• *Please turn to page 44*



Know Your Oscilloscope

PART VI SPECIAL FEATURES

BY PAUL C. SMITH

At various times throughout this series, we have used the concept of the basic general-purpose oscilloscope. Such an oscilloscope would include the cathode-ray tube; high- and low-voltage supplies; intensity, focus, and positioning controls; a horizontal sweep system with frequency controls; provision for synchronization; horizontal and vertical amplifiers; and some provision for controlling the amplitude of the horizontal and vertical signals.

An oscilloscope limited to those features just mentioned is seldom seen. Usually, a number of other features are added to increase the usefulness and efficiency of the instrument. Some of these have already been discussed but are included in the following list along with others which may not have been mentioned previously. Some oscilloscopes may contain a majority of the features listed, although it is probable that no single oscilloscope will contain them all.

1. Expanded sweep.
2. Driven sweep.
3. Slow-speed sweep.
4. Line-frequency sweep.
5. Fixed-frequency sweeps for viewing signals with 60-cycle and 15,750-cycle rates.
6. Sync at line frequency and at two times line frequency.
7. Input for external sync.
8. Automatic sync-level control.
9. Voltage-calibration circuit.
10. RF detector circuit.
11. Polarity reversal of vertical deflection.
12. Positive or negative sync signal.
13. Intensity modulation.
14. Sawtooth output signal.
15. Retrace blanking.
16. Phasing control of line-frequency sweeps.

The first and second features of the list have already received some mention in previous articles. The third is provided in some oscilloscopes by a front-panel jack which connects to the frequency-determining network of the sweep generator at one position of the frequency switch. By adding a large external capacitance at this point, the operator can lower the sweep frequency of the oscilloscope. A good quality capacitor should be used because the leakage of a capacitor tends to raise the rate of the sweep frequency. This is contrary to the effect caused by the capacitor; and if the leakage is sufficiently great, the net result may be a sweep rate that is actually higher than it was before the capacitor was added.

Sweeps at line frequency and at the horizontal and vertical rates of a TV receiver are features that are commonly used by the technician. The line-frequency sweep is not a sawtooth but a sine-wave sweep, and one possible use for it would be in conjunction with a sweep generator so that a response curve of a receiver could be obtained. Such a sweep would also be useful to make frequency comparisons by means of Lissajous figures. When the oscilloscope is used in conjunction with a sweep generator to develop a response curve, the horizontal sweep for the oscilloscope can be either the line-frequency sweep just mentioned or can be obtained by feeding the synchronized sweep signal from the generator to the horizontal input of the oscilloscope. In the first case, proper phasing of the response curve is obtained by means of the phasing control of the oscilloscope (item 16 in the preceding list). In the second case, the phasing control of the sweep generator must be used.

Item 5 refers to features obtained by special positions of the frequency switch. These positions are usually marked V and H TV, or in some similar manner; and sweep rates of 30 and 7,875 cycles per second, respectively, are produced when these positions are used. A display of two cycles of signal at the TV vertical or horizontal sweep rate is obtained in this manner, and with a minimum of adjustment of the sweep-frequency controls.

Items 6, 7, and 8 are features that aid the service technician when an oscilloscope is being used for one of the difficult operations, that of obtaining stable synchronization. As an example of how these features can be used, let us suppose that the technician wishes to view the video signal in a TV receiver as it occurs between two vertical sync pulses but that some fault in the receiver has attenuated the vertical sync pulses at the point where the oscilloscope is connected. If the sync control of the oscilloscope is set to INT (internal) position, synchronization may be difficult to obtain because in this position the sync signal is taken from the signal being viewed and the necessary vertical sync pulses have been attenuated or are missing from the signal at this point. If the sync control is set at the LINE position, sync signals of the proper amplitude and frequency are automatically provided from a point within the oscilloscope.

If trouble is encountered with a signal that is not at line frequency or some multiple thereof, then the sync control can be set to the EXT (external) position and the sync signal can be taken from some point in the receiver circuit where a more definite pulse is obtained.

With regard to item 8, it was pointed out in a previous article that a sync signal that is either too strong or too weak results in poor synchronization; and a feature which automatically provides the correct level of sync signal will do much toward simplifying the synchronization problem.

Voltage-calibration circuits (item 9) enable the operator to measure the amplitude of the signals shown on the oscilloscope screen. Several methods of calibration are used; the simplest consists of a voltage of known amplitude brought out to a jack on the front panel. This voltage can be fed to the oscilloscope input for comparison with the signal to be measured. Another system may use a switching arrangement whereby an internal calibration voltage is fed to the vertical amplifier in steps of ten; another may use a vernier control and a meter to apply any voltage within certain limits.

The oscilloscope is limited in direct viewing to signals within the frequency range of its amplifiers, but modulated RF signals can also be viewed with the oscilloscope if these signals are first detected before being applied to the oscilloscope amplifiers. This detection can be accomplished either by circuits within the oscilloscope, as in some models, or by the use of external probes.

Items 11 and 12 have been mentioned in previous articles. Item 13 describes a feature that can be used to determine the frequency of a signal or to measure the duration of a trace or a portion of a trace. An alternating signal of proper amplitude fed to the intensity-modulation jack will increase or decrease the intensity of the trace in step with the alternations and thus will mark the trace at regular intervals. An alternating signal consisting of sharp pulses works best for this purpose because it produces more distinct markings than an alternating signal of a smoother nature.

Item 14 describes a signal which is taken from the sweep generating system of the oscilloscope and which therefore has the frequency determined by the setting of the sweep controls of the oscilloscope. Such a signal can be used for signal substitution in the vertical and horizontal systems of a TV receiver. Although the sawtooth signal does not match the normal signal found in these systems, it is suitable for trouble-shooting purposes.

Retrace blanking (item 15) is usually included as a feature of most oscilloscopes. In some examples, the blanking is in operation continuously; and in others, it may be turned on or off by means of a switch. Usually, the retrace period is a very small fraction of one cycle of sweep and does not interest the oscilloscope operator. In such cases, retrace blanking eliminates any confusion or distraction which might result if the retrace were visible. When the retrace period occupies a greater portion of the cycle, it may be desirable to turn off the retrace blanking so that no part of the signal will be lost during retrace. The waveform visible during retrace may be more difficult to interpret than that shown on the normal portion of the sweep because the retrace is usually very nonlinear in nature; but it is usually possible to determine facts of a quantitative nature, such as the number of cycles of signal lost during the retrace.

The phasing control (item 16) is useful when a line sweep is used. At this position of the sweep controls, a sine-wave signal is taken from some point of the oscilloscope circuits (usually a winding on the power transformer) and is used to drive the horizontal deflection system. The phasing control is used to vary the particular point on the sine-wave signal at which the sweep begins.

Oscilloscope Accessories

The usefulness of an oscilloscope can be increased even further by the use of some external accessories. A few are shown in Fig. 1. These include a voltage calibrator, two low-capacity probes, and a demodulation probe.

The use of an external voltage calibrator adds this facility to those oscilloscopes which have no calibration feature and will also give a wider calibration range than some oscilloscopes attain with their built-in calibration circuits.

• *Please turn to page 59*

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Audio-Facts

Interesting Facts About Feedback in Amplifiers

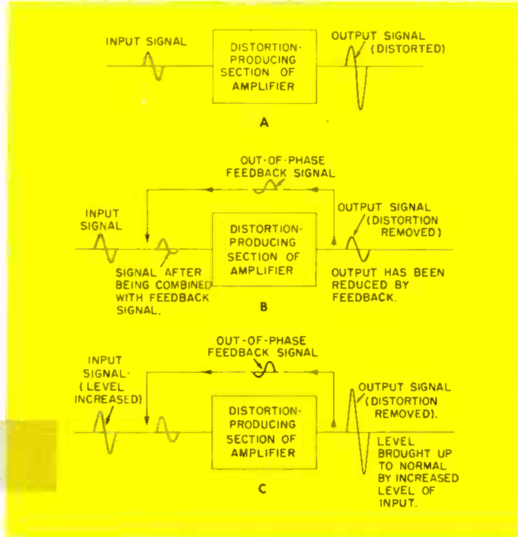

Fig. 1. The Effect of Negative Feedback on a Distorted Signal.

by Robert B. Dunham

Feedback is a term encountered very often by anyone active in audio work, especially by those who have a particular interest in amplifiers. Reference can be made to several types of feedback. Persons who work with public-address systems may connect the term with the howls and squeals that cause so much trouble when the sound from a loudspeaker is picked up by the microphone which picked up the original signal. The radio service technician may be reminded of the whistles and squeals heard from a radio loudspeaker because unwanted feedback or coupling in some part of the circuit of the receiver caused the circuit to oscillate.

Feedback is the descriptive name given the action or process that occurs when a portion of a signal in one part of an amplifier is reintroduced or fed back into a part of the circuit nearer the amplifier input. The feedback is positive when the signal is fed back in phase. Positive feedback increases the gain of the circuit and causes oscillation. The feedback is negative when the signal is fed back out of phase. Negative feedback reduces the gain of the circuit.

In this article, we will concern ourselves with negative feedback (or inverse feedback, to use the term by which we first knew it) as applied to amplifiers to obtain certain desirable results. Almost everyone who works with amplifiers is acquainted with the basic principle of how an out-of-phase signal is fed back into an amplifier to reduce distortion, but that is only part of the story and is far from being enough to be of much assistance when an amplifier is being tested or serviced. The service technician should be familiar with the principles involved in negative feedback because some unusual and puzzling conditions can arise when a circuit included in a feedback loop is modified or disturbed. The term feedback loop refers to the circuit located between the point where the feedback signal is taken from the circuit and the point where it is fed back into the circuit.

Negative feedback is largely responsible for the very low percentages of distortion featured by modern high quality amplifiers. Only a few years ago an amplifier with 5 per cent of harmonic distortion was considered to be very good, but now the situation has changed. With the practically universal use of negative feedback, improved circuits, and high-grade output transformers in present-day amplifiers, 0.5 per cent of harmonic distortion at rated output is common and much lower percentages are not at all unusual.

The basic effect of negative feedback is illustrated in Fig. 1. The undistorted input signal and the distorted output signal are shown in Fig. 1A. The distortion of the output signal is evident because one peak of the signal waveform reaches a greater amplitude than the other. Such distortion, due to the nonlinear operation of the tubes and other circuit components, is characteristic of amplifiers. A portion of the distorted output signal is fed back out of phase to the input where it combines with and modifies the input signal, as shown in Fig. 1B. The input signal is actually distorted by the out-of-phase feedback signal so that the greater part of the distortion developed in the amplifying circuit is counteracted. Note that in Fig. 1B the amplitude of the output signal has been reduced because of the negative feedback. The output can be brought up to its normal level as in Fig. 1C if the level of the input signal is increased. The power-handling capabilities of amplifiers are not reduced by the application of negative feedback.

To be effective, the out-of-phase feedback signal must be taken from the amplifier at a point following the circuit in which the distortion is developed and must be fed into the amplifier at a point ahead of the circuit in which the distortion is developed.

The amount of negative feedback used in an amplifier is rated in decibels and is the ratio of the output voltage obtained without feedback to the output voltage developed when feedback is applied. It can be stated in other words as being the gain reduction, in decibels, caused by the application of negative feedback.

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AFC CIRCUITS in FM RECEIVERS

by Thomas A. Lesh

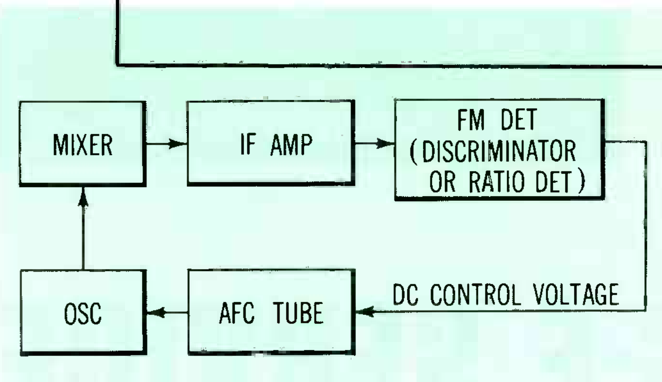

Fig. 1. Block Diagram of the Feedback Path for AFC.

Automatic frequency control (AFC) is applied to the local oscillators of many FM receivers. Although it is not absolutely essential to the operation of a receiver, AFC is a desirable feature which simplifies tuning.

Two problems that are troublesome during FM reception are minimized by the use of an AFC circuit. One of these is oscillator drift. A station may be properly tuned in when the receiver is first switched on, but the heating of components during continued operation may cause the oscillator frequency to change enough that the sound from the receiver will become distorted. If the receiver is equipped with AFC, the oscillator is automatically kept tuned to the proper frequency. As a result, the listener does not have to go to the trouble of readjusting the tuning control after the receiver has warmed up to normal operating temperature.

The other problem is that of distortion which arises from inaccuracy of tuning. The sound which is obtained from an FM receiver is at its best when the local oscillator is tuned so that the center frequency of the IF signal equals the resonant frequency of the detector transformer. (The center frequency is the same as the frequency of the unmodulated IF signal.) Modulation of the IF signal causes its frequency to vary above and below center by as much as 75 kilocycles. The FM detector converts these frequency variations into voltage variations. It has a relatively broad bandpass, and it will develop an output voltage even when the instantaneous frequency of the IF signal is nearly 200 kilocycles above or below the frequency to which the detector is tuned. If the local oscillator is tuned inaccurately, an incoming signal will be converted into an IF signal which will occupy an incorrect range of frequencies but which can still be detected. Sound will then be produced, but it will usually be more or less distorted.

A receiver which does not feature AFC must be tuned somewhat critically if best results are to be obtained. On the other hand, a receiver that has an AFC circuit will automatically adjust itself for the clearest possible reception of a station whether the station is tuned in carefully or not. Most of the expensive FM tuners which are designed to be included in high-fidelity systems are equipped with AFC so that an output which is free from distortion can be easily obtained.

Functional Description of Circuit

The AFC circuit is essentially a feedback system. It is somewhat like an AGC system in this respect, although the two types of circuits have different purposes. Fig. 1 is a block diagram of the stages which are included in the AFC feedback path. The general operation of the AFC system is as follows. If the local oscillator is incorrectly tuned, the center frequency of the IF signal will not be equal to the resonant frequency of the detector transformer. An unbalanced condition will then be set up in the detector, and a DC control voltage which is proportional to the error in the IF frequency will be produced. The correction voltage is positive if the oscillator frequency is high and negative if the frequency is low.

The control voltage is placed on the grid of the AFC tube. This tube functions as though it were a capacitor connected across the tuned tank circuit of the local oscillator, and the tube can therefore be used for the control of oscillator frequency. See Fig. 2. The amount of capacitance which is added to the tank circuit by the AFC tube is determined by the amount of conduction through the tube, and this amount in turn depends upon the DC level of the control voltage on the grid. Placement of reactance in a circuit is

· *Please turn to page 61*

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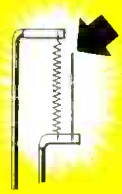

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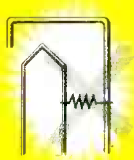

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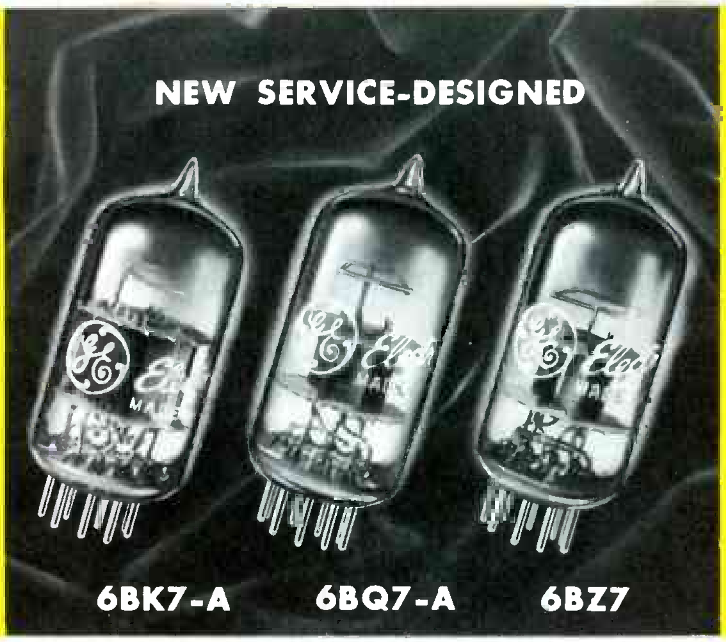

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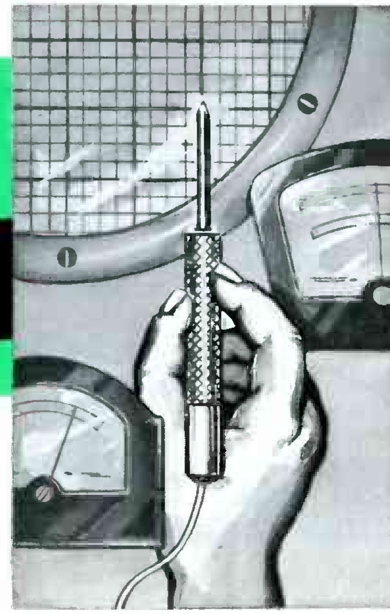

Presenting Information on Application, Maintenance, and Adaptability of Service Instruments

by Paul C. Smith

"RESPONSE TO 5 MC, ± 3 DB"

Just what is the meaning of this title phrase, "Response to 5 Mc, ± 3 Db"? Well, it could mean something pretty good or something not quite good enough, depending upon the response needed for the job at hand. Manufacturers of test equipment use such terms and others of similar nature in describing their products in order that the purchaser or user of a product may get a clear picture of its qualifications. You might look at it as a kind of shorthand which tells the reader a lot in a few words; but of course, the reader must know how to interpret this shorthand in order to get full benefit from it. Let us take as an example the vertical amplifier of an oscilloscope and consider a number of different ways in which the frequency response of this amplifier can be described.

One of the simplest ways to describe such an amplifier would be to say, "The response extends to 4 megacycles," or some such figure. Not only would this be the simplest description, but it would also tell the least. What, then, is lacking? First of all, no comparison is made by such a statement; the reader is not told how the response at 4 megacycles compares to that at, let us say, 1 megacycle. Usually, a stated specification involves comparison with an ideal either expressly or by implication. The ideal in this case would be an amplifier giving perfectly flat amplification from zero frequency up to as high as the user might wish. (It is conceivable that there might be times when a perfectly flat amplifier would not be the most desirable.)

The response curve for such an ideal amplifier would be a straight line like the curve in Fig. 1A. This response curve and all those to follow are plotted with the relative amplification shown on the vertical axis and the frequency shown on the horizontal axis of the graph. The relative amplification is plotted in decibels (db). A review on the subject of decibels will be given later. The ideal amplifier represented by Fig. 1A could be described as, "flat from zero to 10 megacycles," or whatever the upper limit might be.

Most amplifiers will not be ideal but will have a response which drops off at the low and high frequencies. Such an amplifier might have a response like the one shown in Fig. 1B. In this, the response starts to fall at 100 cycles and at 1 megacycle, and it is down 3 decibels at 10 cycles and at 10 megacycles. This amplifier might be described as "flat within 3 decibels from 10 cycles to 10 megacycles." It could also be described as "flat from 100 cycles to 1 megacycle, down 3 decibels at 10 cycles and at 10 megacycles."

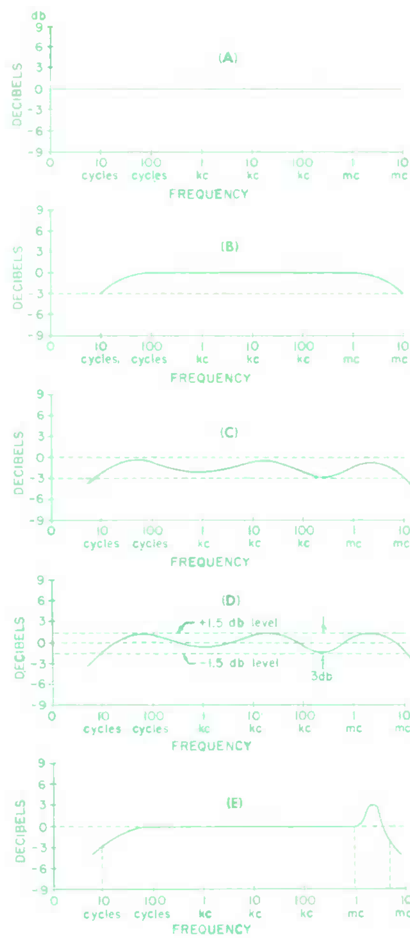

Fig. 1. Some Amplifier Response Curves Plotted in Decibels Versus Frequency. These Curves Are Purely Hypothetical.

This latter description would give a more complete picture of the characteristics of the amplifier, although both descriptions would be correct.

Fig. 1C represents another amplifier with a response that is flat within 3 decibels from 10 cycles to 10 megacycles, although that portion between 100 cycles and 1 megacycle shows more variation than is shown in Fig. 1B. The expression, "flat within 3 decibels from 10 cycles to 10 megacycles," actually means that "the variation in amplification does not exceed 3 decibels for any frequencies from 10 cycles to 10 megacycles." Within this 3-db limit, any variation can occur; and the description, "flat within 3 decibels," will still apply.

Let us change the curve of Fig. 1C so that the O-db reference line will fall halfway between the points of highest and lowest amplification on the curve, as it does in Fig. 1D. Now we can say that the response is plus or minus 1.5 decibels from 10 cycles to 10 megacycles. The total variation is still 3 decibels, however. From these last two examples, we can see that if we are given the expressions, "flat within 3 decibels" and "flat, ± 3 db," the latter expression describes a variation that is twice as great as the first although an uninformed reader might get the impression that they were the same.

Still another example that might be encountered is the response shown in Fig. 1E. This response could be described in several ways depending upon the amount of information to be conveyed. The following descriptions would all apply to the response shown: (a) ± 3 decibels from 10 cycles to 6 megacycles; (b) flat within 6 decibels from 10 cycles to 6 megacycles; (c) flat from 100 cycles to 1 megacycle, ± 3 decibels from 1 megacycle to 6 megacycles, down 3 decibels at 10 cycles.

An expression similar to the following is sometimes seen: "response ± 3 decibels from 20 cycles to 3.6 megacycles, useful to 6 megacycles." This expression is meant to convey the information that, although the response may fall off rapidly above 3.6 megacycles, enough amplification may still be had at 6 megacycles to produce a useful deflection on the oscilloscope. These high frequencies can therefore be viewed with the oscilloscope, but the technician should be aware of the relative amplification at these high frequencies and at some of the lower frequencies. For example, he could not calibrate his oscilloscope with a 60-cycle calibration signal and get an accurate measurement of a 6-megacycle signal unless he used the proper correction factor to compensate for the loss at 6 megacycles.

All the examples used have been hypothetical cases, but they serve to show the variety of ways in which amplifier response characteristics can be described.

The Decibel

The decibel has been used as a comparison unit throughout this article, so perhaps a brief explanation of its use should be given. The decibel is a unit for expressing a power ratio. The ratio between the power output of an amplifier at one frequency and the power output at another frequency can be expressed in decibels. The ratio between the power output at one frequency and the power input necessary to produce that output can also be expressed in decibels. This would be the power gain of the amplifier. The power loss caused by the insertion of an attenuator into a circuit can be expressed in decibels.

Since the power in a circuit is invariably related to the voltage and current present, ratios of voltage and current can also be expressed in decibels. The formula for the decibel in voltage or current considerations is a little different than that for power ratios and takes into consideration the resistance or impedance of the circuits involved. If a comparison is made between voltages or currents at points of equal impedance, the formula becomes much simpler. This article will deal only with such comparisons.

The formula for power ratio expressed in decibels is:

$$\text{No. of db} = 10 \log_{10}\left(\frac{P_2}{P_1}\right) \quad (1)$$

where
P = power.
Formula 1 can be expressed in words in the following manner. Take the logarithm to the base 10 of P_1; subtract it from the logarithm to the base 10 of P_2; and then multiply the difference by 10. The result will be the decibel ratio between the two powers. If the number so obtained is positive, we say that there is a power gain; if it is negative, we say that there is a power loss.

The formula for voltage ratios across equal impedances is:

$$\text{No. of db} = 20 \log_{10}\left(\frac{E_2}{E_1}\right) \quad (2)$$

where
E = voltage.
All the response curves shown in this article are based upon this formula. For example, the response curve of Fig. 1C could be plotted by measurement of the output voltage of the oscilloscope amplifier at some individual frequency and by use of this voltage as the reference voltage E_1. Any frequency that is convenient could be used; but once it is chosen, it will remain the reference during the entire procedure. Then other frequencies are applied to the input of the amplifier at the same voltage level as that of the reference frequency, and the output voltages obtained for each new frequency are used as values of E_2 in formula 2. In this manner, enough points can be obtained to plot the curve.

The decibel notation is often used when amplifier response figures are quoted or when response curves are plotted. The person who is not too familiar with the decibel notation may wish to change it back to a ratio of one voltage to another, and he can do so by applying formula 2 in reverse. For convenience, tables have been published to enable one to convert directly from either decibels to voltage and power ratios, or vice versa.

A few more commonly used values of decibel relationships are quoted in the following table as examples.

From this table, it can be seen that an increase of 1 decibel is a small amount—about 12 per cent. An increase of 3 decibels will double the power because power varies as the square of the voltage, and 1.413 is approximately the

· *Please turn to page 35*

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TROUBLE SHOOTING with George

THE CASE OF THE DISCONNECTED ANTENNA

by Paul C. Smith

George Fleiback glanced at his watch—he had just enough time to fix one more set before supper, that is, with a little luck he might make it in time. There was a 21-inch table model which the owner was extremely anxious to get back again. (Weren't they all?) Guess he'd tackle that one next.

George hadn't been in the business long. He realized he was a little short on practical experience, but he felt that he more than made it up by being long on theory and enthusiasm. In addition, he had managed to acquire some pretty good equipment; and that helped a lot.

This receiver seemed to be having some sync trouble. The owner had said that it was working all right when it was last turned off; but when he had turned it on again, "everything was all blurred and going every which way." George had tested the tubes and had decided to bring the receiver into the shop since he did not find any bad ones.

The receiver had a vertical chassis; and in order to get to the underside of the tube sockets for any tests, George had to remove the picture tube and yoke and rearrange them on the bench beside the chassis. When he was sure everything had been reconnected properly, he clipped an antenna lead to the receiver terminals; plugged in the set; turned it on; and stood back to await results. After a reasonable warm-up period, the raster appeared; but the picture from the local station was certainly nothing to brag about.

He turned the horizontal and vertical hold controls and managed to get a stationary picture, but the horizontal hold was critical and the picture would not hold vertically for more than a few seconds. Another symptom was that all the values in the picture were reversed—parts of the picture which should have been dark were light, and vice versa. The sound seemed to be all right.

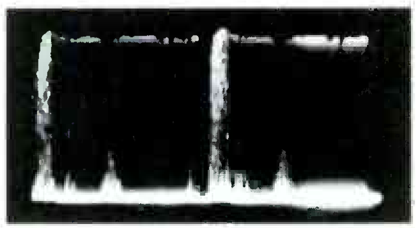
"The sync is so touchy it must be sync trouble," he thought. "I'll just hook up the scope and see what the sync pulses look like."

He spread the schematic out to look for the most likely spot to connect the scope. Because the trouble seemed to affect both horizontal and vertical sync, he chose the last point common to both these signals—the plate of the sync amplifier. Figs. 1A and B show what he saw on the scope.

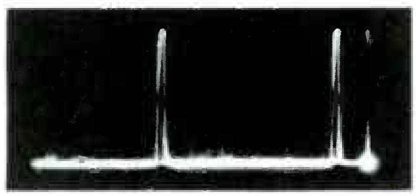
"That doesn't look so good," mused George. "I can hardly sync the scope at all at the vertical rate, and the horizontal pulses are only about 1/10 normal size. Got to keep moving up towards the front end till things look better."

Suiting the action to the words, he shifted the scope lead to the plate of the sync separator stage; and when he noticed no improvement there, he moved to the grid of the same stage. The waveform he saw is shown in Fig. 2. George could tell that the signal was not correct.

He noticed something else, too. Being naturally cautious about getting shocked, he turned off the set each time he shifted the scope lead. As the set warmed up after he turned it on, he could see the vertical sync pulses come through for a fraction of a second and then fade out the next instant.



(A) Sweep Rate—30 CPS.



(B) Sweep Rate—7,875 CPS.

Fig. 1. Waveforms Which George Obtained at the Plate of the Sync Amplifier.

· *Please turn to page 48*

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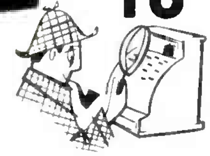

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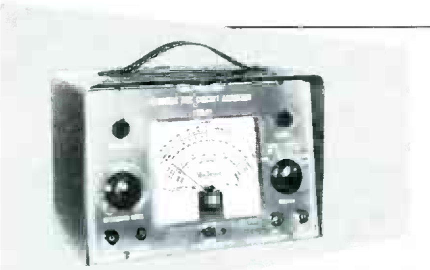

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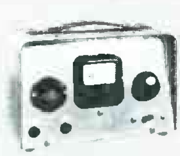

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Dollar and Sense Servicing

by *John Markus*

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

NIGHTMARE. After working all day on plated wiring boards and then downing three whiskey sours as medicine for an oncoming cold, a good GE friend of ours reported this nightmarish dream: The printed circuit lines on the wiring boards started wiggling like worms as they marched past him in dreamland.

ATTENTION! Put a good transistor radio in the handbag of a pretty blonde, hook it up with fine wire to a king-size loudspeaker held in her hand, tune in a station, and you've got the recipe for an attention-getter at any gathering in your community. Paint your shop name and address on the cone, to profit from the attention.

Put the gal in a bathing suit for still more attention. If her handbag has an over-the-shoulder strap, she will have more of a chance to reveal the secret from time to time by taking the radio out of the bag. It's a good promotion idea this season for the new portables.

JOBS. For engineers today, the supply-and-demand ratio is running around 2 applicants for each 3½ job openings. Despite this, salaries are not behaving according to the usual economic laws. Chief reason is that the large companies are keeping salaries pretty much in line within their organizations and hence cannot go too much above on offers to attract more engineers. Gentlemen's agreements among companies not to pirate engineers from each other are another reason for the slow rise in technical salaries.

A recent salary survey showed a median of about $7,000 a year for electrical engineers having little or no executive responsibility. Actual salaries range from under $5,000 to over $12,000, depending on years of experience and on ability.

GE President Ralph Cordiner predicts that average annual earnings, including benefits, for all its employees may well reach $8,000 to $9,000 per person by 1966; the present figure is $5,600, as compared to $2,000 in 1939. Are you giving yourself corresponding boosts in income each year by upward adjustments of your billed hourly rates for labor?

TAPED TV. A demonstration of TV tape-recording equipment by Ampex Corporation at a recent Chicago convention resulted in immediate orders for over 80 of the machines by TV networks and stations at something over $50,000 apiece. Tape speed is 15 inches per second, and a full 65 minutes of both video and audio for a program can be put on a 14-inch reel of the 2-inch magnetic tape.

In comparison tests, taped programs could not be distinguished from direct pickups. The taped programs were considered far superior to the film-recorded programs heretofore used for repeat or delayed telecasts, and they are much cheaper since magnetic tape can be used over and over again.

Thus is solved the problem of delaying the big Eastern network programs by three hours for showing on the West Coast at the most profitable times, without deterioration of picture quality. Each Western station merely feeds the program to its tape recorder when the program comes over the network lines. Playback can be just as quick as it takes to rewind the reel; or it can be hours, days, or years later.

The company is now working on a color-TV adaptation of the recorder and is exploring its possible uses for other types of information storage.

HORSEPLAY. Now making the rounds of West Coast research labs is a device plainly labeled "LITTLE GEM FUSE BLOWER." As described by the *Electronics* magazine, it's just a small aluminum box with a neon pilot lamp, an AC plug, and a push-button switch. The gadget is placed on an engineer's desk while he's visiting the water cooler.

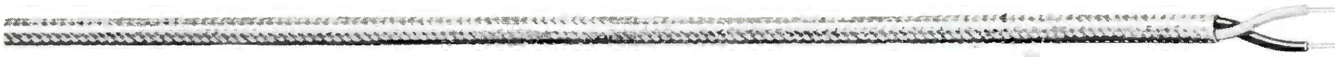
The engineer picks up the box when he returns, examines it carefully, shakes it a few times, and then walks over to the nearest AC outlet and plugs it in. He notes with approval that the pilot lamp comes on, and then he pushes the button.

A loud noise is heard from the direction of the fuse box, the lights in that engineering bay go out, a snickering noise is heard, dull grumblings come from the engineer, and all is darkness about him until the janitor puts in new fuses.

After a short interval, the engineer leaves his office, taking the device with him. He returns without it and sits expectantly at his desk until the lights go out in some other engineering bay. Approximately 60 per cent of the recipients of Little Gem act in this manner.

P. S. If it's not convenient to get a male plug of the type that can be mounted in a punched hole in the aluminum box, just use an ordinary line cord and plug. Put a 100K-ohm resistor in series with an NE-2 across the line, and use a switch rated at 15

· *Please turn to page 49*



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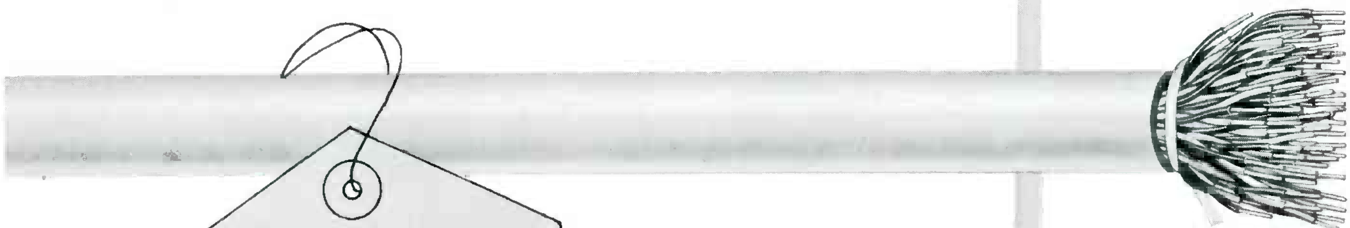

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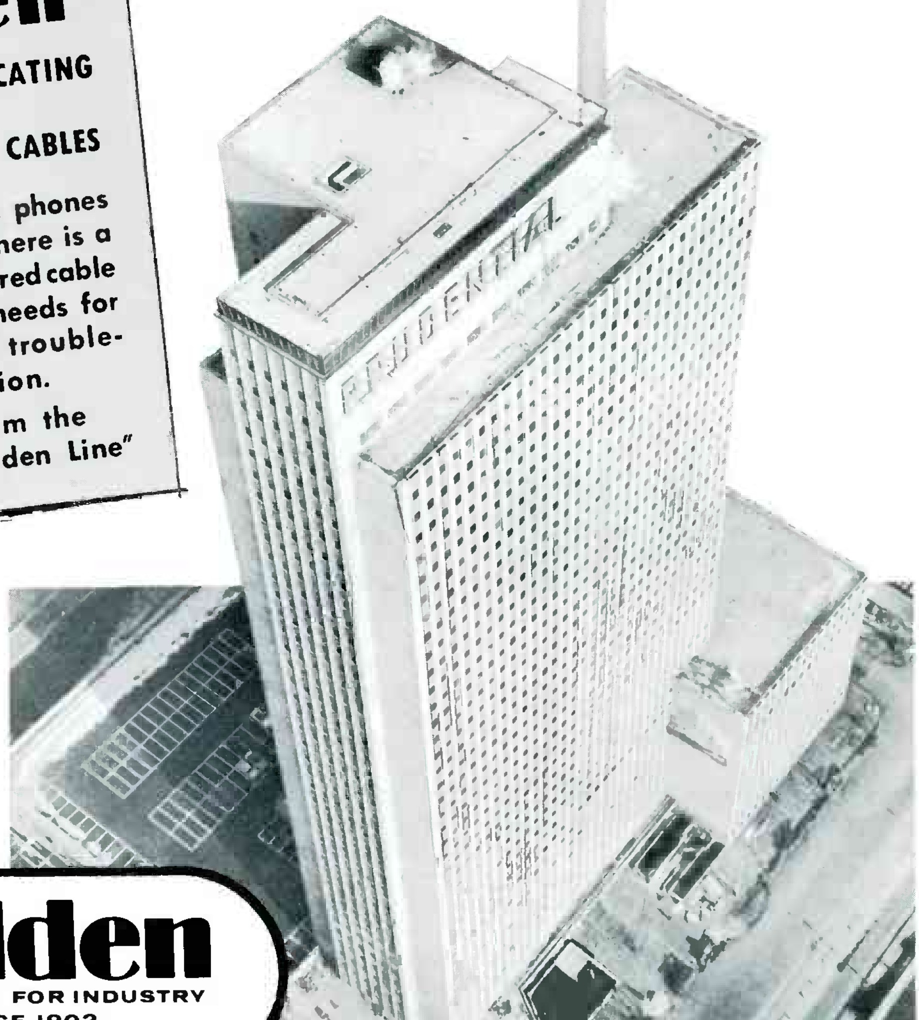

The TV station, the systems for music, paging, and intercommunication in the new Prudential Insurance Company of America's Building in Chicago have been—wired by Belden.

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Notes On Test Equipment

(Continued from page 29)

DECIBELS (db)	VOLTAGE RATIO $\left(\frac{V_2}{V_1}\right)$
1	1.122
3	1.413
6	1.995
20	10.000

square root of 2. For an increase of 6 decibels, the voltage is doubled; and an increase of 20 decibels represents a 10 to 1 voltage increase.

Decibel notation is widely used in electronics and acoustics, but perhaps it is not understood as well as it might be because of the natural aversion which some people have to the mathematics associated with it. The technician should maintain more than a speaking acquaintance with it, though, in order to get the most from manufacturers' specifications for instruments, amplifiers, and the like.

VITAMETER

The Vitameter is manufactured by the Electronic Test Instrument Corporation and is designed to be used by the technician to check, rejuvenate, and repair picture tubes. A picture of the instrument appears in Fig. 2.

A continuity test can be performed on the filament, cathode,

Fig. 2. The Vitameter by the Electronic Test Instrument Corporation.

and grids No. 1 and No. 2 of a picture tube. A check can also be made for shorts between these elements. Shorts or continuity are indicated by a white lamp on the panel.

A rejuvenating function is provided for tubes having low emission. The rejuvenation can be accomplished in three different degrees of intensity according to whether the switch is set to VIT-LO, VIT-MED, or VIT-HIGH position. The VIT-LO position is recommended to be tried first, and one of the other positions should then be tried if the tube fails to respond.

The instrument provides for welding of open filaments and open cathode leads. It also has a function which provides for removal of shorts from between elements.

An indication of the gas content of a picture tube can be obtained if the technician notes the rate at which the meter pointer falls or rises when the GAS push button is pressed and released. This test requires some judgment on the part of the operator, and some experience in testing tubes of known condition would be helpful in this respect.

The Electronic Test Instrument Corporation also manufactures the Volta-Chek which is an instrument for checking the voltages present at the socket of the picture tube while the rest of the receiver is in operation. The Volta-Chek can be used either in conjunction with the Vitameter or as a separate instrument. If the service technician desires, he can mount the Volta-Chek inside the lid of the Vitameter by means of a small bracket.

The Volta-Chek does not give an absolute indication of the magnitudes of the voltages present at the picture tube, but it will indicate their presence and whether they respond to the actions of various controls such as the contrast and brightness controls. Neon and pilot-light indicators are used to show the presence of such voltages.

PRECISION MODELS 68 AND 78 VTVM'S

Two new additions to the line of test equipment made by the Pre-

Fig. 3. The Model 68 VTVM by the Precision Apparatus Company, Inc.

cision Apparatus Company, Inc., are the Models 68 and 78 VTVM's shown in Figs. 3 and 4, respectively. The Model 68 is AC operated, and the Model 78 is battery operated. These instruments are similar in outward appearance, as the illustrations show. The size of each is 5⅞ by 7¾ by 3½ inches. Both use a 5½-inch meter with scales somewhat longer than is customary for that size. The extra length of scale is obtained because the scales are drawn with flatter arcs than would be obtained if the pivot of the pointer were used as the center of the arcs. The electrical characteristics of each model will be discussed separately, starting with the Model 68.

The Model 68 is a wide-range, general-purpose VTVM suitable for general electronics service work in the shop and field. The instrument has 5 positive and 5 negative DC voltage ranges, 5 electronic ohmmeter ranges, 5 AC rms voltage ranges, and 5 AC peak-to-peak voltage ranges. The use of an accessory RF probe and multiplier adds 4 more voltage ranges, making a total of 29 ranges in all.

Fig. 4. The Model 78 VTVM by the Precision Apparatus Company, Inc.

DC voltage measurements are made with a constant input impedance of 13⅓ megohms. DC voltages up to 1,200 volts can be measured. Full-scale values for the 5 ranges are 3, 12, 60, 300, and 1,200 volts. The use of an accessory high-voltage probe extends the DC range to 30 kilovolts.

The full-scale values for AC rms voltages are the same as for the DC voltage ranges. The input impedance characteristics are: for all ranges up to the 60-volt range, 0.65 megohm shunted by 67 micromicrofarads; for the 300-volt range, 0.90 megohm shunted by 67 micromicrofarads; and for the 1,200-volt range, 1 megohm shunted by 67 micromicrofarads.

The full-scale values for the AC peak-to-peak ranges are 8, 32, 160, 800, and 3,200 volts. The input impedances are: for all ranges up to the 160-volt range, 0.65 megohm shunted by 67 micromicrofarads; for the 800-volt range, 0.90 megohm shunted by 67 micromicrofarads; and for the 3,200-volt range, 1 megohm shunted by 67 micromicrofarads.

The full-scale values for RF ranges are 3, 12, 30, and 120 volts.

Resistances up to 1,000 megohms can be measured. The center of the scale for the lowest resistance range is 10 ohms.

A zero-center scale is provided for circuit balancing and for the galvanometer type tests. The sensitivity of the meter used in the Model 68 is 400 microamperes.

The battery-operated Model 78 VTVM offers 6 zero-center DC voltage ranges, 5 AC rms voltage ranges, and 5 electronic ohmmeter ranges. The use of an accessory RF probe and multiplier adds 4 more voltage ranges, making a total of 20 ranges.

The input resistance for DC voltage measurements is 13⅓ megohms. All DC voltage measurements are made on zero-center scales. Full-scale deflection for the various ranges is obtained for the following positive or negative voltages: 1.5, 6, 30, 150, 600, and 1,500 volts. Readings can be made to 60,000 volts by the use of an accessory high-voltage probe. The AC rms voltage ranges have full-scale values of 3, 12, 60, 300, and 1,200 volts.

Resistances up to 1,000 megohms can be measured. The center of the scale represents 10 ohms on the lowest resistance range.

Full-scale values for RF ranges are 3, 12, 30, and 120 volts. The sensitivity of the meter used in the Model 78 is 100 microamperes.

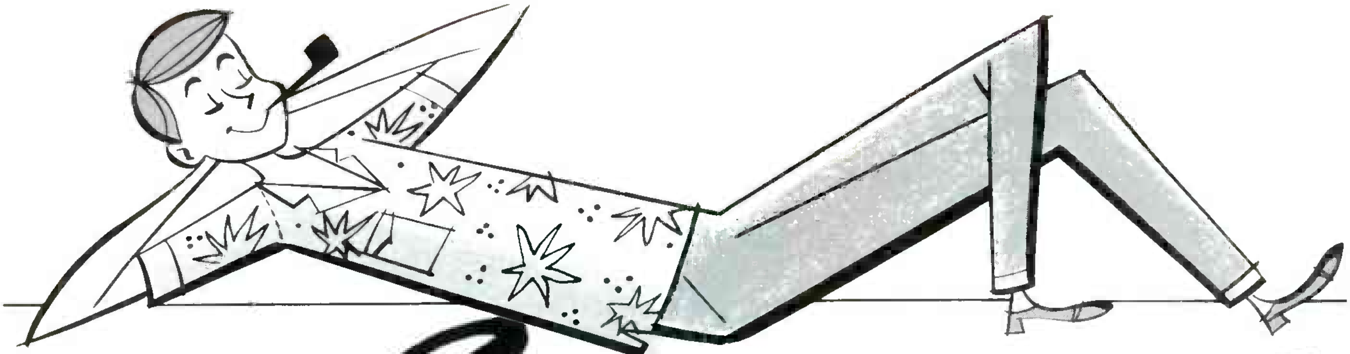
Both the Model 68 and Model 78 VTVM's use a combination probe which serves for all measurements except the RF and high-voltage measurements. The probe contains a switch that is set at one position for DC voltage measurements and at the other position for AC and OHMS measurements.

Fig. 5. The Model 78 VTVM with the Back Cover Removed and with the Batteries Exposed.

Another feature common to both models is the ease with which the back may be removed. The back is held in place by a single screw and a flange. Fig. 5 shows the back removed from the Model 78. A connector is used between the battery leads and the instrument so that the back (and batteries) can be completely detached from the rest of the instrument for convenience in battery replacement.

The A and B batteries of the Model 78 can be tested without removal of the back if the function selector switch is turned to the A or B test position. The condition of the batteries will then be indicated on the BATTERY-CHECK scale as either OK or REPLACE. In the Model 78, the current supply for the ohms test is obtained from a third battery. The condition of this battery can be determined when the meter is set at zero.

PAUL C. SMITH



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Shop Talk

(Continued from page 11)

conventional tube testers. This is because the stability of the contact potential might easily be destroyed by the excessive current which might be drawn during ordinary tube checking with an emission type of tester. The risk is not quite so acute in the case of G_m checkers. As yet, Tung-Sol has no alternate suggestions to offer in the way of safe test procedures; but the problem is being studied carefully and some information on the subject is expected shortly. In the meantime, it would probably be desirable to use tube substitution rather than a tube checker for any suspected units.

The 12K5 is another newly developed low-voltage tube, but it differs considerably from conventional tubes in construction and mode of operation. The operation of this tube is dependent upon the space charge which is produced as a result of the fact that the first or inner grid is connected directly to the positive supply voltage. The combination of the cathode and first grid provides a very large virtual cathode which is necessary for high transconductance and low plate or output impedance. The second grid in the tetrode is the control grid, and the tube effectively operates as a triode. The tube will deliver as much as 50 milliwatts of driving power for the output transistor.

Another way of considering this tube is to regard it as an intermediary between the high impedance of an amplifier tube for small signals and the low impedance of a power transistor. Or, better still, it can be looked upon in the broader sense—as a voltage-to-current converter. Transistors require driving current or power, but vacuum tubes need driving voltage usually with very little power. The 12K5 is designed to reconcile these two opposing requirements.

A Power Transistor

So much for the new tubes in the Motorola receiver. Now let us inspect the power-transistor output stage. This appears, at first glance, to be unlike any other

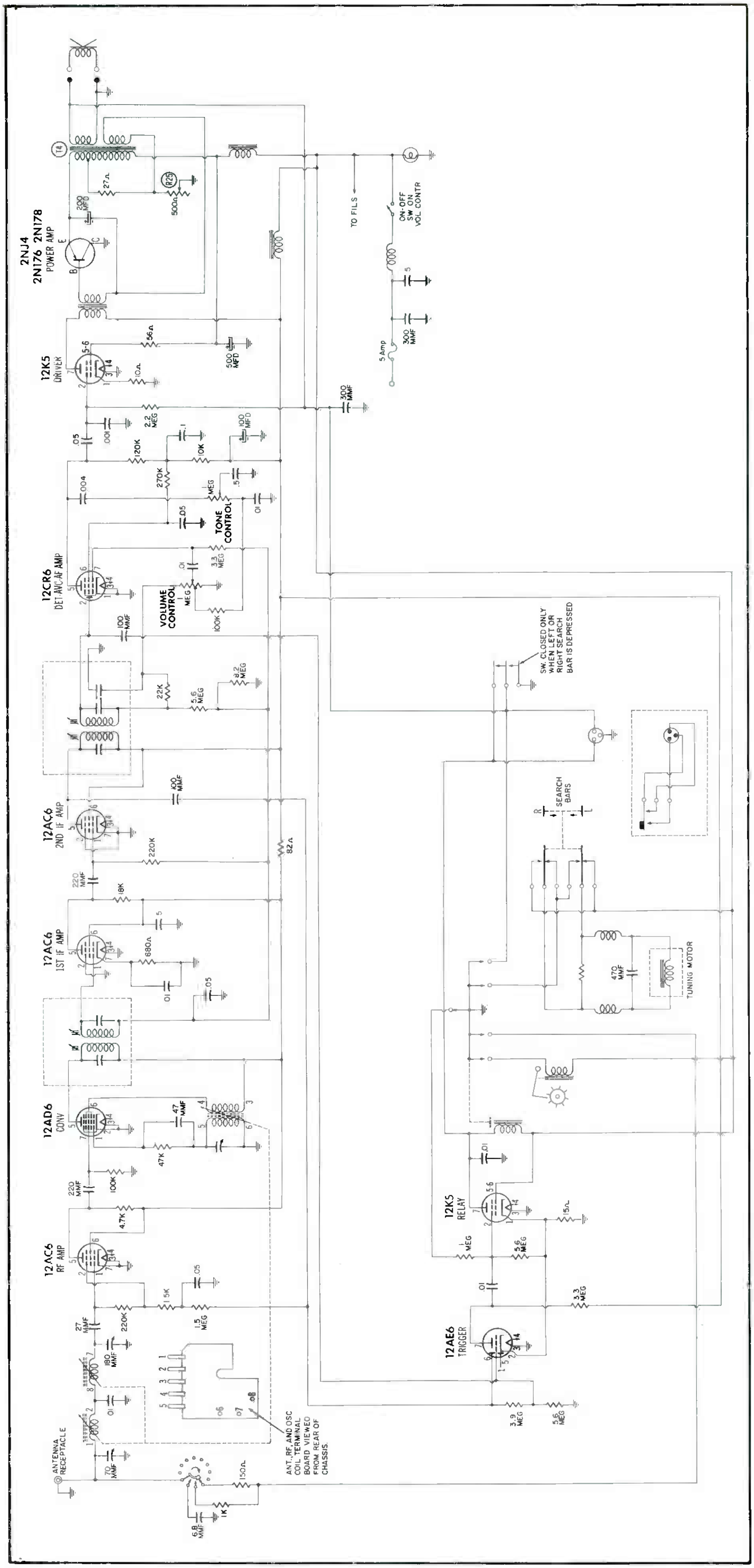

Fig. 1. Schematic Diagram of the Motorola Model 6TAS8 Auto Receiver.

similar stage that we have thus far seen. Part of the strangeness stems from the fact that the collector element of the unit is grounded. The use of this electrical feature is required by the physical construction of the transistor. A very serious limitation on the power-output capabilities of any transistor is the amount of heat that is generated internally. One way of coping with this problem is to de-

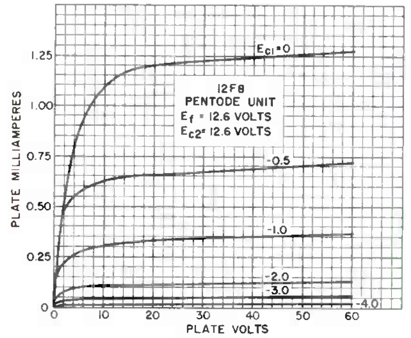

Fig. 2. Plate Current Versus Plate Voltage Curves for a 12F8. Note that the Plate Current Becomes Relatively Independent of the Plate Voltage at About 20 Volts or Less.

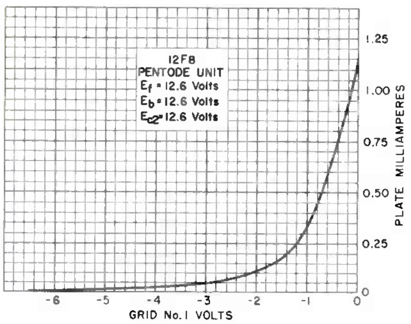

Fig. 3. $E_{g}I_{p}$ Curve for a 12F8.

sign the internal structure in such a way that the collector, at which most of the heat is developed, will be attached directly to the outer metallic housing. This housing, in turn, is directly fastened to the metal chassis of the receiver and provides a large radiating surface. In the present receiver, the transistor is mounted outside the receiver so that it will be as far away as possible from the tubes, because they generate heat, and from the confines of the enclosure, because heat is more likely to stagnate and remain there. Finally, as another measure to assist heat removal, the power resistor is surrounded on either side by several fins for heat radiation. See Fig. 4.

Returning to the circuitry of

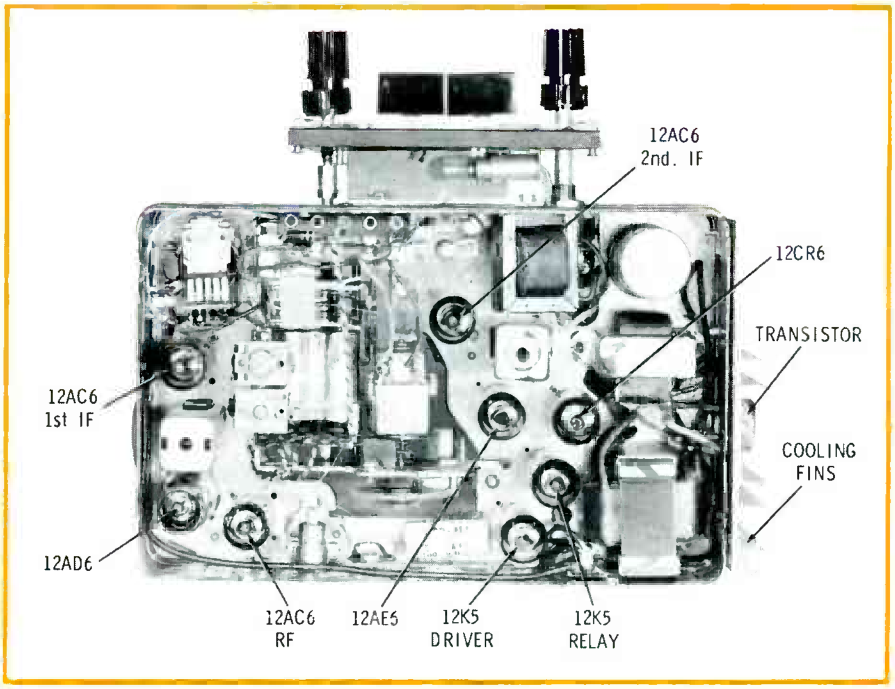

Fig. 4. Photograph Showing Placement of Tubes and Output Transistor in the Motorola Auto Radio. (Courtesy of Motorola, Inc.)

the output stage in the schematic of Fig. 1, we see that the collector is grounded and therefore connected to the negative terminal of the car battery. The emitter, on the other hand, receives the positive potential of the battery through the lower winding of the primary of T4. This still leaves the base unaccounted for. It receives whatever voltage is developed across R25, the 500-ohm potentiometer. The recommended adjustment for R25 is at that point where the emitter current is 500 milliamperes.

The lower primary winding on T4 transfers the audio signal to the secondary and thence to the speaker. The upper winding, according to the engineer who developed this circuit, serves to form this stage into a common-emitter amplifier. It does this in conjunction with the 200-mfd capacitor.

The connection of the 27-ohm resistor to the tap on the lower primary winding helps to improve the low-frequency response of the stage. Undistorted power output is 2.5 watts. The standard 10-percent distortion does not appear until 4 watts are reached.

Checking the Power Transistor

One of the methods for checking this power transistor, as recommended by Motorola, is with an ohmmeter. This check primarily measures the ability of the transistor to conduct current in one direction and to resist it in the opposite direction. The resistance in the direction of conduction is very low in relation to the resistance in the direction of nonconduction. The check is made with the ohmmeter leads connected as shown in Fig. 5.

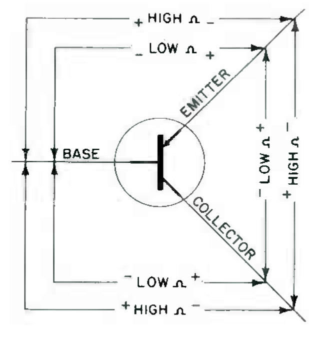

Fig. 5. Ohmmeter Connections for Checking the Power Transistor.

The reader may wonder why an ohmmeter check is recommended for this transistor and yet strongly condemned for many other transistors. The reason lies solely in the current-carrying capabilities of the transistor. If it can safely handle the current produced by an ohmmeter which is set to a low-resistance range, then the foregoing rough check may be performed without fear of ruining the transistor. If the safe current limits are low, as is frequently the case in low-power transistors, then an ohmmeter must not be used.

Audio Gain Controlled by AVC

Another interesting aspect of this receiver is the AVC circuit. If you check this section carefully, you will find that a 3.3-megohm resistor is connected between the AVC line and the control grid of the first AF amplifier (the pentode section of the 12CR6). This means that the gain of the audio amplifier is controlled by the AVC voltage. The purpose of this control is to provide a more constant output volume for wide variations in input signal. Signal variations which require adjustment of the manual volume control are particularly objectionable in automobile radios because the driver must divert his attention from his driving. Furthermore, because of the relatively high noise level in vehicles, the volume of a radio must be held within relatively close limits so that it will be neither too high nor too low. To simplify the operation of auto-radio sets, automatic tuning mechanisms are frequently provided; and as the receiver is automatically tuned from one station to another, it is desirable that the volume be adjusted automatically so that further operation of the volume control will not be required.

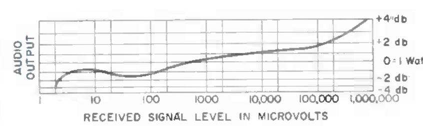

Fig. 6. Graph Showing Variations of Output Level with Variations of Received Signal Level.

By including the audio amplifier stage in the AVC network, we obtain a greater degree of control than it is possible to achieve by using only the RF and IF stages. This is amply demonstrated by the graph shown in Fig. 6. Note that the audio output varies only ±1.5 decibels for a variation in received signal from 5 to 100,000 microvolts. This is considerably better than is normally encountered with conventional AVC systems.

Milton S. Kiver

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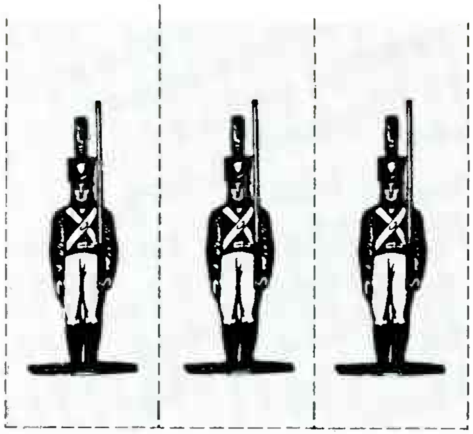

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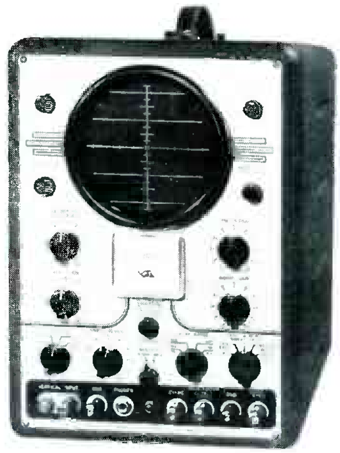

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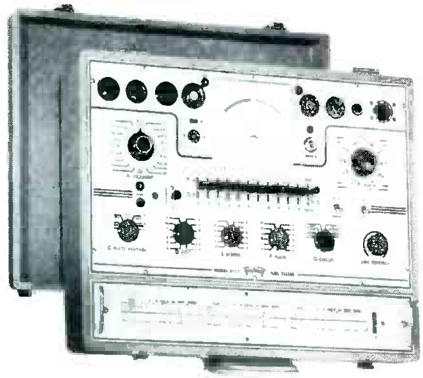

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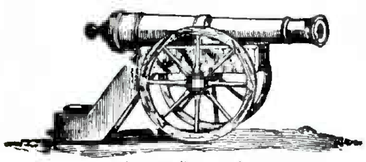

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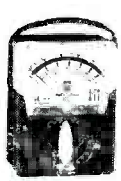

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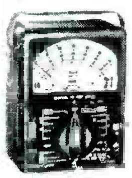

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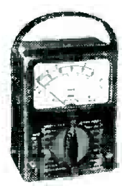

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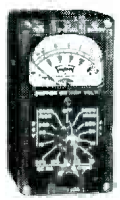

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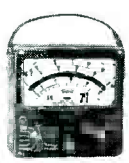

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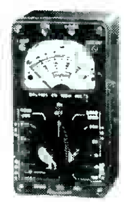

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Operation of Keyed AGC Systems

(Continued from page 19)

which reduces the gain of all stages controlled by the AGC system. Unfortunately, the amplitude of a weak signal at the grid of the RF amplifier is barely more than the amplitude of the noise which is present in that stage. When reception is poor, full gain in the RF stage is essential so that the signal-to-noise ratio can be kept high. Once the signal has been amplified above the level of the noise, it can be acted upon by AGC in the IF amplifiers without bad effects.

Provisions are therefore made for delaying the action of the AGC bias on the RF amplifier in most receivers which employ keyed AGC systems. The delay circuit includes a connection through a high resistance to B+. When a weak signal is being received, the tuner bias is sharply reduced because of the presence of this B+ connection. Included in most delay circuits is a clamper diode which conducts and shorts the AGC line to ground whenever the bias voltage tends to become positive. The circuit of Fig. 2 has this delay feature in the RF branch of the AGC line. The components which are included in the delay circuit are the resistors R3 and R4 and the clamper diode V2.

The operation of the delay circuit lowers the rate of increase of the RF bias voltage. The resulting difference between the RF and IF bias voltages is shown in the graph of Fig. 3. It can be seen that no bias is applied to the RF amplifier until the incoming signal is strong enough to develop −4 volts of bias in the IF section of the AGC line. The RF bias appears at this signal level, increases more rapidly than the IF bias, and eventually becomes greater than the IF bias. When the incoming signal is strongest, the RF amplifier is biased most heavily; and the signal is promptly reduced before it has a chance to overload any of the IF amplifiers.

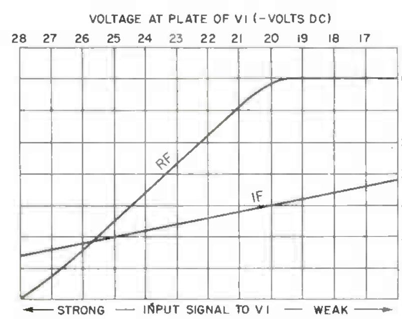

Fig. 3. Graph of the RF and IF Bias Voltages When an AGC Delay Circuit Is Employed.

The take-off point for the RF bias voltage is located between R3 and R4. This point is a tap on a voltage divider between a fixed B+ potential of 180 volts and the negative voltage which is present at the junction of R3 and R7. One-tenth of the total voltage difference is dropped across R3 because the resistance of R3 is one-tenth of the total resistance of the voltage divider. Although a sawtooth waveform of low amplitude is present in the voltage at the junction of R3 and R7, there is a pure DC voltage at the take-off point because of the presence of the filter capacitor C3.

If the average voltage at the junction of R3 and R7 is −20 volts, the difference of potential across R3 and R4 in series is 200 volts. The drop across R3 is:

$$\frac{1}{10} \times 200 = 20 \text{ volts.}$$

The voltage at the take-off point is 20 volts positive with respect to the voltage at the junction of R3 and R7, and therefore it is zero with respect to ground. When the junction voltage is −20 volts, an AGC bias of −4 volts is delivered to the IF amplifiers because of the 4 to 1 resistance ratio of 200K to 50K ohms between R7 and R8.

A decrease in the strength of the input signal would cause the voltage at the junction of R3 and R7 to become less negative. The IF bias would then be slightly reduced. The RF bias would attempt to become slightly positive, but V2 would conduct and would maintain the bias voltage at practically zero. If the input signal became strong enough to drive the voltage at the junction of R3 and R7 to a value more negative than −20 volts, the IF bias would increase in the proportion of 1 volt for every 5-volt change in the value of the voltage at the junction of R3 and R7. The RF bias would build up rapidly to the values shown in Fig. 3.

The manner in which the RF bias is developed is best explained mathematically by computation of the value of a point on the RF curve in Fig. 3. For this computation, it will be assumed that the voltage at the junction of R3 and R7 is −25 volts. The total voltage across R3 and R4 in series will then equal 25 volts plus 180 volts, or 205 volts. Since the resistance of R3 is one-tenth of the combined resistance of R3 and R4, the voltage across R3 will be one-tenth of 205 volts, or 20.5 volts. The RF bias voltage is taken from the less negative end of R3; consequently, this voltage will be 20.5 volts less negative than the value which is present at the other end of R3. The bias voltage will be the algebraic sum of −25 and +20.5 volts, or −4.5 volts.

In actual practice, the clamper diode is frequently a diode section of a combined diode-triode tube such as the 6AV6; therefore, a failure of the clamper tube may affect the operation of a seemingly unrelated section of the receiver.

The AGC Control

A variable resistor is often included in a keyed AGC circuit in order that the output of the keying tube may be varied in some manner. This provision is useful in adapting the receiver to different installations. The control may also be used to compensate for slight differences in the values of components among individual receivers of the same model. The exact location of the control in the AGC circuit is not standardized.

The AGC control is sometimes included as a part of the voltage divider in the RF branch of the AGC line. The control then can be used for the regulation of the amount of time delay in the application of AGC to the tuner. Another possible location for the control is the cathode circuit of the keying tube. The DC level of the cathode voltage depends upon the setting of the control, and the bias of the keying tube is therefore regulated. A third location in which a control is often found is the grid circuit of the keying tube. The setting of the control fixes the value of the DC voltage at the grid.

ADVANTAGES AND DISADVANTAGES OF KEYED AGC

The chief drawback of keyed AGC in comparison with other AGC circuits is the greater complexity of the keyed type. To the technician and the consumer, complexity means that there are more potential sources of trouble. For example, a defect in the horizontal sweep system can disrupt the action of keyed AGC and complicate the process of trouble shooting. The disadvantages of keyed AGC are unimportant, however, when compared with the unusually good performance of the circuit under adverse conditions. Keyed AGC therefore continues to be a popular circuit, and service technicians will profit from a thorough knowledge of its operation.

Henry A. Carter and
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Trouble Shooting With George

(Continued from page 31)

"That looks like overloading," he thought. "Some stage may not be getting enough supply voltage."

As he shifted the scope lead to the grid of the video amplifier, it occurred to him that he should have started with this stage instead of with the sync circuits because the reversed picture values indicated that the video signal was also being affected. Fig. 3 shows what George saw on the scope.

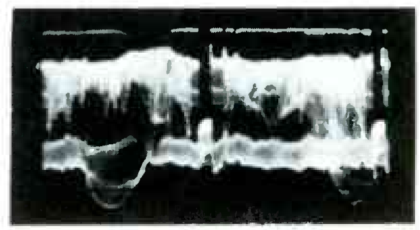


Fig. 2. Waveform Which George Saw at the Grid of the Sync Separator. Sweep Rate—30 CPS.

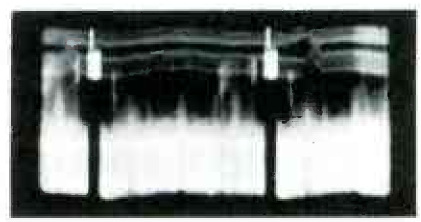


Fig. 3. Waveform at the Grid of the Video Amplifier. Sweep Rate—30 CPS.

"Now, this begins to look a little better," he thought, "but it is awfully fuzzy. The trouble could still be ahead of this point."

He noticed a regularly recurring signal which wandered through the waveform, and he correctly diagnosed it as the signal radiated by the horizontal deflection circuits. The signal was being picked up because of the high scope gain which was necessary for the weak video signal at this point.

George debated whether to work any further towards the tuner or to try a new approach—like, say, a few voltage or resistance checks. If he worked towards the tuner, that would mean working with a detector probe and weak signals; therefore, he decided to make a few voltage and resistance checks. Not that

George was lazy—he just thought that there might be something wrong with the video amplifier or detector stages and that it might be well to check more completely before going ahead toward the tuner and the video IF stages.

He picked up the leads to his multimeter and made a few voltage checks, comparing them as he went with the values quoted in the service literature for the receiver. "Nothing much wrong here," thought George. "All the voltages are within 10 per cent of the quoted values. Guess I'll have to use the probe after all. Not much use to make any resistance checks if the voltages are OK."

In preparing to use the detector probe, he shifted his equipment around on the bench for a little more convenient placement; and as he did so, he accidentally caught the antenna lead and jerked the clip loose from the antenna terminals of the receiver. Immediately, a pretty fair picture flashed onto the screen of the receiver! He clipped the antenna lead back to the antenna, and the picture returned to its original poor quality.

A broad grin of understanding replaced the rather preoccupied stare which George had maintained throughout the preceding tests, and he reached for the multimeter leads again. After a few quick measurements, he began to hum to himself as he removed and replaced a defective component. A quick check showed that the receiver operated normally. George reached for his hat—he would make it in time for supper after all!

* * * *

The reader has probably already guessed the defect which was causing George's trouble and has mentally criticized him for making some false starts instead of going directly to the trouble. After all, he stumbled onto the clue by accident! Well, we said he was relatively inexperienced, didn't we?

Check your opinion of what was wrong with this receiver by turning to page 53.

PAUL C. SMITH

Dollars and Sense

(Continued from page 33)

amperes so that it will outlast the fuse when put across the line.

P. S. S. Such engineering horseplay is to be deprecated in service shops; it interferes with getting out the work. Besides, fuses cost money.

P. S. S. S. We're gonna make one up ourselves. All work and no horseplay makes for a dull day.

UHF TODAY. In markets where UHF stations carry a good share of top network shows, 69 per cent of all TV sets have been converted for UHF reception, according to *Television Digest*. This compares to an average of only 64 per cent early in 1955. Cities without any strong VHF signals averaged 91 per cent on conversions.

With 100 UHF stations now on the air, this means that service technicians in some areas are getting a lot of UHF work. In areas completely dominated by VHF stations, however, such as the New York City market, there is no UHF reception and hence no UHF service work.

CREDIT. So that more people may be educated to enjoy color TV programs, the First Pennsylvania Banking and Trust Co., Philadelphia, is giving terms of 10 per cent down and 24 months to pay on color sets, as compared to 15 per cent for black and white. The goal is to give appliance dealers increased sales and profits and thereby stimulate banking business on time sales. Keep this in mind when you decide to push color hard; your own banker may also be willing to give a credit incentive that can be used as a sales argument for putting across color.

Mass demonstrations in showrooms have generally failed to produce sales of color sets, but the free home demonstrations are paying off in several areas. *Television Digest* reports that out of 113 sets put out on trial by Raymond Rosen & Co., Philadelphia, about 60 per cent were sold immediately. The sets are usually left in the home long enough for the prospect to see at least one good color spectacular or outstanding network color program.

A variation of the home-demonstration technique, reminiscent of home aluminumware parties, is the color TV party being organized by a Long Island dealer. As reported in *Electronic & Appliance Specialist*, this dealer obtains the co-operation of a prospective customer and induces her to invite a group of friends to see an evening color spectacular on the demonstration set. Coffee and cake are served. The hostess receives a commission in proportion to the number of color sets eventually sold to her guests by that dealer.

SLEEP ALARM. Electronic eyeglasses that sound an alarm when the driver of a vehicle starts dozing off were recently granted U. S. patent No. 2,726,380, according to an announcement in *Radio-Electronics*. The diagram shows tiny light sources at each hinge, and these are aimed at equally tiny photocells on each side of the nosepiece.

When the eyelids close, the eyelashes interrupt the light beams and reduce photocell current. In the circuit is a bistable multivibrator connected so that the second tube will be blocked and the first tube will be conducting when the driver's eyes are open. When the driver closes his eyes, the multivibrator goes into its other stable state; the second tube then conducts; and the relay in its circuit is energized to sound an alarm and wake up the driver. Normal blinking does not last long enough to actuate the relay.

A patent is a long way from a product. Economic aspects and human nature combine in this case to make the odds for success of this product pretty slim, so don't count on getting into the business of servicing keep-'em-awake spectacles this year. All we do have so far are the hearing aids built into spectacles.

CANCER. An unusual request came in the other day for a hearing aid operating in reverse. Cancer of the throat leaves patients able to talk in a whisper intelligible only to trained

· *Please turn to page 63*

Product Report

Editor's Note:
The material appearing in this column has been taken from literature supplied by the manufacturers of the various products. The *PF REPORTER* cannot assume responsibility for claims of originality or application.

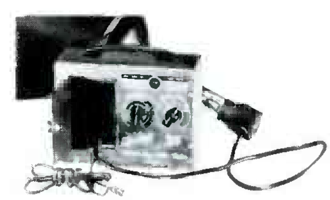
GERMANIUM-DIODE TUNER KIT

The J. W. Miller Company, Los Angeles 3, California, has introduced a kit version of their high-fidelity AM tuner.

This kit, part No. 565, includes all components and wiring instructions, and the instructions are accurate and easy to follow. Assembly and wiring of this tuner is not difficult.

The net price of the kit is $14.70.

PICTURE-TUBE TESTER



The Hickok Electrical Instrument Co., Cleveland 8, Ohio, is now producing the Model CR5 VIDEOCHEK which can be used to determine the condition and quality of picture tubes.

The VIDEOCHEK measures the peak beam current of electron guns of the tetrode type and measures the maximum emission of electron guns of the triode type. The instrument case measures 6 by 8½ by 3 inches and weighs 5 pounds.

SELENIUM-RECTIFIER TESTER

The Model 610 dynamic selenium rectifier tester has been announced by Winston Electronics, Inc., Philadelphia 27, Pa. The Model 610 uses a new principle called dynamic pulsing in which the rectifier under test is subjected to 30 pulses of voltage per minute. The quality of the rectifier, shorts, leakage, and open circuits are indicated on the meter scale.

The dealers' net price of the Model 610 is $22.95.

EXACT REPLACEMENT TRANSFORMER

The HVO-53 horizontal transformer has been introduced by the Merit Coil and Transformer Corp., Chicago, Illinois. This unit is an exact replacement for the horizontal output transformer in various Zenith receivers.

The list price for the HVO-53 transformer is $10.55.

PICTURE-TUBE BRIGHTENER

A new brightener for cathode-ray tubes is now being offered by Anchor Products Company, Chicago, Illinois.

The Anchor UB-160 Universal Britener employs an isolation transformer and operates with either series or parallel filament circuits.

ANTENNA PREAMPLIFIER

The Blonder-Tongue Laboratories, Westfield, N. J., is delivering a greatly improved Model CA-1 broadband VHF amplifier. It provides more than 26 decibels of gain on the low-band channels and 24 decibels of gain on the high-band channels.

The list price for the Model CA-1 is $79.50, and dealers' net price is $47.70.

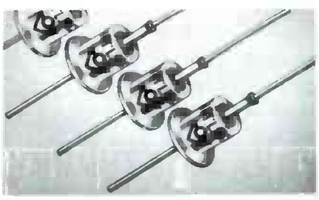
EXACT REPLACEMENT TRANSFORMERS

The Merit Coil and Transformer Corp., Chicago 40, Illinois, has announced two new exact replacement, horizontal output transformers—the HVO-56 and HVO-58.

The HVO-56 can be used to replace Westinghouse transformers bearing part Nos. V-9904, V-9904-1, 10204-1, 10213-1, and 12214-1. The list price is $10.35.

The HVO-58 can be used to replace Airline, Coronado, Raytheon, and Truetone transformers bearing part Nos. C-12E-23939, C-12E-24612, and C-12E-24612-1. The list price is $10.55.

SILICON POWER DIODES



The International Rectifier Corporation, El Segundo, Calif., is now producing silicon power diodes for industrial power supplies and for magnetic amplifiers.

The rectifying barrier of this type of diode is formed by the fused-junction process. The diode is hermetically sealed in a shockproof housing. These diodes are rated at 300 milliamperes of output current in free air and for 1.25 amperes when they are mounted on cooling fins.

VACUUM-TUBE VOLTMETER

Just announced by Radio Corporation of America is the WV-98A Senior Voltohmyst. This new meter measures DC voltages to 1,500 volts, AC voltages (rms and peak to peak) to 4,200 volts, and resistance to 1,000 megohms.

The WV-98A has a large, 6½-inch meter and weighs 6 pounds. The case measures 6½ inches high by 7 inches wide by 3¾ inches deep. The WV-98A retails for $75.00.

In the Interest of Quicker Servicing

(Continued from page 17)

CHART I
TUBES NEEDED FOR RADIO SERVICING

0Z4	†6AV6	6X4	12SK7GT
1R5	†6BA6	6X5GT	12SQ7
1S4	6BD6	12AW5	12SQ7GT
1S5	†6BE6	12AS5	12V6GT
1T4	†6BF6	12AU6	12X4
1U4	†6C4	†12AU7	†25L6GT
1U5	6CM6	12AT6	35A5
1U6	6CR6	12AV6	35B5
3Q4	6SA7	12BA6	35C5
3S4	6SA7GT	12BD6	35L6GT
3V4	6SK7	12BE6	35W4
†5Y3GT	6SK7GT	12BF6	35Z5GT
†6AQ5	†6SQ7	12SA7	50B5
†6AT6	†6SQ7GT	12SA7GT	50C5
†6AU6	†6V6GT	12SK7	50L6GT

that you are regularly encountering radios that have tubes not listed in this chart, then it may be desirable to add them to your stock.

A basic stock of parts for radio servicing should include the following items:

1. A universal audio output transformer of the single-ended type.
2. A universal audio output transformer of the push-pull type.
3. Several 50/30/30-mfd, 150-volt capacitors.
4. One 5-inch speaker.
5. Assorted resistors and capacitors which should already be in stock for television service work.

Parts such as IF transformers, oscillator coils, loop antennas, and printed-circuit units can be obtained as needed.

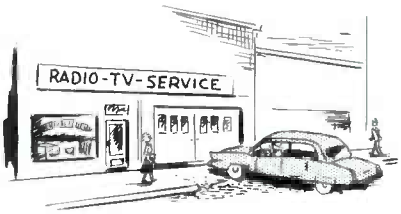
Judging from the list of necessary parts and equipment, it can readily be seen that the outlay of capital necessary to set up a radio-servicing operation is comparatively small. If the owner of a small service shop is in need of immediate additional income, he could by the judicious purchase of only the necessary tubes and parts begin to realize a profit from radio servicing almost at once (taking for granted that all necessary basic tools, equipment, and parts for television servicing are already on hand). The separate bench for radios could be set up at a later time when sufficient money was available for this purpose.

Delivery Charges

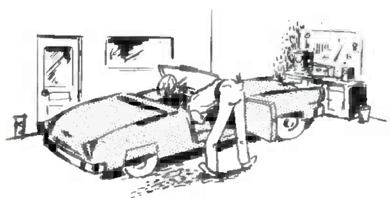
If a small radio is picked up while you are on a television service call, you have the problem of considering how to return it after the repair work has been completed. Most customers will not want to pay a delivery charge to have a small radio returned to them after it has been repaired, and it is not economical for you to deliver a small radio free. For these reasons, it is desirable to have the customer pick up his own radio after it has been repaired and tested. One other possible alternative is to deliver the radio when you have to be in that neighborhood on a television service call. Large console radios will naturally have to be delivered, but the customer will usually expect to pay for this service.

Auto-Radio Servicing

Auto-radio servicing is another possible source of added income during the summer months. The service shop should have a parking space close to the building to provide a place for a radio to be removed from or reinstalled in the car. The ideal situation would be if the parking space were in a garage attached to the service shop. This would provide protection from the weather and would also make it possible to repair some auto radios without removing them from the car.



A battery eliminator that can produce 6 and 12 volts DC at the required currents and a standard auto-radio antenna are additional pieces of equipment required for auto-radio servicing. An assortment of buffer capacitors and several standard 6- and 12-volt vibrators are additional parts which are required.



Most of the tubes currently being used in auto radios are included in the list of Chart I. There are other auto-radio tubes which are not listed in the chart, but they are in a minority and are used mostly in the earlier models.

Conclusion

Although this article is presented to help eliminate the loss in income from television servicing during the summer months, the fact that radio, phonograph, recorder, and auto-radio servicing can be a very profitable operation on a year-round basis should not be overlooked.

CALVIN C. YOUNG, JR.

TROUBLE SHOOTING WITH GEORGE
The Solution

George noticed that a fairly normal picture was obtained from the local station when the antenna was disconnected but that overloading occurred when the antenna was connected. He was reasonably sure that one or more stages between the antenna and the video detector were being overloaded. One of the possible causes for this condition would be a loss of AGC voltage, and a voltage check confirmed this possibility. An AGC capacitor was found to be shorted, and its replacement cured the trouble.

ANTENNA TROUBLES

WHAT TO CHECK IN AN ANTENNA SYSTEM

by George B. Mann

A television receiver has a clear, steady picture on the screen. The owner insists that the picture will flicker and flash for long periods of time some evenings while he is watching it but that the set works fine at other times. A complete check of the receiver failed to indicate any trouble. This was a good time to consider whether the interference could be caused by the outdoor antenna system.

An intermittent trouble of the kind described can be caused by an antenna which has been in use for a considerable length of time. It will usually appear after the antenna system has been exposed to extreme temperature changes, high winds, and ice loading. The strain placed upon the antenna by these conditions can cause the mechanical connections to become loosened, corroded, and even broken.

In many instances, a defect in an antenna system cannot be detected easily because of the prevailing weather conditions. It is possible that the interference will take place only during the time that the wind is blowing from a particular direction or possibly in gusts. In such cases, it is an advantage for the technician to check the reception at the time the interference is occurring. The outside antenna can be disconnected, and an indoor antenna or a signal generator can be attached to the receiver terminals. This will help to determine whether the television receiver is at fault. If it is decided that the antenna is creating the interference, it then becomes a problem of inspecting the entire antenna system.

Continuity Check

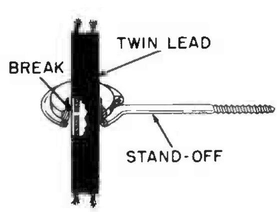
A continuity check can be performed to determine whether the antenna system is open or shorted. An antenna which completes a direct current path between the lead-in conductors can be tested with an ohmmeter for continuity or poor terminal connections. The ohmmeter should give a low resistance reading when it is connected to the ends of the lead-in after they have been disconnected from the receiver. A reading that shows a high or changing resistance will indicate a corroded or loose terminal connection or a broken lead-in.

Antennas such as the conical do not complete a direct current path between the lead-in conductors. An ohmmeter check on an antenna system of this type will only indicate whether the lead-in or antenna is shorted or not.

Transmission Line

Interference caused by a break in the lead-in will not always show up in the test for continuity. Fig. 1A shows an antenna terminal connection which is partially broken, but the few strands of wire will complete a DC circuit. When the lead-in is bent or flexed, the broken ends touch each other; and at television frequencies, this

(A) At Antenna Terminals.



(B) Near a Standoff Insulator.

Fig. 1. Breaks in Lead-in Wire.

intermittent contact can cause a flickering in the received picture.

Transmission-line conductors can also be broken inside the insulating jacket without breakage of the insulation or without a visible mark on the surface of the lead-in. Most breaks of this type occur next to a lead-in clamp or standoff, as shown in Fig. 1B. A constant bending or flexing of the

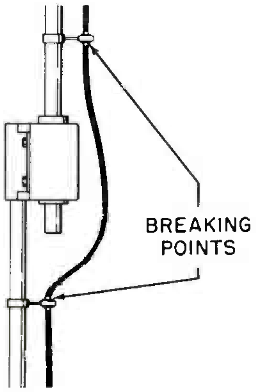


Fig. 2. Possible Breaking Points Near a Rotator.

twin lead causes the wires to break near the place where the conductors are clamped. An installation which employs an antenna rotator is an example. The antenna lead-in is fastened above and below the rotator, as shown in Fig. 2. The loop of transmission line is free to move in the wind and is also bent each time the antenna is turned. In time, the constant movement of the lead can cause it to break near the standoff insulator.

When the lead-in is used to carry UHF frequencies, a single broken strand of wire in the conductor is enough to cause an objectionable amount of interference in the received picture.

Antenna lead-in conductors do not break readily; but over an extended period of time, the constant bending of the wires will cause them to break. When a lead-in conductor does break, the wire is usually old; therefore, it is not important to locate a particular break but only to know that one exists. There is a possibility that more than one break exists or that others will occur in the near future. Defective transmission line should be completely replaced with new line so that the danger of future lead-in failures will be reduced.

Contacts Between Metal Surfaces

Every metal-to-metal connection in an antenna installation is a possible source of interference. The mechanical connections which were tight when the antenna was installed can become loosened or corroded. The continual stresses which are placed on the connections will loosen some of them until intermittent contact will be made between the two surfaces. Loose contact between different metal parts at any point in the installation will cause some effect on the signal.

The bolts and clamps throughout the installation should be checked to make sure that they are tight. Bolts which have become excessively corroded should be replaced by new ones. Particular attention should be given to a connection which is corroded even though it seems to be mechanically solid. Corrosion between metal surfaces acts as an insulator, and these connections should be loosened and cleaned and then tightened again. It is important that all of the metal parts which contact each other should be securely fastened together to prevent intermittent contact.

Metal Surfaces Near Antenna or Lead-in

The intermittent flickering which is usually caused by poor connections in the installation can also be produced by poor bonding between large metallic surfaces which are near the antenna. Metal flashing, eaves troughs, and downspouts that are not bonded together or are badly rusted can create interference. These metal surfaces should be bonded together and connected to an earth ground.

The effects produced by unbonded metal surfaces increase as the received frequencies become higher. Particular note should be taken of these surfaces when the antenna is installed for reception of UHF transmissions. A minimum amount of trouble will be encountered in such installations when all of the metal near the antenna is bonded together and properly grounded.

George B. Mann

Audio Facts

(Continued from page 23)

The amount of negative feedback that can be used is limited for several reasons. In the first place, we can realize that the full signal could not be fed back because the output would then drop to zero. This is never approached in actual practice because more than 20 decibels of feedback are seldom applied in a single feedback loop.

If 20 decibels of feedback were used in such a manner as to be fully effective, distortion and noise in the circuit would be reduced by a factor of 10. The gain of the circuit would be reduced by a factor of 10 also; therefore, ten times the amount of signal required before the feedback was applied would have to be used to obtain the same power output. For example—if 0.1 volt of input signal were required for a 20-watt output from an amplifier without feedback, then 1.0 volt of input signal would be needed to obtain the normal output of 20 watts after 20 decibels of feedback were applied.

An amplifier must be carefully designed and must make use of high quality components if any large amount of negative feedback is to be utilized satisfactorily. Otherwise, the operation of the amplifier can become very unstable even when only a moderate amount of feedback is applied. We will say more about that later.

One thing we must remember is that negative feedback is not a cure-all and that it must not be relied upon to make an excellent amplifier out of one that was poorly designed and has undesirable characteristics. Negative feedback can make a very noticeable improvement in the operation of a rather mediocre amplifier, but it cannot work miracles.

A partial schematic diagram of a typical amplifier circuit in which the output transformer is included in the negative-feedback loop is shown in Fig. 2. A portion of the signal voltage developed across the load (the voice coil of the loudspeaker) is fed back to the cathode of the tube V1 in the input stage. The amount of signal fed back depends upon the resistance value of the feedback resistor R4. A large value of resistance reduces the amount of feedback, and a low value increases the feedback.

The feedback signal must be 180 degress out of phase with the input signal in order to produce the desired effects on the output signal. While the 180-degree out-of-phase relationship can be maintained readily at midfrequencies, the extreme low and high ends of the frequency range present some difficulties in this respect.

Circuit components, particularly the output transformer and the coupling capacitors, tend to shift the phase of the signal at the extreme high and low frequencies. The phase can be shifted so far that the feedback becomes positive at high and low frequencies. This situation can cause the amplifier to become very unstable at the frequency extremes because positive feedback produces oscillations. The feedback may become positive only on signal peaks, and therefore the oscillations may occur in bursts and only at certain frequencies. This condition

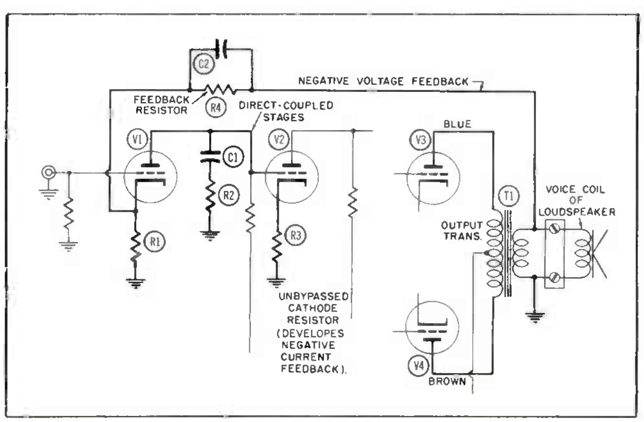


Fig. 2. Partial Schematic Diagram of a Typical Amplifier Circuit Using Negative Feedback.

can give rise to many peculiar and disturbing forms of distortion. Loudspeakers have been blamed for a rattling or buzzing sound when the amplifier was actually at fault.

Various precautions are taken to prevent or at least to reduce the phase shift and thereby stabilize the operation of the amplifier. Output transformers with sufficiently low leakage reactance are a necessity. Very large coupling capacitors are employed where required, or capacitors are eliminated altogether by application of direct coupling. Phase- and frequency-correction networks, such as the resistor R2 and the capacitor C1 in the plate circuit of the input stage V1 or the capacitor C2 across the feedback resistor R4, aid in stabilizing the amplifier.

Since the feedback signal must be 180 degrees out of phase, the output transformer must be correctly phased in the circuit. For instance, if the plate leads of the transformer were reversed so that the blue lead went to the plate of V4 and the brown lead went to the plate of V3, the phase of the feedback signal would be reversed and the feedback would become positive. The amplifier would oscillate and produce a terrific roar or howl if a loudspeaker were connected to the output.

The feedback employed in the circuit we have been discussing is voltage feedback because the feedback signal is a portion of the signal voltage developed across the voice coil of the loudspeaker. The results obtained from the use of negative feedback in this circuit are typical of the desirable effects of voltage feedback when it is applied properly. We can list them as follows:

- Distortion is reduced.
- Certain types of hum and noise are reduced.
- Output impedance is decreased.
- Loudspeaker damping is increased.
- The effects of the varying load presented to the amplifier by the loudspeaker are decreased.
- Frequency response is increased.

Something that can be mentioned at this time is that tone controls should not be located inside a feedback loop because much of their effectiveness will be nullified by the negative feedback. That is one reason why tone controls and other compensating circuits are usually located in another section of the audio system.

The use of an unbypassed cathode resistor is another method of obtaining negative feedback. As an example, R3 in Fig. 2 produces current feedback. Some of the effects of current feedback are the same as those obtained with voltage feedback, but others are opposite. Some of the characteristic effects of current feedback are:

- Distortion is reduced.
- Gain is reduced.
- Plate resistance of the stage in which the feedback is located is increased.
- Effect of load impedance on the output voltage is increased.
- Loudspeaker damping is decreased when current feedback is applied.

The damping applied to the loudspeaker can be controlled by varying the amount of feedback. The damping control circuit (Fig. 3) of the Electro-Voice A20C Circlotron amplifier is a good example of this application of negative feedback. Two negative-feedback loops are used. One is voltage feedback, and the other is current feedback. The damping factor can be changed by varying the ratio of the voltage feedback to the current feedback.

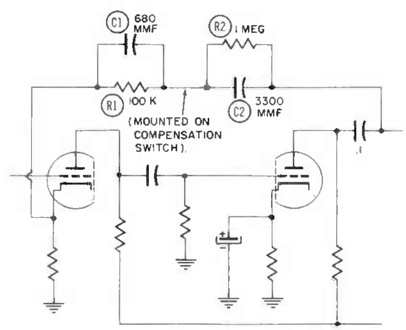


Fig. 3. Circuit of the Damping-Factor Control Used in the Electro-Voice A20C Circlotron Amplifier.

Negative feedback is developed by the voltage-feedback loop connected from the top (or 16-ohm tap) of the output transformer through the feedback resistor R2 to the moving contact of R1A in the cathode circuit of the input tube. When the moving contact is moved to the top or cathode end of R1A, negative voltage feedback will increase to maximum and the maximum damping action will be produced.

Negative feedback is developed in the current feedback circuit connected from the common (C) tap through R1B to ground. When the moving contact of R1B is moved toward the top or cathode end, current feedback will decrease because the resistance is reduced toward zero as R1B is progressively shorted to ground.

When R1B is moved in the opposite direction, current feedback is increased. Here we should recall that loudspeaker damping decreases as negative current feedback increases and that the damping increases when negative voltage feedback increases.

R1A and R1B are ganged and must turn together; therefore, when the damping-factor control is moved to maximum, the negative voltage feedback produces the desired maximum damping factor and no current feedback is produced because R1B is shorted.

When the damping control is set to the minimum position, then minimum negative voltage feedback is developed and the damping factor is reduced. But in this minimum position, maximum negative current feedback is produced; and this in turn also reduces the damping factor. In this way, a large range of damping can be obtained; but since negative feedback is always applied, distortion will be held to a minimum value at any setting of the damping-factor control.

Negative feedback can be utilized by tone controls, by compensation circuits for magnetic cartridges, and by record-playback compensation circuits in phono preamplifiers to modify the frequency response of an amplifier. This action is possible because the negative-feedback loop can be made frequency selective. The feedback network is modified in such a way that certain frequencies are fed back while other frequencies are not. The frequencies that are fed back are attenuated because negative feedback reduces gain, but those that are not fed back are not attenuated and are effectively boosted.

Fig. 4 shows a typical phono-preamplifier circuit in which compensation (bass boost) is obtained with a frequency-selective feedback circuit. C1 (shunted across the feedback resistor R1) and C2 (shunted by R2) offer very little opposition to the feedback of high frequencies; consequently, these

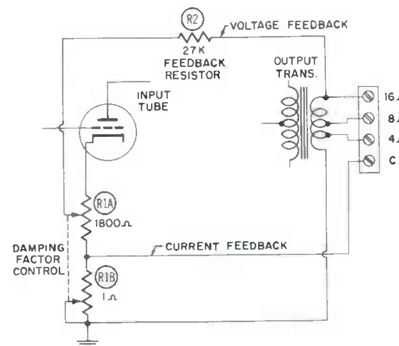


Fig. 4. Typical Phono-Preamplifier Circuit Using Negative Feedback for Compensation.

frequencies are fed back and attenuated. The reactance of C1 and C2 becomes progressively greater as frequency is lowered, and therefore the low frequencies are not subjected to as much loss and are effectively boosted. The compensation can be made to follow most any desired curve if the appropriate network of resistors and capacitors is inserted in the feedback circuit. The values shown in Fig. 4 have been used for RIAA record compensation.

The same basic action is used with tone controls that employ negative feedback for control of frequency response. A variety of such tone-control circuits are used, and some of them can appear to be very elaborate and complicated; but all of them make use of the frequency-selective feedback action.

The definite advantage of using negative feedback in equalizing circuits is that, in addition to the compensation obtained, distortion and noise are reduced by the action of the feedback.

ROBERT B. DUNHAM

Know Your Oscilloscope

(Continued from page 21)

A variety of probes are designed for use with oscilloscopes. These include low-capacity, high-impedance, and demodulator probes. The loading effect of the input circuit of the oscilloscope is normally very low, but it can be decreased to an even lower amount by the use of the first two probes mentioned. The demodulator probe is useful for tracing modulated RF signals through receiver circuits. Other probes not shown are the cathode-follower and the voltage-divider types.

Another accessory that should be mentioned is the electronic switch. This is really an instrument in its own right rather than just an accessory because it can also be used as a source of square waves. When used with an oscilloscope, it provides two traces on the screen so that two signals can be viewed simultaneously.

Fig. 1. Some Accessories for an Oscilloscope. (A) Simpson Model 276 Oscilloscope Calibrator. (B) Triplett Low-Capacity Probe. (C) Jackson Low-Capacity Probe. (D) Simpson Peak-to-Peak, High-Frequency Probe.

Conclusion

We conclude this series on the oscilloscope with a list of general hints for using the instrument. Some of these have been mentioned previously but will bear repeating.

1. Keep the intensity of the beam low when the oscilloscope is not in actual use, and avoid burning the screen.
2. Do not exceed the voltage rating of the input capacitor by applying too large a signal. This includes the sum of both AC and DC

voltages which may be present.

3. Use a probe of proper design if there is any possibility that the signal may be distorted without it.
4. Keep in mind the frequency limitations of your amplifiers. The fact that a response curve is seen on the screen is no guarantee that it is accurate if frequency limitations are exceeded.
5. Do not use too much sync signal or the response may become distorted and synchronization will be difficult to achieve. It is better to set the natural sweep frequency of the oscilloscope just a little lower than that of the signal rather than equal to it. Synchronization will be easier in this case.
6. Make large changes in attenuation with the step attenuator, and then make smaller changes with the vernier attenuator afterwards. There is less danger of overload distortion in this manner. Check for distortion of the curve by changing attenuator settings while watching the curve for changes in overall shape.
7. View at least two cycles of a signal, if possible. If only one cycle is viewed, some important details may be lost during the retrace time.

PAUL C. SMITH

AFC Circuits in FM Receivers

(Continued from page 25)

the main function of an AFC tube; therefore, it is commonly called a reactance tube. A circuit of this same general type can be designed so that it will have inductive reactance, but this article will deal only with the capacitive circuit because this is the one which is used in many FM receivers.

The theory behind the operation of a typical reactance tube will be explained with the aid of the simplified schematic diagram in Fig. 3. The circuit in this figure may be broken down into three

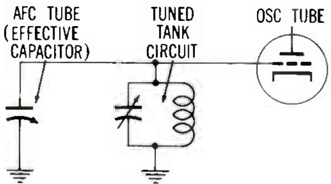


Fig. 2. Equivalent Circuit of an AFC Tube and a Tuned Tank Circuit.

parts. One of these is the tuned tank composed of C4 and L1; the second is the cathode-to-plate circuit of the reactance tube; and the third is a feedback network which includes C1, R1, and the coupling capacitor C3.

The RF voltage that is generated in the oscillator tank is impressed across the feedback network. The reactance of the capacitors C3 and C1 is much greater than the resistance of R1; consequently, the phase of the current which passes through the feedback network will lead the phase of the applied voltage. When the feedback current passes through R1, a voltage which is in phase with this current is developed across the resistor. The voltage across R1 is applied to the grid of the reactance tube.

The AC plate current of the tube will be in phase with the grid voltage. This fact can be illustrated by the observation that the plate current increases when the grid voltage goes in a positive direction.

The AC plate voltage of the tube is identical with the voltage that is fed back from the oscillator through C3. If the plate current is compared with the plate voltage, it will be seen that the former is leading the latter. This behavior is characteristic of a capacitive circuit.

The tube circuit in Fig. 3 has a constant value of capacitance because steady conduction is maintained through the tube. In a circuit in which the DC grid voltage of the tube can be varied, the conduction can be increased or decreased and the capacitance of the circuit can be changed. A swing of grid voltage in a positive direction allows a relatively large capacitive current to pass through the tube. This capacitive current is added to that which is present in the tank circuit. The increase in capacitive current has the same effect as a decrease in the capacitive reactance of the tank circuit, and the frequency of the oscillator is lowered. On the other hand, a negative swing of grid voltage causes a decrease of capacitive current through the reactance tube. The capacitive reactance of the parallel combination of the tank circuit and the reactance tube then appears to be increased, and the oscillator frequency rises.

Details of AFC Circuits

The AFC circuit of an FM tuner is shown schematically in Fig. 4. This circuit has many features which are typical of present-day designs. The AFC tube is one half of a 12AT7 dual triode, and the other half of the same tube serves as the local oscillator. In recent years, the 12AT7 has been by far the most popular tube for use in AFC circuits. Other tubes which are sometimes used are a separate 6AB4 triode or the pentode section of a 6U8.

The control voltage is derived from the output voltage of a ratio detector. This output contains audio-frequency variations, but these are centered upon some DC reference level. When the output signal is put through a low-pass filter, a DC voltage which corresponds to the reference level is obtained. The level of this DC voltage is zero when the frequency of the input signal of the ratio detector is correct. The voltage becomes positive when the frequency

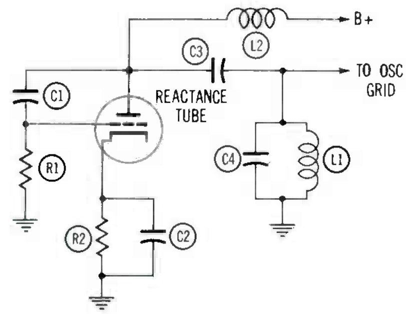


Fig. 3. Basic Circuit of a Reactance Tube.

of the input signal increases, and it becomes negative when the input frequency decreases. The control voltage is produced as long as an output signal is developed by the ratio detector; therefore, the AFC system may be expected to have control of the oscillator frequency whenever sound from a

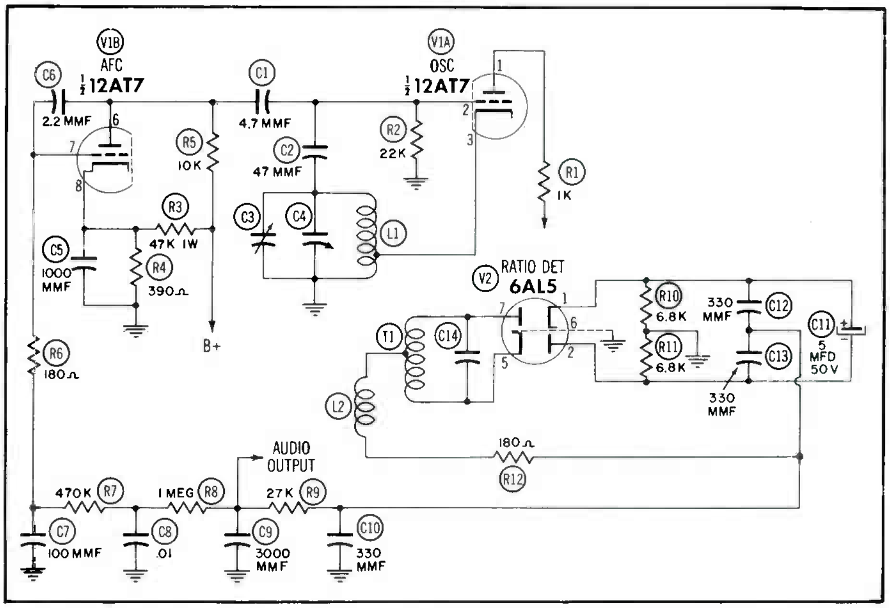


Fig. 4. AFC and Oscillator Circuits of the Packard-Bell Model 10RP1 Tuner.

station can be heard from the speaker.

The control voltage drops off abruptly at the limits of the band-pass of the ratio detector, but the audio output drops off at the same time. Stations therefore seem to "snap" in and out of tune instead of fading in and out gradually when an FM receiver equipped with AFC is tuned through its range.

The design of the AFC filter will be found to vary only slightly among the different makes of FM receivers. The input resistor (R8 in Fig. 4) is very large in value. The combination of R8 and C8 has a long time constant, and these two components filter most of the audio signal out of the AFC control voltage.

The resistor nearest the grid of the AFC tube serves as a part of the feedback network of the AFC tube. This resistor is R6 in Fig. 4 and also corresponds to R1 in Fig. 3. The connection of R6 to ground is made through the 100-mmfd capacitor C7. If a direct connection were made, it would be difficult to apply an adequate DC control voltage to the grid. Fortunately, a direct ground is unnecessary. C7 has little reactance at the very high frequency of the FM local oscillator, and the feedback signal readily follows the path through C7 to ground. The phase of the grid voltage is barely shifted by C7.

A capacitor must have extremely low capacitance if it is to present much reactance to a signal at the oscillator frequency. C6 in Fig. 4 has the same function as the feedback capacitor C1 in Fig. 3, but C6 has a value of only 2.2 micromicrofarads. The coupling capacitor C1 in Fig. 4 corresponds to C3 in Fig. 3, but C1 like C6 has very low capacitance (4.7 micromicrofarads).

Remember that the resistance of R6 must be equal to a very small fraction of the reactance of C6 in order that the proper phase shift will occur in the grid circuit of the tube. The ohmic value of R6 is consequently made very low. The grid resistors of AFC tubes in FM receivers will consistently be found to have values of a few hundred ohms at the most.

In the circuit of Fig. 4, the cathode of the reactance tube is connected to the B+ line through the 47,000-ohm resistor R3. This resistor and the 390-ohm resistor R4 form a voltage divider from B+ to ground. The cathode voltage has a value of approximately one volt. One function of the voltage divider is that of keeping the cathode voltage at a reasonably constant level. If there were no divider, the value of the cathode voltage would depend solely upon the amount of tube current passing through R4. A change in tube conduction would cause a rise or fall in cathode voltage. For example, a positive swing of DC voltage on the grid would cause an increase in the conduction of the tube. The cathode voltage would then become more positive, and some of the effect of the change in grid voltage would be canceled. When R4 is used as a

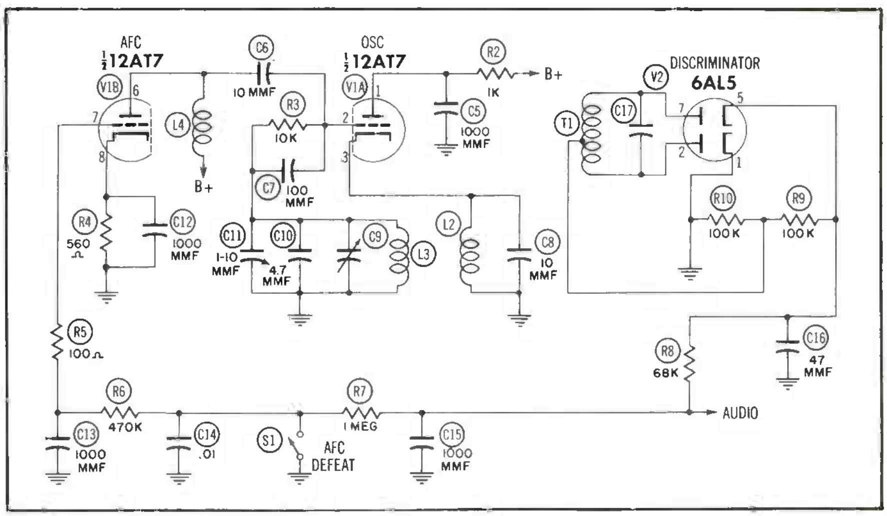


Fig. 5. AFC and Oscillator Circuits of the Harman-Kardon Model D200 Tuner.

part of a voltage divider, additional current passes through the resistor and plays a part in the determination of cathode voltage. This extra current does not fluctuate according to the state of conduction of the tube, and the net result is that the cathode voltage remains relatively steady. The grid voltage then has the greatest possible effect upon the bias of the tube.

Another AFC circuit is shown in the schematic diagram in Fig. 5. The control voltage for this second circuit is the filtered output voltage of a discriminator. This output is the same as that which is obtained from a ratio detector. The filtered voltage is zero when the oscillator frequency is correct, and the voltage will vary in either a positive or a negative direction if there is an error in oscillator frequency.

This circuit contains no actual capacitor which corresponds to C1 in Fig. 3; instead, the grid-to-plate capacitance of the AFC tube fulfills the function of the feedback capacitor. The feedback network also includes C6, R5, and C13.

The AFC circuit of Fig. 5 is in operation whenever the main selector switch of the receiver is in the FM position. A special AFC defeat switch is provided so that the listener will have a convenient means of disabling the AFC circuit momentarily. When the tuning knob is pushed inward, the switch is closed and the control voltage is shorted to ground. This switch is especially helpful when the listener is trying to tune in a weak station which is very close in frequency to a strong station. Under these conditions, the AFC system sometimes ignores the weak station and attempts to adjust the oscillator frequency for reception of the strong station. If this happens, the defeat switch should be closed until the weak station has been tuned in precisely. The AFC circuit should then give satisfactory results when it is put back into operation.

The main selector switches of some receivers have two positions in which FM programs can be received. The AFC circuit operates normally when the switch is in one position, but the control voltage is removed from the grid of the AFC tube when the switch is turned to the other position.

Defects in AFC Circuits

Troubles that might seem to be in the AFC circuit are frequently secondary effects of troubles in related circuits such as the oscillator or the detector. The most serious kind of defect that can originate in the AFC circuit itself is an intermittent condition which gives rise to erratic conduction of the AFC tube. Uneven conduction will cause random changes in the capacitance of the AFC circuit. The frequency of the oscillator will then shift erractically, and distortion in the sound will be noticed from time to time.

Many AFC defects will cause the receiver to behave as if it had no AFC circuit. Clear sound can still be obtained if the receiver is tuned carefully, but the oscillator may drift. Defects such as low transconductance in the AFC tube will tend to change the capacitance of the AFC circuit, but the listener will not be conscious of any trouble in this case. He will probably tune the oscillator to a slightly different frequency, and he will compensate in this way for the defect.

Thomas A. Lesh

Dollars and Sense

(Continued from page 49)

ears. Availability of a miniature portable public-address system would allow many of these people to get along without an interpreter.

We suggested starting with one of the new lightweight pocket portable radios and having a service technician hook up a throat microphone to the audio input through an appropriate switch. It would probably be necessary also to convert the IF stage into an audio preamplifier, since audio gain in a portable is not usually enough for a microphone.

Such conversions mean extra business for a service organization and give a rewarding feeling through helping someone to get along despite a handicap. For an interesting and challenging meeting of your service organization, why not invite a local surgeon to talk about problems like this and follow with a round-table discussion of possible solutions that are economical to the patient and within the realm of the average service shop.

John Marcus

PF REPORTER

INDEX TO ADVERTISERS

July, 1956

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valuable manufacturers' data available to our readers

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Electrolytic and paper capacitors are among the hundreds of types shown in this 16-page pocket-sized guide to this important replacement component. Ratings and prices of single and multiple units listed. *See advertisement page* 16.

2U. BELL (Bell Sound Systems, Inc.)

Complete catalogs on "Pacemaker" P. A. line, catalogs on "Bell" P. A. line (5600 Series), full-color literature on Bell High Fidelity Amplifiers, "Golden Twin" Hi-Fi ensembles, and RT-88 and RT-75 Tape Recorders. *See advertisement page* 47.

3U. BLONDER-TONGUE (Blonder-Tongue Labs., Inc.)

"B-T Labs Bulletin," Bi-Monthly Newsletter and Model FSM-1 Field Strength Meter data. *See advertisement page* 57.

4U. BUSSMANN (Bussmann Mfg. Co.)

Bulletin showing fuses and fuse-holders adapted to protection of TV and other electronic equipment (Form SFB). *See advertisement page* 4.

5U. CHICAGO STANDARD (Chicago Standard Transformer Corp.)

TV Transformer Replacement Guide and Library. Auto Radio Transformer Replacement Guide. *See advertisement pages* 10, 60.

6U. CLAROSTAT (Clarostat Mfg. Co., Inc.)

Form No. 754488. Fixtohm Deposited Carbon Precision Resistors, available in ½, 1 and 2-watt ratings, at 1% tolerance. *See advertisement page* 24.

7U. CORNELL-DUBILIER (Cornell-Dubilier Electric Corp.)

TV, AM-FM, UHF ANTENNAS, Catalog CF-902A. *See advertisement page* 44.

8U. ERIE (Erie Resistor Corp.)

New D-56 Catalog. 16 pages describing complete array of distributor products handled by Erie Resistor. *See advertisement page* 51.

9U. GERNSBACK (Gernsback Publications, Inc.)

Descriptive literature on the Gernsback Library Books. *See advertisement page* 53.

10U. IRC (International Resistance Co.)

S-058A, P2-A, PW-7, and PW10 Resis-O-Card Flyer. *See advertisement 2nd Cover.*

11U. JENSEN (Jensen Industries, Inc.)

Wall Chart. New 1956, completely illustrated; contains all up-to-date replacement needle information, including point size, point materials, cartridge numbers; list price. *See advertisement page* 60.

12U. KEDMAN (Kedman Co.)

Form Q-200-2. Describing Kedman's Quick-Wedge Screw-Holding Screwdrivers. *See advertisement page* 62.

13U. MALLORY (P. R. Mallory & Co., Inc.)

New '56-'57 Replacement Parts Catalog with cross reference information. *See advertisement pages* 36, 37.

14U. MOSLEY (Mosley Electronics, Inc.)

Form 101M. Information on "Antenna Coat" protective spray for antennas, masts and connections. *See advertisement page* 50.

15U. PERMA-POWER (Perma-Power Co.)

New catalog. 3-color catalog showing complete line of Perma-Power products. Illustrated. *See advertisement page* 63.

16U. RADIART (The Radiart Corporation)

F-1146-H Vibrator Catalog. Complete information on all auto radio and communications vibrators. *See advertisement page* 1.

17U. SPRAGUE (Sprague Products Co.)

K-102. TV Replacement Parts Manual. Completely revised 64-page booklet containing recommended electrolytic and special ceramic replacements for every TV set model made from 1946 to April, 1956. *See advertisement page* 2.

18U. TACO (Technical Appliance Corporation)

No. 3C Kit on antenna couplers, multi-set couplers and conical antennas. *See advertisement page* 42.

19U. WEN (Wen Products, Inc.)

Catalog Sheet No. 50A40 shows how new WEN SAW TABLE combines with WEN No. 505 Power Saw to make complete work shop at sensationally low cost. *See advertisement page* 12.

20U. WINSTON (Winston Electronics, Inc.)

Free Literature on Intermittent Condition Analyzer, AGC Circuit Analyzer and Sweep Circuit Analyzer. *See advertisement page* 32.

21U. XCELITE (Xcelite, Inc.)

Literature on new transverse cutters for flush cutoff in miniature circuits; catalog on complete line of screwdrivers, nut drivers, pliers. *See advertisement page* 50.

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PHOTOFACT Service Data is compiled with three objectives in mind: 1. To provide the most complete data possible to accomplish fast and proper service repairs. 2. To provide accurate replacement parts information. 3. To combine the complete data in a practical form to make the Service Technician's job faster, easier and more profitable.

The following picture and word story shows some of the highlights of the operation required to produce PHOTOFACT Folders.

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Actual production-run models of Television and Radio receivers and allied equipment go through a step-by-step analysis in the Howard W. Sams laboratories. Each trained specialist observes, tests, analyzes and records information on a particular circuit section or group of components. From this observation and analysis are compiled diagrams, charts, photographs and data which become the complete technical representation of the model.

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PHOTOFACT is the ONLY service data based upon first-hand laboratory analysis of the actual equipment. Presently more than 4,000 models are processed each year to keep up with current receiver production. In the 10 years of its unique operation, the Howard W. Sams organization has provided complete coverage on over 30,000 TV, Radio, Amplifier, Tuner, Tape Recorder, and Record Changer models. 11,979,618 PHOTOFACT Folder Sets have been produced in less than 10 years.

continued ....

The first step in the processing operation is to remove the chassis from its cabinet. Notes are made on any unusual problems encountered; these are covered in the finished PHOTOFACT Folder.

Exclusive PHOTOFACT Advantage: You get instructions for simplest chassis removal and easiest access to adjustments. Such instructions save you time and effort.

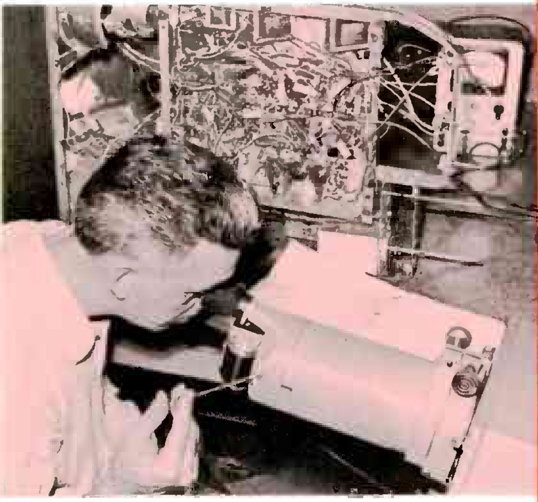
Next, chassis photographs are taken for complete parts identification; separate photos are taken of tuner, major subassemblies or complex design portions. A photograph is also taken of the equipment for identification.

Exclusive PHOTOFACT Advantage: Photos of all chassis views are provided. All parts are numbered and keyed to the schematic and parts lists for quicker, positive parts identification and location.

One of the first operations on the analysis line: Recording electrical and physical measurements of capacitors and identifying their location in equipment.

Exclusive PHOTOFACT Advantages: Analysis of all components results in complete and accurate replacement parts listings in the finished PHOTOFACT Folder. These listings save you time in selecting and purchasing the proper replacement

how PHOTOFACT — the world's finest TV-Radio service data — is created



Oscilloscope camera records waveforms at selected reference points in a normally operating television receiver.

Exclusive PHOTOFACT Advantage: Waveforms with peak-to-peak voltages are shown clearly right on the schematic in PHOTOFACT TV Folders.

Artist prepares scale drawings showing tube location layouts of top and bottom chassis views.

Exclusive PHOTOFACT Advantage: Top and bottom views shown in all TV Folders, (top view positioned as chassis would be viewed from back of receiver; bottom view positioned for bench service). Charts include blank pin or locating key, fuse location and signal paths for sync and sound.

Parts lists and alignment charts are prepared in a standard, easy-to-read style.

Exclusive PHOTOFACT Advantage: Quick reference to a wide choice of accurate replacement parts. Full alignment data in quick-reference form. Uniformly presented in every PHOTOFACT Folder.

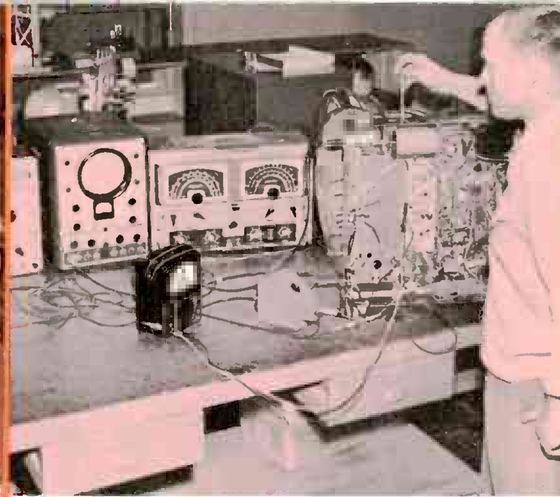
Continuing the analysis process, the receiver progresses through 13 separate operations: Data is gathered and recorded on controls, resistors, RF and IF components, transformers, chokes, speakers, deflection components, tubes and other parts.

part from your Electronic Parts Distributor.

Special installation notes are provided where required. Transformer lead color-coding and winding resistances are indicated on the schematic.

Voltage analysis is performed on the receiver, using typical equipment employed by Service Technicians. Resistance values are also taken here, and in the case of a TV receiver a sketch is made of tube placement.

Exclusive PHOTOFACT Advantages: Voltages appear right on the schematic in each PHOTOFACT Folder. Resistance values and tube placement are shown uniformly in chart form in each Folder.



Actual alignment is performed using typical service type equipment to provide step-by-step instructions for alignment procedure.

Exclusive PHOTOFACT Advantage: Complete, detailed alignment data is presented uniformly in all Folders. Alignment frequencies are shown on radio photos adjacent to adjustment number; adjustments are keyed to schematic and photographs.

to help the Service Technician do his job faster, easier, more profitably

Numbers for parts identification, alignment symbols and connection points are applied to chassis photos by a special art technique.

Exclusive PHOTOFACT Advantage: Because all parts are numbered and keyed to the schematic and parts list, they can be quickly identified and located.

Draftsmen prepare the final schematic in the famous "Standard Notation" style. All schematics use the same clear symbols and the same, uniform layout.

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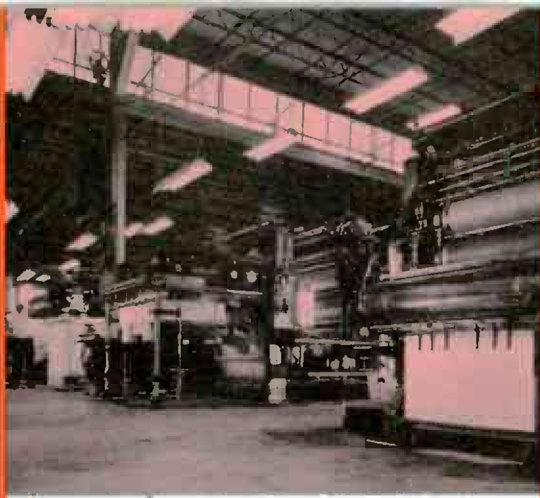
Here, additional data, such as Field Service Notes and Tube Failure Check Charts are compiled.

Exclusive PHOTOFACT Advantages: Field Service Notes include time-saving tips for servicing in the customer's home: hints on adjustments, safety glass removal, and advice covering the specific chassis. Tube Failure Charts show common trouble symptoms and tubes generally responsible for such troubles. Series filament strings are schematically presented for quick reference.

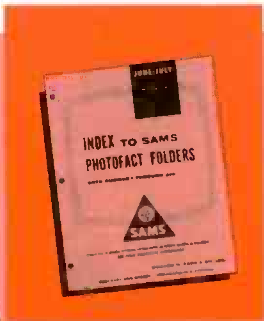
continued . . .

One of the final operations prior to printing is a check of all information which is to appear in the PHOTOFACT Folder. This assures uniformity, completeness and accuracy.



PHOTOFACT Folders are printed on the latest high-speed offset presses. The quality of reproduction is carefully checked for maximum legibility.

Shipments are made daily from this modern warehouse to the more than 1,567 Electronic Parts Distributors who serve you daily with PHOTOFACT.



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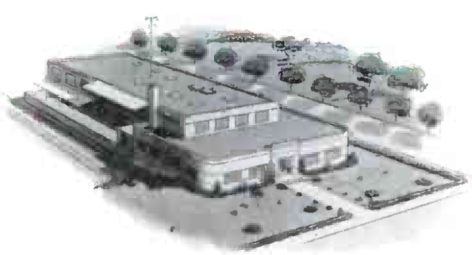
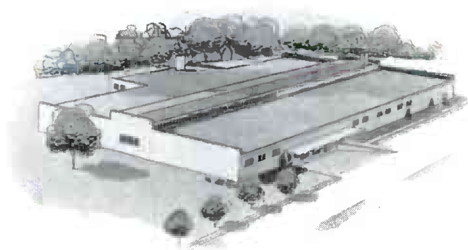


PLANT NO. 1—132 employees work within this 30,000 square foot two-story building, housing the engineering analysis, compilation, sales and accounting divisions.



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