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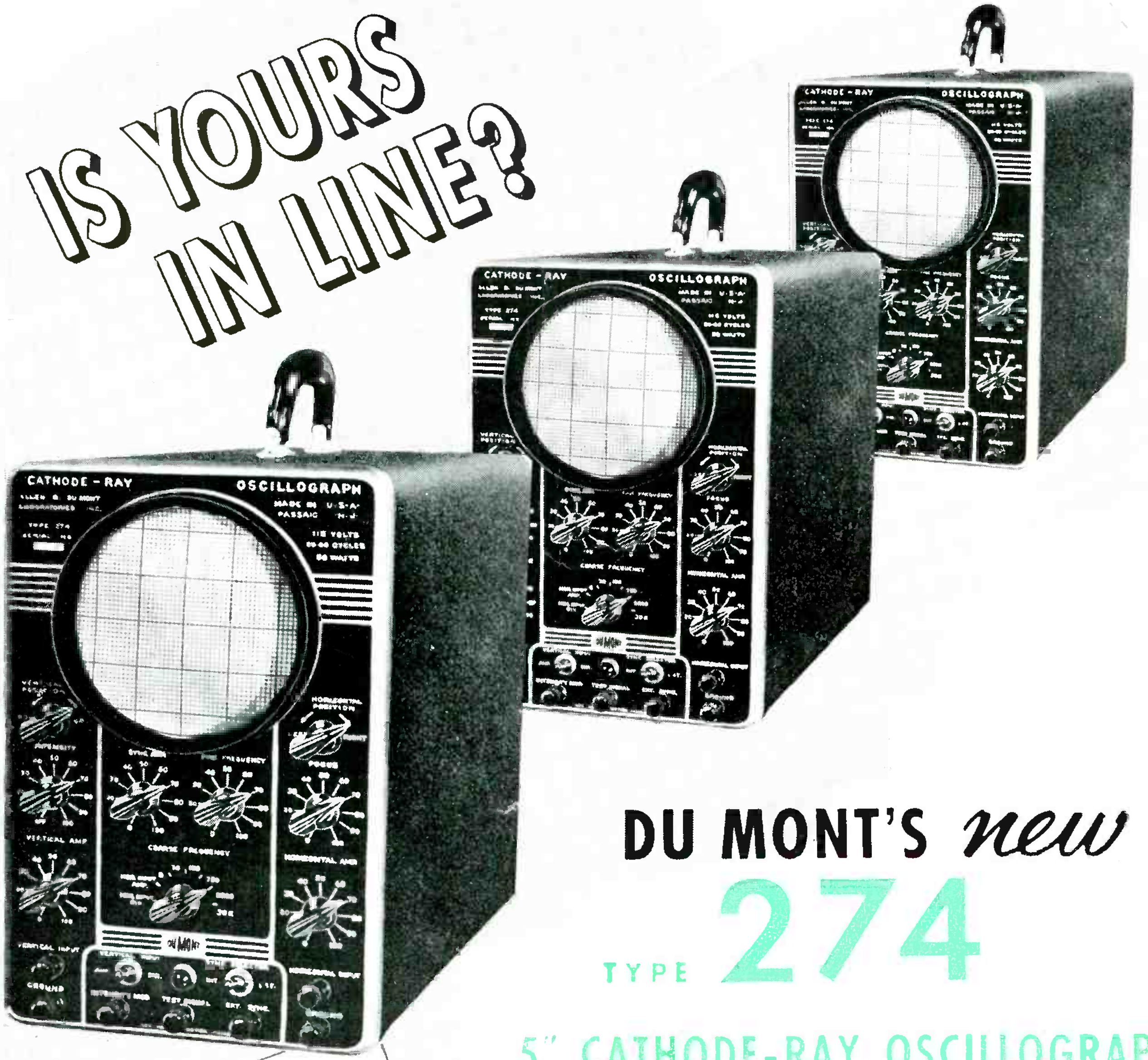

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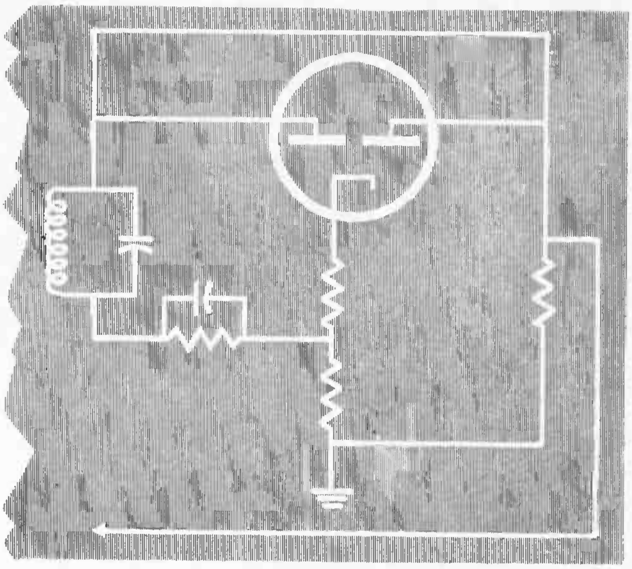

BASIC TYPES AND THEIR CHARACTERISTICS

by PETER MARKANTES

THE DEVELOPMENT of AVC circuits has presented many interesting problems to the radio technician. In attempting to develop a troubleshooting procedure for AVC circuits, it soon becomes evident that it is impossible to approach the problem by composing a list of symptoms, defects, and tests. Such a list might serve to guide the serviceman in troubleshooting a defective power supply, for example; but a procedure of this type is of little aid in locating AVC faults. To begin with, modern AVC circuits, in addition to being rather complicated, appear to be subject to a limitless number of circuit variations. Furthermore, defects in the AVC system are accompanied by somewhat elusive symptoms. Whereas a defective filter condenser in the power supply will manifest itself in a definite and unmistakable manner, a defective filter condenser in an AVC circuit may produce effects that are apparently unrelated to the AVC system as such.

In view of these considerations, it has been decided to approach the problem by investigating, in detail, some features of basic types of AVC circuits and pointing out possible sources of trouble. In this manner a service procedure flexible enough to meet the needs of any particular system may be developed.

Before attempting to analyze the AVC circuit, it may be of assistance to digress into an inquiry of some of the factors that led to its development. Most radio technicians are not too young to remember the days of pre-AVC receivers with their annoying tendency to fade or blast during reception as the intensity of the received signal underwent sudden variations. Fading and blasting were so troublesome that the necessity of eliminating them was obvious.

Since the engineer was confronted with variables over which he could exercise little or no control, there was little that could be done at the transmitter end of the broadcasting system. Accordingly, the solution was sought in the receiver. Since the trouble was occasioned by changes in the intensity of the received signal, the obvious remedy was to develop some device that would act to counterbalance these changes in signal level. The operation of this device was to depend upon the principle of controlling the sensitivity of the receiver in such a manner that an input would be accompanied by a proportionate decrease in receiver sensitivity—conversely, a decrease in signal level would be accompanied by a proportionate increase in receiver sensitivity. This has come to be the operating principle of all AVC systems.

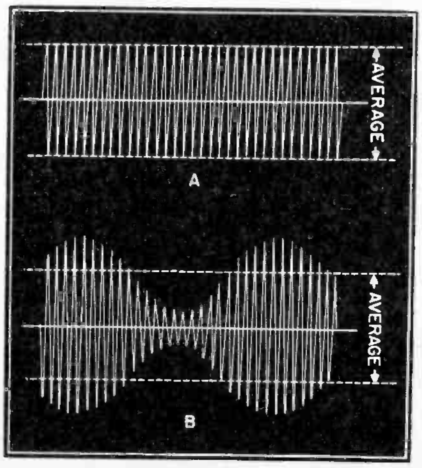

Fig. 1 A represents an unmodulated carrier of a given amplitude. B represents a modulated carrier of the same average amplitude as A.

Incidentally, it is of interest to note that, from the start, the term "automatic volume control" was a misnomer. Actually, it is not the "volume" that is being controlled, but rather receiver sensitivity. A little thought will show that any attempt to keep the volume constant would result in extreme distortion.

From the foregoing, it can be seen that the signal intensity must be automatically controlled before it reaches the audio section. This leads, then, to a more rigid description of the purpose of the AVC circuit; viz., to maintain the amplitude of the voltage at the input of the second detector at a constant value. More specifically, the *average* amplitude must be kept constant.

A glance at Fig. 1 will show why the distinction is made between amplitude and average amplitude. Fig. 1a shows an unmodulated RF wave of some average value. Fig. 1b shows the same RF wave modulated by a sine wave. Note that the average amplitude is the same in both instances. Obviously the control must not act to change the modulation envelope.

How is this control of gain accomplished? From elementary tube theory, we know the amount of amplification of a tube is at every instance dependent upon the value of grid bias. The more negative the grid voltage, the lower the gain of the tube; the less negative the grid voltage, the higher the gain of the tube. If a DC voltage, varying in size with the variations in signal intensity, could be obtained and applied to the grid of a tube, the gain of this tube would vary in accordance with signal variations.

One way of accomplishing the desired result is shown in Fig. 2. Here a diode rectifier receives a portion of the signal from a third winding on the IF transformer. Since the diode conducts only when its plate is positive, there is set up a current flow as indicated by the arrows. This current flow produces a voltage drop across R-1 with polarities as shown. By connecting the grid of V-1, the controlled tube, to point "A" and the cathode to point "B," V-1 receives a negative bias. For strong signals, the voltage drop across R-1 will be large, thus making the grid of V-1 more negative and decreasing the gain. For weak signals, the drop across R-1 decreases, making the grid less negative and thus increasing the gain.

Although this serves as an explanation of the fundamental action of AVC, several important factors have been overlooked. One assumption that has been made is that the voltage across R-1 is steady DC. Actually, such is not the case. The voltage across R-1 is as shown in Fig. 3c. Obviously, the voltage across R-1 in the form shown at 3c is unsuitable for bias since it contains audio variations. Therefore, a filter must be inserted to remove this audio component. The circuit with filter added is shown in Fig. 4. Here R-1 C-1 acts as a filter to remove the audio component.

Filters

Although there are a number of ways of analyzing the action of this filter, perhaps the easiest approach is to consider the DC and AC components of the voltage separately. First, the DC voltage present from "C" to "B" is the same as the voltage from "A" to "B." There is no voltage drop across R-1. This is one reason, incidentally, that R-1 can take the place of the choke in a conventional power supply filter.

The AC component will act to charge C-1 to the peak voltage as shown in Fig 5. The portion A-B of Fig. 5b shows how the voltage across C-1 tends to drop as the AC starts on its negative swing. It is apparent that the efficiency of the filter depends upon the steepness of the portion from A to B. The steepness will in turn depend upon a very important factor: The time constant of the R-1 C-1 filter. An explanation of time constant could fill volumes, but for our purposes it will suffice to define time constant as:

1. The amount of time it will take a condenser to charge up to approximately 67 per cent of the peak of the applied voltage when the voltage is applied through a series resistor.

2. The amount of time it will take a condenser to discharge through a series resistor to approximately 37 per cent of its initial voltage after the applied voltage has been removed.

It can be shown that this time constant is equal to the product of the resistance and the capacitance:

$$t = RC$$

t = time in seconds
R = resistance in megohms
C = capacity in microfarads

To consider a practical example, assume R-1 = 1 meg. and C-1 = .05 ufd in Fig. 4. At a given instant, there is present a voltage of —5 volts on the grid of V-1 as a consequence of the flow of rectified current through R-1, the diode load resistor. A certain instant later, the intensity of the received signal changes so that the flow of rectified current through R-1 produces a drop of 15 volts.

Will this —15 bias be applied to the grid of V-1 instantaneously? From what has been said, it is ap-

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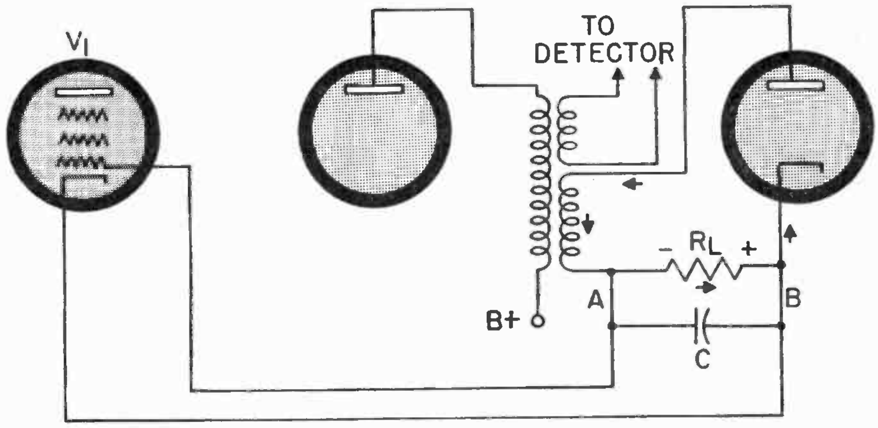

Fig. 2 Simplified AVC circuit.

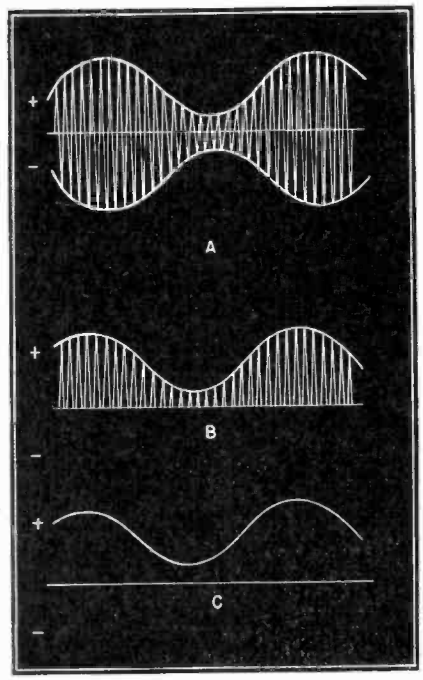

Fig. 3 A represents the voltage in the primary of the IF transformer. B represents the voltage in the diode circuit. C represents the voltage across R-1.

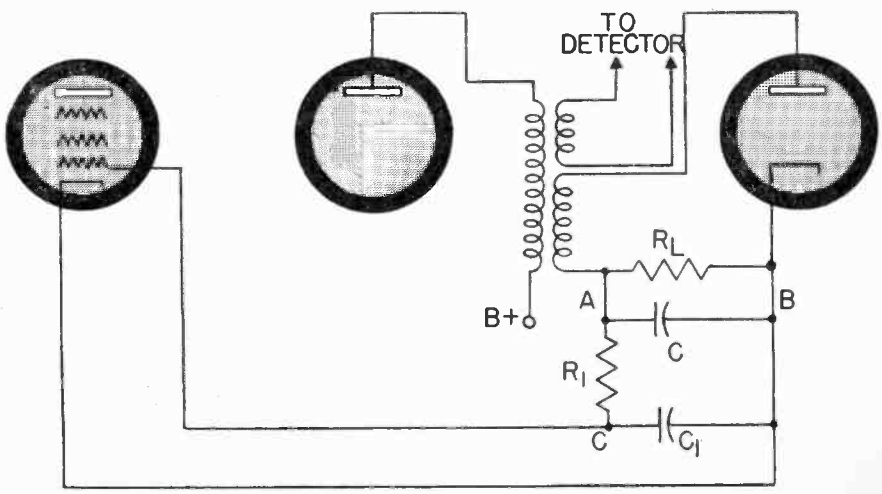

Fig. 4 AVC circuit similar to that shown in Fig. 2. A filter has been added to remove the audio signal component.

AVC Circuits

→ **From Preceding Page**

parent that an appreciable interval will pass before this voltage will appear at the grid of V-1. As a matter of fact, 1/20 of a second after the increase of voltage occurs—

$(R_1C_1 = 1 \text{ meg.} \times .05 \text{ ufd})$
$= .05 \text{ seconds}$

The voltage across C-1 has risen to 11.7 volts (5 volts + 67% of 10 volts). The significance of time constant lies in the fact that it must be smaller than the time taken to tune the receiver from one station to another. If the time constant is large, it is possible, when tuning from a strong station to a weak one, to pass over the weak station since the receiver has been in an insensitive position.

However, if the time constant is compared to the time required for one cycle of the audio component to take place, it is seen that the time constant should be as large as possible in order that the efficiency of the filter will not fall off at the lower audio frequencies.

Therefore, a compromise is made between filtering efficiency and speed of action of the AVC. Commercial design calls for an average value of 0.1 seconds. From the servicing angle, this means that changes in the value of filter resistance or capacity will upset this time constant and result in the aforementioned effects.

Before going on to examine a typical AVC circuit, it would be well to mention another factor that must be considered. This concerns the type of tube that can receive this control voltage. Fig. 6 shows an Eg-Ip characteristic of a tube used in some applications. Here, a negative bias greater than 10 volts will drive the plate current to cut-off. If the amplification of this tube is controlled by an AVC voltage, it is obvious that a strong signal that produces an AVC voltage of say —30 volts will drive the tube beyond cut-off. This will result in severe distortion. Tubes with characteristics of this type are known as sharp cut-off types and are unsuited for use with AVC.

By using a remote cut-off type whose characteristic is as shown in Fig. 7, there is little danger of plate current cut-off. Although this is primarily a design consideration, one fact makes it necessary for the service man to know about it. This concerns the tendency of remote cut-off tubes to change their characteristic with age. As these tubes age, their characteristic tends to change as shown by the dotted lines in Fig. 7. Since this is one type of tube failure that is not revealed by tube testers, it is apt to be overlooked as a possible source of trouble.

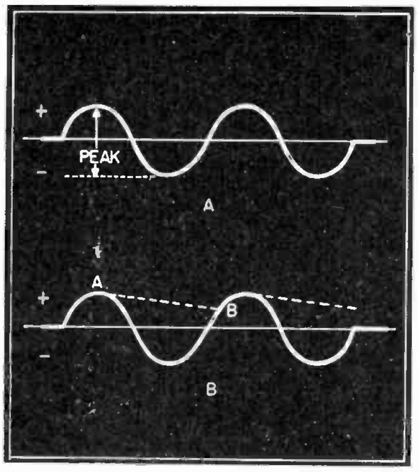

Fig. 5 An illustration of the filtering effect of R-1 and C-1. The upper illustration represents the AC component across condenser C. The lower shows how the charge on condenser C-1 removes the AC component by holding the potential near the peak value.

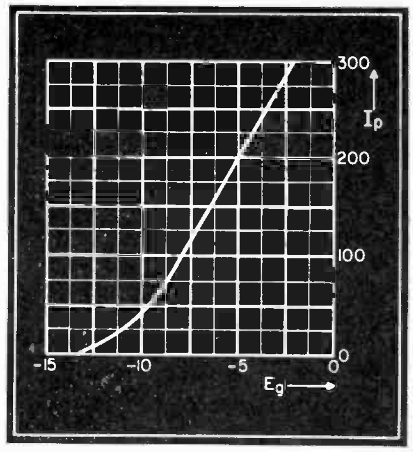

Fig. 6 The grid voltage plate current curve of an ordinary vacuum tube.

So far, the bias for the controlled tube has been shown as being derived from the diode load resistor. In practice, however, the controlled tube usually receives a small initial bias independently of the AVC voltage. This is shown in Fig. 8. Here, R-2 supplies a small bias to the controlled tube. Since R-2 is connected to ground, as is R-1, the total bias on the tube is equal to the sum of the drops across R-2 and R-1 as shown by the indicated polarities on the diagram.

The audio variations which are present across R-1 have been mentioned only in connection with their adverse effect upon the control voltage. Actually, there is no reason why they cannot be applied to the input of the audio amplifier. In other words, the same tube can be used for both AVC rectifier and second detector. Going one step further, the diode load resistor may be replaced by a potentiometer which will serve simultaneously as audio volume control and diode load resistor.

This leads to the circuit of the typical AVC system as shown in Fig. 9. Here the function of the components is as previously described. R-1 serves as the audio volume control and diode load resistor. The filters R-1 C-1, R-2 C-2, and R-3 R-4, in addition to providing filtering, also serve to isolate the stages from each other. It is obvious that the grids of the controlled tubes cannot be returned to the same point if regeneration is to be avoided.

Common Faults

Some of the troubles possible in

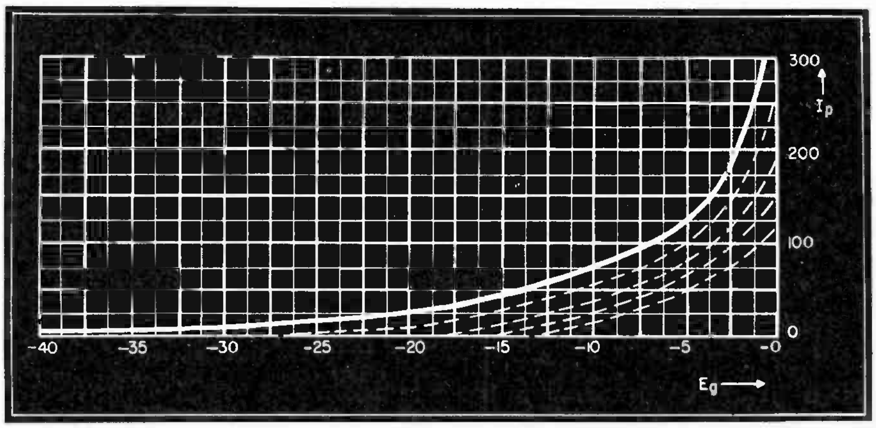

Fig. 7 The grid voltage plate current curve of the remote cut-off type tube used in AVC circuits. The dotted lines show how the tube's characteristics change as it ages.

the AVC circuit may now be investigated.

R-1—Open. The set will be inoperative since no audio voltage is being applied to the audio amplifier. In addition, of course, no bias is available for the controlled tubes.

In checking R-1, some difficulties immediately present themselves. R-1 is 500 kilowatts or higher in value. This means that a high range ohmmeter is needed in order to check continuity.

If a voltmeter is used to check R-1 (by measuring bias on the controlled tubes) it must be remembered that an ordinary voltmeter presents too low a resistance for reliable readings. Therefore, a VTVM is recommended.

R-1—Value Changed. An increase in the value of R-1 will result in excessive AVC voltage and thus distortion on strong signals.

C—Open. This results in severe attenuation of signal present in diode circuit. That this will be so is clear when it is realized that C (usually about 100 uufd) will offer about 4 ohms impedance to an IF signal of 456 kc. If C opens, the impedance rises to the value of R-1 shunted by the impedances of the filters.

An open at C would be difficult to find. The usual troubleshooting procedure would probably consist of isolating the second detector as the defective stage by means of signal tracing. In the course of checking components in this stage, an open C would be revealed by substitution of a good condenser.

C—Shorted. This would result in a dead receiver since the audio input would be shorted to ground.

R-1—Open. This results in complete lack of bias on the controlled tubes since the grids of these tubes are returned to ground through R-1. All the results of floating grids are, of course, present. Again, a VTVM or ohmmeter capable of reading resistances in the order of megohms is required.

R-1—Change in Value. An appreciable increase in the value of R-1 will increase the time constant and may result in distinct "plops" when tuning the receiver.

Occasionally the value of R-1 will vary intermittently, resulting in fading. Trouble of this nature is hard to locate. The most direct method is to replace the resistor if it is suspected.

C-1—Open. This is accompanied by unstable operation ("motor-boating," etc.) since the filtering action is considerably reduced. Again, the direct method of testing is to substitute a good condenser.

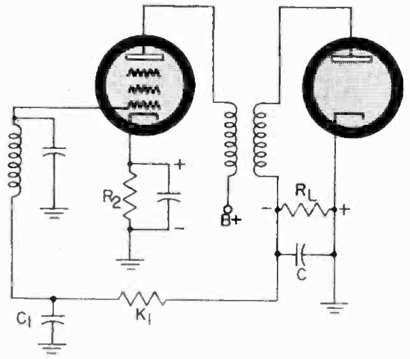

Fig. 8 An AVC circuit with cathode bias provided for the controlled tube.

C-1—Leaky. This will result in reduced AVC voltage on the controlled tubes. If C-1 is leaky, it is in effect a resistance connected from the junction of R-1 and R-2 to ground. As such, R-1 and R-C-1 (leakage resistance of C-1) form a voltage divider across R-1. The voltage available at the grids of the tubes would then be $\frac{R_c}{R_c+R_1}$ of the total AVC voltage.

Although no ill effects might be apparent when tuned to weak stations, a leak in C-1 would result in distortion on strong signals when the AVC voltage would be insufficient to prevent the grids from going positive during a portion of the input cycle.

Inasmuch as no current flows through R-2 and R-1, a VTVM will read the same voltage at "C," "B," or "A" (with respect to ground) if C-1 is intact. A leak in C-1, will then result in a readable voltage drop across R-1.

C-1—Short. This will result in complete lack of AVC voltage on the controlled tubes. The symptoms and tests are much the same as they are when C-1 is leaky.

R-2—R-3—R-4—Open. The grid of the affected tube will be free, resulting in unstable operation. The VTVM or the high range ohmmeter will quickly reveal this defect.

C-2—C-3—C-4—Open. As previously explained, these condensers act as filters for the AVC, and in conjunction with R-2—R-3—R-4, as decoupling filters between the individual stages. For instance, the voltage coupled into T-2 will normally appear between grid and ground of the mixer since C-3 is a virtual short for RF if C-3 opens the grid of the mixer and is coupled to the grid of the IF tube.

C-2—C-3—C-4—Short or Leaky. A short in any of these condensers will result in lack of AVC in the particular stage affected. In addition, the AVC voltage on the other stages will be considerably reduced as a result of the voltage divider action previously discussed.

Leakage in any of these condensers will again result in flow of current through the filter resistors with the same voltage divider action reducing the AVC voltage.

At the risk of redundancy, one word of caution about resistor and condenser replacements. Exact values must be used in order to preserve the original time constant.

Delayed AVC

The AVC system under consideration up to now is a very elementary type. One obvious shortcoming of this circuit is that AVC action takes place on *all* signals. This means that the receiver sensitivity will be reduced, not only on strong signals, but also on weak signals, when the maximum sensitivity is desired. In order to have the maximum sensitivity available for weak signals, a modification known as delayed automatic volume control (DAVC) has been introduced. This type of circuit functions in such a manner that no AVC action takes place until the intensity of the received signal reaches a predetermined level.

Although there are a number of methods of delaying the AVC action, Fig. 10 shows the basic system. Here two separate diodes are necessary: one for AVC and one for second detector action. The IF signal is fed to each of the diodes, although not always in the manner shown here. D-2 functions as the second detector.

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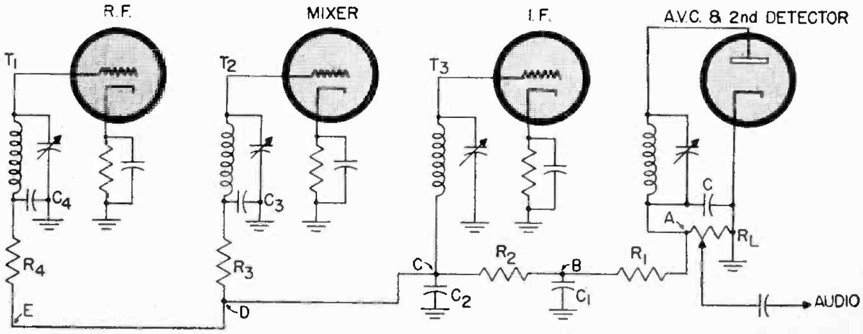

Fig. 9 A complete AVC circuit with filter and isolating resistors.

FM troubleshooting

PHOTO COURTESY SCOTT RADIO

THE FIRST OF A SERIES OF ARTICLES ON THIS SUBJECT

By Ralph B. Roland

FREQUENCY Modulation receivers are already in widespread use and it is very probable that, within the next few years, their number will equal or even surpass the number of Amplitude Modulation receivers now in use. Although FM transmission was introduced commercially about ten years ago, and although many receivers were produced, the recent rulings of the FCC, which confine all FM transmission to the ultra-high-frequency band (around 100 megacycles or higher) will cause definite changes in FM receiver design. These changes are, namely:

(1) The radio frequency is shifted from the 40 megacycle band to the 100 megacycle band.

(2) The intermediate frequency used must be increased to preserve stability and image rejection. 10.7 megacycles has been adopted as a standard IF, instead of 4.3 megacycles as formerly.

(3) Antenna systems will become increasingly important since ultra-high-frequency antennas are quite critical.

These changes will make the job of servicing FM receivers more difficult. The serviceman will have to equip himself with more expensive and more critical test equipment. Although elaborate test equipment is not absolutely necessary, a certain minimum of apparatus cannot be dispensed with.

The block diagram of Fig. 1 shows a standard FM receiver. The familiar heterodyne principle is used in which a signal generated by a local oscillator is caused to beat with the incoming radio frequency signal to produce a signal of intermediate frequency. This system is identical to that used in AM receivers wherein an RF amplifier is used to secure the best signal to noise ratio and to reject images while the IF amplifier provides amplification and selectivity. In the FM receiver, the last IF stage serves a special purpose and is called a limiter because it removed all undesired amplitude modulation from the frequency modulated signal. This amplitude modulation is caused by fading, noise bursts, reflection from moving objects, etc.

Demodulation is accomplished by the discriminator which translates the frequency deviations of the carrier into amplitude variations which appear as an audio signal. The demodulated audio signals are fed through a high-fidelity audio amplifier to the speaker.

From the above, it is seen that the functional characteristics of the FM receiver are different only in the limiter and discriminator. However, it should not be forgotten that the RF circuits operate at frequencies around 100 megacycles and the IF circuits are tuned to 10.7 megacycles. In view of these observations, let us now determine what test equipment is absolutely necessary, and what equipment is further desirable. The serviceman must always realize when choosing his test equipment that he is trading time in exchange for facilities. That is to say that one can get along with the crudest of test set-ups; but a good job can only be done at the expense of time-consuming

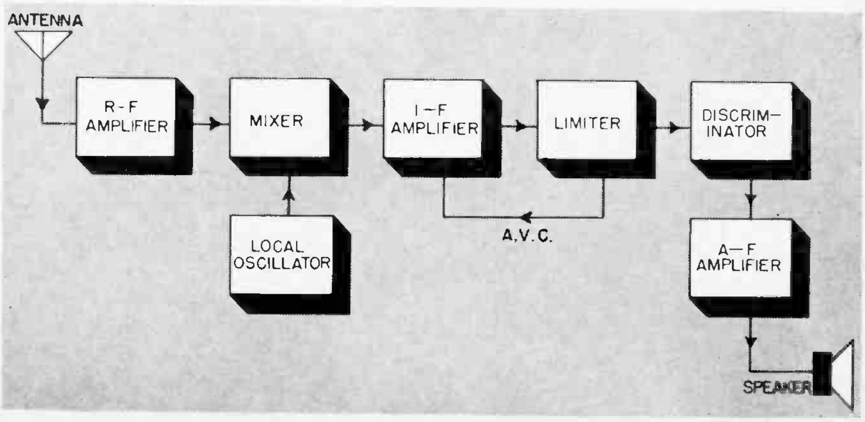

Fig. 1 Block diagram of a standard FM receiver.

labor. At any rate, a number of alternatives will be presented in this discussion, and the reader is free to make his own choices.

Equipment Necessary

Equipment is necessary for the testing of an audio amplifier, a discriminator, a limiter, an IF amplifier, a local oscillator and mixer, and an RF amplifier. Clearly, sources of RF, IF, and AF signals are required.

The IF source may be a signal generator covering an adequate range in the neighborhood of 10 megacycles. It need not be modulated in any way, but its output must be constant and definitely known for any given setting of the attenuator, and the frequency calibration must be accurate. This device will be sufficient for generating all signals required in testing the entire receiver from the mixer input to the discriminator output.

The RF source is the most critical of all the necessary equipment. One *can* get by with a simple oscillator of good stability, which is calibrated in frequency at a few points in the FM band. This is good enough to align the local oscillator so that it will track properly over the entire band.

An audio oscillator with fairly accurate frequency calibration and known output is required to test the high-fidelity audio amplifier. In FM, a wide band of frequencies is utilized which permits the transmission of 15 kilocycles of audio. An FM receiver is worthwhile only when the full audio band is reproduced, so that proper adjustment of the audio amplifier is imperative to give the high-fidelity reception of which the receiver is capable.

To measure the effect of all applied signals, an output meter or AC voltmeter and a DC voltmeter are required. The ordinary 1000-ohm-per-volt DC meter will not do since it will be necessary to measure low voltages across high resistances. A meter with a sensitivity of 20,000 ohms-per-volt is recommended, while an electronic voltmeter with about 10 megohms input resistance is even better.

The foregoing discussion has presented the absolute minimum in test equipment requirements for servicing FM receivers. It should be clearly understood that the use of such simple test setups will cost the serviceman dearly in time and labor. We shall now discuss servicing tests with this simple apparatus.

Simplest Equipment Setups for Necessary Tests

(1) *Adjustment of audio amplifier for high fidelity response.* With the output meter or a vacuum tube voltmeter connected across the output of the audio amplifier, and with the audio oscillator connected to the grid of the first audio stage, it is possible to check the frequency response of the amplifier. With this simple equipment it is not possible to measure distortion. One can only listen to the speaker output and judge the quality of the response by ear.

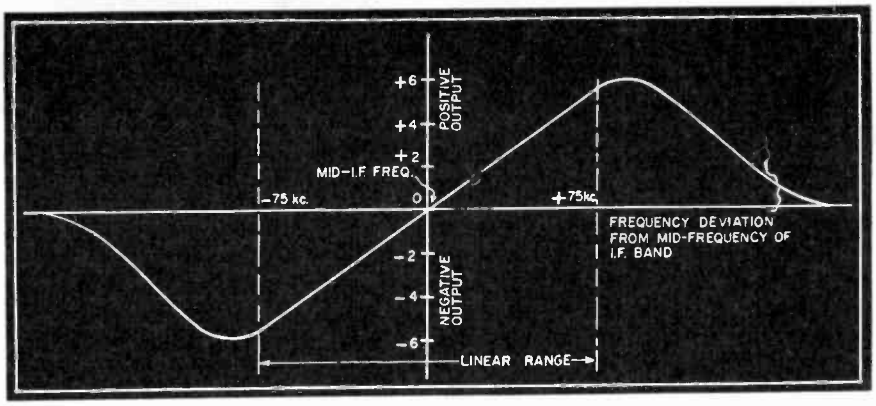

Fig. 2 **Discriminator output plotted against variation of the input frequency. Zero on the graph corresponds to the intermediate frequency of the receiver.**

(2) *Adjustment of the Discriminator.* With the DC (20,000-ohm-per-volt or electronic) voltmeter connected across the discriminator output, and with the 10-megacycle signal generator connected to the grid of the limiter through a .0001 ufd condenser, the discriminator can be adjusted to give the proper amplitude versus frequency characteristic. This adjustment consist of tuning the secondary of the transformer so that the discriminator gives zero output at the IF mid-frequency, and symmetrical positive and negative DC output for equal frequency deviations to either side of the mid-frequency. Of course, the signal generator must be accurately calibrated both as to frequency and amplitude, since it is always necessary to feed a constant amplitude signal to the discriminator. The actual measurement is made in DC volts of discriminator output versus frequency of the generator, where the signal is kept at a *constant amplitude*. The result should be similar to the curve of Fig. 2. The linear portion of the curve should extend 75 kilocycles on either side of the IF mid-frequency. A detailed description of test procedure for both discriminator and limiter will be found in a later section. At this point, only the general nature of the required tests and the necessary test equipment is being described.

(3) *Adjustment of the Limiter.* The operation of the limiter can also be checked by means of an IF signal generator and a DC voltmeter. The signal generator is again connected to the limiter grid, and the DC voltmeter to the discriminator output. Since the purpose of the limiter is to confine the IF signal to a constant amplitude, so long as it is above a given threshold, the following test is in order. Apply an IF signal at a frequency about 10 kilocycles off the mid-frequency. Beginning with very small signal levels (less than 1 volt), increase the amplitude while holding the frequency constant. Measure the DC output of the discriminator. In all cases, the variation of discriminator DC output versus IF signal amplitude fed to the limiter grid should be similar to the curve of Fig. 3. The threshold voltage will vary from one receiver to the next, but in all cases, the manufacturer's specifications should be realized. In general, the threshold voltage will be approximately 3 volts at the grid of the limiter. If this amount of signal is not available from the signal generator, it can be connected to a previous IF stage so that the gain of such stages can be utilized.

(4) *Testing of IF amplifier.* One of the most important groups of tests is the alignment and checking of the IF amplifier, local oscillator and mixer, and the RF amplifier. This group of tests includes the checking of intermediate frequency response, local oscillator tracking and RF amplifier image rejection. Since a discussion of this class of tests is so lengthy, the entire subject of alignment will be treated in a subsequent article.

In addition to alignment tests, routine testing of such factors as IF gain, AVC performance, and general servicing of IF components can be accomplished with the previously mentioned IF signal generator, a vacuum tube voltmeter, and a DC voltmeter.

Elaborate Test Equipment Setups

(1) *Audio Amplifier Tests.* To provide a surer check on any test procedure, it is usually good practice

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FM Troubleshooting

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to monitor the audio signal from point-to-point as it passes through the audio amplifier. The best type of monitoring device is a cathode ray oscilloscope. Such an instrument will quickly show up any distortion which is being introduced in the amplifier. The usual practice in checking an audio amplifier is to feed a sine-wave from the oscillator and to monitor the wave form from point-to-point with the oscilloscope. Where distortion exists, the visual picture on the 'scope will show a flattening or a peaking of the audio sine-wave. Distortion is usually caused by incorrect bias or a faulty tube.

Discriminator, Limiter, and IF Amplifier Tests

One of the most useful of all devices is the frequency swept signal generator. These are made by several manufacturers and operate at a variety of frequencies. In some of these units, a motor driven condenser across the main tuning condenser rotates, thereby sweeping the frequency of a signal generator about some center frequency at a 60 cps rate. Usually, the maximum frequency deviation is adjustable, as well as the mid-frequency and the attenuator setting. Such a device is always used in conjunction with an oscilloscope and can be used to line up quickly and accurately the IF amplifier, limiter or discriminator stages. The correct tuning of the discriminator is accomplished by connecting the oscilloscope to the discriminator output, and the frequency swept oscillator to the grid of the limiter. With the mid-frequency and both extremities accurately adjusted, the discriminator output will respond at a 60 cps rate to the frequency deviations of the oscillator. The overall response is immediately presented on the oscilloscope screen and all necessary adjustments may be made as a result of visual observations. A test set-up such as this allows inter-stage tuned circuits between the limiter and discriminator to be tuned quickly without the necessity of going through a laborious point-by-point procedure. The picture presented on the oscilloscope should resemble Fig. 2.

A frequency swept oscillator and an oscilloscope are also of invaluable aid in aligning the IF and limiter stages since the entire frequency response is continually presented on the oscilloscope screen.

RF Amplifier and Local Oscillator Tests

Another useful piece of test apparatus is a good commercial RF signal generator with internal frequency modulation. Some frequency modulated signal generators in the vicinity of 44 megacycles were produced just before and during the war, but these are obsolete due to the FCC ruling which has shifted all FM broadcasting to the ultra-high-frequency bands. However, similar devices will soon be available for the new frequencies. These frequency modulated RF signal generators will be more expensive, but their use will allow complete performance checks to be made. Their most obvious uses are to check the tracking of the local oscillator and RF tuned circuits, to check sensitivity, RF response, image rejection, IF response (selectivity), and overall performance.

Last but not least in the line of test equipment is the vacuum tube voltmeter with a probe input capable of measuring signals at frequencies in the tens of megacycles. These meters are extremely useful for checking stage gains in the final isolation of defective parts. Several precautions should be observed in the use of vacuum tube voltmeters, the most important of which is that the meter may detune a stage because its input capacitance will be from 4 to 10 uufd. Consequently, tuning condensers should be temporarily readjusted when the VTVM is connected across a tuned circuit.

The chart at the end of this article is a quick guide for setting up test equipment and conducting servicing checks on FM equipment.

Stage-by-Stage Fault Location

The usual procedure for troubleshooting FM receivers is quite similar to AM practice. Either the set does not play at all, or the quality of reception is poor. In either case, the power supply, plate and screen connections should be checked for rated voltage, and a check of filaments should be made. If everything is found to be in order, the output of each stage should be checked in an effort to find the point where the signal is lost.

The discriminator output should be measured. If DC voltage is present, it is a good indication that the IF amplifier is functioning and the audio amplifier is probably at fault. If an oscilloscope is available, the point at which the audio signal fails may be quickly located. It is only necessary to touch the probe on each grid and plate to locate the faulty stage.

If the trouble is not located in the audio stages, connect the audio oscillator to the discriminator and note whether or not there is any output from the set. In general, it is safe to assume that a normal DC discriminator output insures the existence of audio voltage at that point.

In the case of a badly distorted output despite a good audio amplifier, one of three things may be wrong: (1) Either the discriminator is badly misaligned; (2) the limiter is not functioning so that there are amplitude variations in the supposedly pure FM signal fed to the discriminator; or (3) the IF stages are misaligned so that most of the high-amplitude audio components are lost.

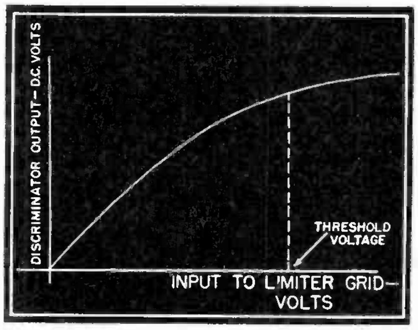

Fig. 3 Output curve of a typical limiter stage. For proper operation the grid voltage must be above the threshold value.

The receiver gain should first be checked by measuring the DC voltage across the AVC circuit with an electronic voltmeter. The AVC circuit is usually found in the grid return of the limiter input as is indicated by R-1 and C-4 of the schematic diagram of Fig. 4. DC voltage should appear for a small input signal to the receiver, thereby indicating that the limiter is being driven sufficiently hard to draw grid current.

When checking receivers that do not have an AVC circuit, a resistor and condenser can temporarily be inserted in the grid return of the limiter stage. This trick actually creates a detector and a DC voltage can be measured across the RC combination. Suitable values for the resistor and condenser are: R—150,000 ohms, C—.01 ufd.

Another method of measuring IF gain is to place a vacuum tube voltmeter across the grid of the limiter and then remove the limiter tube. A slight readjustment in tuning may be necessary since the input capacitance to the VTVM may be different from the input capacitance to the limiter tube. Such test procedures as the above will show whether the gain of the IF amplifier is sufficient to meet the manufacturer's specifications. If the gain proves to be too low, then either the IF amplifier has defective parts which must be isolated or the alignment is off. If, on the other hand, the IF amplifier is proven to be satisfactory, the following procedures should be followed to further isloate the trouble in the discriminator and limiter circuits.

Apply a constant frequency signal to the receiver (with no modulation or with constant modulation) and measure the discriminator output as the input signal level is increased. In the case of an unmodulated signal, the DC discriminator output should remain constant after the specified limiter threshold voltage has been reached. In the case of constant modulation, the discriminator audio output should remain constant after the threshold voltage is reached. In general, the curve should resemble that of Fig. 3. If these conditions are satisfied and if the audio output is still badly distorted, then the trouble is definitely in the discriminator circuit which has probably become badly detuned.

If, on the other hand, the IF amplifier has satisfactory gain, but the discriminator output does not satisfy Fig. 3, then the trouble is clearly in the limiter and may be due to high screen or plate voltages or to insufficient grid bias. The limiter is essentially a tube with a very short grid base (i.e., cut-off to grid-current point), so that on the negative swings cut-off is reached quickly, the positive swings being limited by the loading due to grid and plate current. These conditions are met by using sharp cut-off pentodes operated at low values of screen and plate voltage. Oftentimes, poor operation of the limiter stage may be due to a screen-dropping or plate-dropping resistor which has changed value so as to increase the plate and screen voltages to a value above those specified.

In case the limiter and discriminator both appear to be operating satisfactorily, the trouble must necessarily lie at a point further back in the receiver. Search should be made for such troubles as low IF gain, poor frequency response of the IF amplifier, faulty AVC circuits, poor oscillator tracking, and RF stage or antenna failures. In all such cases, the test procedures are identical with those employed in AM receivers.

The next issue will carry more detailed information on testing and aligning FM receivers.

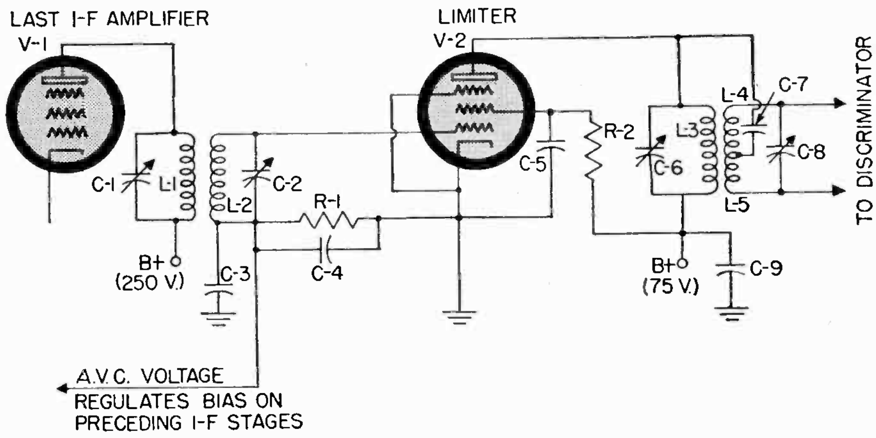

Fig. 4 Typical limiter circuit. The gain of all stages up to the limiter may be checked by measuring the DC voltage found across R-1 with an electronic voltmeter.

Audio Amplifier Test

Equipment to Be Used	*Suggested Technique*
Audio Oscillator Vacuum Tube Voltmeters (preferably two)	Apply audio signals anywhere between discriminator output and loudspeaker. Measure input and output voltages.
Oscilloscope	Monitor the wave form of the audio signal from point to point with the oscilloscope.
Distortion Meter or Wave Analyzer	Accurate measurements of distortion can be made with the Distortion Meter or Wave Analyzer.

Discriminator and Limiter Test

IF Signal Generator (preferably frequency swept) Electronic DC Voltmeter or 20,000 ohms per voltmeter Vacuum tube voltmeter Oscilloscope	Apply IF signal at any point in the IF amplifier. If the signal is not swept in frequency, use the DC voltmeter to measure discriminator response, limiter response, and AVC bias. If a frequency swept signal generator is available, use the vacuum tube voltmeter and/or the oscilloscope to measure and study the important factors.

IF Amplifier Test

IF Signal Generator (preferably frequency swept) DC voltmeter Vacuum tube voltmeter Oscilloscope	Apply signal generator to any desired point in the IF amplifier of the receiver. Apply detector (DC voltmeter, VTVM, or oscilloscope) to limiter grid circuit. Measure IF gain, IF response, AVC response.

Alignment Tests—IF Amplifier, Local Oscillator, RF Amplifier

IF Signal Generator (preferably frequency swept) RF Signal Generator (preferably frequency modulated) DC voltmeter, VTVM, or oscilloscope	Connect the detector to the limiter grid circuit. Apply signal to the grid of each stage, working back from the last IF stage to the antenna lead, stage by stage. ✓ ✓ ✓

TELEVISION RECEIVER FUNDAMENTALS

Lionel P. Paradise

This article explains the basic principles of the television receiver. A previous article explained the transmission of television signals.

PICTURED AT LEFT ARE FRONT AND REAR VIEWS OF THE CBS EXPERIMENTAL RECEIVER.

BECAUSE the operation of a television receiver depends to a very great extent upon the signal emitted by the transmitter, it has been necessary to set up certain standards so that each receiver is capable of properly handling the signals from various transmitters. Present standards call for 525 lines, interlaced, at 30 frames or 60 fields per second. Modulation of the transmitter carrier is such that the sync pulse produces 100% modulation. In other words, black corresponds to a high degree of modulation and white to a very small percentage.

This system is called negative transmission and has the advantage of producing a high signal-to-noise ratio for the sync pulses which are probably the most critical part of the video signal. The 4 megacycle signal used, would, with normal double sideband transmission, require a bandwidth of 8 megacycles for the video channel and, since this was considered to be excessive, it was decided to use a modified form of single sideband transmission, known as vestigial sideband transmission. Figure 1 shows a typical television channel employing this system with a total width of 6 megacycles. The video carrier is 1.25 megacycles from the low frequency edge of the channel. The entire upper sideband is transmitted together with about 0.75 megacycles of the lower sideband. The remainder of the lower sideband is attenuated by means of filters so that a negligible amount of energy is radiated at the low frequency edge of the channel. The sound carrier is located 0.25 megacycles from the high frequency boundary and is frequency modulated with a maximum deviation of plus or minus 75 kc at present.

Although channel assignments have been the subject of much discussion and revision, present regulations provide 13 channels defined as follows:

Channel Number	Frequency (Megacycles)	Channel Number	Frequency (Megacycles)
1	44 - 50	7	174-180
2	54 - 60	8	180-186
3	60 - 66	9	186-192
4	66 - 72	10	192-198
5	76 - 82	11	198-204
6	82 - 88	12	204-210
		13	210-216

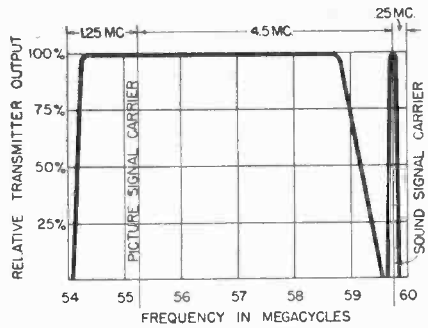

Fig. 1 A typical 6-megacycle television channel.

The Television Receiver

The television receiver is radically different in principle from the standard radio receiver mainly in the circuits following the second detector. Fundamentally the video signal of Figure 2 is applied to the grid of the kinescope so that the picture information voltage varies the intensity of the electron beam striking the fluorescent screen, thereby causing a proportional amount of light to appear on the face of the tube. Scanning circuits provide the necessary sawtooth deflection voltages for vertical and horizontal deflection plates (or sawtooth currents for deflection coils), and the frequencies of the two are accurately synchronized with those of the transmitter by means of the synchronizing pulses. As previously mentioned, blankouts cut off the kinescope beam during the retrace time by driving the kinescope grid to cutoff. The sound is handled by a separate channel in the receiver.

Before discussing specific receiver circuits, it is necessary to consider the basic functional units in the television receiver, as illustrated by the block diagram of figure 5. Keeping in mind the typical channel of figure 1, it is apparent that the RF amplifier and mixer tuned circuits must handle a 6 megacycle bandwidth if both the video and sound signals are to be passed. In accordance with standard superheterodyne principles, a local oscillator beats with the incoming signals in the mixer stage. Since there are two separate carriers in the RF and mixer circuits, the local oscillator, beating with each, will produce two IF signals in the plate of the mixer tube. It is standard practice to have the oscillator frequency higher than both video and sound carrier frequencies. As a result, the difference between oscillator and sound carrier is less than the difference between oscillator and video carrier, resulting in the "inverted" IF signals at the plate of the mixer tube, as shown in figure 6. The sound IF carrier has been standardized by the RMA at 21.25 to 21.9 megacycles, thus providing a certain tolerance for manufacture. The frequency of the oscillator must be between 21.25 and 21.9 megacycles higher than the frequency of the particular sound carrier of the channel to which the set is tuned. The plate of the mixer tube feeds filter networks which separate the video and sound IF signals, diverting them to the respective IF systems. The sound IF includes amplifier stages, limiter, and discriminator for suitable detection of the frequency-modulated signal. A conventional audio frequency amplifier follows. Returning now to the plate of the mixer tube, the video IF is passed through an amplifier whose bandwidth is usually greater than 4 megacycles, the ideal response curve being indicated in figure 6. The response of the video IF should be down essentially to zero at a frequency of 26.5 to 27.15 megacycles. With the oscillator at precisely the correct frequency, it is desirable to have the response of the video IF down approximately 50% at the video IF carrier frequency, this tuning adjustment compensating for the effects of the vestigial sideband.

After passing through several IF stages, the video-modulated signal is delivered to a diode detector which demodulates in the conventional fashion and, depending upon the diode connections, may provide a video signal with the sync pulse in either the positive or negative direction. Since there is a phase reversal of 180° in each succeeding video amplifier stage, and since the blankouts and sync pulses must be in the negative direction at the output of the last video amplifier, the signal polarity at the detector output will be positive if the set has an odd number of amplifier stages and negative with an even number of video tubes. This video amplifier system should be essentially flat from below 60 cycles to 4 megacycles and the phase shift should be linear with respect to frequency over this range in order

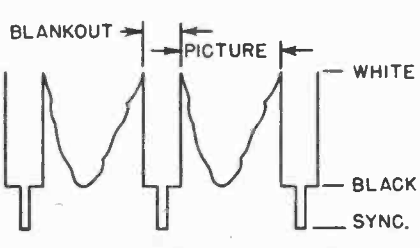

Fig. 2 Waveform of the basic video signal.

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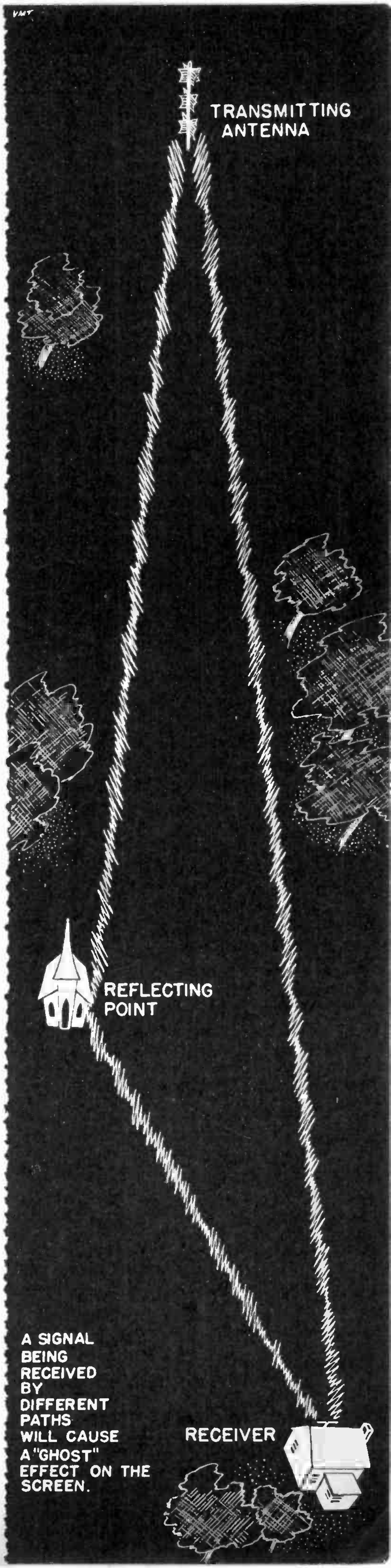

Television Receiver Fundamentals

Fig. 3 An RCA cathode ray tube of the type used in television receivers. The girl is also holding a conventional metal tube to show the difference in size.

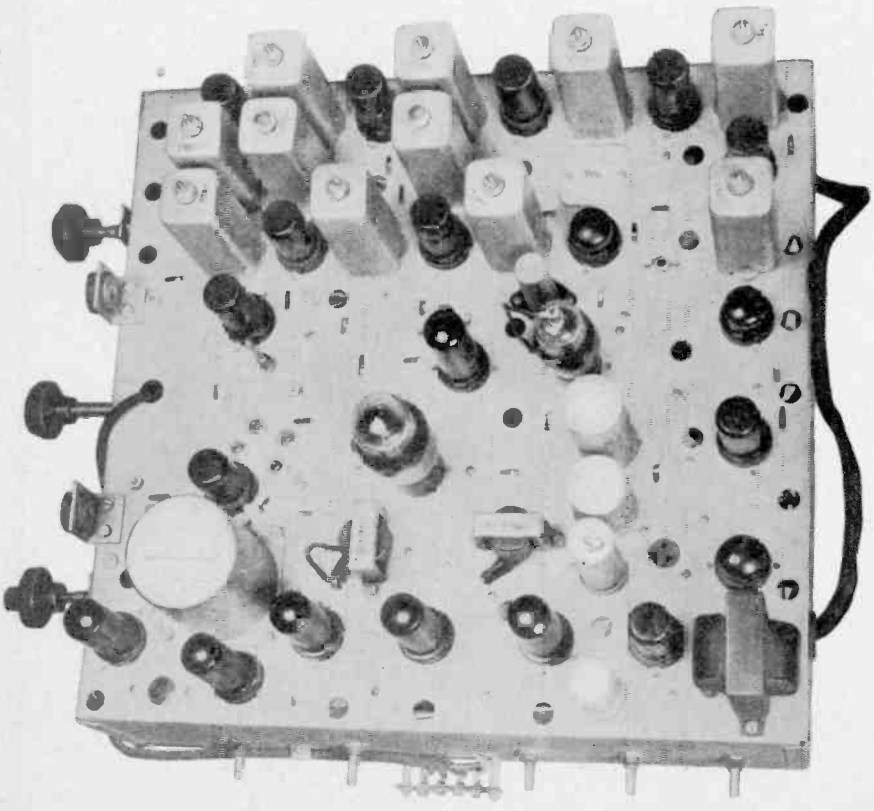

Fig. 4 The video chassis of a pre-war RCA television receiver. The cans on the upper part of the chassis are the picture IF transformers.

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not to distort the video wave shape. This signal, being applied to the grid of the cathode ray tube, will vary the intensity of the electron beam and the blankouts will drive the grid to cutoff. In addition, it is necessary to insert a DC component on the kinescope grid so that the average brightness of the television picture automatically sets itself. It now remains to discuss the sweep circuits.

Usually one-half of a dual diode is used for the video detector and the other half is used as a clipper tube to pass only the most extreme part of the video IF signal, namely the sync pulses. Occasionally the clipper works out of one of the earlier IF stages or even from one of the video tubes, but in any event only the synchronizing pulses appear at its output. The sync is normally passed through an amplifier in whose plate circuit there are so-called differentiating and integrating circuits which separate the horizontal from the vertical sync pulses. These pulses control the frequency of the horizontal and vertical sawtooth generators and maintain them exactly in step with the transmitter sweeps operating at 15,750 and 60 cycles per second. Each sweep voltage is then amplified and fed to the horizontal and vertical deflection plates (or coils) respectively. Thus the kinescope beam is synchronized with that of the camera tube at the transmitter and as the beam sweeps across the fluorescent screen, the signal on the grid of the kinescope produces the proper variation in intensity and so reconstructs the television picture point by point and line by line.

Power Supply

The power supply requirements of the receiver are two-fold: first, the usual 300 volts for plates and screens of all tubes except the kinescope; and second, the high voltage power supply for the cathode ray tube. The exact voltage will vary with the size of the tube, common values being between 1,000 and 6,000 volts at currents of the order of a few hundred microamperes. There are several manual controls associated with the kinescope circuit: the brightness control which is usually a grid bias potentiometer to adjust the average brightness of the entire picture; the focusing control which varies the potential on the first anode of the kinescope in order to focus the beam to a small spot on the tube; horizontal and vertical centering controls which place adjustable potentials on the two sets of deflection plates to center the pattern vertically and horizontally. In the vertical sweep there is a control which permits adjustment of the vertical sawtooth amplitude, or picture height, and similarly the width control varies the horizontal sawtooth amplitude. The two sweep generators are manually adjustable so that their frequencies can be made sufficiently close to the correct values for proper synchronization. These controls are often referred to as horizontal and vertical speed or hold controls. In the IF or video amplifier systems there is a manual gain control which varies the signal amplitude at the grid of the cathode ray tube. Since the peak-to-peak signal voltage determines the difference in brightness (contrast) between light and dark spots, the video gain adjustment is called a contrast control. The usual audio gain control appears in the AF amplifier circuit. Because of the high radio frequencies and the critical band-pass characteristics encountered in a television receiver, usual practice has been to tune the set from one channel to another either by a bandswitch or by pushbuttons. To compensate for drift due to aging or heating, a trimmer condenser is adjustable from the front panel to permit a small degree of tuning of the local oscillator frequency.

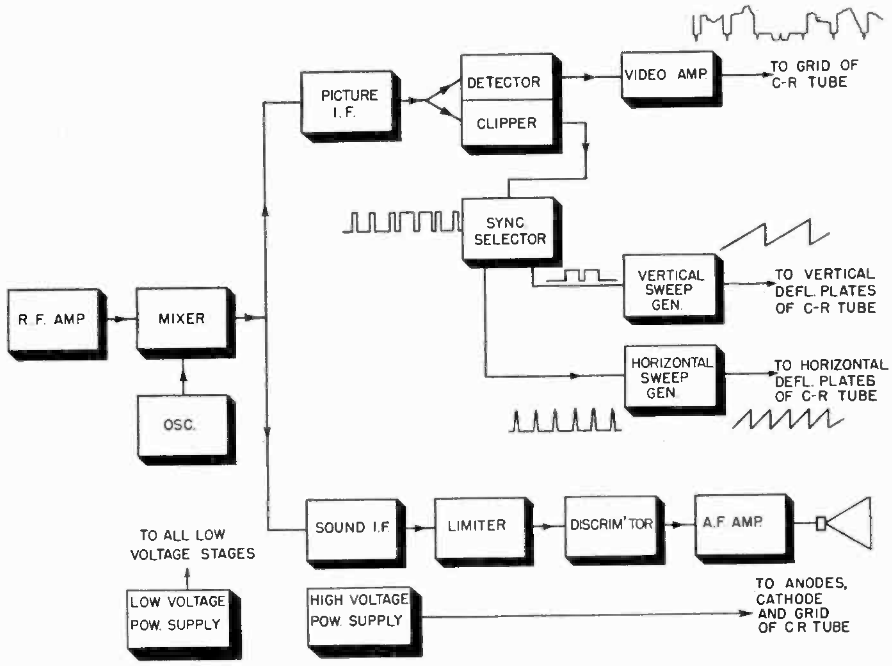

Fig. 5 Block diagram showing the way the television signal is separated into the various channels within the receiver.

Antenna Considerations

The television antenna is much more critical than that required by standard broadcast receivers. It is usually 1/2 wave-length long (at the center of the television band) and may have reflector and director elements for increased directivity. The highly directional arrays are useful for eliminating "ghosts" caused by the reception of signals over two different paths. For example, if the antenna picks up a direct signal and, in addition, one which has been reflected from a building, the same picture information will arrive twice and the time interval between the two will depend upon the difference in lengths of path. Figure 7 shows the effect caused by a ghost. Electromagnetic waves travel at a speed of 186,000 miles per second, or approximately 1,000 feet per microsecond. If, therefore, the reflected path is only 1,000 feet longer than the direct path, one microsecond will elapse between the reception of the direct and reflected signals. At first glance this might seem to be insignificant, but when one calculates the linear scanning velocity for a 12 inch tube it turns out to be about 3/16 inch per microsecond. Thus, a second image would appear 3/16 inch to the right of the first, thereby causing the ghost effect. This condition is greatly improved by properly orienting the antenna and making it sufficiently directional to receive the signal from only one path.

Impedance mismatch between transmission line and receiver antenna-input will also result in multiple images since the signal may be reflected up and down the line several times before it is attenuated to a negligible value. An extra image will result from each such reflection, and the linear horizontal displacement of the ghosts will be proportional to the length of transmission line.

Conclusion

It is apparent that the television receiver is much more complicated than the conventional radio set. Trouble-shooting a unit with 16 to 25 tubes, where frequency response and waveforms are of extreme importance, cannot be accomplished with only a multitester and signal generator. An oscilloscope will be as indispensable for television as the ear is for radio. In addition, a knowledge of theory will be vital for efficient and high quality servicing. ✓ ✓ ✓

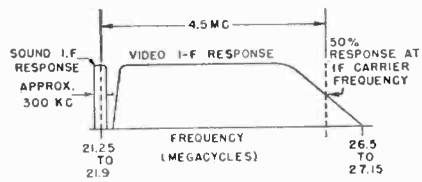

Fig. 6 The ideal response curves for a television receiver.

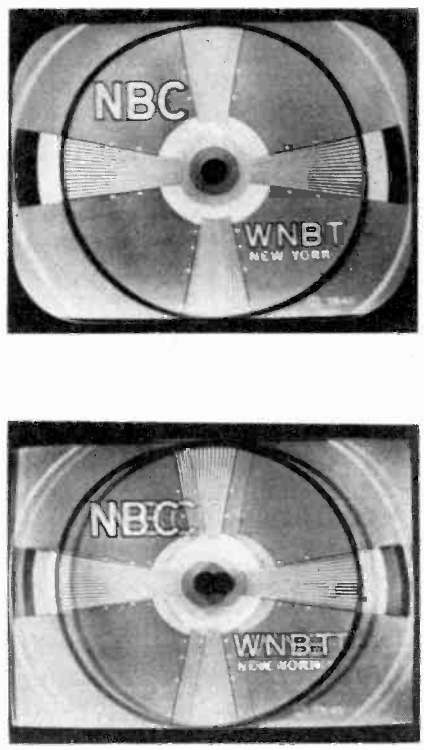

Fig. 7 The upper illustration shows a normal television picture while the lower shows the picture with a "ghost" superimposed upon it.

This article contains some helpful hints on the repair and adjustment of automatic record changers.

PHOTO COURTESY MAGUIRE INDUSTRIES

by GEORGE O. SMITH

Record Changers

THE AVERAGE serviceman, because he has been trained to think in terms of electrical action rather than in terms of mechanical motion, is inclined to view record changers with suspicion. A little study of the principles involved in their operation will make it possible for the average serviceman to handle them without trouble.

In a record changer there are three cycles. First, the pickup is lifted from the record and moved out of the way. Second, the machine deals another record off the bottom of the deck. Third, the pickup is placed on the outside of the record and permitted to play.

If these three cycles took place in sequence, too much time would be consumed. So the record-dealing cycle actually starts before the pickup is out of the way and it is busy setting itself up for the next deal after the pickup is starting to work on the new record.

Adding to the general confusion is the fact that no two record-changer manufacturers seem to agree on how a changer should work. In the triggering of the changing mechanism alone there is more than one method used. One type of changer uses the change in turns per inch of the stylus-arm when the record reaches the run-out spiral. Another type ignores the run-out spiral completely but trips through a toggle lever when the stylus reaches the eccentric groove in the center. A third has a fixed position stop somewhere along the run-out spiral and is doubly protected by incorporating a toggle-lever in case the run-out spiral does not bring the stylus-arm to the proper position. Once these actions are seen and understood, the rest of the sequence takes place logically and similarly regardless of the manufacturer. Cams are cams whether they are on the face of a disc, the surface of a cylinder, or mounted on a shaft.

Since gravity often plays an important part in the operation of the mechanism, it is difficult to gain knowledge of the operation of a changer without resorting to mirrors or lying on the back. A tall framework or wall bracket system will pay dividends. With one of these, the changer may be mounted high enough to see under comfortably. Then the cycling may be inspected carefully; and if the cycle is started and the turntable is moved slowly by hand, the intricate motion may be studied. It will be advantageous to study a few types that are operating properly. When this is done, it is less difficult to locate a defect in a record changer that is not functioning as it should.

Since the job to be performed is neither heavy nor difficult, most record-changer defects consist of loss of adjustment rather than complete breakage of a component part. Lack of proper lubrication will cause many types of changer to "stick" when the pickup reaches the higher velocity section—the run-out spiral. The needle, finding too little freedom in the pickup, will climb the edge of the groove. This will nick the groove at the critical point, making it easy for the same thing to happen at the same place every time the record is played. On the second time around, the mass of the pickup arm presents sufficient inertia to prevent the needle from catching, and the "stuck" record continues to be stuck until the listener is aware of the fact. Each rotation of the record deepens the nick in the groove.

The same thing may happen if the changer has been thoroughly oiled with too much of the wrong kind of oil. Oils will collect dust, and dust will cause a gumming up of the moving parts. When the pickup pressure is on the order of an ounce or two at the end of a ten-inch pickup arm, it takes very little friction to cause the needle to jump out. Cleaning such a defective changer should be the first operation. Radio receivers work when a quarter of an inch of dust covers the chassis. Record changers may work, too, but the chances are unlikely.

Types

Two types of changers are most frequently encountered: The "slicer" and the "toggle-post" types. The Maguire Industries changer shown in the title is of the "toggle-post" type. Of the two, the slicer type of changer is most often subject to maladjustment. Since records are not of the uniform thickness that is desired, the setting of the slicer blade is made average. Use of too thin or too thick records will then require the slicer blade to press down or to raise up; and if an extreme case is often repeated, the slicer blade is subject to strain. Since the blade is necessarily thin, constant strain will cause bending to the point where the slicer blade will neatly meet the full edge of the record which will not permit a "slippage" of the blade to the right position. Then the entire mechanism strains against the record, and either stops the mechanism, breaks the record, or further warps the blade.

Fig. 2 was taken with a high-speed flash outfit. The blade was set low deliberately and the picture was taken at the moment of fracture; the noise of breaking was picked up by a microphone and the impulse used to trigger the flash outfit.

In some slicer types, the blade may be adjusted by a set-screw method. Others are fixed and must be warped into the right position by careful bending. Fig. 3 shows the slicer entering between two records. This is the correct position for the blade. If set too low there will be a shearing action between the slicer and the shelf upon which the bottom record rests. If set too high, the blade will either catch on the record above or may even slice two records if both happen to be slightly thin.

Because there is not enough power in the mechanism, slicers seldom break records directly. They will chip the edges often, though, if they are not set properly.

Hanging up of the slicer blade on the edge of a record may bring forth a secondary trouble. The slicer that chronically hangs up may eventually turn on its pivot, thus losing synchronization. This causes a condition in which one slicer drops the record before the other slicer has released it. The record then drops on one side, the full weight of the record acting as a lever, pivoting around the unsynchronized slicer. Very often the center hole is pinched on the turntable post with sufficient force to crack out the hole.

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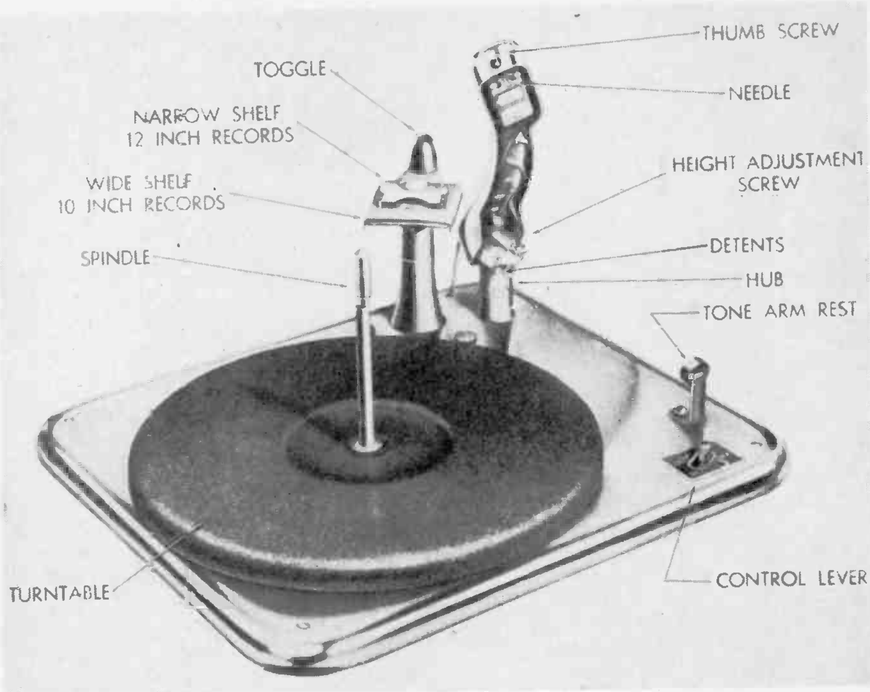

COURTESY OF DETROLA

Fig. 1 The Detrola Model 550 Automatic Record Changer, using the toggle-post mechanism.

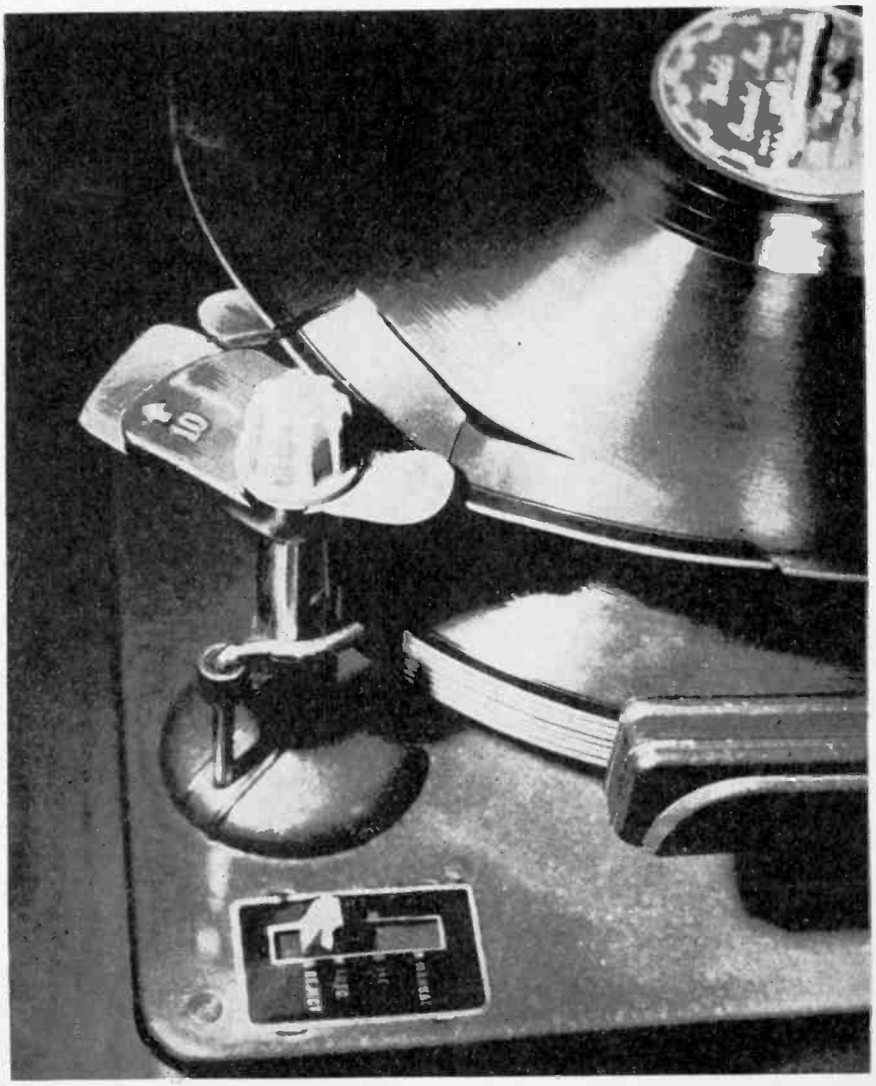

Fig. 2 A maladjusted slicer blade fracturing a record.

Record Changers

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The use of holes and taper-pins to maintain alignment is often ineffective as it is impossible for the crank to turn on its axle. When the slicer is stopped by a record of the wrong thickness, the strain may warp the mechanism. If such a type is out of adjustment, the taper pin should be removed and the mechanism readjusted by setting the record on the shelf and turning the turntable by hand. It is not necessary that both shelves move out at exactly the same instant, though this is most desirable. The "last" shelf to move from under the record should be free before the record can pinch the turntable post. The set screw used to position the slicer shelves will hold the proper location long enough to drill and re-set the taper pin.

Toggle Post Changes

Because the toggle-post type of changer does not offer any of the above difficulties, it is becoming more popular as time goes on. Contrary to the usual opinion, toggle-post changers are not hard on the center-hole of records. Maladjustment of this type of changer is usually caused by bending of the center post. If such a condition is encountered, it is advisable to replace the warped center-post with a factory replacement because the center-posts are usually bent to critical shapes which may be impossible to reproduce. In addition, rebending of the post may either scar the metal or cause burrs which will damage the dropping record. Most of the center-post types are carefully designed so that the average fall of the average record is followed down the center post with a minimum of friction.

Since the mechanism that pushes the bottom record out from below the stack is usually husky and adequate, warpage at this point is seldom observed unless the changer is mishandled or a large stack of records has been dropped directly on the business end. Records becoming stuck between the pusher and the center post will usually cause bending of the toggle post since it can be no larger than 9/32 of an inch in diameter.

In changers which "trigger" or start to cycle before the record is finished, the triggering mechanism often becomes defective. Since the force used to initiate the cycle is very small, lack of lubrication—or gumming caused by too liberal application of heavy oils—may cause stiffness. In such a case, the 100 odd turns-per-inch part of the playing surface will cause the triggering when the triggering device is initially contacted.

Needle Pressure

The needle pressure is important in changers. The trend in pickups has been toward lighter pressures. Lighter pressure not only provides better reproduction with lowered scratch and needle-sing, but also tends to eliminate slippage encountered when two dished records are used that contact only near their centers. With a heavy pressure, the record-friction at the needle may cause slippage, thus slowing the top record and giving a rather weird selection of music. With lighter pressures, this outside friction is lowered and the tendency toward record-slippage is lessened.

Changing cartridges is a simple matter. However, there are a number of important points which must be kept in mind. A light pressure crystal cartridge should not be used in a mechanism operating under heavy pressure without readjustment of the pickup. A handy gadget for measuring pickup pressures is shown in Fig. 4 and Fig. 5. It is a scroll-saw blade which has been heated red hot in the center and bent to the desired shape. Blades with a small pin in either end are desirable since the pin may be removed, leaving a hole in which to place the needle of the

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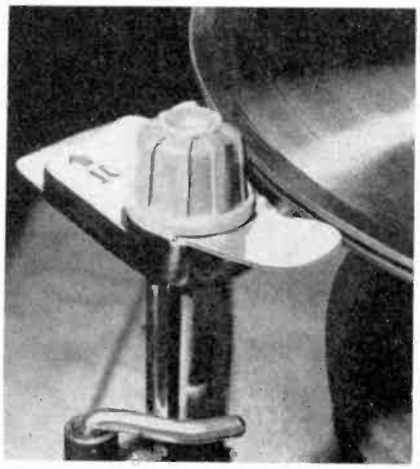


Fig. 3 Slicer blade entering between two records.

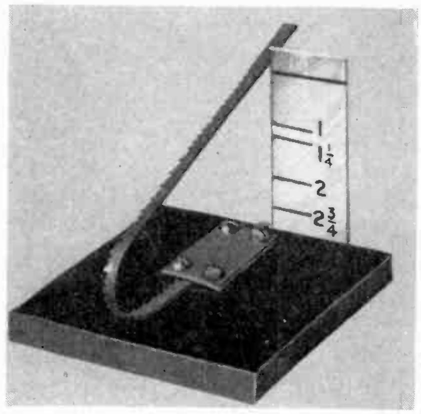


Fig. 4 A homemade scale used to measure the needle pressure in record changers.

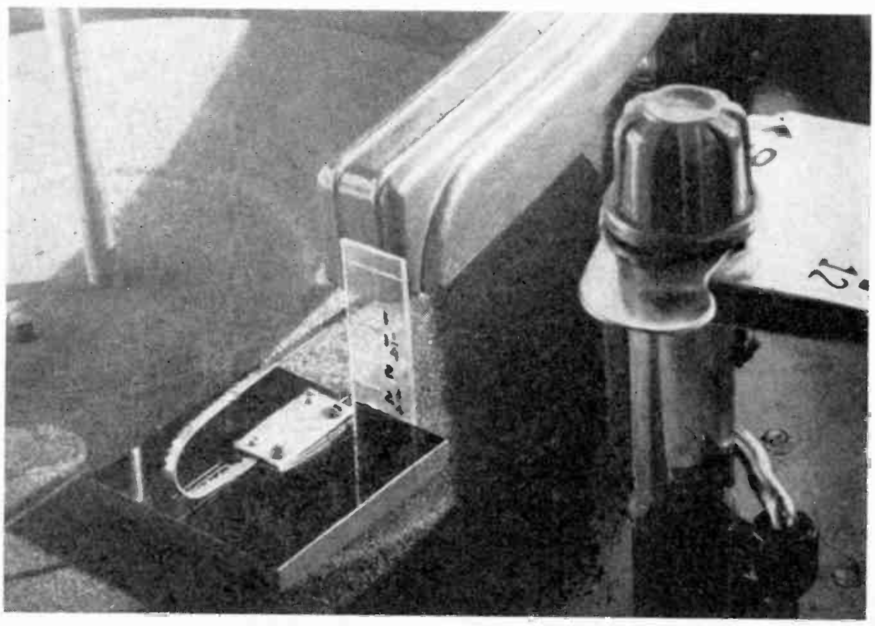
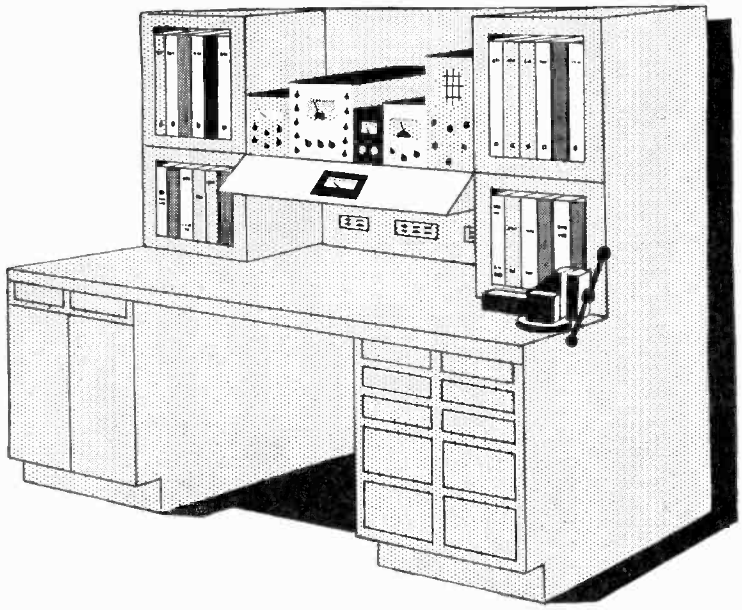


Fig. 5 Using the homemade scale to check the needle pressure of a record changer.

The Radio Service Bench



SUGGESTIONS FOR DIAL BELT REPLACEMENT

PAST EXPERIENCE has proven that it is not always sufficient to replace a broken dial cable and let it go at that. We have come across receivers in which a number of dial cables have been replaced. In most of these cases, the trouble lay in the fact that, while the dial cables had been replaced, the underlying cause of the breakage had not been corrected. In order to insure that there will be no comeback on a dial cord replacement job, the tuning assembly of the receiver must be examined carefully and defects which will cause rapid wear corrected.

When the dial cable breaks in a receiver which has been in use for but a few weeks, the trouble can usually be traced to the metal clip which joins the ends of the cable together. At times the clips are not formed properly or fastened tightly enough. If the clip does not prove to be the cause of the trouble, the chassis should be examined for burrs and the tuning condenser checked for freedom of rotation. A stiff rotor can usually be loosened by bending the back side of the frame of the condenser with a pair of pliers. This must be done carefully in order to avoid trouble with the ball bearings at the front end of the shaft. If all pulleys move freely and are properly aligned, the new cable may be installed. When the job has been finished, check the cable to see that it is not rubbing. If the tuning knob turns easily and no slippage is noticed, you may be reasonably sure that the dial cable will give good service.

In older receivers, dirt and dust gum up the moving parts and the whole mechanism becomes stiff and hard to turn. All bearings, pulleys, etc., should be cleaned and oiled with light machine oil so that they turn freely. Pulleys which have a common drive belt should be aligned so that the belt rides in the center of the groove all the way around. When a pulley is out of line, the cable will pull over the edge at the point where it leaves the pulley, causing wear and unnecessary strain on the cable.

A common source of trouble in low priced sets is the control shaft knob. The shaft passes through a

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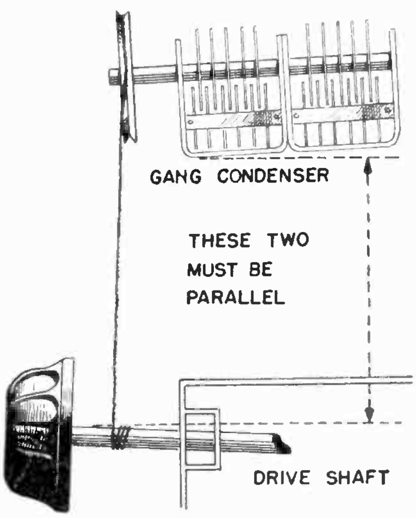

Fig. 1 As illustrated above, the axes of all shafts in a dial assembly must be parallel for proper operation.

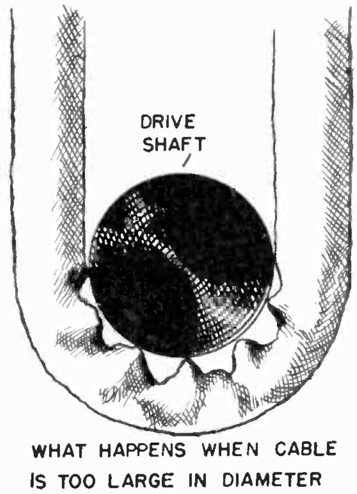

Fig. 2 Wrinkles on the inside of a large diameter cable cause slippage.

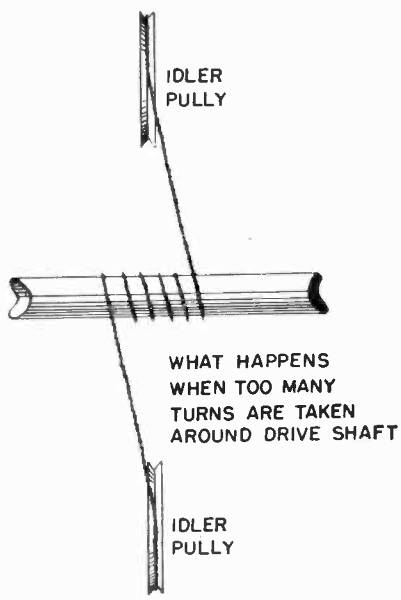

Fig. 3 Too many turns around the drive shaft cause the cable to be pulled over the edge of the pulley.

ELECTRONICALLY SPEAKING . . .

THE FIRST PHOTOFACT FOLIO was issued on June 15 by the new organization, Howard W. Sams and Company of Indianapolis, inaugurating a revolutionary method of supplying the entire radio field, set manufacturers and radio servicemen alike, with servicing data on the thousands of new receivers to be built for the post-war market.

Creation of the service, according to Mr. Sams, was prompted by the need for servicing data material to speed servicing operations, and by the tremendous increase both in number of receiver manufacturers and variety of models to be produced soon. In the past, the radio serviceman needed information on the products of only 36 receiver manufacturers, whereas today there are 212 manufacturers (radio and phonograph combined) about to produce 1,000 models among them.

The Howard W. Sams Radio Service Encyclopedia will be issued periodically in the form of "PhotoFact" Folders, each covering one receiver model. The folders will vary in size from four to twelve pages, depending upon the complexity of the receiver, and will be profusely illustrated, containing completely identified lists of parts and suitable replacements, as well as detailed engineering data and voltage and resistance analysis.

Users of the service will receive these folders in folios of 30 to 50 at frequent intervals and as rapidly as new receivers are placed on the market. The complete service folder on a new receiver will be delivered to subscribers within 90 days after the set goes on sale. The Sams organization has secured the close cooperation of the receiver manufacturers in order to insure delivery of the folders at the expiration of the RMA 90-day guarantee period. The cost of a complete folio of 30 to 50 service folders will be $1.50 to the radio serviceman.

The Sams organization will secure a sample of every new receiver immediately after it goes into production and its engineers will analyze each set, check and list every component part, record each resistance and voltage value, and test the set in every particular before preparing the PhotoFact Folder.

The following detailed description of the PhotoFact Folders shows why they will free the serviceman from working with cumbersome and complicated cross-indexes and manuals:

1. There will be a PhotoFact Folder covering each individual receiver placed on the market after January 1, 1946, containing from four to twelve pages of photographs and service data.

2. Each folder will contain from two to twelve photographs of the chassis taken from various angles so that every component is clearly recognizable and identified for reference to the accompanying list of parts.

3. A keyed reference Parts List will give complete specifications for each component, the manufacturer's part number, available replacement type or types, and other installation notes.

4. There will be a keyed reference alignment procedure for each set with adjustment frequencies and recommended standard connections.

5. Complete voltage and resistance analysis will be given for each receiver. This will include actual measurement data for voltage and resistance at each socket prong to record actual new set performance.

6. Complete stage gain measurement data.

7. A schematic diagram.

Regular subscribers to the service will hold membership in the Howard W. Sams Institute which will be headed by 30 top-notch specialists in radio, radar and radio servicing. This board will help members to solve their problems in connection with servicing, parts selection, promotion, accounting, etc., and will cooperate in every way to help members run their businesses more efficiently and profitably.

Howard W. Sams, who heads the new organization, is well known throughout the radio trade as an executive for many years with P. R. Mallory and Company of Indianapolis. For the past fifteen years he has been intimately associated with the development of the Mallory-Yaxley Radio Parts Division of that company, and has taken an important part in the company's long and successful campaign for standardization of radio components.

For further information on this revolutionary new service, write to Howard W. Sams and Company, Inc., 2924 East Washington Street, Indianapolis 6, Ind.

A MINIATURE ROTARY CONVERTER has been developed and is being marketed by the Ohio Tool Company. It is designed to replace vibrators in automobile receivers. The new converter gives longer life, better efficiency and lower noise level. Units are mounted in cans approximately

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Back Numbers!

ANTENNAS FOR FM AND TELEVISION
BUSINESS MANAGEMENT FOR THE RADIO DEALER
RADIO MAINTENANCE FOR AVIATION
USING THE SIGNAL GENERATOR AND OSCILLOGRAPH

THE PROBLEMS OF ORGANIZATION
TELEVISION RECEIVER INSTALLATION
RADIO MAINTENANCE IN AVIATION
USING THE OSCILLOGRAPH FOR DISTORTION MEASUREMENTS

MODERN BENCH CONSTRUCTION
SYMPOSIUM ON TEST EQUIPMENT
FUNDAMENTALS OF VACUUM TUBE VOLTMETERS
REPAIR OR RECONDITIONING

TROUBLESHOOTING TELEVISION RECEIVERS
APPLICATIONS FOR LOW COST SIGNAL TRACER
RADIO REPAIRMEN'S ASSOCIATIONS
RADIO SERVICE ALONG THE AIRWAYS

PA SYSTEMS
A MIDGET AUDIO FREQUENCY OSCILLATOR
IF I WERE A SERVICEMAN
AN EQUALIZED AMPLIFIER FOR MAGNETIC PICKUPS

P A SYSTEMS
TEST PANEL FOR THE MODERN BENCH
RINGING THE BELL

By popular demand we are making available to our readers the back issues of RADIO MAINTENANCE shown above. The articles featured each month are listed enabling you to select those copies containing material of most interest to you. So many requests are already on hand for these magazines that it would be advisable to get your order in early as the supply is limited.

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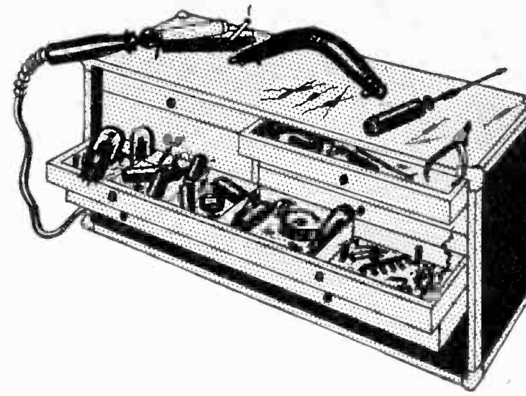
Service Kit



BACKWARD SIGNAL TRACING

MUCH HAS BEEN WRITTEN about the different methods of radio servicing, particularly the methods of servicing by Resistance Measurement and Signal Tracing; but probably the most used and the least recognized is the method known as Signal Insertion. This term may seem a little confusing, but it is one of the oldest types of servicing and has undoubtedly been practiced by most radio servicemen.

When asked for the quickest method of determining whether or not the audio section of a receiver is functioning, the average serviceman will reply, "Touch the grid cap of the first audio stage and if there is a hum in the speaker, then it can be assumed that the audio stages are amplifying."

What did you do when you touched the grid cap? Whenever AC flows through a circuit, there is a field set up in the surrounding area, and if a person is in this field, there will be a voltage induced in his body that is measured in microvolts, or perhaps even in millivolts. When the grid cap is touched, this induced voltage is "inserted" on the grid of the audio tube, and since the AC field frequency is within the audio range of the receiver, it is amplified and heard in the speaker. This is about the fastest way of checking the audio end of a radio receiver. It is a crude way of servicing by signal insertion.

Carrying the idea further, we have a method which will, nine times out of ten, allow us to locate a defective stage in a few minutes. All that is needed for the insertion method of servicing is a conventional type of signal generator such as is used in most shops. For the sake of convenience, the generator must have some means to select either an RF output or an AF output. This is possible with about 90 per cent of the service-type signal generators. It is best to use an ordinary test prod and shielded lead, with a condenser connected between the test prod and the generator output. This condenser is used to protect the attenuator from burnout when the prod is placed on a point of high potential. The shielded lead from the generator output prevents stray AC pickup that would be impressed on the circuits under test along with the desired signal.

One difference between signal tracing and signal insertion is that with the former, one starts with the front end of the receiver under test and works toward the speaker; whereas, in the latter method, one starts with the back or audio end and works toward the antenna input.

For quick servicing by the insertion method, the following procedure is recommended. Turn on the receiver to be tested and allow it to warm up for a few minutes. Adjust the signal generator for audio output and set the attenuator control at maximum. Connect the ground wire from the generator to the ground on the set and insert the signal onto the plate of the output tube (Point A on Fig. 1). This is done simply by touching the plate terminal with the test prod. If a weak audio signal (usually 400 cps) from the generator is heard in the speaker, this means that the output transformer and speaker are functioning. Next, the signal is inserted on the control grid of the output tube (Point B on Fig. 1). The signal should be much louder than when it was inserted on the plate.

The next step is to insert the signal on the grid of the first audio stage (Point C of Fig. 1). If this stage is functioning normally, it may be necessary to reduce the output from the generator. If all the circuits associated with the audio end of the receiver are functioning, then we must turn to the IF and RF sections. If the receiver is a superheterodyne, tune the signal generator to the prescribed IF for the set, and adjust it for modulated RF output. Place the test prod on the plate of the last IF stage (Point D of Fig. 1). The signal heard in the speaker should be the same as in previous tests. Next, the prod is placed on the grid of the last IF stage (Point E

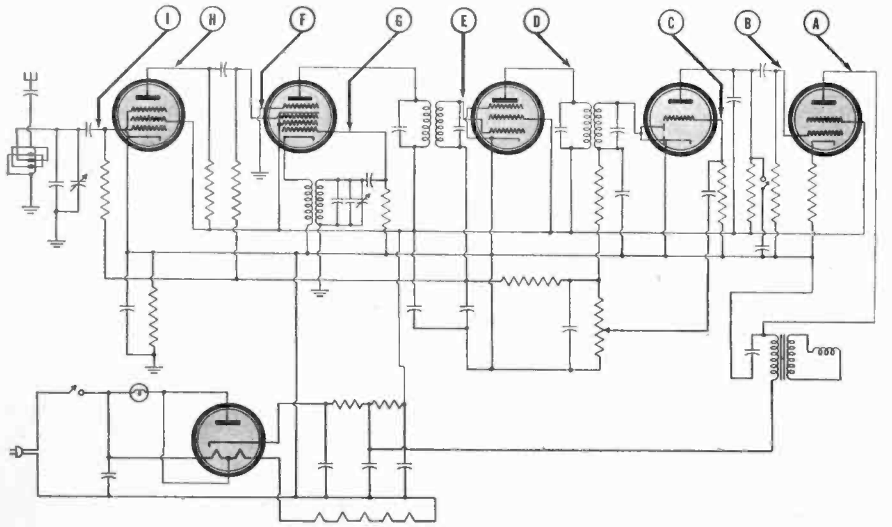


Fig. 1 The letters indicate the points at which the signal is inserted.

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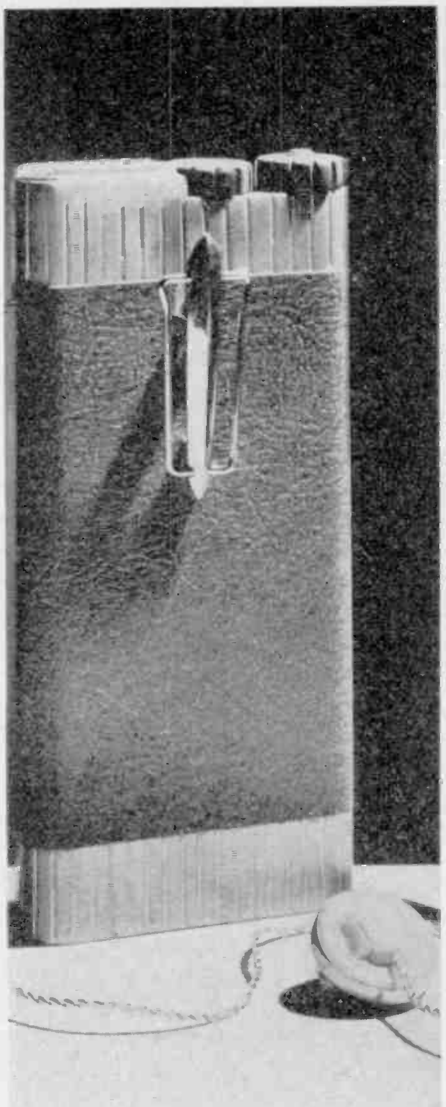
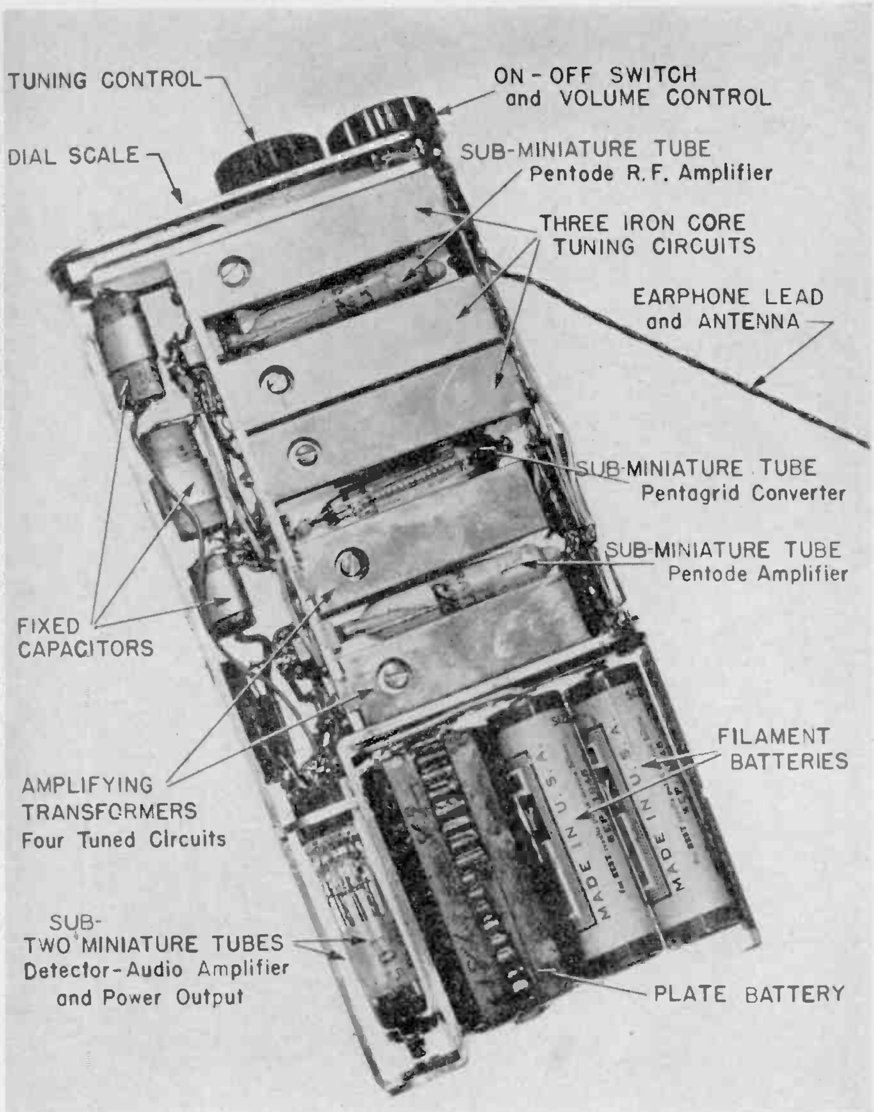
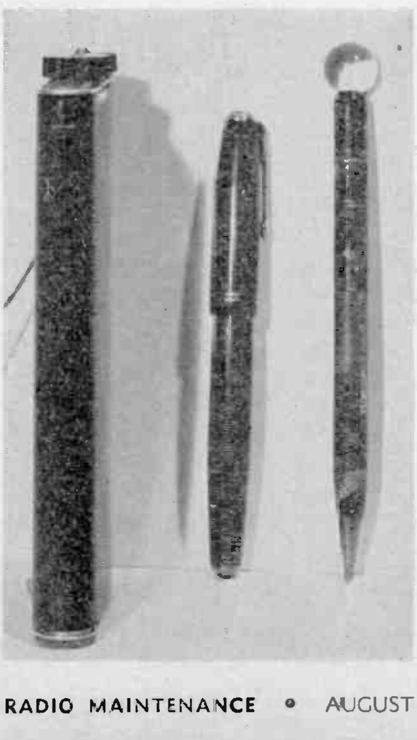




Belmont's new pocket radio



FIRST PHOTO SHOWING INTERNAL CONSTRUCTION OF THE MIGHTY MIDGET

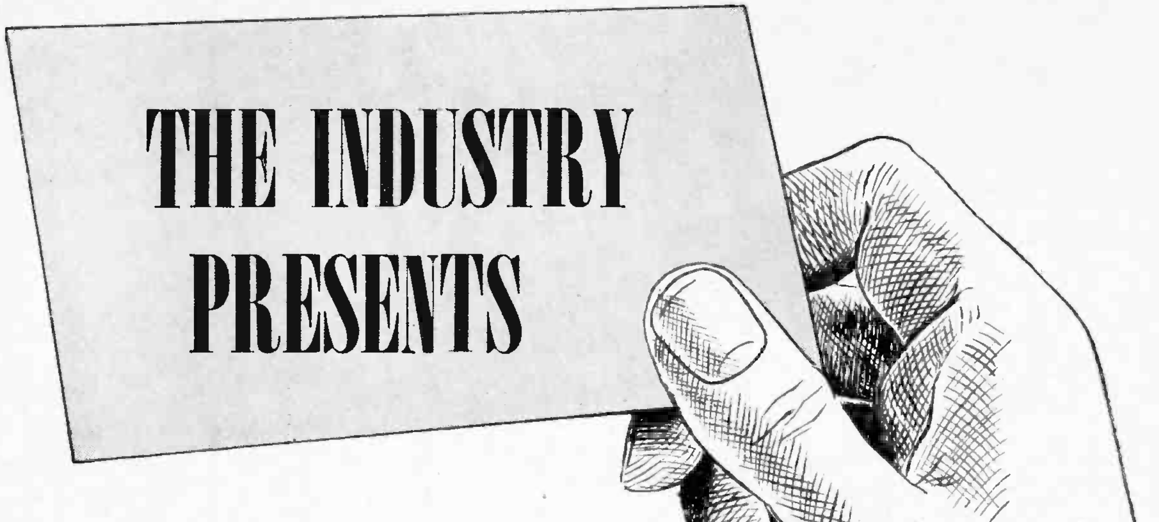
The photo at the upper right shows the internal construction of the new Belmont miniature receiver, the smallest superheterodyne ever produced. The five tiny tubes are an outgrowth of research on the famous VT fuse. Raytheon carried on their research and developed the tubes so that they could be used in this and other small equipment. The tubes are 1-9/16″ long and are equipped with plug-in bases. Approximately 30 parts are used in the construction of each tube.

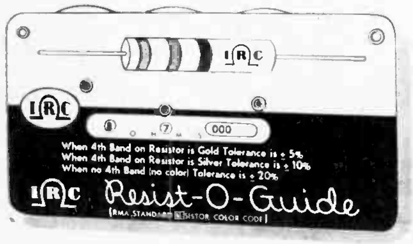
Of the tubes used in the receiver, two are radio frequency pentodes, one is a triode heptode frequency converter, one a diode pentode detector amplifier, and one is an output pentode. Two of the tubes are actually combinations of two tubes in one envelope.

The complete receiver weighs 10 ounces and is 3″ wide, ¾″ thick and 6-¼″ high. The receivers are supplied finished in solid gold, sterling silver, plain and two-tone metal, or morocco, pin seal, alligator, pigskin, suede and other leathers.

The photo at the upper left is an external view of the receiver showing the pocket clip and small earphone. At the lower left is an illustration of the receiver placed beside a pen and pencil to show their comparative size.

The small "B" battery used in the set supplies 22½ volts. The total power consumption of the five tubes is approximately ⅓ watt.

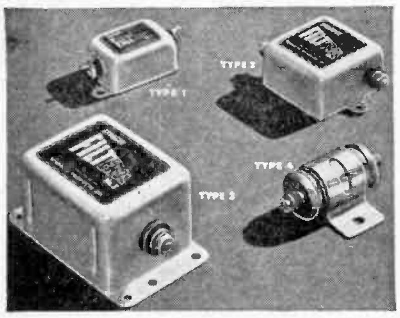




RESIST-O-GUIDE

A practical aid in resistor range identification, the pocket-size Resist-O-Guide has been announced by the International Resistance Company of Philadelphia.

By turning the three wheels of the Resist-O-Guide to correspond with the color code on any composition type resistor, the standard RMA range is automatically and accurately indicated. To obtain the correct color coding, turn the wheels to indicate any desired standard range. This guide is available at International Resistance Company distributors.



FILTEROL

For reducing man-made radio noises on a wide variety of equipment, take note of Filterol Radio Interference Filters manufactured by the Sprague Products Company. They are small, self-contained units applicable to any electrical device within their ratings, and provide greater noise suppression than has ever before been possible. Filterols should be mounted on the frame of the device or in a grounded junction box close to it. Their basic circuit is a three-terminal network of which the can is one terminal.

Further details may be obtained from the Sprague Products Company, North Adams, Mass.

MINIATURE PORTABLE

Just announced by the Garod Radio Corporation and pictured above is the 3-way miniature Model 5D portable which weighs only 6½ lbs., for AC, DC or battery operation, with loop antenna concealed in the front-raising lid which rises automatically when slide lock is released. It has a 5-tube electronic circuit with Alnico "V" P.M. speaker.

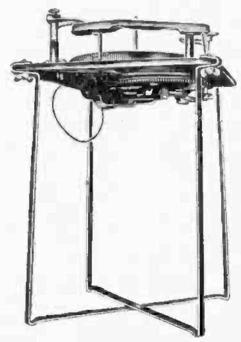
Another new Garod product is the "Esquire" farm receiver, Model 6F1, a 6-tube battery radio that can be plugged into AC or DC where electricity is available, and has 1,000-hour battery pack, large slide-rule dial, and AVC—comes in walnut cabinet.

Write the Garod Radio Corporation, 70 Washington Street, Brooklyn 1, N. Y., for additional data on these items.

CAPACITOR EXAM-ETER

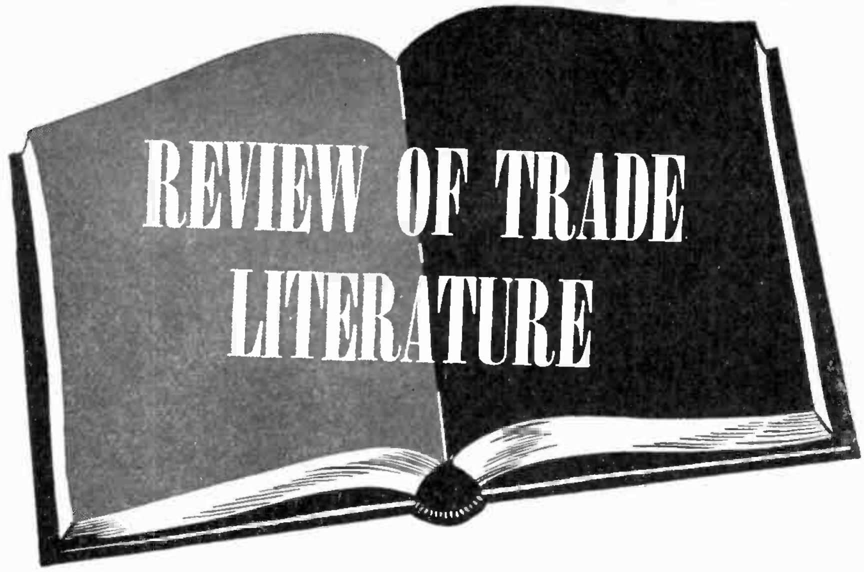
A new capacitor analyzer, Model CF Exam-eter, is now available from Solar Manufacturing Corporation, 285 Madison avenue, New York 17, N. Y. Its patented "Quick-Check" oscillator circuit spots intermittent, open-circuited and short-circuited capacitors without the necessity of the serviceman's unsoldering them from electrical circuits.

The Exam-eter has a DC bridge to check capacitances from 10 uuf to 2000 uf and resistances from 100 ohms to 7.5 megohms; an auxiliary bridge scale to read capacitor power-factors up to 55 per cent; and a 4½-inch meter in the vacuum-tube-voltmeter bridge null indicator. Measurements up to 600 volts DC and 50 volts AC can be made. An electronic test circuit supplements the bridge for measurements of capacitor insulation resistance up to 10,000 megohms.



TURNTABLE SERVICE STAND

The problem of supporting a phonograph turntable for convenient servicing is solved by the new turntable stand which is adjustable to fit any size turntable, manufactured by General Cement Manufacturing Company, Rockford, Ill. Its height of 18 inches permits easy inspection and repairs of the motor and changer mechanism. This stand saves considerable time and effort for the serviceman on a hitherto unwieldy job. ↑ ↑ ↑



REVIEW OF TRADE LITERATURE

THE NEW Centralab catalog is now ready for distribution. It covers the complete Centralab line of controls, capacitors, trimmers and switches. A number of new trimmers, transmitting capacitors, high accuracy capacitors, and silver mica capacitors which have been added to the Centralab line are included in the new catalog.

To secure a copy, write to Centralab, Division of Globe-Union, Inc., 900 E. Keese Avenue, Milwaukee 1, Wis. Request Centralab Catalog No. 25.

The Walter L. Schott Company has announced its new catalog. It covers the Walsco line of radio chemicals and electronic hardware. Over 200 hardware items and a complete line of adhesives, solvents, polishes and other chemicals are listed. The catalog also lists a number of other products of particular interest to the radio serviceman.

To secure a copy of this 16-page catalog, write to Department 127, Walter L. Schott Company, Beverly Hills, Calif.

Just off the press is the J.F.D. Manufacturing Company's new 64-page Dial Belt Manual. It is the most complete book on the subject ever published. It contains information for replacing dial belts on more than 1500 receiver models. Complete listing, specifications and interchange data are given. The manual also contains a special section on radio drive cable and cord, supplemented with a full coverage of rubber drives and dial springs.

To obtain your free copy, write to the J. F. D. Manufacturing Company, 4111 Fort Hamilton Parkway, Brooklyn, New York.

The Stromberg-Carlson Manufacturing Company has issued a catalog outline on their line of sound equipment. The new Stromberg-Carlson line is made up of portable and fixed sound equipment and accessories.

A copy of the catalog outline will be sent upon request to the Stromberg-Carlson Manufacturing Company, Sound Equipment Division, 100 Carlson Road, Rochester, N. Y.

A copy of the McMurdo Silver catalog has just been received. It covers the post-war McMurdo Silver Company's line of test, transmitting and receiving equipment. Featured in the catalog are the Model 900 Vomax, Model 904 Capacitance Resistance Bridge, Model 905 Spark Dynamic Signal Tracer, and the Model 906 FM/AM Signal Generator.

The Model 906 FM/AM Signal Generator covers the radio spectrum from 90 kilocycles to 170 megacycles with either AM or FM provided internally.

To secure a copy, write to the McMurdo Silver Company, 1240 Main Street, Hartford 3, Conn.

The General Cement Company's catalog and a handy Woven Belt Scale will be sent on request to the General Cement Manufacturing Company, 919 Taylor Avenue, Rockford, Ill. The Woven Belt Scale is designed to facilitate the determination of the belt size to be used in replacements. The serviceman will find it to be a time-saver.

P. R. Mallory & Company have issued their comprehensive 37-page catalog No. 467, covering capacitors (dry electrolic and paper dielectric), controls, vitreous enamel resistors (both fixed and variable), switches, jacks and plugs, etc. Most items are clearly illustrated or shown in diagram, as well as being described in respect to application.

Noted in particular were Type P round cased AC capacitors which are encased in a newly perfected plastic and are superior from a moisture-resistant standpoint. They are interchangeable with former types of the same size and may also be used with a new end cap and bracket where required.

This catalog may be obtained without charge by writing P. R. Mallory and Company, Inc., Indianapolis 6, Ind.

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Record Changers

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pickup being measured (see Fig. 5). The blade is cleated to a base of steel or brass of sufficient size to stabilize it when maximum pressure is being measured. The scale is made from a bit of celluloid and is calibrated by hanging weights (as from a photographic scale) from a thread passed through the hole in the end of the blade.

Counterbalancing

When replacing a heavy cartridge with a light one, the pickup arm must be re-counterbalanced, either by replacing the counterbalance spring (see Fig. 6) with a stiffer one, or by cutting a loop or two from the existing spring—or by adding weight to the back end to lighten the total needle pressure. This may lead to non-operation of the changer due to the lightened torque produced by the run-out spiral. With lighter needle pressure, the torque required to trigger the mechanism may be high enough to cause the needle to climb out of the run-out spiral, producing non-operation and the attendant nicking of the groove.

If any doubt exists, it is well to try the instrument on a large selection of records using the regular pickup and the lighter pressure designed for the new cartridge. Proper adjustment can often be made by working through the changer triggering mechanism and lightening all the springs and weights used. Care must be taken not to overdo this or the changer may take off at the wrong time, due to a slightly eccentric record or a heavy footstep on the floor.

In counterbalancing pickup arms using weight only, it may be possible to remove some of the metal apron and enclosure of the pickup arm itself. This is better than adding bar-solder slugs to the back end. Too much mass in the arm itself creates inertia; and since pickups usually ride up and down as the record revolves, excessive mass in the arm will produce a condition in which the needle continues to rise after it has passed the high point on the record. When this occurs, the needle will jump out of the groove. Under ideal conditions, the cartridge and arm weigh slightly more than enough to give proper pressure on the record, and thus a minimum of back-end counterbalance is needed.

In measuring the weight of a spring-counterbalanced pickup, remember that the needle pressure will decrease as the pickup is lowered and will increase as the pickup is moved upward. Therefore, weight should be checked at the average needle height for a stack of records. This height is ordinarily about one-half of an inch from the surface of the turntable. The average pressure should be as close as possible to the manufacturer's specifications.

With the information given here and some actual observation of the operation of the different types of record changers, the serviceman should find little difficulty in adjusting and repairing this equipment.

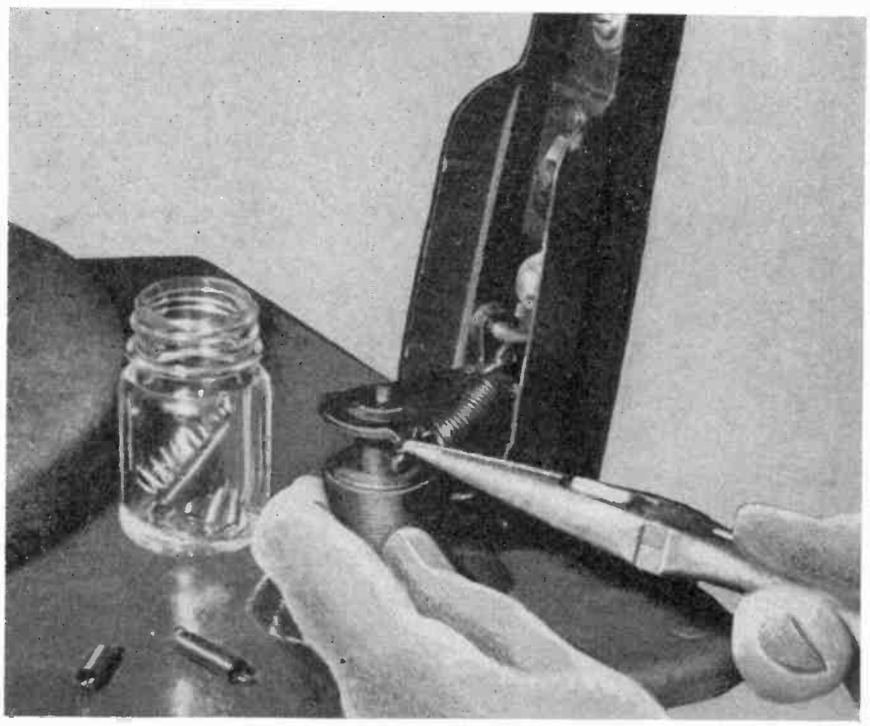

Fig. 6 Replacing the counter-balance spring to give correct needle pressure after having replaced the cartridge.

The Radio Service Bench

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hole in the chassis and then through a hole in a small bracket which holds it. Once worn, little can be done to put this arrangement back in good working condition. Bending with pliers will often help somewhat.

When replacing the dial cable in a set which uses a half-inch or smaller pulley on the tuning knob shaft, a cable of small diameter must be used. Large diameter cables will slip because of the condition illustrated in Fig. 2.

One turn should be sufficient around the drive shaft. When more than one turn is used, the cable is pulled out of line as illustrated in Fig. 3. Three or four turns will result in the end turns climbing over the inside turns binding the cable.

The cable should be just tight enough to turn the condenser with

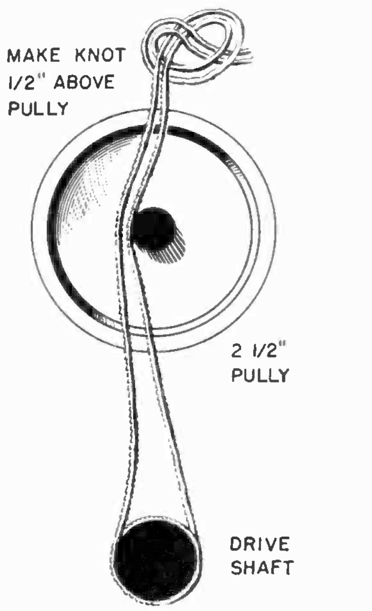

Fig. 4 Method used to tie knot in cable in proper place.

the spring removed. Usually, proper tension can be secured by tying the knot in the cable about a half inch above the top of the pulley, as shown in Fig. 4. On the first try, the knot should be tied loosely and the cable tried for tension. If the tension is not correct, the knot may be opened and retied in the proper place.

The dial assembly should always be carefully examined and adjusted before a repair job is returned to the customer. An inoperative dial is very exasperating and recurrence will certainly not leave a pleased customer. ✓ ✓ ✓

AVC Circuits

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Note that its circuit is substantially the same as the basic circuit of the elementary AVC rectifier, with the exception that its load resistor R-1 is returned to the cathode, not to ground. D-1 is the AVC diode and its load resistor R-1 is returned to ground.

As a result of plate current flow through the triode, resistor R-K develops a voltage with polarity as indicated. Now, with no signal applied, there is no current flowing in the D-1 circuit; and since there is no voltage drop across K-1, D-1 is at ground potential. However, due to the drop across R-K, D-1 is *negative* with respect to its cathode by the amount of voltage drop across R-K. As the signal is applied, D-1 assumes a potential equal to the peak IF voltage. As long as this peak IF is smaller than the drop across R-K, no current can flow through D-1 circuit. However, as soon as the signal increases in intensity and makes D-1 positive with respect to its cathode, current will flow and produce a voltage across

→ To Following Page

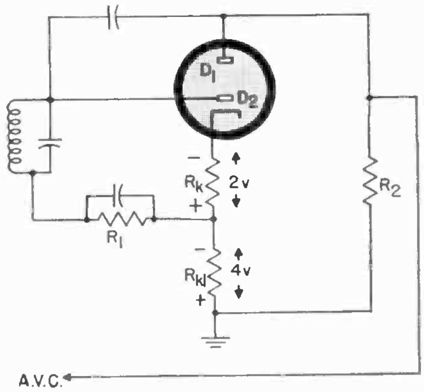

Fig. 10 Circuit used to obtain delayed AVC action.

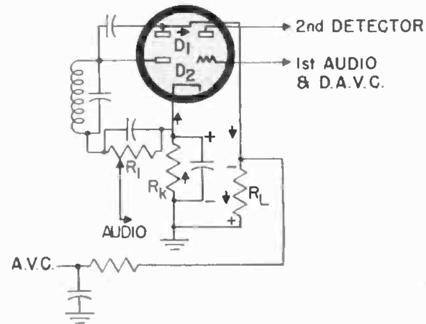

Fig. 11 Circuit of combined delayed AVC, second detector and first audio.

AVC Circuits

→ From Preceding Page

K-1 in the manner shown. Thus the AVC action is delayed until the signal reaches a predetermined level.

Still another modification is that known as QAVC or quiet automatic volume control. The function of this circuit is to prevent the receiver from working at all until the signal strength is high enough to produce satisfactory reception.

For the sake of simplicity, imagine resistor R-1 of Fig. 10 returned to ground rather than to the cathode. Now D-2, the detector diode, will also have a delay voltage to overcome before detection can take place, and weak signals are not heard. This again brings up the objection that AVC action starts with the weakest signal heard. Therefore, in order to delay AVC action until sufficiently strong signals are received, R-K is split in two parts as shown in Fig. 11.

Assuming arbitrary values of voltage as shown in Fig. 11, it can be seen that no signals will be produced until the peak value of the IF exceeds the 2 volts delay on D-2. When the signal intensity is such that the peak of the IF is between 2 and 6 volts, the full sensitivity of the receiver is available. As soon as the peak exceeds 6 volts, AVC action takes place.

These are but a few of the many circuits possible for AVC, but they should point the way toward an understanding of the circuit and the development of a successful service technique. ✓ ✓ ✓

Electronically Speaking

→ From Page 20

the same size as those used for standard vibrators. Using a rotary action instead of the ordinary vibrating reed to accomplish switching, the new component is a step forward in the improvement of portable power supply.

Further information can be obtained from the Ohio Tool Company, Cleveland 11, Ohio.

General Electric's first television receivers are expected to be available to the public in August or September in areas where stations are now operating or will soon be on the air. The first model will use the ten-inch direct-view picture tube, will incorporate the standard broadcast band, and will probably cost around three hundred dollars.

Other sets for black-and-white picture reception will follow shortly afterward, and will be of the projection as well as the direct-view types. All these television sets will be made at the Bridgeport, Connecticut, plant.

Over 200,000 radio sets a week are now being produced by the industry, according to a statement by R. C. Cosgrove, President of the RMA. He pointed out, however, that the majority of these sets were table and portable models. Production of consoles is lagging far behind expectations.

A new Radio Center is being completed in Fort Wayne, Indiana, by the Farnsworth Television and Radio Corporation, President E. A. Nicholas has announced.

The Farnsworth Radio Center is designed to provide Northeastern Indiana with television, frequency modulation and improved regular amplitude modulation broadcasting services, all originating and controlled from newly built central studios in downtown Fort Wayne. Facilities for all three services will be among the most complete and modern in the country. ✓ ✓ ✓

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The Model 670 comes housed in a rugged, crackle-finished steel cabinet complete with test leads and operating instructions. Size 5½" x 7½" x 3".

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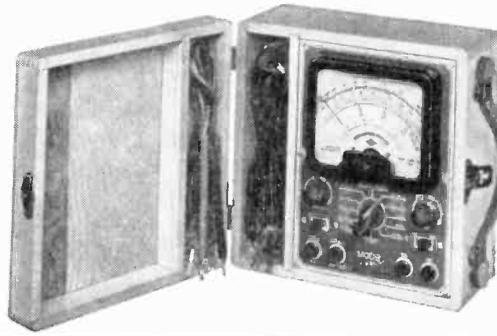

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Service Kit

→ From Page 22

of Fig. 1), and once more a considerable gain in output should be noticed. Now we proceed back through the IF stages, if there are more than one, checking each one as we checked the last IF stage. As we progress to the grids of the preceding stages, it will be noticed that the gain increases greatly. To offset this increase in gain, the generator attenuator setting should be decreased.

Checking back through the IF stages, we come to the mixer stage, or as it is sometimes called, the first detector. The IF signal is inserted on the control grid of the mixer (Point F on Fig. 1), and if another gain in output is noticed, the mixer is amplifying. Tune the receiver to the frequency of the strongest broadcasting station in that particular locality, and if it is not heard, proceed as follows: Tune the signal generator to a frequency that is the sum of the frequencies of the broadcasting station and the IF of the set. For example, if the station operates on a frequency of 1000 kilocycles and the IF of the set is 455 kc, then 1000 plus 455 equals 1455—the frequency to which the signal generator should be tuned. (This is the frequency at which the oscillator in the set should operate in order to receive a station with a frequency of 1000 kc.)

Turn the modulation off, and feed the signal to the oscillator grid, or to the place where the oscillator signal is normally fed to the mixer tube (Point G on Fig. 1). If the station is heard, it indicates that the local oscillator in the set is not functioning. If the station is not heard, the trouble is ahead of the mixer, and we proceed to the RF section. The generator should now be tuned to the frequency at the set, which, at present, happens to be 1000 kc. We now proceed from plate to grid (Points H and I on Fig. 1) with the test prod until the defective stage is found and we finally arrive at the antenna post.

The above procedures and tests require less than five minutes to make. This is fast enough for most radio service requirements. As the serviceman uses this method of checking, he will find many short-cuts and time-savers that are not described in this article.

Checking for Intermittents

If the set under test is an intermittent, then with the insertion method it is comparatively easy to locate the defective stage. Starting with the audio output stage, the signal is fed to the grid of the tube and the preceding stage is stopped from functioning by removing the tube or by shorting out the grid with a jumper. If the set does not show an intermittent with just this stage working for a period of time, then proceed to the next stage and repeat the process until the stage that shows an intermittent is located.

The writer has been in the service business for about ten years and has used practically all the methods of servicing from resistance measurements to signal tracing, and he has found that the method just described is as fast and efficient as any method he has yet tried.

Review of Trade Literature

→ From Page 25

BOOKS

ELECTROLYTIC CAPACITORS, by Paul McKnight Deeley.

Published by Cornell-Dubilier Electric Corporation, South Plainfield, N. J., 270 pages, price $1.50.

This well illustrated book presents new applications of electrolytic capacitors, as well as giving the basic theory of operation, construction, measurements and characteristics in a simple, straightforward manner.

It has an appendix of useful material, including tables, characteristics, conversion charts and other technical data.

UNDERSTANDING MICROWAVES, by Victor J. Young.

John F. Rider Publisher, Inc., 404 Fourth Ave., New York 16, N. Y., 400 pages, price $6.00.

The field of ultra high frequency is the subject of the latest addition to the growing list of excellent books on electronics published by John F. Rider. Its title, UNDERSTANDING MICROWAVES, tells the purpose of the book, and it is designed for any one in the radio business who wishes to increase his knowledge of the electromagnetic field as painlessly as possible. Mathematical explanations are kept to a minimum; but a section on Maxwell's equations and a very comprehensive one on microwave terms, ideas and theorems are given for reference purposes.

To make best use of microwave equipment, the principles on which it is based must be understood. The first few chapters are introductory in nature. The elementary facts of electricity are reviewed to give a foundation for subsequent discussions in terms of both the circuit theory and the electro-magnetic theory.

Subjects treated include: Waveguides, resonant cavities, antennas, microwave oscillators, radar and communication. Two frequency-spectrum charts are given on the reverse of the jacket.


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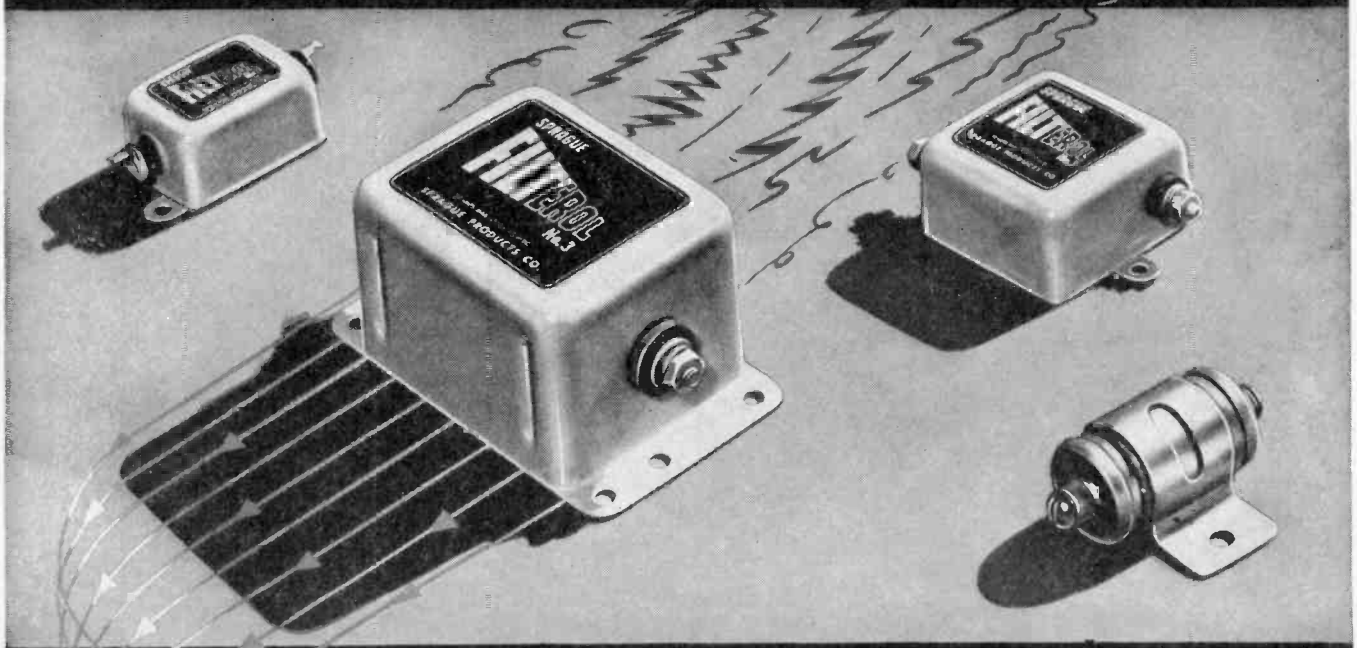
GOODBYE TO MAN-MADE RADIO NOISES!



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