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Signal injection is probably the fastest known method of locating the point of signal disappearance in defective radio receivers. Signal injection is also an economical approach because only a test oscillator is required and such an oscillator should be a part of every technician's equipment for precise alignment work.

Here's how to troubleshoot a dead AM receiver by signal injection:

1. Make sure that the filter input resistance is over 2000 ohms. Repair filter, if necessary.
2. Turn power on and check filter output voltage.
3. Inspect all tubes to see that heaters are operating.
4. Adjust test oscillator for maximum audio output. Connect ground clip of AF cable to the receiver chassis, and touch probe of AF cable to plate terminal of the last IF tube, then to the grid terminal, and proceed progressively toward front end of set; touch probe to grid of output tube, to plate of audio tube, and finally to diode load resistor. If sound from speaker ceases at some point, use an electronic volt-ohmmeter to locate the faulty component.
5. Reduce generator output and proceed progressively toward front end of set; touch probe to grid of audio tube, and finally to diode load resistor. If sound from speaker ceases at some point, use an electronic volt-ohmmeter to locate the faulty component.
6. Adjust test oscillator for modulated output at the intermediate frequency of the receiver. Touch probe in turn to the detector diode, to the plate terminal of the last IF tube, then to the grid terminal, and proceed progressively toward the mixer signal grid. The generator output must be progressively reduced; this reduction serves as a rough indication of stage gain. If signal disappears at one of the check points, use the volt-ohmmeter to "close in" on the defective component.
7. Re-adjust test oscillator to some frequency near the high end of the broadcast band, and tune receiver to this frequency. Touch probe to mixer signal grid. If signal comes through, the trouble is in the RF section. If the test signal does not come through, the trouble is in the oscillator.
8. Check for presence of oscillator bias with an electronic voltmeter. A substitution check of oscillator performance can also be made without modulation off and tone test oscillator to a frequency which is the sum of the intermediate frequency and the frequency of a strong local broadcast station. (Every service shop should be equipped with a good outside antenna.) The test oscillator output is substituted for the local oscillator output as shown in Fig. 1.
9. If set is still dead, and oscillator is ok, turn on modulation and tune both test oscillator and receiver to the same RF frequency. Touch probe to plate of RF tube, and work back progressively to the antenna.

These signal-injection tests usually require less than five minutes to complete. As the technician gains experience, he will find many short cuts which are beyond the scope of this article. To summarize, signal-injection techniques are speedy and versatile, and no specialized test equipment is required other than the test oscillator which is also needed for receiver alignment.

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THE READER SPEAKS

The article by A. K. O'Brien in the December '48 issue of Radio Maintenance on radio servicing business practices is timely and interesting... But let's face it: Through bitter experience the radio public has learned to distrust servicemen and to make the best of a bad deal. Through Federal licensing, technical ability at least could be verified. The Better Business Bureau, and Chambers of Commerce, and other business organizations could assist in policing business operations.

Working conditions in the radio servicing field could stand considerable improvement—a 40-hour week, a clean shop, and pay commensurate with training and ability.

The theoretical side of radio can be taught successfully by correspondence. Often, there is no other way for a man to receive his training. But the practical training should be received in a supervised, regulated, resident school or in a shop under the guidance of a properly trained man. Reasonable tests and educational standards should be set up and adhered to, so that before a man is permitted to take training there is some evidence that he will be able to do the work properly.

The department head in a radio school should be capable of doing what the course teaches, and licensing should see to it that proper tests are given to determine the measure of ability. Tests every five years should be adequate—not renewal examinations, but real tests. Instructors should also hold proper licenses and prove ability. There are far too many incompetent teachers and technicians in radio today, I know — I've seen and worked with many of them.

Until licensing is put into effect, by an impartial authority, servicemen will have no real standing, no proof of ability. May that day come soon, to grant the industry a measure of decent respectability.

Willard Moody
"A Ford in your future?" There will probably be a fine new Ford radio receiver on the dash. Chances are good this receiver will be equipped with tubes by Hytron. For Hytron is a major supplier of Ford auto radio tubes. That is only natural. Hytron specializes in auto radio tubes—both GT and miniature. Close engineering co-operation with leaders like Ford help make Hytron auto radio tubes leaders, too. 'Nuff said. Hytron and auto radio go together.
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ADJUSTING TV TRAPS

Here is a discussion of an often neglected procedure in servicing television receivers. Read it. It will prove of value

by Matt Mandl

A PHASE of television receiver servicing often neglected is proper trap adjustments. Very often the reason for this neglect lies in the mistaken belief that such traps are of importance only in certain areas where adjacent channel interference prevails. Such is not the case, however, for improper trap settings can result in the attenuation of video and sound signals by virtue of their frequency riding too close to the signal i-f frequencies. This can be more clearly understood by an analysis of typical trap circuits and the reasons for their use.

Fig. 1 illustrates the condition set up when a typical receiver is set on Channel 3. If the local oscillator is 87 megacycles, it will heterodyne with both the video and f-m carriers to produce two i-f signals: one 25.75 Mc., and the other 21.25 Mc. Because receivers using 10" or larger picture tubes require a wide band-pass for good picture detail, there is a good chance for adjacent channel interference. When the video i-f stages are 4 megacycles wide, the resonance curve extends sufficiently beyond the desired band limits to amplify signals which are too close to the i-f frequency.

Fig. 2 shows what happens when adjacent channel signals get through the 6 Mc. r-f stage and heterodyne with the oscillator. Here the sound carrier of the next lower channel (No. 2) would mix with the local oscillator and produce a frequency of 27.25 megacycles. This would ride through the i-f stages and produce interference on the screen because it is sufficiently close to the video i-f frequency to be acceptable to the i-f stages.

If Channel 4 is also on the air, its video carrier of 67.25 Mc would mix with the 87 megacycle local oscillator to produce 19.75 Mc., another potential source of interference to picture reception. Besides these, there is the factor of the sound i-f of the channel to which we are tuned. Thus, the 21.25 megacycle sound i-f would also be amplified by the video i-f stages and produce sound bars on the picture tube screen.

Trap Frequency Variations

The above indicates the need for three traps in such a receiver: one for the sound of the channel in use, the other for sound of the adjacent channel, and a final one for trapping out the heterodyne frequency of the

Three trap transformers and a converter transformer (left rear, next to picture tube) are shown here in a view of chassis of an Admiral TV Receiver. On most receivers, traps are located on top of the chassis. Their frequencies vary with different models.

Fig. 1 Video and sound (f-m) carriers of Channel 3 mix with local oscillator to produce

video and sound intermediate frequencies.
carrier for the channel above the one in use.

These particular trap frequencies are only for sets having a video i-f of 25.75 Mc and a sound i-f of 21.25 Mc, such as the RCA 8TS30 or the Admiral 30A1. Other sets which use different i-f frequencies will have trap frequencies which vary accordingly. For instance, the General Electric Model 803 uses a video i-f of 26.5 Mc and a sound i-f of 21.9 Mc. Fig. 3 illustrates the resultant trap frequencies when adjacent channel carriers mix with the oscillator, which would be 87.65 Mc when the set is tuned to Channel 3.

Fig. 4 is a chart showing typical trap frequencies for several representative television receivers. Receivers using 7-inch tubes do not, as a rule, employ traps. The reason for this lies in the fact that the video i-f band-pass for 7-inch sets is usually 3 megacycles or less, which means that the relative gain per stage is greater as well as the over-all selectivity. The added selectivity is sufficient to obviate the necessity for traps, except in unusual signal areas.

The i-f band-pass corresponding to Fig. 2 is shown in Fig. 5. As with all video i-f response curves, the video i-f frequency is set on the slope of the resonance curve because attenuation here should be down due to the unwanted extra gain which would result from the vestigial section of the carrier. The traps, when properly set, will attenuate points as shown in the figure.

Fig. 6 indicates what happens if one of the traps is not properly adjusted. If any trap is off its frequency in the direction of the i-f response curve, it will trap out a section of the band-pass, thus seriously affecting picture gain or fine detail. This clearly illustrates the importance of trap adjustments even though the receiver is in an area free from adjacent channel interference. Trap adjustments, of course, are doubly important in areas where adjacent channel reception is possible, for improper adjustment will then result in herring-bone lines on the screen, sound bars, or other manifestations of adjacent channel heterodyning.

**Trap Adjustments**

Fig. 7 shows the location of the various traps in the video i-f section of the RCA 8TS30 receiver. The ar-
Due to the placement of the r-f tuner, the local oscillator should be made tenuation because of the r-f unit being from the generator will suffer at-connection, however, means the sig-
to the antenna terminals. Such a the signal generator can be attached point, or if the input is inaccessible through a hole in the side of the generator is used, having a frequency range covering the traps. The secondary of T2 not only picks up the sound i-f signal, but also acts as the first sound trap for 21.25 Mc. The other traps are ordinary absorption type circuits.

Alignment of Traps

Before alignment of traps, allow the receiver to warm up for about 10 to 15 minutes so that there is no more danger of oscillator drift. Make sure the fine tuning control is set for maximum sound output. The channel switch should be set for a high channel where no transmitted signal is being received. A vacuum-tube voltmeter is then connected across the load resistor of the picture second detector and set to read low voltage d-c.

A signal generator is connected to the input of the mixer and on the RCA as well as some other sets a connection for this purpose is available through a hole in the side of the chassis next to the r-f tuner unit. In the absence of such a connecting point, or if the input is inaccessible due to the placement of the r-f tuner, the signal generator can be attached to the antenna terminals. Such a connection, however, means the signal from the generator will suffer attenuation because of the r-f unit being tuned to a different frequency. The local oscillator should be made inoperative by removing the oscillator tube when antenna input is used. It must be emphasized here that the use of any signal generator for television alignment should not be attempted unless the signal generator has been calibrated. Particularly in the case of traps, where sharp tuning is employed, it is important that exact frequencies be used.

The signal generator should first be set for 27.25 Mc and the trap corresponding to that frequency adjusted for minimum output on the vacuum-tube voltmeter. Next set the signal generator to 19.75 Mc and adjust that trap for minimum output on the vtvm.

Now set the signal generator for 21.25 Mc and adjust the first of the two sound traps for minimum indication on the voltmeter. If no decrease can be obtained, the second trap (21.25 Mc) may be on its resonant frequency and cutting down the signal. In such cases, deliberately detune the second 21.25 Mc trap, and again try adjustment of the first trap (T2).

When the first trap has been adjusted, it will be difficult to align the second 21.25 Mc trap since the first one will absorb most of the energy. In order to properly tune the second trap, the signal generator must now be moved to the 3rd picture i-f grid, thus by-passing the trap effect of T2. Inject 21.25 Mc into this stage and adjust the second trap (T105) for a minimum on the meter.

A double check on the alignment can be made by modulating the signal generator with a 400 cps note and observing the sound bars which will appear on the picture screen. Tune the traps for a reduction of the sound bars on the screen.

Various Types of Traps

Alignment of traps for all sets follows the pattern which has just been detailed, even though all do not use absorption type traps. Some sets use cathods traps and others use series traps in the grid circuit, or the bridged “T” type shown in Fig. 8. Whatever method is employed, however, the adjustment procedures are the same, since all are intended to trap out the unwanted signals resulting from heterodyning of adjacent channel carriers.

The adjusting of traps without the use of a signal generator should not be attempted except under special circumstances, since interference or i-f attenuation may be made worse instead of better. The only exception would be in the case of a receiver located in an area where the adjacent channels are on the air and it is known that the mixer-oscillator stages are properly tracked. Under such conditions, Channel 3, for instance, could be tuned in and the Channel 4 interference pattern on the screen tuned out, by adjusting the upper channel video trap. If Channel 2 is also on, and producing interference, the lower channel sound trap can be adjusted until the interference disappears. After these two traps have been set, the sound traps for the channel in use can be adjusted.
Inasmuch as the above procedures can be followed by viewing the picture screen, chassis removal for attachment of a vtvm is not necessary. Adjustments are facilitated by placing a mirror before the screen so that changes can be observed while working on the traps from the rear of the set.

**Sound Interference Traps**

With respect to the sound traps, it is important to distinguish between the type of interference presented by the lower adjacent sound carrier and the sound i-f of the channel to which the set is tuned. For instance, a maladjustment of the 21.25 Mc traps in the RCA previously discussed will result in sound bars on the screen. This, however, will be true only when the f-m carrier is being modulated. During transmission of the pattern, a steady tone is also broadcast, and this would result in a stationary sound bar pattern if the traps are out. On the other hand, if a program is in progress, the sound bars would appear only when the actors are talking, or when some other sound accompanies the picture. In such instances, the interference from the sound of the channel to which the set is tuned will usually be distinguished by its disappearing when the sound from the speaker stops, and re-appearing when the speaker produces sound.

The sound carrier interference from the next lower channel, however, may appear as sound bars or it may appear as a herring-bone beat.

---

As shown in this picture, trap adjustments can be made without chassis removal and results can be checked by viewing picture screen. Place a mirror before screen, so that changes can be observed while traps are adjusted from the rear of the receiver.
In trouble-shooting television receivers, the service technician is provided with a very efficient and accurate test instrument: the television receiver itself.

As the serviceman becomes more familiar with the operating characteristics of video receivers, he will more or less develop his own technique or preferred method of testing. Ingenuity of the individual, along with solution of special and isolated problems, will suggest various short-cuts which may successfully be employed in routine servicing. Until such time, however, the simple preliminary analyses described herein will provide a sound basis upon which a “special” servicing technique can be built.

Generally, the television receiver may be treated as two separate units — video and sound. The sound channel is subject to the same troubles as a regular f-m or a-m receiver, and may be traced in much the same manner. Defects common to both video and sound channels will of course be apparent in one or more of the picture channels and can be successfully traced from that point.

For the purpose of this discussion, it will be assumed that the sound channel of the receiver, unless otherwise indicated, is functioning properly.

For alignment and the tracing of distortion and other troubles in the video section, the regular television test instruments must be employed. In the preliminary tests, however, much valuable time can often be saved by simple visual analysis of the cathode ray tube screen. Any defects in the video section of the receiver will affect the resultant image and may be accurately diagnosed at this point. The very composition or reaction of the image or raster to cases point directly to trouble in a particular stage or channel.

First, Check Tubes

In any receiver, it is recommended that all tubes be checked and replaced is necessary before proceeding with the regular stage-by-stage measurements. Since the majority of receiver difficulties involves defective tubes, checking these items first will save much time and trouble, in many instances eliminating the need for proceeding with further tests. It is especially important in f-m and television receivers that necessary tube replacement be made before aligning, otherwise the sensitivity, bandwidth, and dial calibration of the receiver may be seriously affected.

It should also be borne in mind that the high-frequency ranges encountered in all tuned circuits, including the i-f stages, introduce certain peculiarities in operation which must be taken into consideration when checking the receiver. An i-f tube, for example, which may function perfectly at broadcast i-f frequencies, may contain sufficient residual gas to cause extreme instability or loss of gain at the higher i-f frequencies of 11 Mc or 24.6 Mc. Oscillator drift or instability can also be due to a gassy condition, or to loose elements in the tube. For optimum performance, all tubes should be replaced when their emission checks 10 percent or more below normal, even though the tube checks good in other respects.

As a passing thought, it might be well to remember that a “good” indication obtained on a tube tester is not conclusive proof that the tube will function properly in the receiver. If there is reasonable doubt, try substitution. Noisy, intermittent, or microphonic tubes may best be checked by tapping with a small rubber mallet or with the finger while the set is operating (preferably while tuned off the station).

For preliminary visual analysis, the receiver should be connected to its recommended antenna and all controls set to their normal operating positions so that a more accurate indication may be obtained on the cathode ray tube screen.

No Image or Raster

Suppose no image, line, spot, or pattern can be seen on the cathode ray tube screen, even with the brilliance control turned to its maximum position. This could indicate a defective cathode ray tube, failure in the high-voltage or kick-back power
supply, excessive cathode ray tube grid bias, or an open or shorted condition in the cathode ray tube socket or leads. The kick-back and bias circuits should be checked for proper voltage. In checking the high-voltage supply, be sure to use heavily insulated test prods and avoid bodily contact with the receiver chassis or ground return. (It is much easier to treat high-voltage circuits with respect than for someone to break the news to your widow.) If proper voltages are indicated at the socket of the cathode ray tube, check adjustments of the beam centering controls. If these appear to be normal or have not been tampered with, replace the cathode ray tube.

The presence of a single stationary spot on the screen indicates lack of saw-tooth voltage on the horizontal and vertical deflecting plates. Trouble of this sort is usually due to a shorted filter condenser, defective rectifier tube, or a faulty connection in the common sweep power supply.

Raster, No Image

A number of defects may be indicated and localized by studying the screen raster (The raster only should resemble that shown in Fig. 1). Conditions of the raster may be observed by increasing the setting of the brilliance control until the raster back traces are visible, and noting whether they are moving or stationary. A stationary raster indicates that the horizontal and vertical circuits are being properly controlled by sync pulses; a moving raster indicates failure of the sync pulses to control the vertical blocking oscillator.

If the raster is moving but no image is present and the sound channel is inoperative, trouble is indicated at some point ahead of the first i-f stage. All tubes and components in the mixer-first detector, oscillator and r-f stages should be checked and voltages measured at the tube sockets. Trouble often will be found in the low-voltage power supply. The pre-selector band switching and the antenna system should also be checked.

If the above conditions are noted but the sound channel is functioning, look for a defective video-frequency stage ahead of the clipper input. This includes the video detector and i-f system. If the no-image condition is accompanied by a stationary raster, check the video-frequency amplifier between the clipper input and the cathode ray tube.

It is possible that instead of a stationary spot a vertical line will be present on the screen, indicating lack of saw-tooth voltage on the horizontal deflection plates. Trouble in this case is most likely due to a defective tube, part, or connection in the horizontal blocking oscillator. In this manner, presence of a horizontal line only is caused by failure of the vertical blocking oscillator.

Distorted Image

Distortion arising from, or introduced into, any part of the video section will be apparent on the cathode ray tube screen. A smeared picture, for example, with black or white shadow areas is due to loss of the lower frequencies in one of the video frequency stages, usually caused by an open by-pass condenser in the plate or screen circuit of the video-frequency amplifier. This effect can also be due to defective condensers, coils or resistors in the video i-f and v-f coupled circuits. Loss of high video frequencies will result only in blurring or smearing of the finer details of the picture. Loss may be due to misalignment of video i-f circuits, or to defective condensers, resistors, or coils in the equalizing circuits of the video detector, i-f or v-f stages.

Blurring of the entire picture usually is due to an improperly adjusted focus control (see Fig. 2), to incorrect voltage on the first anode of the cathode ray tube. If adjusting the focus control does not clear up the difficulty, check the cathode ray tube power supply unit.

A dim, highly distorted picture (Fig. 3), accompanied by interference patterns, poor contrast, and horizontal shifting, is caused by insufficient signal strength at the input of the clipper circuit. This may be due to a poor or defective antenna system, or to defects in one of the video stages ahead of the clipper. After checking each circuit, it is wise to readjust the horizontal control.

If the center and bottom portions of the picture are normal, but the top is distorted and exerts a fast pulling action in the horizontal plane (Fig. 4), the horizontal sweep is failing to hold to the sync impulses, or the video signal may be leaking through to the horizontal sweep generator. This action may also be caused if the pulses at the sweep generator input are too weak. All parts in the horizontal sweep gen-
crator, clipper, and frequency separator should be adjusted if the trouble does not clear up with readjustment of the horizontal hold control. A picture folding horizontally (Fig. 5) indicates trouble in the damping circuit.

Interference

"Ghost" images are perhaps the most easily recognizable type of interference encountered in video receivers. Two or more super-imposed images of the same picture appear on the screen (Fig. 6). Since the primary cause of ghosts is multiple reception, the only method of elimination is to use a good directive antenna system erected in the clear and oriented to cancel the unwanted signal path.

Excessive a-c ripple or power line hum produces one or more dark horizontal lines on the screen. This trouble may be due to an open plate, cathode or screen by-pass condenser in the v-f amplifier, or to an open or leaky filter condenser in the power supply. Hum in the deflection coils of the cathode ray tube produces the effect shown in Fig. 7.

Ignition interference is characterized by white and black spots which move across the screen, accompanied on some bursts by loss of horizontal or vertical sync control. Diathermy interference and heterodyne interference from other radio sources creates a number of short diagonal bars or lines on the picture tube. The only practical solution is the installation of a directional antenna or, if interference is arriving over one particular frequency, installation of a television wave-trap in the receiver antenna circuit. A similar pattern can be produced by high frequency oscillation in the video channel. In this case, the pattern will disappear when a television signal generator is connected to the receiver input.

Irregular shaped horizontal white and black lines, bars, or patterns may be generated within the receiver as a result of leakage from the sound channel to the video circuits (Fig. 8). Usually, this effect is due to an open by-pass condenser or mis-aligned sound i-f rejector. This trouble may also be caused by microphonic tubes or an incorrectly adjusted oscillator.

Excessive ripple, giving a "snowstorm" effect is due to insufficient gain in the video unit or to a poor antenna system. The snowstorm effect appears when the gain control must be turned abnormally high in order to receive the station.

Superfluous or Irregular Patterns

Most abnormal patterns are the
result of incorrect control adjustments. Test patterns transmitted by television stations are useful in checking linearity of the horizontal sweep and may be used for test purposes when regular television programs are not being broadcast, as shown in the various illustrations in this article. Most of these illustrations are self-explanatory. Instruments, such as the Philco Cross-Hatch Generator are useful for making the necessary adjustments when the station is not on the air.

Insufficient height and width of picture frame are due, respectively, to improper setting of vertical and horizontal size controls. If adjustment of these controls fails to restore correct picture size, check tubes, components, voltages in the vertical and horizontal output stages and in the vertical sawtooth oscillator.

A tilted or off-center picture may be the result of improper adjustment of the vertical or horizontal beam centering controls, or incorrect positioning of the deflecting coils in cathode ray tubes of the electromagnetic-deflection type (Fig. 9). These coils carry high-voltage: Turn the power off before making adjustments. If the deflecting unit in a balanced electrostatic system is unbalanced, a trapezium-shaped picture will be obtained instead of the usual rectangular-shaped picture. Identical results will be obtained in an electromagnetic deflection system if adjacent turns of one of the deflecting coils are shorted.

The bottom half of a picture superimposed on the top half indicates the vertical sweep circuit is operating at twice its correct frequency. A right-hand half-picture, superimposed on the left-hand half denotes a horizontal sweep operating at twice its correct frequency. In both cases the appropriate blocking oscillator controls should be adjusted to decrease the frequency to its proper value.

Two short, full-width pictures, one above the other, result when the vertical sweep is operating at one-half its normal frequency (Pictures are separated by a black horizontal bar). Two narrow, full-length pictures, separated by a black vertical bar, are due to half-cycle operation of the horizontal hold control. A beat pattern (Fig. 10) may be due to interference from a short-wave transmitter or to an improperly aligned sound i-f trap. Antenna orientation and proper trap alignment should remedy this type of trouble.
IN our last article (Radio Maintenance, December '48) we discussed the importance of a knowledge of the nature of audio frequency distortion to the service technician. The three important types of distortion possible in f-m receivers were described as:

1. Harmonic distortion.
2. Intermodulation (cross modulation) distortion.
3. Inadequate frequency response range.

The first two types are also of some importance in connection with a-m receivers, but f-m receivers are much more subject to them because of the extra frequency response required.

Audio frequency amplifier sections in f-m receivers for home use vary widely with the design and price range of the receivers in which they are used. The degree to which the above factors are important depends upon the degree to which the receiver attempts to cover the full frequency response available in the frequency modulation signal.

A-M and F-M A-F Amplifiers

Basically, the purpose and design of the a-f amplifier are the same for f-m receivers as they are for a-m receivers. The a-f amplifier section is electrically composed of two parts, a voltage amplifier and a power amplifier. In small receivers, these parts are represented by one amplifier tube and associated circuits for each. In very rare cases, one tube may even do the whole job.

Differences in a-f amplifier sections in f-m and a-m receivers, when they are present, are all due to the use of a special loudspeaker system, or a conventional loudspeaker fed so as to improve its acoustic frequency response. The more important circuit characteristics arising out of these differences are as follows:

1. More voltage amplification to make up for the somewhat lower output voltage of a ratio detector, as compared to that for the discriminator or a-m diode. However, in most cases this increased amplification is...
necessary to overcome the voltage loss in tone control and booster circuits. The increase in voltage amplification may be obtained by the use of two stages, or one high mu stage.

2. Treble and bass booster circuits are nearly always included in the large console models. These circuits are combinations of resistors and condensers arranged to increase amplification for the highest and lowest frequencies without affecting the amplification in the middle frequency range. The purpose of this is to compensate for the lowered response of the loudspeaker in the bass and treble regions of the audio frequency spectrum.

3. Power amplifier output stages are generally designed to be capable of greater power handling capacity than those for the same stages of a-m broadcast receivers. The increased power capacity is necessary because, in compensating for the loudspeaker response characteristic by booster circuits, a relatively high power must be supplied to the loudspeaker in the boosted frequency ranges. At the same time, a substantial reduction in harmonic and intermodulation distortion is obtained by operating a power amplifier stage considerably below its maximum capacity, and by the use of two tubes in push-pull.

4. Output transformers are more critically designed in f-m receivers. The low distortion and wide frequency response requirements of high fidelity f-m receivers require that the output transformers meet certain rigid requirements. Physically, these transformers are larger in all dimensions and considerably heavier than the type ordinarily encountered in a-m broadcast receivers. Electrical performance requirements include all three types of distortion factors previously mentioned. Failure of, or incorrect substitution of the output transformer is one possible source of distortion in extended range amplifiers, such as those in f-m receivers.

5. Phase converters and push-pull output stages are frequently encountered in f-m. These provide more power output with less distortion than single-ended stages when operated at the same percentage of output rating.

6. Negative feedback is more frequently incorporated in f-m than in a-m receivers. This is because of the higher peak power capabilities and the stabilizing and distortion-reducing property of feedback, necessary to provide the full quality advantages of the f-m system.

7. Tone control and booster circuits are more generally used and are more elaborate in f-m receivers. These circuits form an important subject by themselves and will be discussed in our next article.

Representative Circuits

In order to illustrate the actual application of the principles outlined above, the a-f amplifier circuits of five representative f-m receivers have been chosen and are shown in Figs. 1, 2, 3, 4, and 5 respectively.

The circuit of Fig. 1 illustrates the single output tube or "single-ended" type. This arrangement is more representative of the smaller, table model receiver. As can be seen, it exhibits few, if any, differences in design from the average a-m broadcast receiver a-f section. In this amplifier, as in the other example, a combination tube V1 acts as both discriminator and first a-f amplifier stage. Several new tubes, such as the 6AT6 and the 7X7 have been developed especially for this purpose in f-m receivers.

The circuit of Fig. 2 shows the use of a first amplifier stage V1, a single phase inverter V2 and push-pull pentode output tubes V3 and V4. The Fig. 3 circuit has a similar lineup with different tubes for the first amplifier
and output stages, but the same type of phase inverter.

Fig. 4 illustrates the use of a two tube phase inverter preceding the output stage.

Fig. 5 is representative of the very elaborate type of a-f amplifier circuit. The first stage is a cathode follower V1. The arrangement is used to keep the impedance of the coupling circuit to a low value, thus reducing pickup hum. Then follow two amplifier stages V2 and the first section of V3. The second portion of V3 is a single tube phase inverter. Four tubes connected in push-pull parallel compose the high powered output stage, which drives two loudspeakers.

Now let's consider in detail some of the features found in most types of a-f amplifiers and applied in these examples.

Phase Inverters

Most of the larger FM receivers use a push-pull output stage. Because of this, some sort of phase inverter is required. The simplest phase inverter, of course, is a push-pull interstage transformer (the primary need only be "single-ended"). Although transformers make very satisfactory phase inverters, they are relatively expensive and heavy and take up more space than the compact tube type phase inverter.

As was previously explained fully in an earlier article by the writer ("Phase Inverters," Radio Maintenance, April '47), the need for phase inversion arises because in a push-pull stage the grid input signal voltages must have a definite relation to each other and must both be above ground potential. The grid voltages must be 180 degrees out of phase with each other and have equal magnitudes with respect to ground. A single ended amplifier stage produces only one voltage above ground and can therefore supply only one of the output tube grids with signal. The function of the phase inverter is to add the second signal voltage for the other push-pull tube.

Our examples illustrate several popular methods of phase inversion. In Fig. 1, the output tube is single ended and consequently no phase inverter is required.

In Fig. 2, the out-of-phase voltage for the second power tube grid is supplied from a cathode resistor, R3, of the 6J5 phase inverter tube. Electrons flow away from ground in this resistor, instead of toward ground as in the plate resistor R5. The signal voltages across these two resistors are thus 180 degrees out of phase. The plate circuit supplies the grid of V3 with signal voltage and the cathode circuit supplies the grid of V4. This circuit is quite popular, and it will be noted that it is also used in the amplifier circuits of Fig. 3 and Fig. 5. In each case, two cathode resistors in series are used because the one connected to the cathode directly and used for bias must be relatively low in value. The lower end of the grid resistor connects to the lower end of the first cathode resistor (R4 in Fig. 2, R9 in Fig. 3 and Fig. 4), so that only this one cathode resistor is used to supply bias. Of course, in all cases in which a cathode resistor develops the out-of-phase signal voltage drop, this cathode resistor must be unbypassed or else all the signal voltage across it would be lost. Sometimes unbypassed screens are used to supply the signal-voltage for the second push-pull output tube grid.

Another common method of phase inversion is illustrated in Fig. 4. This method requires the use of two inverter tubes, which in this case are V2 and V3. V2 acts as a straight amplifier and applies amplified signal voltage to the grid of V4. R8 and R10 act as a voltage divider across which this grid signal voltage is applied (C6 is large enough to have negligible reactance and acts as a short circuit as far as signal is concerned). The portion of the grid signal voltage which appears across R10 is then applied through C3 to the grid of V3. However, the signal...
voltage has undergone a phase shift of 180 degrees in passing through V2 (this happens in any resistance coupled stage). The voltage across R10 and, accordingly the voltage on the grid of V3 is thus out of phase with the grid voltage of V2 by 180 degrees. The plate output signals of V2 and V3 are therefore 180 degrees out of phase, as desired for proper operation of the push-pull output tubes V4 and V5.

This inverter is known as the "balanced" type, since it supplies stabilizing negative feedback. The feedback is supplied as follows: After the signal is fed from across R10 back through V3, it is applied to the V5 grid through C7. This also causes it to be applied across the series combination R9-R10. Thus V3 has applied an additional signal across R10 which is in opposite phase to the signal originally applied from V2. This negative feedback has a stabilizing influence on the output of the amplifier and on the balance of loading between the two output tubes.

Negative Feedback

Negative feedback is very frequently incorporated into the a-f amplifier circuits of f-m receivers to keep the harmonic distortion to a minimum, especially when tetrode and pentode power tubes are employed. We noted above how feedback can be a sort of by-product of some other circuit, such as a phase inverter. However, it is also often supplied by a separate circuit exclusively for this purpose.

Actually, any unbypassed cathode (or screen) has a degenerative effect (produces negative feedback). Examples of this are the cathode resistors of V2 in Fig. 2 and Fig. 3. The returning plate signal current develops across these resistors a signal voltage which is applied between the cathode and the grid in opposite phase to the signal arriving at the grid from the previous tube.

Often, the negative feedback voltage is derived from the secondary winding of the output transformer as in Fig. 3, 4, and 5. The feedback signal voltage thus obtained is applied across R3, which is connected in series with the grid resistor of the first a-f stage. The feedback voltage is in opposite phase to the signal arriving there from the discriminator and thus produces the desired degenerative effect.

In Fig. 4 and Fig. 5 the feedback voltage is applied to a cathode resistor and in opposing phase to the signal voltage developed across this cathode resistor.

Output Stage Design

The power output stages in f-m receivers are not much different from those in a-m receivers, except that the use of push-pull is more common and higher output power ratings are encountered. Push-pull stages are generally operated A1, Class AB2 or class B is seldom found. Probable reasons for the lack of use of these types of operations are (1) class A1 ordinarily gives adequate power in a push-pull stage and (2) amplifiers drawing grid current require a preceding power driver stage, adding to bulk and expense.

Fixed bias is quite popular, especially in push-pull amplifiers. It will be noted that the bias for the output stages in Fig. 2, 3, and 4 is of the fixed variety, while in Fig. 5 the cathode bias system is used. Fixed bias allows more output power at a given plate voltage, partly because some of the plate voltage is not used up in appearing across the cathode resistor.

The high power output stage used in the amplifier of Fig. 5 is unusual in home receivers, although it is of a type often found in public address systems. The circuit is a basic push-pull type. Each tube of the push-pull circuit is connected in parallel with another similar tube to double the power handling capacity. Thus V4 is connected in parallel with V5, and V6 in connected in parallel with V7. These two parallel groups are connected in push-pull with each other.

When output tubes are connected in such a circuit, there is danger of parasitic oscillations. These are oscillations developing in the inductance
How to Plan Your Budget

In advertising, as in everything else, plan carefully, spend wisely, and don’t waste a penny.

In our first article in this series on advertising, we endeavored to cover the advantages of business promotion. Now in this issue of Radio Maintenance, we’ll talk about planning an advertising campaign.

In planning your campaign you should, of course, first determine how much you are going to spend on business promotion. This amount should cover everything that publicizes your shop in any way—such as signs or window display material, the lettering on your truck, postcards, newspaper ads, telephone calls, paper and postage for direct mail, fees or wages for others carrying out any part of your program, etc. This is important to keep in mind as there are costs involved in advertising that are not always obvious, especially to a beginner in the business.

The amount to set aside should be established as a fixed percentage of your gross income with an allowance for adjustment one way or another as conditions indicate. These conditions would be the actual returns from your advertising after it has been in effect for a while, or active promotion on the part of your competitors which may force you to increase your ad budget.

The amount to decide on will of course be up to you in the final analysis. We shall present the factors that influence a decision such as this, and some examples of expenditures in other businesses. There is no established custom in the radio service field as to the percentage of income to be spent for promotion, so it has not been pre-arranged for you.

In other fields the advertising budgets vary tremendously with the nature of the product or service sold. In the cosmetics, soap, and tooth paste categories, 25% and more of gross income is spent on advertising, while manufacturers of hard goods of many types spend only 1% or less on their promotion. The amounts also vary among the different companies in any one field. One of the largest radio manufacturer spends between one and one and a half percent; but since their gross income is tremendous compared to small local business, this one per cent buys an extensive amount of advertising coverage.

Study Your Situation

The outside influences that will affect the establishment of your budget should be given careful consideration. As we said before, your competitors will have set a precedent that you must meet or compete with. Chances are that they are not spending so much on promotion that they cannot maintain the same budget indefinitely, so you will do well to observe all the space in the newspapers, etc., used by them. If these organizations are reaching all your prospective customers with their advertising, you must do one of two things: Either spend an equal amount to promote your business and tell a better story, or spend considerably more for advertising space and draw more attention by sheer weight. The former action is more practical and will be more successful in the long run.

There is, of course, a third approach to this problem and that is to develop a promotion campaign that is so clever and efficient in coverage that it will beat your competitor’s even though it costs you much less than his campaign. This is being done constantly in every field of business activity but it takes exceptional promotion ability and much hard work.

Another outside influence on your ad budget is your locale in relation to your customers. This will generally have more effect on the technique of your program than on its size or expense, but it will influence this, too. For example, if you live in a small community you can reach most of its inhabitants through ads in the local paper which usually does not charge a high rate, while in bigger towns your

Some Recommended Books on Advertising

Tested Advertising Methods, by John Cables, Harper & Bros.
Small Space Advertising, by The Editors of "Printer's Ink" Magazine, Funk & Wagnalls
Cutting Advertising and Printing Costs, by The Staff of "Printer's Ink" Magazine, Funk & Wagnalls
newspaper ad will cost more and in the large cities this medium of advertising may be out of the question. The newspaper rates are too high for a small local shop as the papers cover thousands of readers who live too far from you to consider your service.

An Occasional "Splash"

Some men who have just opened a new business or have completed a major expansion, allocate a larger than usual sum for announcing the event. However, rather than make a “splash” of this nature, a once-and-for-all thing, I believe in making this a regular yearly or twice-yearly feature of your program. Every advertising program should incorporate at least one or two of these special boosts every year; and they should be part of the regular budget. All successful businesses open up with heavier guns in their ad campaigns at periodic intervals to keep the program from getting stale.

After taking all these factors into consideration, you should determine how much you are going to spend on advertising. This amount should be fixed and adhered to until you’ve had time to study the effects of your promotion. After a period of six months, let us say, you should review your advertising and its “returns” to date. It may be that you will need to allocate more money to increase the influence on your market, or you may find some of your advertising superfluous and can thus cut your budget.

Your budget is for you to establish, as we said. If you are in doubt as to what to set aside even after surveying the conditions set forth above, I recommend no less than 3% of your gross income and no more than 10%, with 5% as the most effective and practical figure. Ten percent is too high for the average small business, unless there is a definite program for intensive expansion, in which case a heavy advertising expenditure may be necessary. Three percent on the other hand, may be too low for an effective campaign.

Spend Wisely!

So much for the budget. Now let’s go into some of the details of your advertising expenses. While doing this, we want to keep in mind that these advertising dollars are your hard earned money and that every penny must work twice at hard for you!

The first question that arises is—who should prepare your advertising material? Who shall write the copy, design the individual advertisements, select the type?

If you are a man doing all your own work in your shop, and your budget amounts to only a couple of dollars a week, the answer to that questions is obvious. You will do your own advertising as you do everything else.

If you do a large volume of business and it warrants a large enough ad budget, you may want an advertising agency to do your promotion work.

In either case, the same rule still holds—make every penny count. If you are doing your own advertising work, go into it with enthusiasm and study up on advertising in every way you can. In the forthcoming articles in this series we shall give you all the pointers and concrete examples of good advertising technique that we can. Read and study them all. Go to your library and get books on advertising and study them. Advertising is as much a part of your business as fixing radios—so act accordingly. Never stop searching for a better way to tell your story to the public. It will not be an easy job—it isn’t easy for the professionals.
And the smaller your advertising budget, the more difficult a job it is—
the more imperative the rule that you make every penny count.

If you have an agency working for you, your advertising problems are shared by that organization. But do not make the mistake of assuming that the entire burden is lifted from your shoulders. The agency is relieving you of all the cumbersome and time-consuming details and providing you with expert service in carrying out your program, but you also must take an active part in this program. You must pass on to the agency all that you know of your market and countless details of the service you provide to this market. If you don’t do this, the agency must consume time and money (your money!) finding this out for itself. You must keep the agency advised as to the effectiveness of the work they are doing for you.

Agency Selection is Important

If you are about to select an advertising agency for the first time you should be very discriminating in your choice. If possible, engage an agency that is familiar with the radio field. If not, it should at least be familiar with promoting some local business similar to yours. Investigate the agency’s record. If it has kept its present accounts over a period of time without constant dropping of old accounts and acquiring new ones, it shows the ability to provide satisfactory service and stability.

Agencies are not expensive to employ. An agency’s income is derived from the commissions on advertisements placed in newspapers and magazines and from the professional services rendered the client. The commissions are paid to the agency by the newspaper or magazine in which your ad is run. The amount you pay for services depends on how much copy is written for the ad, the amount of art work necessary, if any, and advisory services rendered. However, many small agencies will charge very nominal fees for this work in order to build a list of clients and receive commissions for the ads placed.

Don’t Relax Your Interest

In any case, whether you do your own promotion or whether you employ an agency, keep posted on your advertising progress. Do not lose interest or become discouraged. Letting your promotion sag in the middle is not as obviously a case of neglect as letting your shop go unswept or unpainted, but it is just as foolhardy.

When you practice your own advertising try to get as much out of every “free ride” as you can. Use the displays and selling aids provided by the manufacturers of the parts and equipment you carry. If you live in a small community, make friends with your newspaper editor. Very often these local papers carry feature stories on local businessmen; and if your paper does this, make sure it runs a story on you. This is very excellent free advertising.

When you buy advertising space in a paper or local periodical don’t just have a constant ad carrying the same headline and flat announcement week in and week out. Put as much into each ad as your ingenuity can produce. And don’t forget to take advantage of any cut in rates earned by long-term advertising.

Keep Reproduction Costs Low

On small budget advertising, use every means you can to cut the cost of individual promotion pieces. If you are sending out leaflets, have them mimeographed or muligraphed instead of printed. If you can get your story on a postcard, do so and save the cost of additional postage and paper and envelopes. Use this saving to send out more postcards instead. We’ll cover these techniques in detail later but the point we want to get across right now is this: after planning a promotion piece, review the method of presentation carefully—is there any way you can cut the cost of its make-up distribution? If no cut is apparent to you inquire around first of anyone you may know who does any promotion or reproduction work before you decide to go ahead.

When planning an ad, whether it’s for newspaper, billboard or mailing piece, it’s a good idea to carefully observe ads put out by your competitors and decide how you can improve on their technique. Look at ads put out by other small business concerns and carefully figure out ways that you can incorporate their good points. But in doing this, be careful not to become infatuated with some “trick” attention-grabber that many people are inclined to feature. This practice of using some totally foreign element to catch a reader’s eye is widely used big-time advertisers who spend enough money and employ enough brains to know better. How often have you yourself been attracted by some extremely clever or sophisticated ad in a magazine? “How witty!” you exclaim. Or: “Gee, that’s a beautiful ad!” you say. And then, after turning another page, the effect of the “trick” ad has been completely forgotten—you don’t even recall noticing the name of the company, only the slogan which you may never associate with the product.

In general, and in small space advertising especially, a bold but simple presentation of your service and your name is most effective. In our next article we will go into the technique of good headline and copy creation and how to say as much as you can in small space advertising with utmost effect. 

FEBRUARY 1949 • RADIO MAINTENANCE
Make More Money in the Expanding Servicing Field...

WITH CREI NEW, PRACTICAL
"ON THE JOB" TRAINING IN

TELEVISION & FM SERVICING

The next twelve months will produce some of the greatest opportunities that have ever been offered to alert men in the Servicing Field.

It is the year for you to make the big decision. Either you are going to catch up with the new developments in the industry, or you are going to be passed by.

We think your opportunities are so great, that over a two year period we have been developing this brand new, practical course. It is written for today's serviceman to meet today's problems and opportunities.

CREI knows what you need, and every effort has been made to keep this course practical and to the point. If you are now engaged in servicing work, you will be able to understand and apply each lesson. This course has been reviewed and checked by qualified service experts who know what you must know to get ahead in this booming field.

Every lesson can be helpful in your daily work—you will soon have the technical knowledge necessary to handle all types of good paying Television and FM servicing business.

In offering this course at a popular price, CREI is enabling thousands of the "top third" now engaged in service work to enter the ultimate profitable field of television and FM installation and service. This can be your big year! Write today for complete information. The cost is popular. The terms are easy. The information is free. Write today.

VETERANS! THIS COURSE IS G.I. APPROVED.

MAIL TODAY!
JUKE BOX SERVICING

by Max Alth

A field of profit for the radio service technician

There are some 400,000 juke boxes in this country. Each box is serviced on the average once every ten days. Each box must be serviced at least once every month. Its oiling schedule calls for it.

Many of these boxes are individually owned. More of these boxes would be owned individually if satisfactory service were more readily available.

Many small-scale operators own a string of twenty or thirty boxes.

The rest of the boxes are owned and operated by large outfits whose machines may number in the hundreds, and whose locations may stretch for hundreds of miles across the country.

Each juke box contains radio equipment with which the radio service technician is familiar. A phono motor, and phono pickup and amplifier. Some contain even more radio equipment, having remotely operated coin selector boxes which contain radio transmitters sending signals to the master box, which in turn has a receiver, and relays for interpreting the signals and giving the customer his desired selections.

In addition, these boxes contain coin mechanisms that credit the customer with the proper number of plays, and memory devices for recording the various records selected, complex changer mechanisms, and motor driven slides for making the colored lights in the front of the machine change.

Specialized Knowledge

This means that the juke box mechanism is well beyond the average handy man, well beyond the average mechanic. It calls for a specialized knowledge of radio and mechanics. It calls, therefore, for the experienced radio technician.

Most radio technicians with a sound, and thorough, background in electronic theory, and a working knowledge of mechanics can learn to repair these machines efficiently, and satisfactorily. They seem quite complex upon first examination. But, like the television receiver, they become simpler with experience and study. Unlike radio, juke box designs remain fairly constant through the years, making it very much easier for the repair man to catch up and keep up with the trade.

The tavern keeper who owns his own machine does not tamper with it if he is at all sensible. Tavern keepers who own their own machines are in need of competent, dependable repair service.

The small operator with his twenty or thirty instruments cannot afford to hire a service man on a full-time basis. Juke boxes operate seven days a week, sometimes twenty-four hours a day. Service must be on tap accordingly; actually, until ten o'clock every night, the important money time for the boxes being from six P.M. until closing. This means that full-time service coverage requires two men. Obviously, the income from ten or twenty or even thirty machines does not warrant the hiring of two highly paid specialists. The small operator needs competent, part-time service.

Some of the larger operators confine their activities to one town, or to one area in a large town. But many would place a juke box in China if they thought it were profitable. When one of their distant machines needs attention, the cost of the repair becomes prohibitively high. It pays the chain operator to hire a local man, rather than to send his own man, and a truck over many miles. The large operator needs competent service for his outlying machines.

All the juke box owners, both large and small, often need the specialized knowledge only the radio man has for the repair of the amplifier, and the radio signaling system. Most of the owners, and many of the mechanics, have picked up their knowledge of juke box repairs hit and miss, simply working till the machine ran; and

--- to page 37
Bud Ward is an invalid paralyzed from the neck down. He mastered radio and repairs with his "voice"...by directing the hands of an ex-Marine apprenticed to him under the G-I Bill. Though handicapped, Bud Ward is known as a radio wizard around Norwich and has built up a mighty successful servicing business. "My Rider Manuals are my bible of radio servicing," says Bud. "Having to use someone else's hands to do my work, the clear and concise service data is a 'must' with me."

Rider Manuals
A ready-reference for all sets from 1930 to 1948 — Volumes 1 to 18 are at your Jobber's now. He also has Volume 1 of the Rider Television Manual.

Rider Manuals mean SUCCESSFUL SERVICING

John F. Rider, Publisher, Inc.
480 Canal Street, New York 13, N. Y.
Export Agent: Rocke International Corp., 13 E. 40th St., N.Y.C.
Cable, ARLAB

Note: The Mallory Radio Service Encyclopedia, 6th edition, makes reference to only one source of radio receiver schematics—Rider Manuals.

Another Note: The C-D Capacitor Manual for Radio Servicing, 1948 edition, No. 4, makes reference to only one source of receiver schematics—Rider Manuals.

Radio Maintenance • February 1949
A VOLT per mil per thousand ohms is a very simple mathematical system to calculate values of components and circuit constants in radio and communication equipment, used in conjunction with a practical application of Ohm's Law. By mastering this system you will be able to make rapid mental calculations. This ability is invaluable to the working technician.

Ohm's Law is simple, yet a very important law with respect to electric circuits. A brief discussion of it here is desirable in order to understand the meaning of "Volts per Ohm," "Volts per Milliamperes," or "a Volt per mil per thousand Ohms."

Ohm's Law states:

\[ E = I \times R \]

where

- \( E \) = voltage in volts
- \( I \) = current in amperes
- \( R \) = resistance in ohms

Normally, the unit of current is amperes. However, other units may be used, such as milliamperes or microamperes, provided the correct multiplication factor is used. As an expedient, another unit may be used which eliminates the possibility of error in decimal point due to the use of multiplication or division factors.

For example, the basic formula for current is:

\[ I = \frac{E}{R} \]

In other words, one ampere equals a volt per ohm. This also means that a circuit must have as many ohms resistance as it has volts impressed across it in order to limit the current to one ampere.

**K Ohms and Milliamperes**

It can easily be seen by examining the above formulas that the units in which the formulas are written are not those frequently encountered in radio circuits; and necessary conversions, previously mentioned, would require the use of decimals and make for possible errors. The experienced radio service technician will agree that most resistances in radio or communication circuits are in units of thousands of ohms, and that most currents in these same circuits are in milliamperes. Accordingly, if we have such a circuit, we can say that one milliampere equals a volt per thousand ohms.

Therefore, in accordance with Ohm's Law, such a circuit must have as many K ohms (K = 1,000) of resistance as volts impressed across it in order to limit the current to one milliampere. Consequently, if the current is two milliamperes, then only one-half the resistance is required and if the current is ten milliamperes, only one-tenth the resistance is required.

The basis of this system depends upon this simple application of Ohm's Law: One milliampere flowing through one thousand ohms decreases the voltage drop by one volt.

**TABLE I**

<table>
<thead>
<tr>
<th>CONVERSIONS</th>
</tr>
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<tbody>
<tr>
<td><strong>Formula</strong></td>
</tr>
<tr>
<td>( E = I \times R )</td>
</tr>
<tr>
<td>( R = \frac{E}{I} )</td>
</tr>
<tr>
<td>( I = \frac{E}{R} )</td>
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</tbody>
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**To find voltage drop:**

\[ E = I \times R = \text{volts} \]

\[ E = \frac{\text{volts}}{\text{ma}} \times \text{ma} \]

\[ = \text{volts} \]

---

**To find current:**

\[ I = \frac{E}{R} = \text{milliampers} \]

\[ I = \frac{\text{volts}}{\text{volts per ma}} \]

\[ = \text{milliampers} \]

---

**To find resistance:**

\[ R = \frac{E}{I} = K \text{ohms} \]

\[ R = \frac{\text{volts}}{\text{volts per K ohms}} \]

\[ = K \text{ohms} \]
Build YOUR OWN TEST EQUIPMENT

1. Heathkit VACUUM TUBE VOLTMETER KIT

Everything you want in a VTVM. Shatterproof solid plastic meter face, automatic meter protection in burn-out proof circuit, push pull electronic voltmeter circuit assuring maximum stability. Linear DC and AC scales. AC and DC full scale ranges of 5V-10V-300V-1000V. A total of 21 ranges. Isolated DC test prod for signal tracing and measurements of voltage while instrument is in operation. An ohmmeter section accurately measuring resistance of 1/10 ohm to one billion ohms. Terminal battery. Extremely high input resistance 1 megohm on all ranges DC and 6 megohms on AC. All these features and many more are the reasons why radio technicians and radio and television schools are using Heathkit VTVM's and recommending them to all students. Like all Heathkits, the VTVM kit is complete, 110V. 60 cycle power transformer, 200 microamp meter, tubes, grey cradle cabinet, panel, test leads, 1/2 ceramic precision divider resistors, and all other parts. Complete instruction manual. Better start your laboratory now.

Shipping weight 8 lbs. $24.50

2. Heathkit SINE AND SQUARE WAVE AUDIO GENERATOR KIT

The ideal instrument for checking audio amplifiers, television response, distortion, etc. Supplies excellent sine wave 20 cycles to 20,000 cycles and in addition supplies square wave over same range. Extremely low distortion, less than 1%, large calibrated dial, beautiful 2 color panel, 1% precision calibrated resistors, 110V. 60 cycle power transformer, 5 tubes, detailed instructions and instructions. R.C. type circuit with excellent stability.

Shipping weight 15 lbs. $34.50

3. Heathkit CAPACITOR CHECKER KIT

Checks all types of condensers — electrolytic, ceramic over a range of 0-0001 MFD. to 1000 MFD. All on readable scales that are readable from the panel. No charts or multipliers necessary. A capacitor checker anyone can read without a college education. A leakage test and polarizing voltage of 20 to 500 volts provided. Measures power factor of electrolytics between 0% and 50%. 110V. 60 cycle transformer operated complete with rectifier and magic eye tubes, cabinet, calibrated panel, test leads and all other parts. Clear detailed instructions for calibration and use. Why pay at the quality and capacity of a capacitor checker when you can know for less than a twenty dollar saving.

Shipping weight 7 lbs. $19.50

4. Heathkit SIGNAL TRACER KIT

Reduces service time and greatly increases profits of any service shop. Uses crystal diode to follow signal from antenna to speaker. Locates faults from A.M. to F.M. and P.A. Amplifier available for amplifier testing. Connection for VTVM on panel allows visual tracing and gain measurements. Also tests r.f. oscillator, PA systems, etc. Frequency range to 200 MC. Complete for assembly. 110V. 60 cycle transformer operated. Supplied with 1 tubes, diode probe, 2 color panel, all other parts. Easy to assemble, detailed blueprints and instructions. Small portable 9" x 6" x 1 1/2".

Shipping weight 10 lbs. $19.50

5. Heathkit SIGNAL GENERATOR KIT

Every shop needs a good signal generator. The Heathkit fulfills every service’s need, fundamentals from 150 kc. to 10 megacycles with strong harmonics over 100 megacycles covering the new television and FM bands. 110V. 60 cycle transformer operated power supply. 100 cycle audio available for 30% modulation or audio testing. Uses 6SN7 as RF oscillator and audio amplifier. Complete kit has every part necessary and detailed blueprints and instructions enable the builder to assemble it in a few hours. Large tanks to read calibration. Convenient size 9" x 6" x 4 1/2".

Shipping weight 7 lbs. $19.50

HEATHKIT

BENTON HARBOR 10, MICHIGAN

Heathkits are beautiful factory engineered test equipment kits supplied complete but unassembled with all parts — tubes, grey aluminum cabinets, punched, formed and plated chassis, calibrated panels, ready wound coils and complete detailed instruction manuals for assembly and use. With costs zooming up, Heathkits save the labor cost of assembly enabling thousands to have equipment which they otherwise could not afford.

ORDER DIRECT FROM THIS AD.
W.Y. W. WILL SHIP C.O.D.
Add Postage For Weight Shown
Higher and Higher. Television Receiver production established a new monthly record in its consistent climb toward the 100,000-sets-a-month mark. The Radio Manufacturers Association reports that its member companies reached an output of 95,216 television receivers during the month of October 1948. At this rate, most predictions of future TV receiver production will be exceeded by substantial margins in the months ahead.

New Television Channels. The early addition of new TV channels in the upper part of the spectrum was predicted by Wayne Coy, Chairman of the Federal Communications Commission. The impetus which this addition will give to the field of telecasting promises to be considerable. Chairman Coy forecast that within less than ten years the number of television stations on the air will have reached 1,000. At present, there are 45 stations operating. Television has only begun to grow.

Television for Our Schools. The U.S. Navy has already made definite plans to test the usefulness of television in its various instruction courses. Now word comes from Milwaukee that steps have been taken in that city to introduce the television receiver into the classroom as one of the ways of coping with the problem of overcrowded schools. Although the project is still in the discussion stage, developments in the educational as well as in the television field may soon make the television receiver a companion piece to the traditional blackboard.

18 x 24-Foot Video. The largest television screen, measuring 18 x 24 feet, was set up in the Bay Front Auditorium at Dinner Key, Fla., to enable 2,300 onlookers to witness the Orange Bowl Game being televised. In addition to the complete television station equipment which was brought to Miami to handle the pickup and transmission, the equipment used included an advanced developmental model large-screen television projector, an outgrowth of RCA's research into the use of TV in the motion picture industry. This may be a possible solution to the problem of overflow audiences at major football games.

Radio for Trolleys. New Yorkers may feel that the trolley car is gradually becoming extinct, but in Philadelphia they are about to make it a more efficient means of travel. Two-way radio will be installed in 14 new inter-urban cars. Using selective calling, speakers will be eliminated and communication will take place through hand sets. The purpose of this 'inter-com' system is to eliminate traffic jams and expedite general service. This is probably one of the first applications of selective calling two-way radio for trolley car use. Complete equipment is being furnished by General Electric.

Buy and Fly. Purchasers of Bendix television and radio sets are getting free airplane rides over New York City. This new wrinkle in television receiver sales technique was introduced by the Atlantic Aviation Corporation of Teterboro, N.J., which has entered the field of retail home radio and television sales. Not only does the actual customer get the free ride, but he can take along two of his friends. What next?

Bottleneck Broken. One of the major bottlenecks in the production of television picture tubes—and therefore television receivers—has been the slowness with which face plates were being produced. The Pittsburgh Plate Glass Co. has developed a new technique which will speed up this process greatly. This achievement is the result of considerable research into the problem. Instead of the slow process of molding glass blanks and then putting them through rigorous optical grinding and polishing operations to obtain spherical perfection, the new technique enables a switch to a mass production basis. A specially developed glass is ground and polished with still flat (a standard operation) and then precision bent. The new face plates can be manufactured on a production line basis. Finally, the development of intricate testing devices has made possible a great reduction in inspection time to a few seconds for each plate. This is good news to the television industry.

Small-Town Television— Smaller cities may soon be in line for direct television coverage. RCA has announced that a new 500-watt television transmitter for operation in Channels 7 to 13 is now in production. The transmitter is intended for use in transmitting locations where a low-power transmitter will provide adequate signal coverage to a city and its suburban areas. Coupled with a six-section super turnstile, it is said to be capable of covering a radius of twenty miles under favorable conditions.

Listen While You Work. The world's largest public address system has been installed at the Kaiser-Frazer Willow Run plant. 600 speakers pipe news, music and service programs into every corner of the auto plant. In addition to providing news and entertainment to the 16,000 employees of the plant, the system provides an invaluable safety device in cases of emergencies. Installation of this huge P-A system was made possible through the solution of the problem of making broadcast clearly audible over variable machinery noises without blaring or distortion.

Silver Anniversary. The Radio Manufacturers Association will celebrate its 25th anniversary and 25 years of progress in Chicago, May 16-20. A "Silver Anniversary" banquet on the evening of Thursday, May 19, will climax the affair. Famous stars will participate in a radio and television broadcast over national networks during the industry dinner.
Another reason for Radiart's nation-wide preference is the complete selection of vibrator types manufactured! There is a CORRECT Radiart replacement vibrator for most every need . . . to ORIGINAL SPECIFICATIONS! This completely eliminates guess work . . . and assures peak performance because no "next best" type is installed! Good jobbers everywhere carry almost all types in stock . . . or can get quickly any number you want! In addition . . . each of these 82 types is precision engineered . . . and manufactured under the most careful inspection that assures peak performance from every Radiart vibrator . . . always!

IT'S RIGHT WHEN IT'S RADIART

THE RADIART CORPORATION
CLEVELAND 2, OHIO
MANUFACTURERS OF THE FAMOUS RED SEAL VIBRATORS
Model 260 Volt-Ohm-Milliammeter

There's good reason why this is the world's most popular high sensitivity volt-ohm-milliammeter. In every part, from smallest component to overall design, no competing instrument can show superiority. It outsells because it outranks every similar instrument. And in the Simpson patented Roll Top safety case, shown here, it brings you important and exclusive protection and convenience.

Sub-Panel Assembly
—Strong, Simple, Accessible

The ruggedness, the simplicity of design, and the consequent accessibility of components are shown here. Molded of dustproof bakelite, the sub-panel provides separate pockets for resistors. This separation makes for orderly assembly, highest possible accessibility, and added insulation for preventing shorts. All connections are short and direct. Cable wiring is eliminated. Each battery has its own compartment, again increasing accessibility.

The New Simpson Switch Mechanism. You will find no other switch mechanism on the market like this Simpson switch. It is built of molded bakelite discs. Unusually sturdy contacts, of heavy stamped brass, silver-plated for superior conductivity are molded permanently into each disc. They can never come loose, never get out of position. When the discs are assembled into the complete switch, these contacts are self-enclosed against dust. Danger of shorts is automatically eliminated. At the switch is rotated from range to range, the contact is always positive and unmoving. A ball-and-spring mechanism positions the switch at the selected range by a 3-point pressure. Switch is thus held securely in place, yet smoothly re-positions to each new range.

RANGES
20,000 Ohms per Volt D.C., 1,000 Ohms per Volt A.C.
Volts: A.C. and D.C., 2.5, 10, 50, 250, 1000, 5000
Output: 2.5, 10, 50, 250, 1000
Milliammeters, D.C.: 10, 100, 500
Microammeters, D.C.: 100
Amperes, D.C.: 10
Declinite: 3 ranges: 0 to + 52 D.B.
Ohms: 0-2000 (12 ohms center), 0-200,000 (1200 ohms center), 0-20 megohms (120,000 ohms center).

Model 260, Size: 5½" x 7½" x 4½" ..... $38.95
Model 260 in Roll Top Safety Case, as shown. Size: 5½" x 7½" x 4½" ..... $54.95
Both complete with test leads and 37-page Operator's Manual

Ask your jobber or write for complete descriptive literature.

SIMPSON ELECTRIC COMPANY
5200-5218 W. Kinzie St., Chicago 44, Ill.

THE EDITOR SPEAKS

The ending of a year has always been considered a time for prophecy, and last year was no exception. It ended with a loud prophetic note. What the prophets of television had to say was of particular interest to us. After considerable listening and reading, we were impressed with the lavishment of the predictions which constituted the year's crop. The picture painted had a distinctly rosy quality and, being possessed of a naturally suspicious mind, we determined to do a little investigating. There is nothing the poor prophet hates worse than a good memory, so we decided to refresh ours and do a little checking on past performance.

At the close of 1947 there were 300,000 television receivers in use and our friends with the crystal balls informed us that at the end of 1948 this number would increase to 750,000. We also looked up the figure on the number of stations in operation and found that at the end of 1947 there were 9. The prophets were telling us that 28 new ones would be on the air at the end of '48, bringing the total to 37 stations in operation. This was indeed a pleasant view of the future.

What actually happened in 1948? Were the prophets right or wrong? Here are the final figures. Slightly more than 1,000,000 television receivers were in operation at the end of the year. Forty-four stations were on the air. In other words, the predictions were actually surpassed. The prophets, while not one hundred percent accurate, were on the low side and therefore could not be accused of wishful thinking. With confidence gained from this knowledge, we then set about to average the figures contained in this year's predictions for the purpose of presenting them to you as concisely as possible. In so doing, we feel we may have weeded out the wild and wooly, or at least balanced them off against.
the pessimists. Speaking of pessimists, they are as always present to tell us that all this cannot possibly come true, and even if it does, it wouldn’t do anyone any good.

Getting back to the predictions, we find that at the end of 1949 there will be 120 television stations in operations. During the year, receivers will be produced at a monthly rate well in excess of 100,000 to bring the year end total of sets in operation to approximately 2,750,000.

The past few months have seen many welcome improvements in programming, and with the completion of the coaxial link between the east and midwest and a vastly enlarged audience, this trend can be expected to continue at an accelerated pace. Better programs assure continued consumer interest, and willingness to buy. As stations go on the air to serve new areas, totally new markets will be opened. All of these facts point to the rapid sale of all television receivers as fast as they can be turned out.

Doing a little adding and subtracting we find that 1,750,000 new television receivers will have to be installed during the year. In addition, these and the 1,000,000 receivers already in use will have to be serviced.

With a few calculations based on present prices and charges we can determine what this represents in terms of dollars and cents. In round figures the total in new service and installation business a fantastic 100,000,000 dollars. It is hard to believe that this is only the beginning. In 1950 an even greater volume of installation and repair will be required.

These figures serve to illustrate what a tremendous opportunity television is offering to the wide-awake technician and shop owner. To make something of this opportunity the service industry will have to make a substantial investment in new equipment and in training. Within a few years it will probably be impossible to run a service organization profitably unless the organization is prepared to install and repair television.

The way some people use a speaker will shake a house . . . but, it’s true that the amount of energy an average radio speaker exerts in 8 hours is sufficient to move an average house 4½ feet! This means that although OPERADIO builds speakers with the skill and care of a watchmaker . . . these speakers are sturdily constructed to stand up under heavy, continuous use. OPERADIO speakers are delicately balanced to authentically reproduce the sweetest high notes of a piccolo, yet, carry the tremendous power of a full orchestra crescendo.

ASK FOR OPERADIO SPEAKERS — A FULL LINE OF OUTSTANDING SPEAKERS FOR EVERY PURPOSE!

SPRAGUE KOOLOHM
WIRE WOUND RESISTORS

(Jobbing distributing organization for products of Sprague Electric Co.)

QUESTION
Why do so many television sets use Sprague KOOL- OHM Resistors for all 5- and 10-watt wire wound power resistor requirements?

ANSWER
Because Koolohms far surpass other wire wound resistor types in the essential characteristic of resistance stability. Also because, being doubly insulated, Koolohms can be mounted anywhere—even directly against a metal chassis. Koolohms are highly heat- and moisture-resistant. One type—the standard type handles all wattage ratings, even in enclosed places. No need to worry about choosing special coatings. Moreover, Koolohms cost no more than ordinary resistors, and are actually cheaper in many cases.

SERVICE HINT

Play safe by using Sprague Koolohms in all your work—not only in television, but wherever you want a really first class job. And remember: Koolohms can be used safely at their full wattage ratings, even in enclosed places. No need to buy a 10-watt resistor when the circuit only needs 5-watts. A 5-watt Koolohm dissipates a full 5 watts!

WANTED. Experienced radio serviceman, $45 per week.

WANTED. Carpenters, $2.50 to $2.75 an hour.

Charlie Erhardt, of Rego Park, Long Island, N. Y., wants to know why he sees contrasting ads like the two above almost every day. Why, he asks, do radio servicemen have such a low dollar-and-cents valuation placed upon their services?

The medium with which they work, he points out, is as modern as tomorrow. The apprenticeship they serve is a lengthy and studious one. They have to master the use of delicate and complicated tools. They must study and read and experiment constantly in order to keep abreast of their rapidly-advancing field. Yet these radio service technicians are, as a whole, paid far less than are other mechanics who learn their trade with a much smaller investment of time, effort, and money. In fact, they are often paid less than semi-skilled labor.

I cannot argue with Charlie's statement of fact, and I am not sure that I can explain this state of affairs to his complete satisfaction, but I shall try.

In the first place, the fact that radio servicing is such a new form of maintenance work is against us. The maintainers of any piece of equipment get little respect in the beginning. This is partly because, at first, the repair work is usually a sideline. You will recall that the first garage work was done by the village blacksmiths who liked to "tinker" with the new fangled gas buggies—not realizing that they were digging the grave of their centuries-old trade as they did so. In the same way, those aristocrats of the maintenance men, the doctors, first started playing around with the human machine as a sideline to their really important work, barbering.

How many radio service technicians do you know who deliberately chose this way of making a living, who educated themselves to that end, and who have stuck to it ever since they began? For every one you can name I can give you a dozen who drifted into radio servicing from ham radio, who started radio work to tide them over a lay-off period from their regular work, who have worked at it on and off in between other more lucrative jobs, etc., etc. It is hard to forget respect for a trade that is manned by such haphazard recruiting.

Another reason why the public does not hold radio servicing in such high esteem is that our customers do not understand the nature of the service they pay for. They can see that an auto mechanic, in addition to having a lot of technical information, must work in difficult, awkward positions and get very dirty and greasy while doing it. The jeweler's work is obviously tedious and nerve-wracking because of the tiny mechanisms upon which he works. The carpenter's job takes him out in all kinds of weather and forces him to risk his neck scrambling around rooftops and up and down high scaffolds.

But what does the radio man do? He punches around in the set with a pair of test probes. He snips out a bad part here and there and solderers in a new one. He twists a few knobs on a funny-looking box, turns a few screws, and then says, "That will be five dollars and a quarter."

Why should he be paid that kind of money? The work is not hard and dirty like the garage man's, nor painstaking and delicate as the jeweler's, nor dangerous as the carpenter's. No, it is not these things; but what people do not realize and must be taught is that the radio repairman's work is more like a profession than a trade in at least one re-
gaging in these practices may result in serious harm to the whole servicing profession. Far too often the serviceman, by his wrong thinking and acting, is doing serious harm to the whole servicing profession.

At the risk of bringing criticism down upon my head, I want to say that I honestly believe that those service technicians who offer free estimates, who have no minimum charge, and who do small radio servicing jobs without making a service charge are seriously harming the whole business of radio repairing and in the long run, are doing themselves a great disservice as well. Engaging in these practices may result in a temporary increase in individual income, but this gain is obtained at a cost of respect for radio servicing in general; and sooner or later, chickens of that feather will come home to roost.

A young doctor starting up in business could quickly build up a flourishing practice by offering free diagnoses, by giving bargain prices, by making diagnoses, by giving bargain prices, by cutting wires with diagonal cutters, soldering, turning trimmer screws, etc. But until the public realizes that it is not paying him for these physical acts, it will be hard to raise his pay.

What the public thinks is important in determining the status of the radio service industry. But much more important is the attitude of the service technician himself toward his work. Far too often the serviceman, by his wrong thinking and acting, is doing serious harm to the whole servicing profession.

It will be hard to raise his pay. The money paid to a doctor is based on the same principle that I honestly believe that those service technicians who offer free estimates, who have no minimum charge, and who do small radio servicing jobs without making a service charge are seriously harming the whole business of radio repairing and, in the long run, are doing themselves a great disservice as well. Engaging in these practices may result in a temporary increase in individual income, but this gain is obtained at a cost of respect for radio servicing in general; and sooner or later, chickens of that feather will come home to roost.

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Radio Engineering, by E. K. Sandeman, (John Wiley & Sons, 775 pages, $6.50) volume I.

Starting from the mechanics of broadcasting and the elements of electronics, and progressing into a discussion of radio transmitting equipment, this book is an attempt to furnish the answers to the problems of radio station maintenance. As it proceeds from the elemental to the complex, it is of interest to the beginner in the field as a source of new knowledge, and for the expert as a book of reference.

This first volume includes chapters on sine waves, currents, voltages, resonance and tuning, circuits, harmonics, thermionic valves, amplifiers, oscillators, drive equipment, modulators, and transmitter types and their maintenance. In addition, it has a detailed chapter on antennas. It includes information on a number of subjects such as r-f resistance, inductance of straight wires, impedance characteristics of feeders, and curves for finding the spectra of frequency modulated waves, which is normally not found in similar books.

The author of Radio Engineering was associated with the Engineering Division of the British Broadcasting Corporation. Most of the book is an outgrowth of that experience. As a result, there are occasional references to British broadcasting practices, BBC frequency bands and call signs, not entirely applicable to American conditions. The terminology, however, is up to date. A list of the main conventional symbols at the head of selective chapters eliminates ambiguities, and will be of particular value to the beginner in the field. For the student, the numerical exercises and examples given at the end of applicable chapters will prove helpful. These examples consist of the questions, the methods of solution, and the answers.

The book is well filled with diagrams and graphs, all of which are clear and uncrowded. A number of tables, such as attenuator networks and db loss, characteristics of various S.W.G.s, a number of conversion tables, etc., will all be of value to the radio station maintenance engineer and the radio equipment designer.

Servicing the Modern Car Radio, by A. L. Hurlbut (Murray-Hill, 692 pages, $7.50)

The purpose of this volume is to enable the practicing radio service technician to add automobile radio servicing to his operations. It presupposes a knowledge of fundamental radio on the part of the reader, and aims to enlarge this knowledge so as to be applicable to the special conditions of radio in the auto field.

In the first part of the book, which contains all the text material, the author discusses the car radio field generally. The considerations that affect a decision to enter the field, the differences between servicing car and home radios, the various major components (antenna, power supply,
NOW... SYLVANIA RECEIVING TUBES
SPECIALLY PROCESSED
FOR FINER TELEVISION PERFORMANCE!

Each tube is identified by the special orange markings. This is your assurance of the higher quality demanded by television.

Now, when you replace worn-out receiving tubes in your customers’ television sets, give them the finest in television reception with these new receiving tubes specially processed by Sylvania for the extra-tough requirements of television service.

These new Sylvania television tubes, in the new bright orange and green television cartons, actually undergo three times more exacting tests to insure they are unsurpassed! Their higher quality and superior performance more than justify their small additional cost.

They are not just good tubes, they are superior tubes... results of Sylvania's years of experience in the electronics field. Be sure you have a ready supply for increased television tube replacement business. See your Sylvania Distributor today! Sylvania Electric Products Inc., Radio Tube Division, Emporium, Pa.

LOOK FOR THE BRIGHT ORANGE AND GREEN CARTON

Replace worn tubes with these specially processed Sylvania tubes made to pass television's rigid requirements.

AVAILABLE NOW IN THE FOLLOWING TYPES

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SYLVANIA ELECTRIC

RADIO TUBES; CATHODE RAY TUBES; ELECTRONIC DEVICES; FLUORESCENT LAMPS, FIXTURES, WIRING DEVICES; PHOTOLAMPS; ELECTRIC LIGHT BULBS

RADIO MAINTENANCE • FEBRUARY 1949
Volt per 1000 Ohms

velops a drop of one volt across the resistor. Those resistors which are less than one thousand ohms may be written as a decimal part of a thousand ohms, e.g., 150 ohms = 0.15 K ohms, 500 ohms = 0.5 K ohms; and the voltage drop across them is calculated by the proposed system.

To illustrate the use of this system, examples of actual calculations for conventional circuits will be made.

Examples

a) Suppose we want to calculate the cathode biasing resistor for a conventional beam power tube in an a-c-dc radio receiver such as 25L6 or 501.6. Referring to the tube manual we find that the average cathode current (plate plus screen current), using a 2000 ohm load resistance, is approximately 57 milliamperes, and the required bias is 7.5 volts. Using this system, we can say that 57 milliamperes is 57 volts per thousand ohms. Since we require only 7.5 volts, we can readily see that the cathode resistance must be less than a thousand ohms, i.e., seven and one half 57th of a thousand ohm, or:

\[ R = \frac{7.5 \text{ volts}}{0.131 \text{ K ohms}} = 57 \text{ volts per K ohms} \]

The above equation may be recognized as involving Ohm’s Law, but the unit of current has been changed from ampere to volts per thousand ohms. In this way, volts above the division line cancel volts below the division line; and the answer comes out directly in K ohms.

b) To obtain a voltage drop, a resistance may be expressed in volts per milliamperes. As an example, let us calculate the voltage drop across the plate load resistance of a 6SQ7 whose plate current under normal operating conditions is 0.8 milliamperes. The load resistance is usually 250 K ohms, which may be expressed as 250 volts per milliamperes. Therefore, multiplying the current in milliamperes with the resistance in volts per milliamperes, we have:

\[ V = 0.8 \text{ milliamperes} \times 250 \text{ volts per milliamperes} = 200 \text{ volts} \]

c) Consider the case of calculating the resistance required to drop the screen voltage for a pair (2) of 6SK7s. Our tube manual shows that with a 250 volt supply, the screen should be 100 volts with a screen current of 2.6 milliamperes. Using a common screen dropping resistor for both tubes, the total current through this resistor will be 5.2 milliamperes, or 5.2 volts per K ohms. To impress 100 volts on the screens of the tubes, a drop of 150 volts (250 volts minus 100 volts) across the screen dropping resistor is necessary. In order for the answer to come out in ohms, we must divide the volts per K ohms into the voltage drop required. Therefore:

\[ R = \frac{150 \text{ volts}}{5.2 \text{ volts per K ohms}} = 28.8 \text{ K ohms} = 28,000 \text{ ohms} \]

As in example a) volts cancel volts, and the answer comes out in K ohms.

d) Let us discuss one more case by calculating the line dropping resistor for an a-c-dc filament circuit in which there are three 6.3 volt tubes and two 25 volt tubes connected in series making a total voltage drop of approximately 69 volts. To connect this filament circuit across a 117 volt supply line (the actual voltage in a 110 volt line), it is evident that we must drop 48 volts with a series resistor. The manual shows that these tubes have a current drain of 300 milliamperes which, in using our system, we term 300 volts per K ohms. Then, dividing:

\[ R = \frac{48 \text{ volts}}{300 \text{ volts per K ohms}} = 0.160 \text{ K ohms} = 160 \text{ ohms} \]

In conclusion, we wish to say that this system is a manipulation of Ohm’s Law in which the basic electrical quantities of ohms, volts, and amperes are converted to other units so that the answer comes out directly in the units desired by the cancelling of the equivalent units in division or multiplication. For review, Table 1 has been prepared. This table shows the conversions that can be made. If the reader will practice this system every time he has to make a calculation, he will soon adopt it as part of his kit of tricks for rapid servicing.
while they are usually good at the mechanical end, they lack the theory necessary for efficient electronic work.

A Juke Box Service Technician

Peter Manzoli, who owns and operates the Radana Radio Shop at 173 South Broadway in Yonkers, N. Y., services a string of fifteen juke boxes for a small local operator, along with his regular radio repair work.

He supplies this service at a flat rate of $2.00 per week per box. He furnishes the labor, and the owner furnishes all parts. Each machine bears Pete’s phone number, and when the location owner has trouble, he calls Pete directly. Pete answers service calls up until 10 o’clock each evening, seven days a week. When he goes on vacation or wants to take an evening off, he transfers his calls to a service man friend, who takes over. (Phone answering and message taking services can be had for about $12 to $15 a month)

Peter finds that he averages about one call per machine every ten days. When he first took over the route, he had many more calls to make. The machines were in very poor condition, and required a great deal of work. Now, most breakdowns are caused by some minor fault. Ten minutes per job is about average. Careful preventative maintenance keeps things that way.

The only addition to his regular radio tools are a box of juke box tubes and some parts, which he takes along on his jobs.

Business Promotion

Pete got into the business of servicing juke boxes through the recommendation of a customer who sent the operator around with a faulty amplifier. Pete plans to secure additional work by a direct mail campaign, followed, when practical, by personal visits to the operators. He also intends to make personal calls to the taverns and clubs in town to ascertain whether or not the box is leased. He will also write letters to the various manufacturers of juke boxes so that they may place his name on file in the event a box purchaser asks for the name of a nearby service man.

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• Detecting microphonic tubes.
• Replacing output transformers.
• Aligning video amplifiers.
• Trouble-shooting sync and sweep circuits of television receivers.

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• Recurrent sweep from 15 to 30,000 cps.
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• The Type 164-E is a rugged, low-cost, light-weight cathode-ray oscillograph capable of doing a complete radio and television job. Even though its price is low, nothing has been sacrificed in the way of quality in building this instrument for you.

In the design of the Type 164-E, emphasis has been placed on combining simplicity and portability with utility. Those are the things that are important to you.

And please remember too, the Type 164-E is a time-tested, proven oscillograph. This popular oscillograph, now in such general use among servicemen, has stood the test of many years’ usage.

So when you buy your oscillograph for better servicing, if it’s a Type 164-E you can be sure it’s of the best.
TEMPERATURE REGULATING STAND

This is a thermostatically controlled device for the regulation of the temperature of an electric soldering iron. When placed on and connected to this stand, iron may be maintained at working temperature or through adjustment on bottom of stand at low or warm temperatures.

ELECTRIC SOLDERING IRONS

are sturdily built for the hard usage of industrial service. Have plug type tips and are constructed on the unit system with each vital part, such as heating element, easily removable and replaceable. In 5 sizes, from 50 watts to 550 watts.

TEST EQUIPMENT

Series 2654 is a combination of cathode conductance tube tester, dynamic (underload) battery tester, and high sensitivity a-c and d-c circuit tester (20,000 ohms-per volt d-c.), produced by Precision Apparatus Co., Inc., 92-27 Horace Harding Blvd., Elmhurst, L. I., N. Y. The instrument handles all modern tubes with full anti-obsolescence features, and circuit tests all AM and FM units as well as TV, set up to 30,000 volts with the addition of the Series TV-2 Super-High-Voltage television test probe. The unit is available in 4 modes (portable, laboratory portable, panel mount, and counter model). Additional information is obtainable by writing directly to the company.

WINDOW ANTENNA

This antenna was especially designed for locations where no permanent installations are allowed. It employs a dipole and reflector for complete 12 channel reception. Installation time is about 1 minute and no special tools are required. When not in use, the antenna can be folded up like an umbrella and stored away. A bulletin describing and illustrating the JFD Quick-Rig Window Antenna is available upon request from the company. Manufacturer: JFD Manufacturing Co., Inc., 4117 Fort Hamilton Parkway, Brooklyn 19, N. Y.

PHONO AMPLIFIER AND PREAMP

Special Products Co., Silver Springs, Md., has announced the availability of its Model 309 phono amplifier and preamplifier combination. The unit may be used with low level pickups, such as Pickering or GE variable reluctance, as well as through a separate input tap for use with regular crystal cartridges for playing either standar or LP microgroove records. The response is essentially flat from 1000 cps to 14,000 cps, but provides necessary rising characteristics be-
low 1000 cycles with a boost up to 12 db at 50 cycles. The hum level is 40 db below maximum signal output.

**FRINGE AREA ANTENNA**

This new Vee-D-X antenna, the Sky Monitor, is designed for reception in prime or near fringe TV areas, offering broad band characteristics and reasonably high gain. It provides a tunable "Q" section for matching line impedance, and high channel orientation independently of low channel orientation. Manufacturer: LaPointe Plascomold Corp., Unionville, Conn.

**PORTABLE WIRE RECORDER**

The Harrison Magnetic Wire Recorder, available from Progressive Marketers, 41 Union Square, New York 3, N. Y., is a compact machine weighing only 23 pounds, housed in a leatherette overnight case. Its overall dimensions are 8½ x 10 x 14 inches. To facilitate operation, the instrument is provided with a "roll-out" control panel. The features of this recorder include: recording and playback up to one hour, record player for 10 and 12 inch records, public address system, tone control, musical instrument amplifier, records from phonograph, radio or microphone, has built in 4 x 6 inch speaker, an extra speaker input jack for external speaker, and a recording level indicator. Extra accessories are available from the factory.

--- to page 44
PHONO DRIVE REPAIR

When the complaint is a phonograph or record changer that plays too slow or is wavy, the trouble will usually be poor traction between the motor shaft and the idler pulley. The rubber drive will usually be very smooth, and that is what causes the trouble. I find that by dressing the idler pulley rubber down with finger nail emery board, a good flat surface is obtained and the transfer of power to the turntable is greatly increased.

Daniel Fieldman,
Cuyahoga Falls, O.

MICA CUTTER

The undercutting of mica on small commutators is an easy task if you use your 1/4" electric drill and a simple cutter made from an iron chassis bolt. File the bolt head down to the mica thickness. Then file several notches in the head to form a saw.

Carl O. Williams
Argos, Indiana

SCREEN FOR INACCESSIBLE PLACES

A practical and easy way of placing screws in difficult and inaccessible places, when a special screwdriver is not available, consists in placing a rubber tube of proper diameter onto the screwdriver in such a way that the rubber extension holds the screw in position. When the use of the rubber tube is not needed for holding the screw, a simple push back will leave the end of the screwdriver exposed for normal operation.

Jose Urteaga Unda
Santiago, Chile

ELECTRIC SHOCK

In some of the older receivers of the power transformer type, a bypass condenser is connected across from one side of the power line to ground at the transformer primary contacts. If attempts are made to connect ground wire while the receiver is on, a shock may be received. Reversing the plug will correct this condition, but a better method is to remove the ground end of the condenser from the chassis, or ground, and place it across the a-c line.

D. South Travis
Sherman, Texas

PHILCO 1001

If there is an absence of high voltage, check first current limiting resistors in series with the high voltage line. This one megohm carbon resistor may be open completely, or partially open and arcing across the gap. Many service technicians check for high voltage by shorting this circuit momentarily to ground, a practice which will ruin the resistor in short order.

Max Allt
Yonkers, N. Y.
Trade Literature

etc), setting up a car radio service station, installation and servicing of the equipment, and the special problem of auto radio interference.

The second part of the volume is taken up entirely by circuit and alignment data for over 200 models of automobile radios.

The information presented by the author is given in clear and relevant fashion. Step by step procedures, essential to the beginner in the field, are provided wherever applicable. Since the author has been active in the car radio field for many years, he draws on considerable practical experience to present his ideas. The text is well illustrated with drawings and diagrams, helping the reader get a better picture of the discussion.

Illustrations for the second part of the book do not always have the clarity that might be desired. Almost all of them were furnished by the respective manufacturers, and in the process of reproduction, clearness has been lost in some cases, making the reading of some diagrams and some parts lists difficult at times. In the vast majority of cases, however, both diagrams and parts lists are clear.

For the radio serviceman who wishes to enter the field of auto radio servicing, and who has been looking for a comprehensive source of up-to-date information (all auto radio models from the mid-thirties to the present are covered) which is complete as well as authentic, this book may well be what he has been seeking.

Rider Manual, Volume XVIII

(John F. Rider, 2000 pages, $19.80)

The latest in the series of Rider servicing manuals is a collection of authentic manufacturer's radio service data covering a-m, f-m, automobile receivers, and record changers, up-to-date as of January 1949. Included in the volume is a cumulative index, covering volumes XVI, XVII, and XVIII, as well as the popular How It Works book. A breakdown of difficult multi-waveband receivers, the Rider Chari-Skematix, also comes with the book. This volume is bound in the standard Rider blue loose-leaf binder.
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Trade Literature
-- from page 41

Rider Public Address Equipment
Manual, Volume I, (John F. Rider,
2021 pages, $10.00)

Covering the period of 1938
through 1948, this manual presents
serving data of 147 public address
equipment manufacturers, thereby
constituting a valuable reference
book for the p.a. specialist. Being compiled
alphabetically, reference is made easy.
Included with the manual is the com-
panion How It Works book, describing
the special circuitry found in various
public address systems. This vol-
ume comes complete with index.

Instruction and Service Manual
for the T.A.C. Projection Television
Assembly, Model P-520, prepared
by John F. Rider Laboratories, in
cooperation with Gerard R. Fran-
cour. (79 pages, $2.50)

Although this book was specifically
written as an instruction manual for
the assembly of Television Assembly
Co.'s Model P-520 Projection Tele-
vision receiver, it will prove of con-
siderable value to all those who are
interested in projection television,
because so few books are available on
the subject of projection television.

The double sized pages of the man-
ual allow the text and illustrations to
be uncrowded and clear. This, to-
gether with unambiguous instruc-
tions, make understanding easy.

Aside from the diagrams for as-
sembly operation, the book contains a
number of schematics on insert pages.
Also included are sections on final ad-
justments, trouble shooting, voltage
and resistance chart, and an electrical
and mechanical parts list.

This manual is provided free with
each Model P-520.

Catalogs and Pamphlets

"Keep Your Iron In The Fire" is
a booklet free of advertising, issued
by IRC, pointing out the relationship
between the number of hours the
soldering iron is in operation and the
serviceman's income. It shows eight
ways more time can be devoted to actual
soldering. Radio service tech-
nicians may obtain free copies from
International Resistance Co., 401 N.
Broad Street, Philadelphia 8, Pa.

A Guide to Midget Relays has been
published in the form of a catalog-bulletin by Struthers-Dunn, Inc. It contains complete information on the hundreds of Struthers-Dunn Midget industrial control relays with the exact contact arrangement, mounting details, and construction required for each application. A copy of this bulletin (No. 2100) may be obtained by writing to the manufacturer at 150 N. 13th Street, Philadelphia 7, Pa.

Soldering Tips is a 20-page booklet published by the Weller Mfg. Co., Packer Street, Easton, Pa., giving a condensed soldering course. It will instruct the beginner and refresh the memory of the proficient solderer. The booklet, illustrated with cartoons throughout, goes through the entire soldering process, step by step and in simple language. Even though you have been soldering for years, the 22 rules given in this handbook will prove interesting to you. Price 10c.

99 Questions has been prepared by the Engineering Department of the Amplifier Corporation of America, 396 Broadway, New York 13, N. Y. and is an attempt to answer inquiries most commonly made to the company about the Magnetape Twin-Trax Recorders. The 12-page booklet lists the 99 questions and gives the answer to each. Topics such as general theory, tape handling mechanism, performance, operating facilities, standard applications, special applications, variations in models, sales information, recommended accessories etc. are treated. Copies may be obtained free by writing to the company.

Advance Relays. The Advance Electric and Relay Company has released a catalog of its line of more than fifty types of relays. The catalog is illustrated throughout, and complete details are provided for each type relay.

Catalog 73 is a useful and convenient reference book published by the American Phenolic Corporation, 1830 South 54th Ave., Chicago 50, Ill. It is profusely illustrated and includes descriptions of each part or component listed. The more than 8,000 Amphenol items are grouped according to their uses and are alphabetically listed in the index.

Over the Bench

would have been theirs if they had spent their time improving their ability instead of trying to attract customers with give-away tactics.

In conclusion, I think that the radio service technician is steadily winning the respect of the public. As the equipment upon which he works increases in cost and complexity — and television receivers have certainly done both — the general public is being forced to realize that he is no "tinkerer" and cannot be expected to work for common-labor wages. At the same time, the increasing cost of service equipment and the high technical skill required for working on modern radio equipment are rapidly driving out of the picture those part-time, screwdriver-and-soldering iron servicemen who have always hurt the real service technician with their masquerade. Finally, and most importantly, the servicemen are beginning to think and act more like business and professional men and less like hobbyists. It will take some time yet, but we are on our way up!

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This model has proper rectifier, choke coil, condenser and transformer to provide heavy instantaneous output and still maintain rated output under unusual load and heat conditions.

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Write for complete information

ELECTRO PRODUCTS LABORATORIES
Pioneer Manufacturers of Battery Eliminators
549 W. Randolph St. Chicago 6, Ill.
**Visual Analysis**

→ from page 15

**Instability**

If the picture is clean-cut, yet moves up or down (Fig. 11) the vertical sweep is not holding or the sawtooth sweep pulses may be too weak.

If adjustment of the vertical hold control does not help, look for a defective part or tube in the frequency separator, clipper, vertical sweep, or any of the amplifier stages in the sync circuit. A similar vertical movement of the picture, accompanied by interference, indicates static or excessive interference pulses which evidently are controlling the vertical sweep circuit. The same trouble can be due to leakage of video signals through the clipper circuit to the vertical sweep generator. Check all parts and adjustments in these circuits.

If the picture background is unstable, trouble in the d-c restorer circuit is indicated. This condition may be determined by turning the contrast control to its extreme clockwise position and measuring the voltage from the picture-tube grid to the receiver chassis with a 20,000 ohm-per-volt meter. The voltage at this point should be 20 to 30 volts positive with a 2 volt peak-to-peak signal at the detector. If low-voltage is present, check all components in the restorer circuit, particularly those in the low-voltage power supply.

It is evident from the above discussion that the cathode ray tube is, in itself, an accurate and rapid means of isolating or narrowing the number of stages in which trouble is present. Correct interpretation of cathode ray tube screen images and test patterns will provide the serviceman with first hand information of the receiver's condition.

**Industry Presents**

→ from page 39

**AM-FM TUNER AND AMPLIFIER**

Altec Lansing Corporation, 161 Sixth Ave., New York, N. Y., is now marketing the new AM-FM tuner (ALC-101) and an associated high fidelity amplifier (A-321C). The tuner has a TRF circuit on the AM side and separate electron indicators for AM and FM. Also provided are inputs for television sound and phone, the latter permitting operation direct from magnetic pickups. The amplifier has flat frequency response within 1 db from 20 to 20,000 cycles, full power delivery within 1 db from 35 to 12,000 cycles, hum and noise 30 db below 6 milli-watts, less than 6% intermodulation or 2% total harmonic content at full 18 watt output.

**DUAL RECORD CHANGERS**

Webster-Chicago has now come out with two new record changer models that can play both standard and LP microgroove records. The Models 246 and 256 are dual speed and dual groove automatic changers, providing automatic and manual play for both types of records.

**FM AND TV ANTENNA**

The Andrew Type 710 Di-Fan is a new broadband receiving antenna, broadly tuned to receive all TV and FM channels. Its horizontal directivity pattern in TV channels 2 through 6 and in the FM band is a figure eight, broadside to the major axis of the antenna. For channels 7 through 13, the forward gain is decreased somewhat while the angle of acceptance is enlarged. The Di-Fan Antenna Kit includes a 6-foot steel mounting mast and 60 feet of 300-ohm transmission line. Manufacturer: Andrew Corporation, 421 Seventh Ave., New York 1, N. Y.
TV CONVERTER

The problem of TV in d-c areas is tackled by a new converter, enabling television reception from 115 volt d-c lines, and making picture reception equal to that obtained with a-c operation. The "Picture Control" is designed to regulate the converter frequency and to eliminate picture flutter. This control is designed to operate as a separate unit. The Carter Super Converter Model DIOIOCT is made to operate 7-inch receivers of 125 watts power or less from 115 volts d-c. The larger-screen sets (10 and 12 inches), it is now possible to obtain perfect picture reception equal to that obtained with a-c operation. The "Picture Control" is designed to allow steady and clear pictures over a range of 110 to 135 volts d-c input. For the larger-screen sets (10 and 12 inches), it is not always possible to obtain perfect picture control with a single converter. This problem is now being investigated by engineers of the company. Manufacturer: Carter Motor Company, 2644 N. Maplewood Ave Chicago 47, Ill.

SLIDE SWITCHES

To meet the need for small, inexpensive and sturdy units having sufficient current carrying capacity for electrical tools, fans appliances, etc., the Stackpole Carbon Co., St. Mary's, Pa., has produced two new slide switches. Both are rated 1 ampere at 125 volt d-c, or 3 amperes at 125 volt a-c. They are 11/16" long and 17/32" wide. They are equipped with a 11/32" black trigger as standard. Type SS-26 is single-pole double throw, Type SS-26 is single-throw, Type S526-1 is single-pole single throw single pole. Both switches are Underwriters approved.

AMPLIFIER

Langenfeld Manufacturing Corporation, 27

BACK NUMBERS...
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APRIL 1947
ANTENNAS . . . FM AND TELEVISION. PART I
PHASE INVERTER CIRCUITS
A UNIVERSAL SPEAKER
TELEVISION RECEIVERS . . . THE HORIZONTAL SWEEP

MAY 1947
THE OPEN AND CLOSE CASES
VOLTAGE DOUBLERS
SIGNAL TRACER
TELEVISION RECEIVERS . . . THE CATHODE RAY TUBE

JUNE 1947
WHEN THE CUSTOMER ISN'T RIGHT
TEST EQUIPMENT MAINTENANCE
CRYSTAL CONTROLLED SIGNAL GENERATOR
TELEVISION RECEIVERS . . . THE POWER SUPPLY

JULY 1947
SERVICING FM RECEIVERS
TEST EQUIPMENT MAINTENANCE, PART II
TELEVISION RECEIVERS . . . FLYWHEEL SYNC

AUGUST 1947
SPEAKER MATCHING
TEST EQUIPMENT MAINTENANCE, PART III
SERVICING FM RECEIVERS PART II
TELEVISION RECEIVERS . . . POWER SUPPLIES

SEPTEMBER 1947
SERVICING IS BIG BUSINESS
ANTENNA SYMPOSIUM
TELEVISION PICTURE TUBE
SERVICING FM RECEIVERS PART III

NOVEMBER 1947
TEST EQUIPMENT SYMPOSIUM
HOW'S YOUR SERVICING FUTURE? TELEVISION TEST EQUIPMENT

DECEMBER 1947
ABOUT WIRE RECORDERS
RURAL RADIO SERVICE
AUTO RADIO NOISE
ALIGNMENT METHODS

JANUARY 1948
HOW TO IMPROVE YOUR SIGNAL TRACING TECHNIQUES
SPECIAL F.M. CIRCUITS
WHAT'S NEW IN VIDEO SECTIONS?

FEBRUARY 1948
LET'S WORK TOGETHER
HOW TO USE SWEEP GENERATORS
VOLTAGE REGULATORS

MARCH 1948
HOW TO ELIMINATE HUM
TELEVISION INTERCARRIER SYSTEM
SWEEP GENERATORS FOR FM ALIGNMENT PART II

APRIL 1948
NEW FM SIGNAL GENERATOR
DB CALCULATORS MADE EASY
GET THE MOST FROM YOUR VTVM
AFC IN FM

MAY 1948
TROUBLESHOOTING RECEIVER DISTORTION
INTERFERENCE
A POCKET FM SIGNAL GENERATOR
A SWEEP GENERATOR FOR F.M. & T.V.

JUNE 1948
INTERFERENCE PART II
HEATER-CATHODE HUM
SUPER SERVICE
F. M. AND YOU

JULY 1948
OHM'S LAW IN RADIO SERVICING
INTERFERENCE PART III
HOME SERVICE CALLS... DO THEY PAY?
SERVICING RC FILTERS

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YGS-3 SIGNAL GENERATOR

SEPTEMBER 1948
SERVICING WITH VTVM
TRANSMISSION LINE PROBLEMS
RADIO PHOTOGRAPHS
RECEPTION UNLIMITED

OCTOBER 1948
RECORD CHANGER REPAIRS
SIGNAL TRACING TV
NEW TV INSTRUMENTS
F.M. DETECTORS

November 1947
February 1947
June 1947
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Audio Systems in F-M Receivers

from page 19

and capacitance of the elements of the tubes, associated components, and the wiring. To damp out these oscillations, resistors R13, R15, R18, and R22 are connected in the respective grid leads and R17, R19, R20, and R21 are connected in the screen leads. The former have a value of 1,000 ohm each, the latter 100 ohm each. These resistance values are small compared to the total impedance of the respective circuits in which they are connected, but they are large enough to discourage parasitic oscillation.

Servicing Problems

The servicing of f-m a-f amplifiers involves all the basic problems connected with the same section in a-m receivers with a few extras. For instance, when two phase inverter tubes are used (Fig. 4), the failure of one of these tubes can cause the section to go "dead." The failure of the other tube simply lowers output with some distortion appearing, due to the fact that one output tube is not receiving grid signal voltage. Aging resistors can cause phase inverters to go out of balance, producing harmonic distortion.

Feedback circuits are an additional source of distortion if any of their components should fail. Often a feedback resistor, such as R13 in Fig. 3, will age to a higher value, reducing feedback and increasing hum and distortion. Or a short in this resistor causes R3 to shunt the voice coil of the loudspeaker and lower output with accompanying distortion effects.

Most a-f sections in f-m receivers have a high gain, making the possibility of hum pickup on the grid leads very great. Shielding is provided in the input circuits in the use of shielded wire, proper lead dress, and placement of components. Anything which might disturb this shielding and component arrangement should be a suspected cause of hum and a-f feedback.

Tone control and booster circuits have purposely not been discussed in this article because the principles of these circuits are to be treated separately in our next f-m article.
note pattern due to the mixing process with the converter. This pattern will not follow the sound modulation of the carrier in use, but of the lower channel sound, and this fact must be studied to find out which trap is the one needing adjustment.

Before adjustments are made in a set which previously has given good performance, consideration must also be given to the fact that other types of interference can simulate the type procured when the traps need adjustment. This other type of interference can be due to x-ray machines, diathermy, or the harmonics of short wave stations in the vicinity. Only when it has been definitely ascertained that the interference lies in the trap circuits, should they be adjusted.
"KEN-RAD TUBES BRING REPEAT BUSINESS!"

Says C. F. Patterson, J & M Radio Service Shop.
838 North Rampart, New Orleans, La. Like thousands of reliable service men, Mr. Patterson insists on Ken-Rad tubes because he knows quality pays off.

"I started in business in 1933 and I've been using Ken-Rad tubes ever since."

"In all that time I've never had a complaint. Ken-Rad tubes perform. They last. No other tube I know does a better job for you or your customers."

"This is important, because you've got to satisfy customers if you're going to build repeat business."

"Ken-Rad tubes always satisfied my customers. And that satisfies me."

"KEN-RAD TUBES ARE TESTED TUBES!"

"Ken-Rad tubes satisfy customers and build repeat business because they're tested tubes. Tops in quality, stamina, endurance."

"I know—because I've been supervising the making of Ken-Rad tubes for years."

"We make Ken-Rad tubes with the greatest of care. They're thoroughly tested for noise, microphonics, static, life, shorts, appearance, gas, air and hum."

"You can sell them with confidence. And you can rely on them to increase business, too!"

---

KEN-RAD Radio Tubes
PRODUCT OF GENERAL ELECTRIC COMPANY
Schenectady 5, New York

The Serviceman's Tube
Your local jobber believes in helping you—his best customer—to make more money, because then you will become a bigger customer and everyone will be happy!

In line with this policy, he pledges his high standard of service and better buys for radio servicemen . . . AND he will present ideas to help you expand your business. In the months to come he will feature a different subject each month on this back cover of RADIO MAINTENANCE. This may be in the nature of new moneymaking ideas, or announcements of special sales in his store, or suggestions on the proper equipment for your work. In all cases, the idea will be to help you—the radio serviceman—make more profit.

Of course his staff of experienced clerks are ready to serve you every day. Drop in his store today—browse around. He has all kinds of good buys you may want to look over. Just mention RADIO MAINTENANCE—and watch this back cover for extra profit for you!