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RADIO MAINTENANCE

DECEMBER 1946

TELEVISION RECEIVERS . . .
THE R-F SECTION

TUNING INDICATORS

PART II—THE OSCILLOGRAPH
. . . HOW TO USE IT

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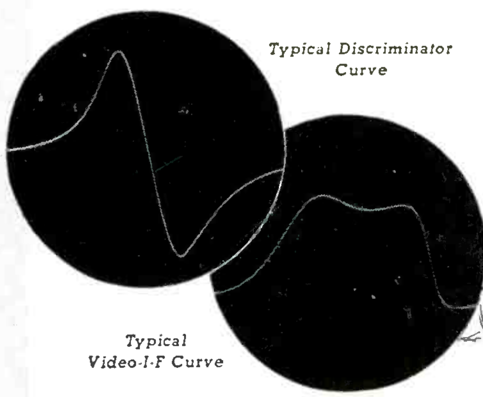
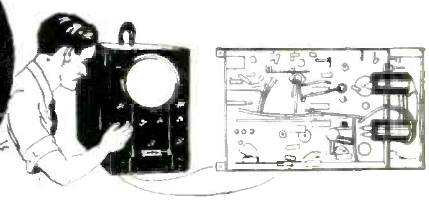


Typical Discriminator Curve

Typical Video-I-F Curve



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Volume 2 DECEMBER 1946 Number 11

Contents

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Courtesy RCA

TELEVISION RECEIVERS

the R-F section

Morton Scheraga

Allen B. DuMont Labs.

In previous articles, the author has covered the adjustment and operation of the television receiver. With this article, he begins a series on the troubleshooting and repair of television receivers.

IT TAKES THE WORK of about fifteen to thirty tubes to produce picture and sound in a typical television receiver. The reception of the ultra-high frequency television signal is accomplished only with very critical elements and circuits which require meticulous design and construction. A television receiver is a complex electronic mechanism. As such, the problem of troubleshooting is difficult and painstaking and calls upon the ingenuity of a competent serviceman for successful results.

In order to approach the subject of troubleshooting along logical and well coordinated lines of thinking, the television receiver will be broken down into seven units, each of which will be considered in detail in this and succeeding articles. By being able to localize the trouble to a particular unit, the serviceman will save considerable time and effort, as will be demonstrated in these articles.

Fig. 1 shows a block diagram of a typical television receiver divided into seven units: 1. The RF Section, 2. The Sound Channel, 3. The Video Channel, 4. The Vertical Sweep System, 5. The Horizontal Sweep System, 6. The Cathode-Ray Tube, and 7. The Power Supplies.

In this first article, we shall be concerned with the problems of troubleshooting the RF section, which includes the antenna, RF input circuits, RF amplifier (if present), the local oscillator, and the first detector. Fig. 2 is a schematic diagram of the RF section in greater detail. It is well to remember that the circuits presented here may differ somewhat from those encountered in other receivers. The basic principles involved, however, will be kept as general as possible to meet the demands of troubleshooting various types.

The function of the RF section is to select the desired television channel containing both sound and picture information and to separate and direct these signals to the audio and video sections at lower intermediate frequencies. This operation can be traced in Fig. 2. The signal is picked up by the double-dipole antenna and fed by a transmission line to the primary of the RF transformer of the particular channel selected. In the receiver of Fig. 2, a manually operated switching system permits the selection of any one of five channels by the transfer of input coupler and oscillator circuit connections. This is shown diagrammatically by arrows which can be considered as being connected together mechanically by the dashed lines on the left of the illustration. Each coupling transformer is designed to be sufficiently broad in tuning to pass one of the 6 mc television bands including sound and picture carriers with their associated sidebands. (Fig. 3 shows the video and audio bands of a television channel.) In this circuit, the secondary of the antenna transformer is connected directly to the first detector. Other designs may use an RF pre-amplifier stage before the mixer, as for example in Fig. 4. This increases the number of tuning circuits which must be aligned to respond to the 6 mc band.

The lower portion of Fig. 2 shows the local oscillator necessary for superheterodyne operation. It employs a Hartley type of circuit and its frequency of operation is controlled by the range switch which changes the circuit constants. A portion of the tuned circuit is always coupled to the small inductance shown connected to the range switch position at the extreme right. This position is connected through condenser C-1 to the lower left section of the switch which is also connected through condenser C-2 to the input of the first detector. The small variable condenser C-3 provides vernier tuning for each position of the band selector switch.

The sound and picture carriers and local oscillator signals are fed to the first detector producing two intermediate frequencies. Since associated sound and picture carriers are always separated by 4.5 mc, two IF carriers with the same frequency difference will be produced. For a typical case, the picture carrier would be 77.25 mc, the sound carrier 81.25 mc, and the local oscillator frequency 90 mc. These conditions will produce a sound IF carrier of 8.25 mc, and a picture IF carrier of 12.75 mc. (These IF frequencies were used in most pre-war receivers. Many sets now coming on the market will have the newly adopted RMA sound and picture IF frequencies of 21.9 mc and 26.4 mc, respectively.) The output of the first detector is connected to a filter network where the unwanted frequencies are attenuated and the desired IF signals are separated. The sound IF signals are applied to an amplifying system tuned to pass the sound IF carrier of 8.25 mc and both side bands. The picture IF signals are applied to an amplifying system tuned to pass the IF carrier of 12.75 mc and the usable side band (only one side band is used in the picture transmission).

With this functional description of the RF section, let us go back to the

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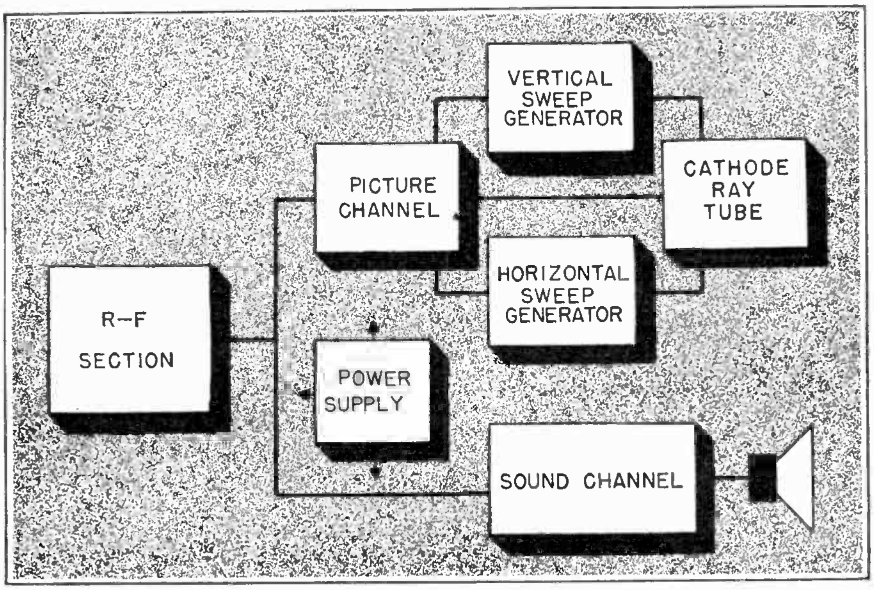

Fig. 1 A block diagram showing the seven major sections of a television receiver. In this and future articles, the author outlines a method of servicing based on this breakdown.

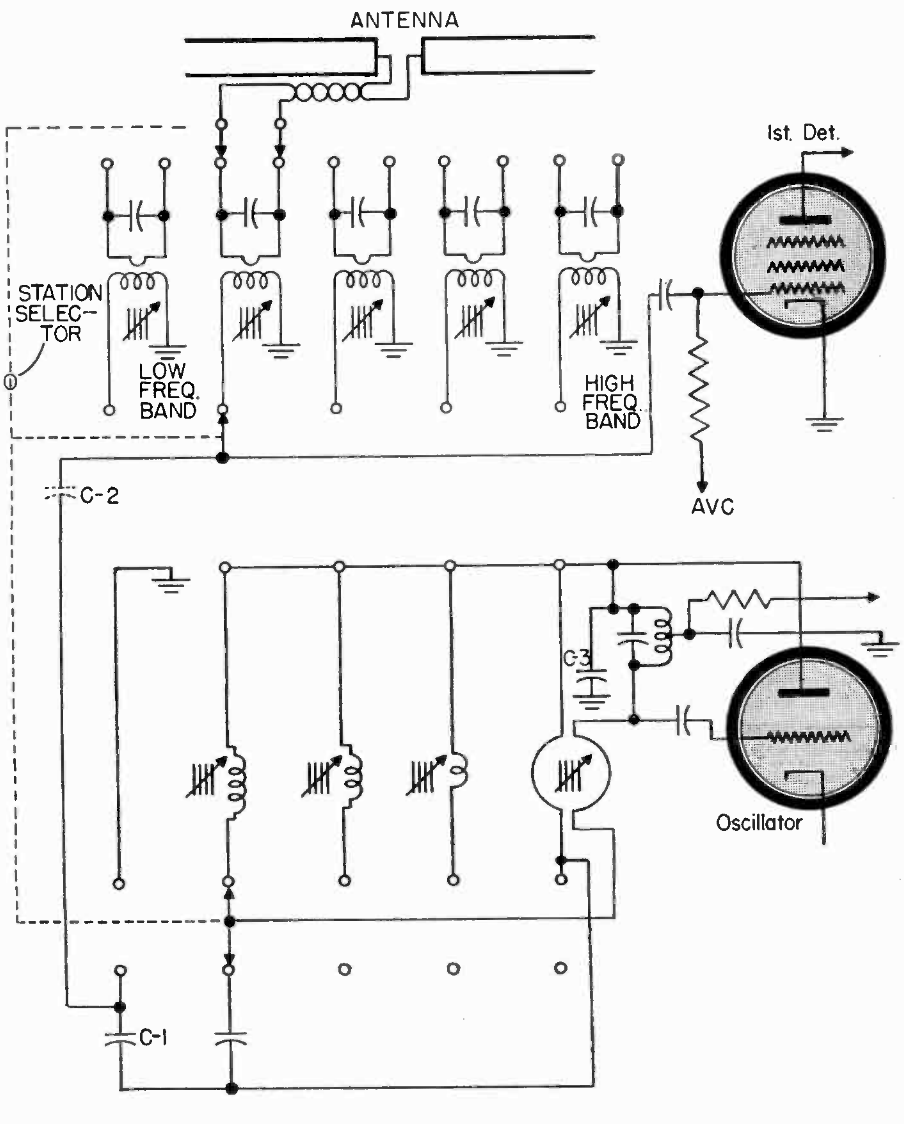

Fig. 2 A typical television RF input section, showing the oscillator and first detector.

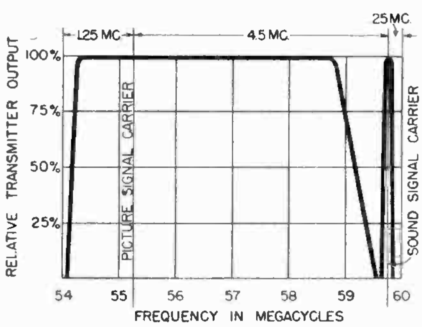

Fig. 3 A 6-megacycle television channel.

The R-F Section

→ From Preceding Page

antenna and examine the requirements that have to be met at the input of a receiver. It would be advisable for the serviceman when installing receivers to use a ready-made antenna kit recommended by the same manufacturer. However, if some other type is preferred, the serviceman must make sure that the antenna, the transmission line, and the receiver input are all properly matched. The commonly used half-wave dipole antenna has an impedance of 73 ohms and a transmission line must be used that will match it to the receiver input impedance. Too great a mismatch results in serious loss of signal, and reflections are set up all along the transmission line which may cause double images (ghosts) to appear in the picture as readily as multi-path reflections at the antenna itself.

The transmission line is coupled to the receiver through coupling transformers, each tuned for a different channel. It is well to consider the usual faults associated with the switches generally used for channel selection. Ganged to the coupling coil switch are the oscillator circuit coils. At the high television frequencies, the contact resistance and inductance in the switch terminals are critical; and slight variations are enough to detune the oscillator or change the characteristics of the band pass circuits. Gradual wear in the contacts changes the contact resistance and the inductive path. The latter trouble occurs especially with knife type switches which do not close in the same position at all times, resulting in severe oscillator drift.

Most receivers using switches will have a small variable trimmer on the oscillator to correct for this drift. This trimmer, however, may or may not have sufficient range to compensate for circuit changes, depending upon the design of the oscillator and the seriousness of the change.

Troubleshooting a television receiver must start at the installation itself. Unlike radio where the set can be brought to the service shop and repaired, the location of the television receiver and its antenna and transmission line all bear on its performance. Therefore, before removing a receiver from a home, the serviceman should carefully examine the complete installation to make certain that the trouble does not exist outside the receiver. Thus the troubleshooting procedure for the RF section can be divided into two steps: 1. Preliminary checks at the receiver installation, and 2. Repair work back at the service shop. A third step might also be considered, that of re-installing the receiver after repairs have been made. This again involves the routine of step 1.

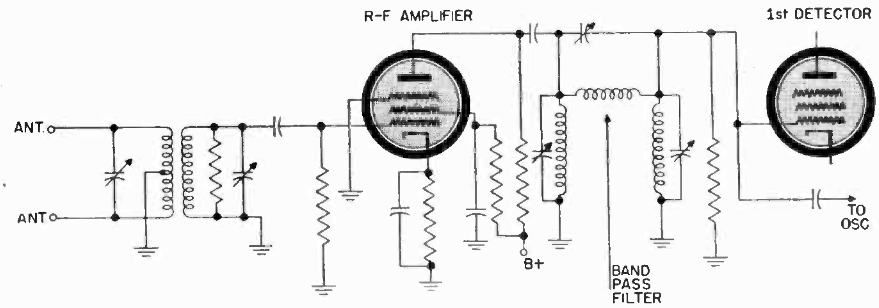

Fig. 4 A receiver input system with an RF amplifier stage before the first detector.

The troubleshooting procedure should progress in the following manner: If the set will not operate at all, there is little need to follow step 1; the set should be removed for repair work at the shop, leaving the installation to be examined when the set is returned. On the other hand, if the set is operating, but the picture quality is poor, the installation may need scrutiny. Let us outline the troubles that can be attributed to the antenna system and receiver input.

Ghosts

A check of the antenna system to determine whether any reflections are caused by improper match can be made by first referring to the manufacturer's manual to learn the input impedance of the receiver. The impedance of the transmission line and the antenna can be judged by recognizing the types used, or else by consulting the particular manufacturer's catalogs. Any mismatch in the antenna system should be corrected before proceeding with the elimination of ghosts due to multipath reflections. (For a complete treatment of methods to avoid multipath reflections, the reader is referred to the article on Television Receiver Installation, in the January 1946 issue of Radio Maintenance.)

Local Interference

Ignition systems of automobiles, electric motors, trolley lines, and diathermy are man-made static conditions that ride through the RF section and cause the picture to tear. The serviceman should become familiar with these local disturbances which cannot readily be avoided so that he will not look needlessly for troubles in the receiver. The only possible aids at present to minimize local interference are to locate and shield the source of the trouble; or what is next best, locate the receiving antenna well away from streets or industrial estab-

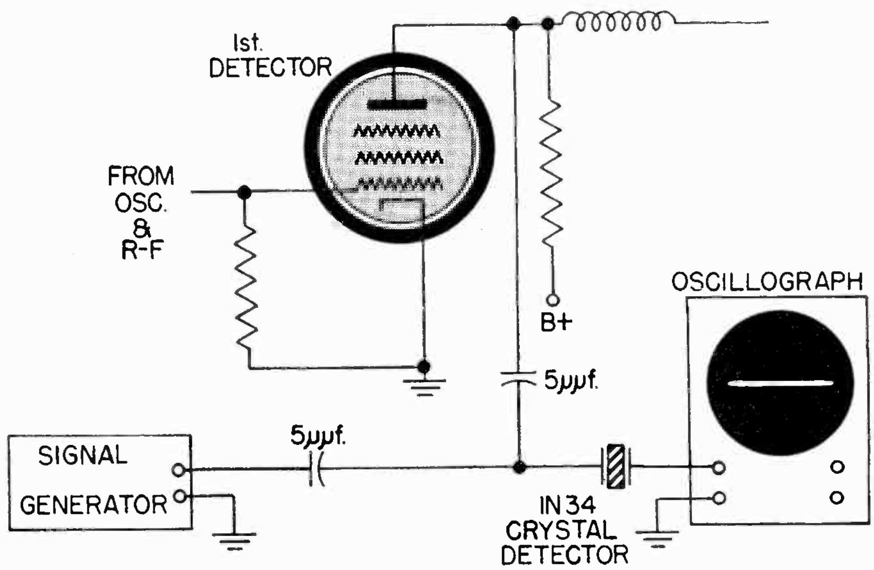

Fig. 5 Method used to check the oscillator frequency. Oscillator signal voltage is picked up from the plate of the first detector and fed through a 5 uuf condenser and crystal detector to the test 'scope. The output of the signal generator, fed through the 5 uuf condenser, beats with the oscillator frequency. The oscillator circuits are adjusted for zero beat.

lishments. It is realized that the latter is not always feasible, but sometimes mounting the antenna higher and farther from the troubled area at the expense of a few hundred feet of cable will bring much better results.

Image Interference

Image interference troubles will vary, depending upon the area in which the receiver is installed. For example, in the New York City vicinity, the television channels are so assigned that a receiver tuned to Channel 2, WCBW, might have a faint picture of Channel 5, WABD, in the background. Unless the receiver has a high image rejection, it will be necessary to insert a tuned circuit consisting of an inductance and a paralleled variable capacitor in the transmission line, the trap being resonated for WABD's frequency. In another part of New York City, the interference may be due to the Armstrong FM station operating on 92.1 mc. A parallel circuit of a coil and variable capacitor sharply tuned for 92.1 mc and inserted in series with the transmission line will reduce interference from this source which comes in on Channel 4. No fast and set rule or values for traps can be given since the image interference will depend upon the frequency assignments in different parts of the country. By recognizing its existence, however, and knowing how to eliminate it, the serviceman can cure the source of trouble.

These rejection circuits can be wired permanently into the gang switch in some receiver designs so that they operate on the specified channel only. In other cases, it may prove more convenient to arrange easily connected rejection circuits which may be inserted in the transmission line as given channels are selected for reception.

Too Strong a Signal

Sometimes a receiver may be situated in a locale where the signal strength is so high as to overload the input circuits. This may be indicated by a loss of synchronization and sometimes by sound modulation in the picture as well as an over-contrasty picture. Attenuators to correct this condition are described in the October issue of RADIO MAINTENANCE.

Too Weak a Signal

The signal strength at the receiver might be so low that only a faint picture can be obtained with considerable noise and poor synchronization. This condition may be deceiving and prompt the serviceman to attempt to realign the video circuits for greater gain, a procedure which would be of no avail. A small calibrated receiver or field strength meter connected at the installation will readily indicate the signal level. If this level is below the minimum signal for which the receiver is designed (see manufacturer's manual) a few things can be done to increase the signal. Increasing the height of the antenna may help, provided the increased transmission line loss does not offset the increase in signal strength. A reflector may be added to the antenna if one does not already exist, or finally an RF amplifier stage may be required.

It is important that the serviceman recognize these troubles at the installation before removing the receiver. If it is certain that none of these exist, then the receiver should be removed to the service shop and the fault localized to one of the seven basic units.

The line of reasoning to isolate the trouble to the RF section may be as follows: If a raster can be obtained on the face of the tube, there is nothing wrong with the sweep circuits, the cathode-ray tube, or the power supplies. Tapping the grid of the first video IF stage to give noise signals on the face of the tube will eliminate that section as a cause of trouble, while tapping the first IF grid of the sound system to produce noise in the speaker will indicate this unit is operating properly.

If, after these checks, no picture or sound is coming through, the fault will probably lie in the RF unit. Let us investigate the possible troubles in these circuits.

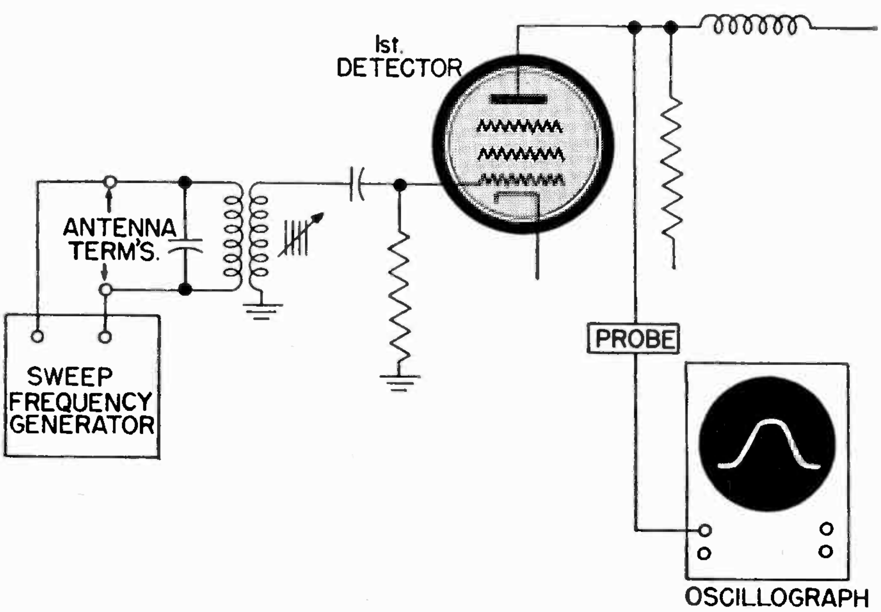

Fig. 6 Method used to align the RF coupling transformer, using a sweep frequency generator and test 'scope.

Picture but No Sound

This is a common trouble caused by too great a drift of the oscillator which cannot be compensated for by the tuning trimmer capacitor. Of course, the picture obtained under these conditions will not be good, but some of it will come through since the picture channel is 4 mc wide (greater than the probable oscillator drift). The sound channel for television on the other hand is only 50 kc wide and the change in oscillator frequency may be sufficient to move the resulting sound intermediate frequency out of the correct pass band. Common causes for oscillator drift are poor switch contacts, corroded tube sockets, or damaged condensers or coils. If parts of the oscillator circuit have to be changed, which will affect the frequency on other channels, then all the oscillator frequencies will probably have to be reset.

A stable, well calibrated signal generator will be necessary to realign the oscillator. This is done as shown in Fig. 5. With the band switch in position for the desired channel, set the signal generator to the proper frequency and then adjust the oscillator tuning trimmer or inductor until a zero beat is indicated on the oscillograph. Repeat this procedure for all positions of the band switch. The correct oscillator frequencies for the thirteen television channels are given in Table I.

No Picture, No Sound

This condition may have several causes. First check to see that the oscillator is working by holding the input lead of the oscillograph near the oscillator and noting whether the

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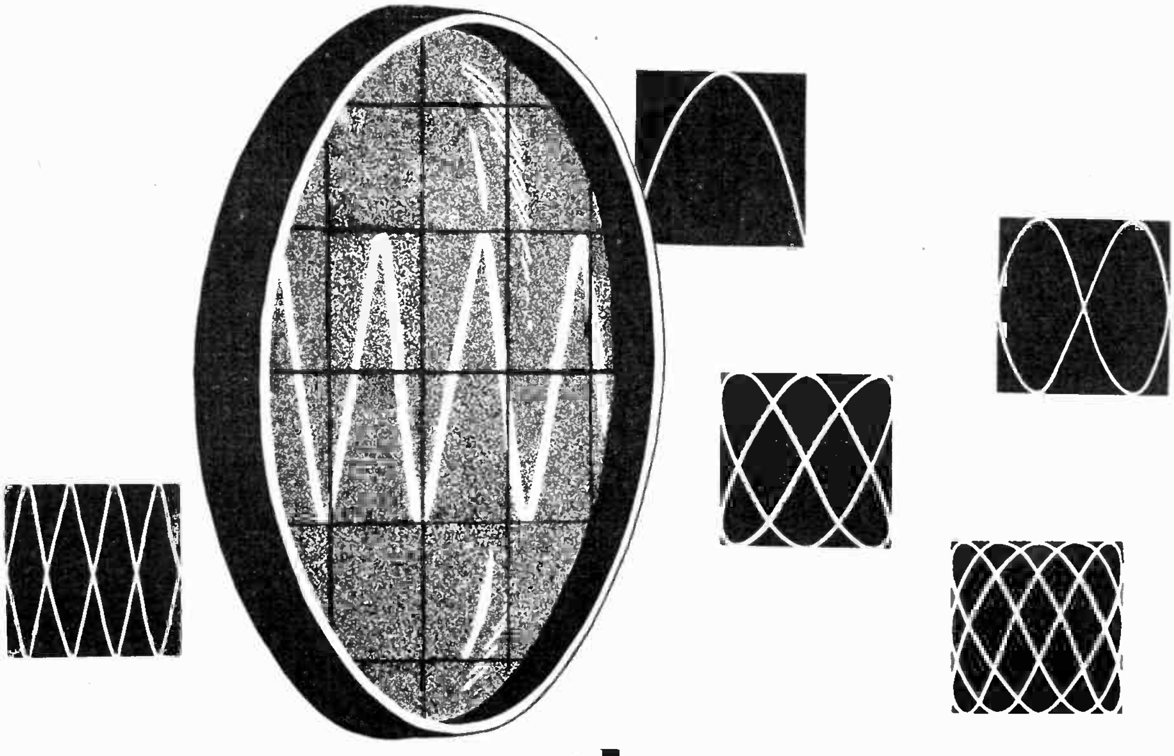

PART II

the Oscillograph ... how to use it

Continuing with his discussion of the operation and use of the cathode-ray oscillograph in radio servicing, in this article the author covers distortion measurement and the detection of phase shift in audio systems.

by Karl R. Alberts

IT WILL BE RECALLED that in the preceding article of this series, the use of the cathode-ray oscillograph for measuring DC and AC voltages was described in detail. That information was given not only because it represents a real, practical use to which the radio maintenance man can put the oscillograph, but also because it is fundamental to all other more complicated uses, such as those to be discussed now and in the following articles of this series.

The author has borne in mind the fact that the serviceman cannot afford to spend too much time on any *one* problem, no matter how interesting and instructive it may be; and that, therefore, any uses of a complicated instrument which involve a lot of complex additional equipment, extremely tedious and involved adjustments, and hours of "diddling," are usually of no more than passing interest to him. Certainly he never considers them in the light of practically applying them to his business. Therefore, in all the material which follows in this and succeeding articles, careful attention has been given to simplicity of operation, speed in carrying out the tests, and practicability of all the uses outlined.

Measuring Amplifier Distortion

One of the chief difficulties experienced in superheterodyne radio receivers is trouble in the operation of the audio and IF amplifiers. Distortion or malfunctioning in either the audio or IF stages is, of course, not objectionable until it reaches a point where the ear can detect the difference between what is being heard and perfect reception.

In this section, we will review simple steps that can be taken with the aid of the oscilloscope to detect distortion in the audio; and in later sections, we will deal with measurements in the IF and alignment of the IF amplifier. (It is useless to speak of alignment of the audio, for there are no audio tuning controls available. Trouble indicated by the oscilloscope can usually be cleared by replacing a defective part, such as a tube, resistor, condenser, output transformer, etc.)

An electrical amplifier, normal in its operation, has as its function the amplification of an electrical signal applied to its input terminals. That is, it must provide at its output terminals a voltage or power which is exactly like that applied to its input except in amplitude. Any deviations from this prime function result in what is called "distortion."

These deviations from normal may take the form of *frequency distortion*, which is the term given to variation in gain over the band; i.e., the gain of the amplifier is not constant with frequency over the desired pass-band. In a good audio system, the amplifier characteristic should be flat from below 100 cycles to above 3000 cycles; an excellent audio system has a flat pass-band from below 50 cycles to above 10,000 cycles.

A second form of distortion is *amplitude* or *"non-linear" distortion*. This is the type wherein the amplifier introduces some frequencies which were not present in the input; in other words, the output voltage is not a linear function of the input voltage. This can arise either from the overall amplifier characteristics or from a particular component within the amplifier. For example, if the drive on a Class A amplifier tube is too great, or the grid bias improperly adjusted, the grid may be driven positive (a highly non-linear region of operation) or below cutoff, both conditions giving rise to frequencies which were not present in the applied input signal.

A third form of distortion comes about through unequal *phase shift* at different frequencies. Phase shift at a given frequency means a difference in phase between the output and input voltages of that frequency. A plate voltage which is applied to the grid of a following stage through a coupling condenser-grid leak resistor arrangement is shifted in phase somewhat; and if this phase shift is noticeably different at different frequencies, the overall output signal from the amplifier will differ from the input signal. In audio amplifiers, in general, this is not serious because the ear for some reason cannot detect phase distortion in moderate amounts. Serious phase distortion, however, will be picked up by the ear and will cause the same sensation as frequency distortion.

Completely testing an audio amplifier with the cathode-ray oscilloscope should take the serviceman about one-half hour. As he becomes more familiar with oscilloscope techniques and improvises set-ups which are quickly torn down and replaced in working order, as required, the testing should take less and less time until finally a stage is reached where nearly complete information about a given amplifier can be obtained in a very few minutes.

Connect the output terminals of a suitable audio oscillator to the input of the amplifier under test. In most radio receivers, this will be the grid of the triode section of the duplex-diode-triode tube (6SQ7, 12Q7, etc.). Use the highest impedance output available from the oscillator. The voltage across the voice coil of the loudspeaker will be referred to as the "output."

Checking Amplifier Pass-Band

To check the pass-band of the amplifier, many interesting techniques have been evolved, some of them requiring special and complicated apparatus. One scheme is to connect the variable condenser or resistance of the frequency-determining circuit to the shaft of a geared-down motor and use the internal sweep of the oscilloscope, synchronized with the input signal. When the motor is turned on, the oscillator frequency varies as the condenser or resistance is varied; and if the circuit is properly adjusted, the frequency will vary over the entire audio range. With constant output from the oscillator, if the amplifier output is connected to the vertical deflecting plates of the oscilloscope, a rapidly recurrent curve (depending on the speed of the variable element in the oscillator) which represents voltage plotted against frequency, will appear on the face of the oscilloscope screen.

This is an entirely too expensive, complicated, and cumbersome method, particularly for the moderate results obtained. Many authors who have extolled the virtues of the oscilloscope as a panacea for all radio servicing ills have suggested the foregoing method both for audio and IF checking; but it is this author's opinion that such complex methods find very little application in the field—even by those who propose them. For an instrument to be useful and replace another instrument which can do the same job very effectively and with which the operator is thoroughly familiar, it should have the virtues of greater simplicity and give more information for the amount of work done.

A tried and proven method of checking the band-pass of an audio amplifier is to measure the output voltage with a voltmeter as the frequency of the input voltage is varied over a wide range (say, 50 to 12,000 cycles) with the input voltage level kept constant; a curve of output voltage against frequency is plotted and the band-pass characteristic of the amplifier results. For a quick check which is not quite as accurate as the voltmeter method but has the advantage of greater simplicity in that information is instantly imparted to the eye as the test is performed without further additional work, the following is recommended. Connect the amplifier output to the vertical deflecting plates of the oscilloscope. Turn the horizontal sweep gain to minimum so that there is no horizontal deflection. Set the oscillator frequency to 1000 cycles. When signal voltage is applied to the vertical plates, a straight up-and-down line will result on the screen of the oscilloscope. (At this point, it might be well to review Part I of this series for the electrical meaning and interpretation of patterns on the screen.) Draw several calibrating marks on the face of the cathode-ray tube, to cover about three-quarters of the vertical diameter of the tube (see Fig. 1).

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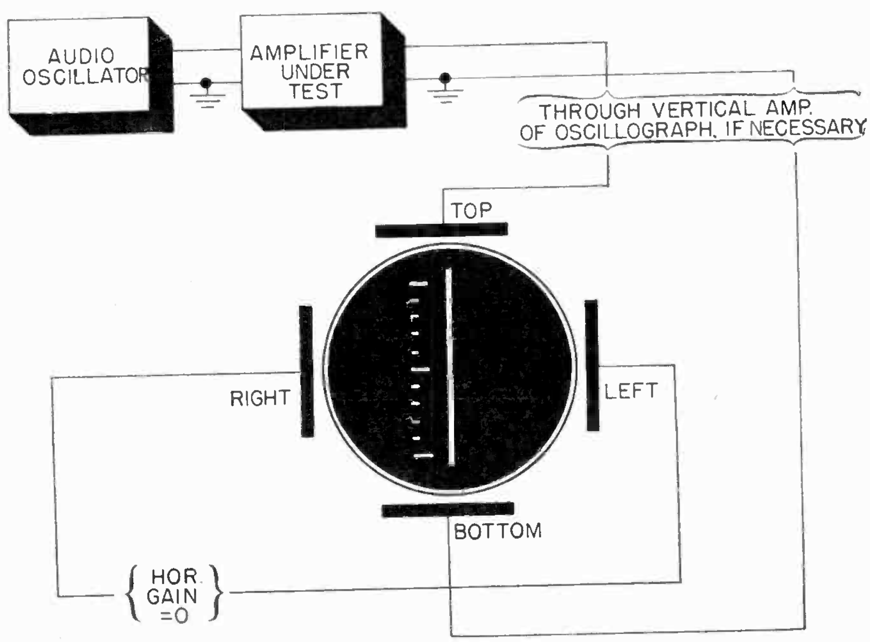

Fig. 1 Block diagram of the test setup used when checking the distortion and pass band of an audio amplifier.

The Oscillograph . . . how to use it

→ From Preceding Page

With a small signal applied to the input of the amplifier, observe the deflection on the cathode-ray tube. If it is less than an inch, connect the amplifier output to the vertical amplifier of the cathode-ray oscilloscope and make the necessary connections on the terminal strip for vertical amplifier output to deflecting plates. This is a valid step since the band-pass characteristic of the vertical amplifier is essentially flat over the audio range. Now, with a three or four inch deflection at 1000 cycles, rotate the tuning dial of the audio oscillator and cover the entire audio range, say from 30 to 15,000 cycles. Observe the line on the oscilloscope screen as the tuning control is varied. Its amplitude (deflection of the spot) represents a direct measure of output voltage from the amplifier. It is only necessary to note where the line first starts to decrease markedly in magnitude as the frequency is varied. The points where the line shrinks to one-half its maximum value are usually taken as the arbitrary limits of the amplifier pass-band. These points are 6 db down from the maximum value.

Thus, if the half-voltage points were 120 and 1000 cycles, the amplifier is poor in both high and low frequency response. If the figures were 120 and 5000 cycles, poor bass response, good frequency response. For 50 and 1000 cycles, excellent bass, poor high response. For 50 and 5000 cycles, excellent high and bass response.

In checking the pass-band of an audio amplifier, care should be taken not to overload the amplifier anywhere along the frequency spectrum. Methods for checking overload will be given presently.

The interpretation of the results obtained from a pass-band check is conditioned by knowledge of the amplifier and the use to which it is being put. The audio in a five or six tube radio set need not be any wider than 100-3000 cycles for most purposes. An audio amplifier to be used with an FM receiver, on the other hand, should be much better in order to do justice to the distortionless FM signal. A public address system amplifier which is to be used entirely for speech can have a very limited pass-band since here gain is the all-important item and the frequency characteristic of the amplifier is relatively unimportant so long as the amplifier's output is intelligible and the spoken words are clear and distinct.

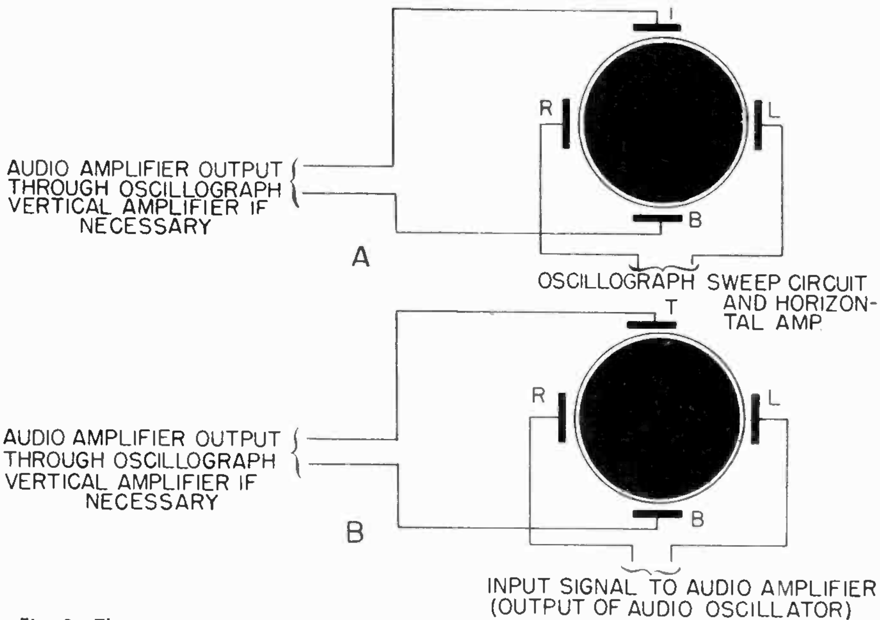

Fig. 2 The connections used when checking for overload in an audio system. In A, the internal sweep is used, while in B, the output of the audio oscillator is applied to the horizontal plates.

Often it is not the amplifier itself that is at fault so much as the loudspeaker or horn. In the case of the loudspeaker, physical damage to the cone, loss of magnetization in the permanent magnet (if it is such a speaker) or insufficient current through the field coil (if it is an electrodynamic speaker) can cause degradation of performance.

Checking Overload

To check for overload of an audio system, it is necessary to perform the test only at one or two frequencies. Connect as shown in Fig. 1, except that the horizontal sweep is to be turned on. Synchronize the pattern so that two or three complete cycles are shown. Use either "internal sync." or "external sync." with part of the signal connected to the external sync. jack on the oscilloscope. This set-up will be referred to as "A." (See Fig. 2A.) To get another picture which will add to the information obtainable, arrange the apparatus so that the input to the audio amplifier is also applied to the horizontal amplifier input of the oscilloscope, with the horizontal deflecting plates connected to the output of the horizontal amplifier. This will be referred to as set-up "B." (See Fig. 2B.) Set-up B, then, will have the input to the amplifier under test on the horizontal plate, and the output on the vertical plates. Part I of this series on the oscilloscope showed that for two identical signals, adjusted to be equal in amplitude, on the horizontal and vertical plates, a straight 45° line should result. Any deviation, then, from a perfectly straight line will show that the two signals are not identical or in other words that the output is a distorted version of the input.

NOTE: Since the horizontal gain is less than the vertical, it may be impossible to obtain equal deflections, horizontal and vertical, on the cathode-ray tube. If this should be the case, reverse the signals shown in Fig. 2B, placing the audio amplifier output on the horizontal amplifier and the input signal on the vertical amplifier.

Set the frequency to, say, 1000 cycles. Set the oscillator output to a low value. Then with set-up A, a pattern like that of Fig. 3A should result. Turn up the oscillator output until the volume of sound from the loudspeaker is judged to be about the maximum that the set is capable of furnishing, i.e., the volume level beyond which it will never be necessary to go. Observe the waveform. If it is still a pure sine wave, there is no overloading. Switch to set-up B. For no overloading, the straight line of Fig. 3B should result. It will be easier to detect the beginnings of overload with set-up B than with A since any slight departure from equality between output and input signals at the amplifier (other than in amplitude, of course) will immediately distort the straight line while it might not be too noticeable on the sine-wave pattern. A small amount of distortion is shown in Fig. 4A. The corresponding picture observed with set-up B is shown in Fig. 4B. A large amount of distortion is shown in Figs. 5A and 5B. If distortion is not evident with the oscillator output level adjusted for normal maximum power output from the horn or loudspeaker, as explained above, then turn up the oscillator output until the oscillograph waves *are* distorted so that the signs of overload can be seen and thenceforth recognized in the future.

If a considerable amount of overloading is evident, it will be worthwhile to try to isolate it in the amplifier. The procedure is to move the output connections which go to the oscilloscope closer to the input terminals of the amplifier under test, one stage at a time. For example, first move the output leads from the speaker voice coil to the plate of one of the final output tubes, then to the other tube, then to the preceding phase inverter or voltage amplifier, and so forth. Attempt to discover which stage is producing all or most of the overload distortion. After the chief point of overload contribution has been found, the cause must be determined. Why is the stage overloading? The easiest things to look for are improper grid bias, wrong B+ voltage on the plates, excessive hum on the B+ supply, etc. All of these items are most easily checked by the method described in the preceding article of this series: Using the Oscilloscope as a Voltmeter. Of course, it may be a defective circuit component, like a vacuum tube. It is not the purpose of this article, however, to point out ways of fixing defective amplifiers, but to present convenient, speedy oscillographic methods by which the presence and type of trouble can be detected and the general source of the trouble located.

Detection of Phase Shift

As noted above in the general discussion of performance of audio amplifiers, phase shift generally is unimportant in audio systems except where it becomes of excessively large value, when it proves offensive to the ears. The test to be described, then, is designed to show a gross presentation of phase shift which is readily observable only when it is of sufficient magnitude to be undesirable.

Phase shift is a relative matter, necessitating the viewing of two waves at one time. Thus, set-up A will be useless here. Set-up B is the only one that can be used successfully without a lot of additional external

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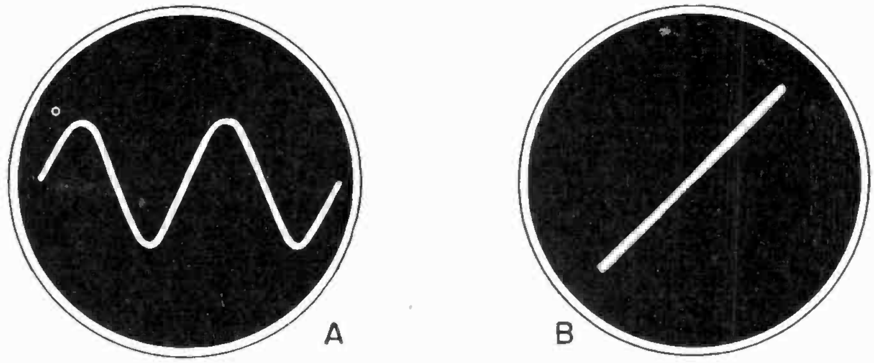


Fig. 3 The patterns obtained with the test setups of Fig. 2. With setup 2A, the pattern shown in A is obtained. With setup 2B, the pattern shown in B is obtained.

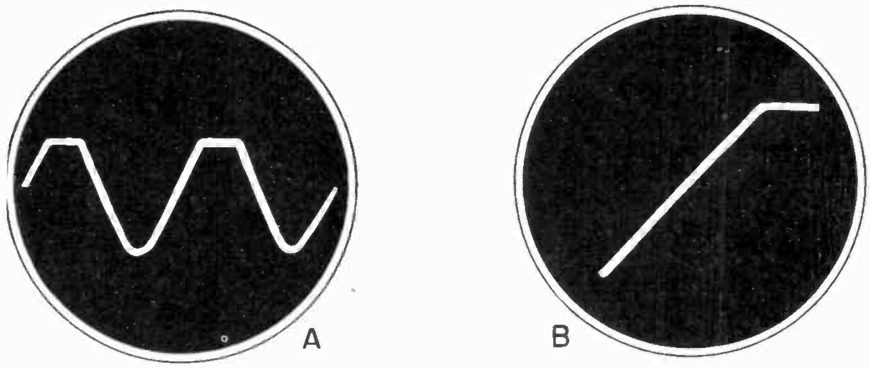


Fig. 4 The patterns obtained with the test setups of Fig. 2 when distortion is present in the amplifier under test. A is with the setup of 2A; B is with the setup of 2B.

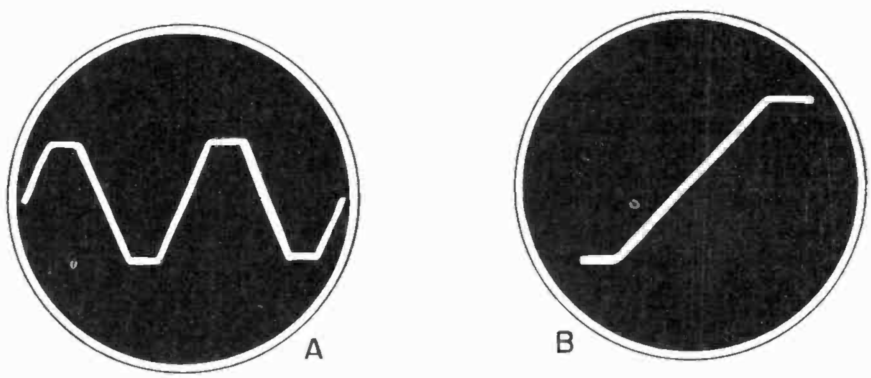


Fig. 5 The patterns obtained with the test setups of Fig. 2, when a great deal of distortion is present in the amplifier under test. A is for setup 2A; B is for setup 2B.

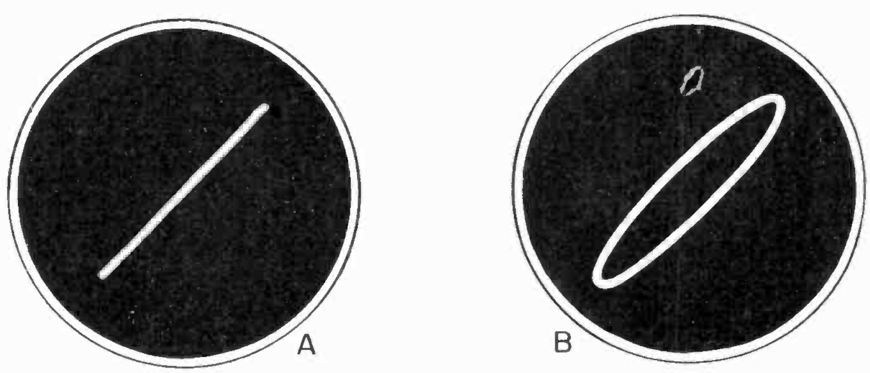
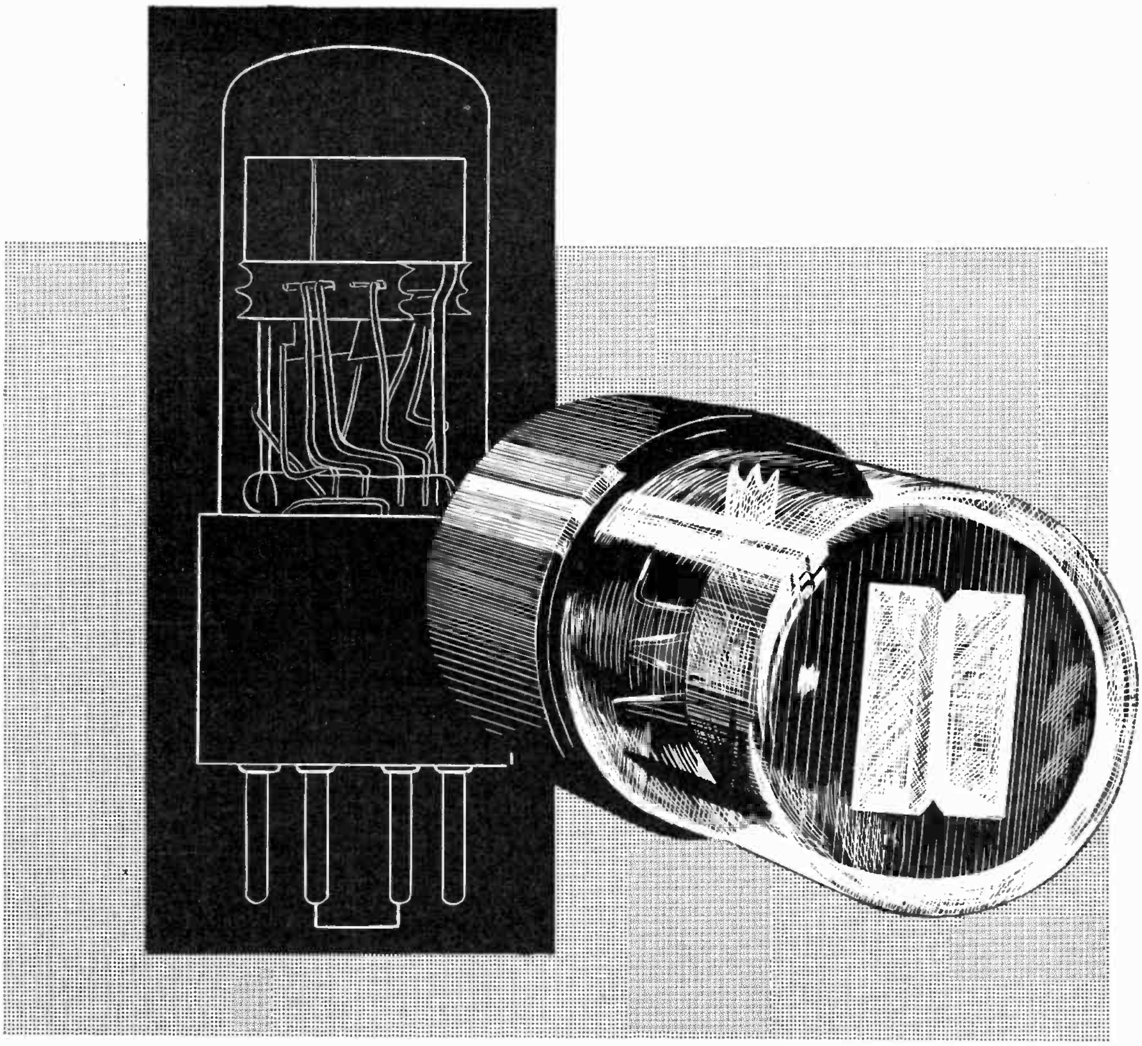


Fig. 6 The patterns obtained when checking an amplifier for phase shift. A shows the amplifier under test to be without phase shift, while B shows the amplifier under test to have an appreciable amount of phase shift.



TUNING INDICATORS

The evolution of tuning indicators has been taking place for the past twenty years. Several systems have been devised. The author discusses all of these, including the new frequency modulation tuning indicator just announced.

by Fred W. Schmidt

TUNING INDICATORS came into general use on the better radio receivers as a solution to the tuning difficulty presented to the public when receiver circuits became almost spot selective. In the transition from straight RF circuits to neutrodyne systems and various methods of RF preselection and finally to the superimposed-heterodyne principle, radio receivers acquired more tuned stages with an increased selectivity. To add to the problem, AVC circuits gave an apparent broadness to tuning by keeping the volume of the receiver at a fairly constant level over a ten-kilocycle width when a strong or local station was tuned in. Since the average radio user tuned by volume rather than quality of reception, the set would be tuned in anywhere in the level volume area with a consequent loss of fidelity. To complicate tuning further, the manufacturers had incorporated a tone control which acted as a filter for all the high frequencies. This added to the sales appeal but gave most radios a "boomy" response with no high fidelity when the tone control was turned to maximum position.

The result of all this confusion was reflected to the set owner. It was common practice for the owner of a fine radio receiver to crank up the tone control, cut out all high frequency response, and then tune into one of the side bands. This condition became even worse with later radios when the emphasis began to be on high response and more faithful reproduction. Since the low frequencies are contained near the center of a response curve with the high frequencies extending out from this center point, it is imperative for true reproduction that the radio receiver be exactly tuned.

The ear of the average set user doesn't give too sharp an indication of exact tuning and only a trained ear will detect small amounts of distortion. Visual indicators were the solution. The eye is a more sensitive receptor than the ear and the indicator sensitivity can be increased to such values that the eye will detect a change in tuning that even a trained ear cannot notice.

The visual indicator facilitated tuning for any set user and anyone could be taught rapidly to watch a visual change. So the average owner of a better radio began to get maximum response performance from his radio in spite of his indifference to distortion. The visual indicator added a gadget to a radio which made it still more mysterious and therefore more attractive from a sales point of view. It also made possible comparatively simple methods of silent tuning between stations which is advantageous in a high noise level location when AVC is used and the output operated at a predetermined level.

Since amplitude modulation receivers are in the vast majority, it would be well to consider them first. Four common methods of visual indication have been used. These are (1) the saturated core, (2) glow lamps such as neon lamps, (3) meter movements, and (4) electron-ray tubes.

Saturated Core

The saturated core method of indication (Fig. 1) used a pilot bulb which became dim off station, and burned brighter on station. A special iron core was used upon which were several windings. One winding was connected in series with a pilot lamp which was energized to full brilliance by a suitable tap on the power transformer. The impedance in the lamp circuit presented by the core winding was low when the core was unsaturated. Another winding acted as a control winding and was connected so that it carried the plate current of one or more of the tubes controlled by the AVC voltage. The plate current of the controlled tubes was sufficient to saturate the iron core when no AVC voltage was present. This raised the impedance in the winding in series with the lamp and caused the bulb to burn dimly. When the receiver was tuned into a station, an AVC voltage was developed which became a maximum at absolute resonance; the resulting decrease in plate current caused a decrease in the impedance in the lamp circuit and the lamp brightened to maximum brilliance. Since the lamp brightness followed AVC which indicated resonance, the lamp brightness could be used for exact tuning. Some stations were weaker than others and developed less AVC voltage which gave small differences in lamp brightness at resonance. This condition was minimized by introducing a bucking voltage in the control circuit which could be adjusted and would cause the core to saturate at very low values of plate current, making the light bulb sensitive to small changes in AVC voltage and usable on comparatively weak stations.

Glow Tubes

Glow tubes and bulbs were used more extensively than the saturated core. The glow lamp, a regular ¼ watt neon lamp, required a specially added control tube. The tube was so connected that the plate current was limited to a small value by means of a high series resistance (R_P) in the plate circuit (Fig. 2A). The grid of the tube was controlled by a developed AVC voltage. The neon lamp was connected directly across the plate to ground. Off station, with no AVC voltage, the plate current was a maximum and the voltage drop across the plate resistor (R_P) became a maximum with the actual plate voltage becoming too low to light the neon lamp. On station, with developed AVC voltage applied to the grid, the plate current in the control tube dropped to a minimum, the voltage drop across the plate resistor (R_P) became a minimum and the voltage at the plate became a maximum, sufficient to light the neon lamp. Since a neon lamp does not give a very sharp indication by means of brightness but glows rather uniformly after it is once lit, a specially sharp circuit (T_1) was required if the neon lamp was to light only at exact resonance.

Some manufacturers overcame this glow persistence by constructing a gas tube which would glow along its length with applied voltage and thus eliminated the need for a special sharp circuit. The tube was used in a manner similar to that employed with the neon tube (Fig. 2B).

Meter Indicators

Meters were used extensively and were called everything from "Shadowgraph" to "Target" tuning. The principle underlying them all was identical. In actual practice, not many styles looked alike for each manufacturer had a different idea of what would appeal to the public.

In application, a current meter movement was inserted in the plate circuits of the tubes controlled by AVC. The movement registered maximum and minimum current: Maximum off station with no AVC voltage and minimum on station with AVC voltage applied to the grids. The circuits were essentially more simple than earlier indicating devices and since no accuracy other than that of merely indicating was required, the

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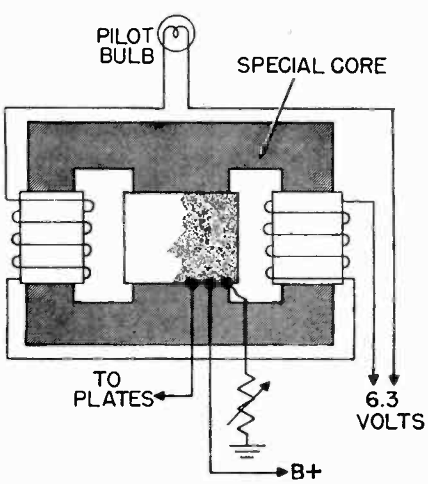

Fig. 1 The saturated core type tuning indicator. This is one of the first means devised to assist in the proper tuning of a receiver.

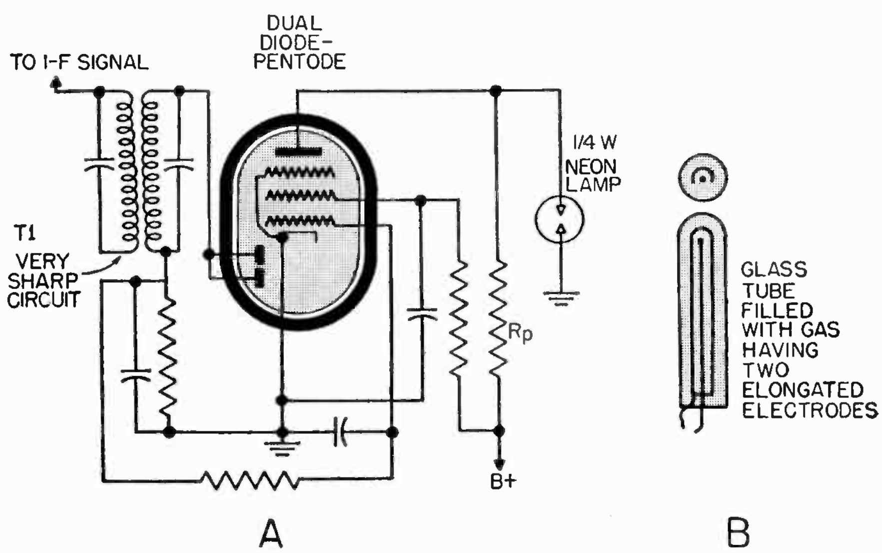

Fig. 2 A shows the circuit used in the neon lamp tuning indicator. B shows the construction of the gas tube used with the circuit shown in A. This type of tuning indicator was used widely.

Tuning Indicators

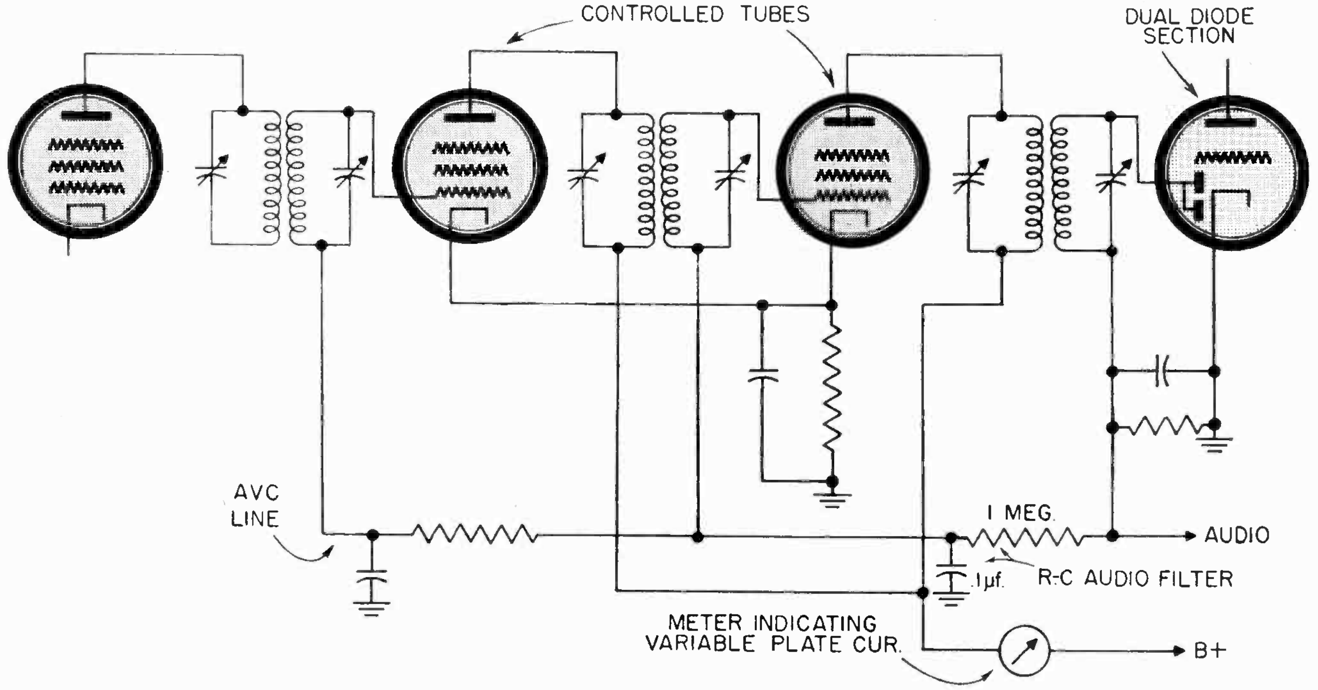

Fig. 3 The circuit used in the meter type indicator. This type of indicator was very successful and is still used in communication equipment.

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system was fairly cheap to use (Fig. 3).

In the shadow type of movements, a light bulb was placed behind a vane actuated by the movement. The vane was fixed so that it presented its length to the bulb off station and gave a maximum show. When a station was tuned in, the vane would turn, blocking off less and less light so that the shadow became a minimum at resonance. The shadow was cast upon a celluloid screen. This method was called "Shadowgraph" (Fig. 4B).

Another type was called "Target Tuning." In this case, the celluloid screen had a target outlined on it and a small round shadow would move up into the bullseye when the set was tuned to resonance. The shadow was made by attaching a small disc of light material to a balanced movement and having it intercept the light from a small bulb as above (Fig. 4C). Sometimes the lamp bulb was so placed that the shadow of a bent up needle would fall on a celluloid screen which had printed on it "Tune for Greatest Swing" with an arrow indicating the direction of swing.

As a whole, meters were very successful indicators and were used until the advent of the cathode-ray indicator tube. This device was purely electronic and had no mechanical moving parts. It became the best and most universally used method of visual indication.

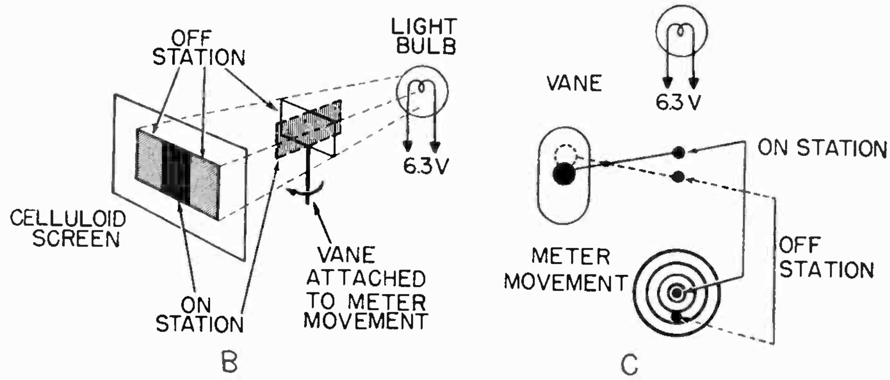

Fig. 4 The system illustrated in A is known as "Shadow tuning." The system in B is known as "Target tuning." Both are adaptations of the meter indicator method.

Cathode-Ray Tubes

The cathode-ray indicator tube (Fig. 5) consisted of a fluorescent screen material placed on a round disc and called the "target." This target was placed at the top of the tube and could be plainly seen through the clear glass top. The electron stream generated by the cathode was accelerated by putting a positive voltage on the target. This stream of electrons hitting the target caused the fluorescent material to glow a bright green color. A small plate called the "deflection plate" or "control plate" was placed so that it could affect about 90° of the target. A negative voltage on the control plate inhibited electron flow and when applied, gradually controlled an angle of 0° with positive voltage to a maximum of 90° with maximum negative voltage. The tube manufacturers supplied various types of these tubes and gave technical applications and voltages.

The most widely used type of electron-ray tube commonly called "Cat's Eye" or "Magic Eye" contained a triode section in addition to the target and deflection plate (Fig. 6). The deflection plate in this case was tied directly to the triode plate internally and the tube could be made to oper-

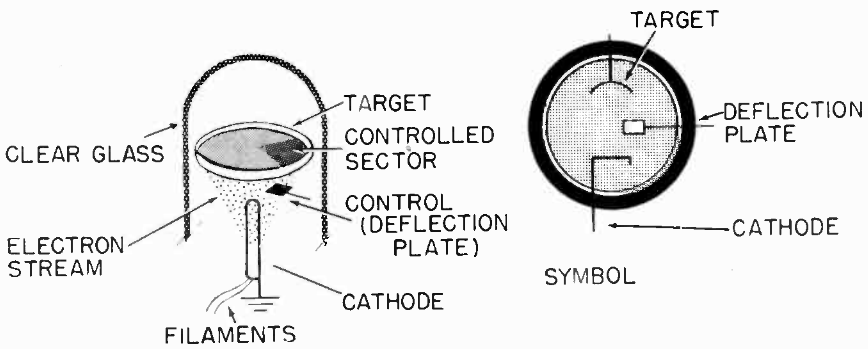

Fig. 5 The above figure shows the construction of the well known cathode-ray indicator tube.

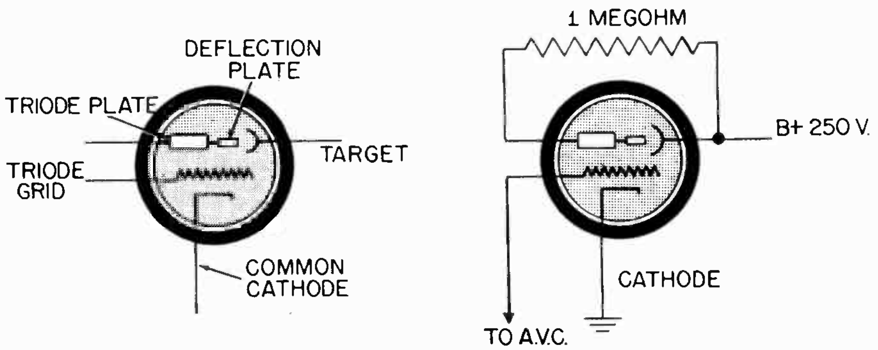

Fig. 6 The illustration on the left shows the elements used in the triode cathode-ray indicator tube. On the right is shown the circuit used with this type tube.

ate directly off the AVC circuit. The grid of the triode was coupled directly to the AVC line through a suitable filter system which from standard practice was a one-megohm resistor and a 0.1 ufd condenser. This filter was usually already in the receiver and the grid was connected to the correct point. The cathode of the triode was connected to ground so that all bias was obtained from the AVC voltage; the triode plate was connected to the positive B voltage through a one-megohm resistor (R_P); the target was connected directly to the positive B line. When the receiver was off station, no AVC voltage was developed and the bias voltage on the grid of the triode was zero volts; the plate current of the triode became a maximum (with this maximum a function of tube design), the drop across the plate resistor (R_P) became a maximum also with the actual plate voltage becoming very small.

Since the deflection plate was tied internally to the triode plate, the electron stream was cut off in the controlled sector and the fluorescent material showed a non-glowing sector of approximately 90°. When the receiver was tuned into a station, an AVC voltage was developed which began to bias up the triode section until, at cut-off for the triode, no plate current flowed; the plate current became a minimum, the voltage drop across the plate resistor (R_P) became a minimum, and the actual plate voltage a maximum. In turn the voltage at the deflection plate became a maximum, and the electron transit was accelerated in the controlled target sector so that it began to fluoresce. This change from a non-glowing to a glowing condition was very smooth and gave the appearance of an eye winking, hence the names of "Magic Eye" and "Cat's Eye."

Since the visual indicator told the set operator when a station was correctly tuned, it was now possible to tune into a station correctly without aural aid. Therefore, the output of the receiver could be turned off or a button incorporated which would short the audio section during tuning. This gave absolute silence between stations and added another gadget to promote sales (Fig. 7). This was used on many receivers.

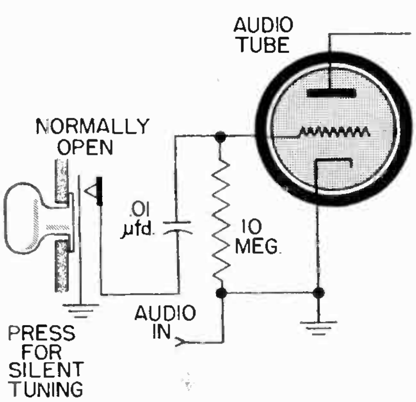

Fig. 7 The insertion of a switch in the input of the first audio stage makes possible a simple method of silent tuning.

This type of indication was suitable when a receiver had sharply selective circuits which gave a maximum indication at one point. However, when the manufacturers began to broaden out the response of the intermediate frequency system of receivers, the AVC voltage would hold up at a steady value over a considerable portion of the band and gave rise to some of the original difficulties. This indicator insensitivity was circumvented by warning the set user to tune the receiver in the sharp position and then —after tuning—broaden the response.

Not much mention need be made here of receivers which use push button tuning since indicators are not necessary under such conditions. The alignment of the push button settings can be done without an indicator by a trained serviceman who can detect side-band distortion. If the serviceman has a "tin ear," he can insert a meter which has an input impedance of at least a megohm into the AVC circuit and tune to greatest negative voltage. A milliammeter of about five to ten mils can also be inserted in the plate leads of the controlled tubes (or even only one of the controlled tubes) and tuned for minimum reading.

FM Receivers

Frequency Modulation receivers present a problem closely allied to that of the wide band AM receiver. Since an FM receiver should (at the present writing) have an IF response of plus or minus 75 kc of center frequency or a total band width of 150 kc, the method of using AVC voltage for indicator control would give a maximum indication of tuning over practically the whole band. The receiver could be tuned to a carrier anywhere in the band area and give a maximum AVC voltage. At this time it would be well to review the differences between AM and FM reception.

In amplitude modulation (AM) transmission, the carrier frequency is fixed while the modulating frequency is superimposed upon the carrier amplitude. The resulting modulated carrier varies in amplitude as the amplitude and frequency of the modulation vary. In detecting or

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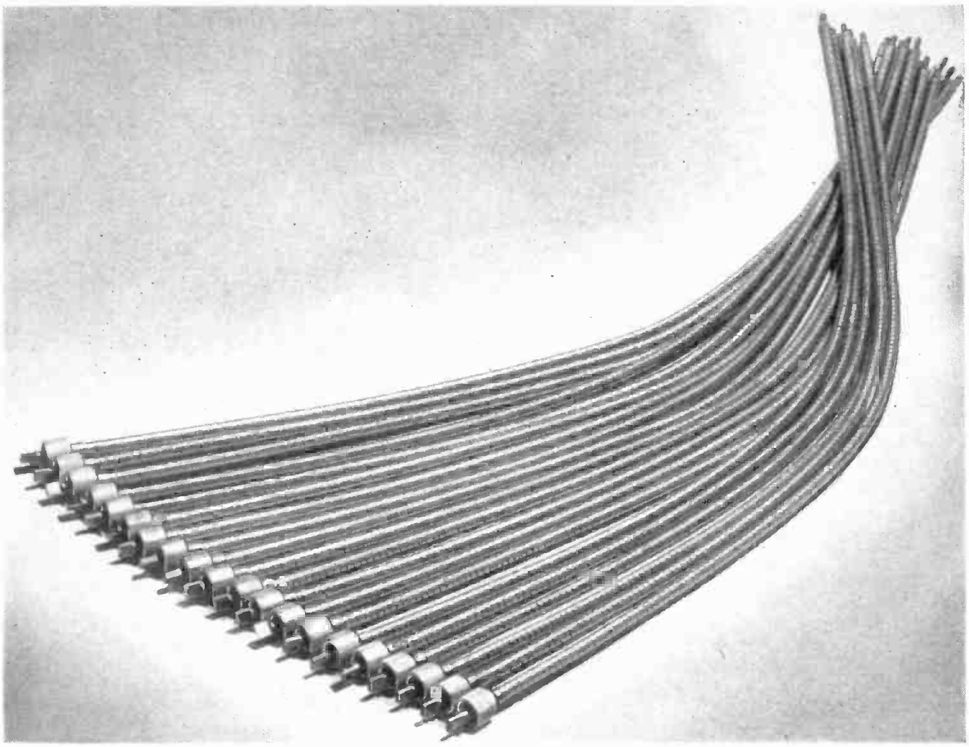

by Albert Lustig

REPLACING auto cables

A new tool designed to simplify the job of replacing and installing automobile radio remote control cables.

SINCE THE NEW AUTOMOBILES began to reach the public, there has been a steady increase in the quantity of auto radio repair and installation work being done. One of the most difficult operations in the repair and installation of automobile radios is the cutting and fitting of the control cables. While a satisfactory job can usually be done with conventional tools, a great deal of time is required.

Remote control cables are made from a tough steel which is very difficult to work with. In installing a cable, it must be swedged to prevent unravelling when it is cut (swedging consists of crimping). If the cable is not properly swedged before it is cut, it will unravel and become useless. A newly introduced tool, known as a Cable Replacer, greatly simplifies this and other operations necessary when installing new control cable.

The cable replacer consists of a heavy cast-iron base and three tool steel rods, as shown in Fig. 2. Each rod performs a separate function: One swedges the cables; the second splices the cable; and the third clamps the fitting on the cable end. The tool is heavily made to withstand the hard pounding it receives in use.

Remote cable comes in two diameters, .150″ gauge for the old type radios, and .130″ gauge for the latest models. Fittings come in a wide range of sizes and shapes; kits can be purchased which contain all of the ones commonly needed.

Fig. 1 Shafting, cables, and a few of the many types of cable fittings.

To use the Remote-O-Cable replacer, it is first bolted down to a work bench or other solid support. It should be bolted directly over a leg. Additional equipment needed consists of a sledge hammer and an ordinary hacksaw.

The first operation is swedging. The swedger has two jaws: One for the .130″ gauge, and the other for the .150″ gauge cable. The cable to be swedged is placed between either one of the two jaws, depending upon its size. The upper jaw of the swedger is brought down until it rests on the shafting, and the swedger pin is struck with a sledge hammer. The cable is then rotated one-eighth turn and the operation repeated. This results in a smooth multi-sided swedge approximately ¾″ long.

When the cable is properly swedged, it is placed in the cutter and the cutter pin is struck sharply with the

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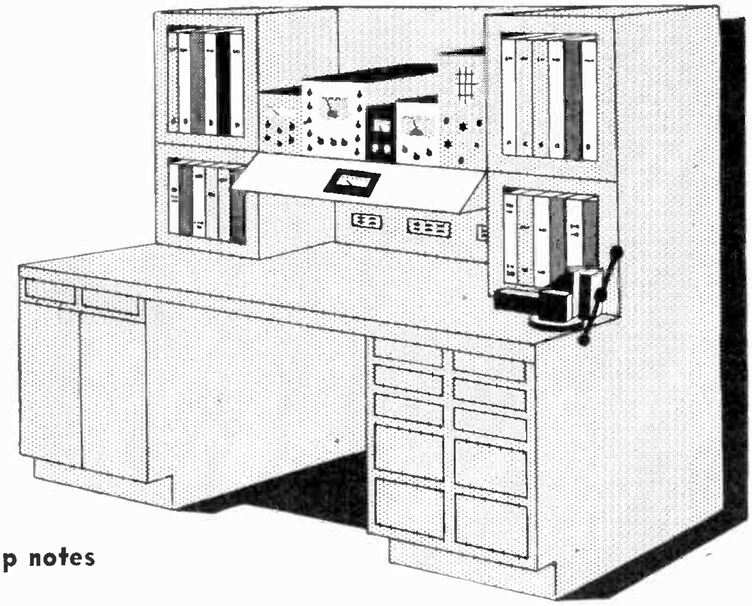
The Radio Service Bench



Case histories and shop notes

Max Alth

RCA 12X2

Fading:

Heat generated in the chassis causes the sealing wax to melt out of the audio coupling condenser, .01 ufd., between the 12SQ7 and the 50L6 output tube, with the leads consequently breaking off at the foil. Replace.

RCA PT 15

Weak:

Batteries check OK. Remove chassis and check for broken antenna lead. (This is the lead that is soldered to the metal tab that projects from the inside of the door through the front of the cabinet.) It should be extended.

Majestic 90 Series

Fading:

When everything else has been checked, remove the gang condenser and replace the fixed paper condensers found just below and connected in series with the stators.

An improvement in the tone quality of this set and a decrease of distortion on high powered local signals can be effected by rewiring the 27 grid leak detector system for cathode bias detection, and removing the DC current in the input side of the push-pull input transformer.

Short the grid leak out of the circuit and insert a 5000 ohm resistor, bypassed by a 1.0 ufd condenser (or larger) in the cathode circuit. Break the plate lead, and insert a .05 ufd condenser. Disconnect the other end of the input winding from B+ and ground the lead. Run a 50,000 ohm resistor from B+ to the plate of the 27 used as the push-pull driver. Replace the speaker with a PM, or if that is considered too costly, replace the old cone on the speaker with a new improved cone.

Majestic 91

Intermittent, noise when tuning dial is moved:

The pot on the rear end of the condenser gang shaft is worn and should be replaced. This control is inside the condenser housing, and its function is to reduce RF gain at the high end of the band. It should be replaced rather than shorted out of the circuit for, without it, it may be impossible to reduce high powered locals to room volume.

Motorola 51X12

Low frequency audio oscillation:

Increase the B+ output filter condenser by 20 ufd or more.

Mopar 600

Intermittent oscillator, on and off periods sometimes separated by as much as several weeks:

Tube checks OK. Replace the oscillator coil. A defective coil will not always show up on an ohmmeter test.

Silvertone 7081

Erratic oscillator:

Check oscillator grid bias resistor. It should be 22,000 ohms.

Farnsworth BT 22

Hissing, arcing noise on full volume:

Partially shorted output tube plate bypassing condenser. Replace with one of higher voltage.

GE 60

Set howls sympathetically with certain audio signals:

Check volume control for high resistance between shaft and collar. Speaker vibrations sometimes act upon this moving contact to make it a crude microphone.

RCA Phono Player Attachment, Synchronous Motor

Wows:

Remove, clean and polish turntable spindle. Grind a new bearing surface on the end that rests on the ball bearing. Lubricate and replace.

Philco 38-39

Slight distortion:

Voltages check OK. Realign with 'scope.

Motorola 65 BP Series

Where this set is used as a portable at a great distance from the station to be received, it is permissible to increase its RF gain by increasing the coupling between the 1P5GT RF amplifier and the 1A7 oscillator modulator. This is easily done by increasing the length of the twisted pair of wires (one is actually wound around the other) forming a 5 uufd coupling condenser. Increasing this coupling will, of course, decrease the selectivity of the set.

• • • •

There is nothing that will give a dirty old radio chassis that completely overhauled look more quickly than a good air blower. One can be rigged up from an old air compressor, or a commercially manufactured unit can be used.

• • • •

A better way of running bell wire, used for antenna and ground leads inside the home is to use furniture nails instead of staples. Drive the

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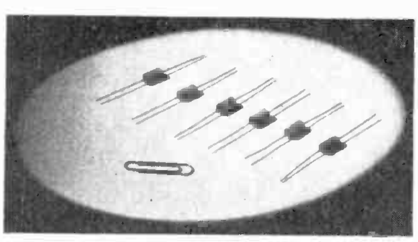
THE INDUSTRY PRESENTS

NEW RECEIVER LINE

Directed particularly to the needs of radio parts distributors and independent radio service dealers, the "Presentation Model," G-619, 6-tube AC-DC receiver is the first of a series of five diversified models soon to be announced by National Union Radio Corporation.

This first table model is housed in a mahogany all-wood cabinet. It employs a tuned RF superheterodyne circuit with broadcast band tuning and full vision slide rule dial scale. Chassis and component layout has been engineered to afford the maximum accessibility and simplification for rapid and easy servicing.

For further information, write National Union Radio Corporation, 57 State Street, Newark 2, N. J.

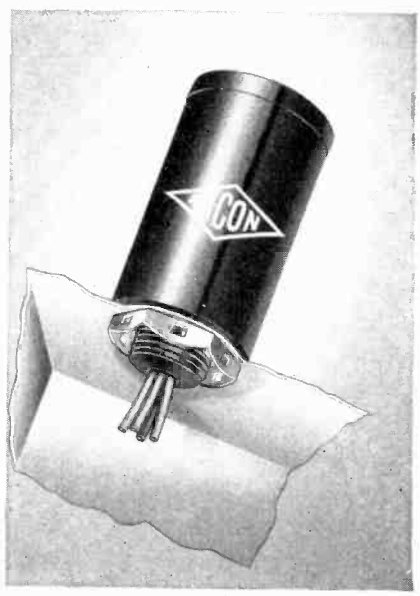


NEW CRYSTAL DIODE

A new germanium crystal diode, with a safe forward current of .05 amperes and a safe back voltage of 60 volts for radio and television receiver and other equipment applications, has been announced by the Specialty Division of the General Electric Company's Electronics Department.

Feature of the new diode, which will serve as a rectifier, modulator, detector or voltage regulator, is the point-to-plane contact between a micro-sharp platinum wire and the face of a specially processed germanium crystal. GE engineers say the new diode will handle higher voltages than any of its type.

Further information may be obtained on request to the Specialty Division, GE Electronics Department, Wolf Street Plant, Syracuse, N. Y.



PLASTIC CAPACITOR

Just announced is a new small size AMCON plastic capacitor, 2⅛″ high and with a diameter of 1⅜″. It is specifically intended for top chassis mounting. Self-insulating because of its molded plastic case, the unit resists high temperatures and has a wide climatic range.

Additional information about the AMCON LITTLE PL may be obtained from the American Condenser Company, 4410 North Ravenswood Ave., Chicago 40, Ill.

SIGNAL TRACING ANALYZER

Called an electronic "Stethoscope," the new TS-2 Signal Tracer Analyzer cuts servicing time to a minimum. It "listens" for trouble at any point in a radio circuit, isolates and locates the cause quickly. It has built-in high impedance isolation network. By touching bakelite probe to any signal circuit, the signal is heard in speaker or headphones, or is visible on output meter.

The TS-2 Professional Signal Tracer Analyzer is contained completely in a handsome metal portable case with handle, and weighs only 10½ lbs. with batteries. It uses low-drain tubes and economical battery supply, and has a built-in 5″ PM dynamic speaker.

Complete details may be obtained from the Feiler Engineering Co., Dept. RM, 803 Milwaukee Ave., Chicago, Ill.

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the recognized PRODUCTS

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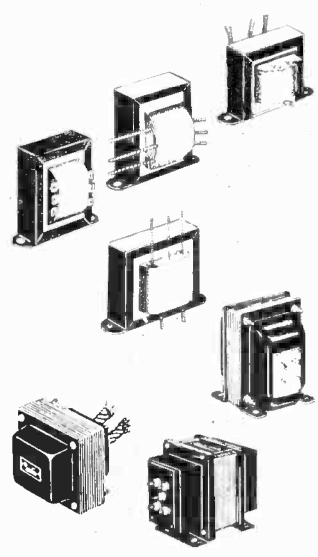
Addison-Elston and Kedzie Avenues
Chicago, Illinois

the Standard of PERFORMANCE
that assures you of Satisfied Customers

To serve you better in 1947, we add new streamlined plant facilities. Now, more than ever, you can look to Stancor for the complete selection of Replacement and General Purpose Transformers proven in performance to give your customers lasting satisfaction.

Stancor's highest standard of product performance, advanced designs and universal application will continue to make Stancor your favorite . . . will continue to help you build your reputation for dependable, satisfactory service.

Yes, Stancor has the PLANT . . . the PRODUCTS . . . and the PERFORMANCE . . . to help make your service business bigger and more profitable in 1947.



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Tuning Indicators

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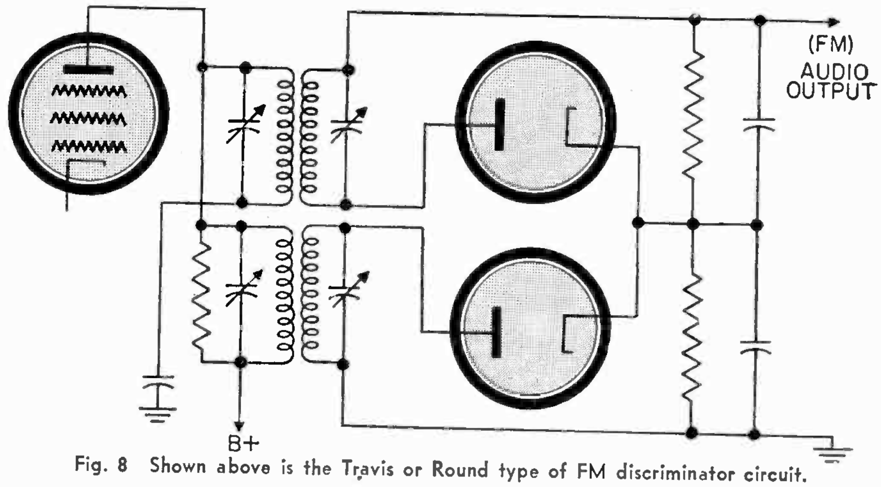

Fig. 8 Shown above is the Travis or Round type of FM discriminator circuit.

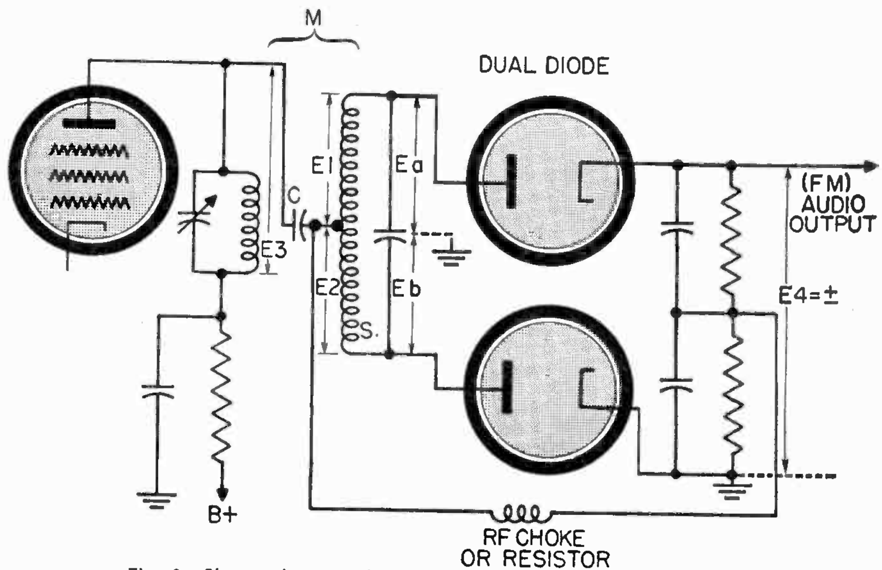

Fig. 9 Shown above is the Foster-Seeley type of discriminator.

rectifying this composite carrier, a device is used which separates the high carrier frequency from the relatively low modulating frequency. Since the amplitude of the carrier varies as the "amplitude and frequency" of the modulating voltage, a selective circuit must be used which has a band width of twice the highest frequency to be transmitted. That is, in order to transmit 5,000 cycles (5 kc), a band width of plus and minus 5 kc is required, or in other words a band width of 10 kc. Thus a receiver having a band width of 10 kc is theoretically limited to a maximum high response of 5 kc. However, most manufacturers do not confine their receivers to this strict limit but extend it somewhat so that more than 5 kc response is possible on better receivers. An important thing to remember is that band width does control the highest frequency obtainable, both in transmitting and receiving.

In frequency modulation (FM) transmission, the carrier frequency swings above and below a fixed point. The amount of swing corresponds to amplitude and the rate of swing corresponds to the frequency of modulation. At first glance this might appear confusing, but consider a sine wave of 60 cps: If the sine wave is expanded in amplitude, the form of the sine wave appears to change at any specific point on the wave but the angular rotation remains a constant and the wave is still a sine wave. The increased amplitude of the 60 cycle sine wave will not make it sound like a different frequency—only louder. You might consider AM as varying in a vertical axis for frequency, while FM varies in the horizontal axis for both amplitude and frequency and any variation in the vertical axis is undesirable.

Since FM should not have any amplitude differences, a system of detection must be used which will be sensitive to frequency differences. Such a device is called a frequency detector or frequency discriminator. Two types of discriminators have been used: (1) the Round (Travis) circuit, and (2) the Foster-Seeley circuit.

The first circuit (Fig. 8) has two loosely coupled circuits, one being tuned slightly above and the other slightly below the desired center frequency. Each circuit has its own diode detector and the diodes are connected in DC opposition. The output is taken off the common diode load so that at center frequency no voltage is developed due to cancellation. When the frequency varies either above or below the center point, the efficiency of one of the circuits rises while the other lowers, giving either a positive or negative voltage respectively. If a frequency modulated carrier is introduced into the system, as the carrier swings above and below center frequency, the rate of swing is recorded as frequency and the amount of swing as voltage.

The most popular of discriminator circuits is the second or Foster-Seeley circuit (Fig. 9). This circuit depends upon the phase difference which exists between the primary and secondary circuits in loosely coupled (M) double tuned circuits at the resonant frequency. A 90° difference exists between two double tuned circuits at resonance, and this angle varies as the frequency moves either above or below resonant frequency. Likewise, if one of the tuned circuits (S) has a center tap, the potentials at the ends of the circuit (or coil) are 180° out of phase using the center tap as a reference point. If the center tap is coupled back to the plate end of the primary (P) by means of a condenser (C), the phase angles can be so related that the resulting voltages will cancel at resonance and increase in opposite polarities as the frequency moves either above or below center frequency (Figs. 10 and 11).

The second circuit is easier to align since all adjustments are made at a single center frequency. If a sweep-frequency oscillator is not obtainable, a single frequency oscillator can be used and the secondary tuned to a null with the carrier set at the center (or resonant) frequency. Then the primary is adjusted by making the discriminator output voltages equal

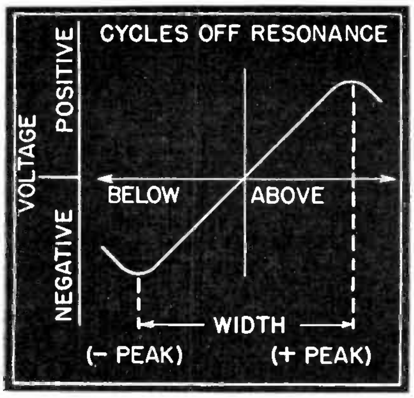

Fig. 10 The above curve shows the effect that a change in input frequency has upon the output voltage of a Foster-Seeley discriminator.

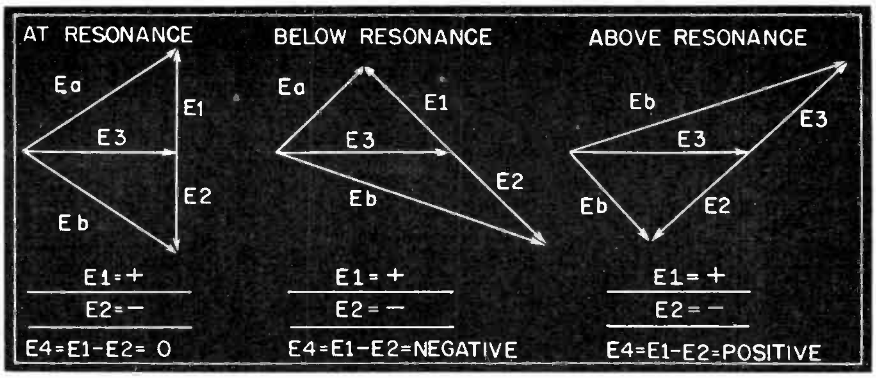

Fig. 11 The above vectors graphically illustrate the electrical changes which take place in the discriminator circuit as the frequency is varied from one side of resonance to the other. The voltages represented are shown in Fig. 9.

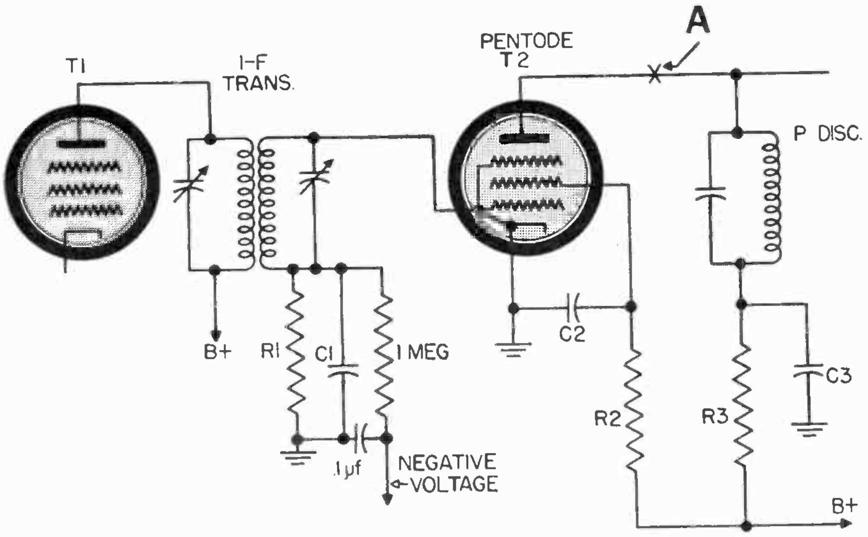

Fig. 12 The typical limiter circuit R1 and C1 control the time constant. C2 and C3 are bypass condensers. R2 and R3 control the limiter output amplitude. A second limiter can be inserted at point A.

and opposite in polarity for equal additive and subtractive amounts of excursion from the center frequency at set points over the discriminator range.

It was stated above that any amplitude variation is undesirable in FM reception. If two stations are tuned in one after the other with the output level set for the first, and the carrier amplitudes varied by a ratio of ten to one, the resulting volume in the receiver will be in the same ratio. Likewise, if static or man-made noise should amplitude modulate the carrier, the noise would be detected in the discriminator since the discriminator is susceptible to some amplitude detection. This effect is eliminated by using a "limiter" circuit which keeps the carrier input to the discriminator at a constant level. This is done by supplying much more signal to the limiter circuit than can be used. The limiter clips the excess off and passes the clipped level input to the discriminator. This does not cause any distortion (as it would in AM) since the frequency and rate of change of the carrier is unaffected and the discriminator is primarily sensitive to frequency.

The limiter is usually a pentode with the plate and screen currents limited to a low value to protect the tube since it operates entirely on self bias which it obtains through a resistor-condenser combination (Fig. 12). This bias is a function of signal (carrier) level and keeps the limiter output at a constant level, just as AVC does in the RF stage in AM. This bias is negative and consequently can be used as an AVC voltage for controlling the IF stages of the FM receiver. It must be remembered that this voltage holds up over the band width of the IF circuits which is 150 kc. Thus it cannot be used directly to indicate resonance or center frequency.

The discriminator output varies from positive to negative or vice-versa while the limiter voltage stays negative at a level value. At center frequency, the DC developed at the discriminator is zero. Thus the discriminator voltage can be used to indicate exact resonance. If a meter with a centered needle is placed in the discriminator circuit, it will swing negative or positive when the set is tuned slightly below or above center frequency, going through zero when the receiver is exactly on center frequency. Such meters are being used as visual indicators on FM receivers and give very sharp indications of resonance. However, these meters have to respond to only small amounts of current and microammeters are expensive. The voltage is less than ten volts and sometimes less than two. To give an indication of only two volts *without loading the discriminator circuit*, means that a high value of resistance must be placed between the meter and the discriminator circuit, and the meter itself must give an indication of around one microampere and can have a maximum value of 100 microamperes for full scale deflection if a sensitive null indication is desired without introducing distortion.

A magic eye can be used by taking advantage of all the DC voltages developed in tuning. The discriminator voltage must be changed so that it will be positive on both sides of the center frequency and when this is bucked against the negative limiter voltage, the following results: At resonance the positive transposed discriminator voltage cancels and the limiter voltage makes the resultant negative; either slightly above or below resonance, the transposed positive discriminator voltage bucks the limiter voltage making it less negative. When

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Tuning Indicators

this resultant voltage is placed on the grid of an electron-ray indicator tube, it acts exactly like the AVC voltage in an AM receiver and gives a very sharp indication (Fig. 13).

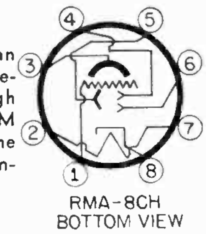
New Indicating Tube

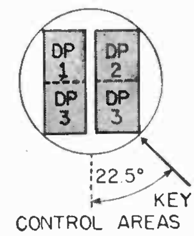
Recently, G.E. and Raytheon announced a new tube Type 6AL7-GT which may solve many of the former problems of getting a sharp indication of tuning on FM. It is an electron-ray tube containing a triode and three deflection plates. The principle of operation is similar to the Magic Eye with the exception that the grid of the triode section can be used to control the brightness of the fluorescent target so that the target beam can be turned off when the set is tuned off any station and will glow when a station is tuned in. A squelch circuit can be used which will furnish a negative bias to the grid when the set is off station and will remove the bias when the set is tuned into a station. This will control the target glow. This is just an added feature, a gadget for sales appeal.

The tube can be used as a regular indicator device by connecting the grid back to ground or to cathode, and connecting the three free deflection plates in any combination as desired. The fluorescent area of the tube is

TYPE 6AL7-GT ELECTRON-RAY INDICATOR
General Description

Principal application: The 6AL7-GT is an electron-ray tube indicator designed especially for use in FM-AM receivers. Through its use, precise tuning of either FM or AM signals is easily accomplished without the use of additional tubes or circuit components.





Cathode	Coated unipotential
Heater Voltage	6.3 volts
Heater Current	0.150 amperes
Envelope	T-9 glass
Base	B8-6 8-pin octal
Base material	Black phenolic
Mounting position	Any

Characteristics and Typical Operation
Indicator Service

Heater voltage	6.3 volts
Target voltage	315 volts (max.)
Deflection electrode #1 voltage	0 volts
Deflection electrode #2 voltage	0 volts
Deflection electrode #3 voltage	0 volts
Cathode resistor (approximate)	3300 ohms
Deflection sensitivity (approx.)	1.0 mm/volt
Fluorescent cut-off grid volts*	—6.0 volts

* The grid should be connected to the cathode when not used for fluorescent control.

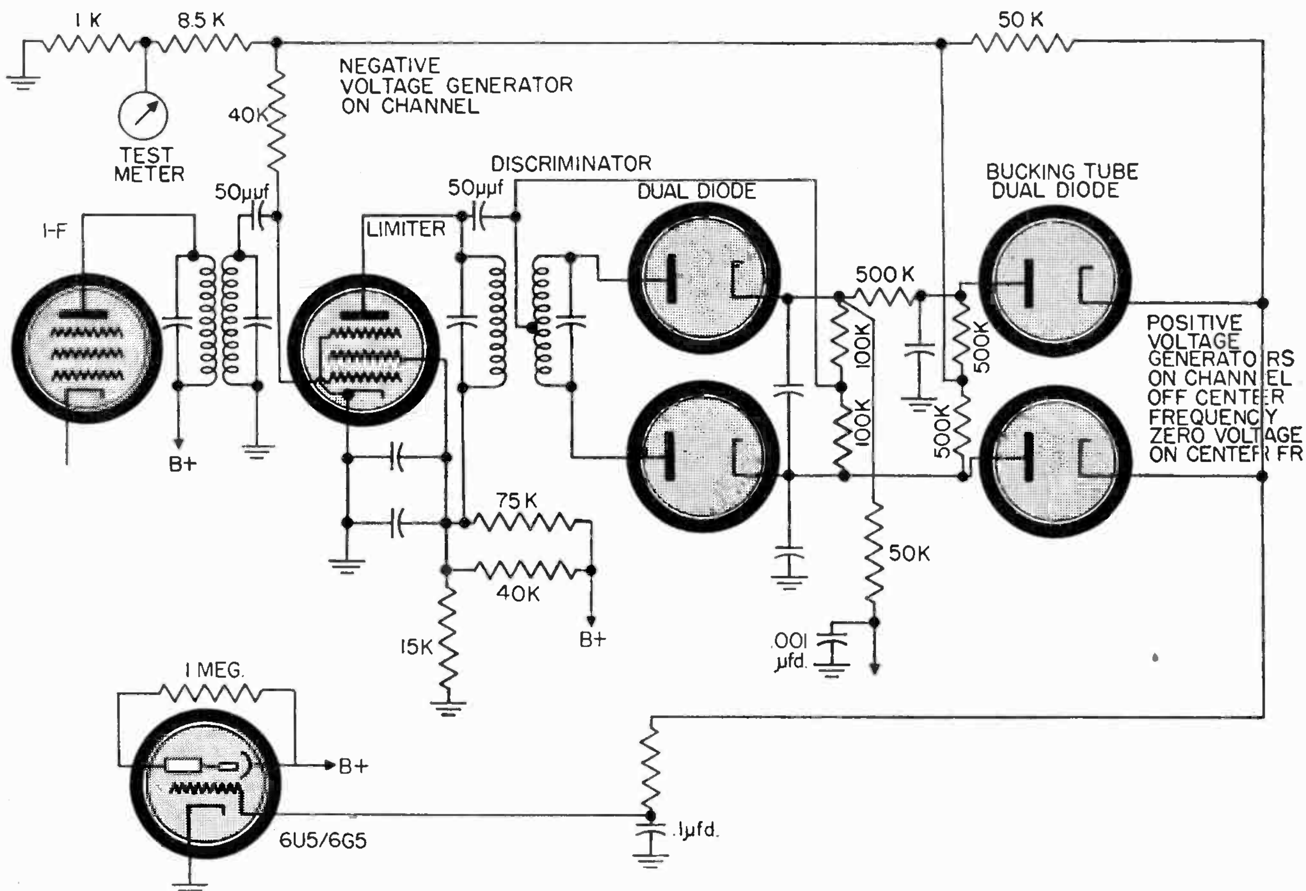


Fig. 13 A tuning indicator circuit designed for use in FM receivers.

shaped like a rectangle with the controlled areas being roughly the two top quarters and the lower half of the rectangle. For convenience, the areas controlled are shown as quarters. Actually, the tube is divided into vertical halves (see characteristics chart).

Since it is possible to vary any one of the areas independently of the others, the plate of the area to be varied can be connected directly to the discriminator output and the glow area will elongate with positive voltage and shrink with negative voltage, and at zero voltage (center frequency or no station) will balance with the other areas whose plates are at zero potential (Fig. 14, circuit 1 & 2). Thus, the stationary area acts as a reference.

With the above circuit, tuning away from or into a station has the same effect if the maximum negative or positive frequency peak is used as the point of reference (See Fig. 10). To eliminate this difficulty and thereby make possible the addition of silent tuning, the grid can be used in conjunction with a squelch circuit as stated above (Fig. 14, circuit 3).

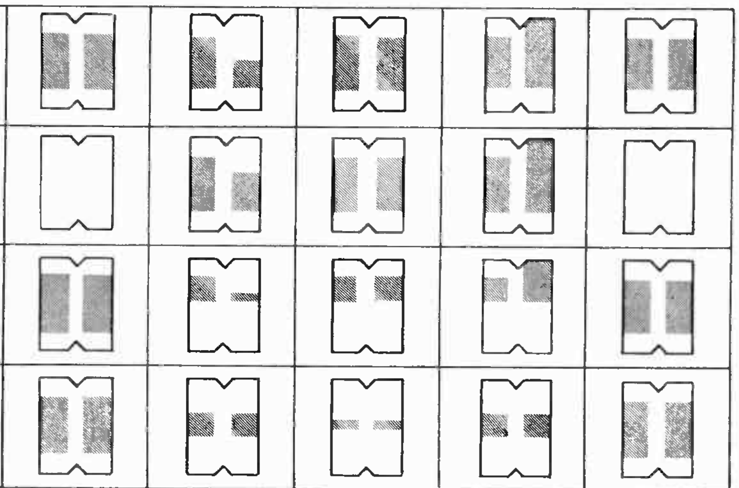
Another way of accomplishing the same result without having to add a squelch circuit is to use the two bottom areas which are controlled by one plate, connecting them to the limiter voltage. The limiter voltage starts to develop as a station is approached; this negative voltage causes the bottom areas to shrink and this in addition to the effect of circuit 1 or 2 gives complete indication of approach, exact tuning, and no station (Fig. 14, circuit).

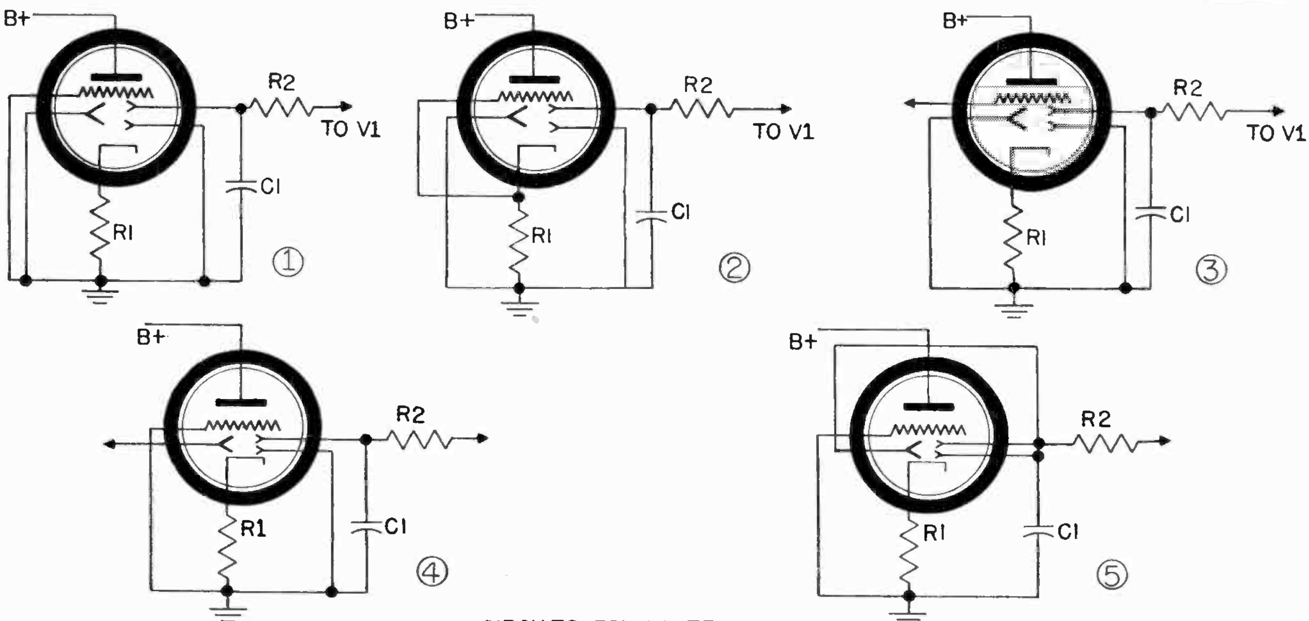
The indicator can be used in the usual manner on AM (Fig. 14, circuit 4) and both bottom and top of the indicator shrink toward the center as resonance is approached and regain full size off station.

In conclusion, it may be said that the field of indicators is far from exhausted and that manufacturers will meet new challenges with more and better indicators. ✓ ✓ ✓

PATTERN SEQUENCE DURING TUNING

CONTROL VOLTAGE SOURCE	SIGNAL	CIRCUIT	OFF CHANNEL (−)	ON CHANNEL (−)	ON TUNE	ON CHANNEL (+)	OFF CHANNEL (+)
DISCRIMINATOR	FM	1 & 2					
DISCRIMINATOR & SQUELCH	FM	3					
DISCRIMINATOR & LIMITER	FM	4					
AVC	AM	5					





CIRCUITS FOR PATTERNS

Fig. 14 The circuits used and the patterns obtained during tuning, with the new tuning indicator tube.

B+ — 250 VDC
E_f — 6.3 VAC
R_1 — 3300 Ohms
R_2 — 1 Megohm
C_1 — .05 ufd

V_1 — Output voltage of the discriminator
V_2 — Voltage developed by squelch circuit
V_3 — Voltage developed at limiter grid
V_4 — AVC voltage developed by diode

ELECTRONICALLY SPEAKING

GOVERNMENT estimates place the industry's present potential set output at approximately 24,000,000 per year.

Du Mont plans to deliver more than seven million dollars worth of television receivers by the end of the year. According to Mr. Levaur, "public interest in television reaches a new high each month and manufacturers will experience difficulty in maintaining deliveries to satisfy demands.

In the first half of 1946, 85,470,800 tubes were made. In June, 17,979,636 tubes were shipped, compared with 12,722,188 in June, 1941. If this rate continues, the tube shortage will soon be over.

A number of new standards which will result in the simplification of many servicing problems have been established by the RMA. Among them are: A standard color coding for all set wiring, 10.7 megacycles as the intermediate frequency for all VHF broadcast receivers, 300 ohms as the characteristic impedance of television receiving antenna transmission line, and a set of dimensional characteristics for drive pulleys.

After nineteen years in South Bend, Indiana, Electro-Voice, Inc., microphone manufacturer, has moved to Buchanan, Michigan. All the facilities of the three South Bend plants are combined in one modern factory nearly an acre in size.

Complete development and manufacturing processes, from the raw materials to the finished products, are now centralized under one roof, including die-casting equipment and a unique non-echoing sound room.

RCA Victor's initial post-war television home receivers have now been shown to the company's television set distributors. Limited quantities of two of the new models shown are planned for delivery to dealers' stores for sale to the public early in November, according to Joseph B. Elliott, Vice President, RCA Victor Home Instruments.

Allen B. DuMont Laboratories, Inc., recently gave its first Familiarization Course to the servicemen of its franchised dealers, in the studio at 515 Madison Avenue, New York.

A written examination was held a week prior to the course and no candidate was admitted without passing the preliminary test successfully. The course deals with general principles, adjustments, maintenance and installation, as applied to DuMont postwar telesets.

This training will continue as more franchised dealers and their servicemen appear with the spread of television, says Ernest A. Marx who heads the television set activities of DuMont.

A new mobile radiotelephone highway service will be inaugurated upon the completion of an initial test period. Subject to the FCC's licensing, the service will operate in the 30-44 mc band, permitting travellers on or in the vicinity of the Boston Post Road to carry on radiotelephone communications while enroute.

Six RCA 250-watt land transmitters will be used in the New England link of the Bell System's proposed radio telephone network. They will be installed at New York City, Mt. Kisco, New Haven, New London, Providence and Boston. Each of these fixed installations will also include a lower power transmitter to be used for testing to assure continuity of service. In addition, the Bell companies are installing appropriately spaced land receivers so that, at every point along this busy highway, vehicles equipped with radiotelephone will be within range for both transmission and reception.

RCA mobile radiotelephone equipment is being supplied to the Bell System, and will be installed in subscribers' cars. The units provide 30 watts of FM output and are designed for easy installation in the trunk or other suitable space of a motor vehicle. A ship-type antenna can be mounted on either the side or the roof of the vehicle.

Deliveries of similar equipment for a proposed New York-Albany-Buffalo link in the Bell network are scheduled to begin in the near future.

Prices will not rise because price controls have been removed from radio sets, according to R. C. Cosgrove, President of the RMA. Mr. Cosgrove states that the industry will now be able to resume its normal highly competitive pre-war practices under which radio prices steadily were reduced with quality improved.

Television receiver production has

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PLEASE PLACE YOUR ORDER WITH YOUR REGULAR RADIO PARTS JOBBER. IF YOUR LOCAL JOBBER CANNOT SUPPLY YOU, KINDLY WRITE FOR A LIST OF JOBBERS IN YOUR STATE WHO DO DISTRIBUTE OUR INSTRUMENTS OR SEND YOUR ORDER DIRECTLY TO US.

The New Model CA-11

SIGNAL TRACER

Simple to operate . . . because signal intensity readings are indicated *directly on the meter!*

Essentially "Signal Tracing" means following the signal in a radio receiver and using the signal itself as a basis of measurement and as a means of locating the cause of trouble. In the CA-11 the Detector Probe is used to follow the signal from the antenna to the speaker—with relative signal intensity readings available on the scale of the meter which is calibrated to permit constant comparison of signal intensity as the probe is moved to follow the signal through the various stages.

NOW AVAILABLE FOR IMMEDIATE DELIVERY!

The Model CA-11 comes housed in a beautiful hand-rubbed wooden cabinet. Complete with Probe, test leads and instructions. . . Net Price **$18.75**

Features

- ★ **SIMPLE TO OPERATE—only 1 connecting cable—NO TUNING CONTROLS.**
- ★ **HIGHLY SENSITIVE—uses an improved Vacuum Tube Voltmeter circuit. Tube and resistor-capacity network are built into the Detector Probe.**
- ★ **COMPLETELY PORTABLE—weighs 5 lbs. and measures 5" x 6" x 7".**
- ★ **Comparative Signal intensity readings are indicated directly on the meter as the Detector Probe is moved to follow the Signal from Antenna to Speaker.**
- ★ **Provision is made for insertion of phones.**

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The Oscillograph

. . . how it works

→ From Page 11

apparatus. It is possible to build or purchase a unit called an "electronic switch," which enables two signals to be viewed on the cathode-ray screen simultaneously, either separated or on top of each other. In this way, relative phase shift between two sine waves can quite readily be observed. This additional equipment, however, is quite expensive and is not absolutely necessary. The method to be described is just as effective in securing the desired information.

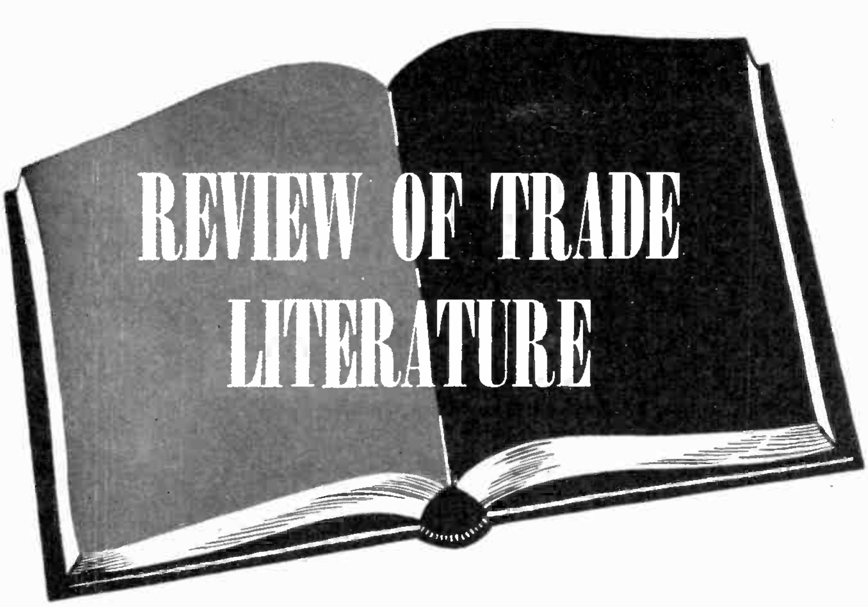
With set-up B in operation, set the frequency to 1000 cycles and observe the wave-form closely. If the 45° line is a pure straight line, there is no phase shift. If the line is slightly opened to form a thin ellipse, phase shift is present. The amount of phase shift can roughly be determined by comparison with the curves in Fig. 6 of the first article of this series (September 1946 issue of RADIO MAINTENANCE). This sketch showed curves, "Lissajous Figures," obtainable with different degrees of phase difference between the signal on the vertical plates and that on the horizontal plates. It will be noted from this figure that a phase shift of only 45° results in a fairly wide-open ellipse. Hence, a thin ellipse which is almost a straight line represents a phase shift on the order of 10°. See Figs. 6A and 6B.

In any case, it is not phase shift in itself which disturbs us, but a difference in phase with frequency. Thus an amplifier is satisfactory if it has zero phase shift over the pass-band of frequencies, or if it has the same amount of phase shift for all frequencies. Thus, whether there was zero or some finite phase shift at 1000 cycles, carefully adjust the tuning dial of the oscillator to the low-point frequency obtained in (1) above (the test for the band-pass of the amplifier). Starting at that frequency, gradually increase until the upper limit of frequency obtained in (1) is reached, carefully observing the phase-shift pattern on the oscilloscope screen while changing frequency. If the phase shift is zero throughout, or varies over extremes which do not exceed 30°, the amplifier can be considered satisfactory from the standpoint of phase.

General Remarks

It is well to conclude this section with a few reassuring comments, in case the tests just described seem to represent too much fussing with audio amplifiers. Actually, all that has been described is absolutely necessary to gain a true picture of the performance of a given amplifier. With magnificent radio sets coming on the market now and about to appear in huge numbers, with FM receivers, high quality phonographs, and television with its associated FM sound channel, it is essential that good audio systems be maintained in their original condition. In the final analysis, it is the sound that hits the ear (as in television the picture that strikes the eye) which furnishes our sole means of judging the performance of a piece of electronic equipment, whether it be a huge public address system or a superlative combination radio set.

EDITOR: The next article will cover methods of using the oscillograph to align IF stages in a receiver, and other miscellaneous uses.



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A RECENTLY ANNOUNCED BOOKLET entitled, "How to Install Federal's Miniature 5-Plate Selenium Rectifier," and other literature on installing and selling the new rectifiers are available on request from the Federal Telephone and Radio Corporation. The booklet is well illustrated and gives a step-by-step procedure for installing the rectifiers in place of the various vacuum tubes now in use. This information is of interest to every radio serviceman.

To obtain your copy, write to Federal Telephone and Radio Corporation, 200 Mt. Pleasant Avenue, Newark 4, N. J.

A new catalog has been announced by the Metropolitan Electronic and Instrument Company. It lists a wide variety of test equipment for use in radio servicing. To secure a copy, write to the Metropolitan Electronic and Instrument Company, 6 Murray Street, New York 7, N. Y.

The United Transformer Company has released a revised catalog and price list covering their complete line. The catalog contains listings on a wide variety of transformers, reactors, voltage control units, equalizers and filters.

To secure a copy, write to the United Transformer Company, 150 Varick Street, New York, N. Y.

A revised edition of the General Cement catalog No. 147 is now available. The 24-page booklet contains hundreds of popular servicing items, such as radio cements, polishes, varnishes, cleaners, knobs and accessories, phono needles, dial belts, tools, testers, switches and radio hardware.

A copy of Catalog No. 147 may be had free of charge by writing General Cement Mfg. Co., Rockford, Ill.

Two Shure 1946-47 catalogs have come to our attention. Catalog 155 illustrates their line of microphones and features an article on selection of the proper microphone, covering requirements, types, polar response, characteristics and frequency response.

Catalog 156 covers "Glider" crystal phonograph pickups and lever-type cartridges, as well as giving information on needle-point compliance, tracking angle, type of needle, amplifier input circuits, etc.

For these catalogs, write Shure Brothers, 225 West Huron St., Chicago 10, Ill.

A four-page bulletin on the JFD adjustable AC-DC ballasts has been released, giving the salient features of Types A and B (both 8-prong) and Type C (4-prong). It contains a chart for replacement of AC-DC resistance tubes. For your copy, write J.F.D. Manufacturing Co., 4111 Ft. Hamilton Pkwy., Brooklyn 19, N. Y.

A Reference Guide for Miniature Electron Tubes has just been issued by Hytron Radio & Electronics Corporation, giving extensive data on fifty-six different types. In addition to the chart, basing diagrams are shown, giving bottom views of socket connections.

For the Reference Guide, write

→ To Following Page

Trade Literature

→ From Preceding Page

Hytron Radio and Electronics Corp., Salem, Mass.

A 16-page catalog highlighting the line of Scenic Radio & Electronics Co., is just off the press. It contains some of the latest developments in both the test equipment and sound apparatus fields, including volt-ohm-milliammeters, signal generators, tube testers, oscilloscopes, vacuum tube voltmeters, signal tracers, audio amplifiers, automatic record changers, microphones, radio text books, etc.

A free copy of the booklet will be forwarded on request to Scenic Radio & Electronics Co., 53 Park Pl., New York 7, N. Y.

A handy chart for the proper selection and installation of Public Address systems has been published by the Mark Simpson Manufacturing Co. The reverse side of the chart gives information on impedance matching of speakers, speaker phasing, selection of speakers and microphones, feedback elimination, etc.

To obtain a copy of the chart on sound systems, address Mark Simpson Manufacturing Co., Inc., Long Island City, N. Y.

A brochure, "School Sound Systems," has been issued by a joint committee of the RMA and the U. S. Office of Education, as a result of an extensive study on school audio-equipment needs. It is an excellent guide to the planning and installation of varied types of central radio-sound systems and classroom equipment.

While the use of radio in schools has increased greatly in recent years, widespread use of various types of radio producing and recording equipment is just getting started and will doubtless provide profitable new pastures for the radio serviceman.

The contents include: Basic standards for equipment, specifications for school sound systems, and installation considerations.

Single copies of "School Sound Systems" are available by writing to the Radio Manufacturers Association, 1317 F Street, N.W., Washington, D. C.

Books

RADIO TUBE VADE-MECUM, by P. H. Brans, Price $2.50, is a complete compilation of vacuum tube ratings and characteristics, covering most of the tubes manufactured throughout the world. It covers American, British, German, Italian, French, Russian and other types. A substitution chart and a special listing of Allied, German and Italian Army tubes are also included. This book is undoubtedly the most complete listing of vacuum tube data ever published.

It is published in Belgium and is distributed in the United States by Editors and Engineers, Ltd., 1300 Kenwood Road, Santa Barbara, California.

COMMUNICATION THROUGH THE AGES, by Alfred Still, published by Murray Hill Books, Inc., $2.75.

This is the story of communication from sign language to television, written in a simple, interesting style. Though early forms of communication are discussed, the emphasis of the book is upon communication since the end of the eighteenth century, which marks the first attempts to utilize electric sparks for long-distance communication.

An interesting chronological table gives key dates in the history of communication, with major stress on events surrounding the telegraph, telephone, radio-telephony and television.

RADIO'S CONQUEST OF SPACE, by Donald McNicol, published by Murray Hill Books, Inc., $4.00.

This book, without mathematics, presents a narrative of how radio started and how it grew, with a broad picture of how it operates. Principally, however, it is a personalized history of radio. Its most interesting feature is its account of the contributions of individuals to the perfecting of radio communication.

As the author constructed the first experimental wireless transmitter and receiver in the Midwest in 1900, and has been active in the field ever since, many of the great figures in radio about whom he writes are personally known to him, and his personal recollections add much to the book. ✓ ✓ ✓

Electronically Speaking

→ From Page 24

finally gotten under way with 3,242 units produced in September, as against a total of 225 for the previous eight months. Most of the sets being produced are of the video radio-phonograph combination class with direct viewing. Production of FM receivers and AM consoles is rising steadily while the production of table models, although still high, is tapering off. ✓ ✓ ✓

The R-F Section

→ From Page 7

high frequency is picked up. If no oscillations are generated, the oscillator tube and wiring should be checked. On the other hand, if the oscillator is functioning, the trouble will lie in the RF amplifier (if one is present) or in the tuned RF circuits. Test the RF tube and associated circuit wiring. If any changes are required, the circuits should be realigned as shown in the method of Fig. 6. The test signal is inserted at the antenna terminals and the output checked first at the grid of the RF amplifier and then at the plate of the first detector. With the sweep frequency generator set for the channel under test, the overall pass band of the RF circuits will be shown on the oscillograph and should have a wave form similar to that shown in Fig. 7. (The manufacturer's service notes should be consulted for the exact shape of the RF pass band.) Marker frequencies in the sweep generator, or applied externally from a signal

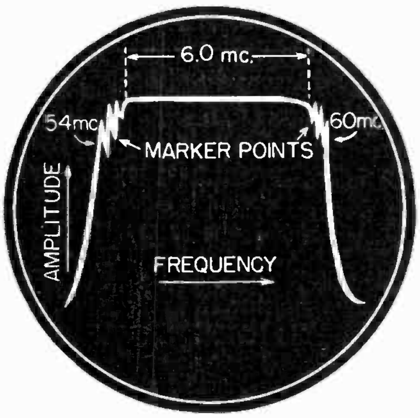

Fig. 7 The pattern obtained using the sweep generator when the RF circuit is tuned to pass a 6-megacycle band. The markers indicate the frequency limit on the curve.

generator, will indicate the band width of the circuit and will appear as pips on the oscillogram. The RF coils are adjusted until the desired band pass is obtained. The procedure is then repeated for all other channels.

These are the common faults to look for in the RF section. When the trouble has been corrected, the receiver should be given an on-the-air test at the shop and then returned to the owner's installation for a final performance check.

Next issue, we will take up the problems associated with the trouble-shooting of the video channel. ✓ ✓ ✓

Industry Presents

→ From Page 18

WIRE STRIPPER KIT

The insulation of any wire from size 8 to 30 can be stripped quickly with the new Speedex 733-K stripper kit. It makes possible the rapid stripping of wires in a neat manner, and seven interchangeable blades are put up in a permanent steel case small enough to be conveniently carried in a tool box.

Speedex Wire Stripper Kits are manufactured by the General Cement Manufacturing Co., 919 Taylor Ave., Rockford, Ill.

HIGH ENERGY BATTERY

A new "Eveready" high energy dry cell battery with twice the capacity of present battery has been announced. It will provide longer playing time per power unit for small personal radios, longer life in flashlights, and very high capacity even when carried on the shelf for extended periods of time. Service is far in excess of the American Standards Association's required performance for Size D general purpose flashlight cells.

The new "Eveready" is manufactured by the National Carbon Co., Inc., 30 East 42 St., New York 17, N. Y. ✓ ✓ ✓

Replacing Auto Cables

→ From Page 16

sledge hammer. A smooth, clean edge will result, enabling the shafting to fit easily into a fitting.

Fittings are fastened to the end of the shafting by clamping. The fitting is placed on the end of the shaft and then the fitting is inserted between the jaws of the clamper. Two jaws are provided: One for the smaller and one for the larger gauge cable. The upper jaw of the clamper is brought down until it rests on the collar of the fitting, and the clamper pin is struck a sharp blow with a sledge hammer. Fittings are usually drilled for .130″ shafting but can be reamed out to fit the .150″ size.

Cable casing can be cut to size by inserting it in the casing cutter and hacksawing it through the slot provided.

The radio serviceman who is repairing and installing automobile radios will find this tool worthwhile. There are many individual tricks and knacks in its use which can only be learned from experience.

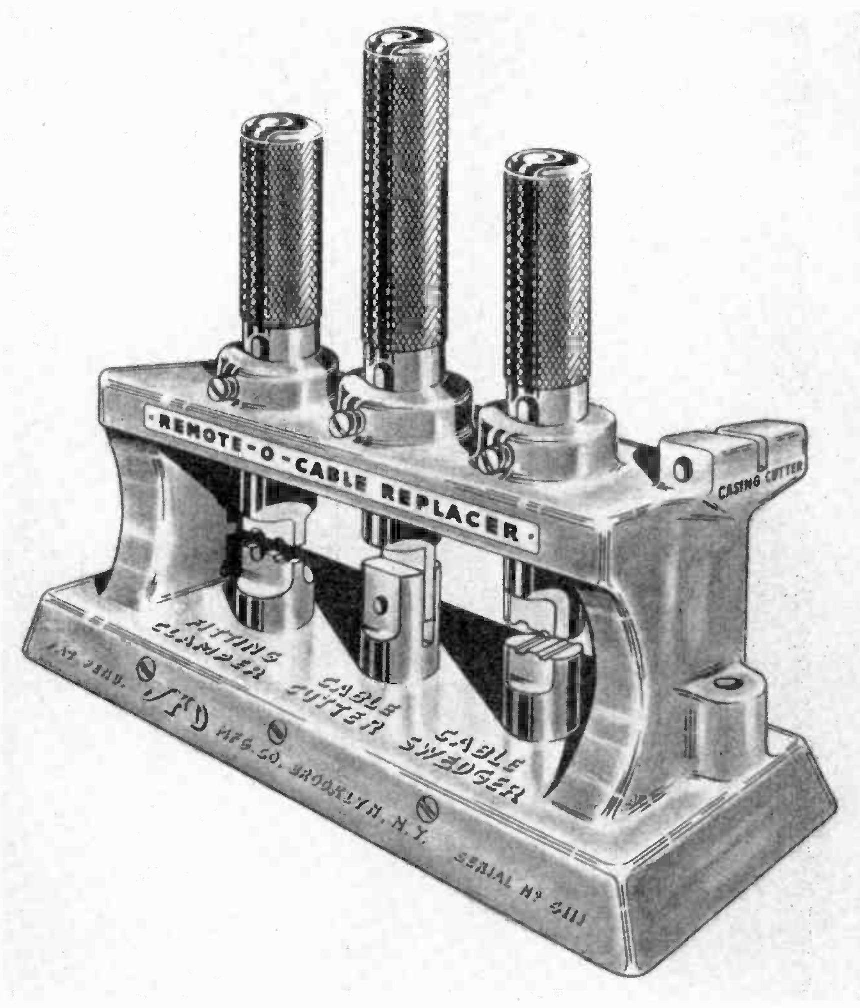

Fig. 2 The new auto cable replacing tool which greatly simplifies the fitting and installation of automobile radio remote control cables.

The Service Bench

→ From Page 17

nail part way in and take a turn of wire around it, then clinch it. The nail will hold a greater tension on the wire, and can be started much more easily than a staple. (See Fig. 1.)

• • • •

A simple and effective aid to replacing dial lights in hard-to-get-at places can be made from a short length of rubber hose. Use a stiff piece of hose with the proper internal dimensions. The light bulb can be inserted in one end of the hose and started in its socket. The other end of the hose can be bent around a corner and turned from there. (See Fig. 2.)

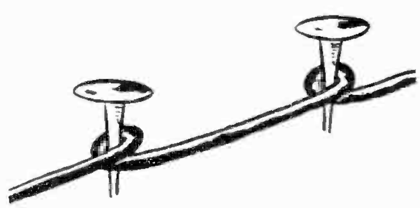

Fig. 1 A simple way to run bell wire, using furniture nails.

• • • •

While record player attachments are best sold by actual home demonstrations, the time consumed in connecting the unit precludes this method. One way of getting around the time needed is to build a small amplifier right into your demonstration player. With the output increased, it is possible to feed the phono signal into whatever circuit is available. There is so much stray coupling in the average set that even a connection to an RF grid lead will give satisfactory volume. If you feed a point of higher gain, simply cut the output to prevent blocking and distortion.

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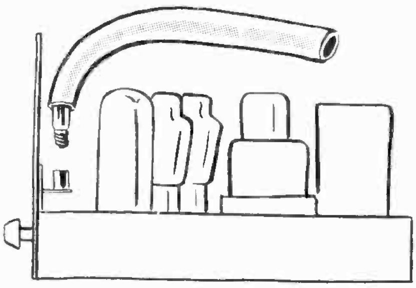

Fig. 2 A stiff piece of rubber hose used as an aid in replacing dial lamps.

The problem of carrying more than two midget sets in the back of the car or truck at the same time without having them scratch up against each other can be solved by making quilt jackets for them. A set of jackets can be made up from an old quilt. Cut the pieces out as shown on the diagram, and have a tailor sew up the edges with reenforcing tape. once each midget set is slipped into its

→ To Following Page

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Service Bench

→ **From preceding page**

cover, it can be packed without damage. (See Fig. 3.)

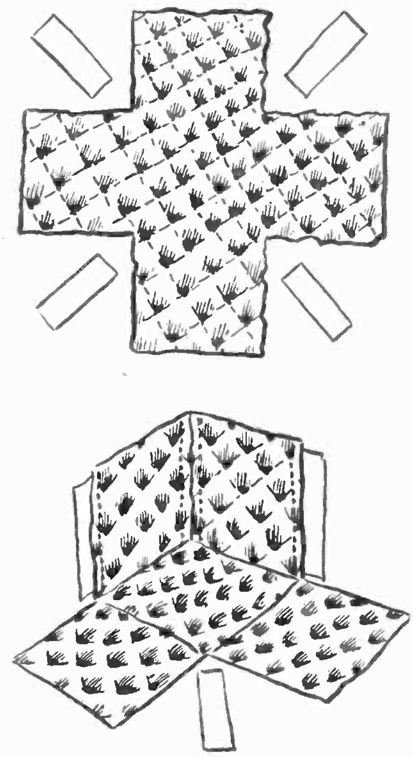

Fig. 3 Method used to construct jackets for small sets in order to prevent scratching.

Radio cabinet resonance which is sharp enough to increase the volume of one particular note and its harmonics to an objectionable level above the rest of the sound can be cured by lining the interior of the cabinet with Celotex, or a similar material, and/or cutting some large holes in the bottom of the cabinet just behind the baffle, and/or moving the speaker back from the baffle.

• • • •

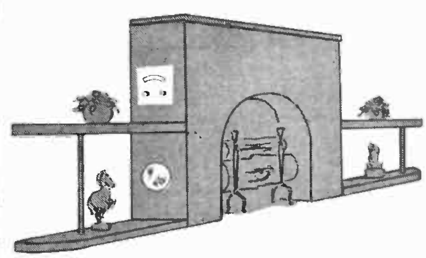

Fig. 4 A midget set mounted in a false fireplace.

A good bet for a midget sale is the false fireplace that is so much in vogue today. (See Fig. 4.) The set can be easily fitted into the fireplace and its speaker installed so that the entire fireplace acts as a baffle, thus giving almost big set quality. ✓ ✓ ✓

This Is Good News!

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The Simpson 260 is easily the world's most popular set tester for television and radio servicing. You cannot touch its precision, its useful ranges, or its sensitivity in any other instrument selling for the same price or even substantially more.

It has been a long time since we have been able to produce enough 260's to meet the demand, because the 260 has consistently out-sold every other remotely similar test instrument. The reason is simple: it out-performs and out-values them all. Simpson advanced engineering and unyielding standards of quality and precision manufacture enable it to *stay* accurate under conditions ordinary instruments cannot survive.

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2.5	2.5	2.5 V.
10	10	10 V.
50	50	50 V.
250	250	250 V.
1000	1000	1000 V.
5000	5000	5000 V.

Milliamperes D.C.	Microamperes	Ohms	
10	100	0-1000	(12 ohms center)
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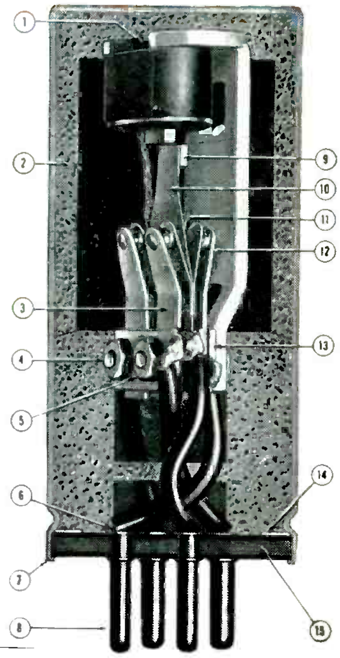

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