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RADIO MAINTENANCE

W. H. Melvin
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Hillsboro 3, Ohio

FEBRUARY 1947

SELENIUM RECTIFIERS

THE AUDIO OSCILLATOR

PART IV—THE OSCILLOGRAPH
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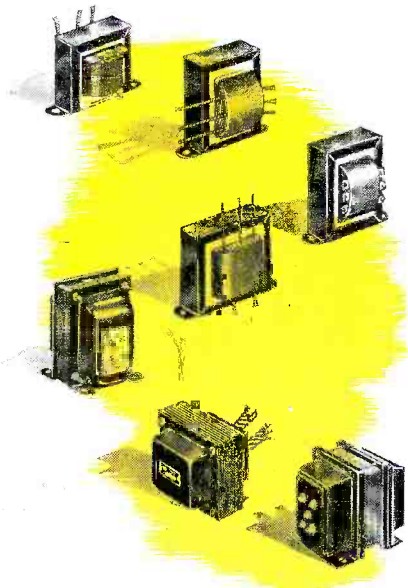

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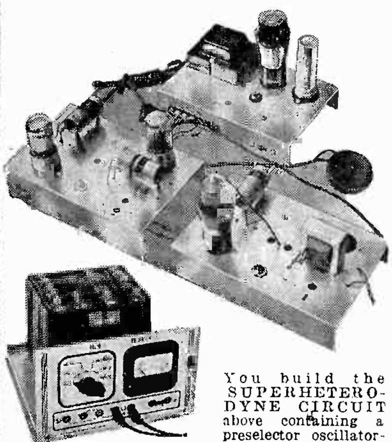

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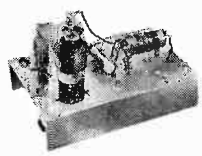

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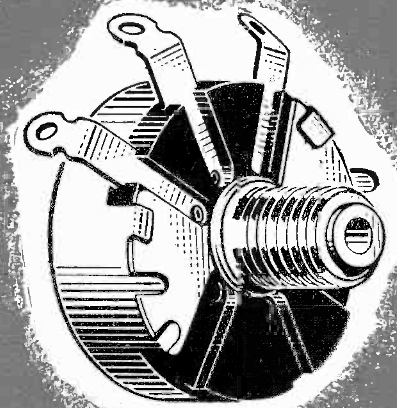

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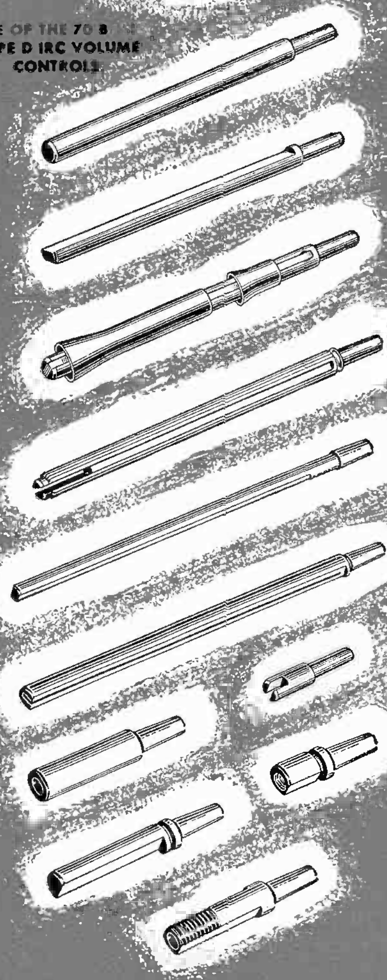

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RADIO MAINTENANCE

INCLUDING
ELECTRONIC MAINTENANCE

Volume 3 FEBRUARY 1947 Number 2

Contents

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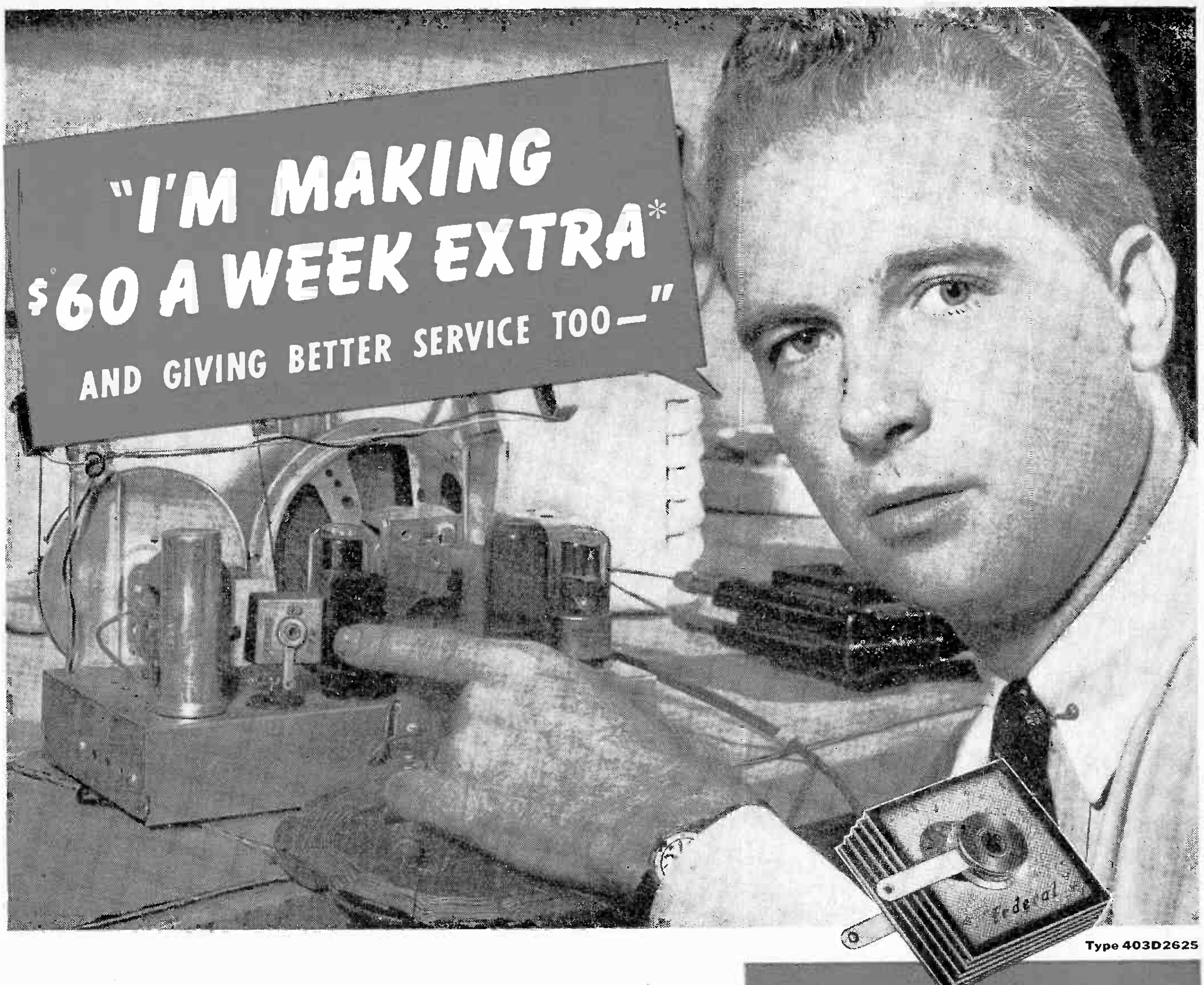

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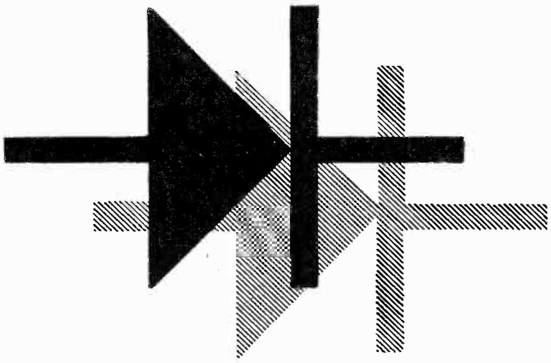

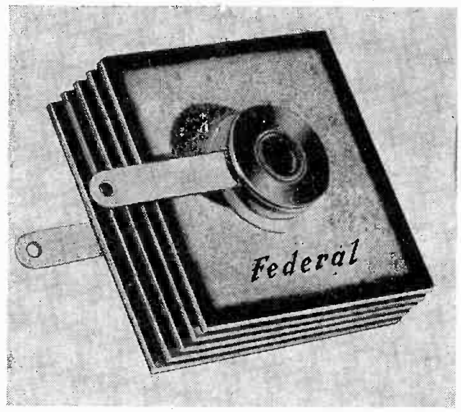

SELENIUM RECTIFIERS

The theory and application of the selenium and other dry metal rectifiers. Improvements recently made in these units are resulting in their widespread use.

by
Monroe M. Lange

FOR YEARS, science has known about the asymmetrical resistance properties of two dissimilar substances in close contact. However, it was not until quite recently that the modern home receiver benefited from this knowledge in the form of the selenium rectifier.

The roots of the dry metal rectifier are in the very familiar "cat's whisker" of the crystal set days. Even as far back as 1874, it was known that if a point contact were inserted into a crystal, current passed through the circuit more easily in one direction than in the other. This, of course, is the principle which later made possible the crystal detector.

The first solid rectifiers were of the detector type (low current requirements) and consisted of two separate pieces of unlike metals. Later, in the 1920's, the copper oxide rectifier, as such, was developed by L. O. Grondahl while studying the use of light sensitive cells as relays.

Various types of dry metal or junction rectifiers, as they are sometimes called, such as the copper oxide, magnesium-copper sulphide, and the selenium rectifier, have been utilized in electronics for some time, especially in Europe. They have been applied to battery charging, DC control circuits (relays, magnets, solenoids), meter rectifiers, filament voltage rectifiers (to supply 6 or 12 volts at 7 amperes), to energize field coils of dynamic speakers, and even as mixer-detectors in low frequency superheterodynes. However, their use was limited by their high initial cost and large space and weight requirements when used for high voltages and currents. The Federal Telephone and Radio Corporation which originally introduced the selenium rectifier in this country in 1935 has overcome these disadvantages in their new miniature selenium rectifier shown in Fig. 1. To appreciate fully the qualities of the rectifier, and before considering its practical applications, it will be interesting as well as beneficial to examine the theoretical aspects of this type of rectifier.

Application

Any device which conducts current much more easily in one direction than in the other may be used as a rectifier. In other words, if something has a very high resistance one way, and a correspondingly low resistance in the opposite direction, it may be used to change AC to pulsating DC (see Fig. 2).

There are many such contrivances, all having a common characteristic of unidirectional conductivity. This, as we shall subsequently see, is only one of many factors to take into consideration when choosing a rectifier.

All dry metal rectifiers consist generally of a metal and crystalline metallic salt in close contact. The junction presents a low resistance from the metal to the compound, and a high resistance in the opposite direction. Fig. 3 shows a typical elementary unit of a copper oxide rectifier. The lead contact is the connection to the oxide. The selenium rectifier is formed by coating a metallic disc, such as iron, with a special alloy and selenium. Similar units may be connected in series or parallel so that a wide range of voltages and currents may be obtained. Previous to Federal's miniature rectifier, an increase in current and voltage requirements meant that the unit became prohibitively large. The new rectifiers vary from 1″ diameter by 15/16″ deep, for 75 ma, to 1¾″ x 15/16″ deep for a 200 ma unit. The disc or plate form aids in keeping the rectifier cool.

The selenium rectifier may be

compared to the ordinary diode with one side corresponding to the plate and the other to the cathode. Fig. 4A and 4B show the symbols of the diode and the dry metal rectifier respectively. It is interesting to note that, when the symbol for the latter was devised, current was thought to flow in the conventional manner from positive to negative. Although we now use the electron theory of direction of current flow, the symbol was never revised.

As previously mentioned, the rectifier must meet other demands beside furnishing the necessary voltage and current. Briefly, they are as follows:

1. Good regulation
2. Durability and ruggedness.
3. Low cost
4. Small size and weight
5. Low heating effects
6. Adaptability

While most of the above are self-evident, point number one perhaps needs further elucidation. A power supply rectifier, just as any other electrical unit, has a certain amount of internal resistance. When current is drawn through a rectifier, an IR drop occurs within it, resulting in a lower available voltage. Referring to Fig. 5, the lower the value of R int., the greater will be the

Fig. 2 The input and output voltage wave patterns of a half wave rectifier.

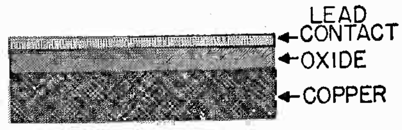

Fig. 3 Cross-sectional view of a simple copper oxide rectifier.

current drawn; and, consequently, the greater will be the internal voltage drop, resulting in a lower Et. By keeping R int. low, good regulation may be obtained. The percentage of regulation is the measure of the amount of voltage available under no load conditions, as compared to full load conditions

$$(\% \text{ of regulation} = \frac{Enl\text{-}Efl}{Efl} \times 100).$$

The lower the percentage, the better the regulation.

Let us see how the selenium rectifier measures up to some of the above qualifications. An examination of the regulation curves shown in Fig. 6A and 6B indicates that the regulation is excellent, even with the voltage doubler circuit which ordinarily has a poor regulation characteristic.

Since the filament of the rectifier is eliminated, there is little heating effect. This brings up another interesting point: In circuits where the rectifier furnished filament voltage for the rest of the tubes in the circuit, such as AC-DC battery portables, the equipment becomes instant starting as the rectifier filament warm-up time is not required. In applications such as intercommunication systems, this is a distinct advantage. The fact that little heat is generated also means longer life for all the components in the equipment.

One of the most common troubles with transformerless power supplies where there is no line voltage dropping resistor for the filaments is the burning out or shorting of tubes and input filter condenser. These failures usually arise due to the high initial current surges while the filaments are still cold and their resistance low. The resistor used to replace the rectifier filament when a selenium rectifier is employed will limit this surge, thus minimizing these difficulties.

As for ruggedness and durability, there is no doubt that the selenium rectifier is tough. The manufacturer states that, based on

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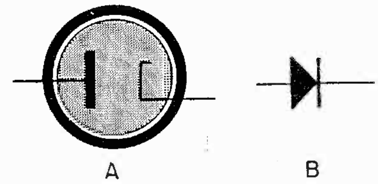

Fig. 4 A is the symbol for a vacuum tube diode, and B is the symbol for a dry metal rectifier.

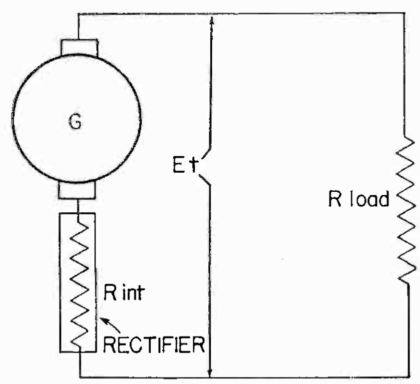

Fig. 5 Simplified diagram illustrating the effect of the rectifier internal resistance on the output voltage.

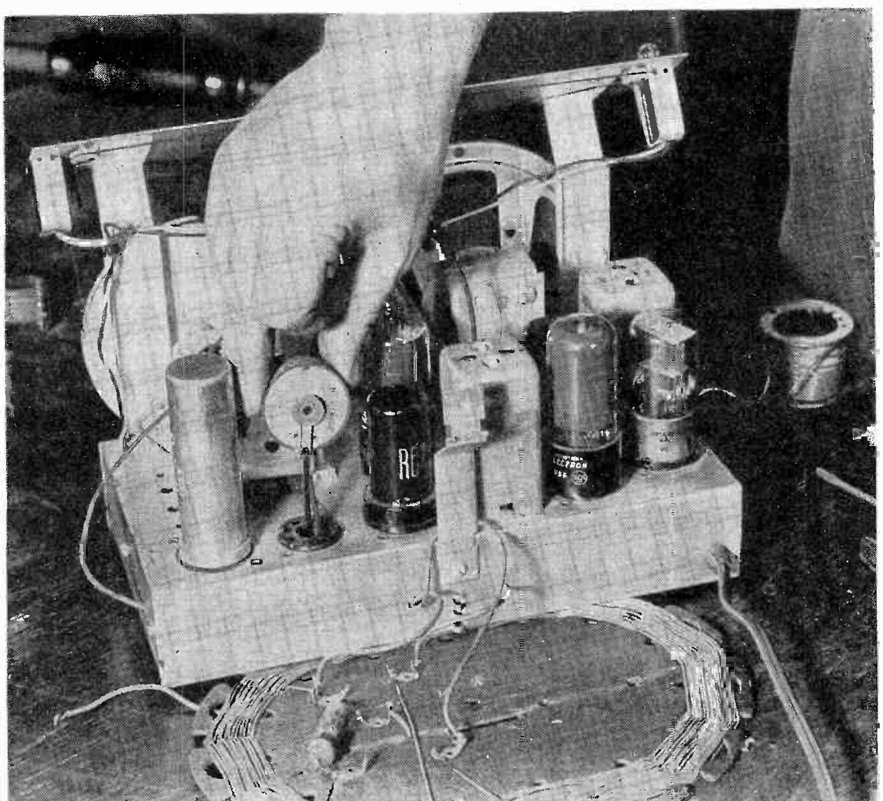

Fig. 1 A selenium rectifier being placed in mounting position above the rectifier socket of a small table model receiver.

Selenium Rectifiers

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their tests, the selenium rectifier has very long life. As the product is comparatively new, it is too early to make a statement from actual experience in the field. However, the outlook seems very promising.

The selenium rectifier may be used in various types of power supplies. The most common, of course, is the conventional half wave AC-DC power supply shown in Fig. 9B. If higher voltages are desired, tripler and quadrupler circuits may be employed (Fig. 7A and 7B). Using the 200 ma rectifier and 40 ufd condensers, it is possible to obtain 325 volts at 200 ma with the tripler, and 425 volts at 200 ma with the quadrupler.

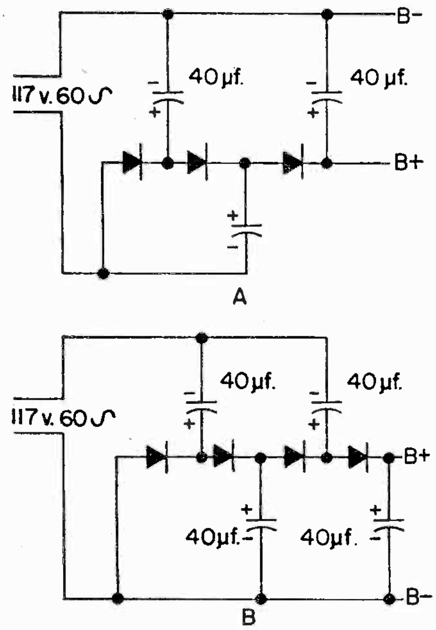
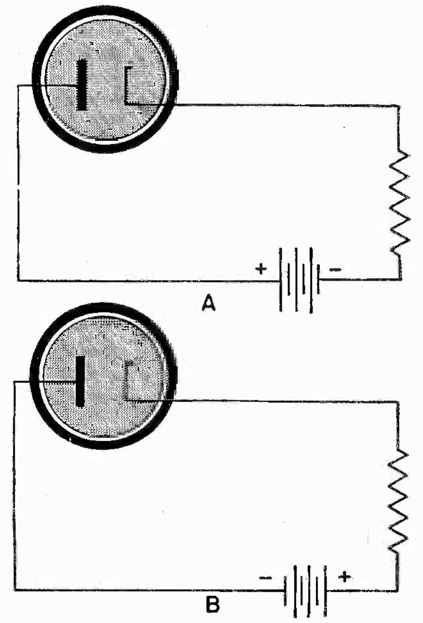


Fig. 7 A is a voltage tripler circuit using three 200 ma selenium rectifier units. B is a voltage quadrupler circuit using four 200 ma selenium rectifier units.



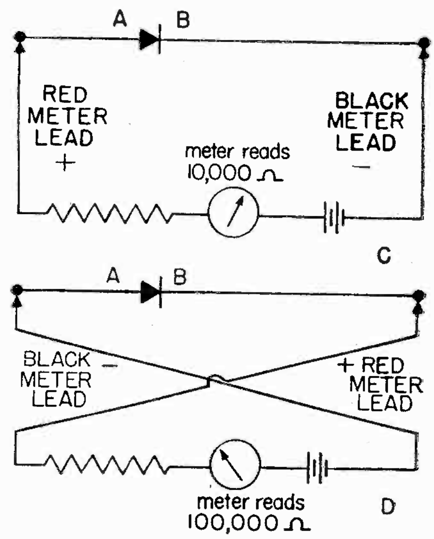


Fig. 8 In circuit A, current will flow through the diode. In circuit B, current will not flow through the diode. C is the effective circuit of an ohmmeter connected across a selenium rectifier. The meter reads 10,000 ohms. When the leads are reversed, as in D, the meter reads 100,000 ohms. The greatest current flow is, therefore, with the connections of C.

Installation

The important question to the radio serviceman is naturally, "What special benefits can I derive from this new product?" These benefits should take the form of increased profits, greater customer satisfaction, and the reputation of being "in the know" about all the latest developments. It is suggested that some time be spent explaining the advantages of the new rectifier, especially if the customer is new. The fact that the manufacturer guarantees it to last the life of the set should be pointed out.

Installation of the new component is a simple matter. Following are some hints and some typical installation procedures.

There are four Federal selenium rectifiers now available with maximum DC output currents of 75 ma, 100 ma, 150 ma, and 200 ma. By checking the circuit requirements and the tube to be replaced, the proper one is selected. Ordinarily, there is not enough room under the chassis to install it there without interfering with other parts. In case space is available, a cool spot should be chosen. The rectifier may

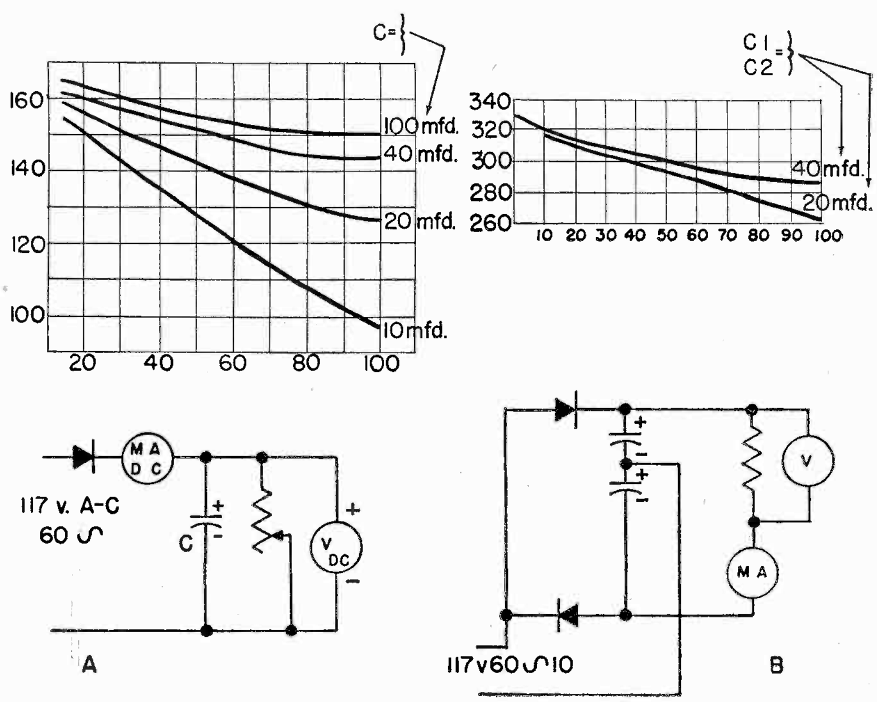


Fig. 6 A shows the voltage regulation curves of a half wave rectifier using a 100 ma miniature selenium unit. B shows the voltage regulation curves of a voltage doubler circuit using two 100 ma units.

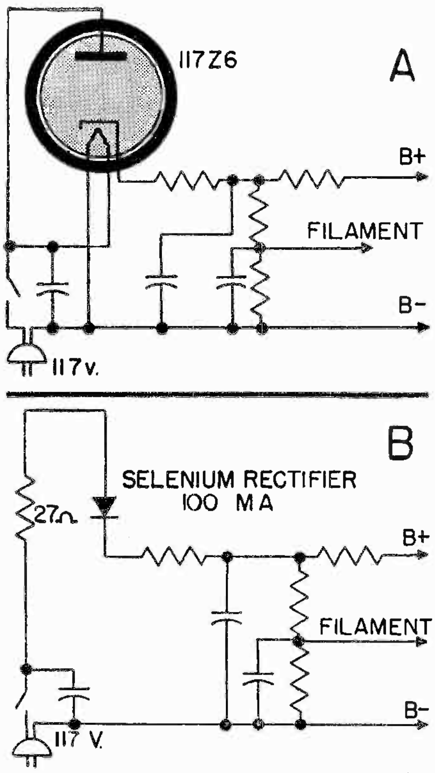


Fig. 9 A is a typical power supply circuit using a 117Z6. B is the same power supply circuit after conversion to a selenium rectifier unit.

be mounted on the chassis by means of a screw inserted through the eyelet in the center of the unit. It has been found, however, that caution must be observed to prevent shorting the rectifier by applying too much pressure to the screw. An ohmmeter measurement taken between the two leads of the rectifier, after it has been mounted, will provide a check. The usual location for the new unit is over the rectifier tube socket.

While the manufacturer does indicate the polarity to be observed by a yellow and red dot on either end (corresponding to the plate and cathode respectively), it will be worthwhile, both from a theoretical and practical standpoint, for the serviceman to know how to determine the proper connections. A further analogy to the diode will make this obvious.

When the plate of a diode is made positive in respect to the cathode, the diode conducts. Hence, it may be said to have a low resistance (Fig. 8A). Conversely, when the plate is made negative with respect to the cathode, no current flows, in which case the diode represents a high resistance (Fig. 8B).

Keeping this thought in mind, let

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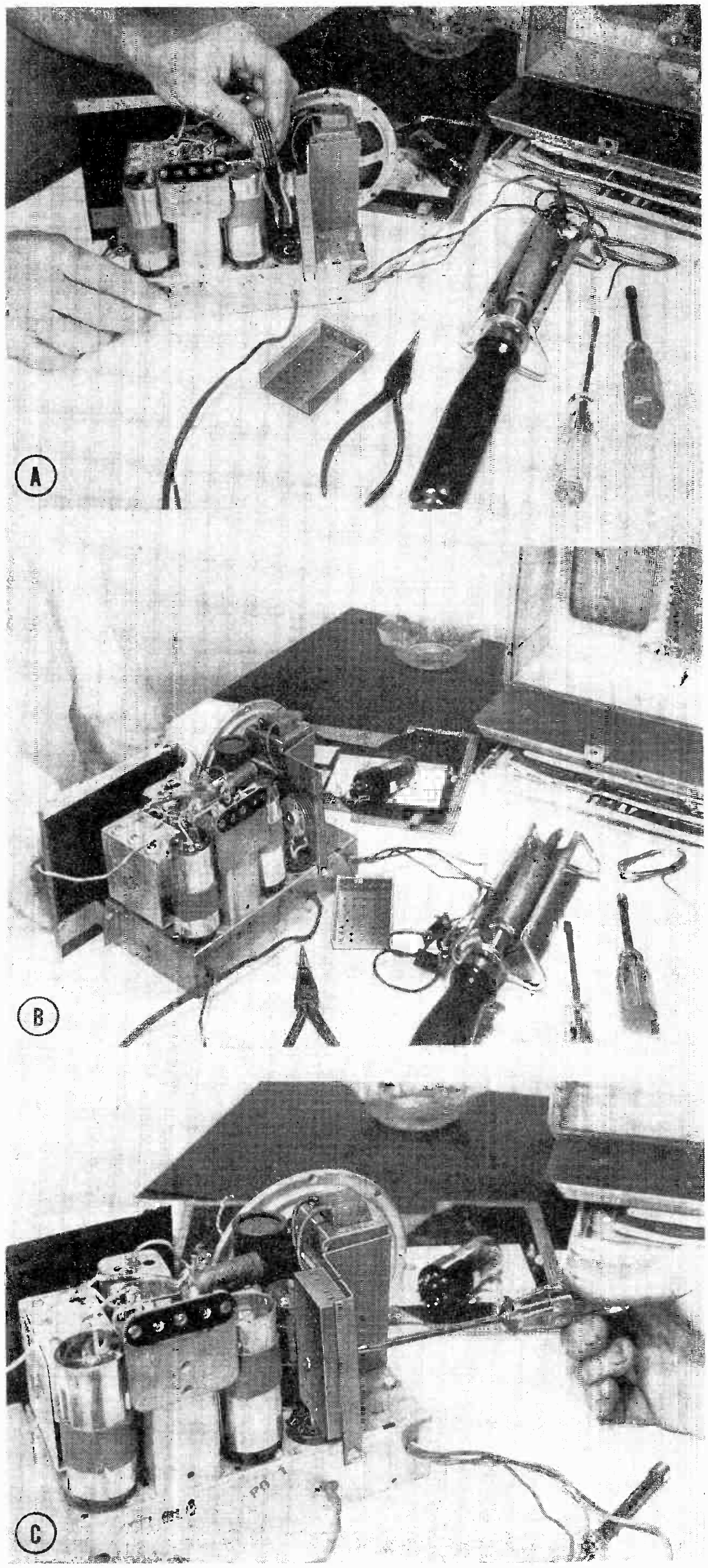

Fig. 10 Steps followed in installing a selenium rectifier. The unit is mounted above the rectifier tube socket, and a shield is placed over it as illustrated.

The Audio Oscillator

by A. R. Knight

A good audio oscillator is a necessary instrument in the small shop. An understanding of the operation of this instrument is helpful in its choice and use.

THE AUDIO oscillator is an instrument whose function is the generation of sine-wave voltage signals in the audio-frequency range: About 20 cycles to 20,000 cycles. Its use to the radio serviceman is manifold:

1. Checking of response of public address systems;
2. Checking of audio stages in radio receivers;
3. Use as a modulating source for RF and IF signal tracing in a receiver;
4. Analyzing loud-speaker and transformer performance;
5. Measurement of frequency of an unknown signal, with the aid of the cathode-ray oscilloscope (See September issue, "Cathode-Ray Oscillograph . . . How It Works," section on Lissajous figures).

It is proposed in this article to discuss in some detail the theory of most types of audio oscillators. The Jackson Model 655 is illustrated above as a typical example of this type of instrument.

General Theory of the Audio Oscillator

An audio oscillator is generally a resistance-capacitance (R-C) device with resistance tuning. Inductance-capacitance (L-C) oscillators are not employed because of the high values of components necessary at audio frequencies. For example, at 1000 cycles, a tank circuit of an L-C oscillator would have values of, say,

$$L = 250 \text{ mh}, \; C = .1 \text{ ufd}$$

(These values come about from the relationship $f = \frac{1}{2\pi\sqrt{LC}}$.)

It is extremely difficult to arrange an inductance for continuous variation, and it is just as impractical to vary capacitance when it is of the order of .1 ufd.

Since it is just as simple to obtain a potentiometer of high value as of low value, resistance - capacitance oscillators with resistance as the variable element are usually the rule in audio oscillators. No tank circuit of inductance and capacitance is used to control the frequency of oscillation.

There are two types of audio oscillators which are most widely known and used: The Phase-Shift Oscillator and the "Wien Bridge" Oscillator.

The Phase-Shift Oscillator

This is the simpler of the two types and hence will be described first. It consists of one tube plus a resistance-capacitance network. To obtain oscillations with a single tube, it is necessary that positive feedback between the plate and grid be maintained; in other words, that a signal be fed back from the plate *in phase* with the signal on the grid. Now it is well known that an ordinary amplifier tube (for example, a triode) produces a voltage at the plate which is an amplified version of the grid signal voltage but 180° out of phase with it. This can be simply shown by Fig. 2. An amplified version of e_g (the grid signal voltage) appears on the plate

(e_p) but is 180° out of phase with e_g. from Fig. 2,

$$e_p = E_{(B+)} - Ri$$

The plate current (i_p) varies directly with the grid voltage (e_g). As the grid voltage increases, the plate current increases; as the grid voltage decreases, the plate current decreases. Therefore, effectively, the plate voltage (e_p) varies opposite to the grid voltage, or the plate voltage is 180° out of phase with the grid voltage.

In order for a single-tube amplifier to be used as an oscillator, the plate voltage must be so altered that it is in phase with the grid voltage; that is, the plate voltage must be shifted 180° in phase to bring it back into phase with the grid voltage. This is accomplished with three or more sections of resistance-capacitance phase-shifting networks. In Fig. 4 is shown a phase-shift oscillator with three of these networks. Consider first Section 1 alone as a series R-C circuit. If a sine-wave AC voltage e_p is applied across C_1 and R_1, a current i_1 will flow through C_1 and R_1. This current will lead the applied voltage in phase because of the general property of a condenser which causes the current through it to lead the voltage in phase. This same current, flowing through R_1, will then create a voltage e_2 which leads the applied voltage e_p in phase. Suppose C_1 and R_1 are adjusted so that this leading phase angle is 60°. If this voltage e_2 is then applied to section 2, as shown in Fig. 4, a similar action will take place and a new voltage e_3 which is 120° out of phase with e_p will result. By adding a third section, the voltage resulting (e_g) will be 180° out of phase with the voltage at the input. We have thus produced a condition in which the grid voltage (e_g) is made to *lead* the plate voltage (e_p) by 180° in phase. This completely cancels the 180° by which the plate voltage *lags* the grid voltage by normal triode action explained above.

Of course, it might be argued, "Why not limit the number of R-C sections to two or even one?" The answer is that the maximum phase shift that can be obtained with an R-C circuit is 90°. This would mean a minimum of two sections. Since 90° is obtainable only when the resistance is made equal to zero, and since making the resistance zero would also make the voltage output from that section zero, more than two sections must be employed. A minimum of three must be used. If four sections were used, each could be adjusted to have a phase shift of 45°. It is not necessary for each section to have the same phase shift as the others. For example, in Fig. 4, sections 1 and 2 could be made to have phase shifts of 70° each and section 3 a phase shift of 40°, making this last section the fine-tuning control element.

Oscillator action is as follows: Assume the tube initially to be at rest with only DC voltages on grid and plate. The tube is now in a condition of unstable equilibrium. If some slight electronic disturbance occurs (e.g., tube "noise," ripple in the B+ plate supply, etc.), it is amplified, shifted —180° at the plate, passed through the R-C networks 1, 2, and 3, and returned to the grid to meet more of the original disturbance. The returned signal is then re-amplified and the entire process repeated. This occurs again and again until no further amplification occurs because of saturation of plate current. The original signal can be considered to consist of a whole band of frequencies. However, only one frequency will be shifted exactly 180° by the three R-C networks and consequently only that frequency will be exactly in phase with the original signal on the grid.

All other frequencies, even those nearby, are rejected because they will be shifted by amounts other than 180° through the R-C networks and

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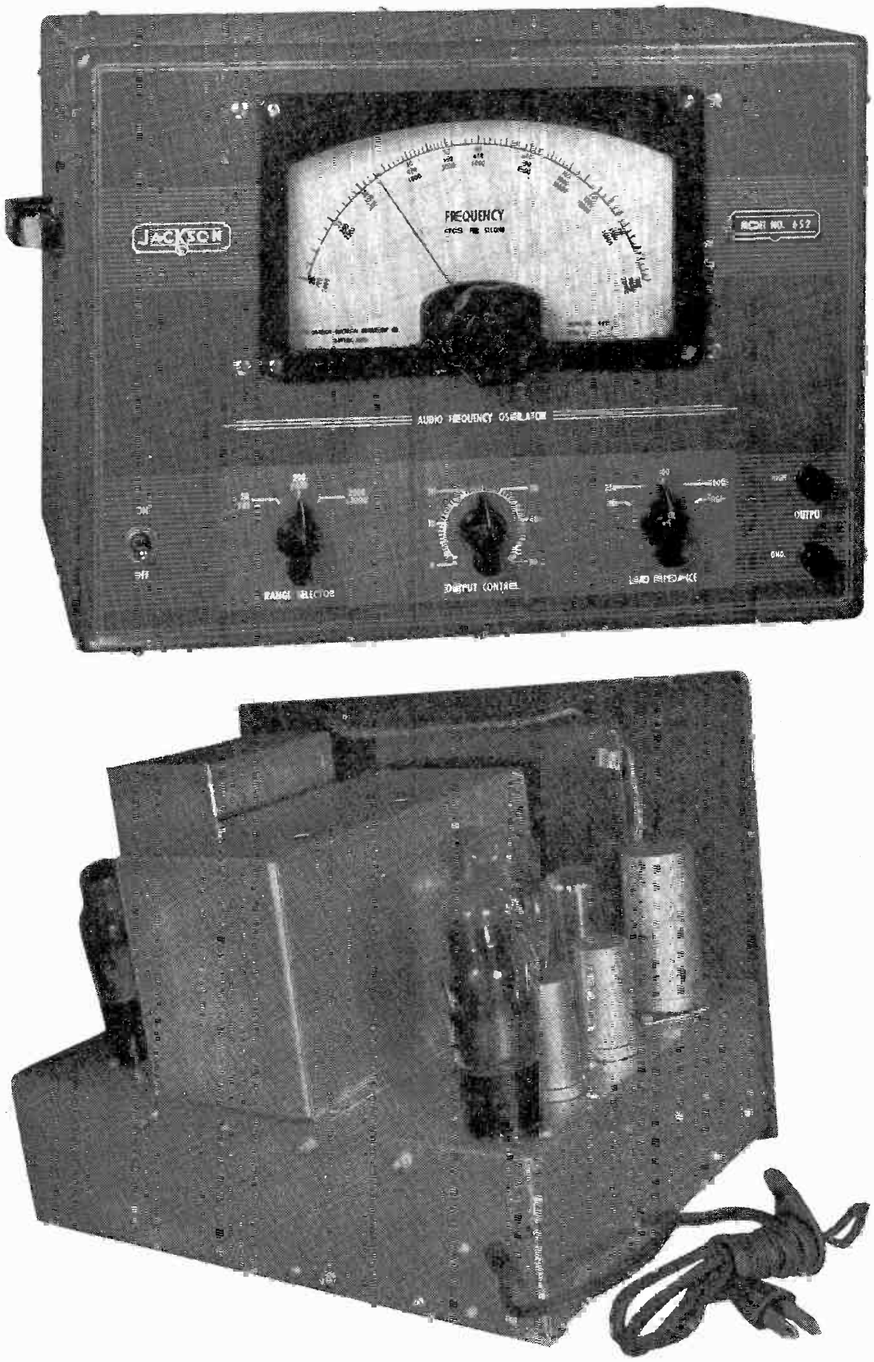

Fig. 1 The Jackson Audio Oscillator Model 652. This is an example of a well designed Wien bridge audio oscillator. Note the conveniently arranged controls and good internal construction.

The Audio Oscillator

→ **From Preceding Page**

hence will arrive at the grid out of phase with the original grid signal by amounts depending on how far off-frequency they were. Each time these off-resonance frequencies are passed through the R-C networks, they are shifted farther and farther away from 180° and, consequently, in an exceedingly short time, they are completely rejected.

The output voltage from a phase-shift oscillator of this type is a nearly pure sine wave when the bias on the grid is adjusted to a correct value. The output frequency remains constant for given values for R_1, C_1, R_2, C_2, R_3, and C_3. To increase frequency, decrease any of the resistances or capacitances. To decrease frequency, increase any of the resistances or capacitances. Usually the capacitances are switched to obtain different frequency bands, and the resistances are potentiometers used as fine frequency controls.

The Wien Bridge Oscillator

Essentially the same problem is solved by the Wien Bridge oscillator as by the phase-shift oscillator: That of producing, at a particular frequency, a 180° phase shift to cancel out the 180° phase shift produced by the amplifier tube. In this case, a second tube is used to produce an additional 180° phase shift which, added to the 180° produced in the first tube, equals 360° which, of course, is the same as 0°). The Wien Bridge is interposed in the feedback path between the second and first tubes. Its function is to cancel out all unwanted frequencies by shifting their phase further (either + or —) thus permitting only the oscillation frequency to go through without any further phase shift, and to attenuate unwanted frequencies so that their rejection is facilitated.

To examine the oscillator in greater detail, consider Fig. 5, Tubes V_1 and V_2 are both amplifiers, with V_2 output fed back to V_1 grid. Thus the two tubes, as shown above, are capable of acting as an oscillator without additional circuits. However, they would oscillate over a wide range of frequencies (the band-widths of the two amplifiers) and hence some additional apparatus is necessary to limit the oscillations to one frequency. This is the function of the Wien Bridge, shown enclosed in Fig. 5.

As in the case of the phase-shift oscillator, the signal voltages on the grid and plate of the tube V_1 must be made in phase with each other. This condition is satisfied by the two tubes for a wide range of frequencies; each tube shifts the signal 180°, resulting in a net zero shift. The Wien Bridge allows only one frequency out of this band to be effective because it provides (1) degeneration (negative feedback) and (2) phase shift for all extraneous frequencies. A part of the output of V_2 is also fed back to the cathode of V_1 through the voltage divider consisting of R_3 and the lamp. This feedback voltage is *negative* feedback because its effect is to introduce a voltage 180° out of phase with that on the grid. (The cathode and grid of an amplifier tube are 180° out of phase with each other and a signal introduced into the cathode will be out of phase with a signal put on the grid.) All frequencies are given the same amount of negative feedback by R_3 and the lamp.

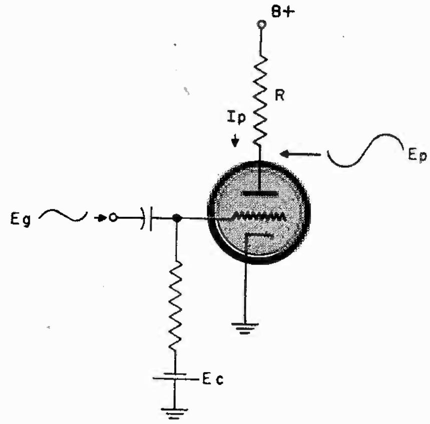

Fig. 2 The plate voltage variation is an amplified version of the signal fed to the grid.

Function 1 of the Wien Bridge listed above provides that all fre-

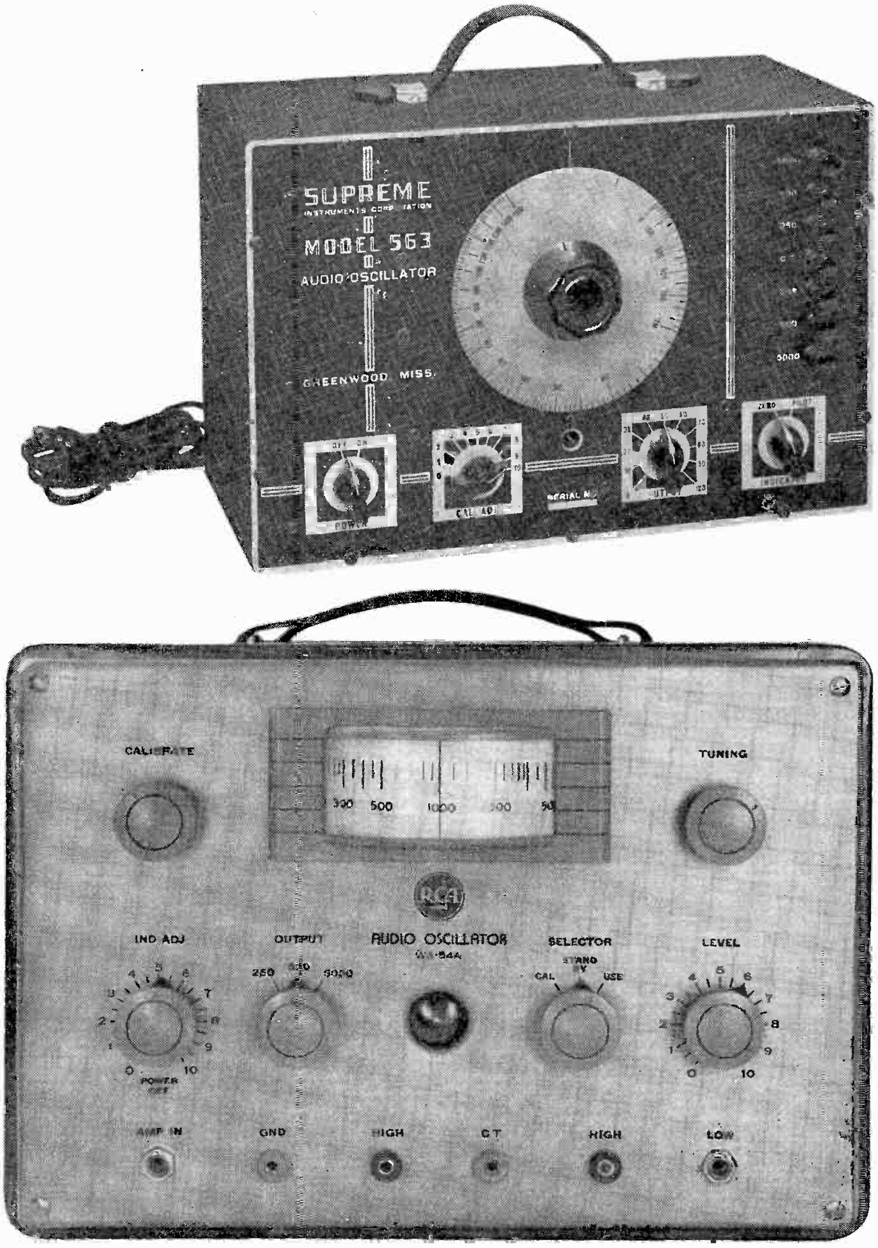

Fig. 3 Two examples of commercially constructed audio oscillators, the Supreme model 563 and the RCA model WA-54A

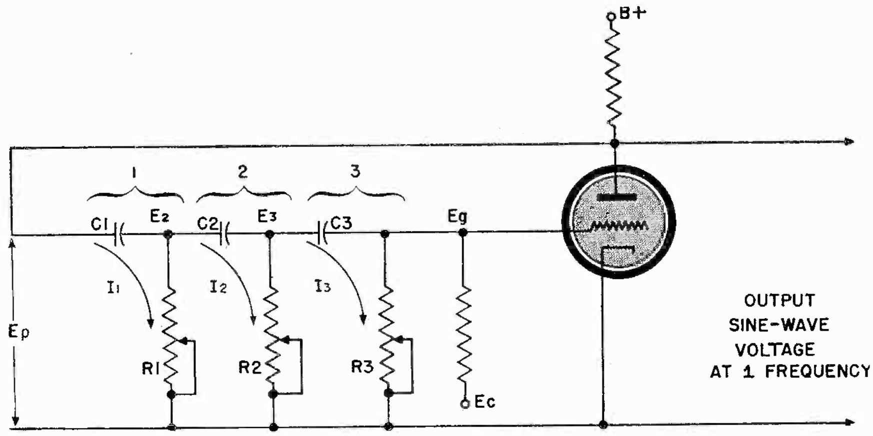

Fig. 4 A simplified schematic of the phase shifting network used in a phase-shift oscillator.

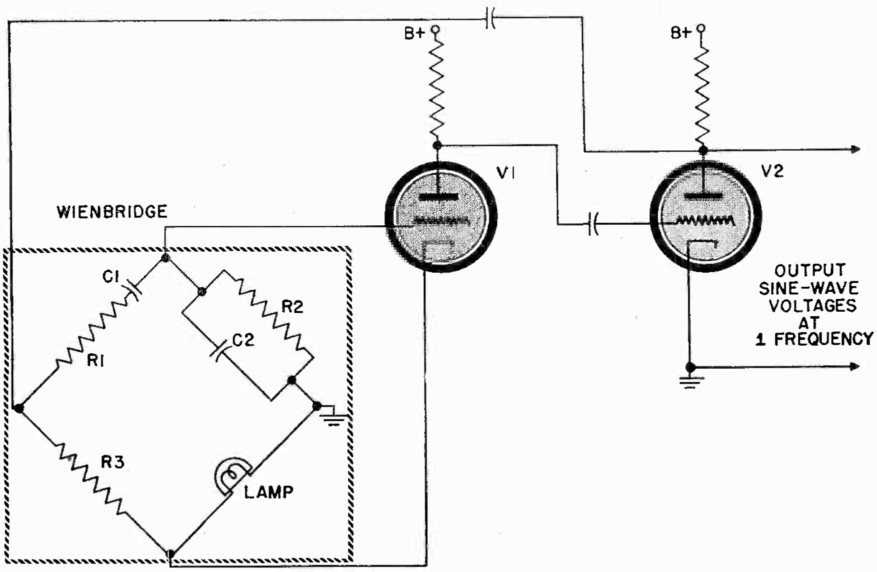

Fig. 5 A simplified schematic of a Wien bridge audio oscillator.

quencies other than those in the vicinity of the frequency of oscillation will be attenuated sufficiently so that the positive feedback from the plate of V_2 to the grid of V_1 is less than the negative feedback from the plate of V_2 to the cathode of V_1. These frequencies will then not be amplified further in V_1 and will thus be rejected. This attenuation of unwanted frequencies in the Wien Bridge comes about in the following manner: If the frequency is too low, the reactance (AC resistance) of C_1 becomes so high that little of the V_2 plate feedback voltage gets to the grid of V_1 and the grid voltage of V_1 is brought close to zero. If the frequency is too high, C_1 and C_2 have negligible reactances and hence R_2 is shunted by a low AC resistance, bringing the grid voltage of V_1 close to zero.

At some frequency between these "too high" and "too low" frequencies, the voltage which gets to the grid of V_1 is a maximum. Thus, frequencies other than those in a narrow band immediately around the center desired frequency are rejected. This action of the Wien Bridge is a broad one. Function 2 eliminates *all* the close frequencies and permits only the desired center frequency to pass.

Function 2, as noted above, is the characteristic of the Wien Bridge by which it acts as a phase-shifting device. From the theory of the Wien Bridge, it is proved that the voltage across the two branches R_3 + lamp is in phase with the voltage across R_2 when $R_1C_1 = R_2C_2$. But the voltage across R_3 + lamp is the output voltage of V_2, and the voltage across R_2 is the input voltage to the grid

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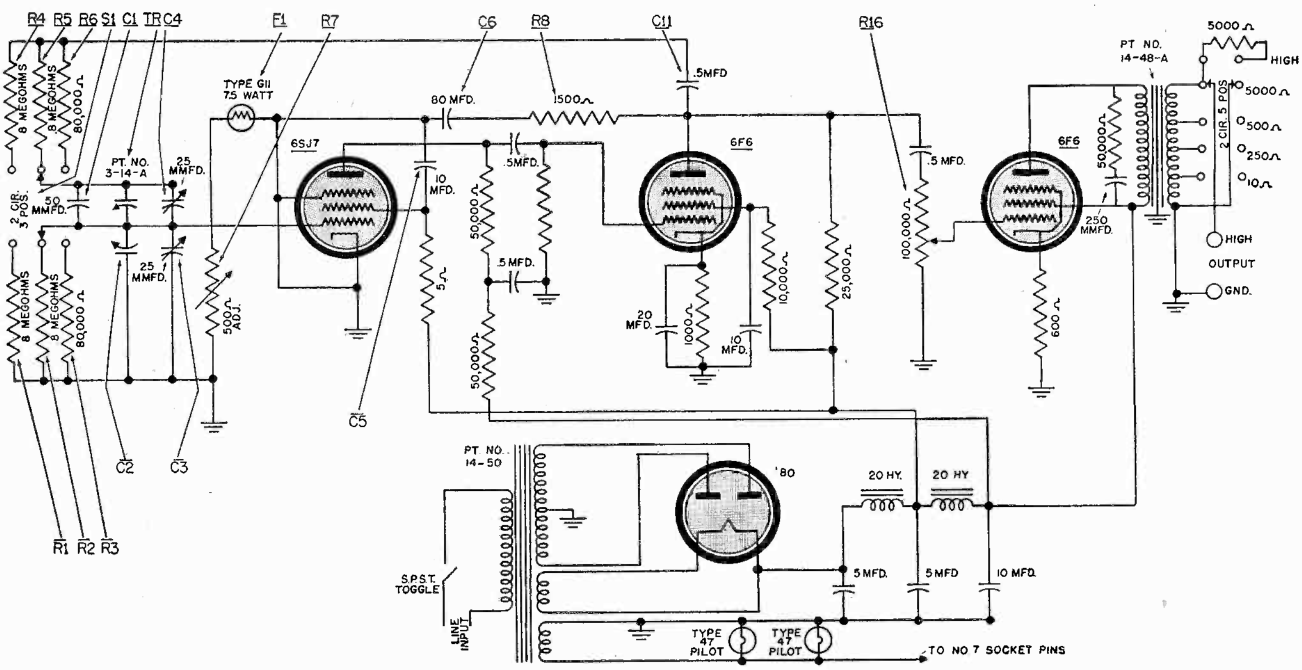
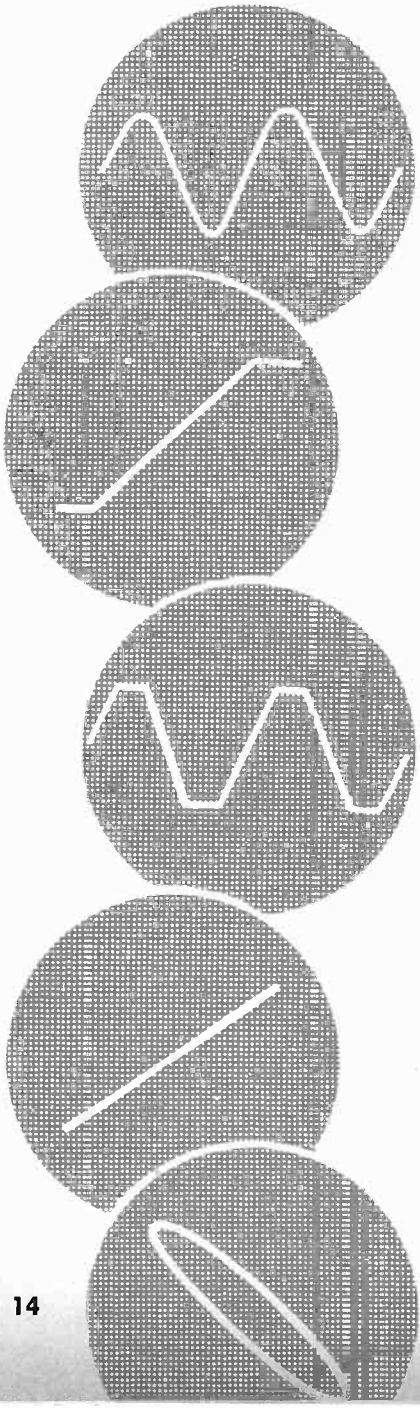


Fig. 6 A complete Wien bridge type audio oscillator.

This is the concluding article of a series on the use of the oscillograph. It covers the alignment of receivers, using the oscillograph and a frequency swept generator.

part IV
the Oscillograph...*how to use it.*

by Karl R. Alberts



A BRIEF NOTE OF REVIEW may be profitable here before proceeding with this last article in the series of six on the cathode-ray oscilloscope. The last article dealt with means for detecting distortion in the IF and RF stages of a typical receiver. This distortion was of the form called *amplitude distortion* which comes about through overloading somewhere in the amplifier.

A second form of distortion is called *frequency distortion* which is in the term given to incorrect functioning of the amplifier when its band-pass characteristic is not what it should be when the amplifier is working normally. An intermediate-frequency amplifier has as its ideal characteristic a peaked curve which may be of the shape of any one of the curves of Fig. 1. For each one, the center (or "peak") frequency occurs at the nominal intermediate frequency of the amplifier. Deviations in the shape of this curve, or in the position of the peak along the frequency axis, represent frequency distortion in an IF amplifier.

There are three general types of coupling between stages of an IF amplifier: Single-tuned coil (coil between plate and succeeding grid circuits, tuned by trimmer condenser across coil, or slug through coil); single tuned transformer (secondary tuned); double-tuned transformer (primary and secondary tuned). Representative curves for all three types are shown in Fig. 1.

Alignment of the IF Amplifier

Alignment consists of adjusting the variable tuning and trimming condensers, or the metal slugs in coils using inductance tuning, until the proper band-pass frequency curve is obtained. When working on the IF stages, it is most convenient to have a continuous picture of the intermediate-frequency output (i. e., a curve of voltage output against frequency of signal input) while adjustments are being made. How can such a set-up be most expeditiously obtained so as to be most

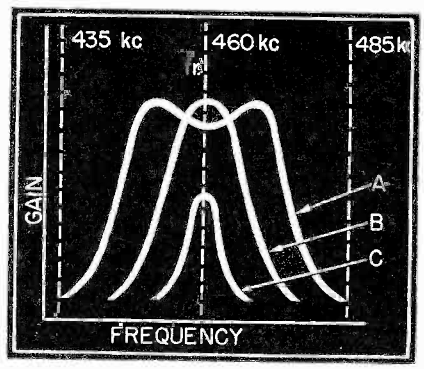
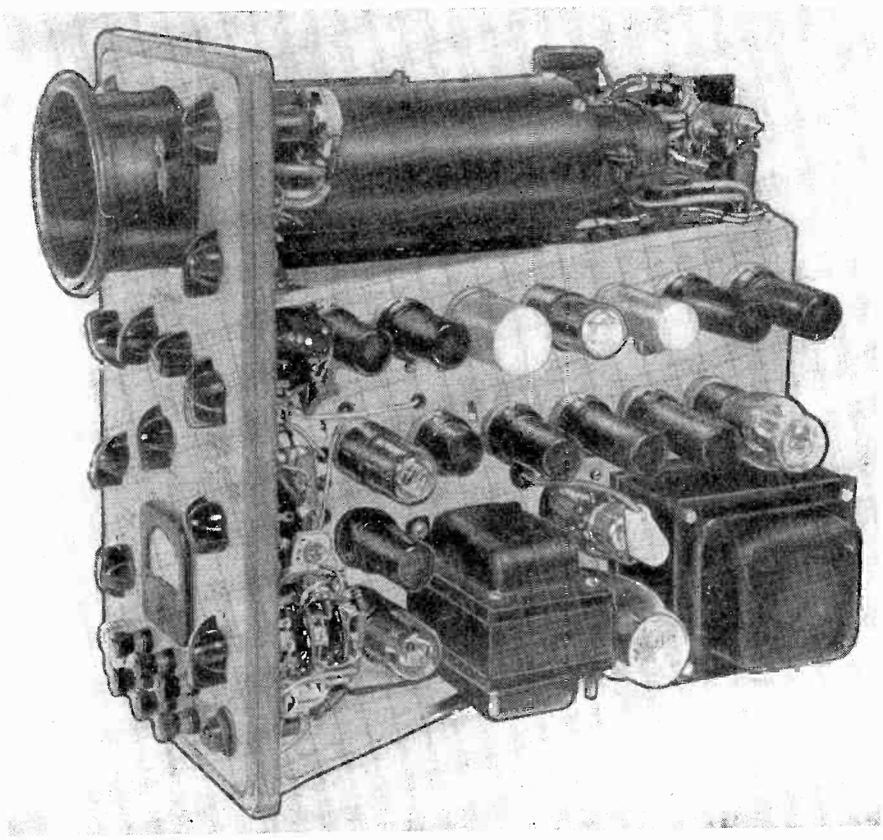


Fig. 1 Intermediate frequency curves with various degrees and types of transformer coupling. A is for double tuned transformer coupling when overcoupled. B is double tuned transformer coupling at critical coupling. Single tuned coil or single tuned transformer coupling gives a similar curve. C is the curve for double tuned transformer coupling when undercoupled.



The internal construction of the new oscilloscope shown in the lower right hand corner of the page. This 'scope is characterized by a wide frequency range and high gain.

conveniently observable by the operator, and yet involve a minimum of complexity of apparatus so that the serviceman need not make an abnormally large fixed investment in equipment and saddle himself with burdensome circuits? The author has given the problem considerable thought before setting out to write this section, and has carefully reviewed all well known methods. The equipment and methods described below all require some special apparatus, but they more than repay the serviceman in convenience of testing and excellence of results obtainable. In other words, it is felt that the special apparatus specified, by the very fact that it will enable more sets to be checked competently and correctly in a given time, will be well worth the radio repairman's initial investment.

It is possible, of course, to check an IF amplifier by observing the amplitude of a straight vertical line on the oscilloscope as the input frequency to the amplifier is varied over the entire range. This was a practicable method for audio because in general an audio curve is a straight line over most of its range, and it is only necessary to note where the curve slopes off to half-value on the low and high ends of the band. An IF band-pass curve, on the other hand, is a more complicated affair. To apply the foregoing method to the alignment of the IF would require hours of "diddling," consisting of alternate adjustments of the trimmers and running through the band-pass curve, the whole process repeated over and over until the desired curve appeared. With early broadcast receivers, it was possible to align by using the broadcast stations as signal sources, and the ear as an output indicator. This method is a poor one for several reasons:

(1) It is possible to tune the trimmers for maximum audio output and still have frequency distortion remaining somewhere in the receiver, distortion which would later be most evident when a high fidelity musical program was being broadcast;

(2) The audio modulation from a broadcast transmitter is not always absolutely constant over a long period of time;

(3) The response of the ear is not linear, i. e., a doubling in audio volume does not manifest itself as a sound "twice" as loud in the ears; the minimum volume change which the ear can discern is about 20 per cent in voltage, which is a serious limitation on its use as an output indicator.

A far more practical and speedy method, whereby the results of tuning are instantly shown on the oscilloscope, is to be described here. Fig. 1 shows typical IF band-pass curves. The vertical parameter is voltage plotted against the horizontal frequency. If the IF output curve can be kept before the eye of the serviceman continuously as he tunes and adjusts, until the desired curve (like those of Fig. 1) is obtained, the whole process can take but a few minutes, and a greater degree of accuracy will have been achieved.

In order to maintain a picture of the band-pass of the amplifier constantly on the screen of the oscilloscope, some means of "sweeping" the input frequency to the amplifier must be obtained, and then the horizontal sweep voltage of the oscilloscope must be made coincident and synchronous with the sweep-frequency input to the amplifier under test. The curve traced on the oscilloscope screen will then be one of voltage plotted against frequency effectively. (Note that this interpretation of the oscilloscope screen pattern must be borne in mind clearly, for it represents a departure from our standard concept of

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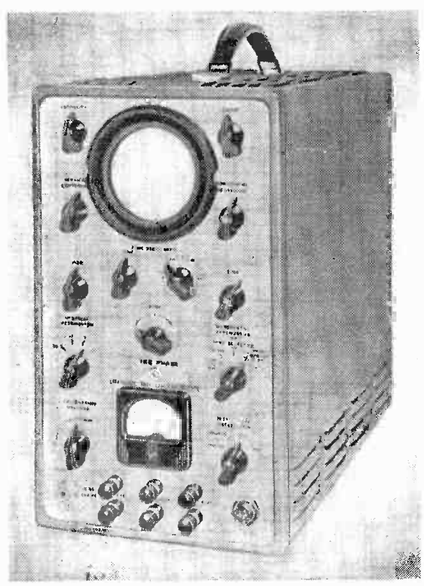

The control panel of the new RCA general purpose oscilloscope Model WO-79A. This unit is unique in that it includes a built-in calibrated voltmeter.

The Oscillograph... how to use it

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oscilloscope patterns: Voltage plotted against time.) The presentation on the screen thus is a complete trace of the IF band-pass characteristic.

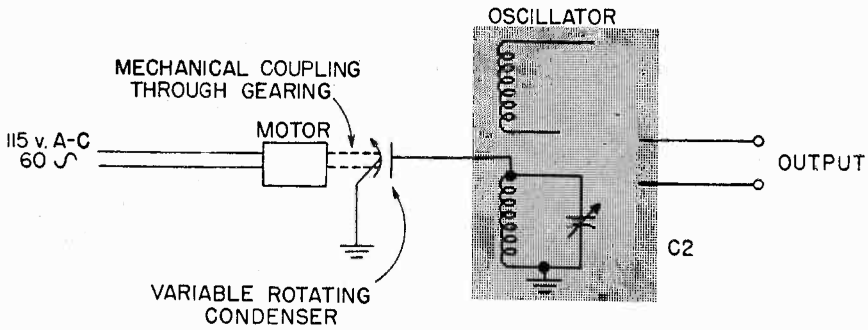

Fig. 2 A sweep frequency modulated signal generator using a motor-driven rotating condenser.

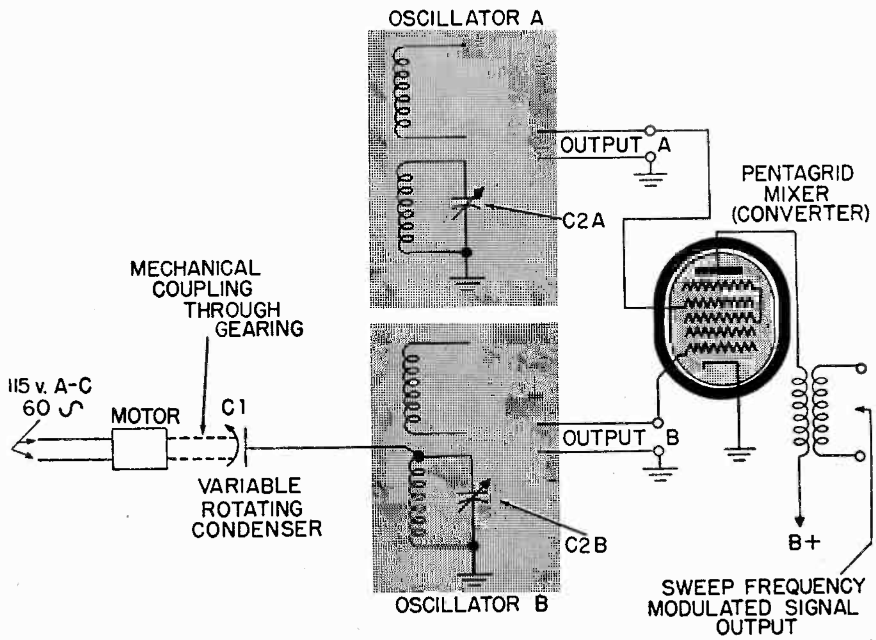

Fig. 3 Sweep frequency modulated signal generator using the double oscillator method. The sweep frequency remains constant for all center frequencies.

Sweep-Frequency-Modulated Signal Generator

In order to accomplish a sweep-frequency signal (i. e., a signal which varies in frequency at a linear rate with time, in exactly the same fashion as the horizontal sweep voltage in the cathode-ray oscilloscope circuits, as described in Part II of the series "The Oscillograph . . . How It Works"), a sweep-frequency-modulated signal generator is necessary. There are two general types available: The motor-driven rotating-condenser type, and the reactance-tube type.

Motor-Driven Rotating-Condenser Generator

This type of variable sweep-frequency signal generator may be purchased as a complete unit containing oscillator, variable rotating condenser, and driving motor, or it can be made by modifying a standard signal generator by the addition of a motor and condenser. The motor is a small fractional horse-power AC synchronous or induction type. The electrical relationship between the rotating condenser and the tank circuit of the oscillator should be made such that a rotation of the condenser from maximum to minimum capacitance will vary the output frequency by an amount somewhat greater than the expected band-width of the amplifier. For example, a commercial superheterodyne type standard broadcast receiver having an intermediate frequency of 460 kilocycles will in general pass frequencies on the order of 10 kilocycles above and below this center frequency; then in order to gain a complete picture of the band-pass, the frequency modulation should cover the range from about 25 kc below to 25 kc above mean frequency. In a typical setup, the variable rotating condenser can easily be made to produce frequency excursions of 25 kc, which means the output frequency from the signal generator will vary from 435 kc to 485 kc and back again, at a rate determined by the speed of the shaft on which the rotating condenser is connected.

With C1 of Fig. 2 connected to the oscillator tank circuit and its variable plates adjusted to approximately half capacitance (rotor and stator plates slightly less than half engaged), tune the oscillator (C2 is shown symbolically as the main tuning element of the tank circuit) to 460 kc. Then rotate the variable condenser C1 and determine whether or not the output frequency varies from approximately 435 kc to 485 kc and back to 435 kc for one complete revolution of C1. It is not necessary to have a frequency excursion of ±25 kc but the center frequency must be the desired mid-frequency of 460 kc. If the gearing between the motor and the rotating condenser is so arranged that C1 is driven at 60 cycles per second, or some multiple of 60 cycles, then the oscilloscope sweep circuit can be synchronized with line voltage. Otherwise, synchronize the oscilloscope internally.

(NOTE: Commercial sweep-frequency modulated signal generators have contacts arranged on the condenser shaft for synchronizing the oscilloscope externally.)

The type of frequency-modulated oscillator described above is characterized by variable band-width for different center frequencies because the same *percentage* frequency shift is always realized. Thus, if we obtain, as above, a shift of 50 kc about a mid-frequency of 460 kc, the same *percentage* change would be experienced at any other mid-frequency setting of the oscillator. For example, unless the oscillator circuit were radically altered or the rotating condenser were changed, if a new mid-frequency of 1000 kc were desired, the frequency shift here would be 11 per cent

$$\left(\frac{50\text{ kc}}{460\text{ kc}} = 11\%\right)$$

of 1000 kc, or 110 kc, more than twice the shift at 460 kc.

Constant band-width at any output mean-frequency can be derived from a double-oscillator generator, as shown in Fig. 3. Here the outputs of two oscillators, one whose frequencies are varied by the rotating condenser, are mixed to produce a single difference frequency. It will be shown briefly how this double-oscillator circuit works. Oscillator A is the fixed frequency oscillator, and B is the oscillator whose frequency is varied by rotation of C1. For 460 kc, adjust A to some fixed frequency, say 500 kc. Then adjust B to a mean frequency of 960 kc. The output of the mixer tube will then be their difference, 460 kc, the desired center frequency.

If B is arranged so that complete rotation of C1 from maximum to minimum capacitance will produce a frequency range in B of from 935 to 985 kc, then the mixer output will be 435 to 485 kc. If now, for some particular new application, we desire a sweep - frequency output centered about 250 kc, then A should be adjusted to 710 kc and B maintained at a center frequency of 960 kc. Now, since B has not been changed, rotation of C1 will still produce an output from B which varies from 935 to 985 kc. The difference frequency at the lower limit will be 935 — 710 = 225 kc; at the upper limit, 985 — 710 = 275 kc. Thus, the output of the mixer tube will be a variable sweep - frequency whose limits are 225 and 275 kc, with a center frequency of 250 kc. The spread here is again ±25 kc about the mean of 250 kc, exactly as it was for the first mean frequency of 460 kc. Thus this double - oscillator technique provides a band width which is the same no matter to what desired value the center frequency is adjusted.

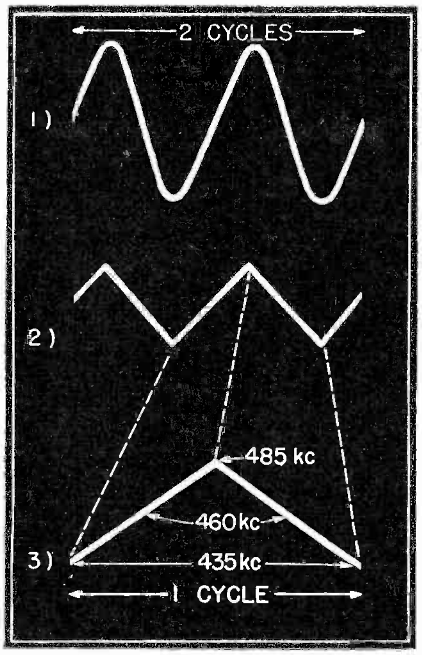

Fig. 4 A pyramid saw-tooth wave. (1) is the 60-cycle line voltage wave from which it is developed.

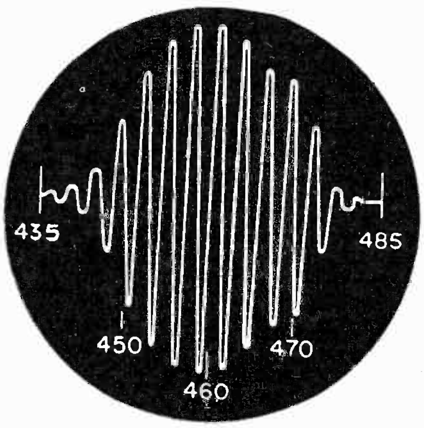

Fig. 5 Wave form appearing across the secondary of an IF transformer when using a frequency swept signal. The actual wave as it appears on the 'scope will fill in.

Reactance-Tube Type

This is the more modern method of producing a sweep-frequency-modulated signal for IF alignment. The circuit comprises an oscillator whose tuned circuit is shunted by a *reactance tube*. The latter is a special circuit, consisting usually of a pentagrid-type tube plus associated components, so arranged that a change in bias level of the grid materially alters the transconductance of the tube and causes the impedance, "looking into" the plate-to-cathode terminals, to change, becoming effectively a greater or smaller capacitance, or, by an alternate arrangement, a greater or smaller inductance. This tube, then, connected across the tank or frequency - determining circuit of a standard oscillator, will cause the output frequency to change as its grid voltage is changed. If a linear sawtooth voltage wave is impressed on the grid of this reactance tube, the oscillator output frequency will vary approximately linearly with time. For convenience, the sawtooth voltage wave can be obtained from the 115-volt 60-cycle line voltage. See Fig. 4 which shows the development of the sawtooth waveform from the 60-cycle power voltage, and the output frequency of the oscillator under the influence of the reactance tube. The 60-cycle line voltage can then also be used to synchronize the oscilloscope sweep.

It is possible for the radio serviceman to construct a motor-variable condenser type of sweep-frequency-modulated signal generator; the reactance tube type, however, is too complex for further discussion here, and the serviceman is not encouraged to construct one of this type himself. All of the types described are available on the market.

Connections for a Typical Set-up

In general, this method of alignment provides a visual curve showing the voltage output of the amplifier plotted against the frequency of the input signal, assuming the applied input signal remains constant in amplitude. So far, the requirements of the signal have been discussed with no mention made of the means of reading the amplifier's voltage output under the influence of this signal. If the oscillograph were connected across the secondary of the last IF transformer, the voltage of the signal could be observed on the cathode-ray tube. The signal at this point is an AC voltage, at the frequency of the IF amplifier. While this would serve, it has the characteristic of an AC signal — that is, it varies equally above and below zero; and furthermore, the pattern would give the appearance of a "filled-in" curve, as shown in Fig. 5.

For the alignment indication, a more suitable form is a single line indicating either the positive or the

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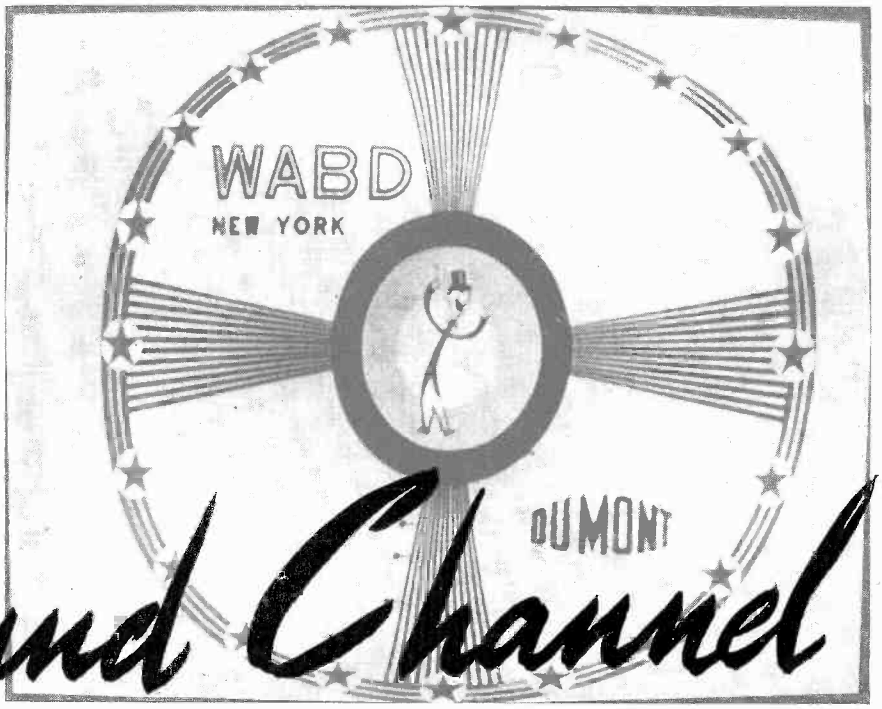
TELEVISION RECEIVERS

This article covers the third of the seven sections of the television receiver. The RF and Video sections have been covered previously.



the Sound Channel

by
Morton Scheraga
Allen B. DuMont Labs.

TELEVISION RECEIVERS marketed before the war had AM on both the sound and picture channels. As television technique progressed during the war years, the audio system was switched over to FM and will definitely continue in this manner in accordance with the new FCC standards announced in 1945. FM is not only superior to AM in reception, but it also lessens the possibility of interference from other nearby stations operating on the same frequency. There is also the consideration of transmission costs in favor of FM. Television stations have two separate transmitters, one for video and another for audio. The lower audio power required to produce a given signal strength using FM makes this transmission system more desirable.

The two transmitters at the television station operate on separate carrier frequencies. The frequency difference between the audio and video carriers is the same for all stations, namely, 4.5 mc. It is because of this fixed difference in carrier frequencies that correct tuning of a perfectly aligned television receiver is most easily accomplished by tuning for maximum sound.

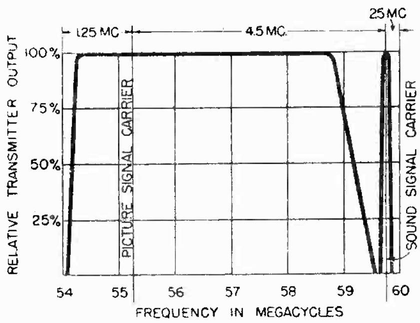


Fig. 1 The combined video and audio channels of a typical television station.

Part I on the RF section told how the RF passband of 6 mc permits reception of the 4 mc video channel and its associated sound channel. The combined video and audio channels of a typical television station are shown in Fig. 1. Both signals are heterodyned by the local oscillator and appear at the output of the first detector at lower IF frequencies, 8.25 mc for the audio, and 12.75 mc for the video. It will be shown later how the 8.25

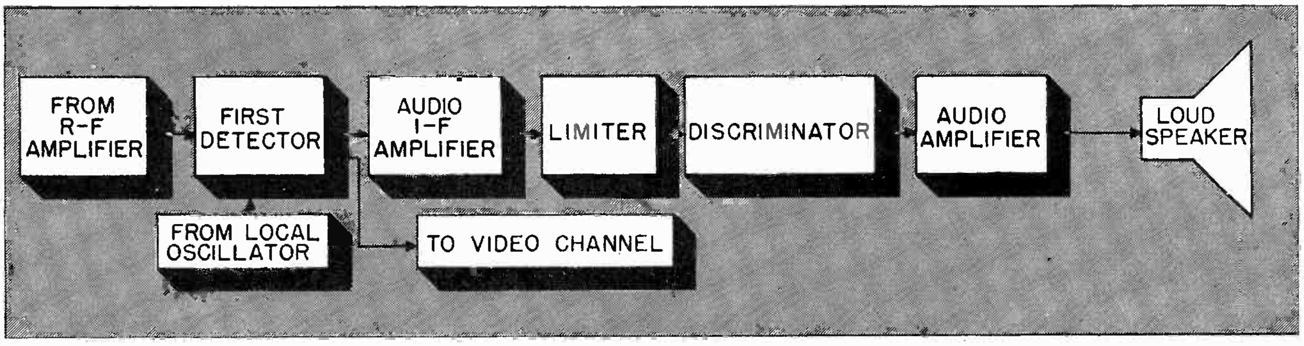


Fig. 2 A partial block diagram of a television receiver showing the audio and video channels. At the output of the first detector, the video and audio signals separate and feed into their respective intermediate frequency amplifiers.

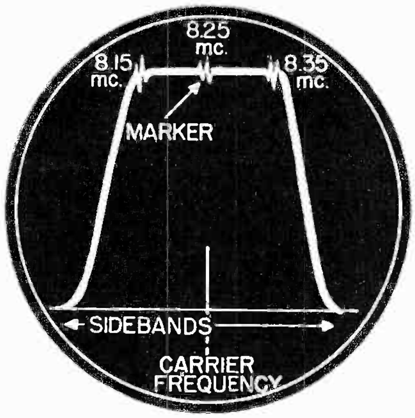


Fig. 3 Typical response curve of a tuned IF amplifier as used in the audio system of a television receiver.

mc sound carrier is separated from the video information and directed through the remaining audio system.

Previous articles in this series have traced the signal path from the antenna through the RF section to the first detector. It was shown that at the first detector the video information was obtained and the audio rejected from the picture IF amplifiers by suitable filter traps. In this article, we again go back to the output of the first detector, but this time describe the manner in which the audio carrier is selected and amplified, while the video signal is rejected from the sound system. Fig. 2 is a block diagram of the sound channel of a television receiver which we shall treat in detail.

Referring to Fig. 2, we see that once the audio IF carrier has been separated from the video at the first detector, the succeeding stages are identical to a conventional FM receiver. The number of IF stages needed will depend upon the gain obtained in the RF section of the particular television receiver, while the use of more than one limiter will be governed usually by the quality of the receiver.

In the ordinary FM receiver, designed for use between 88 and 106 mc, each station is allowed side bands ranging up to 75 kc on either side of the carrier. For television audio, only 25 kc is used, the narrower band width simplifying somewhat the problem of receiving both the video and the audio carrier simultaneously. Despite the fact that the actual frequency deviation of the incoming audio signal amounts to only 50 kc (plus and minus 25 kc about the carrier), the band-pass filters in the audio IF amplifiers are generally designed for a width of 200 kc. The extra band width is purposely provided to permit a small amount of frequency drifting in the high frequency mixer oscillator to occur without resultant detuning. A typical response curve for a tuned audio IF amplifier is shown in Fig. 3.

Any amplitude distortion introduced either in the IF amplifiers or by man-made or natural static is smoothed out by the action of the limiter. This operation of the limiter stage is shown in Fig. 4 with the limiter tube characteristic indicated for reference later.

The transforming of the frequency modulated signal into amplitude variations is performed by the discriminator which has a characteristic as shown in Fig. 5. At the center frequency of 8.25 mc, the output voltage is zero and all frequencies below 8.25 mc result in positive output voltages, whereas all those above 8.25 mc give rise to negative output voltages. In this way, audio voltages varying in amplitudes that depend upon the frequency deviations are obtained.

The audio signal is then fed to a conventional audio amplifier and finally to the speaker.

The selection of the audio carrier and the rejection of video signals which would cause amplitude modulation of the signal is accomplished at the first detector by a parallel resonant circuit tuned to 8.25 mc. This circuit is shown in the schematic diagram of Fig. 6, and consists of L-1 and C-1 in parallel, shunted R-1. It will be recalled that the impedance of such a

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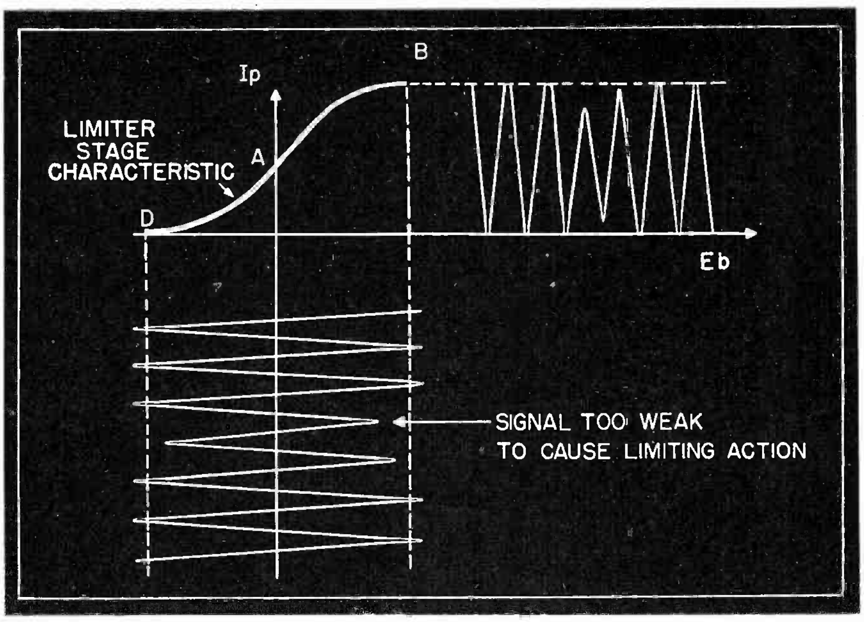

Fig. 4 Limiter stage response curve showing the limiter action on the signal. When the signal is not strong enough to reach points B and D and saturate the limiter, no limiting action occurs.

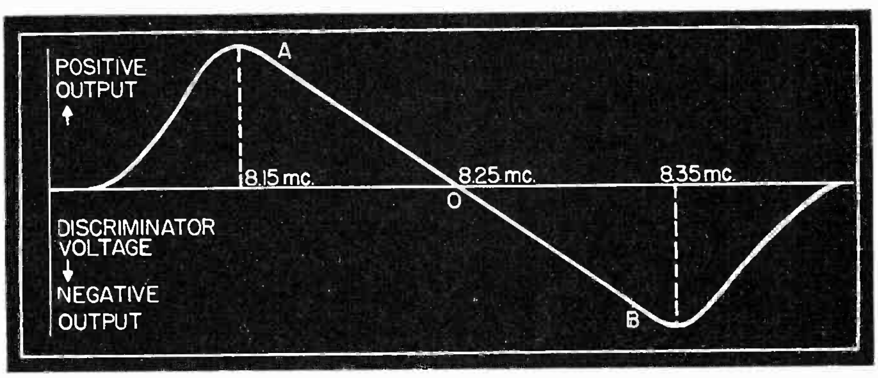

Fig. 5 Characteristic response curve of a typical discriminator as used in a television receiver.

The Sound Channel

→ From Preceding Page

parallel circuit is a maximum at the resonant frequency. Hence, at 8.25 mc, a strong IF signal voltage is developed across the tuned circuit. This voltage is coupled to the grid of the first sound IF amplifying tube. The circuit will not offer much impedance to the picture IF signal currents and therefore very little picture IF signal voltage will be applied to the first sound IF amplifier.

Usually two stages of IF amplification are required to bring the signal up to a level at which it can saturate the limiter so that it operates beyond point B on the curve in Fig. 4. From this point, the output of the limiter will remain constant. Should a signal be so weak that it causes the tube to operate within the region DAB, signal noise and distortion present will appear in the output and be passed on to the discriminator.

Greatest amplification is obtained from the limiter if grid-leak bias is used. See Fig. 7. The grid-leak resistor is also a convenient point to align the preceding IF amplifiers, for the voltage across this resistor will vary with the amplitude of the incoming signal. For the alignment of the audio IF stages, the vertical input terminals of the oscillograph are placed across the grid-leak resistor. The same sweep generator that was suggested for the alignment of the video IF stages may be used. It is fed into the IF amplifier across the control grid and ground. The curve that should be obtained is that shown in Fig. 3. To indicate the 8.25 mc on the pattern, place another oscillator in parallel with the sweep generator and set this unit to 8.25 mc. This will generate a marker point which appears as a slight pip on the curve. Now adjust the transformers of the audio IF stage until the response curve is flat to the 100 kc points above and below the 8.25 mc point. (These frequencies may be indicated by moving the frequency of the marker oscillator first to 8.15 mc and then to 8.35 mc. If there is a second IF stage, leave the oscillograph input across the grid-leak resistor, but move the sweep generator input to the next IF ampli-

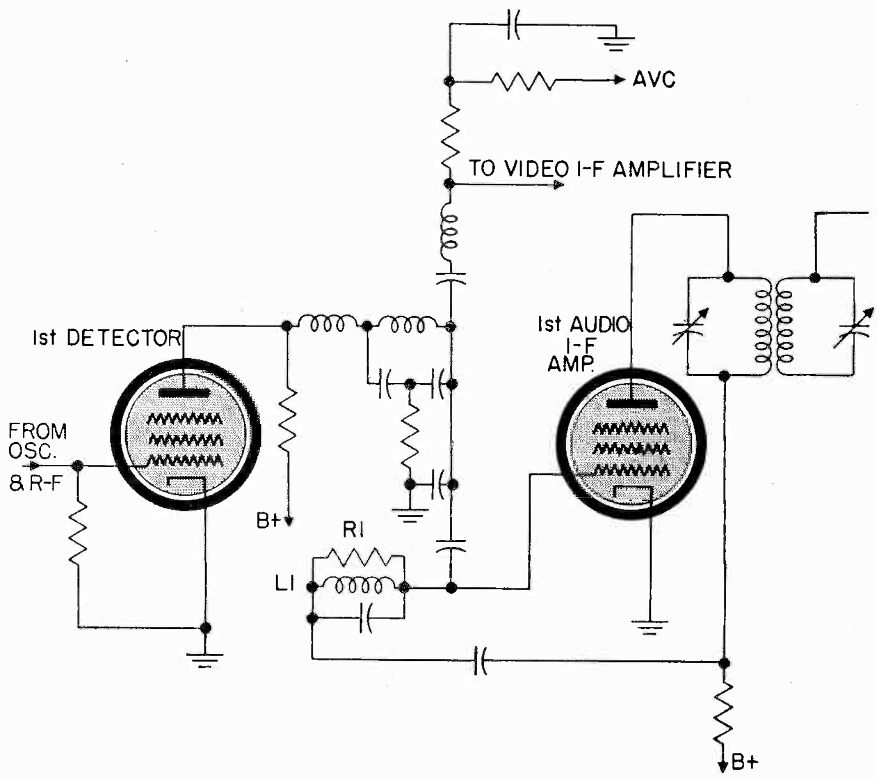

Fig. 6 Simplified diagram of first detector and first audio IF amplifier stages showing the parallel resonant circuit which is used to select the audio carrier and reject the video signal.

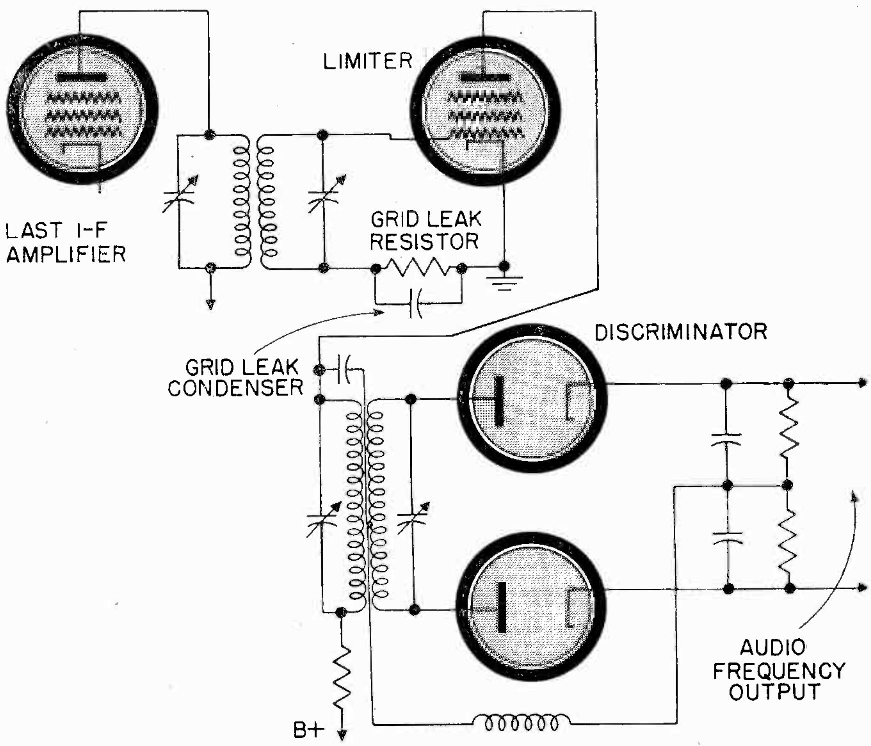

Fig. 7 Simplified diagram of the limiter and discriminator circuits. The limiter shown above uses grid leak bias.

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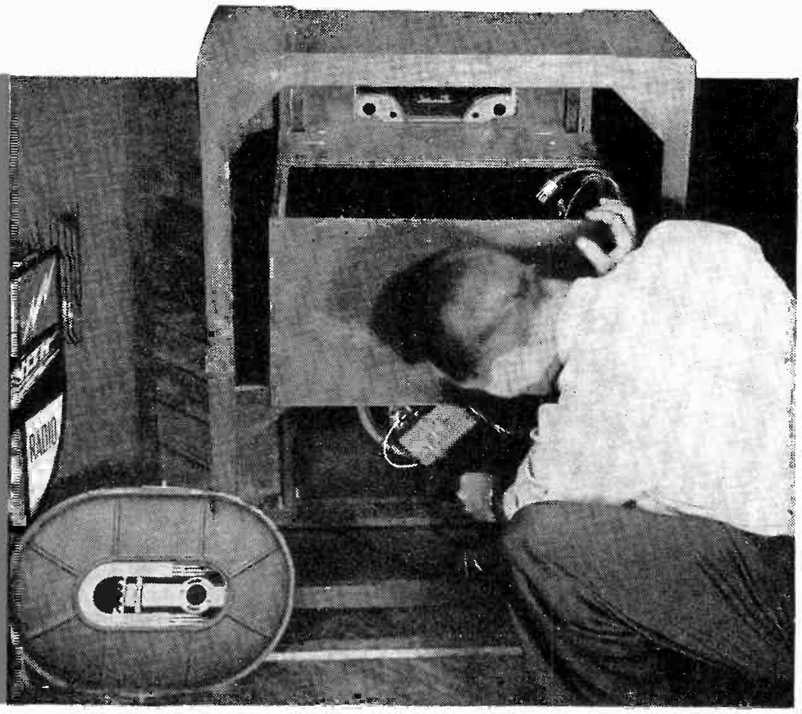

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→ from page 20
fier grid and repeat the procedure.

The discriminator is aligned by feeding the two oscillators (the sweep generator and the marker unit) into the grid of the first IF amplifier. The input to the oscillograph is connected across the output of the discriminator (the AF output terminals shown in Fig. 7). Another possible location would be at the grid of the first audio amplifier. The curve to be obtained when adjusting the discriminator tuned circuits is that of Fig. 5. The important thing to achieve in the alignment of the discriminator stage is the linearity of the portion of the curve between points A and B. If the discriminator input transformer has two adjustments, the primary winding adjustment will control the length of the linear portion of the curve. The secondary winding adjustment controls the position of the resonant frequency of the secondary, which should be midway between the two peaks.

The alignment of the audio amplifier is best done by a point-by-point check, feeding a sine wave from an audio oscillator and noting the output on an oscillograph. A complete description of this procedure is given in the December 1946 issue of Radio Maintenance in Part II of "The Oscillograph . . . How to Use It."

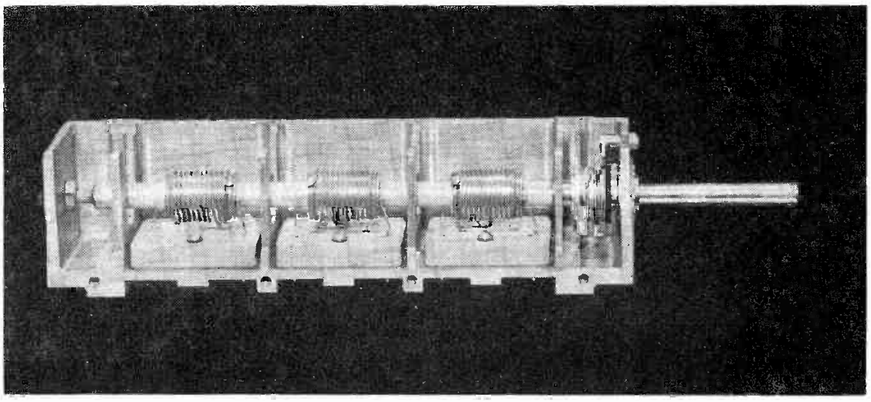
The understanding of the operation and alignment procedure of the sound channel makes the troubleshooting problem relatively simple. The usual faults fall into two basic categories in the audio system of a television receiver: (1) No sound at all, and (2) distortion of the sound.

Lack of sound is due to one of two types of general fault. The first is obvious and is due to an open lead or defective component in the audio channel. A stage-by-stage check should isolate such a fault quickly. The second cause for no sound reception lies outside of the audio channel in the RF section wherein the oscillator has drifted so far that the sound IF carrier and its associated side-bands fall outside the band pass characteristic of the amplifier system. This condition and methods for realignment were treated in detail in Part I of this series on the RF section. It was shown that the easiest way to localize this type of fault to the RF section is to tap the grid of the first audio IF amplifier. If the tapping sound comes through the speaker, the likelihood is that the audio channel is operating correctly but that the cause for no sound lies in the RF section.

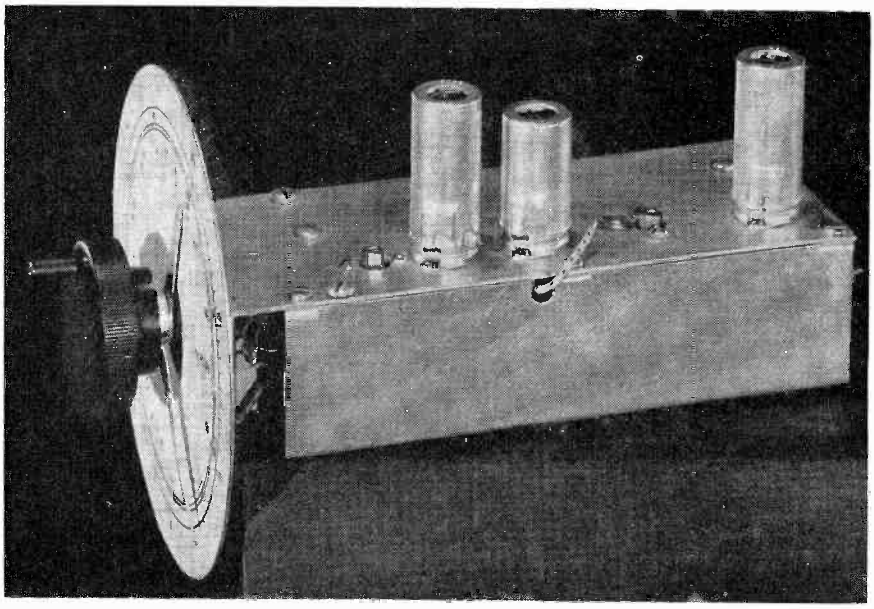
Location of the causes for distortion is most quickly accomplished by an alignment check starting from the audio amplifier and working through the discriminator, limiter, and IF amplifiers, using the methods described above. This alignment procedure constitutes in reality the troubleshooting attack in the audio system. If in the course of aligning a particular stage it is impossible to obtain the required band-pass characteristic, then a check should be made of the tube, the operating voltages, and any suspected off-value components. Reference to the manufacturer's manual will help in this case, since the latter usually contains typical operating voltages and also the characteristic band-pass curves of each stage.

This discussion of the audio system in a television receiver and the two previous articles on the RF section and the video channel have covered the circuits which bring the signal from the antenna up to the picture tube in the case of the video and through the loud speaker in the audio system. There remains for discussion those circuits which operate the cathode-ray tube and control the motion of the electron beam so as to produce the composite picture on the face of the tube.

In the next issue, we shall deal with one of these circuit units, the Vertical Sweep System. ✓ ✓ ✓

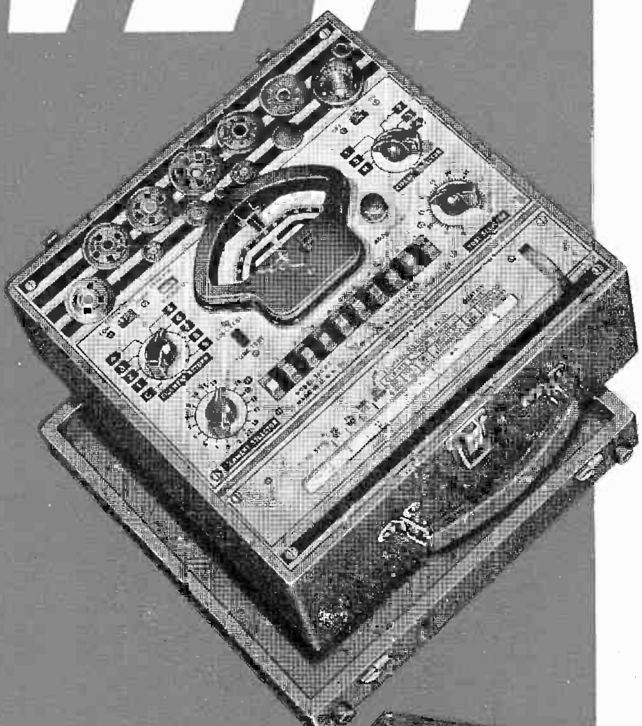


The Inductuner, a unit developed by Du Mont Labs. It provides an extremely wide tuning range from approximately 49 to 210 megacycles. Provision is made for RF stage, mixer stage and oscillator stage tuning.



The Inputuner, in which the Inductuner is used. The three shields cover the RF, mixer and oscillator tubes.

NEW . . . Simpson Model 305RC Tube-Tester with "No Backlash"* Roll Chart



With the addition of the new Simpson "No Backlash"* Roll Chart to the 1947 version of our Model 305, this famous instrument becomes beyond question the finest tube-tester on the market in its price range. Read the description of this new Roll Chart in the panel below.

Model 305RC provides for filament voltages from .5 volts to and including 120 volts. It tests loctalc, single ended tubes, bantams, midgets, miniatures, ballast tubes, gaseous rectifiers, acorn tubes, Christmas tree bulbs, and all popular radio receiver tubes.

Like other Simpson tube-testers, the Model 305RC incorporates 3-way switching which makes it possible to test any tube regardless of its base connections or the internal connections of its elements. This method, the result of exhaustive research and expensive construction, protects the Model 305RC against obsolesence to a degree not enjoyed by competitive testers. No adapters or special sockets are required. In addition to having a complete set of sockets for every tube now on the market, this tester has a spare socket, to provide for future tube developments.

The Model 305RC has provision for testing pilot lamps of various voltages as well as Christmas tree bulbs. It tests gaseous rectifiers of the OZ4 type—also tests ballast tubes direct in socket for burnouts and opens. Has neon bulb of proper sensitivity for checking shorts. This tube-tester is fused, and has the latest improved circuit. It provides for line adjustment from 100 to 130 volts, with smooth vernier control.

Model 305RC is distinguished for its beautiful exterior. It has a two-tone metal panel in red and black on a satin-finished background. Sockets and controls are symmetrically arranged for quick operation. The large, modern, fan-shaped instrument has an exceptionally long scale. It has "good" and "bad" English markings, also a percentage scale for matching and comparing tubes. Cases, both portable† and counter style, are made of strongly built hardwood, durably and beautifully finished.

Size, 11"x11"x6". Wt. 10 lbs. Shipping wt., 15 lbs.
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- Entire unit removable by taking out four screws. Just lift from receptacle to make new entries or install new chart.
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Counter Model 305RC. Same instrument as portable model, but set in fine walnut finished hardwood case, with tilted, easy-to-use panel.

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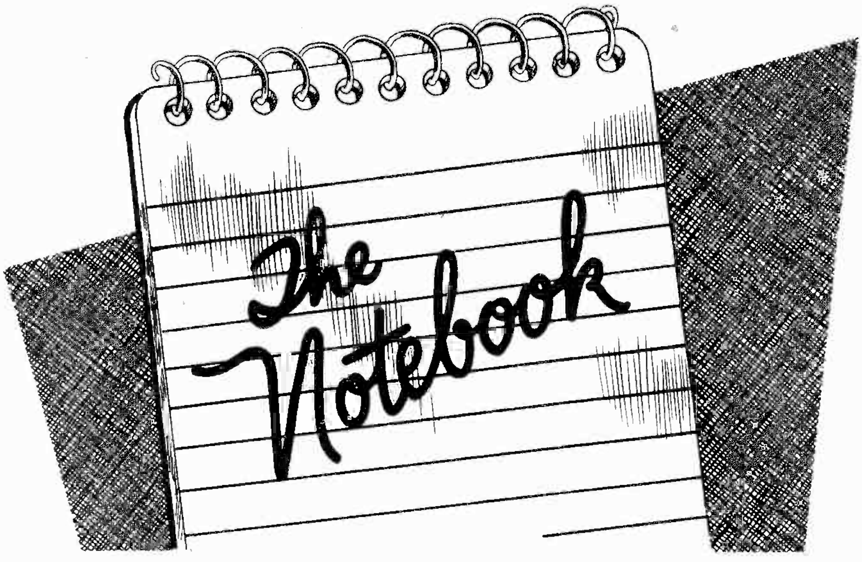

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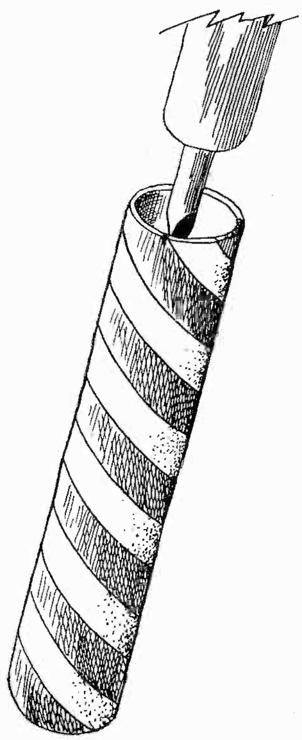
Portable Soldering Iron Holder

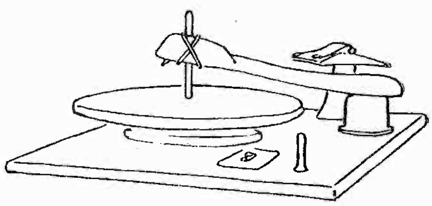
A GOOD PORTABLE soldering iron holder can be made out of a piece of aluminum tubing about 10 inches long and 2 inches in diameter. One end of the tubing is plugged with a piece of wood cut to fit. A piece of sheet iron or aluminum is tacked to the inside end of the plug to protect the wood from the hot iron. The tube is then wrapped in two or three thicknesses of sheet asbestos and the whole thing covered with friction tape. Another piece of asbestos is placed inside on the plugged end. This holder answers the question of what to do with the hot iron when returning to the shop from an outside call.



Bob J. Oja
Bob's Radio Electric Shop
Laurium, Michigan

Protecting Pickup Cartridges

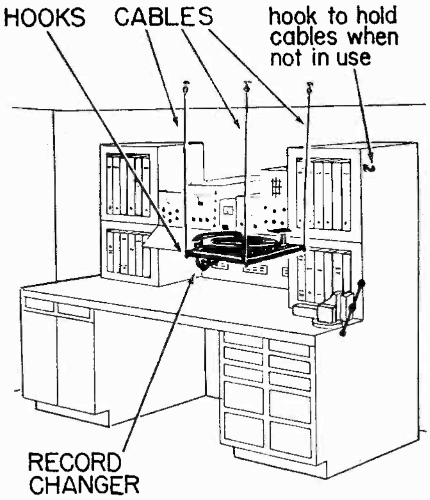
When a unit containing an automatic record changer is being moved to or from the shop, the crystal cartridge and needle can be protected from breakage by tying the pickup arms to the center post as shown in the accompanying diagram. The arm is placed near the top of the spindle and an elastic band is wound back and forth around them.



James E. Dalley
3133 Jefferson Avenue
Ogden, Utah

Record Changer Rack

A good record changer rack for use while doing a repair job can be constructed with three sash cord chains. The three chains are fastened to the ceiling above the bench with screw eyes. Hooks are used at the ends of the chains to hold the changer being worked on, as shown in the diagram. A hook or wire placed on the upper corner of the bench serves to keep the chains out of the way when they are not in use.



John Hoffman
Supreme Radio Service
St. Louis, Mo.

Bridging Filter Condensers

When bridging filter condensers, it is difficult to listen to the output of the set for elimination of hum. A doctor's stethoscope greatly simplifies matters. The end of the stethoscope (incidentally, they sell for less than three dollars) is placed in front of the speaker. Thus it is possible for the serviceman to move his head around and locate the condenser to be bridged.

W. Stuedeman
Radio Service Associates
East Orange, N. J.

Novel Bench

In small shops where it is often necessary to move a disassembled set from the test position, as when checking for an intermittent, or in large shops where a set is moved from one bench to another while being worked on, a bench con-

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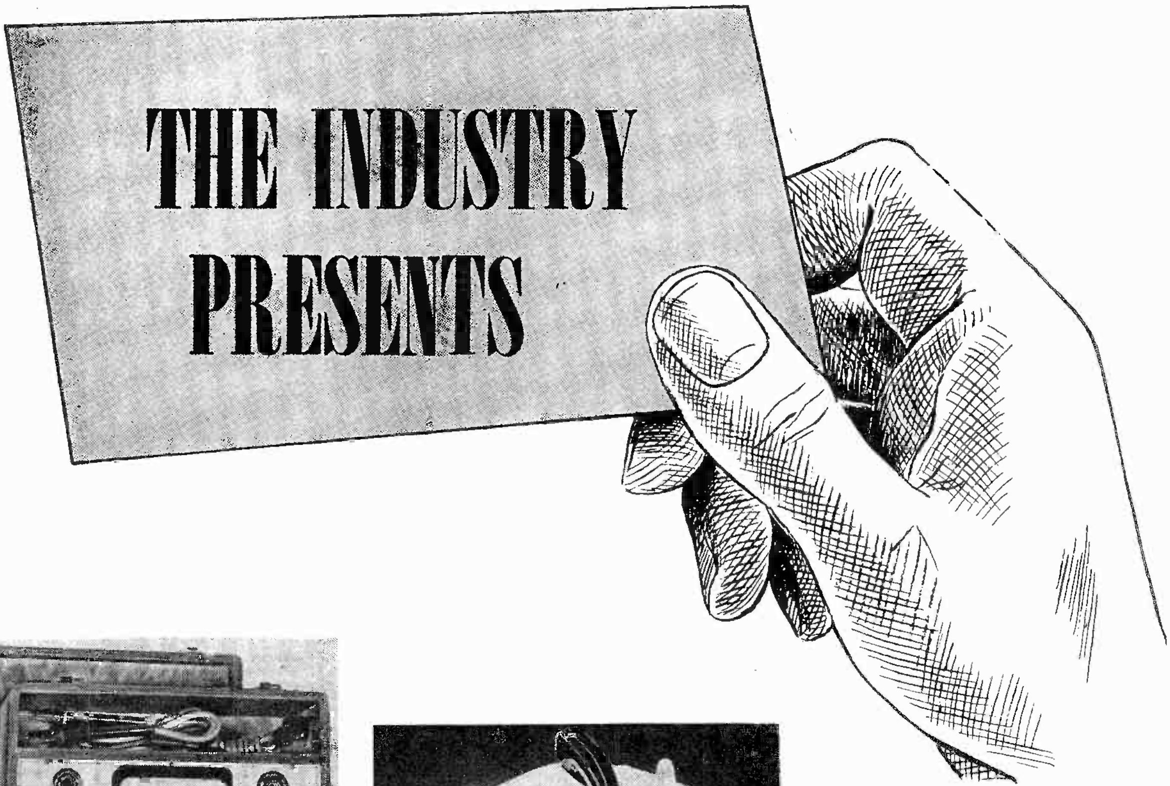
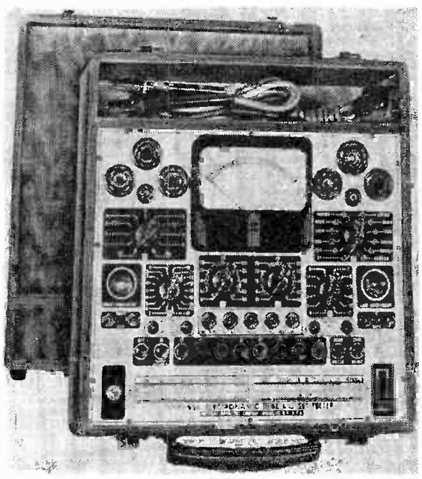




NEW TESTER

Precision Apparatus Company of Elmhurst, N. Y., announces their 954-P Electronamic Tube-Battery and Set Tester. This unit is a portable combination mutual conductance type vacuum tube tester, radio battery tester and 37-range supersensitive AC-DC multi-range set tester (ranges to 6000 volts AC and DC at 20,000 ohms-per-volt DC. It it useful for tube test, set measurement and other service problems in AM and FM. It has a wide-faced 4½ inch bakelite cased meter.

Outstanding feature is the Electronamic circuit, which in one operation tests all radio receiving tube types for both mutual conductance and cathode structure. Tubes and batteries are tested under load conditions and are rated on a simple 3-colored "Replace-weak-good" scale, in addition to the calibrated reference scale. It features an automatic push-button system. All regular AC-DC analyzing connections are made through only two polarized pin-jacks. The 954-P provides wide range current scales from 60 microamperes to 12 amperes; resistance to 60 megohms and db ranges to 70 db.

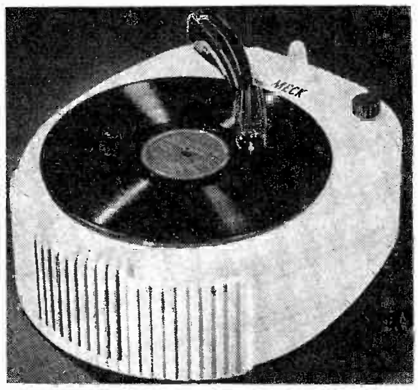
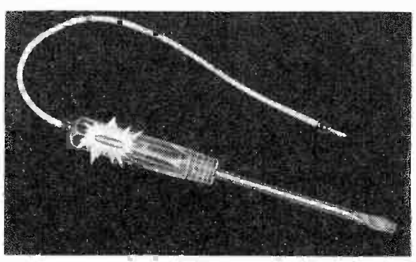


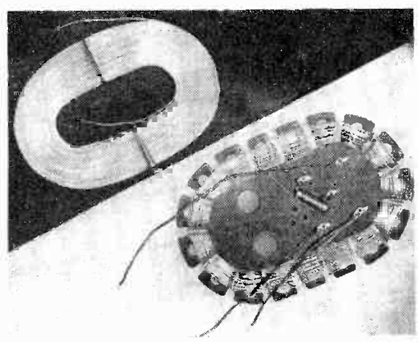
TABLE RECORD PLAYER

The production of a new table-model record player, Model 3 A6-P8, by John Meck Industries, Inc., of Plymouth, Ind., is under way and distribution to dealers and jobbers is now in progress. This model, the Saratoga, is encased in a white plastic cabinet, approximately 11" wide, 4" high and 15" deep. It has an electronic amplifier, crystal pickup, a 4" electrodynamic speaker, and a heavy duty motor.



ELECTRICAL SCREW DRIVER

A new combination circuit tester and electrical screw driver has been announced by the Ox-Wall Tool Co., of New York City. It is a safe electrician's screw driver with a long-life transparent plastic handle, plus an all-purpose test lamp for fuses, outlets, cords, radios, etc., for 105-550 volts AC or DC. It operates on a principle that eliminates false indication. It is a neon test lamp that lights on any house voltage, won't burn out, won't light on capacity and leakage. The lead is detachable and leaves the tester free for use as a screw driver and for testing ignition circuits.



LOOP ANTENNA WIRE

A small diameter, polyethylene insulated wire for home radio receiver loop antennas has been developed by Federal Telephone and Radio Corporation, Newark, N. J. K-1044 wire is constructed of bare soft copper #24 awg. This wire adds additional sensitivity and selectivity to the radio receiver. Electrical losses at radio frequencies are extremely low. The "Q" factor of an average size loop (6" x 9") reaches and often exceeds 200. Treatment of the wire with polyethylene makes it possible to design a coil without support. Polyethylene-insulated wire is highly resistant to water, acids, alkalies and oils, insuring efficient receiver operation under all atmospheric conditions.

ELECTRONICALLY SPEAKING

RADIO TUBE PRODUCTION is now 40 per cent above the 1941 monthly average, according to a year-end statement made by M. F. Balcom, Chairman of the RMA Radio Tube Committee and Treasurer of Sylvania Electric Products Inc. Though tube demands continue to be far above earlier estimates, the present rate should meet most requirements. As production is increasing, no serious tube shortage is anticipated by the end of the first quarter of 1947.

In spite of strikes, raw material and labor shortages during the first half of 1946, the salutary effect of OPA-authorized price increases, followed by the total decontrolling of all radio tubes and parts during the last quarter of the year, eased the situation. The release of military surplus standard type tubes also helped matters.

PENNSYLVANIA SERVICEMEN have taken a long stride forward in organization with the formation of the Federation of Radio Service Men's Associations of Pennsylvania. At present member organizations consist of the Philadelphia Radio Service Men's Association, The Luzerne County Radio Service Men's Association, The Radio Service Association of Pittsburgh, Associated Radio Service Men of Central Pennsylvania, and the Harrisburg Radio Service Men's Association.

Dave Krantz, President of the Philadelphia Association was elected Temporary Chairman of the Federation. Art Guild of the Central Pennsylvania Association is the Temporary Secretary. Dave Krantz states that the purpose of the Federation is to further the aims and purposes of the local organizations and their members. At present, the group is planning to assist member organizations in their educational programs and is setting up a committee to obtain and distribute technical data and information.

THE FOURTH SESSION of the Du Mont Television Familiarization Course was held February 4-6 in New York City. Rigid screening examinations to prove themselves already familiar with television service were held for the servicemen applying for the course. This course deals specifically with Du Mont telesets and is for the purpose of insuring proper installation and maintenance.

AN UNUSUAL ADVERTISING CAMPAIGN has been started by John Meck Industries in the Saturday Evening Post. It consists of a series of half-column ads which suggest that radio owners should patronize their local radio repairmen in order to overcome the results of the wartime period when repair parts and service were difficult or impossible to obtain. There is no suggestion that new radios be purchased nor that the repairman chosen should have any connection with a Meck dealer.

"The radio repairman who somehow managed to survive the difficulties of the war years deserves all the help that can be given him by radio manufacturers," says John Meck. "He is an essential part of the radio business. Aside from that, he has a more thorough knowledge of radio from the consumer's viewpoint than anyone else."

THE FCC issued revised figures on receiver ownership in the United States late in '46. Standard or AM sets totalled 66 million; FM sets 500,000; television sets 7,000.

OVER THE BENCH

by John T. Frye

EDITOR'S NOTE: "Over the Bench" will be a monthly feature from now on. Mr. Frye will present his ideas on a wide range of subjects. John T. Frye has been a serviceman since the late Twenties, and we feel that he is qualified to discuss these subjects. At present, he is hanging his sign in Logansport, Indiana. They will be his ideas and as he himself says, "They may not always agree with yours, nor may they always be right." If you have anything you would like to say about the subjects he discusses, write us. All letters will be thoughtfully read and anything we feel is of current interest to your fellow servicemen will be passed on in the pages of this publication.

Address all mail to Mr. John T. Frye, c/o Editor, RADIO MAINTENANCE, 460 Bloomfield Avenue, Montclair, N. J.

When the editor of Radio Maintenance asked me about writing a column for this magazine, I accepted with unseemly haste. When such an opportunity to do what I had always wanted to do was in the offing, it was no time to be coy.

Radio Maintenance, you see, is the kind of magazine I have always wanted to see on the newsstand. I have long preached that it is high time radio servicing came into its own. It has been treated as a poor step-child far too long. The first step toward achieving such recognition is the acquiring of a "voice," that is to say, a magazine devoted to and interested in our problems—and in nothing else. Instead of having our interests pushed off into the back pages, we have in Radio Maintenance a whole magazine that is exclusively ours. Having a small part in the writing of such a publication is everything that I could ask for.

Let me make one thing clear at the outset: This column will wander over a wide range of topics in the following months, but it will always be distinguished by two characteristics. First, it will always be written *for Servicemen,* for you solder-slingers yourselves. Sometimes the program may sound a little fuzzy, like a set with a leaky coupling condenser, but you had better listen anyway, for it is directed straight at you.

Secondly, it is written *by* a serviceman. These fingers on the keys right now have soldering-iron burns across the backs and little flecks of that stubborn speaker cement on the nails. Every day, just as you, I am sweating out intermittents, trying to get the oscillation out of four-tube midgets, tapping 75s and 6A7s on the gridcaps with a piece of fiber to see if they are the cause of those abrupt changes in volume. No longer than an hour ago, I patiently explained for the umteenth time, "But, Madam, I know you had a new condenser put in last year, but this is a different one. You think that a radio has only one condenser, apparently; actually, it has around half a hundred."

I have to bite my tongue just as hard as you do when the customer says nonchalantly, "I am sure there's not much wrong with this set. It was playing all right when we shut it off last night, but it smoked when we turned it on this morning. Probably some little thing like a wire off, or something."

And just like you, I think about this radio servicing business while the soldering iron is heating, while I am waiting on an intermittent to cut out, etc. Out of this thinking have come several ideas that I should like to talk over with you, ideas that range all the way from the best thing to do with those jobs that "Jump away up in volume when we turn on a switch anywhere in the

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Selenium Rectifiers

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us consider the construction of an ohmmeter. It may be represented in simplified form as a milliammeter in series with a resistor and a battery (Fig. 8C). Assume that the ohmmeter is placed across the selenium rectifier with the polarity of the meter as indicated in that diagram and that it reads 10,000 ohms. Reversing the meter leads, as in Fig. 8D, results in a reading of 100,000 ohms. In an ohmmeter, the current through the meter increases as the resistance being measured decreases. This indicates that the proper direction of current flow for the rectifier being checked is from B to A.

Comparing the selenium rectifier to a diode in which the current flows from the cathode to the plate, B is equivalent to the cathode and A is equivalent to the plate. Therefore, A should be connected to the AC line. The manufacturer's marking would show a yellow dot at A and a red dot at B. Following this simple test procedure will, in case of doubt, avoid erroneous connections and ruined rectifiers.

The first sample replacement procedure to be described is for a 117 volt rectifier tube. In this type of rectifier circuit (shown in Fig. 9A), the filament voltage for the other tubes in the circuit and the B+ voltage are secured from a voltage divider, and are therefore proportional. The internal resistance of the rectifier is an important factor in maintaining the proper filament voltages. If this resistance should be decreased, both the B+ and filament voltages would necessarily increase. The latter, of course, is undesirable as it shortens the life of the filaments. Hence, when a 117 volt tube is being replaced by a selenium rectifier, the difference in the internal resistance of the two must be taken into consideration.

The following operational steps (Fig. 10 illustrates these steps) are recommended:

1. If the tube being replaced is still good, measure the original B+ and filament voltages.
2. Add properly color-coded extension leads (red for the positive side and yellow or black for the negative). If the unit is to be self-supporting, number 12 or 14 bus wire may be used.
3. Solder the red lead to the cathode pin of the tube socket.
4. Solder the yellow lead to one end of a 27-ohm, 1-watt resistor.
5. Solder the other end of the resistor to the plate pin of the tube socket.
6. Check to see if the B+ and

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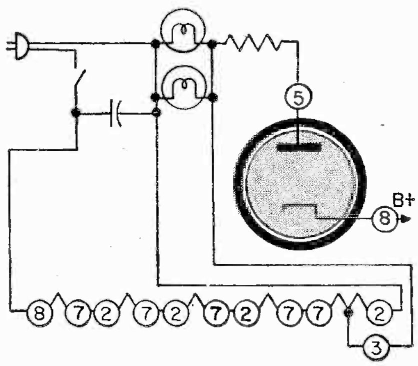


Fig. 11 A power supply circuit using a 35Z5 rectifier tube and two pilot lights.

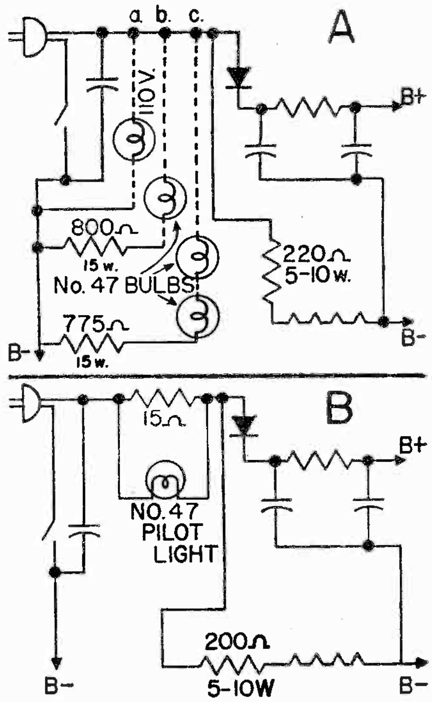


Fig. 12 Four ways in which the pilot light may be connected when converting a power supply using a 35Z5 rectifier to a selenium rectifier unit.

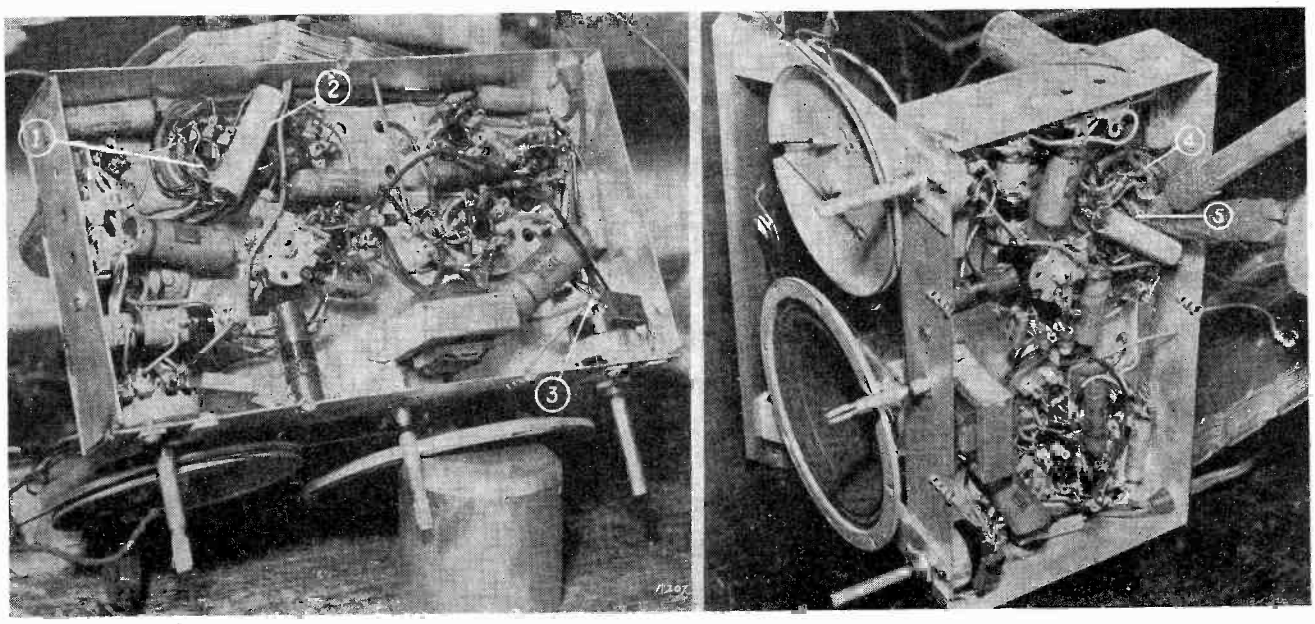
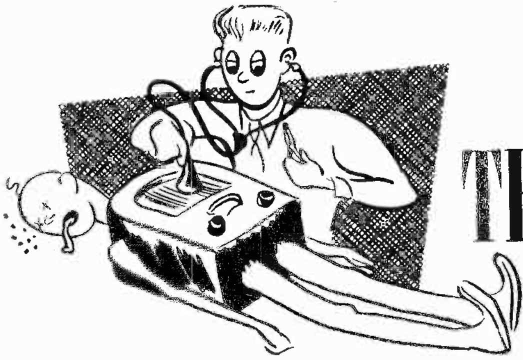


Fig. 13 Underside view of a chassis showing the connec tions used when installing a miniature selenium rectifier.



THE PATIENT

Don Blair

ACCURATE TROUBLESHOOTING is the cornerstone upon which a successful repairing career is built. Neat soldered joints and the workmanlike replacement of defective parts are always the sign of a careful worker; but sharp diagnosis will forever remain the screen that separates the gold from the sand.

Thorough diagnosis defines not only the immediate source of trouble, but goes deep enough to ascertain the original cause, and thus points out a repair procedure to prevent the trouble from recurring.

Simply replacing a defective part without debating the cause of its failure is very often the reason for a call-back. And every repairman worthy of the name knows how embarrassing and unprofitable these can be. We should remember that even a simple job entails checking every possible question if the job is to be completely and honestly done. Fortunately, in the majority of routine repair jobs, the investigation of basic cause requires only a moment.

For every effect or failure then, there will be a cause; and our diagnosis will not be complete and dependable unless that cause is found, examined, and remedied.

The need for examining the basic cause for a tube or part failure is constant even in new equipment. Engineers and designers are human and fallible, just as we servicemen are fallible. But a point to remember is that it is never wise to condemn another man's work until we are thoroughly certain he was wrong. In the case of the designer, he is under pressure to keep costs down; and skirts the danger line between safety factor and parts failure many times oftener than his failures would imply.

Complete diagnosis requires more than the investigation of trouble and its causes. It thrives on experience and accurate memory of similar cases, to wit:

Doc pulled his car up in front of the shop one evening just as I was dousing the lights after a long, hard day.

"Car radio on the bum," he said. "I've got some traveling to do tonight. Could you fix it now?"

"I'll try," I answered, wearily turning the bench lights on again.

Investigation showed mechanical hum, but no sound in the speaker.

"Sounds like a bad tube," I said, suspecting an OZ4. The set was mounted in such a way that it seemed easier to remove it from the car than to try to replace the tube in under the dash. When I opened the set on the bench, I found the RF-IF assembly but no audio or rectifier. Then I remembered that the power supply and audio section in that model was crowded into the innocent looking round speaker case. So I replaced the radio, removed the speaker housing and found the thing I had been looking for—a bad OZ4.

As I finished the job, Doc chided me, "Faulty diagnosis, but the patient survived."

Tired, I replied, "Yes, but you fellows have an easy job compared to ours. You work on the same two models all the time! Why, if you doctors find a patient with his stomach upside down, you make the front pages of all the newspapers in the country. And if that engineer had not put your radio's heart where its larynx ought to be, we'd have been out of here an hour ago."

Coming:

Articles on

ANTENNAS

The Notebook

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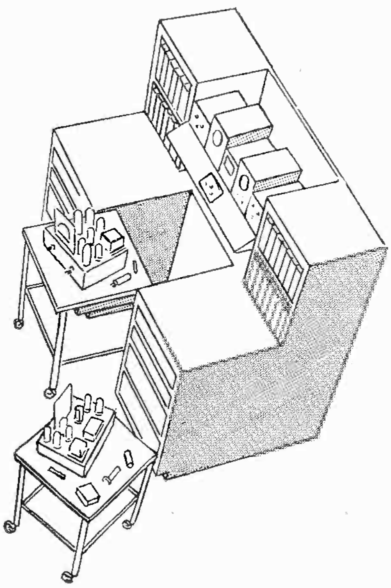
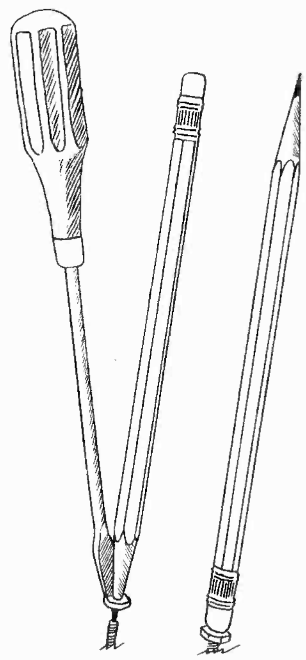
structed as shown in the accompanying diagram is very useful. The center section of the bench is cut away and two or more small tables are built to fit into the space. The tables are mounted on casters



and can be moved in and out of the test position at will. In this way a disassembled set can be moved about the shop without difficulty.

Clay B. Seidel
Neighborhood Radio Service
Camden, N. J.



Starting Screws

It is sometimes very difficult to start a small nut on a screw in a close place. A lead pencil and small

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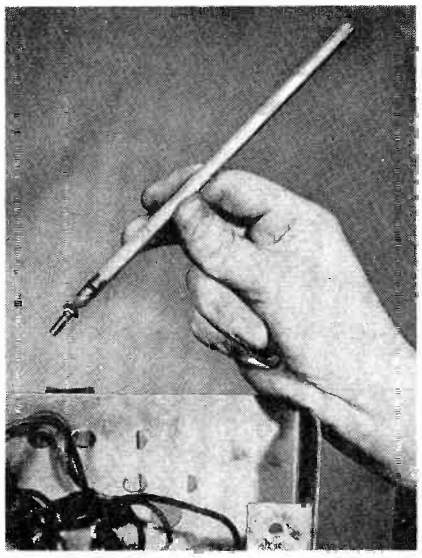
screwdriver used as shown in the diagram are of great assistance. The nut is placed on the sharpened end of the pencil and pushed lightly until it is held. The pencil point is placed on the end of the screw; and using the screwdriver, the nut is pushed off the pencil and held in place. The pencil is then reversed, and the eraser end is used to start the nut. (ED. NOTE: A pencil can also be used to advantage when starting a machine screw in a hard-to-get-at spot, as shown in the accompanying photograph.)

D. G. Ballard
Belmont, N. C.



IMPORTANT

RADIO MAINTENANCE is inaugurating a new department for the purpose of reporting on the activities of servicemen's organizations.

We feel that this column will be of vital interest to our readers. If you are a member of an organization, we would like to hear from you. We would also like to know the names and addresses of the officers of your group so that we may write them and tell them how your organization can obtain writeups in this new column.

Many other organizations have already expressed a desire to participate. So let's hear from you.

Selenium Rectifiers

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filament voltages are within at least 10 per cent of the required values. If not, the 27-ohm resistors must be changed to obtain the correct reading.

In order to save time when determining the corect value of resistance to be placed in series with the rectifier, two Fahnestock clips connected to two alligator clips and leads may be mounted on the work bench. The experimental value of resistance may be placed between the Fahnestocks and the alligator clips connected to the yellow lead of the selenium rectifier and the plate pin respectively. The voltage readings may then be taken; and when the proper value of resistance has been determined, it may be soldered permanently into the circuit. Incidentally, this same set-up may be used for general trouble-shooting purposes.

The replacement of such tubes as the 35Z5 presents a different problem. In this case, not only is the 35Z5 filament in series with the others, but in addition, the dial light derives its potential from half the filament as shown in Fig. 11. Unlike the 117 volt tubes, the drop across the tube may be neglected.

The size of the resistor to use in place of the filament may be calculated in the same manner as a line cord resistor by means of Ohm's Law. The filament voltages of the remaining tubes are added, and the result subtracted from 120. This difference is the voltage to be dropped across the substitute resistor. As the filament current is known, the value of the resistor may be found by the formula $R = \frac{E^1}{I_1}$. It is essential to use the proper wattage rating as well. A wattage of *twice* the calculated value ($W = E \times I$) is recommended. For the 35Z5, a 220 ohm, 10 watt resistor will suffice.

The pilot lamp circuit presents various possibilities depending on the original circuit. Fig. 12A and 12B illustrate four alternatives, as follows:

(A) A 110 volt bulb across the line.

(B) A number 47 (brown bead, 6-8 volt, 150 mil.) pilot light in series with an 800-ohm, 15-watt resistor across the line.

(C) Two number 47 pilot lights in series with a 775-ohm 15-watt resistor across the line.

(D) A number 47 pilot light in parallel with a 15-22 ohm 1-watt resistor, depending on the amount of illumination desired.

The sample replacement procedure for a 35Z5 illustrates the use of a 110-volt bulb such as the 10-watt 10C7. The advantage of this is twofold; more light and the isolation of the pilot light from the rest of the circuit.

The first step is, as before, to solder properly color-coded extension leads on to the selenium rectifier. A jumper wire is then placed between pins 2 and 3 (1 on Fig. 13, photo) to short out the original pilot light circuit. Next a 220-ohm, 10-watt resistor is soldered between pins 3 and 7 (2 on Fig. 13).

The extension leads may then be brought down through the tube socket. One side of the 110 volt bulb and the yellow lead of the rectifier are then soldered to pin 5 (4 on Fig. 13, photo). The red lead is then soldered to pin 8 (5 on Fig. 13) and the other side of the 110 volt bulb to B—. A handy place for this connection is the "dead" side of the "on-off" switch. Placing it on the other side of the switch would obviously cause the light to be on all the time. After completing the installation, the B+ voltage and the overall performance of the set should be checked. In situations where no series resistor is used with the rectifier, an optional refinement is to insert a fuse where the resistor would be ordinarily be. Then if the input filter condenser should short, causing a shorted rectifier, the house fuse would not be blown.

Many other tubes may be replaced by the selenium rectifier. Unfortunately, it is impossible to cover all these installations. However, the ones described are typical. It is suggested that the serviceman keep a record of pertinent information when making a replacement so that it will be available for future reference. Having this information at hand will save valuable time. ✓✓✓

Over the Bench

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house" (No, I don't mean burning them in the furnace!) to whether radio servicing should be termed a profession or a trade.

Naturally, since I am their parent, I am proud of all of these ideas; but that does not signify that they are *all* good. That is where you come in. I want to hear from you. Let me know what you think of what I write. If you disagree, tell me where I make my mistake. If you think along the same lines, let me know what you have to add; pick up the idea where I leave off and take it from there. Anything that applies to radio servicing is of deep interest to me, and anything you have to say on that subject will be thoroughly studied.

To give you something to be thinking about, here are some of the ideas that I expect to take up in deail in future columns:

I believe that radio servicing has proved during the war that it is a remunerative business in itself, instead of the "rent payer" or "customer contacter" that many insisted on considering it prior to the time it was forced to carry the load during the years when there was nothing tangible to sell. If a garage can operate independent of an automobile sales room, so can a radio repair shop operate upon repair business alone—if it is properly handled.

I think that the radio serviceman is doing a job that calls for much more intelligence, training, and experience than many servicemen themselves realize. There are too many people who think of radio

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The Oscillograph . . .

How to use it

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negative envelope of the signal. This is available at a different part of the circuit. With a diode detector, for example, the envelope of the IF signal is available across the diode load resistor, and this same voltage envelope is also available across the volume control in conventional circuits, as shown in Fig. 6. Therefore, the high side of the oscilloscope vertical amplifier input may be connected at A and the low side to ground. In all cases, the low (or ground) side of the oscilloscope should be connected to the chassis ground of the receiver.

In receivers using infinite impedance detectors, the high side of the oscilloscope should be connected to the cathode of the detector, and the low side to ground. In the case of grid leak and biased detectors, the high side of the oscilloscope should be connected to the plate of the detector; the low side to ground. If the plate load for this type of detector is a choke coil, or if the detector is coupled to the first audio stage by means of a transformer, insert a 20,000 ohm resistor in series with the plate and short-circuit the choke or the primary of the transformer in order to eliminate the reactive component of the load. This arrangement is shown in Fig. 7.

Connect the sweep-frequency-modulated signal (from whichever type generator is being used) to the grid of the last IF stage through a .001 ufd condenser. Set the mean frequency to the intermediate frequency of the set (usually 460 kc, exact value obtainable from manufacturer's service notes). We will here consider 460 kc as the IF. With the oscilloscope connected as above, adjust the oscilloscope controls to obtain a pattern of suitable intensity, properly focused, with the sweep and synchronizing controls set to give one synchronized pattern for each complete frequency variation (e. g., 435 to 485 to 435 kc). With the signal generator on, turn off frequency modulation and turn horizontal gain of the oscilloscope to minimum. Adjust the IF trimmers to obtain a vertical line of maximum amplitude. Keep the signal generator output as low as possible to prevent AVC action from flattening the response. If necessary, turn up the vertical gain of the oscilloscope. Set the receiver tuning dial of the set to some point where no interfering signal is passed on to the IF amplifier, and short the antenna input terminals. Turn on the frequency modulation to the signal generator. The pattern on the screen should now be similar to Fig. 8. This is purely an example since the IF response can be almost any curve at this point.

Fig. 8 shows a typically unbalanced response curve. It will be noted that the two curves are near mirror images of each other. In order to obtain a clearer idea of the distortion present, both curves can be superimposed on each other by doubling the oscilloscope's horizontal sweep rate. When properly synchronized, the oscilloscope will now show a double trace representing the two curves: 435 kc—485 kc and 485 kc—435 kc. The pattern should now resemble Fig. 9, or

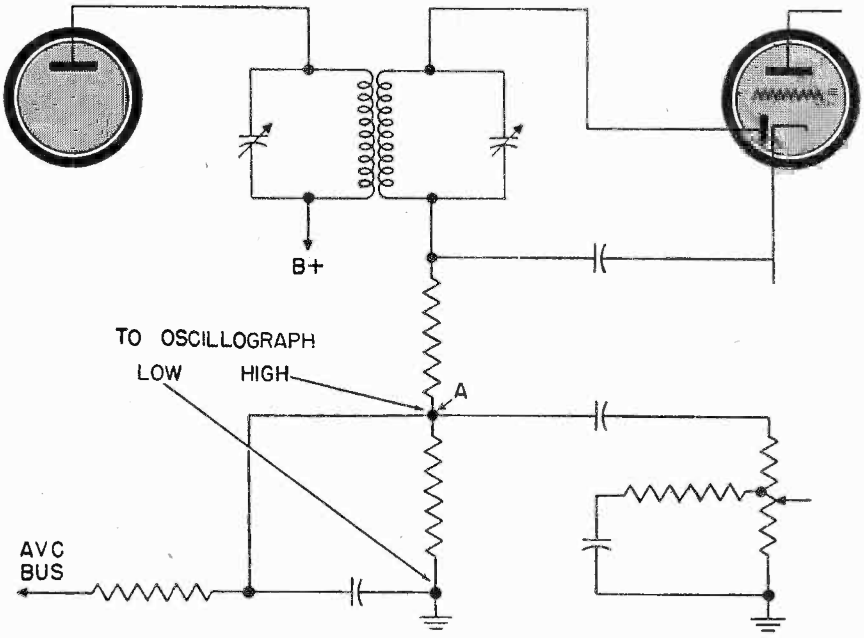

Fig. 6 Points at which the oscillograph leads are connected to a receiver using a diode second detector.

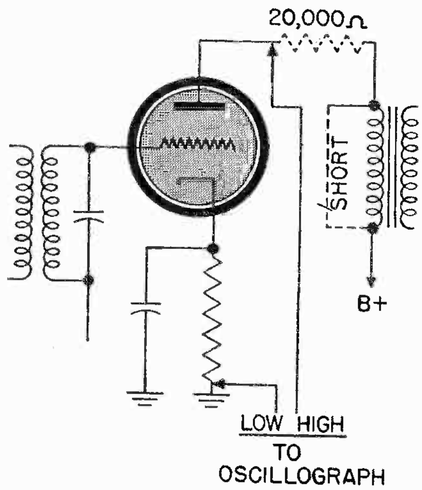

Fig. 7 Points used when connecting the oscillograph to a receiver using biased detector. A 20,000 ohm resistor is inserted in the plate circuit and the primary of the transformer is shorted out.

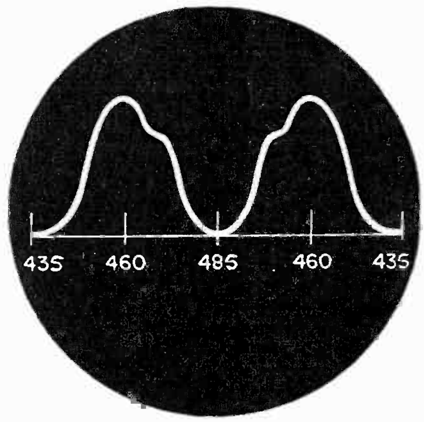

Fig. 8 The appearance of an improperly adjusted IF amplifier with the oscillograph synchronized at a rate of one sweep per rotation of the motor-driven condenser. If a reactance tube modulator is being used, the synchronization is at power line frequency.

rather the relationship between the two curve patterns observed should be the same as that shown in this example. Readjust the IF trimmers to make the two curves of maximum amplitude and as symmetrical as possible (i.e., overlap as closely as possible). When properly adjusted, the two curves appear as one line. Now, reduce the output of the signal generator and shift the input connection to the grid of the first detector or mixer tube. The pattern should change its appearance, becoming narrower and more peaked. Adjust the trimmers of the first IF transformer for maximum amplitude, retaining the symmetry of the two traces (readjust the other trimmers slightly, if necessary). If the IF amplifier has variable selectivity, make these adjustments at the sharp or maximum selectivity position; then check the curves at the broad or minimum

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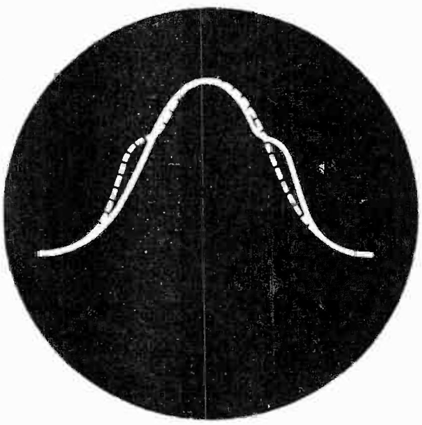

Fig. 9 The same intermediate frequency response as that shown in Fig. 8 with the oscillograph sweep synchonized at twice the former rate. The solid line indicates the response for the half cycle at increasing frequency, and the dotted line represents the response at the decreasing frequency half cycle.

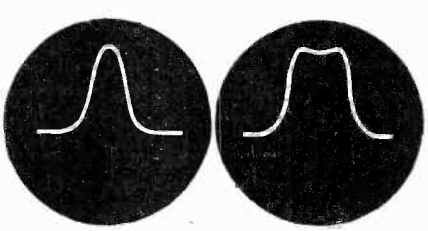

Fig. 10 The response traces for two different degrees of selectivity: On the left for sharp, and on the right for broad.

The Oscillograph . . .

How to use it

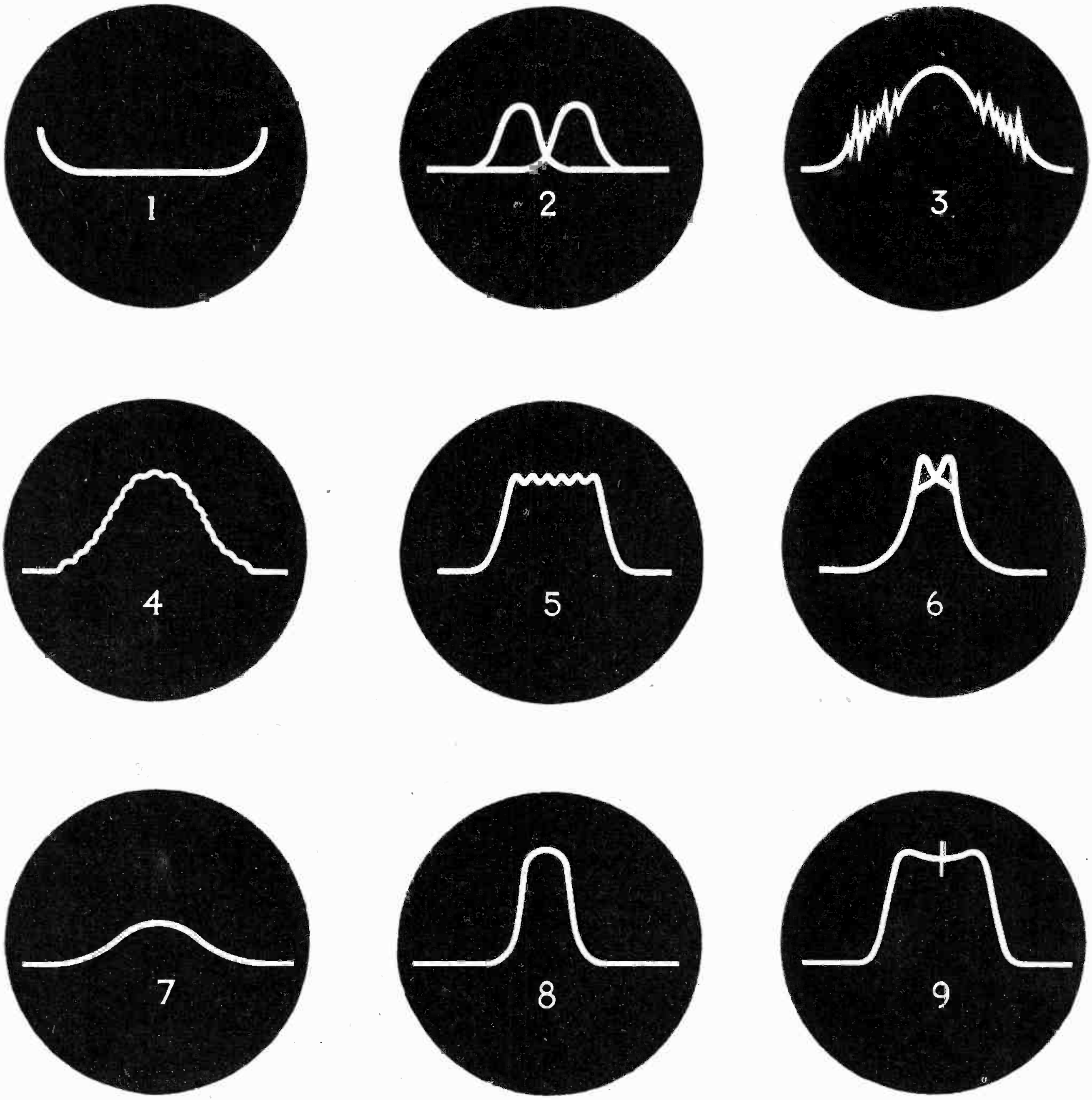

Fig. 11 Typical patterns observed on the oscillograph screen. (1) Signal approximately 20 kc off resonance of IF amplifier. (2) Signal approximately 5 kc off resonance. To correct (1) and (2), be certain signal generator frequency is right, then adjust trimmers to make curves coincide, as in (8). (3) shows presence of spurious signal from external source. (4) "singing" in IF amplifier. While (5) has good selectivity, as shown by steep sides of curve, ragged top indicates overload of oscillograph or IF amplifier. Reduce output of signal generator. (6) shows a symmetrical alignment. These two curves can be made to coincide by suitable adjustment of trimmers. (7) shows broad curve, such as is generally obtained from first step of the alignment, with only one tuned IF transformer. Increase the vertical gain of oscillograph to obtain higher curve, for greater ease in observing results of adjustments. (8) shows good curve for IF amplifier. Top of curve is fairly broad, and sides are steep. (9) shows double peak effect for higher fidelity. Curve is symmetrical, both peaks of equal amplitude, and equally spaced from frequency of resonance. Sides are fairly steep, a condition indicating good selectivity. Curve (9) characteristic of over-coupled double-tuned transformer-coupled amplifiers.

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position. Fig. 10 shows the relative appearance of the traces for these two conditions.

Fig. 11 shows several different types of patterns that may be observed on the screen of the oscilloscope in the course of aligning an IF amplifier. In all cases, the sweep range was ±25 kc. Patterns 1 to 6 show incorrect conditions. Patterns 7 to 9 are satisfactory.

Audio Oscillator

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of V_1. Therefore, for the plate of V_2 to feed back a voltage with *no phase shift* to the grid of V_1, R_1C_1 must equal R_2C_2. Thus, for a given setting of R_1, C_1, R_2, and C_2, only one frequency will have zero phase shift through the Wien Bridge, and will hence be the only frequency to arrive at the grid of V_1 exactly in phase with the original signal. This resonant frequency is

$$f = \frac{1}{2\pi\sqrt{R_1C_1R_2C_2}}$$

$$f = \frac{1}{2\pi R_1C_1} \quad (\text{since } R_1C_1 = R_2C_2)$$

The reason for the lamp in the cathode of V_1 is this: If the amplitude of oscillation should increase, the plate current through the lamp will of course increase, making the filament of the lamp hotter and its resistance greater. This greater resistance increases the negative feedback voltage applied to the cathode of V_1 directly from the plate of V_2 (see Fig. 5). This lowers the gain of tube V_1 and decreases the size of the oscillation to its normal condition. Similarly, should the oscillations fall off slight-

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ly, the plate current through the lamp will decrease, making the filament of the lamp cooler and its resistance consequently less. This lower resistance will decrease the amount of negative feedback applied to V_1 cathode, increase the gain of the tube, and consequently restore the amplitude of ocsillation to its correct higher value. The lamp thus serves as a stabilizing influence on the oscillator output. While the lamp is mentioned as in the negative feedback circuit, the same results can be obtained by placing it in the positive feedback half, with slight circuit modifications.

Beside this stability of output, the Wien Bridge type of audio oscillator is generally preferred to the phase-shift type of audio oscillator because it can more readily be made to cover a wide range of frequencies; and, once set to a given frequency, it is less likely to shift in frequency because of the two actions of the Wien Bridge: Attenuation and shifting of phase of unwanted or extraneous frequencies.

As an example of a complete Wien Bridge type of audio oscillator circuit refer to Fig. 6.

By comparing Fig. 6 with Fig. 5, it can be seen that R_4 R_5 and R_6 of the complete oscillator correspond to R_1 of the simplified Wien Bridge oscillator of Fig. 3; C_1, C_4, and trimmer condenser correspond to C_1; R_1, R_2, and R_3 correspond to R_2; C_2 and C_2 correspond to C_2. R_8 corresponds to R_3; R_7 and F_1 correspond to the lamp branch of the Wien Bridge. C_6 and C_{11} are merely coupling or blocking condensers and can be neglected in a critical study of the schematic diagram. C_5 is a screen-to-cathode bypass condenser.

Two pentodes, a 6SJ7 and a 6F6, are used for V_1 and V_2, the oscillator tubes. The output from the 6F6 is coupled through a gain control potentiometer (called *output control*) to the third tube, a 6F6, which further amplifies the oscillating wave. The output from this amplifier tube is connected across the primary of an output transformer with a multi-tapped secondary. Provisions are made, under control of a *load impedance* switch, to switch the output terminal to any one of four taps on the secondary or to the high side of a series resistor for high impedance output. The four secondary taps provide impedances of 10, 250, 500, and 5000 ohms. The proper output load tap should be used to match the impedance of the load circuit (input of the circuit to be connected to the oscillator) to the output of the audio oscillator, as closely as possible. The low side of all five outputs is a terminal connected to chassis ground. A fourth tube, type 80, is the rectifier for the B+ power supply.

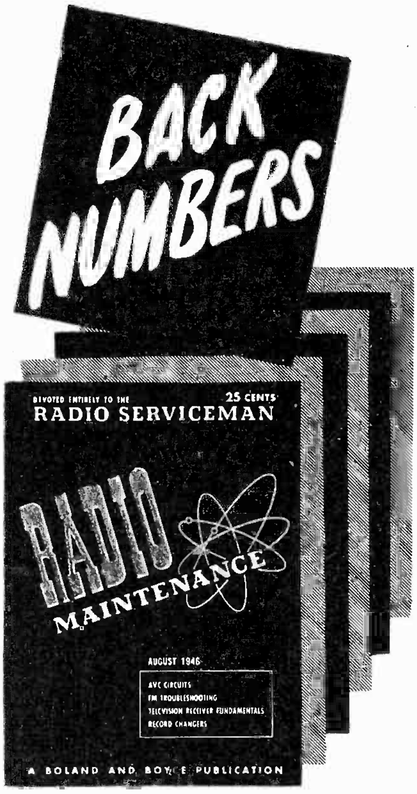
Switch S1, *range selector*, selects combinations among R_1, R_2, R_3, R_4, R_5 and R_6 in the Wien Bridge circuit, to provide frequency ranges of 20 to 200 cycles, 200 to 2000 cycles, and 2000 to 20,000 cycles. C_3 and C_4 are ganged fine tuning condensers, each paralleled with trimmers. R_{16}, *output control*, is a .1 megohm potentiometer.

The Jackson Audio Oscillator

As an example of a well designed Wien Bridge type audio oscillator recently to come out of the factories of a major electrical instrument company is the Model 655 Audio Oscillator manufactured by the Jackson Electrical Instrument Company of Dayton, Ohio.

In the Jackson audio oscillator, stabilization is accomplished in the positive feedback circuit. This instrument has a frequency range of 20-200,000 cycles with an accuracy of 3 per cent (or 1 cycle) at any frequency over the band. The scale is a large one—calibrated logarithmically. It is illuminated for the operator's convenience.

The range switch selects any of the four ranges: 20-200, 200-2,000, 2,000-20,000, 20,000-200,000 cycles. The load selector switch provides selection of the following loads: 10 ohms, 250 ohms, 500 ohms, 5000 ohms, resistive; approximately 1 watt power output is available throughout the audio range. The output waveform is guaranteed to have less than 5 per cent distortion at all frequencies. The frequency characteristic is as follows: Constant amplitude of oscillation within ± db over the range 30-50,000 cycles. The hum level is down more than 60 db from the maximum output voltage value.



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The Notebook

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servicing as "tinkering," when actually good radio servicing requires as much background study and training as many professions.

I think that there should be better mutual understanding of each other's problems on the part of radio servicemen and radio manufacturers. The former must realize that the manufacturer cannot build his set "bread-board" style so that it will be easy to service if he hopes to sell the housewife on buying it for her living room. On the other hand, the manufacturer must keep constantly in mind that the continuing satisfaction of the customer who bought his product is largely in the hands of the radio serviceman. If the serviceman cannot keep the set working through lack of service information or the inability to secure specialized parts, the dissatisfaction of the purchaser will be directed against the manufacturer. What is more, few people buy a new radio without consulting some authority, more often than not the serviceman, as to the comparative value of the various brands. There is a vast amount of potential goodwill, virtually untapped, awaiting the manufacturer who demonstrates his sympathetic interest in the serviceman's problems.

These are a few of the matters that I hope to develop at some length in the future. When I do, I want your comments; and it doesn't matter whether they are brickbats or bouquets. Both will be equally welcome! ✓✓✓

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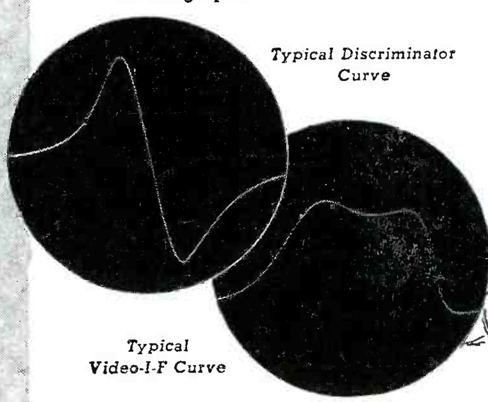

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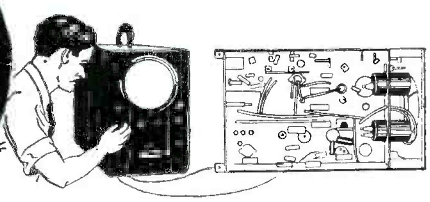

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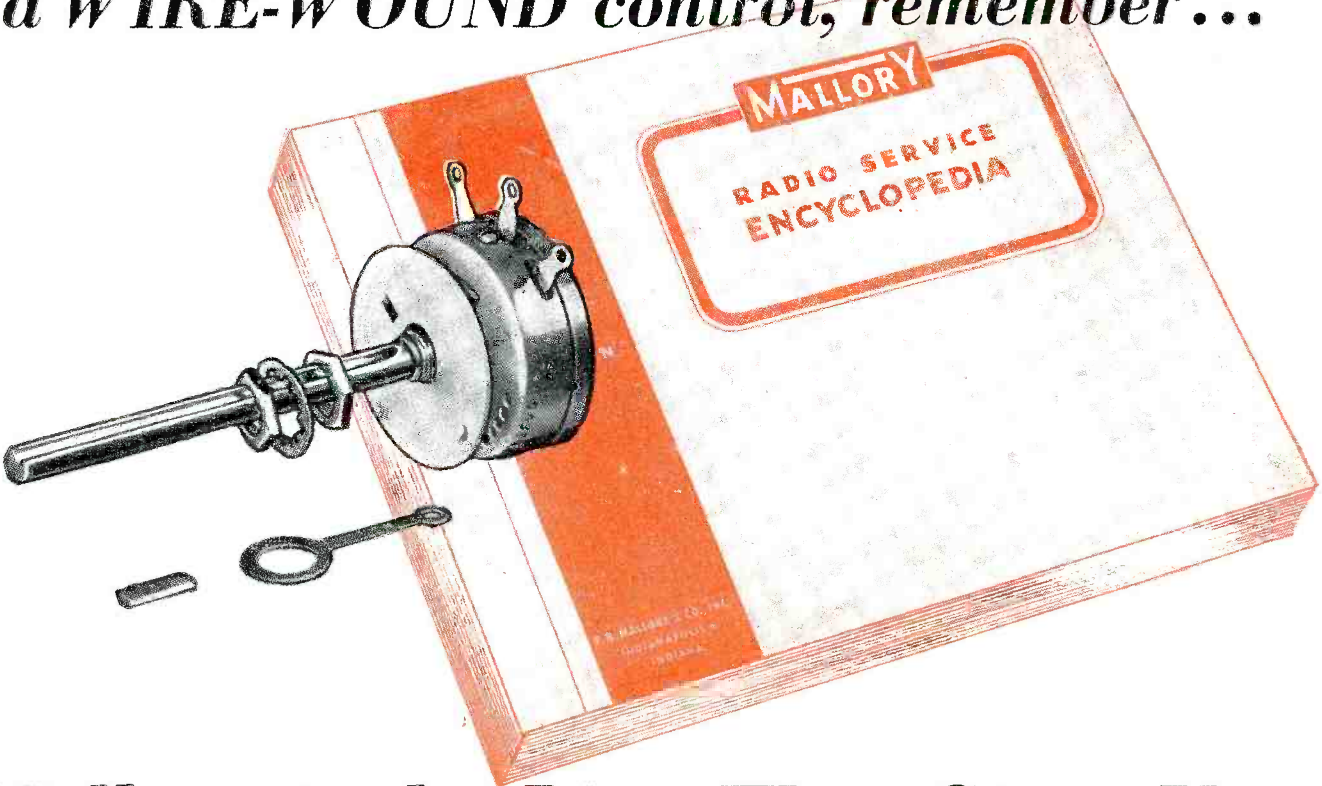

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