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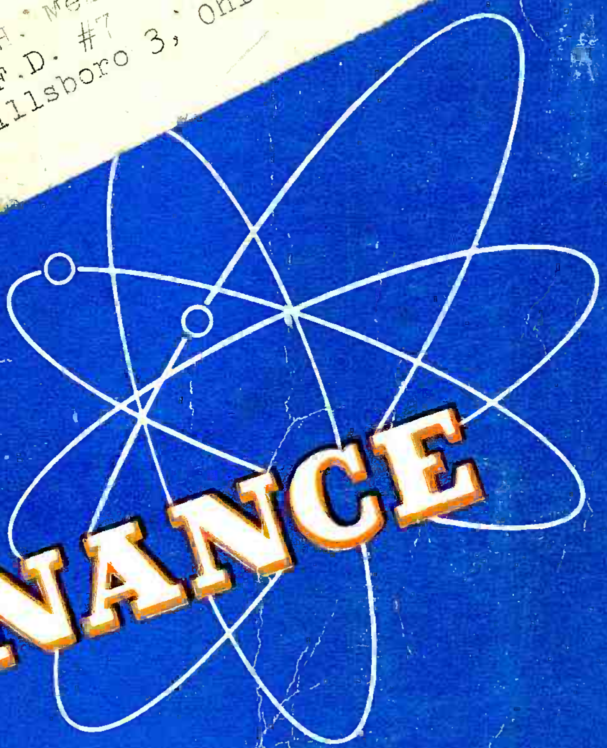
RADIO MAINTENANCE



JANUARY 1947

- SERVICING BY EAR
- TELEVISION RECEIVERS . . . VIDEO CHANNEL
- PART III. THE OSCILLOGRAPH . . . HOW TO USE IT
- MINIATURE TUBE CHART

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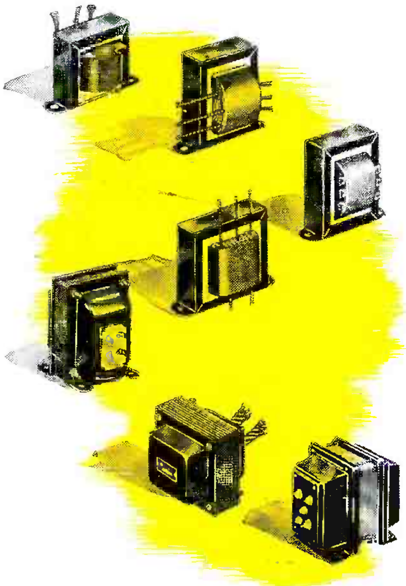

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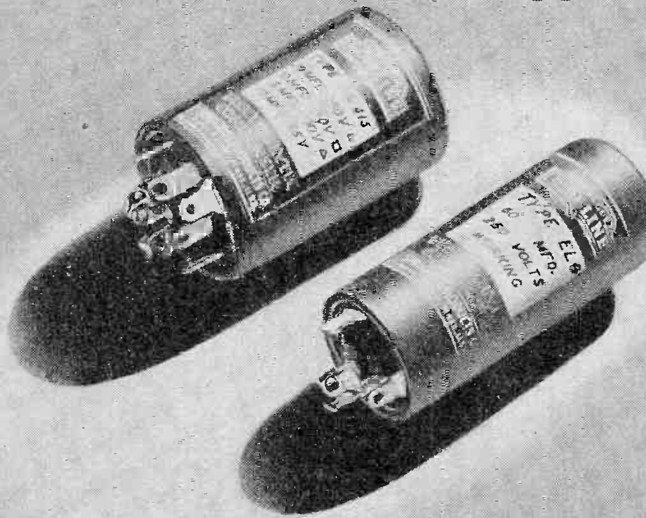

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Catalog No.	Mfd.	Voltage DC working	Dimensions	
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SINGLE SECTION				
EL-13	3000	10	1 3/8	3
EL-111	1000	15	1	3
EL-121	2000	15	1 3/8	3
EL-142	40	25	3/4	2
EL-112	100	25	3/4	2
EL-152	500	25	1	2 1/2
EL-122	1000	25	1 3/8	2
EL-50	150	50	3/4	2 1/2
EL-55	500	50	1 3/8	2 1/2
EL-31	30	150	3/4	2
EL-51	50	150	3/4	2 1/2
EL-14	40	200	1	2
EL-12	20	250	3/4	2
EL-30	30	250	3/4	2 1/2
EL-42	40	250	1	2
EL-6	60	250	1	2 1/2
EL-203	15	300	3/4	2
EL-33	30	300	1	2
EL-53	50	300	1	2 1/2
EL-123	125	300	1 3/8	3
EL-5	50	350	1	3
EL-125	125	350	1 3/8	3
EL-10	10	400	3/4	2
EL-20	20	400	1	2
EL-80	80	400	1 3/8	2 1/2
EL-1	10	450	3/4	2
EL-15	15	450	1	2
EL-2	20	450	1	2
EL-3	30	450	1	2 1/2
EL-4	40	450	1	3
EL-115	10	525	1	2
DUAL SECTION				
EL-242	40-40	25	1	2
EL-250	50-50	50	1	2
EL-221	20-20	150	1	2
EL-231	30-15	150	1	2
EL-230	30-30	150	1	2
EL-24	40-20	150	1	2
EL-35	50-30	150	1	2
EL-25	50-50	150	1	2
EL-26	60-60	150	1	3
EL-101	10-10	250	1	2
EL-120	20-20	250	1	2
EL-245	40-40	250	1	3
EL-21	10-10	300	1	2
EL-253	15-15	300	1	2
EL-22	20-20	300-25	1	2
EL-23	30-30	300-350	1	3
EL-32	30-20	350	1	3
EL-254	15-15	400	1	2 1/2
EL-214	80-10	400	1 3/8	3
EL-210	10-10	450	1	2
EL-151	15-10	450	1	2 1/2
EL-220	20-20	450	1	3
EL-240	40-40	450	1 3/8	3
TRIPLE SECTION				
EL-325	20-20-20	25	1	2
EL-335	30-30-30	50	1	2
EL-313	10-30-30	150	1	2
EL-320	20-20-20	150	1	2
EL-224	40-20-20	150	1	2
EL-340	40-40-40	150	1	3
EL-321	30-20-100	150-150-6	1	2
EL-222	20-20-20	150-150-25	1	2
EL-324	30-20-20	150-150-25	1	2
EL-332	30-30-20	150-150-25	1	2
EL-43	30-40-25	150-150-25	1	2
EL-343	40-30-20	150-150-25	1	2
EL-351	50-30-100	150-150-25	1	2
EL-352	50-50-20	150-150-25	1	2 1/2
EL-355	10-15-15	250	1	2
EL-315	10-15-30	250	1	2
EL-354	40-20-20	250	1	3
EL-331	15-15-20	250-250-25	1	2
EL-334	30-30-20	250-250-25	1	2 1/2
EL-314	10-20-30	250-250-350	1	3
EL-316	10-10-10	300	1	2
EL-333	20-20-20	300-300-25	1	2
EL-341	40-15-20	300-300-25	1	2 1/2
EL-102	10-10-20	350-350-25	1	2
EL-153	15-10-20	350-350-25	1	2
EL-326	15-15-20	350-350-25	1	2 1/2
EL-212	20-10-20	350-350-25	1	2 1/2
EL-323	30-20-20	350-350-25	1	3
EL-311	10-10-10	400	1	2 1/2
EL-342	15-15-40	400-400-25	1	2 1/2
EL-322	20-20-20	400-400-25	1	3
EL-310	10-10-10	450	1	2 1/2
EL-344	15-15-10	450	1	3
EL-362	20-15-10	450-300-300	1	3
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EL-364	15-20-20	450-350-250	1 3/8	2
EL-345	10-10-10	450-450-25	1	2
EL-202	10-10-20	450-450-25	1	2
EL-312	10-20-20	450-450-25	1	3
EL-353	15-15-20	450-450-25	1	3
EL-205	20-15-20	450-450-25	1	3
EL-350	20-20-20	450-450-25	1	3
EL-330	30-30-20	450-450-25	1 3/8	2 1/2
EL-360	15-15-10	450-450-300	1	3
EL-215	15-5-15	450-450-350	1	3
QUADRUPLE SECTION				
EL-434	30-30-30-40	150-150-150-25	1 3/8	2
EL-443	40-40-30-20	150-150-150-25	1 3/8	2
EL-452	50-50-50-20	150-150-150-25	1 3/8	2
EL-422	40-20-10-20	200-200-200-25	1 3/8	2
EL-412	10-10-10-20	300-300-300-25	1 3/8	2
EL-432	40-40-20-20	350-300-300-25	1 3/8	3
EL-415	20-10-5-10	350-350-350-25	1 3/8	2
EL-442	20-20-20-20	400-400-400-25	1 3/8	2 1/2
EL-410	10-10-10-10	450	1 3/8	2
EL-420	20-20-20-20	450	1 3/8	3
EL-421	20-15-15-20	450-350-350-25	1 3/8	2
EL-423	20-15-20-20	450-450-25-25	1 3/8	2
EL-425	20-20-30-30	450-450-300-300	1 3/8	3
EL-431	10-10-10-20	450-450-450-25	1 3/8	2
EL-424	40-30-10-20	450-450-450-25	1 3/8	3

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INCLUDING
ELECTRONIC MAINTENANCE

Volume 3 JANUARY 1947 Number 1

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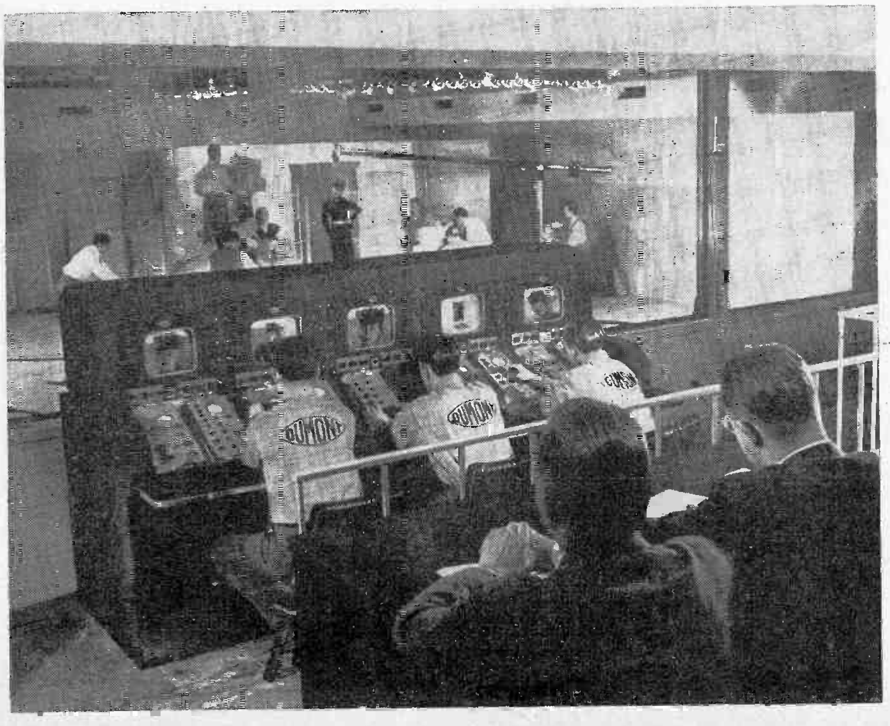
TELEVISION RECEIVERS

In this article the author covers the video channel of the television receiver. This is the second section of the seven to be covered.

the Video Channel

by Morton Scheraga

Allen B. DuMont Labs.



LAST MONTH'S ARTICLE covered the troubleshooting of the RF section, the circuits of which provide the signal path from the antenna through the first detector. The detected signal thus reaches two channels, one leading to the audio system and the other to the video circuits. This article deals with the latter signal path and will trace the signal from the first detector through the video IF amplifiers, the second detector, the video amplifier, and finally the DC restorer at the grid of the cathode-ray tube. This video channel is shown in block diagram form in Fig. 1, and in greater detail in the schematic circuit of Fig. 2.

The video IF carrier produced at the first detector is at 12.75 mc modulated with the picture signals (many new sets coming on the market will have a video IF carrier of 21.9 mc). The picture IF signals are amplified by an amplifier system which is tuned to 12.75 mc and which passes a band of 2.5 mc to 4 mc, depending upon the quality of the receiver.

Fig. 3 shows the idealized IF response curve for the entire video amplifier system. Several important characteristics of this response curve should be noted which will facilitate the understanding of the troubleshooting problems. It is seen that the response is very small at 8.25 mc so that none of the accompanying sound IF signals will get into the picture. It is also necessary that the response at 14.25 mc be very small so that sound signals from the adjacent lower frequency television channel will not

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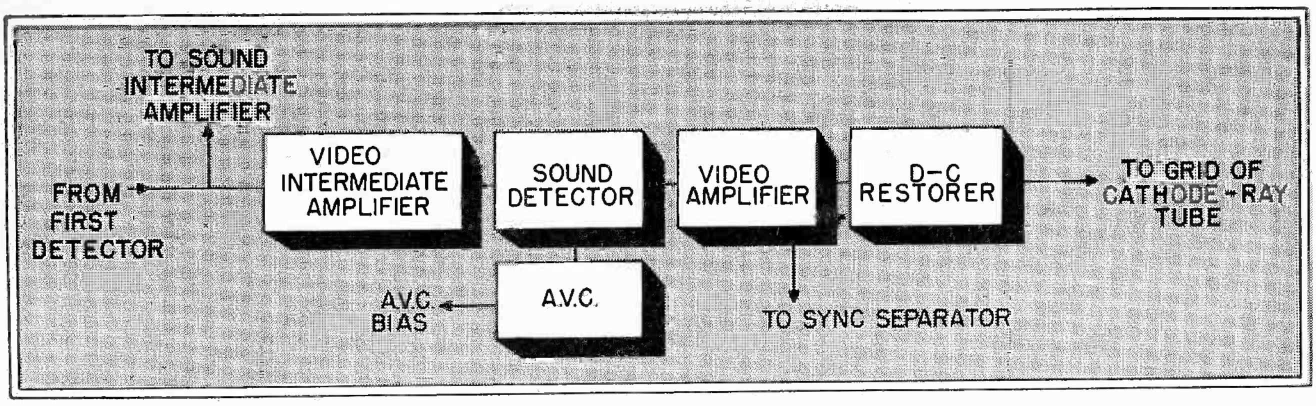

Fig. 1 A block diagram of the video channel of a television receiver.

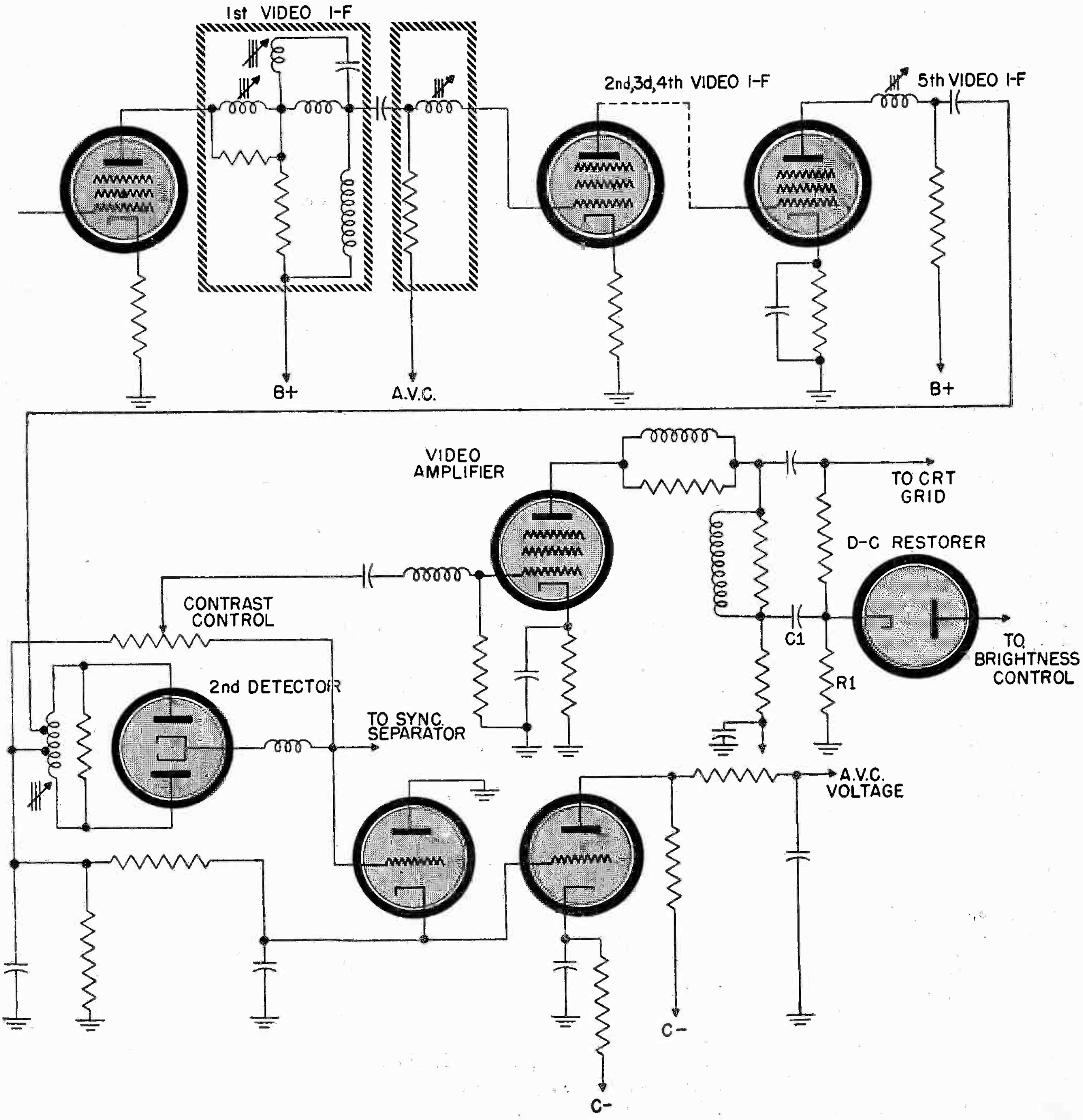

Fig. 2 A simplified schematic diagram of the video channel of a television receiver

The Video Channel

→ From Page 4

get into the picture. The major shaping of this response curve occurs in the video IF amplifier. In the particular IF system shown in Fig. 2, five stages are used to obtain a 4 mc band pass with sufficient gain. Some low-priced receivers sacrifice band width for increased gain and employ only three IF stages.

The amplified IF signal is fed to the second video detector which converts the IF signal carrier into a signal containing the video and synchronizing information. These waveforms are shown in Fig. 4. The detector in Fig. 2 is a balanced full wave rectifier and it is noted that the polarity of the output signal is negative. This is the polarity required because there follows only a single video amplifier stage in this receiver which reverses the signal 180 degrees and provides the correct polarity at the grid of the picture tube.

The AVC system shown in Fig. 2 differs considerably from that of audio amplifiers in broadcast receivers where it is customary to use the filtered DC drop across the diode resistor as the source of the AVC voltage. However, in the broadcast receiver, the average variation of the carrier is used to furnish a DC bias level for AVC. If this were done in the television receiver, the AVC would vary with each picture as the contrast varied because the average variations in a television carrier are important components of the picture. Therefore, a means of getting a constant DC level equal only to the maximum carrier strength of the television signal must be used. This is done by using the sync tips of the video signal (which recur at a rate of 15,750 times per second and are a constant indication of carrier strength) representing 100 per cent modulation of the carrier.

The video amplifier amplifies the detected signal with its blanking and synchronizing components to a level sufficient for the proper operation of the picture tube. The frequency response of the video amplifier must be excellent up to 4 mc for a high quality receiver. Since the video amplifier is an AC amplifier with RC coupling, the DC component of the video signal that represents the average illumination of the original scene will not be passed. The restoration of the DC component in the typical receiver under consideration is accomplished by means of a DC restorer (See Fig. 2) which utilizes a diode rectifier placed across a portion of the output of the video amplifier. The action of the AC video signal across C_1-R_1, and the diode results in C_1 charging to the peak value of the sync pulses. It then discharges partially through R_1, and the effect of the condenser charge is to add the necessary DC component into the AC video signal. The composite signal is then DC coupled to the grid of the cathode-ray tube.

Having described the basic operation of the video channel in most television receivers, let us consider the factors that will localize any faults to this section of the receiver.

It is well to recall the common faults described in last month's article on the RF section to rule out these troubles as being distinct from the video channel. Ghosts, local interference, image interference, too strong a signal, or too weak a signal are in the main attributed to the RF section. If a picture is present on the receiver at the installation, but does not suf-

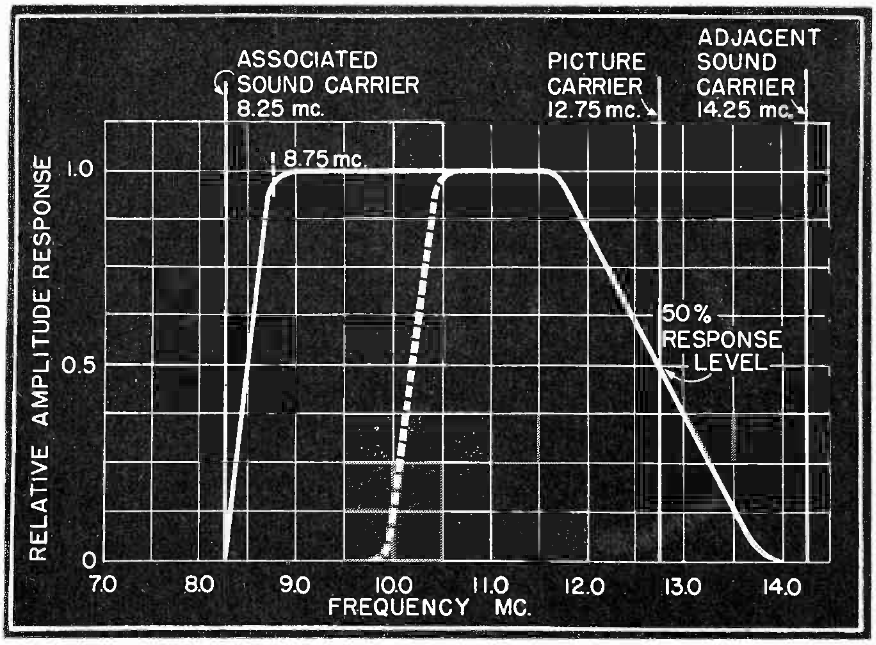

Fig. 3 The ideal picture intermediate frequency amplifier response curve.

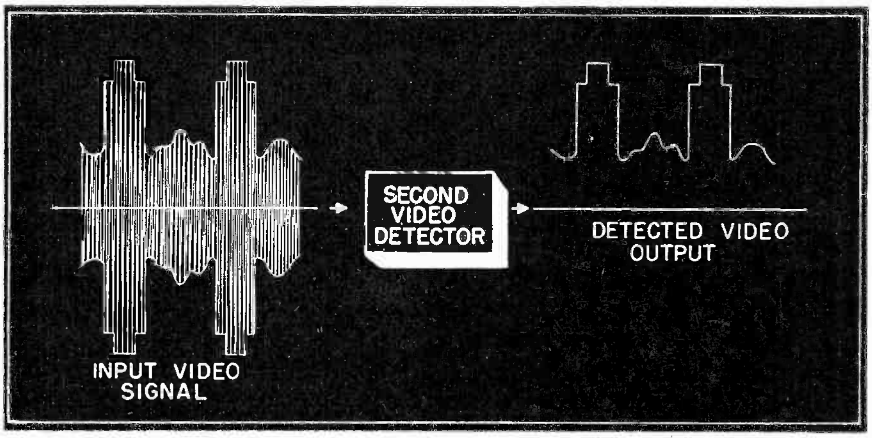

Fig. 4 The input and output signals of the second video detector.

fer from these faults and yet is poor in detail, it is likely that the trouble lies in the video channel. In this case, the receiver should be brought to the service shop for testing and realignment.

Proceeding further to localize the trouble to the video channel, it is obvious that if there is a raster on the face of the tube, there is no trouble with the sweep circuits, the cathode-ray tube, or the power supplies. This confines our troubleshooting then to the video channel.

No Video but Audio Good

The fact that the audio is coming through is a fairly reliable indication that the RF section is functioning properly and the trouble lies somewhere after the first detector. Obvious faults in this case are open leads, burned-out components, or tubes. One efficient method of troubleshooting the video channel rapidly is that of signal substitution. This consists of substituting a signal from a signal generator for the normally received signal and noting the output on an oscillograph or vacuum tube voltmeter. The procedure should start from the grid of the picture tube and work back toward the input of the IF amplifiers. Thus, for example a 2 mc signal can be injected into the video amplifier grid and the output voltage observed at the grid of the cathode-ray tube. If such voltage indication is obtained, there is continuity through these circuits. Now, putting the vacuum tube voltmeter across the grid of the video amplifier and injecting a signal of 12.75 mc into successive IF stages starting from the output of the last stage (or input to the second detector), the continuity through these circuits is checked. If the above method finds the trouble to be other than an open lead, that is, a defective tube, resistor or capacitor, it is advisable after replacing the component to recheck quickly the overall response of the video channel. The reader is referred to the alignment procedures outlined in the article "Testing and Aligning Television Receivers" in the October and November issues of this magazine. All alignment operations mentioned further in this article are covered in these two issues.

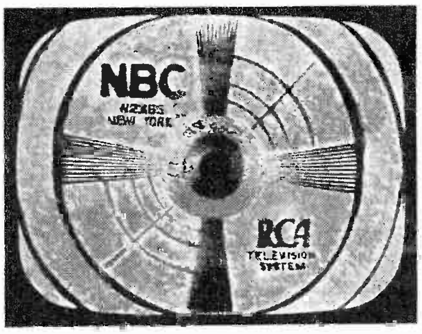

Fig. 5 The effect on the picture of the loss of high video frequency.

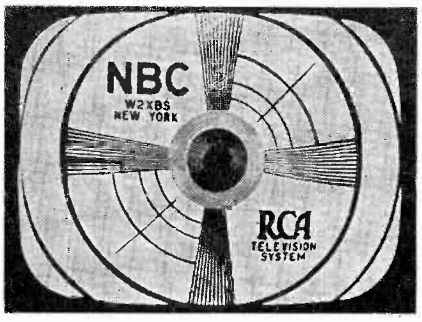

Fig. 6 A normal test pattern.

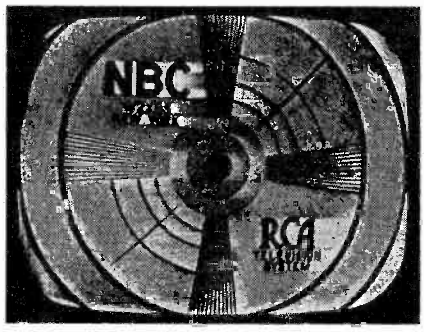

Fig. 7 A test pattern showing the effect of loss of low video frequencies.

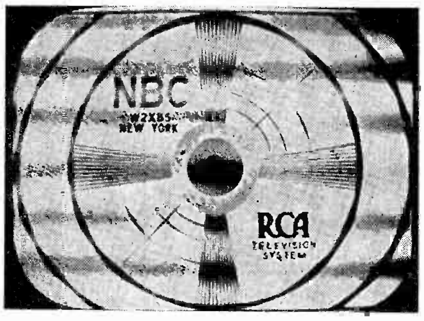

Fig. 8 A test pattern showing the effect caused by sound modulation in the video channel.

Loss of High Video Frequencies

This trouble is most quickly noted on the test pattern and will appear as in Fig. 5. In the normal test pattern (Fig. 6) the vertical wedges are clearly defined down to the outer circle of the "bull's eye." The receiver giving the pattern shown in Fig. 5 has poor IF amplifier or video amplifier response for the high frequencies and requires realignment. Unfortunately, there is no quick way of distinguishing whether poor video response is arising in the video IF stages or the video amplifier. Individual checking is necessary.

Loss of Low Video Frequencies

The appearance of the test pattern when this trouble exists is that of Fig. 7. Poor low frequency response results in a smearing of the low frequency elements, such as large letters or blurring of the horizontal wedges. Such a condition might be caused by a shorting-out of video amplifier load resistors or an open by-pass condenser in the plate or screen supply circuit. An improper RF or IF response may affect the high frequency response but it seldom influences the lower frequencies unless the receiver requires alignment. In the latter case, other defects such as sound interference bands on the screen, or poor tone quality, will also be present.

Sound in the Picture

Fig. 8 shows the effect of sound modulation in the picture and is a common trouble arising from the improper alignment of the IF amplifiers. This is understood by referring to the IF response curve of Fig. 3. If the IF amplifier band pass is not as shown or spills over the 8.25 mc and 14.25 mc points, the attenuation of these sound carriers will be insufficient to prevent their riding through the video channel. The response curve of the IF system shown in Fig. 2 is represented in Fig. 9, and indicates the

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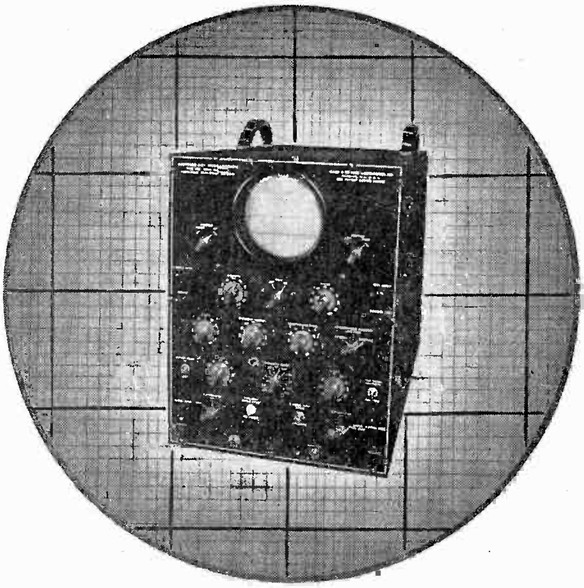

In this article the author discusses the checking of the RF and IF stages of a receiver for distortion.

the Oscillograph . . . how to use it

PART III

by Karl R. Alberts

THE TECHNIQUES DEVELOPED in the two preceding sections of this series, Parts I and II (and particularly the latter), will be found extremely useful and necessary in carrying out the test procedures which will be dealt with in this and the next article. In Part II, it will be recalled, the use of the oscilloscope was discussed in making thorough analyses of audio amplifier performance. This information must necessarily be placed first chronologically in radio receiver troubleshooting with the oscilloscope because (1) the audio is the most conveniently checked stage in the receiver; and (2) if trouble is found in the audio, no further checking need be made since the audio amplifier and loudspeaker are the last points in the receiver where the signal appears.

If distortion is present, or if no audio signal at all can be heard from the speaker, and if the audio is found to be working properly, then the signal checking must be carried one step back to the IF stages.

Distortion in the IF Amplifier

As was pointed out in Part II on the audio amplifier, an electrical amplifier, in general, has as its function the amplification of an electrical signal applied to its input terminals. That is, it must provide at its output terminals a voltage or power which is exactly like that applied to its input except in amplitude. Any deviations from this essential function results in distortion.

Amplitude or "non-linear" distortion comes about through overloading in the amplifier and is manifested as the introduction of new frequencies in the signal which were not present in the input.

Frequency distortion is the term given to the malfunctioning of the amplifier when the band-pass characteristic of the amplifier is not what it should be (when the amplifier is working normally). In the case of an audio amplifier, the band-pass characteristic ideally is a straight line curve of voltage plotted against frequency, over the desired range. For an IF amplifier, the ideal characteristic is a peaked curve, roughly resembling one-half of a sine wave, the peak amplitude occurring 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, cause frequency distortion in an IF amplifier.

Phase distortion comes about through unequal phase shift over the frequency pass-band. In IF amplifiers used in radio receivers, this type of distortion is relatively unimportant since conditions which normally give rise to phase distortion would, in an IF amplifier, produce a far greater degree of fre-

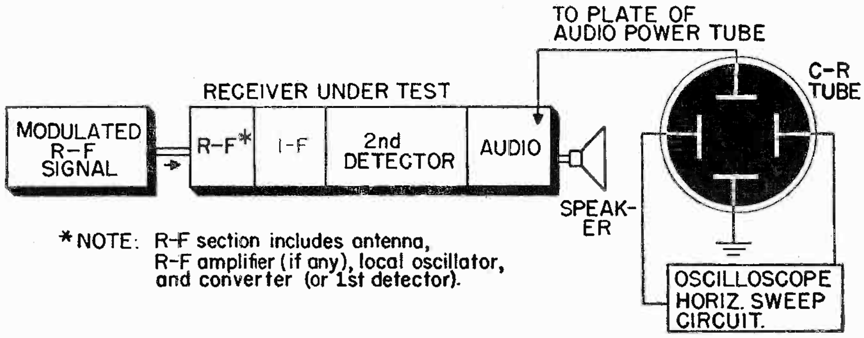

Fig. 1 Method used to check a receiver for overloading. The RF signal generator is set at a point on the broadcast band and its output is modulated by a 400-1000 cycle audio signal.

quency-pass-band distortion. Correction of frequency and amplitude distortion in an IF amplifier will make it function properly.

Testing for amplitude distortion involves looking for evidence of overloading in the amplifier. Testing for frequency distortion and then correcting it involves taking the band-pass characteristic of the amplifier and then aligning the amplifier until the required curve is obtained.

Checking Overload in an IF Amplifier

With a signal of normal strength being fed into the receiver, overloading can come about either through incorrect operating voltages (bias or B+) or faulty AVC action. Operating voltage can best be checked by using the oscilloscope as a voltmeter (see Part I of this series) because the high resistance circuits involved render low-impedance voltmeters useless. Faulty AVC action is most likely attributable to a leaky condenser or a bad tube in the AVC circuit. With proper voltages and a good AVC circuit, overload can occur as a result of excessive signal strength.

A signal generator (RF) with provision for modulating with an audio voltage will be necessary. Most present-day RF signal generators have either an internal audio oscillator for modulating the output RF, or provisions for connecting an external audio frequency signal to the signal generator for modulating. If an external audio oscillator is used, a constant level of applied audio signal must be maintained. If the RF signal oscillator operates with a plate voltage of 100 volts and draws 5 milliamperes, the impedance of the circuit to be modulated is 100/.005 = 20,000 ohms. To modulate 100 per cent, an audio voltage of 100 must be used. Fifty per cent or less modulation is sufficient, however, which means that, for the example taken, an audio signal of 50 volts or less is satisfactory. The output impedance of the audio oscillator must be made to match the RF signal generator. If the former is 1000 ohms, a transformer with an impedance ratio of 1000/-20,000 must be connected between the audio oscillator and the external modulation jack on the signal generator. Use a modulating frequency of 1000 cycles.

Couple the modulated output of the RF signal generator to the antenna of the receiver under test. Connect the top vertical plate of the oscilloscope to the audio power tube plate (or one of the plates if it is push-pull). See Fig. 1.

This test assumes of course, that the audio circuits have been completely checked as per the method of Part II, and are now distortion-free. Use internal sweep in the oscilloscope, adjusted to approximately the audio modulating frequency, and synchronized either with "Internal Sync.," or with "External Sync." by connecting a portion of the audio voltage to the "External Sync." jack. Set the frequency of the RF signal at a point in the broadcast band where a dead spot (i.e., no broadcast transmitter signal) exists, and turn the main tuning knob on the receiver until the indication on the oscilloscope screen is at maximum. Increase the level of the modulated RF input signal until the volume of the 1000 cycle note heard from the speaker is a little greater than average loudness for the receiver (i.e., a little stronger than a "comfortable" level of sound). Observe the pattern on the oscilloscope screen. If the pattern is a clean sine wave like that shown in Fig. 2, no distortion exists. If it is like Fig. 3 or Fig. 4, then there is distortion, and it is most likely to be in the IF amplifier.

The reason for the above statement that distortion, if shown to be present by this method, is most

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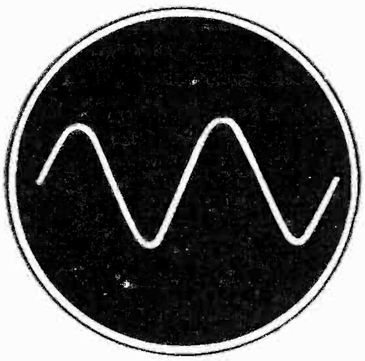

Fig. 2 The pattern obtained on the oscillograph screen when no distortion is present in the receiver.

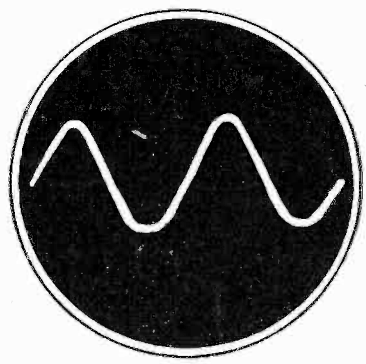

Fig. 3 The pattern obtained when a slight amount of distortion is present in the receiver. Note the flattening of the bottom of the wave form.

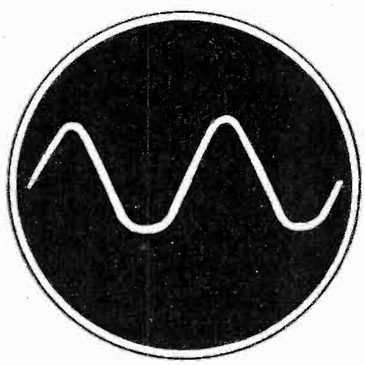

Fig. 4 The pattern obtained when severe distortion exists. Note the flattening of the bottom of the wave form pattern.

The Oscillograph...how to use it

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likely produced in the IF stages, is as follows:

(1) The audio is assumed to have been checked and cleared of distortion, as noted in the first paragraph of this article, by the method outlined in Part II of this series.

(2) Trouble must, therefore, be occurring in the RF, IF, or second detector:

(a) Distortion is seldom produced in the RF section (which includes RF amplifier, if present, local oscillator, and converter).

(b) It is possible, though not likely, for distortion to occur in the second detector.

(c) The modulated RF input signal itself may be "unclean."

To check point 2 (b), connect the top vertical plate to the vertical amplifier of the oscilloscope; and connect the amplifier input to the "high side" of the second detector load resistance. (The second detector output will be audio at 1000 cycles, but of so low an amplitude that it must be amplified by the vertical amplifier before it can be applied to the vertical deflecting plates. See Fig. 5.)

Turn up the vertical gain until the pattern is about two inches in height on the screen. There may be some fuzziness or "fill-in" around the peaks due to the presence of a small amount of IF signal. If this is not enough to disturb the observation of the waveform, it may be ignored. Otherwise, insert a series- or parallel-resonant inductance-capacitance filter between the point being observed and the oscilloscope. By comparison with Figs. 2, 3, and 4, determine whether there is any distortion in the second detector output signal. It is unlikely that trouble will be found here.

To check points 2 (a) and 2 (c) and thus determine definitely where the trouble is, an additional apparatus must be procured or built. This circuit is a video amplifier. It is necessary because the signal strength at any point in the receiver ahead of the audio circuit is too low in amplitude to be seen by direct connection to the vertical deflecting plates of the oscilloscope. The vertical amplifier of the oscilloscope is too narrow in its frequency pass-band (less than 100 kc for the DuMont 208 and similar types) to pass RF signals (550 kc or greater) or IF signals (which may be as high as 455 kc).

Of course, if the oscilloscope being used is of the more advanced type having a vertical amplifier pass-band up to about a megacycle, or at least greater than the highest frequency to be amplified, no further apparatus is necessary, and all signals in the receiver can be connected to the vertical amplifier input of the oscilloscope. In the absence of such an oscilloscope, however, some additional amplifier must be used external to the oscilloscope and the oscilloscope's vertical amplifier bypassed.

Some authors, in articles on radio receiver servicing with the oscilloscope, recommend that this external amplifier be an IF amplifier, essentially the same type as that in the typical receiver. This practice is not recommended here because an IF amplifier is characteristically peaked at some particular frequency; and if that peak frequency were made equal to the intermediate frequency of the receiver under test, then the amplifier could not be used for other standard intermediate frequencies encountered in

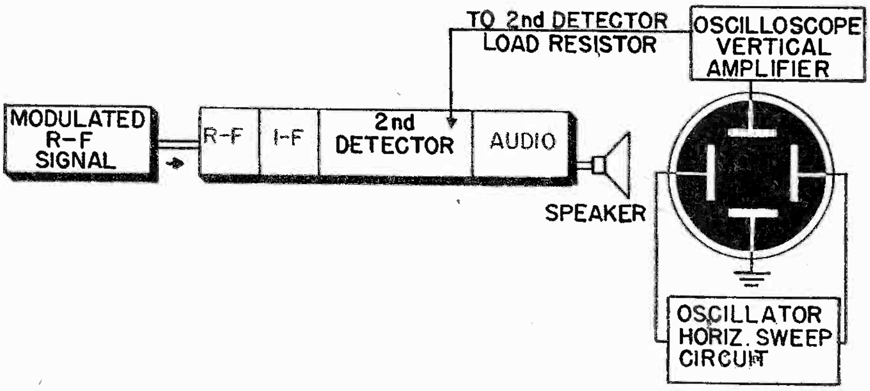


Fig. 5 Method used to check for distortion in the circuits up to and including the second detector.

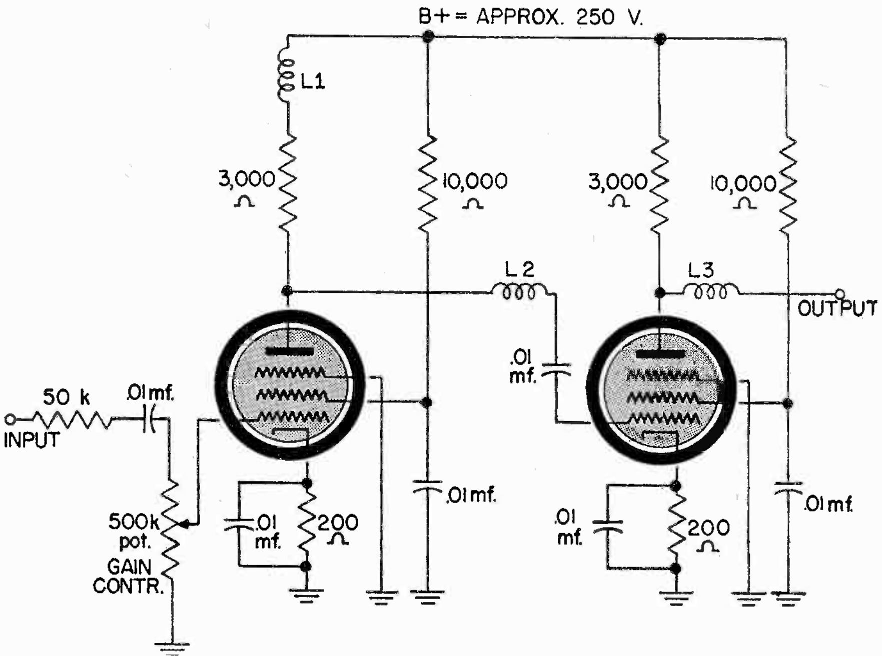
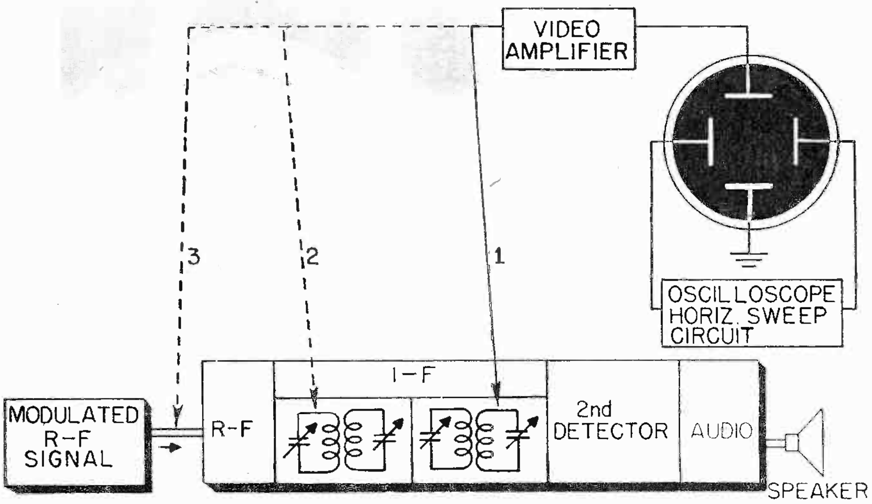


Fig. 6 The circuit diagram of a two-stage video amplifier suitable for use when checking the RF stage of a receiver for distortion.



1: I-F Output transformer secondary.
2: I-F Input transformer primary.
3: Signal generator output.

Fig. 7 The test setup used to check the RF and IF stages of a receiver for distortion.

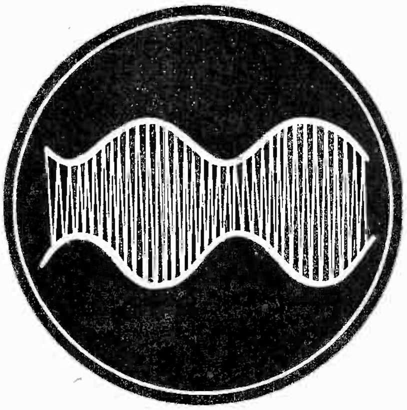


Fig. 8 The pattern obtained with the test setup of Fig. 7 when no distortion exists.

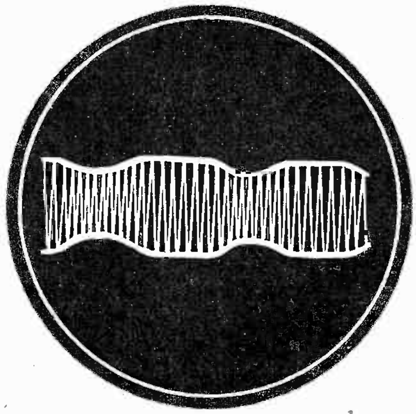


Fig. 9 The pattern obtained with the test setup of Fig. 7 when distortion is present in the receiver.

different receivers, nor for RF signals. The only method by which the amplifier could be made versatile and universally applicable would be to equip it with plug-in coils to accommodate all possible IF's and RF's which might be encountered. Such equipment is both expensive and cumbersome to handle.

A video amplifier, it will be recalled from a definition given in Part I of this series, is an amplifier with nearly constant gain and uniform phase shift over a *wide* frequency band. It is usually well to build up a small unit, complete with B+ power and filament supplies, in a compact form because it will be required for most future testing which the serviceman will do on RF and IF circuits. A representative two-stage video amplifier is shown schematically in Fig. 6. The resistor in series with the input grid is necessary to minimize the loading effect on the high-frequency circuit to which the input terminal is connected. The tubes are 6AC7's.

It will be noted that both plate load resistors are low in value: Gain in a video amplifier is sacrificed to extend the upper limit of the amplifier's frequency range. Coil L_1, called a "shunt peaking" or "shunt compensation" coil, boosts the response of the higher frequencies while having practically no effect upon the lower frequencies. Coil L_2, called a "series peaking" or "series compensation" coil, resonates with the succeeding grid-to-cathode interelectrode capacitance and the distributed wiring capacitance to ground at high frequencies, causing an increased voltage input to the succeeding grid. L_3 similarly can overcome the effect of the capacitance between the top and bottom vertical deflecting plates of the oscilloscope. All three coils are small—on the order of 100 microhenries or less. L_2 and L_3 may not be necessary in a particular unit. The unit should be wired and assembled and then tested for its frequency band-pass by means of a signal generator and oscilloscope.

The pass-band should include the range from audio to well above the highest IF to be encountered: From below 1000 cycles to about 1 megacycle. Adjust the values of plate resistors, coils, and cathode resistors and by-passes until maximum gain and approximately the desired frequency range are obtained. It will probably not be necessary to use both L_2 and L_3 in the final unit, and in some cases neither need be used. For a particular receiver, a third video stage may be required. The total number of stages for a particular serviceman's applications cannot be determined until he has had experience with several different receivers. The upper frequency limit and the overall gain of the amplifier are points which cannot be given here for universal application. Once the unit has been built up, it will be found invaluable for future servicing.

Connect the output of the video amplifier to the top vertical deflecting plate and connect the input to position 1 of Fig. 7, the secondary of the last IF transformer. When observing IF through the external amplifier, it may be necessary to mount an inductance-capacitance filter between the point being observed and the input terminal to reject RF and local oscillator signals. Always use shielded leads (or coaxial cable) for connecting to the input and output terminals.

Observe the pattern on the screen of the oscilloscope tube and by a comparison with Figs. 8 and 9, determine whether distortion is present. It will be a bit more difficult to recognize the presence of distortion by looking at the modulated IF or RF wave on the oscilloscope screen than it was by observing the audio voltage alone in the previous tests. The observer must note carefully the shape of the top

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Servicing by EAR

Troubleshooting by fault analysis

by John T. Frye

SURROUNDED AS WE ARE by our modern vacuum tube voltmeters, signal tracers, oscilloscopes, et cetera, we are prone to overlook one of the best instruments for radio servicing yet discovered: The human ear.

Every ill which a radio receiver suffers is reflected in the sound—or lack of sound—that comes from the speaker; and an intelligent serviceman can train himself to diagnose seven out of ten defective receivers simply by listening to them. He may even do better than this percentage, for it is based on my own experience, and I make no claims to perfection.

Please do not think that I am arguing that a good ear is all the equipment needed to service radios—far from it. I merely contend that intelligent listening can hasten the process of isolating the trouble; and every serviceman knows that this business of "isolating the trouble" constitutes ninety per cent of his work. If you can train yourself to diagnose radio troubles by ear, you can save hours of aimless probing; you can often avoid the unnecessary removal of a chassis from the cabinet, and you can make yourself tremendously more efficient.

In this article, I shall try to point out a few of the most common faults that can be determined by listening to a set. The list is by no means exhaustive for it is intended more as a guide to the technique involved than anything else. Still, I feel confident that the newcomer to the service game will find many practical hints of the "trade secret" variety. Perhaps, even veteran servicemen will profit by some half-forgotten and therefore unused knowledge.

Suppose our first set tested is an AC console. It is plugged into the line and turned on while the rectifier is watched. If this does not show excessive blue glow between the filament and plates, and if the plates do not show any tinge of red, the set may be left on safely without worry of burning out anything important. If you want to make doubly sure, make a resistance check between the rectifier output and ground through the rectifier socket. If this measures 10,000 ohms or better, you can proceed.

Most of us apply the word "diagnosis" to the medical profession, but the word applies to the serviceman as well. The author proves that a good ear, a sharp eye and the ability to make an intelligent guess are the mark of the experienced serviceman.

The set is without sound. There is no hiss, no hum, no nothing. All the filaments are revealed to be burning, either by visual check or a warming-up of the metal envelopes. Glance at the speaker and see if it is a permanent magnet or a field coil dynamic job. If the former, your trouble is very likely (a) an open voice coil, (b) an open primary on the output transformer, (c) an open connection in the output tube (See Fig. 1). Look at the tube. If it is glass and the screen is red hot, (b) is your trouble. The tube checker will take care of (c). Quite often a little manual manipulation of the speaker cone will show up (a), the set "coming alive" when the cone is pushed a certain way so as to bring the broken ends of the voice coil winding or leads in contact. If the speaker has a field coil, there is another possibility: That this coil, located in either the positive or negative high voltage leads, has opened up and so taken the voltage off the set. A continuity test at the speaker plug will quickly reveal this.

Now suppose that the only sound is a low hum. No stations nor static can be heard. Pull the output tube and see if a loud click is heard. If not, suspect a shorted bypass condenser from the plate of the output tube to cathode or ground (See Fig. 2). An ohmmeter check at the socket will quickly take care of this. If the speaker is a field coil type, you may have an open primary in the output transformer, the hum being caused by the ripple voltage passing through the field coil (See Fig. 2). Use your voltmeter at the output tube socket to check this.

If you do not get a click when you pull the output tube, try pulling out the tube just ahead of it and proceed in this way toward the front end of the set until you come to one that does not yield a click. This will show you in which stage to start looking for trouble. If the clickless tube is in the detector or audio portion, look for open coupling condensers, open plate resistors, shorted audio bypass condensers, and bad tubes. If it is in the RF or IF section, look for shorted screen and plate bypass condensers, for open coil windings and for bad tubes.

Next, we have the set that can pick up stations, but there is a background hum of annoying loudness. The chances are good that the trouble is filter condensers. If the input condenser is open, the hum will be very loud and it will usually modulate the voice and music with a 120 cycle hum; if it is the output condenser, the hum is usually not so heavy and quite often it is accompanied by "motor-boating" or squealing because of the loss of the bypassing action of the output filter condenser. If bridging the filter condensers with good units does not diminish the hum, try changing the output and other audio tubes, one at a time, of course. If this does not help, check for a short in the filter choke or the speaker field that serves as a choke. If the filter condensers are both in one container, sometimes the insulation between sections breaks down and effectively shorts out the filtering inductance. Removing one of the uncommon leads while inserting a good condenser will check this although the usual bridging test will not.

One other hint: If the set is an AC-DC and has a double-diode rectifier, if one of the filter condensers is rated at higher than 150 working volts, make sure you are not dealing with a voltage doubling circuit. If so, what looks like a big bypass condenser may really be a third electrolytic filter condenser, in addition to the two that ordinarily are placed in a single container. When one of these condensers opens up, the voltage goes down to about where you would expect it to be with half-wave rectification, and a loud hum develops. The sets that use such circuits are so few that it is easy to overlook the possibility, but you can certainly lose a lot of time trying to get the hum out of a voltage doubling circuit by treating it as a straight half-wave rectifier.

Then we have the little dandy that whistles or squeals. Pay no attention to what the customer says it does, for I have had them call a 120 cycle hum a whistle and label a piercing 5,000 cycle note a buzz. If the note is fairly high-pitched, if it varies slightly in frequency as the volume control is rotated over the high-volume portion of its rotation and disappears entirely at the low-volume setting, look for an open bypass condenser on the plate of the output tube, or look to see if an original metal output tube has not been replaced with one of glass. Dressing the plate leads away from the grid leads will occasionally cure this trouble.

Oscillation

If the set is a "railroad radio"—whistles at every station—there is oscillation in the RF or IF portion. Suspect screen, plate, cathode, and AVC bypasses first. Bridging with a .1 ufd condenser is the quickest way to check these units for opens. A pair of bamboo photo print tongs, equipped with old "B" battery clips

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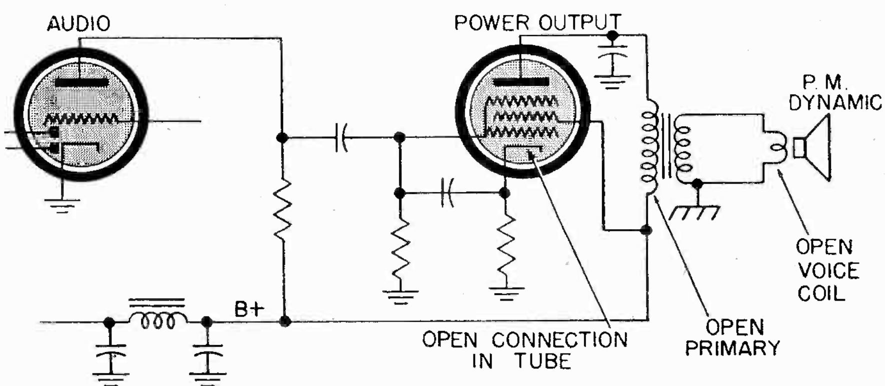

Fig. 1 When there is no sound coming from the speaker of a receiver using a permanent magnet dynamic speaker, the trouble is usually an open at one of the points indicated.

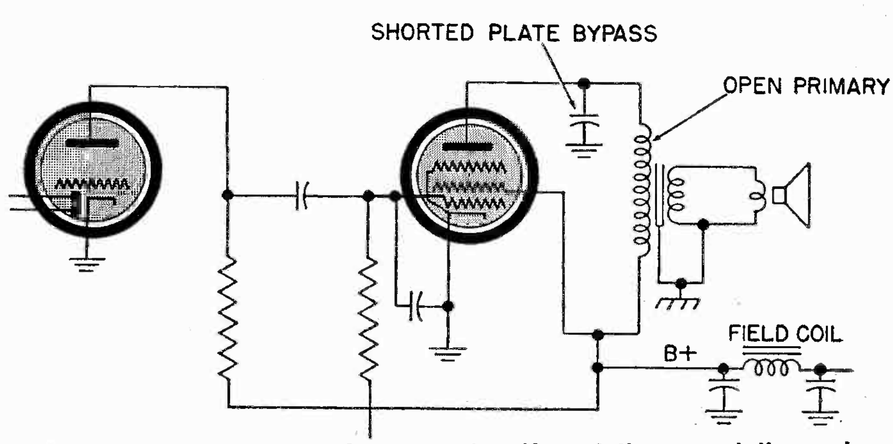

Fig. 2 In a set using a field type speaker, if no stations nor static can be heard but the speaker emits a low hum, the trouble is usually one of those indicated above.

Servicing by Ear

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as illustrated in Fig. 3, are useful in making these checks. The tongs are squeezed or spread to fit across the condenser under test. If they are all okay—and be very, very sure you do not overlook one hidden away on top of the chassis or inside an IF can—check the alignment. If you cannot peak the IF stages without oscillation with the signal generator attached to the mixer grid, try moving it to the IF tube grid and aligning the output IF transformer and then going to the mixer grid with the service oscillator and aligning the input IF transformer. If you still cannot peak the IF stages without oscillation, if all the tube shields are tight, if the grounding lugs on the tube sockets are all grounded and the leads properly dressed, look for a gassy IF or RF tube. Such a tube will cause oscillation in spite of anything you can do, and overlooking this possibility has put many a serviceman on the verge of a nervous breakdown.

If the set is an AC-DC and the whistling is accompanied by some hum, look for a bad output filter condenser. This condenser doubles in brass as an RF bypass; and when it loses its capacity, the plate returns are left more or less floating. Usually, in this case, the set whistles when first turned on; but the whistling gradually dies out as the set warms up and the electrolytic builds up a little more by-passing ability.

A bad volume control can cause squealing, too. If the set squeals at certain settings of the volume control, if the volume control makes considerable noise when being rotated, and if the control of volume is erratic, you can be sure the control is the source of your trouble. The squealing is occasioned by the fact that the rotating portion makes poor contact with the connecting lug and leaves the grid of the audio tube attached to this lug "floating." Sometimes the control can be repaired by disassembling and cleaning, but I personally have had little success with "dunking" the controls in carbon tetrachloride. This will relieve the trouble temporarily, but not for long. The most satisfactory repair is a new control.

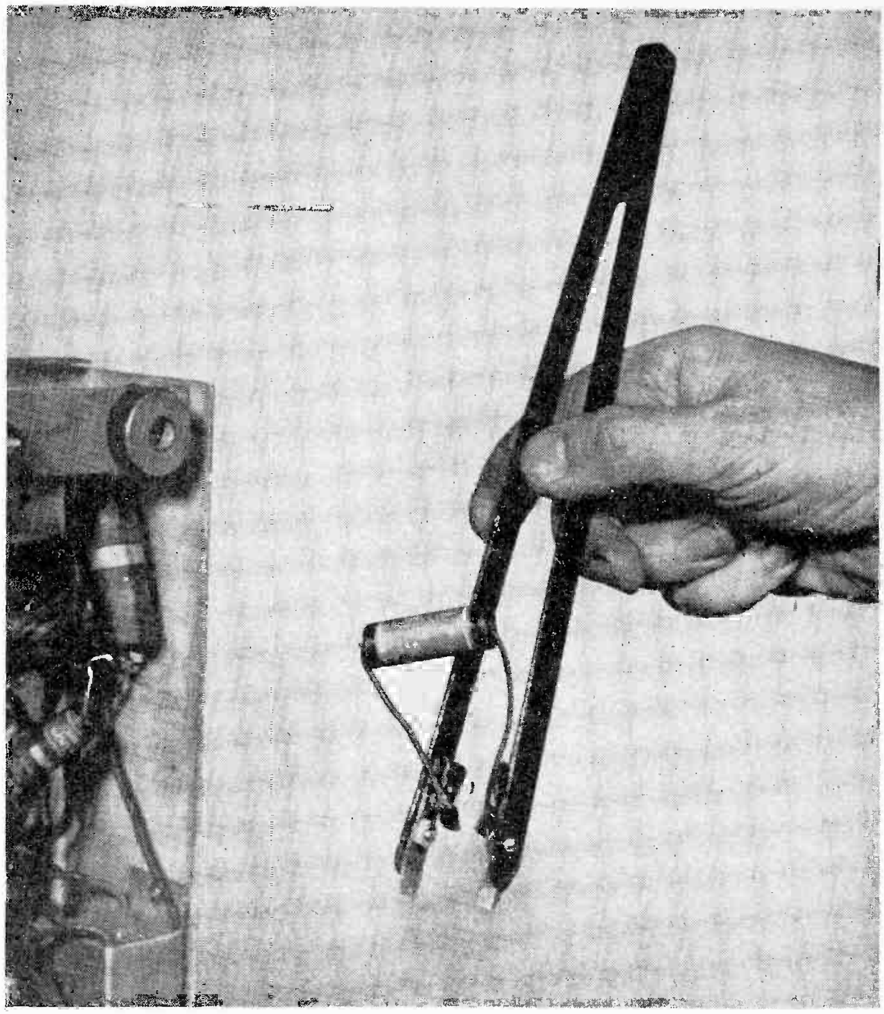

Fig. 3 A handy gadget for use when bridging by-pass condensers to check for opens. Two battery clips are mounted at the ends of the tongs. The battery clips project past the end of the tongs. The proper size condenser is selected and connected to the two clips. A .1 ufd condenser can usually be used to check all the by-passes on a set.

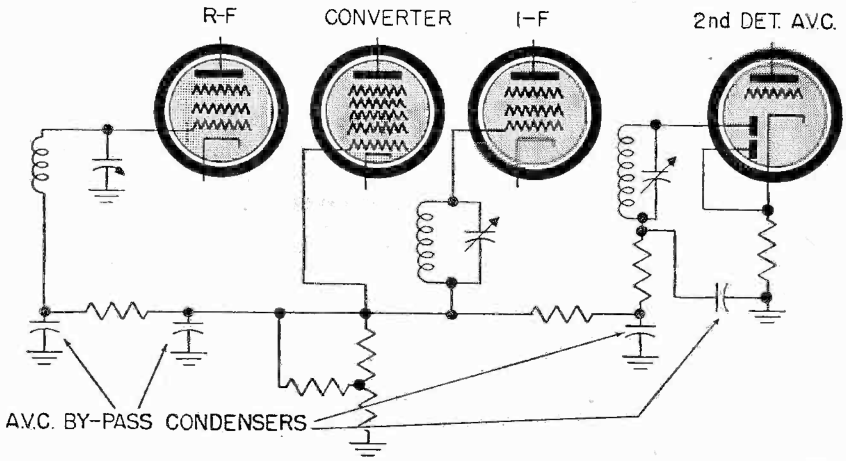

Fig. 4 If any one of the by-pass condensers indicated above is shorted, the set will distort badly on loud stations but will sound normal on weak stations.

Noisy sets are a common source of complaint. If the noise is a continuous scratching and frying sound, if there is some hum, and if the condensers are of the fabricated plate type, suspect these condensers. The trouble apparently develops in the connections between the terminals and the foil. It is hard to locate because when a good condenser is bridged across the de-

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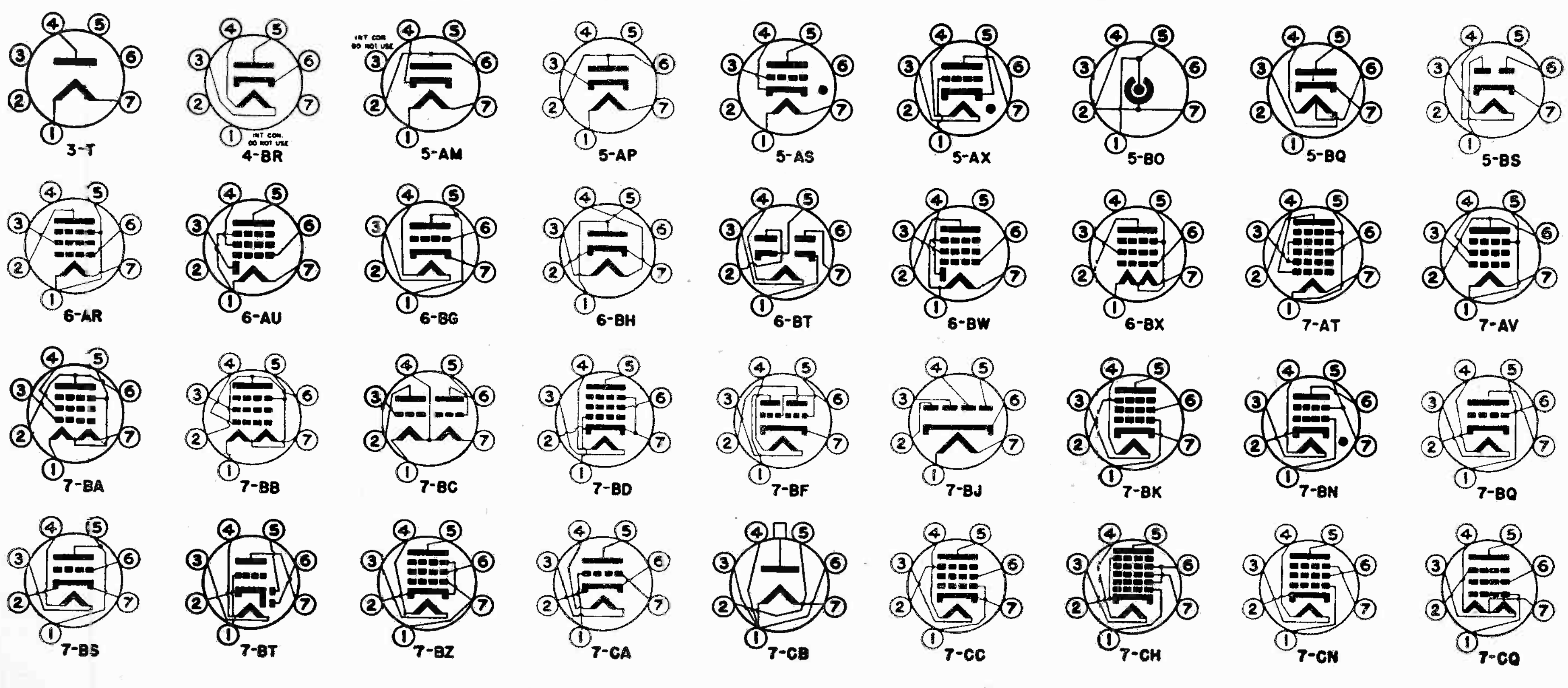
MINIATURE TUBE CHART

Type designation	Description	Prototype in larger envelope	Cathode & Ratings: Type	Volts	Amps	Base connections	Overall height	Capacitances: G-P μμf	G-K μμf	P-K μμf	Typical Operation and Characteristics: Circuit application	Applied voltages: Plate	Screen	Grid	Plate curr. ma	Screen curr. ma	Amp factor	Plate resis. ohms	Trans conduc. μmho	Power output watts	Load resis. ohms	Cutoff bias volts	Type designation
0A2	Gaseous v regulator	0D3/VR150	Cold	--	--	5-BO	2 5/8	--	--	--	Voltage regulator	185 min 150 v approx. output through a current range of 5-30 ma.											0A2
0B2	Gaseous v regulator	0C3/VR105	Cold	--	--	5-BO	2 5/8	--	--	--	Voltage regulator	133 min 108 v approx. output through a current range of 5-30 ma..											0B2
1A3	Vhf diode	--	Cath.	1.4	0.15	5-AP	2 1/8	--	--	0.4	H-w rect. or det.	Max plate 117 v rms at 0.5 ma d-c output											1A3
1L4	R-f pentode sharp cutoff	1N5GT	Fil.	1.4	0.05	6-AR	2 1/8	0.008	3.6	7.5	Voltage amplifier	90	90	0	4.5	2	360	350M	1025	--	--	-8	1L4
											" "	90	67.5	0	2.9	1.2	--	600M	925	--	--	-6	
1R5	Pentagrid converter	1A7GT	Fil.	1.4	0.05	7-AT	2 1/8	0.4	7	7	Converter	90	67.5	0	1.7	3	--	500M	300	--	--	-15	1R5
											"	90	45	0	0.8	1.8	--	750M	250	--	--	-9	
1S4	Power amp pentode	1Q5GT	Fil.	1.4	0.1	7-AV	2 1/8	--	--	--	Power output amp	90	67.5	-7	7.4	1.4	--	100M	1575	0.27	8000	--	1S4
											" " "	67.5	67.5	-7	7.2	1.5	--	100M	1550	0.18	5000	--	
											" " "	45	45	-4.5	3.8	0.8	--	100M	1250	0.065	8000	--	
1S5	Diode a-f pentode	--	Fil.	1.4	0.05	6-AU	2 1/8	0.2	2.2	2.4	Detector & volt. amp	67.5	67.5	0	1.6	0.4	--	600M	625	--	--	--	1S5
1T4	R-f pentode remote cutoff	1P5GT	Fil.	1.4	0.05	6-AR	2 1/8	0.01	3.6	7.5	Voltage amplifier	90	67.5	0	3.5	1.4	--	500M	900	--	--	-16	1T4
											" "	90	45	0	1.8	0.7	--	800M	750	--	--	-10	
											" "	67.5	67.5	0	3.4	1.5	--	250M	875	--	--	-16	
											" "	45	45	0	1.7	0.7	--	350M	700	--	--	-10	
1U4	R-f pentode sharp cutoff	1N5GT	Fil.	1.4	0.05	6-AR	2 1/8	0.008	3.6	7.5	Voltage amplifier	90	90	0	1.6	0.5	--	1500M	900	--	--	-4.5	1U4
											" "	90	67.5	0	--	--	--	--	--	--	--	--	
1U5	Diode a-f pentode	--	Fil.	1.4	0.05	6-BW	2 1/8	--	--	--	Detector & volt. amp	67.5	67.5	0	1.6	0.4	--	600M	625	--	--	--	1U5
1Z2	H-w rectifier	--	Fil.	1.5	0.3	7-CB	2 11/16	--	--	0.6	Rectifier	Max plate 7800 v rms; curr. 10 ma peak, 2 ma avg.											1Z2
2B25	H-w rectifier	--	Fil.	1.4	0.11	3-T	2 1/8	--	--	--	Rectifier	Max plate 1000 v rms; curr. 9 ma peak, 1.5 ma avg.											2B25
2C4	Triode thyratron	--	Cath.	2.5	0.6	5-AS	2 1/8	--	--	--	--	Max plate 350 v inv. peak; curr. 22 ma peak, 5 ma avg.											2C4
2D21	Tetrode thyratron	2050	Cath.	6.3	0.6	7-BN	2 1/8	0.02	2.4	1.6	Relay service	Max plate 1300 v inv. peak; curr. 500 ma peak, 100 ma avg.											2D21
2E30	Beam tetrode *	--	Fil.	6.0	0.7	7-CQ	2 5/8	0.5	10	4.5	Power amplifier	250	250	-21	40	3	--	--	3400	4	4500	--	2E30
3A4	Power amp pentode	--	Fil.	1.4	0.2	7-BB	2 1/8	0.35	4.8	4.2	Power output amp	135	90	-7.5	14.8	2.6	--	90M	1900	0.6	8000	Par. fil.	3A4
				2.8	0.1						" " "	135	90	-8.4	13.3	2.2	--	100M	1900	0.7	8000	Par. fil.	
3A5	Twin triode *	--	Fil.	1.4	0.11	7-BC	2 1/8	3.2	0.9	1	Voltage amplifier	90	--	-2.5	3.7	--	15	8300	1800	----	--	--	3A5
				2.8	0.22																		
3Q4	Power amp pentode	3Q5GT	Fil.	1.4	0.1	7-BA	2 1/8	0.41	5.5	4	Power output amp	90	90	-4.5	9.5	2.1	215	100M	2150	0.27	10M	Par. fil.	3Q4
				2.8	0.05						" " "	90	90	-4.5	7.7	1.7	215	120M	2000	0.24	10M	Ser. fil.	
3S4	Power amp pentode	3Q5GT	Fil.	1.4	0.1	7-BA	2 1/8	--	--	--	Power output amp	90	67.5	-7	7.4	1.4	--	100M	1575	0.27	8M	Par. fil.	3S4
				2.8	0.05						" " "	90	67.5	-7	6.1	1.1	--	100M	1425	0.24	8M	Ser. fil.	
											" " "	67.5	67.5	-7	7.2	1.5	--	100M	1550	0.18	5M	Par. fil.	
											" " "	67.5	67.5	-7	6	1.2	--	100M	1400	0.16	5M	Ser. fil.	
3V4	Power amp pentode	3Q5GT	Fil.	1.4	0.1	6-BX	2 1/8	--	--	--	Power output amp	90	90	-4.5	9.5	2.1	--	100M	2150	0.27	10M	Par. fil.	3V4
				2.8	0.05						" " "	90	90	-4.5	7.7	1.7	--	120M	2000	0.24	10M	Ser. fil.	
6AG5	R-f pentode sharp cutoff	6SH7GT	Cath.	6.3	0.3	7-BD	2 1/8	0.025	6.5	1.8	Voltage amplifier	250	150	R_k=200	7	2	--	800M	5000	--	--	-8	6AG5
											" "	100	100	R_k=100	5.5	1.6	--	300M	4750	--	--	-5	
6AJ5	R-f pentode sharp cutoff	--	Cath.	6.3	0.175	7-BD	1 3/4	0.02	4.1	2	Voltage amplifier	28	28	R_k=200	3	1.2	250	90M	2750	--	--	--	6AJ5
											Class AB_1 power amp	180	75	-7.5	6.1	4.5	--	--	--	1	28M	--	
6AK5	R-f pentode sharp cutoff	--	Cath.	6.3	0.175	7-BD	1 3/4	0.02	4	2	Voltage amplifier	180	120	R_k=200	7.7	2.4	3500	690M	5100	--	--	-12	6AK5
												120	120	R_k=200	7.5	2.5	1700	340M	5000	---	--	-12	
6AK6	Power amp pentode	--	Cath.	6.3	0.15	7-BK	2 1/8	0.12	3.6	4.2	Power output amp.	180	180	-9	15	2.5	400	190M	2300	1.1	10M	--	6AK6
											" " "	135	135	-6	11.5	2	360	170M	2100	0.6	12M	--	
6AL5	Twin diode	6H6GT	Cath.	6.3	0.3	6-BT	1 13/16	--	--	3.2	F-m discriminator	Resonant frequency of each unit approx. 700 megacycles.											6AL5
											Rectifier	Max plate 150 v rms at 9 ma d-c per plate; peak plate curr. 54 ma max.											
6AN6	Quadruple diode	--	Cath.	6.3	0.2	7-BJ	2 1/8	--	--	--	Rectifier	Max plate 117 v rms at 3 ma per plate; peak curr. 9 ma max.											6AN6
6AQ5	Beam tetrode	6V6GT	Cath.	6.3	0.45	7-BZ	2 5/8	0.35	7.6	6	Power output amp	250	250	-12.5	45	4.5	218	52M	4100	4.5	5000	--	6AQ5
											" " "	180	180	-8.5	29	3	--	58M	3700	2	5500	--	
6AQ6	Duplex diode high-mu triode	6T7G	Cath.	6.3	0.15	7-BT	2 1/8	1.8	1.7	1.5	Detector & volt. amp	250	--	-3		---	70	58M	1200	--	---	--	6AQ6
											" " " "	100	--	-1	0.8	--	70	61M	1150	--	--	--	
6AS6	R-f pentode, dual control, sharp c.o.	--	Cath.	6.3	0.175	7-CN	1 3/4	0.02	3.9	2.8	Voltage amplifier	120	120	-2	5.2	3.5	--	--	3200	--	--	-10	6AS6
												Transconductance of No. 3 grid in above conditions is 470 μmhos.											
6AT6	Duplex diode high-mu triode	6Q7GT	Cath.	6.3	0.3	7-BT	2 1/8	2.1	2.3	1.1	Detector & volt. amp	250	--	-3	1	--	70	58M	1200	--	--	--	6AT6
											" " " "	100	--	-1	0.8	--	70	54M	1300	--	--	--	
6AU6	R-f pentode sharp cutoff	6SH7GT	Cath.	6.3	0.3	7-BK	2 1/8	0.0035	5.5	5	Voltage amplifier	250	150	-1	10.8	4.3	--	2000M	5200	--	--	-6.2	6AU6
											" "	100	100	-1	5.2	2	--	600M	3900	--	--	-4.2	
6BA6	R-f pentode remote cutoff	6SG7GT	Cath.	6.3	0.3	7-BK	2 1/8	0.0035	5.5	5	Voltage amplifier	250	100	R_k=68	11	4.2	--	1500M	4400	--	--	-20	6BA6
											" "	100	100	R_k=68	10.8	4.4	--	250M	4300	--	--	-20	
6BD6	R-f pentode remote cutoff	6SK7GT	Cath.	6.3	0.3	7-CC	2 1/8	0.004	4.3	5	Voltage amplifier	250	100	-3	9	3.5	--	700M	2000	--	--	-35	6BD6
											" "	100	100	-3	13	5	--	120M	2350	--	--	-35	
6BE6	Pentagrid converter, remote c.o.	6SA7GT	Cath.	6.3	0.3	7-CH	2 1/8	0.3	7.2	8.6	Converter	250	100	-1.5	3	7.1	--	1000M	475	--	--	-30	6BE6
											"	100	100	-1.5	2.8	7.3	--	500M	455	--	--	-30	
6C4	Power triode	6J5GT	Cath.	6.3	0.15	6-BG	2 1/8	1.6	1.8	1.3	Voltage amplifier	250	--	-8.5	10.5	--	17	7700	2200	--	--	--	6C4
											" "	100	--	0	11.8	--	19.5	6250	3100	--	--	--	
6D4	Triode thyratron	--	Cath.	6.3	0.25	5-AY	2 1/8	--	--	--	--	Max plate 320 v inverse peak; curr. 110 ma peak, 25 ma avg.											6D4
6J4	Triode uhf grounded grid	--	Cath.	6.3	0.4	7-BQ	2 1/8	4	5.5	0.24	Voltage amplifier	150	--	R_k=100	15	--	55	4500	12000	--	--	--	6J4
											" "	100	--	R_k=100	10	--	55	5000	11000	--	--	--	
6J6	Twin triode	--	Cath.	6.3	0.45	7-BF	2 1/8	1.6	2.2	4	Voltage amplifier	100	--	R_k=50	8.5	--	38	7100	5300	--	--	--	6J6
6N4	Triode uhf	--	Cath.	6.3	0.2	7-CA	1 3/4	2.35	3.1	0.55	Voltage amplifier	180	--	-3.5	12	--	32	5400	6000	--	--	--	6N4
6X4	F-w rectifier	6X5GT	Cath.	6.3	0.6	5-BS	2 5/8	--	--	--	Rectifier	Max plate 450 v rms at 70 ma d-c total output; peak plate curr. 210 ma max.											6X4
12AT6	Duplex diode high-mu triode	12Q7GT	Cath.	12.6	0.15	7-BT	2 1/8	2.1	2.3	1.1	Detector & volt. amp	250	--	-3	1	--	70	58M	1200	--	--	--	12AT6
											" " " "	100	--	-1	0.8	--	70	54M	1300	--	--	--	
12BA6	R-f pentode remote cutoff	12SG7GT	Cath.	12.6	0.15	7-BK	2 1/8	0.0035	5.5	5	Voltage amplifier	250	100	R_k=68	11	4.2	--	1500M	4400	--	--	-20	12BA6
											" "	100	100	R_k=68	10.8	4.4	--	250M	4300	--	--	-20	
12BD6	R-f pentode remote cutoff	12SK7GT	Cath.	12.6	0.15	7-CC	2 1/8	0.004	4.3	5	Voltage amplifier	250	100	-3	9	3.5	--	700M	2000	--	--	-35	12BD6
											" "	100	100	-3	13	5	--	120M	2350	--	--	-35	
12BE6	Pentagrid converter, remote c.o.	12SA7GT	Cath.	12.6	0.15	7-CH	2 1/8	0.3	7.2	8.6	Converter	250	100	-15	3	7.1	--	1000M	475	--	--	-30	12BE6
											"	100	100	-1.5	2.8	7.3	--	500M	455	--	--	-30	
12BF6	Duplex diode low-mu triode	12SR7GT	Cath.	12.6	0.15	7-BT	2 1/8	2	1.8	1.1	Detector & volt. amp	250	--	-9	9.5	--	16	8500	1900	--	--	--	12BF6
26A6	R-f pentode remote cutoff	--	Cath.	26.5	0.07	7-BK	2 1/8	0.0035	6	5	Voltage amplifier	250	100	R_k=125	10.5	4	--	1000M	4000	--	--	-25	26A6
											" "	26.5	26.5	R_g=2meg	1.7	0.7	--	250M	2000	--	--	-8	
26C6	Duplex diode low-mu triode	--	Cath.	26.5	0.07	7-BT	2 1/8	2	1.8	1.4	Detector & volt. amp	250	--	-9	9.5	--	16	8500	1900	--	--	--	26C6
											" " " "	26.5	--	R_g=2meg	1.1	--	17	15500	1100	--	--	--	
26D6	Pentagrid converter, remote c.o.	--	Cath.	26.5	0.07	7-CH	2 1/8	0.3	7.5	14	Converter	250	100	-1.5	3.0	7.8	--	1000M	475	--	--	-30	26D6
											"	26.5	26.5	-0.5	0.45	1.6	--	--	270	--	--	-6	
35W4	H-w rectifier	35Z5GT	Cath.	35	0.15	5-BQ	2 5/8	---	--	--	Rectifier	Max plate 117 v rms at 90 ma d-c output; peak plate curr. 600 ma max.											35W4
45Z3	H-w rectifier	--	Cath.	45	0.075	5-AM	2 1/8	--	--	--	Rectifier	Max plate 125 v rms at 65 ma d-c output; peak plate curr. 390 ma max.											45Z3
50B5	Beam tetrode	50L6GT	Cath.	50	0.15	7-BZ	2 5/8	0.5	13	6.5	Power output amp	110	110	-7.5	49	4	--	14M	7500	1.9	2500	--	50B5
117Z3	H-w rectifier	117Z6GT	Cath.	117	0.04	4-BR	2 5/8	--	--	--	Rectifier	Max plate 117 v rms at 90 ma d-c output; peak plate curr. 540 ma max.											117Z3
9001	R-f pentode sharp cutoff	--	Cath.	6.3	0.15	7-BD	2 1/8	0.01	3.6	3	Voltage amplifier	250	100	-3	2	0.7	--	1500M	1400	--	--	-10	9001
												90	90	-3	1.2	0.5	--	1000M	1100	--	--	-10	
9002	Vhf triode	--	Cath.	6.3	0.15	7-BS	2 1/8	1.4	1.2	1.1	Voltage amplifier	250	--	-7	6.3	--	25	11400	2200	--	--	--	9002
9003	R-f pentode remote cutoff	--	Cath.	6.3	0.15	7-BD	2 1/8	0.01	3.4	3	Voltage amplifier	250	100	-3	6.7	2.7	--	700M	1800	--	--	-45	9003
9006	Uhf diode	--	Cath.	6.3	0.15	6-BH	2 1/8	--	--	1.4	H-w rect. or det.	Max plate 265 v rms at 5 ma d-c output; peak plate curr. 15 ma max.											9006
												Resonant frequency is approx. 700 megacycles.											

* These types frequently used as class C amplifiers or oscillators in low-power transmitters for portable or mobile operation. Data for use in such applications are listed in the Hytron transmitting and special purpose tube catalogue.

The data in this reference guide have been compiled with the utmost care as to technical accuracy -- from sources we believe to be authoritative and reliable. Hytron Radio & Electronics Corp., however, cannot assume any liability or obligation for the use or application of these data.

BASING DIAGRAMS—BOTTOM VIEWS OF SOCKET CONNECTIONS



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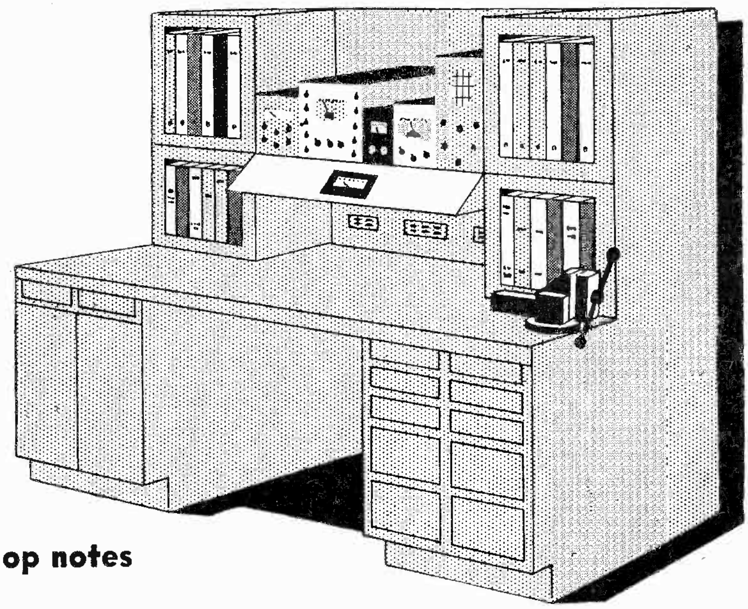
RADIO MAINTENANCE • JANUARY 1947

The Radio Service Bench



Case histories and shop notes

by Max Alth

Clarion C104A

Weak station response subnormal:

Check the antenna loop link for correct positioning. If it is in the wrong position, the loop will be disconnected or the RF stage will be slightly out of tune.

G.E. 50

Lack of volume, broad tuning:

Check the RF and detector circuits for alignment at the upper and lower ends of the band. If the circuits cannot be aligned, the dial cord has changed its length. Either one of the knots has slipped, the cord has stretched, or the spring has lost its tension and is allowing the cord to relax. The dial cord from the top of one iron core to the top of the other should be exactly 4 1/16" in length.

Emerson 510

Dead up to and including the second IF can; voltages okay:

Detune both sides of the IF coil carefully. The trimmer sometimes shorts when compressed too tightly. Realign the set on a slightly higher IF frequency, or replace the IF transformer.

Majestic 500

The 6A7 does not oscillate over the entire band:

Measure oscillator grid - to - ground resistance. It should be from 47,500 to 52,500 ohms.

Audio oscillation:

Motorboating in this set is sometimes caused by a high resistance short between windings on the same IF transformer. Replace.

The selectivity of this set can be noticeably improved by adding a trimmer to the untuned primary circuit of the second IF, or by replacing the 456 kc unit with a new high gain, double tuned unit.

Silver Tone 7211-13

Interstation and on-station whistle:

The coil of antenna wire is regeneratively coupled to the set. Uncoil it and remove it from the proximity of the set.

Spartan 930-1

Intermittent fading:

The tuning condenser bearings are loose and the entire assembly moves when vibrated. Grounding contacts dirty. Clean, or replace with pigtails.

If the set breaks into low frequency audio oscillation, the bleeder resistor has increased in resistance. All voltages will be slightly higher than normal. Remove and replace the bleeder resistor with a 15,000 ohm, 25 watt unit.

Simplex 6

Weak, oscillator ceases oscillation on low end of dial:

Replace the 700 ohm oscillator cathode bias resistor with a 400 ohm unit.

Stewart-Warner Companion, AC-DC

Voltages low, hum:

The electrolite in the filter condenser block often leaks through the cardboard container and makes a high resistance short to the chassis, putting an extra load on the power supply. Replace it with a dry electrolytic unit.

Stewart Warner R112

Motor noise coming through:

Check for source by disconnecting the antenna, then the dial light wires, and last the control cables at the chassis. Shield dial light wires and ground the shield at both ends. If this does not eliminate the noise, shield the control cables in the same way.

Excessive vibrator hash:

Connect two 0.25 ufd, 600 volt condensers across the vibrator contacts. Place these inside the power transformer housing. Improve the already existing bonds between the power transformer housing, the vibrator can, and the chassis.

The output of this set may be increased by moving the output transformer's B+ lead (yellow and red) from where it is to a point ahead of the relay and choke. Connect it directly to the cathode of the

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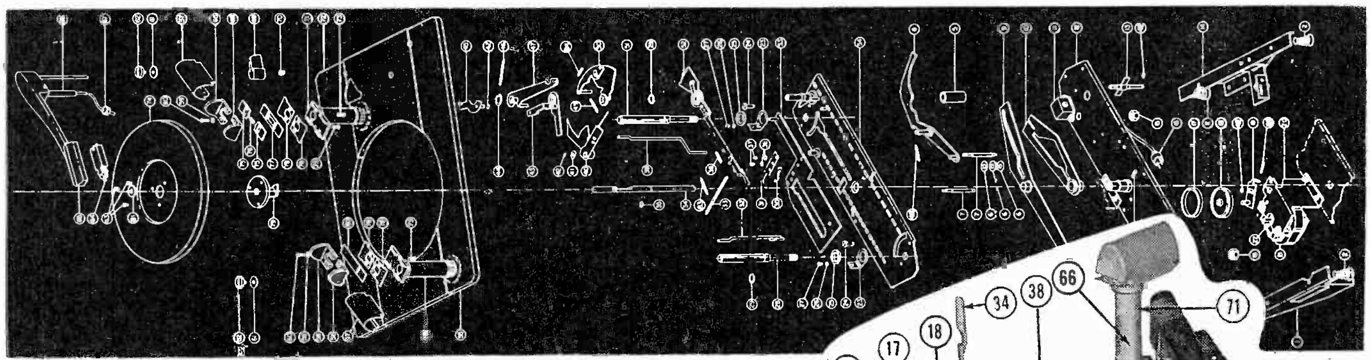
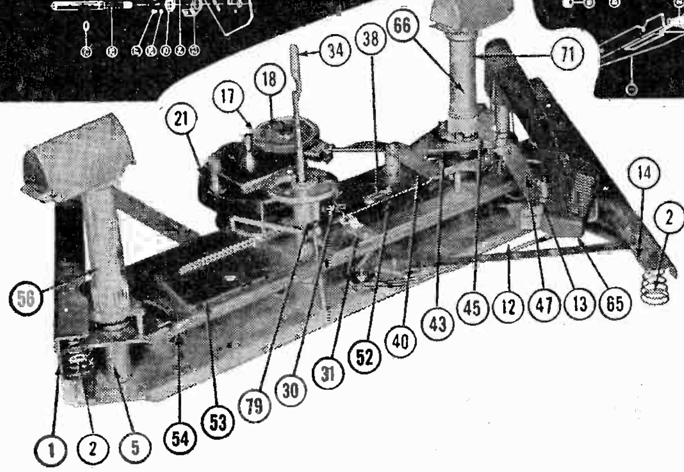
New! Exclusive!





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analyze all post-war

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PUBLICATION DATES:
Set No. 11 . . . . January 10
Set No. 12 . . . . January 25

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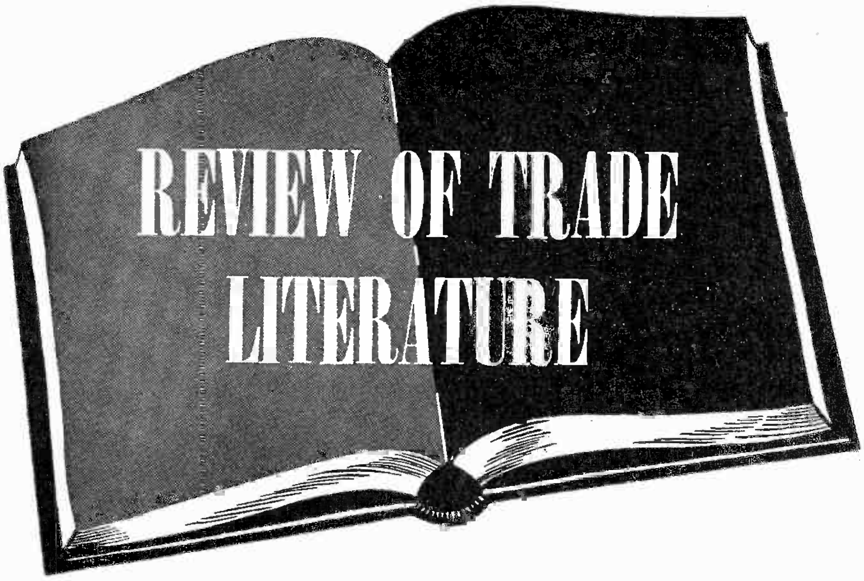

To avoid delay when writing to the manufacturer give issue and page number.

THE Volume Control Cross-Index Guide, issued by Clarostat Mfg. Co., consists of a collection of cards printed on both sides with the complete cross-index of corresponding type numbers of four leading volume control manufacturers. They are arranged in numerical order so that the serviceman can instantly pick out his favorite brand type. The Guide may be had free of charge from any Clarostat distributor or by writing Clarostat Mfg. Co., Inc., 130 Clinton St., Brooklyn 2, N. Y.

An illustrated manual covering a wide variety of relays available for immediate delivery from stock has just been released by Wells Sales, Inc. Engineering information includes coil resistance and voltage, contact data, sensitivity, insulation, dimensions and prices.

To secure a copy, write Wells Sales, Inc., 4717 West Madison St., Chicago 44, Ill.

The Operating and Maintenance Manual issued by Allen B. Du Mont Laboratories, though pertaining specifically to Du Mont Type 274 oscillograph, contains much general information of interest to others. The 8½ x 11 manual contains 39 pages of solid information, plus a folded chart of the circuit schematic and constants of Type 274. The theory of operation of the cathode-ray tube and oscillograph circuits is discussed, clarified by illustrations and diagrams. The operating instructions deal with the alignment of AM and FM receivers and the use of the oscillograph in conjunction with radio transmitters.

This manual is being offered at 50 cents per copy, or $5 per dozen copies postpaid in the USA only, and may be obtained from the Allen B. Du Mont Laboratories, Inc., 2 Main Ave., Passaic, N. J.

Lake Radio Sales Company announces that their new 16-page illustrated catalog NR-116 is now available. It features over 1500 items including condensers, resistors, crystal sets, transformers, microphones, amplifiers, sound equipment, test equipment, record changers, and many other items, all manufactured by the leading firms of the country. Complete descriptions, prices and all technical data are included in this compact and complete listing of radio parts and equipment.

Servicemen may write for their free catalog to Lake Radio Sales Company, 615 West Randolph St., Chicago 6, Ill.

The second of a series of Temporary Bulletins has been issued by Centralab. This Bulletin No. 934 is on the subject of the Model 1 Radiohm, attenuator for pocket radio receivers and miniature amplifiers. (Bulletin No. 933 describes the new B C capacitors.)

The latest Centralab catalog on Switches is now available, giving construction information, specifications and a key to dimensions on the various types of switches, as well as data on clips and contacts, interstage shields, and relevant material.

Temporary Bulletins No. 933 and No. 934 and the Catalog on Switches can be obtained at no charge by writing Cen-

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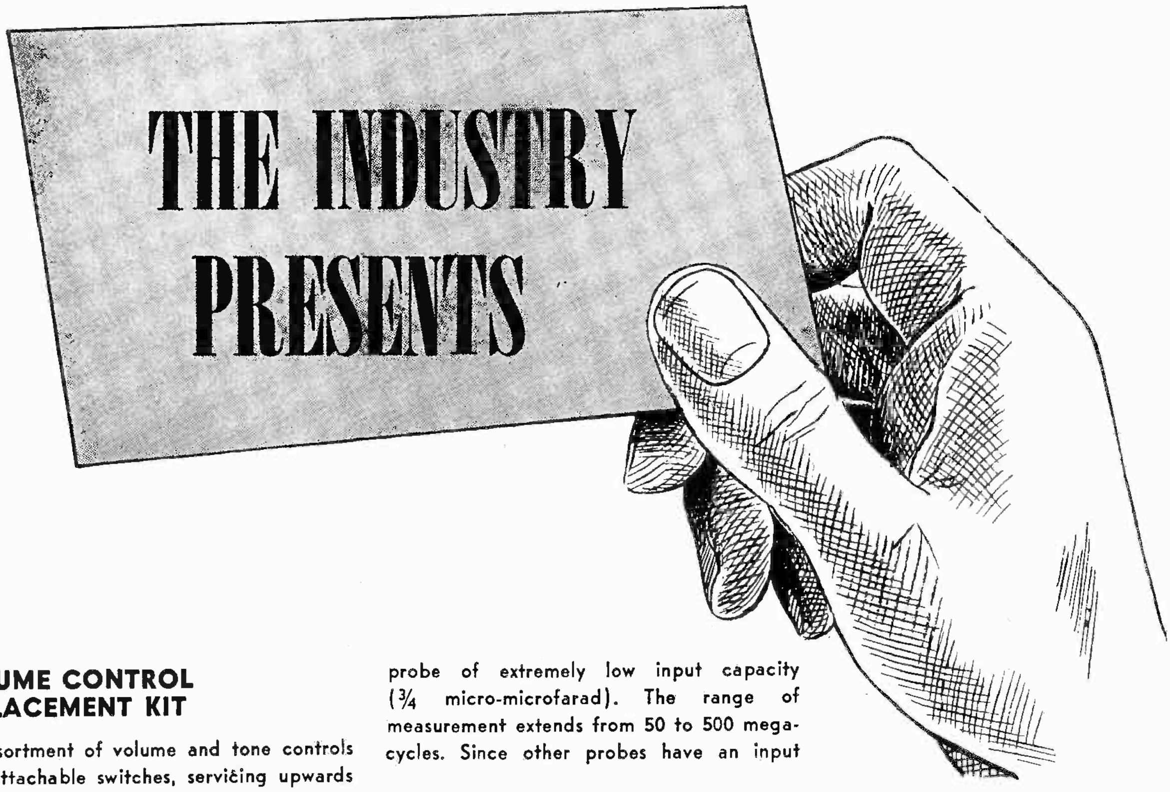
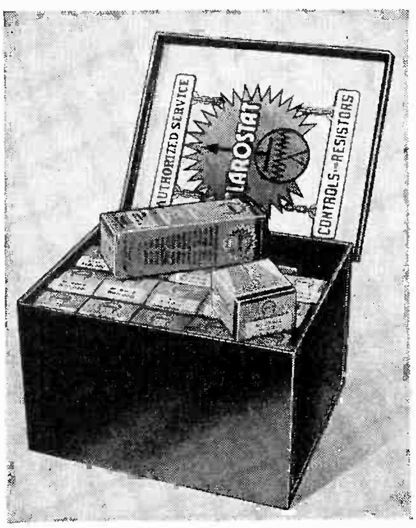


VOLUME CONTROL REPLACEMENT KIT

An assortment of volume and tone controls with attachable switches, servicing upwards of 95 per cent of standard replacement needs, packed in a neat steel cabinet, has been announced by Clarostat Mfg. Co., Inc., 130 Clinton Street, Brooklyn 2, N. Y., and is now available through its jobbers.



The kit contains 17 controls, 8 switches and 4 glass-insulated flexible resistors. Controls and Ad-A-Switches are individually packed in standard cartons that fit snugly in the hinged-top steel cabinet (which is devoid of advertising matter). Also included are the Clarostat Volume Control Selector or cross-index of various brands and types, and the Clarostat Authorized Service plaque for display purposes.

HIGH FREQUENCY VOLTMETER

The Alfred W. Barber Laboratories have announced a new high frequency electronic voltmeter Model 32. It is equipped with a probe of extremely low input capacity (¾ micro-microfarad). The range of measurement extends from 50 to 500 megacycles. Since other probes have an input

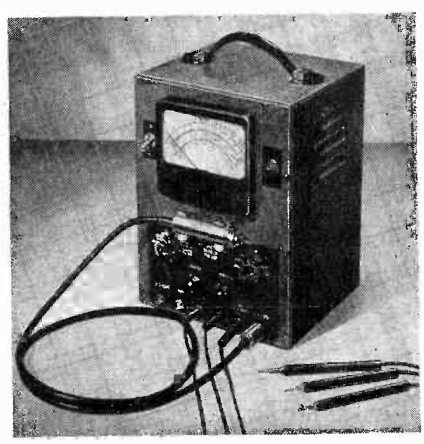
capacity of 5 micro-microfarads or more, the loading and detuning of very high frequency circuits have presented a serious problem, to which Model 32 supplies the answer.

Descriptive bulletins are available from Alfred W. Barber Laboratories, 34-14 Francis Lewis Blvd., Flushing, N. Y.

NEW TEST INSTRUMENT

This instrument, Type 134 Polymeter, permits radio and electronic repairmen to isolate condensers, coils and resistors quickly when faults occur, and to check circuit operation after replacements are made. An unusually compact vacuum tube probe is provided for modern signal tracing technique. It employs a tiny proximity fuse type tube.

Features of the new instrument include balanced amplifier circuit, practically independent of line voltage and normal amplifier tube changes; preset factory adjustments, permitting correct zero setting for all ranges through one front panel adjustment; convenient range switch for correct multiplier values; five jacks for plug-in test-lead readings of AC volts, DC volts, ohms, amperes and milliamperes.



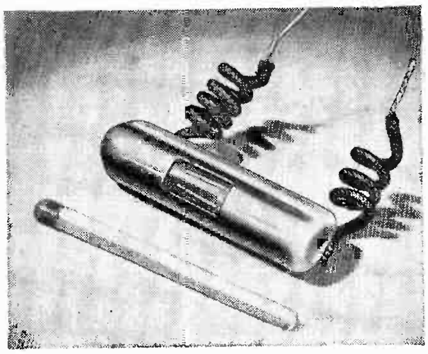
Measurement ranges of the Polymeter include: DC volts, 0-1000, in six ranges; AC volts, 0-300, in five ranges. Current measurements are provided for by seven ranges, and resistance by six ranges up to 1000 megohms.

The Polymeter is manufactured by Sylvania Electric Products, Inc., 500 Fifth Ave., New York 18, N. Y.

MIDGET NEON PILOT LIGHT

Maximum indication in minimum bulk

characterizes the Tiny-Glow pilot light announced by Industrial Devices, Inc. Housed in a heavy metal casing, the miniature neon lamp consumes under 1/10 watt and operates at any voltage from 75 to 250, AC or DC, with a life of over 10,000 hours of



actual burning time. The unit is shock- and vibration-proof, and is especially desirable on instrument panels, switchboards, electrical and electronic appliances, and equipment of various kinds where a high visibility, negligible current, cold pilot light is needed.

For further information, write Industrial Devices, Inc., Edgewater, N. J.

CRYSTAL MICROPHONE AND DESK STAND

The BA-106 Acousticel Microphone is the latest addition to the Brush Development Company's line of crystal microphones for home recording, public address, amateur radio and industrial applications. Using the newly developed Acousticel incorporating sintered bronze damping, it provides essentially flat response from 40—6000 cps with

exceptionally high output. The BA-106 Acousticel is high impedance and can be used with any amplifier or recorder employing high impedance input. This microphone is an attractive combination of black molded plastic and satin chrome finish.

For further information, write the Brush Development Co., 3405 Perkins Ave., Cleveland, Ohio.

SECOND NEW RECEIVER

National Union Radio Corporation announces the second in their series of five new home radio receiving sets designed specifically for sale by the serviceman. The Companion Model 571 (not yet delivered) is a 5-tube AC-DC superheterodyne (gang condenser tuned) with built-in loop antenna, automatic volume control and electro-dynamic speaker, American Broadcast Band coverage over a slide rule type panel lighted dial scale. It comes in a walnut veneer wood cabinet with inclined front panel and bronze metal finish grille.

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

CONDENSER-RESISTOR BRIDGE

A portable Condenser-Resistor Bridge, Type YCW-1, capable of measuring a wide range of capacity, resistance and other electrical characteristics of condensers, has been announced by the General Elec-

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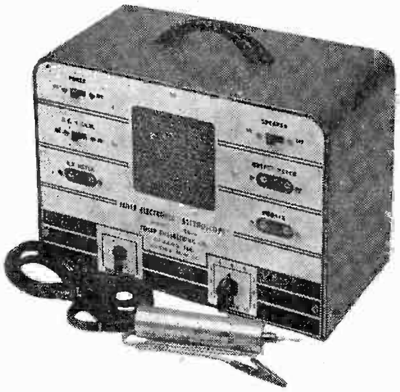

Industry Presents

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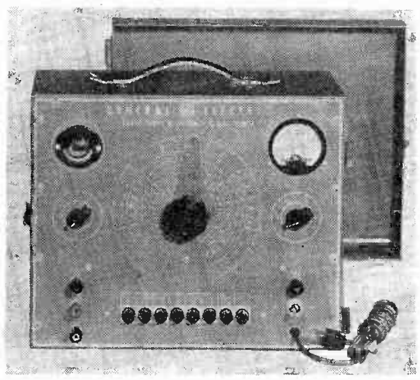
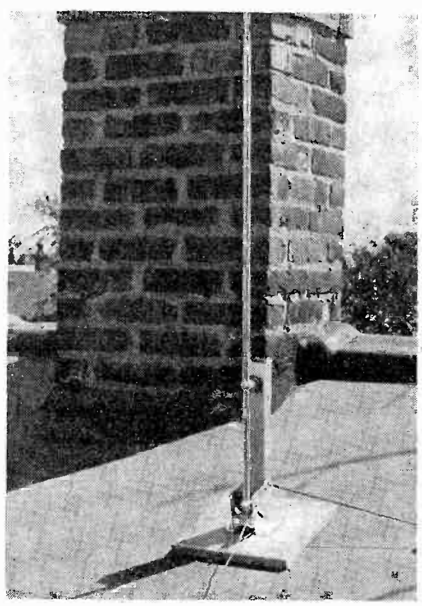
tric Company. It measures capacity from .000005 to 200 microfarads in three convenient ranges, and resistance from 5 ohms to 20 megohms in two ranges. Using the Wien Bridge principle with standards of ±1 for capacitance and ±2 per cent for resistance, bridge balance is indicated by a sensitive (electronic) visual indicator tube. Insulation resistance and leakage current are indicated directly on a 2½ in. instrument mounted in the panel. Power factor is measured on the high capacity range by a potentiometer in series with the standard resistance which has a scale of 0 to 50 per cent.



Further information may be obtained from the Specialty Division, G-E Electronics Department, Wolf St. Plant, Syracuse, N. Y.



NEW RADIO MASTS

The Ward Products Corporation has announced two new house and window radio masts, engineered for vertical polarization. Both types of mast feature a telescopic design, and are weatherproofed with heavy cadmium plating.

The house mast (with built-in lightning arrestor) extends to 12 ft. for greatest signal pickup, and is collapsible to 4 ft. for easy handling. It may be mounted easily in various roof positions, including installation on the soil pipe if desired.

The window type extends to eight ft. and may be collapsed to 40 in. Installation on window frame or sill of home, apartment or office building, takes only three minutes.

For further information, write the Ward Products Corporation, 1523 East 45 St., Cleveland, Ohio.

DYNAMIC AND CRYSTAL MICROPHONES

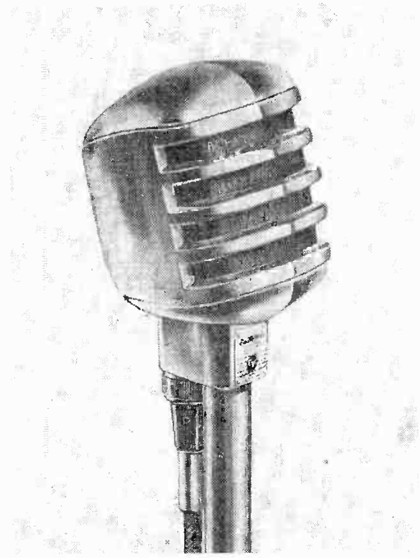
Two modern, high quality, low priced, general purpose dynamic and crystal microphones are announced by Electro-Voice. Frequency response is substantially flat from 50—8000 cps, for fine reproduction of voice and music. Polar pattern is non-directional at low frequencies, becoming directional at higher frequencies.

Model 610 Dynamic employs the new E-V Acoustalloy diaphragm which withstands high humidity, extremes of temperature, salt air, and severe mechanical shock. It uses Alnico V in the magnetic circuit. Out-

put level is —53 db. It is available in Hi-Z (direct-to-grid, 25,000 ohms), 50, 250 or 500 ohms impedance.

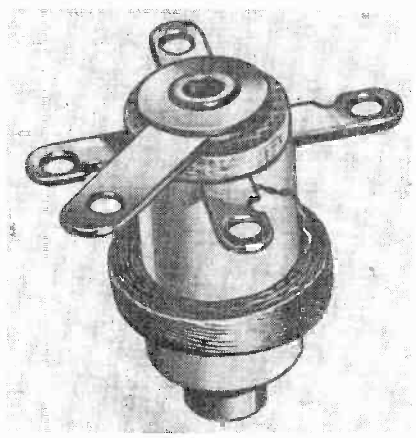
Model 910 Crystal microphone employs a high capacity moisture-sealed crystal and duralumin diaphragm. Output level is —48 db. High impedance.

For complete information, write Electr Voice, Inc., Buchanan, Michigan, and a:' for Catalog No. 101.



ADJUSTABLE INDUCTANCE COIL

The Pioneer Electric and Research Corporation has recently announced the development of an unusual miniature oscillator coil specifically for operation in small radios—both prewar and postwar models. It is only 9/16" x 3/4", small enough to fit any radio, thereby answering the demand and need of the serviceman.



This new adjustable inductance coil can be used for replacement in any radio employing a pentagrid converter and 455/6 kc IF's. A bifiliar winding acts as the grid coupling capacitor when required; and its inductance is adjustable by means of a movable iron core to replace any oscillator coil. It is furnished complete with instructions for use.

For additional information or a catalog featuring other models, write to Pioneer Electric and Research Corporation, 7212 Circle Ave., Forest Park, Ill.

INSULATION TESTER

The "Billionaire" manufactured by Radio City Products Company has an insulation resistance range up to 10 billion ohms. It also includes a vacuum tube voltmeter, ohmmeter and capacitymeter.

This Model 665A has an 8" meter, accurate to 2% at full scale. Automatic line

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Servicing by Ear

→ From Page 14

fective unit, the surge that takes place usually stops temporarily the sound; but it will be back, usually just after the customer takes the set home. The best plan is to "ease" the suspected section in and out of the circuit with a high resistance variable resistor, a good condenser being used to keep the hum down while this test is being made.

If the set is an AC-DC with a built-in loop, and if the noise appears at the slightest vibration, even that caused by the speaker, suspect the rectifier. 35Z5's and 35Z3's, especially when in the field of a loop antenna, develop some kind of a loose connection inside that causes them to make a scratching noise with the slightest movement. Another tube is the only cure, and a tube checker will seldom reveal anything wrong with these rectifiers. Very rarely, output tubes will do the same thing.

If the noise is of the kind that starts at a low volume, rapidly builds to a crescendo and then snaps off, only to repeat this a few seconds later, suspect either the mixer or detector tubes. Striking these tubes smartly with a bakelite rod (directly on top of the grid cap if they have a cap) will usually reveal which one is guilty). Quite often the noise is accompanied by an abrupt change in volume as well.

A low but persistent scratching sound, especially when a station is tuned in, is an indication of a bad coil. Usually, manipulation of the volume control will show whether this coil is ahead or behind the detector. If the coil is the primary of the output transformer, the noise is usually worse just as the tubes are warming up, and the scratching is often accompanied by a squeaking, frying sound terminating in a loud pop as the tiny arc between the broken ends of the wire temporarily weld together.

On the other hand, if the trouble is a bad coil in an IF transformer, the scratching will go along for hour after hour, occasionally accompanied by changes in volume. If such a condition is suspected, a low resistance should be inserted briefly between the plate end of the primary coil and ground. This will cause a greatly increased current to pass through the coil. If it is good, no harm will be done; but if there is a weak place in the winding, the current will cause it to burn open. A 2,500 ohm resistor will serve for this purpose.

Loud background and static noises without any stations being heard are an indication of oscillator failure. Touch the stator portion of the oscillator tuning condenser. If the oscillator is working, you will hear a loud "plop" as it goes out of oscillation and another when it starts as the finger is removed. Open coils, open or changing-value resistors, bad tubes, and bad coupling condensers—especially those innocent-looking little mica cusses, the ones you do not ordinarily suspect—are among the most common causes of oscillator failure.

If you have the loud hiss of background noise coupled with weak station reception, try touching the mixer-tuning stator. When this brings the volume of the station way up, you can be pretty sure that you have an open antenna coil, or if the set has an RF stage, an open interstage coil.

Distortion

Distortion is about as common as noise. If you have a set that distorts, try turning the column control up and down. If the distortion disappears at high volume but is bad at low volume, the trouble is probably that the speaker voice coil is rubbing on the pole-piece. At high volume, the cone is jerked back and forth in spite of this friction; but when the volume is low, it does not move freely enough to reproduce faithfully.

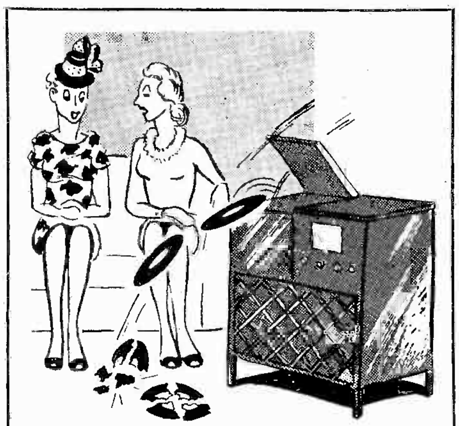
If, on the other hand, the distortion is worse at high volume, look for a leaky coupling condenser to the grid of the output tube or some other reason why the normal negative bias on this grid is low. A change in the value of a cathode resistor, a leaky cathode condenser, or a change in the value of the negative-voltage bleeder network resistors are the other common causes. When the bias is low, the positive peaks cause the grid to swing positive, resulting in bad high-volume distortion. A voltmeter will usually reveal the lack of proper grid bias; and if the coupling condenser shows the slightest trace of leakage, it should be replaced for the leakage usually increases after the set is in operation for some time.

You may run across a set that operates very well when turned on; but after playing for fifteen minutes to a half hour, gradually begins to distort. A voltage check will show a slight positive voltage on the grid with respect to ground, although the coupling condenser shows absolutely no leakage. If the tube is a beam tube, it is causing the trouble. Slight misalignment of the beam-forming grids causes heating and secondary emission by some of the elements, accompanied by creeping plate current. Replacement with a good tube is the best cure, although sometimes lowering the value of the grid resistor will help.

The set that performs normally on weak stations but distorts badly on loud ones has a shorted bypass condenser in the AVC system (See Fig. 4) that prevents the AVC voltage from being applied to the grids of the RF and IF tubes. Usually, this is accompanied by an unusually loud background noise when stations are being received.

When a set sounds choked, with only the peaks of the audio signals coming through, look for a defective coupling condenser in the audio system. If these check all right, see if there is not a gassy tube in the second detector or along the AVC line.

Once in a while, you will come across a set in which you cannot cut the volume clear off, even though the volume control is good



"It's a very exclusive model. It refuses to play anything but Bach or Beethoven."

and is properly installed. When this happens, see if there is not an open low voltage electrolytic condenser across a cathode resistor in the second detector circuit. When this condenser deteriorates, the audio present in the diode detection portion of the tube leaks across to the grid of the triode amplifier portion and prevents complete cutting off of the volume.

A rasping sound as the dial is turned, usually accompanied by weak response, or no response at all, on the low-frequency end of the dial is just what you would think: The tuning condenser plates are rubbing. However, if the set is a TRF, and if the noisy condition is accompanied by a tendency to oscillate, try cleaning the wipers on the rotor of the tuning condenser. This will work wonders in the performance of older sets.

Intermittents

Having stalled as long as possible, we finally come reluctantly to the hobgoblin of all servicemen: The intermittent. This is the one that the customer leaves with the cheerful remark, "I am sure there is not much the matter with this set. It will be playing along all right until some one turns on a light or the refrigerator cuts in, and then the volume drops way down. If you snap it off and on again, the volume comes back up. Can I pick it up in about an hour?"

The first thing to do is to see if the trouble is mechanical. Wait until the customer leaves and then deal the set a good lusty blow with your fist. If this does not cause the volume to change (exclusive of any detuning effect from the jar) try playing "Chopsticks" on the tubes with a bakelite rod. This failing, too, just resign yourself to a long and tedious struggle. Put the set on the back of the bench, set it at a station on the low-frequency end of the band, turn the volume down low—this is important, for many sets will not cut out at high volume—and start working on something else. Eventually, the set will cut out; and when it does, be prepared to note the following points:

Did the station disappear entirely, or did it just go down in volume? If there is a tuning eye, did the shadow angle change? Did the station being received apparently shift its frequency? Was the change in volume accompanied by any noise or change in audio quality?

If the station disappeared entirely, but if stations can be tuned in at the high frequency end of the band, the oscillator is functioning as it should. It is ceasing to oscillate on the lower frequencies where the feedback is normally less. If there is a shift of all the low frequency stations toward the high frequency end, the padder—or more likely a mica condenser across the padder—is changing its value. If the tuning eye retained the same shadow angle when the volume changed, your trouble is in the audio system. If the tuning eye changed, look to the RF and IF systems.

When the volume change is accompanied by a rustling popping sound, be suspicious of mixer or second detector tubes or of defective coils. If whistles develop at the same time as the volume changes, look for opening bypass condensers on screens, plates, cathodes, and AVC bus. If the audio quality suddenly becomes thin, with only the higher frequencies being heard, it is a good bet that one of the audio coupling condensers is opening up.

This by no means takes in all of the causes of intermittent reception; but as I said at the beginning, this article makes no pretense of detailing every possible observed condition and its cause. Instead, I have tried to show that "servicing by ear" is really a union of radio theory and radio practice. If the serviceman will note what particular peculiarity in reception accompanies each discovered fault (keeping a notebook of these cases is an excellent idea) it will not be long before he will be able to work backward from an observed effect to the logical cause. By keeping constantly alert to the possibility of tying together the cause of defective reception with its peculiar aural effect, the serviceman will become more and more adept at "servicing by ear." Then he will be in a position to employ his various instruments as does a doctor: To verify or disprove his shrewd guess as to the cause of the trouble.

Industry Presents

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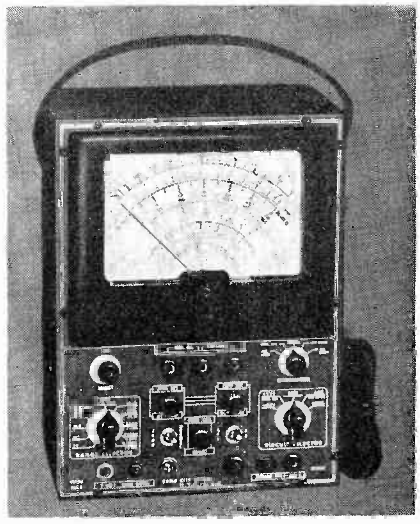
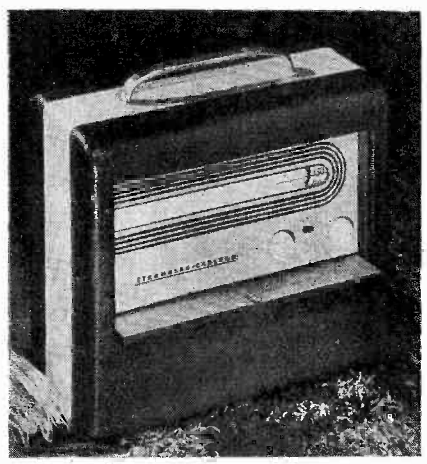
voltage check provides AC as well as DC regulation to assure accuracy and stability. An automatic ohmmeter battery check warns when to replace the battery.



This instrument is 9¾" x 12½" x 6" and weighs 13 lbs., complete in metal case with 4 leads.

PORTABLE RADIO

"The Vagabond," superheterodyne receiver with 5½" Alnico speaker, has been announced by Stromberg-Carlson Company. It contains six tubes, including rectifier, is equipped for AC-DC or battery operation,



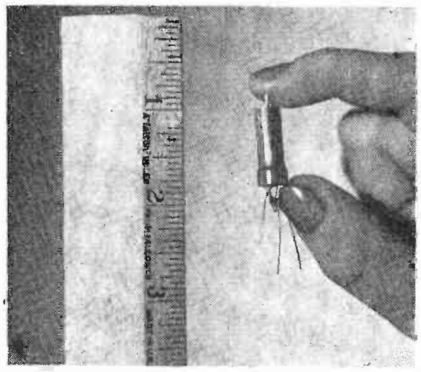
and is housed in a maroon leather-finish fabric case with gray trim. Special features are a tuned radio frequency stage and a built-in low inductance loop. The portable

→ **To Opposite Page**

Industry Presents

→ From opposite page

is 11½" x 13" x 6⅜" and weighs 15 lbs. with batteries.

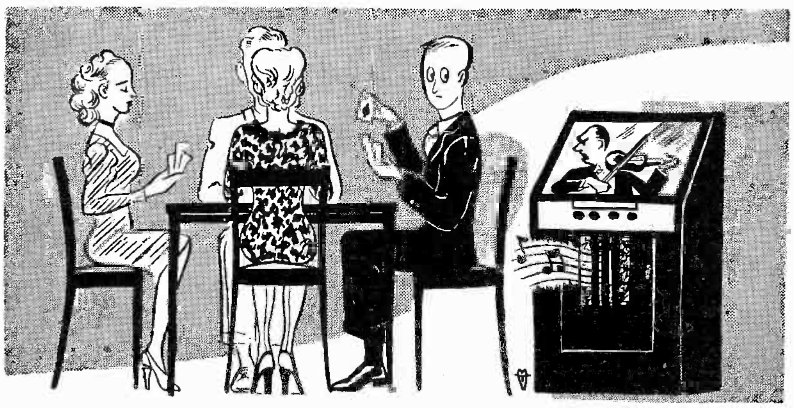


VIBROTRON

RCA's new tiny metal electron tube has been developed for converting motion directly to a variable electron flow. It weighs only one-fifteenth of an ounce and is 1 inch long and one-quarter of an inch in diameter. The vibrotron is particularly suited for use in phonograph pickup devices, microphones, and industrial devices for indicating motion. The movable electrode extends through a flexible metal diaphragm at the top of the tube and serves as an eternal lever.

Do You Know a Better Way To do it?

Don't forget . . . Radio Maintenance pays ten dollars for the best serviceshop suggestion each month . . . five dollars for each one published . . . Send 'em in!



"P-s-s-t! No, stupid! Not that one!"

The Oscillograph... How to use it

→ **From Page 11**

and bottom envelopes of the wave and judge whether they represent pure sine waves or over-loaded sine waves like those shown in Figs. 8 and 9.

If distortion is present, then, as mentioned above, it is most likely that overloading is taking place in the IF stages. It is, of course, possible though unlikely that the difficulty is somewhere in the RF circuits, or in the input signal itself. To check these points, connect in succession to points 2 and 3 of Fig. 7. If position 3 shows a distorted picture, there is trouble either in the RF signal or in the audio modulating signal. Disconnect the signal generator from the receiver and troubleshoot it.

If position 3 is clear and 2 shows distortion (which will rarely occur), then the RF section (including RF amplifiers, if any, local oscillator and first detector) must be investigated; the trouble will most likely be found attributable to a bad tube, incorrect bias or B+ voltages, or a leaky condenser.

If positions 2 and 3 are clear and position 1 shows distortion, then as predicted, the overloading is in the IF amplifier and the difficulty can probably be traced to incorrect operating voltages (bias or B+) or faulty AVC action.

It must be borne in mind, and it is here stressed again, that the only reason for the external (video) amplifier is the fact that all signals before the second detector are too small in amplitude to cause a visual deflection on the cathode-ray tube screen if connected directly to the deflecting plates, and are of too high frequency to be amplified by the oscilloscope's vertical amplifier. Men for whom the servicing art has progressed to the stage where they require a more complex oscilloscopic instrument than the DuMont 208 or equivalent type such as has been described up to now, may quite possibly not require the additional external amplifier for these tests because some of these advanced oscilloscope sets have vertical amplifier band-widths of a megacycle and more. There are other interesting features provided by some of these instruments, such as double-sweep tracing (enabling two signals to be viewed at once), Z-axis (intensity) modulation, and other useful devices. These advanced types may be discussed in a future article.

The above testing for overload distortion, although described with the broadcast AM band specifically in mind, can be carried through just as easily and expeditiously on short-wave band testing. On short-wave, it will be possible, using the above techniques, to trace the signal back only as far as the input to the IF amplifier because the RF signal will, of course, be higher in frequency than the maximum frequency capable of being passed through the external video amplifier. However, just as with the broadcast band, overload distortion, if not present in the audio, will almost certainly be discovered in the IF or second detector—not in the RF section or in the signal genera-

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The Service Bench

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rectifier tube. This increases the voltage on the plate of the 41 some 35 volts. Reduce the grid resistance of the 41 from ½ megohm to ¼ megohm, and decrease the plate bypass condenser from .01 ufd to .006 ufd 600 volts. Readjust the relay to operate on less current by softening the spring.

Zenith 10002

Set lacks bass note response:

Open center tap on the push-pull driver transformer. Open 85 cathode bypass condenser.

• • • •

A simple guard against working on a hot chassis can be made from a metal plate placed on the service bench and grounded to the power line through a small signal light. Place the chassis on the metal plate, then plug it in; if the light goes on, reverse the plug.

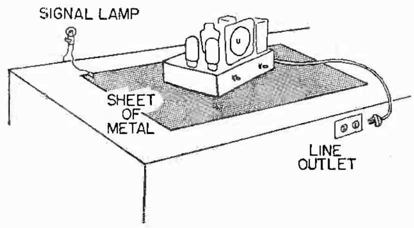


Fig. 1 A plate mounted on the workbench and grounded through a lamp acts as a signal to indicate voltage on the chassis of a set.

• • • •

Power transformers that hum excessively, because of loose laminations which cannot be further tightened by the means provided, can be silenced by this method: Loosen the nuts, and let the set run long enough to get hot. Then apply shellac or gasket glue to the edges of the laminations with a brush in such fashion that some of the glue is forced in between the sheets of metal. Tighten and allow to dry.

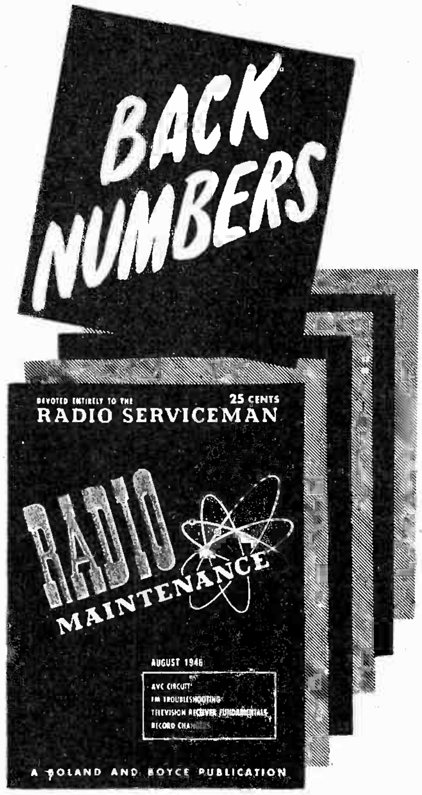
Review of Trade Literature

→ From Page 19

tralab, Division of Globe-Union, Inc., 900 East Keefe Ave., Milwaukee 1, Wis.

The Atlas Sound Corporation has issued a new catalog listing and giving information on their line of horn projectors, driver units, microphone stands, and other products.

A copy may be secured by writing Atlas Sound Corporation, 1443 39th Street, Brooklyn 18, N. Y.



By popular demand, Radio Maintenance is continuing to make available to its readers the back numbers still on hand. We are sorry that several issues are completely sold out but offer those still in stock for as long as they last.

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The Oscillograph . . .
How to use it

→ From Page 28

tor. (Distortion in the signal generator is most unlikely since, unless there were previously some distortion in the receiver proper, the elaborate testing described would not have been started.)

No Signal on the Screen

If, at the very beginning of the testing, no signal is found on the oscilloscope screen, which means no audio output at the loudspeaker, the method described can be used (and has been successfully used several times by the author) for tracing down the signal until the point is found where it disappears. There may be an obvious difficulty present, of course, such as failure of the rectifier tube or of a filter condenser which would cause plate voltage to disappear. In the absence of any such easily recognized troubles, however, the procedure outlined in the preceding paragraphs can be followed. Starting with the audio, trace progressively back until the signal first appears. If signal appears on the oscilloscope screen at any point in the receiver, then the trouble is somewhere beyond the point (i.e., between it and the speaker). The test procedure will not point directly to the source of trouble, but it will aid in isolating it to a specific section of the receiver.

Alignment

In the next article on the oscillograph, the problem of frequency distortion in the receiver will be taken up, together with means for taking a band-pass characteristic of the IF amplifier and then aligning the amplifier until the required curve is attained.

Picture Credits

Radio Maintenance, Jan. 1947

P. 4—Top: RCA
Bottom:
Allen B. DuMont Labs.
P. 7—RCA
P. 8—Allen B. DuMont
Oscilloscope
P. 14—H. Leeber

The Video Channel

→ **From Page 7**

relative sound rejection obtainable in a good quality receiver.

Picture Containing 60 Cycle Ripple

The symptoms of a faulty power supply sometimes show up in the video channel as horizontal black and white bars on the test pattern. Since these faults do not lie in the video circuits, but rather in the power supplies, we shall treat the latter in a later article on the troubleshooting of power supplies. Suffice to say at this point that excessive ripple in the low or high voltage supplies produced by improper filtering will affect the video circuits as shown in Fig. 10.

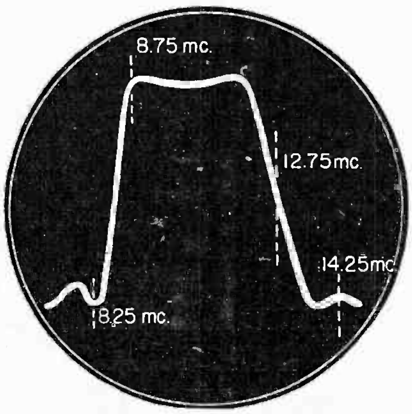


Fig. 9 The sound rejection obtained between 8.25 megacycles and 14.25 megacycles in the video intermediate frequency system of a good quality receiver.

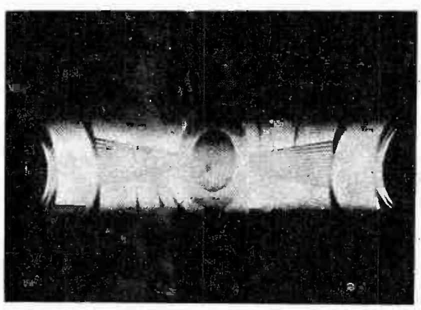


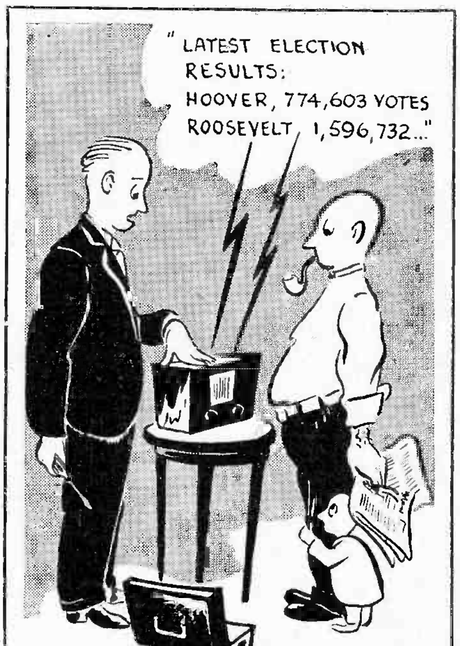
Fig. 10 The effect on the pattern of 60 cycle ripple.

It is relatively easy to distinguish 60 cycle ripple from sound modulation. Ripple produces one or two dark bands across the screen, whereas sound modulation voltages, being of a higher frequency, produce many more. Also, the sound will vary in intensity, and when it stops, the bands disappear. Distortion from the power supply, on the other hand, is steadier in intensity and tuning to another station does not alter the position of the bands.

Microphonic Noises

These are caused by microphonic resistors, condensers, or tubes in which the elements are not rigidly fixed. Any vibration sets the elements in motion, generating transient currents. Such noise in the video channel results in patterns of splotches appearing in the picture. Noisy tubes, resistors and condensers can usually be located by tapping with a light object such as the eraser end of a pencil. Sometimes, individual replacement of each tube is necessary.

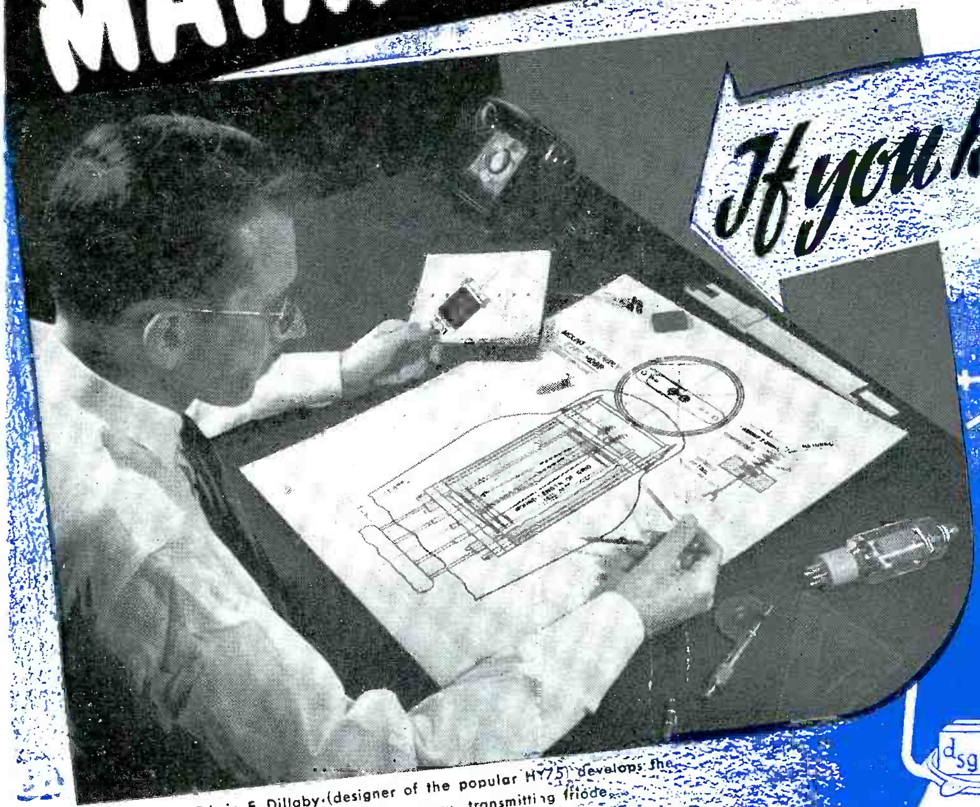
The foregoing discussion of common faults will give the serviceman the basic troubleshooting techniques for the video channel. With the RF section covered in the previous issue, the entire video signal path from the antenna up to the grid of the picture tube has been traced. Next issue, we shall go back to the first detector and follow the audio signal through the sound channel.



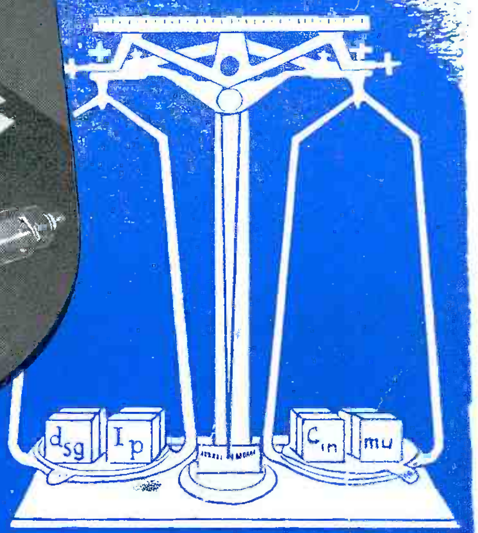
"Offhand I would say that the time lag in the AVC is definitely too pronounced."

MAKING TUBES *is easy*

If you know how!



Edwin F. Dillaby (designer of the popular HY75) develops the mount structure for a new transmitting triode.



TUBE DESIGN is a BALANCING ACT

The job of a vacuum tube designer would really make you tear your hair. Drawing mainly on long experience — only the bare principles of tube design are found in books — the design engineer must co-ordinate the innumerable interlocking characteristics you specify.

Using standard parts when possible — hand-fabricating others, he assembles and processes engineering samples. Some characteristics may fall outside limits. Then begins a seesaw of compromises. Screen diameter is lowered; input capacitance rises. Plate current is raised; amplification factor drops. Back and forth teeters the design. Interlocking electrical, mechanical, physiochemical, ceramic, and metallurgical characteristics must be reconciled one after another. Finally the harassed designer submits apparently satisfactory tubes for application tests.

You guessed it. Changes are required. The balancing act begins anew. Innumerable variables are again co-ordinated. Science and creative craftsmanship triumph; everyone is satisfied. Production takes over. Sure, it's a swell tube. But could this lead be changed, this spacer eliminated, this material substituted? Well, you see what we mean.

Through the years, Hytron design engineers have sweated for you. They have originated: GT, subminiature, vhf, instant-heating tubes. They have improved standard types including: OC3, OD3, 1616. Their experience will continue to craft for you the best in tubes.

OLDEST MANUFACTURER SPECIALIZING IN RADIO RECEIVING TUBES

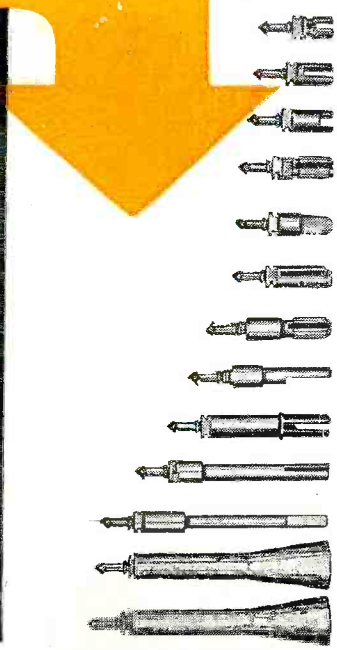
HYTRON RADIO TUBES

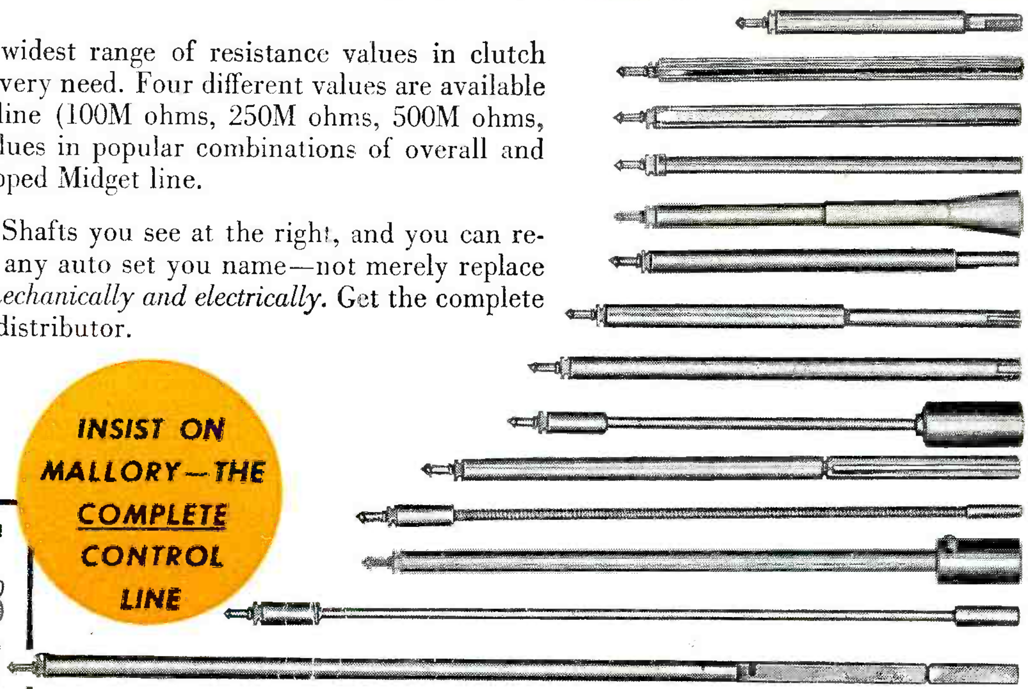
HYTRON

RADIO AND ELECTRONICS CORP.

MAIN OFFICE: SALEM, MASSACHUSETTS

Mallory Offers 12 Clutch Type Controls for Use in Auto Receivers





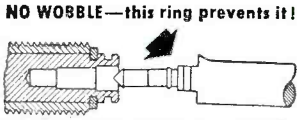
MALLORY offers the widest range of resistance values in clutch type controls to fit every need. Four different values are available in the Universal Midget line (100M ohms, 250M ohms, 500M ohms, 1 megohm), and eight values in popular combinations of overall and tap resistances in our Tapped Midget line.

Add these to the Plug-In Shafts you see at the right, and you can replace original controls in any auto set you name—not merely replace them but *duplicate them mechanically and electrically.* Get the complete story from your Mallory distributor.

You Expect More . . . and Get More . . . from Mallory

INSIST ON MALLORY—THE COMPLETE CONTROL LINE

NO WOBBLE—this ring prevents it!



All Mallory Plug-In Shafts are made with a small ring as shown above. That's why they can't wobble or work loose—why they fit as securely as a fixed shaft.

P.R. MALLORY & CO. Inc

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