



Vol. 13

JULY, 1948

No. 7

CORNELL-DUBILIER ELECTRIC CORP.
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RECEIVER DISTORTION*

A Systematic Method of Distortion Trouble-Shooting

The prime requisite of a radio receiver is that it be able to deliver from its loudspeaker an intelligence which is as nearly identical to the intelligence which is superimposed upon the carrier wave of the broadcasting station as is possible. To achieve this, the output voltage fed to the speaker must be identical in every respect, other than amplitude, to the voltage wave comprising the modulation envelope of the carrier. Any condition which brings about a deviation from the original waveform will introduce distortion into the intelligence received.

There are essentially three (3) types of distortion, i.e.:

(1) Harmonic Distortion—also referred to as amplitude, or non-linear distortion, (2) Frequency Distortion, and (3) Phase Distortion.

Since the ear is very insensitive to phase distortion, it is of little importance in receivers of sound only. Therefore, in this article we will be concerned only with the first two.

Harmonic Distortion

This type of distortion is caused by generation in the receiver of frequencies not present in the signal. These frequencies are harmonics of the frequencies present in the signal, and also frequencies equal to the sums and differences of those frequencies. These sums and difference frequencies are known as intermodulation frequencies.

Harmonic distortion is brought about primarily by improper operating conditions of the tubes, resulting in curvature of the dynamic

characteristics, and will generally be held to a minimum if the grid bias, plate voltage, and load impedances are correct, and the signal voltage is not so strong as to cause overloading.

Overloading of any particular stage occurs when the signal voltage is so high as to cause the normal range of operation on the dynamic transfer characteristic of the tube to be exceeded. If the signal becomes sufficiently strong, the plate current may cease to flow entirely during a portion of the cycle.

Frequency Distortion

Frequency distortion is the result of unequal amplification of the different frequency components of a signal and results from the dependence of circuit impedances upon frequency, causing attenuation of some frequencies and accentuation of others, and is generally held at a minimum in circuits not containing transformers or other inductors. There need not be frequency distortion in reactance or transformer coupled stages, however, if the reactors or transformers are properly designed. Impedance mismatches in audio stages are also a source of frequency distortion. If a signal rich in harmonics is fed into a stage with mismatched impedances, some frequencies will be reinforced and others will be attenuated. The load impedance of an audio stage should be high for maximum voltage output, but where current is involved, distortion will be introduced by any mismatch of impedance. Consequently, the load impedance is designed to effect a compromise between power output and distortion.

* By K. E. Stewart in "Radio Maintenance."

Distortion can originate in any stage of a receiver, including the speaker itself. The experienced serviceman can often recognize the peculiar kinds of distortion associated with certain troubles, and can go directly to the source without the aid of any instrument other than his ear. In most cases, however, much valuable time will be saved by the use of test equipment. In a great many cases it is impossible to locate and properly remedy such troubles without the aid of proper test equipment. An oscilloscope is a very desirable instrument to have access to for such work, although a signal tracer with a detector probe will often lead the serviceman to the trouble and requires less time to use than the oscilloscope. A modulated signal generator is, of course, a must. The writer also considers a vacuum tube voltmeter to be an essential instrument for servicing modern receivers, and especially so in shooting distortion troubles. If one does not have access to either a vacuum tube voltmeter or an oscilloscope, he will waste many hours of valuable time at best, and in many cases probably will not be able to effect the proper cures at all.

Harmonic distortion is responsible for the majority of the distortion troubles in a receiver, and since tube

operating conditions are the chief cause of this type of distortion, it is important to be able to determine the exact voltages which are applied to the various tube elements. A vacuum tube voltmeter is absolutely necessary to make these measurements. Many distortion troubles can be located without any instrument other than the VTVM.

Since distortion can originate in any part of the receiver, time will be saved by first localizing the distortion to a stage through the use of a signal tracer (see Fig. 1). For instance, if a signal taken from the voice coil of a receiver is distorted and the signal appearing on the control grid terminal of the output stage is undistorted, then it is logical to assume that the trouble is in the last stage. If distortion exists at the grid of the output stage, then the output of the preceding stage should be checked, then its input, etc., working back toward the first stage in this manner until the distortion is localized. When the offending stage has been located, it is necessary to test voltages, etc., in the stage where the distortion exists rather than to make haphazard tests throughout the receiver.

The tubes should always be tested first. A defective tube is often the source of distortion trouble and al-

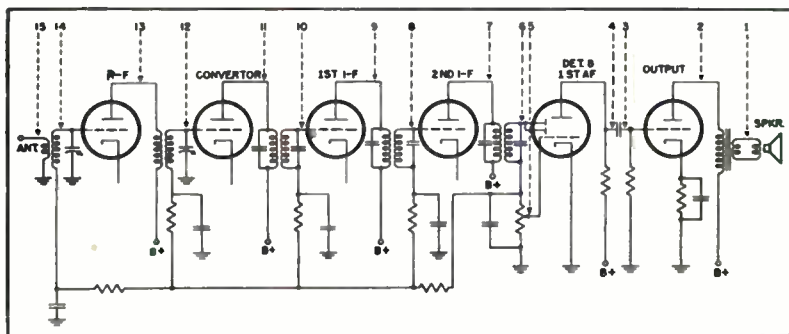


Fig. 1 A simplified schematic diagram of a receiver showing recommended check points in the order in which tests are made. The tests are made with a signal tracer while a signal is being fed into the input of the receiver.

though a tube tester will not point out a defective tube in 100% of the cases, it will do so in the majority of cases. If there is any reason to doubt the merits of a tube, it is better to check it by substituting a tube known to be good.

Coupling Condensers

No one method can be claimed to be the universal solution to tracking down the source of distortion in a radio receiver. Each case is an individual one and poses its individual problems. It is of paramount importance to utilize one's knowledge of theory together with logic and reasoning in analyzing distortion troubles. For instance, one of the most common offenders in audio stages is the leaky coupling condenser, which is connected between the plate of one stage and the control grid of the following stage.

In most cases, this condenser is not "dead shorted" but has a high resistance leak, sometimes of the order of several megohms. It would be a comparatively simple matter to apply the test leads of any voltmeter between the grid end of the condenser and B+ in order to determine a "dead short" as the grid potential would be the same as the plate potential of the preceding stage and therefore a high positive reading would be obtained on

the meter. Logic points out, however, that where the leak is in the order of megohms, there would be little use to expect a reading on an ordinary low resistance voltmeter as the I-R drop across the condenser would be equal to approximately the plate voltage of the preceding stage the instant that the meter became a part of the circuit.

If a vacuum tube voltmeter is used (Fig. 2), the presence of any positive voltage at the grid can be readily determined, as this type of meter does not draw current from the circuit. It will not be necessary to disconnect the condenser from the circuit. Where a leak is suspected, the tube, which has its grid connected to the condenser in question should be removed from its socket before dismissing the possibility of leakage. Flow of grid current may sometimes reduce the voltage at the grid to a minimum, or the bias which is developed across the cathode resistor may be sufficient to cancel out the positive voltage which would otherwise be present. It must also be remembered that if a fixed bias is being applied to the grid, this bias may be greater than the positive potential. The bias voltage would be less negative than normally, if the coupling condenser is leaking because of the I-R drop which will consequently take place across the grid load resistor. A comparison should be made between

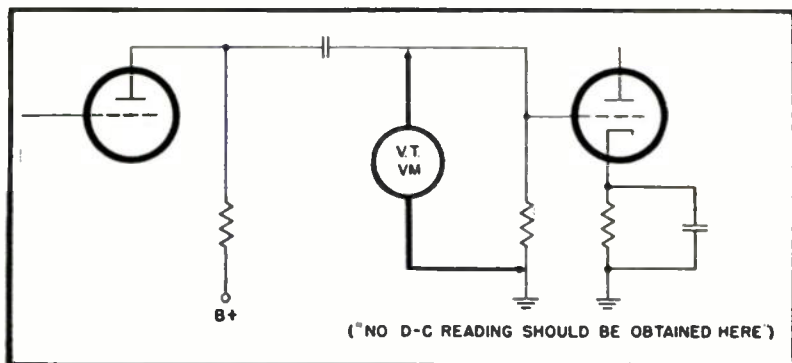


Fig. 2 If the vacuum tube voltmeter indicates the presence of a voltage drop across the grid resistor, the coupling condenser is probably leaking.

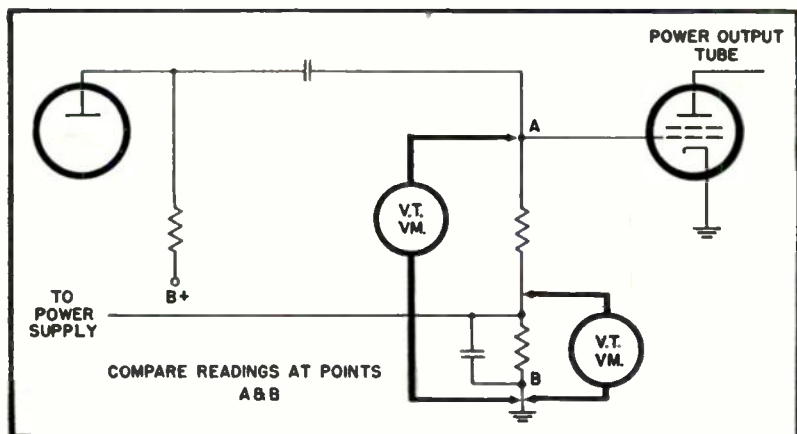


Fig. 3 Taking two successive readings as shown above, the coupling condenser may be checked. If there is a considerable difference between readings the condenser is probably bad.

the bias supply voltage and the voltage at the grid. A leaky coupling condenser will be indicated if a considerable difference exists between the two readings (see Fig. 3).

Overloading

As previously stated, overloading may take place in one or more stages when the amplitude of the input signal is excessive. In some cases, the signal may swing the grid-voltage beyond the plate-current saturation point. The grid may swing positive and draw current, or the grid voltage may swing past the plate current cut-off point. An oscilloscope is an ideal instrument for detecting such conditions. A sinusoidal voltage from the signal generator may be fed into the input of a circuit and a comparison between the input and output waveforms will detect the presence of overloading. If the serviceman does not have access to an oscilloscope, there are other methods of approaching the problem.

We know that the grid of a class A amplifier should never become positively charged. A positive potential can be readily detected with the

VTVM and indicates overloading (see Fig. 3). It should be remembered that the grids of a class B output stage may normally swing positive during the cycle of operation.

A D-C milliammeter can also be used. We know that the average plate current flow should remain constant in a push-pull class A amplifier. Therefore, the reading on a D-C milliammeter placed in the common B+ lead to such a stage (Fig. 4) should remain the same and overloading will be indicated by any fluctuation of the meter reading.

A VTVM connected to the plate will also detect any current fluctuation, since any change in current flow will produce a corresponding change in plate voltage, although the voltage change may be very slight if the voltage regulation is good. In a stage containing only a single tube, overloading will not necessarily cause any change in the average plate current, because both the negative and positive halves of the cycles are affected. An upward fluctuation of class A amplifier plate current will indicate excessive negative bias, whereas a

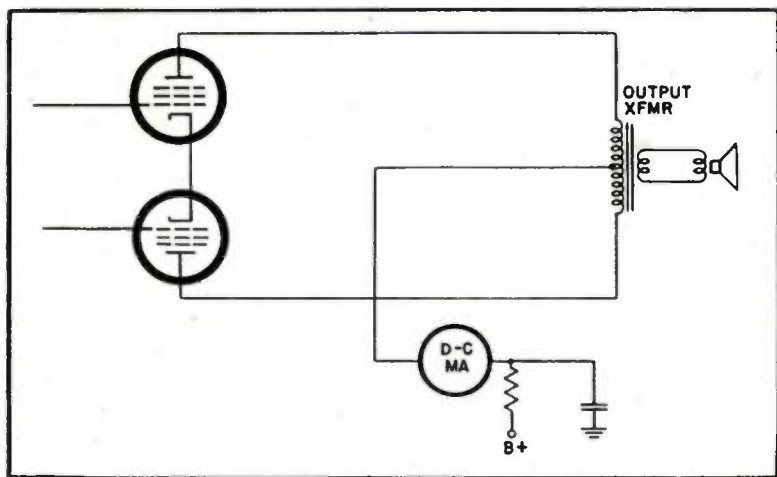


Fig. 4 A d.c. milliammeter connected as shown may be used to check the operation of a push-pull class A amplifier.

downward fluctuation of plate current will indicate insufficient negative bias. Grid current flow in a class A amplifier will indicate either excessive signal voltage or insufficient negative bias, or a combination of both.

A. V. C.

Improper A. V. C. action may be the cause of incorrect operation of the R-F or I-F stages.

The great majority of present day receivers utilize the diode detector A. V. C. system. A trouble often encountered in this circuit is that of too strong an A-V-C action. Such a condition will not only reduce the sensitivity of the receiver but serious distortion may result, especially if the A-V-C voltage becomes strong enough to bias one or more tubes beyond their cut-off. If one or more R-F stages should have its grid driven negative to the extent that plate current flow ceases entirely during the negative half of the applied signal, the tube will tend to act as a grid bias detector, and a form of distortion known as "cross modulation" results. Two stations will

appear to come in together. Such a condition is not always the fault of the A-V-C action, however. The D-C bias supplied to the tube may be too great or the fault may lie in the tube itself. The cut-off point of remote cut-off, or variable Mu tubes, which are used in A-V-C controlled stages, tends to approach zero grid bias as these tubes age. New Tubes should be substituted before concluding that some other trouble exists. In a receiver operating normally, the A-V-C voltage developed may run as high as 40 volts, depending upon the amplitude of the signal and the number of tubes under control. Generally, the fewer the number of tubes controlled, the greater will be the A-V-C voltage developed for a given signal strength. If it becomes apparent that the A-V-C voltage is too great, the A-V-C diode tube should first be checked by substituting a tube known to be good. A gassy diode will cause excessive A-V-C voltage to be developed. This diode is often incorporated in the same envelope as the first A-F amplifier triode such as in the 6SQ7, 7C6, etc. The A-V-C and, or the detector diode may

also be incorporated in a separate envelope such as the 6H6 or 7A6. If the tube is not faulty, the diode load resistor has probably increased in value. If this load resistor becomes lower in value, the A-V-C action will not be great enough, that is, the voltage developed will not be sufficient and a strong signal may overdrive one or more of the stages under control. The absence of A-V-C voltage is usually accompanied by fading as well as poor tone quality. In many cases, the volume control potentiometer itself serves as the A-V-C load resistor as well as the audio load resistor as shown in Fig. 5. It is important that the potentiometer be of the correct value, not only to assure the correct A-V-C voltage being applied to the stages under control, but also in order to preserve the time constant. If the value of the load resistor or any of the associated filter condensers or resistors in the A-V-C line should change in value, or if they are replaced with the wrong values, the time constant will be upset. The effective time constant, in seconds, in an R-C circuit is equal to the product of the resistance in megohms and the capacity in microfarads. The optimum value of time constant is a compromise value which is sufficiently great to provide adequate filtering and yet small enough

to prevent too long a time lag from being introduced, which in turn would prevent the A-V-C action from keeping pace with rapid fading and tuning operations.

Generally the time constant of an A-V-C circuit should not exceed 0.1 of a second. Many receivers are so designed as not to allow an excess of about 0.06 of a second. Should the time constant be too great, it will become difficult to tune in stations accurately to the point of resonance and the signal will be received with a "plopping" sound. On the other hand, if the value of time constant is too small the gain of the stages under control may become a function of the modulation (due to insufficient filtering action. This condition will result in distortion due to the audio frequency modulating the R-F signal, and may also result in howling due to feedback. A leaky by-pass condenser in the A-V-C line will reduce the A-V-C voltage and also lower the time constant. The slightest leakage in one of the by-pass condensers will seriously affect the voltage because of the high values of resistors used in these circuits. An absence of A-V-C action will usually be indicated by blasting as the receiver is tuned and the output will usually be accompanied by excessive static-like noise.

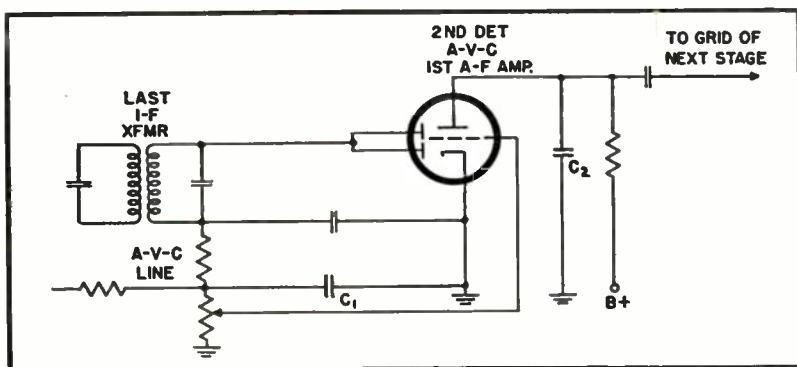


Fig. 5 A simplified circuit showing a combined second detector, a.v.c., first audio amplifier.

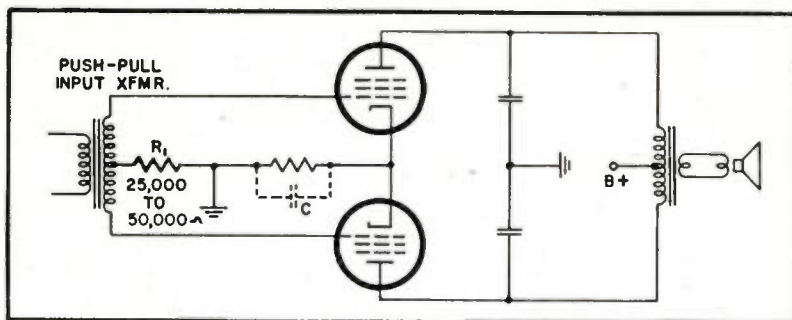


Fig. 6 As explained in the text, the insertion of R_1 will often eliminate parasitic oscillations.

If the small R-F filtering condenser across the audio load resistor (C_1 in Fig. 5) should become open, or be too low in value, a high pitched whistle or howl will be introduced into the output. The value of this condenser is in the order of micro-microfarads. On the other hand, if the value of this condenser is too large, the high frequency response will be affected and a loss of volume will result.

Small filter capacitors are often (C_2 in Fig. 5) connected between the plates of one or more of the audio stages and ground. The same symptoms generally apply to corresponding defects associated with these con-

densers as with the detector R-F filtering condenser.

Howling will sometimes originate in a push-pull stage due to parasitic oscillations. This can usually be remedied by inserting a resistor of from 25,000 to 50,000 ohms in the common grid return lead (R_1 in Fig. 6). The filter components, especially the plate by-pass condensers, should be checked first, however. Inherent frequency discrimination in inter-stage audio transformers used may introduce frequency distortion. A more linear frequency response may often be obtained by connecting a resistor across the secondary winding of the transformer, as

(Continued on page 15)

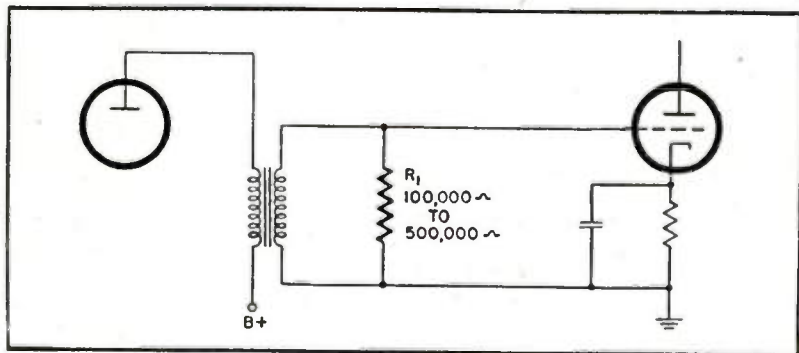


Fig. 7 Resistor R_1 will often improve a receiver's quality.



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WANTED — Manuals for BC-329-E transmitter, Communications Co. Model 150CT transmitter-receiver, BC-653-A transmitter, BC-315 transmitter, FT-253-A mounting, high voltage chokes and transformers. Malcolm E. Hughes, 4819 Euphrosine St., New Orleans 15, La.

FOR SALE — Triplett Model 666-H. Pocket volt-ohm-milliammeter, price \$15.00. Norris McKamey, 1220W 7th St., Davenport, Iowa.

SELL OR TRADE — Superior Model 600 tube and set tester, \$40; Ghirardi's Modern Radio Servicing Book, \$4; Amperite Kontak mike, \$6; Hallicrafters S-38 (like new), \$35. Mathew J. Dunipin, Box 1091, Wewoka, Okla.

TRADE — RCA TT5 Television Receiver, good condition. Need Aircraft radio servicing equipment. Tony Owsiany, 511 Arthur Ave., Kalamazoo 8, Mich.

FOR SALE — Precision Model 920P Tube and Radio Analyzer, like new. Carr's Radio Center, 17 Kelley Sq., Worcester 4, Mass.

WANTED — BC 348 or BC 312, good condition (110 AC converted acceptable). M. Feldman, 108 Orange Lane, Oak Ridge, Tenn.

WANTED — Amertram 6,200 volt plate transformer or similar; also meters, 50 watt sockets, etc. Ed Howell, Gen. Del., Gastonia, N. C.

FOR SALE — Radio, RCA model 66X3, 2 band, 48 Model, like new; will sell for \$39. Stanley J. Dembowski, 1204 Everett St., Camden, N. J.

WANTED — Rider's Manuals, all volumes, cash or trade. Sheboygan Radio and Appliance Co., 2314 N. 15th St., Sheboygan, Wis.

FOR SALE — 12 5-tube genuine Ivory Plastic Airing Radios, 2 gang condenser, inbuilt antenna, \$23.95 each. Sheboygan Radio & Appliance Co., 2314 North 15th St., Sheboygan, Wis.

SELL OR TRADE — 30 watt amplifier, mike and speaker, \$40.00; electric Megaphone type TPM, complete, \$25.00; Dynamotor, PE-103-A, like new, \$8.00; Silver Marshall short wave converter, \$10.00. Want 16mm. movie projector. John Arnold, P. O. Box 84, Bluffs, Ill.

WANTED — Westinghouse meters, 2 1-2 in. or 3 1-2 in. round, flush, bakelite case. State size, range, price. G. P. Schleicher, 410 North Green St., Ottumwa, Iowa.

FOR SALE OR TRADE — Miscellaneous high fidelity transformers in UTC and Thordarson. Trade for test equipment or broadcast quality microphones and television equipment. Radio Communication Service, 4475 Myrtle St., San Diego 5, Calif.

SELL OR TRADE — RCA 852 tube, used, good, \$5.00. Starting motor, 12 volt, used, good condition, for boat or car, crated, \$4.00 f.o.b. Need 5 watt speech amplifier or small intercom set. Bulmer, 90 Main St., Rockland, Me.

SELL OR TRADE — B19 Transmitter-Receiver, 3 Head Phone, mic units, all connectors, Dynamotor, antennas, etc. Will furnish AC conversion charts. Service Manual operating instructions, and schematics. Price \$35.00. Need 6V-110V, Mobile P.A. system, 25 watts. Bixby Radio Service, Bixby, Okla.

SELL OR SWAP — Contester miniature gas model motor, Class C, used once, excellent condition, price \$28.50. Want Rider's Manual XIV, XV. Jayel Enterprises, 212 Grand St., Brooklyn, N. Y.

WANTED — BC-412 Oscilloscope. Will buy or swap tube tester or equipment. William Conlon, Jr., 922 W. Sargent, Litchfield, Ill.

FOR SALE — Jackson tube tester, Model 633, \$15.00, perfect condition. Checks all types of tubes. William Conlon, Jr., 922 W. Sargent St., Litchfield, Ill.

FOR SALE — Precision Model E 200, Precision Model 720P, tube checker and radio analyzer. Priced reasonable. Carr Electric Products Co., 15-17 Kelley Sq., Worcester 4, Mass.

FOR SALE — One Hickock Dynamic Mutual Conductance Multi-Tester, Model 510X Tube Tester. Charles S. Brotzman, 173 Main St., Mexico, Maine.

WANTED — Pierson KP-81 communications receiver, used or new. David Ross, 2105 E. 35th St., Brooklyn 10, N. Y.

WANTED — Power supply 78 volt DC at 20 amps. or more for BC-375E transmitter. W8BUU, 3150 E. 49th St., Cleveland 4, Ohio.

WANTED — Position by graduate familiar with all types of test equipment and want experience in Radio-Television repair line. Max Wiesler, 886 E. 172d St., Bronx 60, N. Y.

FOR SALE — Rider's Manuals and Auto Radios. Technical Books, Tubes, Capacitors, Resistors and Parts. Henry B. Tense, P.O. Box 73, Westwood, N. J.

FOR SALE — 22 cal. Winchester repeating rifle, W.R.T., take down. Marble sights, fine condition, with case and cartridges, \$25.00, or exchange for let's model radio tube tester. Horace W. Leeds, 15 West 15th St., Ocean City, N. J.

SELL OR SWAP — Signal generator for tube tester or 35 MM Camera, or sell for \$25.00. Covers from 100 to 3200 K.C. Everts Repair Shop, Box 155, Rt. No. 1, Odenton, Maryland.

SWAP — A German 3-barrel gun by Walter Kirsten. Includes double-barrel, 16-gauge, shotgun with 38 rifle barrel. Swap for Precision Series 10-12 tube tester. Arthur A. Capaccio, 1901 Gleason Ave., New York 60, N. Y.

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FOR SALE — Brush PL-20 pickup complete with No. 3761-B equalizer. First-class condition, \$10.50 postpaid. Albert R. Hodges, 353 Brooklawn Drive, Rochester 10, N. Y.

FOR SALE — One Super Meter, Model 670, \$20.00; 1 Tube tester, Superior Inst. Co., Model 450-A, \$26.00; 1 Signal Generator, Model A-200, \$28.00. Electronic Inst. Corp., 2237 So. Homan Ave., Chicago 23, Ill.

FOR SALE — BC-654-A Receiver-Xmitter, portable and CW Xmitter, frequency 3800-5800 K.C. 7-tube superhet and 6-tube Xmitter with 24.6 watt output. Complete except for power supplies; accessories, and receiver tubes. Xmitter complete with tubes and crystal. Herbert Edelson, 48 Talcott St., New Britain, Conn.

TRADE — SAC Standard Air Conditioner, window type, perfect condition, for portable P.A. system, 15 to 30 watts; must be complete with mike, etc. Vincent Kessner, 96 Noble St., Brooklyn 22, N. Y.

WANTED — Clough-Bregle No. 131 Speaker Substitute, also No. 132 battery voltage control. Paul Capito, 637 W. 21st St., Erie, Pa.

FOR SALE — RF-IF test cable and probe for RCA Rider Chanalyst, like new, \$3.00. Paul Capito, 627 W. 21st St., Erie, Pa.

FOR SALE — One Superior model PB 100 volt-ohm-milliammeter. Push button range selector. Sell for \$15.00. H. Jacobs, 157 Fulton Place, Paterson, N. J.

SWAP — ICS Industrial Electrician home study course. Swap even for N.R.1 Radio home study course or a 1500 VCT plate transformer. 300 mils. Harry E. Blase, W9A0P, 107 Hayes St., Peoria, Illinois.

FOR SALE — 771 Weston tube and ohm meter combination tester in good condition, \$25.00. Harold Brink, RR No. 1, Dixon, Illinois.

FOR SALE — Precision series 912 Electronic tube tester, slightly used, price \$50. Ghirardi Radio Physics Course, second edition, good as new, price, \$3.50. Radio Handbook, tenth edition, like new, price \$1.50. Eldridge Brandon, R.R. 3, Hazel, Ky.

FOR SALE — One Supreme Radio Servicing Course book. Includes Television, PA, photo-cells and recordings. Like new, \$2.00; one Schick single head electric razor, used, good shape, \$10.00. Bert Albrecht, Auburn, Neb.

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WANTED — RCA Model 9558 Frequency Modulator, also a Clough-Brengle Model OMA frequency modulator; RCA No. 157; also No. 9572 Crystal Calibrators. Paul Capito, 637 W. 21st St., Erie, Pa.

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FOR SALE — 150 two oz. clear glass jars with metal caps at \$1.00 per doz., postpaid in U. S. One Sylvania cathode ray tube 5BP1 at \$4.00, postpaid in U. S. Robert Garbarini, 42-12, 68 St, Woodside, N. Y.

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WANTED — Dayrad Circuit Diagram for Model 381 Tube Tester. Resistor and condenser ohms and capacitor size for Amrad Model 7100 or manual for same. C. E. Peters, 2925 Apple Street, Lincoln 3, Nebr.

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WANTED — RA-74C or PA-94 Power Supply for Super-Pro. Also Scott, Silver, Hammarlund or similar receiver with or without cabinet. Have Weston 772, Rider's, other items. Glenn Watt, Chanute, Kans.

FOR SALE — IRE Proceedings for 1944, 1945, 1946 except October '46. \$20., shipping charges collect. E. H. Schoenfeld, 210 Warren Ave., Mamaroneck, N. Y.

FOR SALE — Triplett Model 1200-E volt-ohm-milliammeter, with instructions how to use. This is a 25,000 ohms per volt instrument. Used very little. Price, \$20. H. B. Workman, 310 E. North St., Waverly, Ohio.

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FOR SALE — Superior Model 670 volt-ohm-milliammeter, \$25.00. Model B-45 Signal Generator, 150 kc to 50 mc. Shielded test lead, batteries, instructions, \$25.00. Both for \$47.00. Both like new. John P. Laughlin, Route 4, Bedford, Virginia.

FOR SALE — Model B-45 signal generator, 8 months old, \$25.00, perfect condition. Vega Banjo-mandolin with case, good condition, \$20.00. Jack Kellam, Box 12, Rhodes Point, Maryland.

FOR SALE OR TRADE — Radio magazines, hard to get radio tubes, parts and testing instruments. Write for list. All bargains. Forrest M. Tinker, P.O. Box 774, Canon City, Colo.

FOR SALE — Good used radios, consoles, tables, portables, good working condition; will trade for vacuum tube voltmeter, capacitor analyzer or signal tracers. V. A. Torkildson, 1505 N. 39th St., Milwaukee 8, Wis.

FOR SALE — Sylvania Portable Tube Checker, model 140, in new condition, \$59.00. Also one Stenotype machine in new condition \$50. Matt's Radio Service, 21452 Fennell, Detroit 23, Mich.

TRADE — One model 185a electronic switch and square wave generator, Dumont, new condition, for a Precision model E-200 signal generator in good shape, complete with leads and manual. Desperately needed. Lear and Metcalf Co., Center Sandwich, N.H.

FOR SALE — Precision 920P Tube & Set Tester, perfect condition. Will send prepaid to sender of first \$49 Money Order. Soundways, 560 Walnut St., Fall River, Mass.

- SELL OR TRADE** — Complete 1947 De-Forest's Training Course in radio and television; Robson-Burgess Multimeter, \$12.00; Dazor Twin-Bulb Fluorescent drawing board light, \$15.00. Need V-max or similar V.T.V.M. R. E. Schmidt, 1029 No. Notre Dame Ave., South Bend 17, Ind.
- TRADE** — Miscellaneous radio parts, tubes, testing instruments, condensers, resistors, radio, for guns and ammunition of all kinds. Morton Berndt, Dupree, S. D.
- WANTED** — Philco Station Setter for push-button setting. Will pay reasonable price. Marks Radio Service, 21 Exchange St., Glens Falls, N. Y.
- FOR SALE** — Superior Model 670 multimeter in splendid condition, with fused plug. Best offer. Only cash accepted. Stathis Linardos, 190 Wadsworth Ave., New York 33, N. Y.
- FOR SALE** — Hammarlund Receiver, model SP-200-X Super Pro. Excellent condition, rack model, complete, \$125. Mr. J. Topalian, 615 E. 138th St., Bronx 54, N. Y.
- FOR SALE** — Superior 1280 Set Tester (combination tubetester and multimeter), good condition, original instructions, wiring diagram, test leads, \$20. Superior Channel Analyzer, good condition, original instructions, wiring diagram, test leads, \$20. Shipping charges collect. Veto M. Twaska, 3321 W. Carson St., Pittsburgh 4, Pa.
- SELL OR TRADE** — Have Army .45 Colt Automatic, good condition; Meissner amplifier-recorder, Triplett 2342 oscillator, all Sam's Photofacts, many radio books and radio parts. Want movie camera, good make, or will sell. Julio Bellber Arroyo, care of Pan American Airways, Inc., San Juan, Puerto Rico.
- FOR SALE** — Mossberg 44US clip repeaters, sacrifice at \$21 postpaid. Urgently need complete radio test benches. Dan Waranius, Carney, Mich.
- WANTED** — One or two 12B8 radio tubes. Thomas Lusher, 1815 7th Ave., Charles-town, W. Va.
- FOR SALE** — Midwest 16-tube AM-FM 5-band radio, \$80.00; De Luxe Signal Tracer (Mod. 250), \$35.00; AC-Bridge Analyzer (Mod. Br-44) with tracer, \$20.00. Henry Schappi, Nucla, Colo.
- FOR SALE** — Dayrad Series 14 tube checker, obsolete, but in good condition, mounted in carrying case, for \$11.00. Ernest J. Soens, 109 W. First St., Mishawaka, Ind.
- FOR SALE** — Used Melehan valiant automatic key. Good condition. First \$20.00 takes it. Fred H. Isaac, W8PLD, 625 Stratton St., Logan, W. Va.
- FOR SALE** — First Radio Book For Boys, 200 pages, \$1.00; Radio, A Study of First Principles, 300 pages, \$1.00; Radio Amateur Handbook, by Collins, 360 pages, \$1.00. Buy all three and I will send you 1940 radio diagram by Supreme, 200 pages, free of charge. Daniel Seidler, 4355 So. Honore St., Chicago 9, Illinois.
- WANTED** — Log-Log Duplex Decitrig 10 in. slide rule and case (K&E No. 4081-3). Please state lowest price, age and make. Arthur Rudin, 31 Edgerton St., Rochester 7, N. Y.
- FOR SALE** — Hickok portable tube checker, model AC51, excellent shape; test all tubes, including miniature base and 117 volt types. Price \$75.00. M. D. Banta, 541 Flower St., Turlock, Calif.
- TRADE OR SELL** — QST's, 77 copies, 1929 to 1946; R/9 Radio's, 21 copies, 1933-1937. Excellent condition. Some years complete. Lot deal only. Want Rider's or Sam's Manuals or Ghirardi's text books. M. M. Valentine, P.O. Box 24, Laredo, Texas.
- FOR SALE** — Philco 3-way portable model 42-PT87, \$15; Fada 3-way slide rule dial, \$20; RCA Victor model 25BP 3-way, \$18. All sets in perfect condition but less batteries. Silber's Radio Service, 7303 Metropolitan Ave., Middle Village, N. Y.
- SWAP** — Motorola 300 car radio with '36 Clere tuning head for surplus transmitter receiver. Also have Brunswick model 20 dynamic speaker and old RCA phono motor and magnetic pickup motor. John Horzepe, 1122 E. Blanche St., Linden, N. J.
- SWAP** — German valves, set diagrams, stamps, etc. Want: Different Test sets, ham gear, etc. Address Gerhard Kensy (20a) Alvern-Soltau, Germany, British Zone.
- FOR SALE** — Superior tube tester and analyzer, model 1180-S, \$20.00. Superior generator, model 1130-S, \$20.00; or best offer for each. Al Diziki, 24 East 15th St., Bayonne, N. J.
- FOR SALE** — Rider's Chanalyst, 162-C, with Brush Phones, good as new, \$115. Rider's Manuals 1, 2, 3, 9, 10, in good condition, \$25. D. W. Forsmark, Palisade, Minn.
- WANTED** — RCA 1 KW modulation transformer. Name f.o.b. price. C. Burton Crumly, 13 State St., Schenectady 5, N. Y.
- FOR SALE** — One Weston Model 772 volt-ohm milliammeter, \$40; one Simpson 315 signal generator, \$50. One vacuum tube volt meter RCA model 195A, \$50. Harold Davis, 111 South Commercial St., Emporia, Kans.

WANTED — High grade commercial broadcast model microphones. 500 ohm input impedance necessary. Will trade miscellaneous parts for same. Send for list. Radio Communication Service, 4475 Myrtle St., San Diego 5, Calif.

SELL OR TRADE — 3 tube 10 meter converter, 9003 RF, 9003 mixer, 9002 arc, in case, with National Velvet Vernier dial, \$25. RME DB20 preselector, A-1 condition, \$50. Want BC-610 Xmitter cabinet. K. A. Woehrer, W2CT1, 1510 Tenth Ave., Neptune, N. J.

WANTED — Code practice equipment; like a code machine with code tapes or code records. Quote lowest prices. SWL, John Griffin, 713 Vogel Place, East St. Louis, Illinois.

WANTED — Rider's Manuals 9 to 14. State condition and price. Will consider lot or individual. V. J. Balcar, 3805 Alice Ave., Austin 21, Texas.

FOR SALE — "Birch" portable spring driven phonograph, excellent condition, \$10. "Sentinel" model 247-P Portable Radio, 3-way, including batteries, \$15. Joe Confino, 2255 80th St., Brooklyn 14, N. Y.

FOR SALE — Precision E-200 signal generator, in original carton. Cost \$65.43. First money order for \$50 takes it. Milton Maultsach, 535 Grand St., Brooklyn 11, N. Y.

WANTED — SX25 super-defiant Hallicraft-er radio receiving set, preferably with speaker, in good condition. State minimum price acceptable. David Landesberg, 179 Marcy Ave., Brooklyn 11, N. Y.

FOR SALE — Bausch & Lomb Microscope TL507, double revolving nosepiece, magnifications up to 430 power. Best offer over \$75 plus express charges. Excellent condition. Peter Bedrosian, 2 Unicorn Street, Newburyport, Mass.

WANTED — 35 mm. camera or communication receiver. Chuck Borasewich, W2GWO, 1066 President St., Brooklyn 25, N. Y.

WANTED — 3 in. square GE meters. State condition, scale and price. Bob Naff, Box 325, Skagway, Alaska.

SELL OR TRADE — RCP No. 704 Sig. Gen. \$30; RCP tube tester No. 322. \$35. Both for \$60 f.o.b. Ft. Wayne. Trade both for 'scope or either for panadaptor. George Whitten, 213 West Williams, Ft. Wayne 6, Ind.

FOR SALE — Brush Soundmirror magnetic tapesound recorder. Records on magnetic tape 40 minutes; matching output transformer installed for 4, 8, 15, 500 ohms. Sacrifice \$185.00, with 2 rolls tape; microphone. Charles Schmitz, 4737 Matilda Ave., New York 66, N. Y.

FOR SALE — Precision Model 920 P Tube and set tester, \$60. Henry W. Drnek, 1606 South Allport St., Chicago 8, Ill.

SELL OR TRADE — Rider's Chamalyst in good condition, all probes and instructions; Sell for cash, or trade for good portable typewriter and cash. Ellison Radio Service, Centertown, Ky.

WANTED — Information and diagrams on Navy, RT19, ARC4, Aircraft trans-receiver. Will pay cash. Carl Harp, Crescent, Okla.

SELL OR TRADE — Radio and Appliance magazines and books. Send for sale and want list. J. T. Cookson, Lock Box O, Puxico, Mo.

FOR SALE — Model 442, Triumph tube-tester, in good condition, for \$25. Kenneth H. Googe, 1910 Prospect Drive, Kirtland Field, Albuquerque, N. Mex.

SELL OR TRADE — \$500 in new tubes, original cartons, or trade for surplus gear. Write for list. Want BC348, SCR 522, RAX1, ARC1, ARC4, BC1058, ART13, GP, G09. C. R. Wilson, 260 Stevens Ave., Portland 5, Maine.

FOR SALE — Majestic 70 and 90 condenser blocks. Completely rebuilt and guaranteed one year, \$3.50 and old block. Dial scales for GE G-D 60 sliding panel table radio. Enough to service 20 sets for \$1, including P.B. tabs. I. Susman, 1052 Blake Ave., Brooklyn, 8, N. Y.

FOR SALE — Start of low power exciter, including 20 meter xtal, meters, and osc. plate and final tank coil for 10. Less supply and tubes. Philadelphia area only. H. C. Hunsworth, 436 Flamingo St. Roxborough 28, Philadelphia, Pa.

FOR SALE — Many miscellaneous radio devices and books. Write for information. T. Wojciechowski, 2837 Fulton St., Brooklyn 7, N. Y.

WANTED — Rider's Manuals 14, 12, 11, 10, 8; must be in good condition. Will trade photo equipment. books. Donald A. Johnson, 2271 No. Monitor Ave., Chicago 39, Illinois.

WANTED — A Sky-Buddy short-wave receiver. Must be in good condition. Norman Lee Borchers, 90 North 9th St., San Jose, Calif.

WANTED — Used "Solar" exam-eter model CE. Must be in good condition and have instruction book. State price. Famous Radio Repair Shop, 2753 N. 27th St., Milwaukee 10, Wis.

WANTED — Manual of Instructions for installation and maintenance of Model 600 or 700 Everett Oraatron. Dewey Mell, 619 Ohio St., Lima, Ohio.

- WANTED** — 8 mm. projector, projection screen, paint spraying equipment, floor sander. Cash or will trade binoculars, radios, parts, etc. Make proposition. L. Tuluskas, 72 N. Fenton Ave., Indianapolis 19, Ind.
- WANTED** — Position by young man, 22, would like employment as radio technician or serviceman in or around New York City. Salary secondary. Leonard Feilerholtz, 273 East 164th St., Bronx 56, New York.
- TRADE** — 1 Hickok Model 203 VTVM for good scope, Rider's Manuals or portable typewriter. Gregg's Radio Service, 701 N. Garfield St., Chanute, Kan.
- SELL OR SWAP** — Table model radio, AC-DC. Also a Philco tube tester and volt-ohm meter; wanted, a portable typewriter, prefer Remington. Frank R. Gurin, 4841 S. Hermitage, Chicago, Ill.
- FOR SALE** — Hamarlund Super Pro. SP400X, used 20 hours, \$290.00 f.o.b. Also universal binoculars, 6x30, individual eye focusing, coated lens, leather carrying case, like new, \$100.00 f.o.b. Bob Horst, 398 Brimhall St., St. Paul 5, Minnesota.
- FOR SALE** — Miscellaneous radio equipment all in perfect working condition. Write for details. Ralph G. Cummings, 170 Clark St., Portland 4, Maine.
- WANTED** — Diagram and instructions for building an FM converter. Will pay cash or swap. Robert Burns, 285 Warburton Ave., Yonkers 2, N. Y.
- WANTED** — German tubes Nos. 1-WY11, 1-DL11, 1-DF11, 1-DCH11, 1-DAF11. Must be in good condition. State price. If you need a hard to get tube, write me. I may have it. Frank S. Townsend, Auburn, Maine. Box 141.
- FOR SALE** — Sonar VFX-680 exciter, \$75; 90-day warranty card from factory. G. C. Corrigan, 1102 State St., Guthrie Center, Iowa.
- SELL OR TRADE** — One new Warner's Electric Brush Plater Set, complete, \$18 cash, or will trade for electric train, old stamps, etc. W. E. Tracy, Box 261, Norwich, N. Y.
- SELL OR TRADE** — New RCA Electronic Volt-Ohmyst and National Radio School's course, complete with all equipment, unused. Would like Scope, Signal Generator or Signal Tracer. J. C. Jensen, 4064 So. Wells St., Chicago 9, Illinois.
- SELL OR TRADE** — Excellent Presto Model "K" recorder, complete with meter, amplifier, speaker, recording and playback (magnetic) heads, arms, cords, case. \$250 cash or complete recent HRO with speaker, powersupply. Frank Cavano, 1629 Doan, East Cleveland, Ohio.
- TRADE** — Aircraft instrument course (cost \$75) for radio test equipment, text books, course or what have you. Michael Kebles, Jr., 142 W. 28th St., Bayonne, N. J.
- WANTED** — Coins of all nations, old guns, watches, etc. Private collector. Andrew Kranack, Jr., 806 Montiero St., Pittsburgh 17, Pa.
- FOR SALE** — Howard Sam's Photofac Folders, 1 to 17, in excellent condition, \$20.00 postpaid. H. J. Ashford, 532 8th Ave., Dayton, Ky.
- FOR SALE** — Hallicrafter model S-22R in good condition \$40. Sell or swap for Ham gear three flight books by Jordan-off, all slightly used. D. T. McKenzie, 1010 North Vermilion, Danville, Ill.
- SELL OR SWAP** — One Rider Chanalyst 25-60 cycle No. 162 and one SG. 4 Signal Generator, 60 cycles 100 KC-90 MC. Trade for television set or kit, complete; or hand power saw. M. Gerموik, 364 Skillen St., Buffalo 7, N. Y.
- WANTED** — Army Scope either BC-612 or BC-412, not remodeled. Give price and condition in first letter. Brook's Electric Shop, Twin Bridges, Mont.
- SELL OR TRADE** — Complete Photocopy outfit, hardly used, makes photostats, duplicates, etc. Includes "Apeco" photocopies up to 18 x 22 inches, print and negative electric dryer, trays, etc. Want perfect 8 mm. projector or will sell. Lawrence Epstein, 670 Barretto St., Bronx 59, New York City.
- SELL OR TRADE** — Delta No. 17-212 Drill press with motor, Atlas 6 in. lathe model No. 618 with motor, accessories and stand. Trade for good home freezer, refrigerator with freezer, or automatic washing machine. R. W. Tuglus, 5215 West Schubert St., Chicago 39, Ill.
- SELL OR TRADE** — Collins TCH tranceiver, 2-16 m.c., 15 watts cw, 8 watts phone, portable. Public address amplifier and microphone. Weston socket selector analyzer. Need tube checker, signal generator, oscilloscope, good speaker, intercommunication sets. Thermionic Control Co., 1287 Brentwood Road, N.E., Washington 18, D. C.
- FOR SALE** — A complete line of tubes, condensers, resistors; Model 599-A Supreme tester; \$159.00 worth. Will sell for \$110.00. Everything guaranteed. Russell Andlers, 33 Adams St., Nelsonville, Ohio.
- FOR SALE** — Parts and equipment worth \$200 for servicing hearing aids, including tubes, condensers, resistors, mikes, chokes, multimeter plus valuable information on sources of supply and organization. All yours for only \$180. Gurleys, 4360 19th St. N., St. Petersburg, Florida.

FOR SALE — Standard brand tubes in cartons at 60% off list price. Send for list. J. Hogan, 114 Frederick Ave., Medford 55, Mass.

FOR SALE — Daco model 303 tube tester, first class condition, \$25. All letters answered. Henry M. Bissell, 1061 Iglehart, St. Paul, Minn.

FOR SALE — Complete 1947 N.R.I. course, perfect, \$20. Covers radio servicing, radio communications, television and F.M. Daniel Seidler, 4355 So. Honore, Chicago 9, Ill.

WANTED — Dial head and cables for 1946 Chevrolet auto radio and chrome plate for dashboard. Louis Lucatelli, Jr., 19 College Road, Netcong, N. J.

FOR SALE — Radio shop equipment, tools, test equipment, radio parts and supplies. Write for details. J. S. McLadden, P.O. Box 176, Yucaipa, Calif.

FOR SALE — BC 348 communications receiver, converted to 110 volt, 60 cycle A.C. operation, \$75 F.O.B. Tubes and parts from recently closed radio service shop. Send for list. High-Tor Radio Center, 8 First St., Haverstraw, N. Y.

SWAP — General stamp collection for ten meter phone transmitter. List of stamps on request. Donald Hall, DeKalb, Texas.

SELL OR TRADE — RCA Chanalyst, Model 11, complete. Want oscilloscope equivalent value. Cash offer. Newton Center Radio Shop, 759 Beacon St., Newton Center 59, Mass.

FOR SALE — All standard makes used radios, power packs, trickle chargers, power transformers. Send stamp for Bulletin. Goldstone Radio, 1279 Sheridan Ave., Bronx 56, New York.

FOR SALE — Knight 5-tube Radio, 105-125 volts, AC-DC, 30 watts. Excellent condition, like new, \$10.50. Jack Udseth, Summit, South Dakota.

WANTED — PE-103A dynamotor power unit. Jack Udseth, Summit, South Dakota.

WANTED — Complete set Supreme Publications, Radio Diagrams, Manuals, or any separate manuals, except Vol. 4. R. W. Daniels, Route 1, Box 456, Hopkins, M.nn.

SELL OR TRADE — Hallicrafter's Model S38 for sale, \$45. Good condition. Will take used Hallicrafter's Model S22 in good condition. Arthur Jude, 3210 Fairview Ave., Alameda, Calif.

SELL OR TRADE — Closing out complete stock transformers, miscellaneous parts. Want laboratory test equipment. Radio Communication Service, 4475 Myrtle St., San Diego 5, Calif.

RECEIVER DISTORTION

(Continued from page 8)

shown in Fig. 7. Some receiver manufacturers incorporate this resistor in their receivers. The optimum value of this resistor is that which will give improved frequency response without seriously reducing the amplification. This value will usually lie between 100,000 and 500,000 ohms. The lower the value, the better the tone quality and the lower the amplification.

If the output transformer has been replaced, it is well to make certain that it is the correct replacement, as a mismatch to either the output tube or the voice coil, or both, may result in serious distortion, and possibly loss of volume.

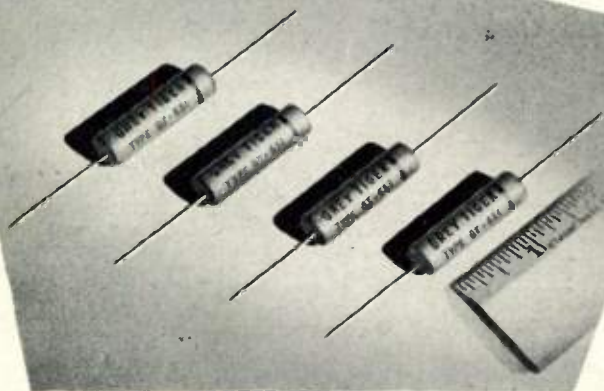
An R-C filtering network is often connected across the primary winding of the output transformer that is used in conjunction with a beam power pentode. This filter network is for the purpose of giving the plate load the effect of a pure resistance and the values of the resistors and condensers are therefore very critical. If any component of this network becomes defective, or is of the wrong value, serious distortion will result. If there is any doubt about any of these, they should be replaced.

A by-pass condenser is not generally needed across the cathode biasing resistor in push-pull stages and usually one is not used. Current fluctuations, however, due to mismatched tubes and uncancelled odd harmonics can usually be materially reduced by the installation of a by-pass condenser, as shown in Fig. 6 (C). The optimum value of this condenser may be determined by the following formula:

$$RC = \frac{1.6}{F}, \text{ WHERE } R \text{ is the value}$$

of the cathode resistor in ohms, C is the desired Capacitance in Farads, and F is the lowest audio frequency (in cycles-per-second) to be by-passed.

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