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POCKET RADIO GUIDE

HANDY REFERENCE BOOK FOR RADIO MEN – SET CONSTRUCTION ARTICLES – AUDIO AMPLIFIER CIRCUITS – USEFUL RADIO FORMULAS AND DATA – HANDY SHORT-CUTS – INDEX TO IMPORTANT RADIO ARTICLES PRINTED IN RADIO-CRAFT

by N. H. LESSEM

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The 1935 (volume 2)

Official AUTO-RADIO SERVICE MANUAL

$2.50 LIST

HERE NOW—is the second volume of the OFFICIAL AUTO-RADIO SERVICE MANUAL—the 1935 Edition.

With so large a number of new auto-radio sets placed on the market by different manufacturers, the 1935 OFFICIAL AUTO-RADIO SERVICE MANUAL becomes an essential part of Service Men's equipment. Remember, there are nearly 1,800,000 auto-radio sets in use today.

THERE IS ABSOLUTELY NO DUPLICATION OF MATERIAL BETWEEN THE 1933 EDITION (VOLUME I) AND THE NEW 1935 EDITION (VOLUME II). THE MATERIAL IS 100% NEW.

Every radio man connected in any way with the booming auto-radio business needs a copy of the 1935 OFFICIAL AUTO-RADIO SERVICE MANUAL. It contains only auto-radio service "dope."

HERE ARE HIGHLIGHTS OF THE 1935 AUTO-RADIO MANUAL

240 pages crowded with diagrams, service material and other essential data required for proper servicing of new auto-radio receivers. Included are diagrams of sets which appeared during 1934, and which were not included in the supplement to the first edition.

Complete schematic diagrams, chassis layouts, voltage tabulations and servicing instructions are included for practically all sets. "Under-side" tube symbols are also included to facilitate the job of servicing the sets.

Instructions are included with many sets telling how to suppress stubborn cases of ignition interference. This includes the newest "suppressorless" sets—and what to do when interference is encountered with this type of set.

Details on how to make installation in "turret-top" cars are included. The different methods used by car makers and set manufacturers are listed with the individual circuits and service information.

The index contains the listing of sets which were published in the first edition, as well as the sets which appear in the new volume. This information helps the Service Man to locate the circuit and details for any receiver that has been made.

The book is bound in a handy, flexible leatherette cover. To be sure the pages are sturdy, to withstand constant use, the book will be printed on a special "bible" stock. This is a very durable, but thin paper. The book printed on this paper can be easily rolled to fit into your pocket or slipped in the service kit.

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Here Is a Partial List of Sets Covered

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Audiola Radio Co.
Autocrat Radio Co.
Belmont Radio Corp.
Century Radio Products Co.
Chevrolet Motor Corp.
Chrysler Motor Corp.
Colonial Radio Corp.
Crosley Radio Corp.
Delco Radio Corp.
Detrola Radio Corp.
Emerson Radio & Phonograph
Fada Radio & Electric Corp.
Ford Motor Corp.
Ford-Majestic
Franklin Radio Corp.
Galvin Mfg. Corp.
General Electric Co.
General Motors Corp.
Graham-Paige Motors Corp.
Grigsby-Grunow Co.
Chas. Hoodwin Co.
Howard Radio Co.
Hudson Motor Car Corp.
International Radio Corp.
Karadio Corp.
P. R. Mallory & Co.
Montgomery Ward & Co.
National Company, Inc.
Noblitt-Sparks Industries, Inc.
Philco Radio & Television Corp.
Pierce Airo, Inc.
RCA Manufacturing Co., Inc.
Sears Roebuck & Co.
Sentinel Radio Corp.
Sparks-Withington Co.
Stewart Radio Corp.
Stewart-Warner Corp.
Stromberg-Carlson Tel. Mfg. Co.
Transformer Corp. of America
United American Bosch Corp.
United Motors Service, Inc.
U. S. Radio & Television Corp.
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POCKET RADIO GUIDE

EDITED BY

N. H. LESSEM

Handy Reference Book for Radio Men—Set Construction Articles — Audio Amplifier Circuits—Useful Radio Formulas and Data — Handy Short-Cuts — Index to Important Radio Articles Printed in Radio-Craft

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CONTENTS

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MAKING A GOOD CRYSTAL SET FOR 65c

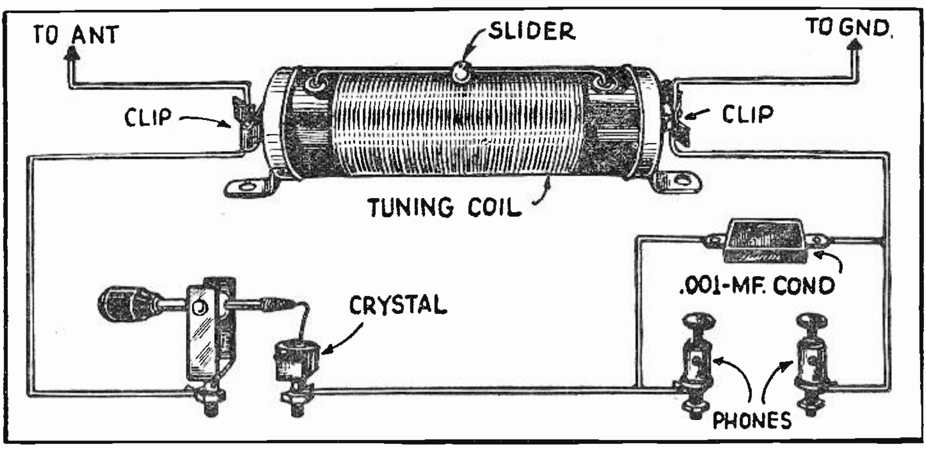
A set for the beginner in radio which will not deplete the pocket-book. It is extremely easy to make and operate.

ALTHOUGH this little set is made entirely from manufactured parts, the cost is only 65c. The constructor can build up quite a trade in parts for crystal sets, among the youngsters of his neighborhood. The only item that could not be obtained ready-made was the tuner, and many of the customers could not make a workable one. This problem was solved when it was found that the ICA No. 93 tuner was just what was needed. This unit is intended for use as an antenna tuner, or wavetrap and similar requirements, but is ideal for use in a cheap crystal set.

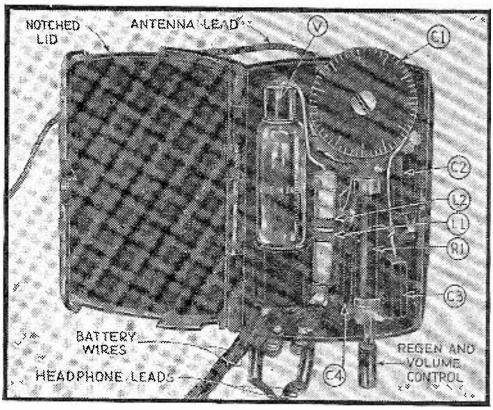
The constructor of this set has been building crystal sets in large numbers and finds that, for the type of set they represent, they are very effective. The construction is of the very simplest, only 3 wires or connections being necessary. Thus it can be made by the veriest beginner, with little chance of a mistake. (For those who wish to buy it ready-made it can be built up in a short time.)

A user in Phoenix writes that he has received KNX, KGO, and KSL. Also that he can get KNX as soon as KOY (1,390 kc.), Phoenix, goes off the air and with KTAR (620 kc.), Phoenix, still operating.

Stations KTAR and KOY can be separated very nicely with no interference from each other, with KTAR located about 7 blocks away and KOY about 15 blocks away.



The very simple connections between the parts of the set are indicated here. Tuning is accomplished by moving the slider on the coil.



HOW TO MAKE THE World's Smallest 1-TUBE SET

The introduction of a new tube and battery have made possible this tiny, 1-tube "cigarette-case" receiver. The cigarette case in which it is built is so small that it holds only 10 cigarettes!

MANY small sets have been built, but unfortunately the really small ones were all of the crystal type, since suitable tubes have not been obtainable. The small tubes such as the Western Electric type N tube and the more recent "acorn" tube require rather heavy filament current values which makes the battery problem a serious one.

However, as was announced in the July 1935 issue of *Radio Craft* on page 11, an English tube company has introduced 3 new types of tubes which are smaller than either of the two types mentioned above. And what is even more important, the filament requires only 0.06-A. at 2 V. In other words, two small dry-cells connected in series are sufficient to operate one of these tubes for many hours.

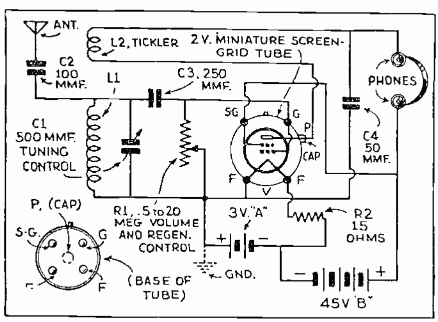
The possibilities of these tubes for pocket receivers were so encouraging that several of them were imported—and arrangements were made to have them made available in this country.

The little set shown here, completely enclosed in a small-size cigarette case—(the case is so small that it will only hold 10 cigarettes!) is the first use to which these tubes have been put. THIS IS THE SMALLEST SET IN THE WORLD!

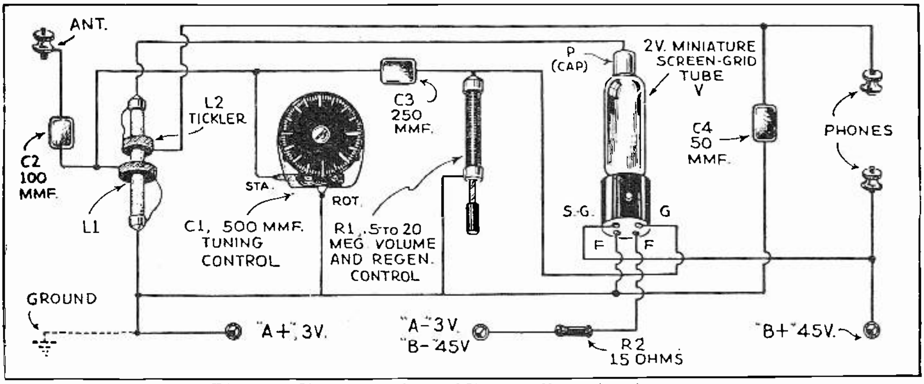
To further aid the construction of this pocket set, a well-known battery manufacturer has introduced a new 45 V. "B" battery which measures only 3 x 4 x 1¼ ins. deep. This battery supplies sufficient "B" voltage for the set and is small enough to fit easily into a coat pocket. The filament battery, as mentioned, can be small-size flashlight cells, so a "penlight" was adapted for the purpose.

Some difficulty was encountered in finding coils and condensers small enough to fit in the bakelite cigarette case, but a solution was found in each case. The tuning condenser was a mica compression-type "trimmer" condenser having a maximum capacity of 500 mmf. The fixed condensers were unusually-small bakelite covered mica units measuring $\frac{5}{8} \times \frac{3}{8} \times \frac{3}{16}$-in. thick.

The coil was made from two sections of a Hammarlund type CHX R.F. choke. The original choke contained 5 "pies" or sections and it was found that each section had about 200 microhenries inductance. This was about right for the tuning coil, so one section was separated from the others for this purpose. Next, the adjacent pie was "cut loose" from the remaining three, and 55 turns were removed to give the correct inductance for the regeneration coil. The last 3 sections were then removed from the isolantite core, leaving the 2 useful coils in place.



Schematic diagram of the tiny 1-tube regenerative set.



Picture diagram of world's smallest 1-tube set.

The tube was prepared by filing two opposite sides of the insulated base, so that the tube would fit into the cigarette case. A smooth, flat file was used; only enough was removed from the tube base to permit the case to close. The use of a socket, of course, was out of the question, so the tube was cemented to the case with a drop of acetone cement and wires were soldered to the pins in the base.

The tuning condenser was prepared by cutting a fibre disc 1¼-ins. in dia. and cementing it to the head of the compression screw of the condenser with acetone cement. White lines were then marked on this disc to give it the appearance of a dial. Calibration numbers could not be added since the compression screw made 4 revolutions between the maximum and minimum positions.

The cigarette case was prepared for use as the container for the set by cutting a slot in the top edge of the upper section to permit the edge of the "dial" to protrude—thus giving a thumb control. Two holes were cut in the back to mount the tuning condenser and two more for the 'phone binding posts—which consisted of 2 No. 4-36 screws. A small slot was cut in the bottom edge of the upper section for the adjusting strip of the plunger-type variable grid-leak to protrude, so that regeneration could be controlled without opening the case. These slots for tuning and regeneration can be seen in the photos.

This completed the preparation—the parts were then mounted in place as shown in the photos and the few wires connected as shown in the circuit diagram (also shown in the picture circuit).

When these were completed, a 15-ohm resistor was secured to the positive terminal of the filament battery and the battery wires were connected. The aerial wire (which consisted of about 25 or 30 ft. of flexible wire) was strung up as high as conveniently possible, and a pair of the new piezoelectric crystal headphones was connected to the phone terminals (with an iron-core inductance in shunt in order to reduce D. C. through the crystal phones). These phones were used because they were unusually sensitive. If desired, though, smaller phones may be obtained.

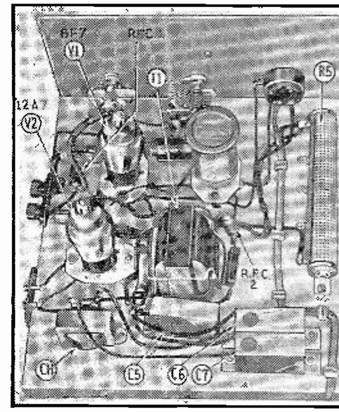
The set was tried out some 25 miles from New York City, and also in the heart of Manhattan. In both locations, all the local stations could be picked up with ample headphone volume.

There is no doubt that this unique little set can be put to many useful applications, for police use, etc., though it was designed simply in an effort to make the smallest possible pocket receiver.

LIST OF PARTS

One Solar 500 mmf., compression-type mica condenser, C1;
One Cornell-Dubilier 100 mmf. midget mica condenser, C2;
One Cornell-Dubilier 250 mmf. midget mica condenser, C3;
One Cornell-Dubilier 50 mmf. midget mica condenser, C4;
One Hammarlund R.F. choke, type CHX, L1, L2;
One Hi-Vac screen-grid tube, type X SG, V;
One plunger-type grid-leak, ¼-20 megs., R1;
One 15-ohm filament resistor, R2;
One penlight—with two small cells, "A";
*One special 45 V. "B" battery, "B";
*One pair crystal headphones;
*One bakelite cigarette case;
Screws, wire, acetone cement, etc., as needed.
(*Name of manufacturer upon request.)

BEGINNER'S "4-in 2" A.C.-D.C. Short-Wave RECEIVER



THERE are only 2 tubes in this interesting A.C.-D.C. "breadboard" receiver. It is perfectly stable, oscillates easily from 200 down to 15 meters, and really provides foreign reception with surprising ease.

The 6F7 is really 2 tubes in a single envelope: a **pentode**, and a **triode**. The pentode section of the tube is connected to the aerial by way of an R. F. choke, labeled R.F.C. 1 in the circuit diagram. The output is then connected to the triode section through the use of R.F. coils, as illustrated. The pentode section of the 6F7 is not tuned. The 12A7 is a combination pentode amplifier and power rectifier of the half-wave type.

Rectification is accomplished by the diode section of the 12A7 tube which is equipped with a separate cathode for this purpose.

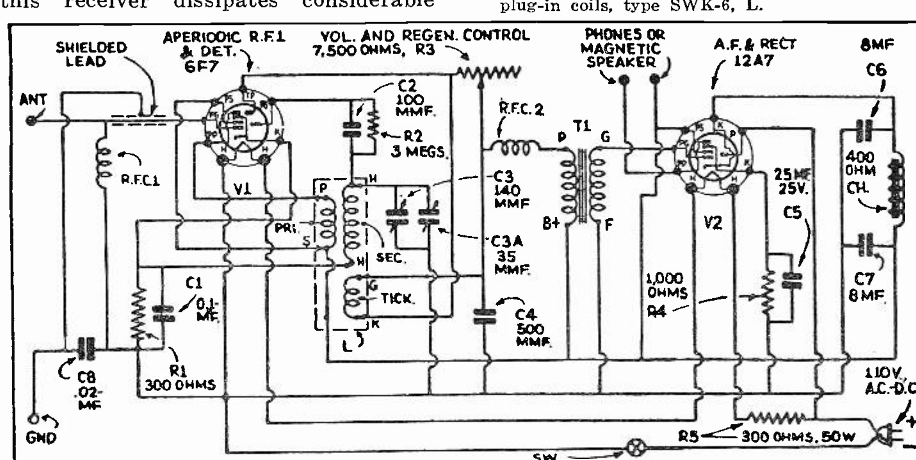
The terminals of the power plug have been labeled "plus" and "minus," and these wires must be traced carefully when wiring the receiver. The 6F7 heater must be in that side of the line labeled "negative." The resistor should be placed where ventilation is best for this receiver dissipates considerable heat. (Incorporate R5 in the power cord, if you care to.)

The small condenser (C3A) which is shunted across C3, the main tuning unit, is a band-spread condenser.

Of course, that bugaboo, hum, may be apparent when used on A.C. unless care, **painstaking care**, is taken to keep all A.C. leads away from the tuning condenser, coil, and gridleak condenser.

LIST OF ESSENTIAL PARTS

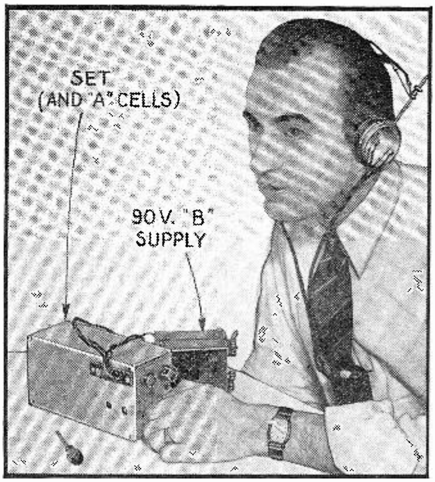
One condenser, 0.1 mf., C1; One condenser, 100 mmf., C2; One midget variable condenser, C3; One midget variable condenser, 35 mmf., C3A; One condenser, 500 mmf., C4; One electrolytic condenser, 25 mf., 25 V., C5; Two electrolytics, 2 mf., 200 V., C6, C7; One condenser, .02-mf., C8; Two Hammarlund R.F. chokes, type CH-X, R.F.C. 1, R.F.C. 2; One resistor, 300 ohms, R1; One gridleak, 3 megs., R2; One tapered potentiometer, R3, 7,500 ohms, with line switch, Sw.; One resistor, 1,000 ohms, R4; One resistor, 300 ohms, 30-50 W., fully shielded, R5; One A.F. transformer, T1; One small 400-ohm A.C.-D.C. filter choke, Ch.; One 6-prong isolantite socket for coil, type S-6; Two 7-prong isolantite sockets, type S-7-B; One Hammarlund kit of 6-prong plug-in coils, type SWK-6, L.



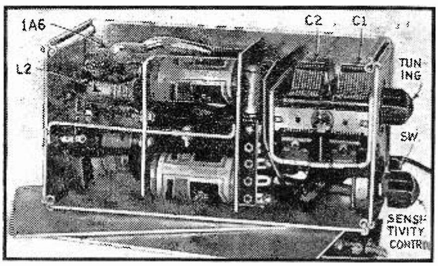
Schematic diagram of the "4-in-2" receiver.

HOW TO MAKE A Beginner's 2-Tube PORTABLE

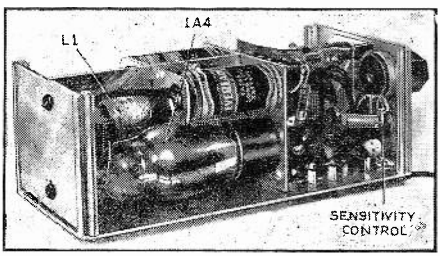
Here is a battery set that just suits the beginner. It is easy to build, efficient and can be carried in a coat pocket. It compares favorably with sets using several more tubes.



THIS midget set will fit in the average overcoat pocket; reception is of the headphone type—but with sufficient volume to make the received programs enjoyable; the receiver requires no lengthy antenna for pick-up, but will enable reception from a considerable number of broadcast stations simply by connecting the antenna lead from the set to any convenient mass of metal (or ground); the "A" cells are self-contained (2 flashlight batteries) and the "B" battery is a 90-V. block which will fit in the other pocket of the coat; battery consumption is at a minimum, due to the use of 2-V. tubes; covers the complete broadcast band, as well as some of the police calls slightly below 200 meters.



Above is the top view of the set looking down on the coils and condensers.



Above is a side view showing the volume control and one filament battery.

LAYOUT OF PARTS

The layout of parts is well illustrated in the photos, and the wiring diagram is pictorially shown. The aluminum case may be made up from sheet aluminum and corner posts, which also may be obtained from any supply house that specializes in short-wave parts; or may be purchased complete. The midget tuning coils are mounted on the upper shelf, and close to the grid-caps of each tube.

The coils should be mounted as shown, and **not too close to the side of the case** since the grounded sides will then tend to absorb energy from the coils and reduce their efficiency.

The controls for operation of the receiver are all mounted on one end of the case, which constitutes the upper side; this is the side which protrudes from the pocket so that the controls are easily accessible and may be manipulated at will.

CIRCUIT DISCUSSION

In order to secure maximum possible sensitivity and selectivity from 2 tubes it was decided to employ 2 tuned circuits. One stage to consist of T.R.F. amplification, the other to be a tuned detector circuit. The type 34 tube would have been satisfactory were it not for its physical dimensions. Hence, the use of a 1A4 and a 1A6.

In the wiring diagram it will be noted

that the 1A4 is employed as the R.F. stage. The pentode section of the 1A6 is employed as the detector, while the triode section is used for A.F. amplification. The gain (amplification) from this section, although very slight, is quite acceptable. In addition, there is an electron-coupling effect (due to the construction of this tube—placement of the various grids—between its 2 section (pentode and triode). Consequently, any R.F. component which may exist in the plate of the detector tube is fed back, by electron-coupling, to the grid of the detector tube. In this manner regeneration is created, which serves to boost the sensitivity of the receiver.

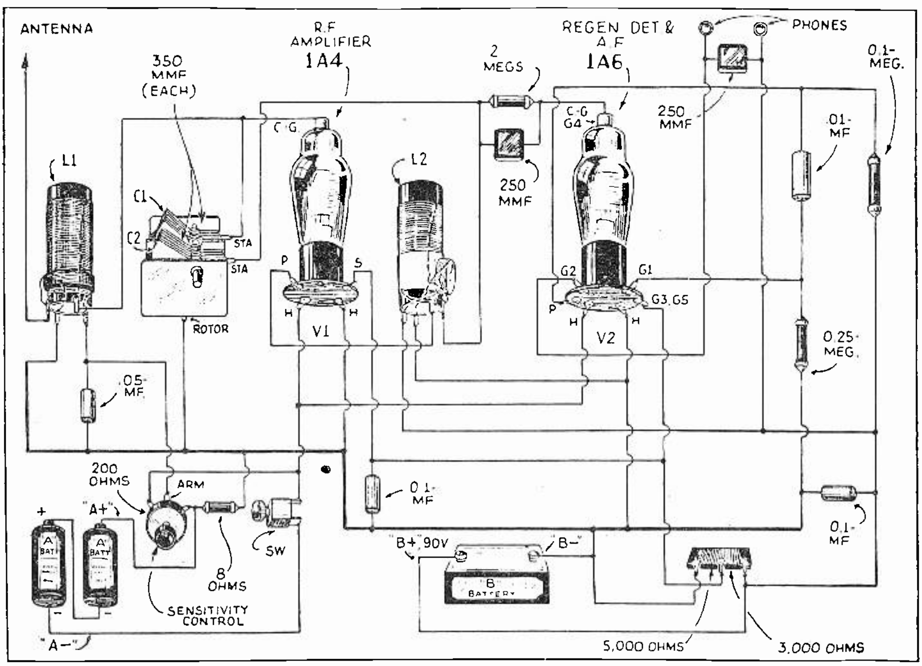
Since the voltage of 2 flashlight cells in series results in 3 V., and the tubes require only 2 V., an 8-ohm resistor is employed for reducing the initial voltage to the required value. The gain (amplification, or sensitivity) of the R.F. stage is controlled by a 200-ohm potentiometer which connects across the 3 V. supplied by the cells. The "on-off" switch is connected in series, before the potentiometer, to prevent any constant current from flowing through this resistance, especially when the power is turned "off."

LIST OF PARTS

- One I.C.A. midget variable condenser, 350 mmf. each section;
- *One midget antenna coil (shield removed);
- *One midget R.F. coil (shield removed);
- One I.C.A. aluminum case, $7\frac{3}{8}$x4x$2\frac{3}{4}$ ins. deep;
- One power switch;
- *One midget 200-ohm potentiometer;
- One wire-wound 8-ohm resistor;
- One Aerovox or I.R.C. 5,000-ohm 1-W. resistor;
- One Aerovox or I.R.C. 3,000-ohm 1-W. resistor;
- One Aerovox or I.R.C. 0.25-meg. $\frac{1}{4}$-W. resistor;
- One Aerovox or I.R.C. 0.1-meg. $\frac{1}{2}$-W. resistor;
- One Aerovox or I.R.C. 2-meg. $\frac{1}{4}$-W. resistor;
- One Cornell-Dubilier 0.01-mf. 200-V. tubular condenser;
- One Cornell-Dubilier 0.05-mf. 200-V. tubular condenser;
- Two Cornell-Dubilier 0.1-mf. 200-V. tubular condensers;
- Two Cornell-Dubilier 250-mmf. fixed mica condensers;
- One 6-prong wafer socket;
- One 4-prong wafer socket;
- One I.C.A. 5-terminal bakelite strip;
- Two No. 935 dry-cells;
- One Sylvania 1A4 tube;
- One Sylvania 1A6 tube;

Miscellaneous parts, such as aluminum scrap for shelving and brackets; knobs, etc.

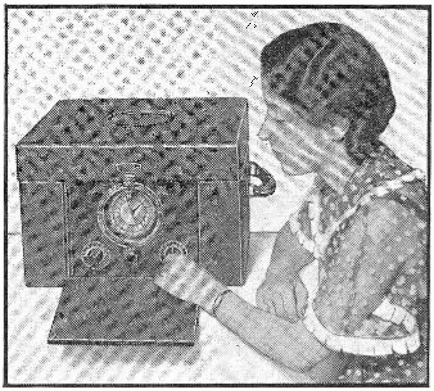
*Name and address of manufacturer will be furnished upon receipt of a stamped and self-addressed envelope.



Complete diagram of simple 2-tube portable set.

HOW TO MAKE A 6-TUBE ALL-WAVE "Farm Portable" BATTERY SET

Covers a complete tuning range of from 12 to 2,100 meters! Employs 2-V. tubes throughout, and operates with a minimum of "A" and "B" battery drain.



The Farm-Portable in use.

THIS receiver may be employed for home use as a table-model receiver, since the case lends itself attractively for such a purpose, or as a portable radio set for beach, picnics, etc. Batteries and speakers are all contained within the case; and only a short, 20-foot wire extended on the ground is necessary as an antenna (a ground is not required). The weight of the complete receiver, with batteries, is approximately 25 pounds—not at all heavy for a receiver having the many features described in the text to follow.

No plug-in coils. Separate coils for each band, with a selective switching arrangement, are used in this portable. Small trimmers placed across each coil (excepting oscillator coils) compensate for any slight differences that may be created by the circuit wiring.

DELAYED A.V.C. EMPLOYED

In this receiver a type 25S tube is the equivalent of 3 separate tubes (triodes), and functions as a detector, A.V.C., and first A.F. stage. The tube is a duo-diode triode; one diode used for rectification, the other for A.V.C., and the triode for A.F. amplification. With this circuit, as shown in the schematic diagram, a delayed A.V.C. action is obtained which makes it possible to get away from negatively biasing the A.F. circuit. This results in better fidelity and improved A.V.C. action.

The final (power output) stage employs a pair of 33 tubes in push-pull arrangement, class A. This results in ample, high-quality power output.

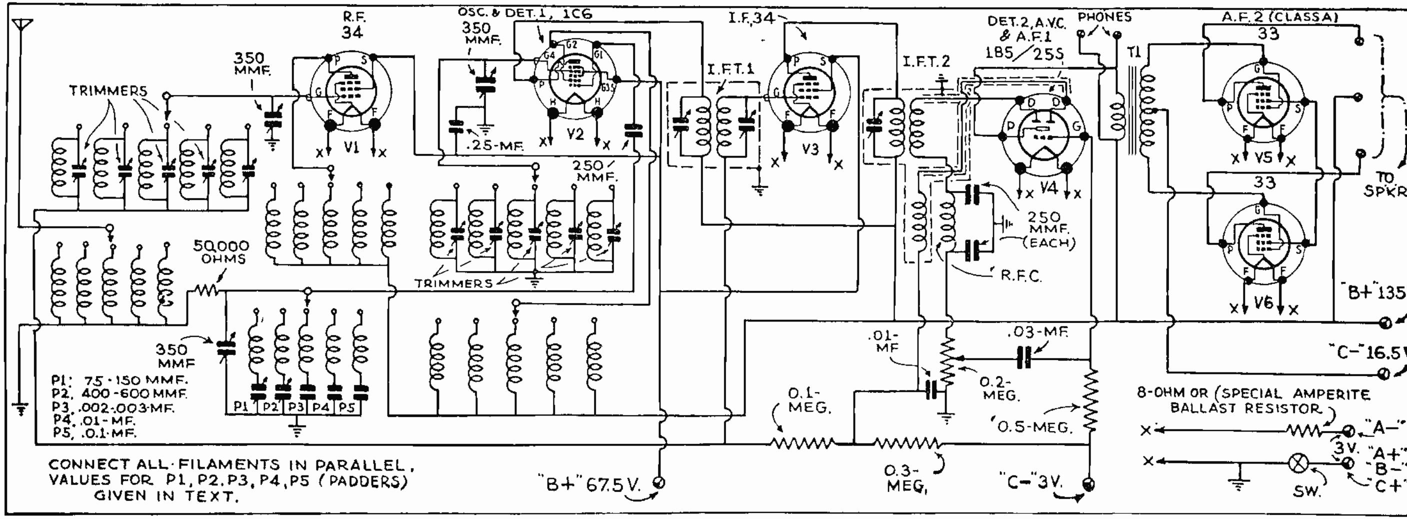
The I.F. peak employed is 465 kc. The second I.F. transformer secondary **must** have two separate secondary windings, as shown in the diagram.

The "on-off" switch is placed in the "A+, B—, C+" lead, so that, when the receiver is turned "off," **absolutely no current will flow from any of the batteries.** Either a permanent-magnet dynamic speaker, or a magnetic speaker (of rugged design and good quality) may be employed. In either case the "B" battery drain remains the same, approximately 40 ma., since no current is required for field excitation. If the speaker is not provided with an output transformer having a center-tapped (3-connection) primary it will be necessary to provide one.

CONSTRUCTIONAL DATA

It is rather difficult to advise a constructor exactly how to build a receiver, since set rules are often confusing and apt to make a simple job seemingly difficult. A few words of precaution in this direction, however, would not be amiss.

The antenna coils (for each band) need not be shielded, but the R.F. coils must be. There is no need for separately shielding each coil (individually) from each other since the selective switching system only introduces that coil which is necessary for a specified band coverage. Thus all R.F. coils may be placed in a single can or container without consideration given to individual shielding from each other. The oscillator coils, in this case, were mounted on the underside of the chassis since this medium is sufficient to shield them from those coils in the other tuned circuits. They were all arranged



Complete schematic diagram of the farm portable battery set.

so that the trimmers for each coil were conveniently accessible when alignment or realignment would be necessary.

The padders are mounted on the side of the chassis, as shown in Fig. A, for convenience in aligning.

Only two padders were employed, one for broadcast and one for the long-wave band, fixed padders for the other bands being suitable—**with these coils**—for the higher-frequency bands.

Coils for a stage of tuned R.F., first detector and oscillator, all tuned by a 3-gang variable condenser (350 mmf., and gain, besides eliminating the conventional "birdies" and "tweets" which 2-gang superhet. sets generally contain. A total of 15 coils is necessary to cover the complete range of from 12 to 2,100 meters (3 for each band) in 5 bands. No skipping of bands or any important wavelengths is the net result of such an arrangement.

A single high-gain I.F. stage furnishes simple amplification. The 1C6 tube (used as a composite first-detector and oscillator) has a translation gain of approximately 25 (practically) and is therefore equivalent to a stage of amplification in itself.

BATTERIES AND VOLTAGE CHART

Two dry cells (total, 3 V.) suffice for the "A" battery and will give almost a month of service using the set a few hours each day! A ballast resistor serves to reduce this voltage to that required for the tubes—but its most interesting feature is that it tends to reduce this voltage drop **as the batteries become weakened.** This means that additional service may be obtained from cells which otherwise would have to be thrown away if an ordinary 8-ohm resistor was used in reducing the "A" supply to the tubes to 2 V.

The following is a table of voltages which the constructor can employ as a guide for trouble-shooting should this receiver ever fail to operate. All measurements are made from ground to terminal indicated.

Tube Type	Purpose	Plate Volts	S.-G. Volts	C.-G. Volts
34	R.F. Amp.	135	67.5	—3
1C6	Det. 1	135	67.5	—3
	Osc.	67.5	—	—
34	I.F. Amp.	135	67.5	—3
25S	Det. 2	—	—	—
	A.V.C.	—	—	—
	A.F.1	70	—	—3
33	Output	130	135	—16.5
33	Output	130	135	—16.5

ALIGNMENT DATA

The receiver should only be aligned with the volume control turned to maximum position. First align the I.F. transformers by feeding a 465 kc. signal to the control-grid cap of the 1C6 tube, after removing the control-grid cap terminal.

Then adjust trimmers of coils in each band (separately) for maximum output, feeding to Ant. and Gnd. terminals of the receiver, the following indicated service oscillator frequencies. Use attenuator on oscillator only when output is too high.

Band No. 1 (long-wave): 150 and 450 kc.; Band No. 2 (broadcast), 540 kc. and 1,500 kc.; Band No. 3, 1,500 and 4,500 kc.; Band No. 4, 4,000 kc. and 12,000 kc.; Band No. 5, 8,000 kc. and 24,000 kc.

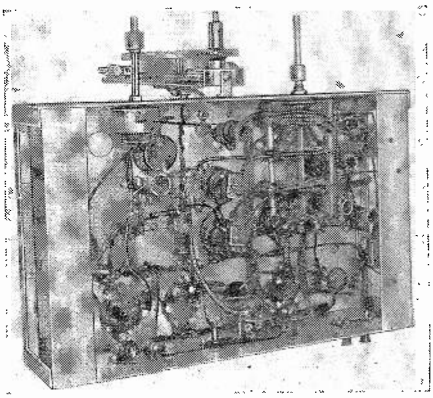


Fig. B. Under-chassis view of receiver. Note positions of band switch and oscillator coils.

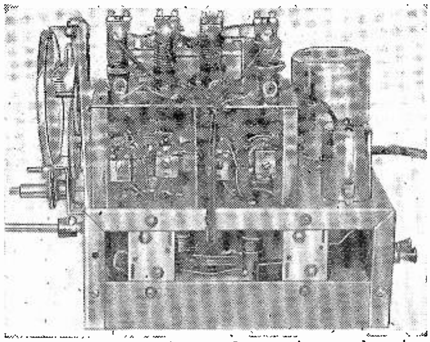
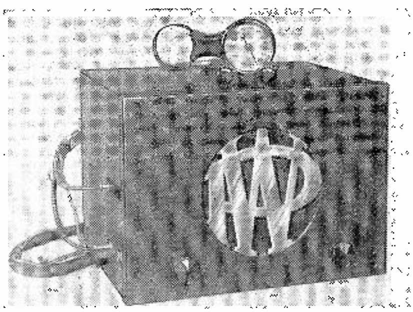


Fig. A. Side view of receiver showing some of the coils and padding condensers.

The alignment of this receiver is similar to that of any all wave superheterodyne receiver, in that individual adjustment of the trimmers is necessary on each band. The job should not be tried without the use of a good service oscillator—preferably of the all-wave type, covering each band.

LIST OF PARTS

One Paragon 7 x 12 x 3 in. cadmium-plated steel chassis;
One Paragon complete set of coils, 15 in all, for R.F., oscillator, and antenna circuits, to cover range of from 12 to 2,100 meters;
One Paragon 3-gang 350 mmf. (each) variable condenser;
One Trutest push-pull input transformer;
One Paragon 3-deck (double row of contacts, 5 on each side) switch;
One Paragon airplane-type tuning dial, dual ratio;
One shield can for R.F. coils;
One 0.2-meg. volume control with switch;
One Amperite ballast resistor (6-1 type);
Three Eby 4-prong wafer sockets;
Two Eby 5-prong wafer sockets;
Two Eby 6-prong wafer sockets;
One Na-Ald pin-jack terminal strip, for phones;
One Ant. and Gnd. terminal strip;
One Solar 150 mmf. (maximum) variable padder, for long waves, P1;
One Solar 600 mmf. (maximum) variable padder, for broadcast, P2;
Three Cornell-Dubilier mica-dielectric fixed padding condensers—.002-mf., P3; .01-mf., P4; 0-1-mf., P5;
One IRC ½-W., 0.1-meg. resistor;
One IRC ½-W., 0.3-meg. resistor;
One Hammarlund R.F. choke, 85 mhy.;
One Lafayette 465 kc. double-tuned I.F. transformer;
One Paragon special single-tuned 465 kc. I.F. transformer;
Two Cornell-Dubilier 250 mmf. (postage-stamp size) fixed condensers;
One Cornell-Dubilier .03-mf. tubular condenser;
One IRC 0.5-meg. (½-W.) resistor;
One battery cable;
One Lafayette speaker (permanent magnet, or magnetic with center-tap);
One Cornell-Dubilier .01-mf. tubular condenser;
One Cornell-Dubilier 0.1-mf. tubular condenser;
One .25-mf. tubular condenser;
One Raytheon or National Union complete set of tubes;
One Paragon special portable case;
Miscellaneous, such as wire, hardware, knobs, etc.



View of complete receiver.

HOW TO MAKE A DUAL-WAVE CAR-RADIO RECEIVER

Suppressor-less design and features not found in manufactured sets make this receiver worthwhile.

TO provide maximum sensitivity and volume much time was spent in design of this circuit. Unusual care was exercised in filtering every plate, screen- and control-grid lead so that the greatest possible amplification could be obtained from each stage. For this reason, too, the "B" supply selected for this receiver delivers the highest convenient voltage. (The resulting high gain of the set is especially useful in compensating for the characteristics of the "varitone" tone compensator built into the instrument.) A stage of R.F. amplification utilizing a 6D6 tube is included ahead of a combined first-detector and oscillator multi-purpose type 6A7 tube, to give the desired selectivity and freedom from "birdies," and to improve the stability of the receiver. Because of its high power output sensitivity, and fine power-handling ability, the new type 6B5 tube (see *Radio-Craft*, April 1935, "The New 6B5 Dynamic-Coupled A.F. Tube.") is included in the power audio stage. A multi-purpose, type 6B7 tube is used as combined diode detector, delayed A.V.C., and pentode A.F. stage; an unusual A.F. transformer is used to couple this tube to the 6B5. This transformer (known as the "varitone"—see *Radio-Craft*, May, 1935, "Variable-Fidelity A.F. Transformers") has a tertiary winding which permits tone compensation on the low and high frequencies without the usual "ills" of tone controls. (It also has a low-impedance primary which can be used by the ambitious constructor for a "mike" or phono, pickup, using the A.F. amplifier section and reproducer of the set as a small P.A. system.)

The special dust-proof magneto-dynamic (permanent-magnet) speaker specified for this chassis supplies "dynamic" quality without the usual 2 or 2.5 A. drain for field current.

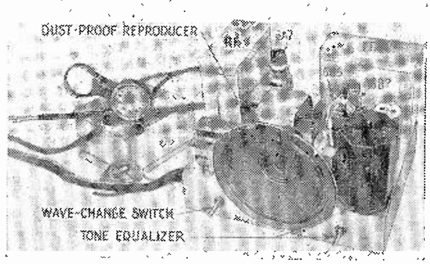
It was necessary to design a special set of R.F. coils for this car-radio set, in order to obtain proper impedance match between the car antenna and the input circuit of the set.

ALIGNMENT

When the parts have all been mounted and the wiring is completed according to the circuit diagram, the receiver is ready for alignment.

A good service oscillator delivering accurately-calibrated **fundamental** frequencies will be required; it must cover not only the broadcast band and the I.F. of 456 kc., but also the 49-meter short-wave band. The I.F. is the first adjustment to tackle. Take the control-grid cap from the 6A7 tube and connect the service oscillator input to the tube cap. Adjust the service oscillator to 456 kc., and connect the output meter to the plate circuit of the 6B5 tube, in the usual manner. Align the I.F. trimmers for greatest deflection of the output meter.

When this operation is completed, replace the grid clip and connect the service oscillator to the aerial wire, hav-



Open top view of receiver showing placement of major components.

ing the wave-change switch in the broadcast position. Tune the service oscillator to 500 kc. and turn the knob on the remote control until the pointer also reads 500. Then align the oscillator broadcast band padder for greatest deflection on the output meter. Two points will be found where the service oscillator signal can be heard. Use the louder (higher frequency) position.

Next tune the oscillator to 1,400 kc. and adjust the broadcast trimmers in the R.F., intermediate (first-detector) and oscillator coil cans for greatest output meter deflection. Check the alignment at several other points across the band, and if necessary, bend the slotted end plates of the variable condenser sections to correct for misalignment. Do not touch either the padder or trimmer condensers once they are adjusted.

The short-wave alignment is carried out in the same manner as the broadcast adjustment, but with the wave-change switch in the short-wave position. In this case, tune the receiver condenser to nearly maximum capacity and adjust the service oscillator until the signals are heard in the speaker; then, adjust the oscillator short-wave padder for greatest meter deflection. Finally, move the condenser plates to a point near minimum capacity, find the resonant point on the oscillator, and then adjust the trimmers (short-wave trimmers, which are the lower ones) on the 3 coils for greatest meter deflection. The short-wave range covers the 19, 25, 31 and 49 meter "short-wave broadcast" bands.

LIST OF PARTS

*One set of special shielded, dual-range, high-gain R.F. and I.F. coils (see text), L1, L2, L3, IFT1 and IFT2;

*One 410 mmf. three-gang condenser and remote control with 2 flexible shafts, C1, C2, C3;

*One dual 6-plate padding condenser, C13, C14;

Cornell-Dubilier Condensers

Five .05-mf. 200 V. paper condensers, C4, C8, C17, C21, C24; Four .1-mf. 200 V. paper condensers, C5, C9, C20, C26; Eight .1-mf. 400 V. paper condensers, C6, C7, C10, C11, C16, C18, C19, C27; Two 100 mmf. mica condensers, C23, C28; One 450 mmf. mica cond. C22; One 250 mmf. mica cond. C12; One 25 mf. low-voltage electrolytic condenser, C25; One .004-mf. mica cond. C15.

I.R.C. Carbon Resistors

Three .25-meg. , 0.3-W., R1, R4, R8; Two 40,000 ohms, 1-W., R3, R10; Two 300 ohms, 0.3-W., R2, R9; One 200 ohms, 0-3-W., R5; One 50,000 ohms, 1-W., R7; One 25,000 ohms, 0.3-W., R6; Two 1.-meg., 0.3-W., R11, R17; Two 0.5-meg., 0.3-W., R12, R13; One 0.1-meg., 0.3-W., R15; One 3,500 ohms, 0.3-W., R14.

Additional Components

One Centralab 0.5-meg. volume control potentiometer with switch, R16; One Centralab 50,000 ohm tone-control potentiometer, R18.

One United Trans. Corp. VT-1 Varitone transformer, A.F.T..

*One 6 in. special dynamic reproducer.

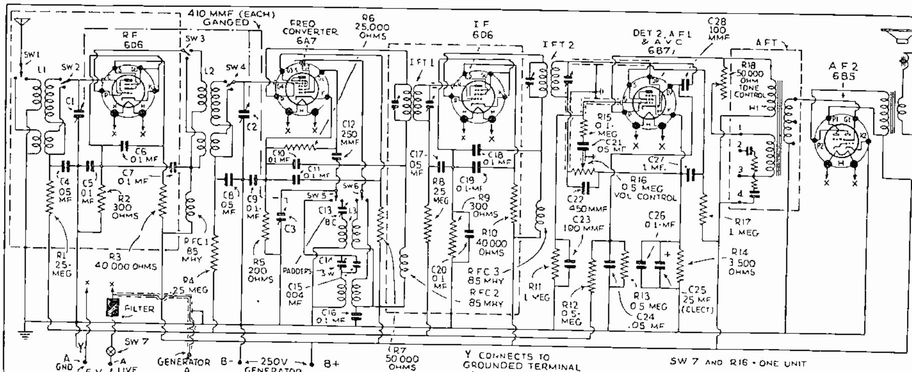
*One special, "A"-circuit filter; *One genemotor "B" unit; *Three 6 pin wafer sockets; *Two 7 pin wafer sockets; One 6-pole 2-throw switch, Sw.1 to Sw.6.

Two type 6D6 tubes; One type 6A7 tube; One type 6B7 tube; One type 6B5 tube; (Hygrade Sylvania).

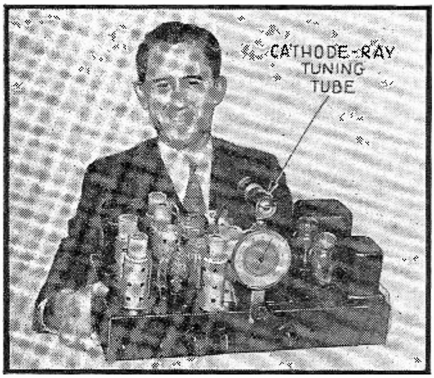
Chassis And Miscellaneous Parts

One Blan aluminum chassis; Two Blan aluminum shield boxes; *One crackle-finish iron case; One 3-wire battery and genemotor cable (two No. 10 and one No. 14 flexible wires, 10 ft. long); Four National Union form-fitting tube shields; Three Hammarlund 85 mhy. R.F. chokes, R.F.C.1; R.F.C.2; R.F.C.3; Four screen-grid caps; Shielded and plain hook-up wire, screws, soldering lugs, etc..

(The names of manufacturers of parts marked * will be sent upon request.)



Complete schematic diagram of the automobile receiver.



Complete tuner, ready for operation.

HOW TO MAKE A A 12-TUBE HIGH-FIDELITY BROADCAST SET

Here is a real high-fidelity set solely for superior reception of local stations on the broadcast band.

BRIEFLY, the set comprises 2 T.R.F. amplifier stages followed by a diode detector. This in turn feeds into a 2-stage A.F. amplifier, with both stages in push-pull. High-quality transformer coupling is employed between the driver and power stages. A separate 2-stage amplifier with both stages in push-pull is used as a "bass booster" stage to insure adequate bass response when the receiver is operated at low volume levels. (A 1-stage preamplifier with mike input transformer is also included although this may be left out if the builder does not plan to make use of it.)

CIRCUIT DETAILS

The T.R.F. amplifier follows conventional design with the exception that no attempt has been made to secure sharp tuning. The band-width is of the order of 30 to 40 kc.

The tuning range with a 3-gang, 365 mmf. tuning condenser is 530 to 1,700 kc.

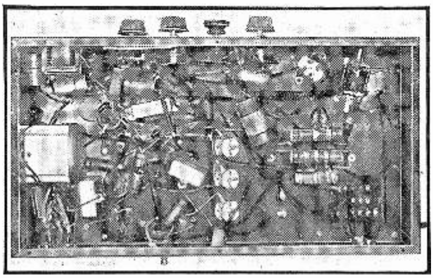
It should be noted that the plates of the R.F. tubes are supplied with 100 V. instead of the usual 250. With 100 V. the impedance of the 6D6 tubes is greatly reduced and makes possible a better impedance match between the tubes and R.F. coils. Automatic volume control is employed on both R.F. tubes.

The output of the diode employs the "split-tapped" load resistor arrangement which allows a pair of push-pull grids to be coupled to the diode without the need of a coupling transformer or phase-inverting tube. The first A.F. stage was connected in push-pull in order to keep second-harmonic distortion at a very low value and also to insure sufficient undistorted power for the grids of the power stage. The inter-stage A.F. transformer is a precision device and will give a response flat within ½-db. from 30 to 16,000 cycles.

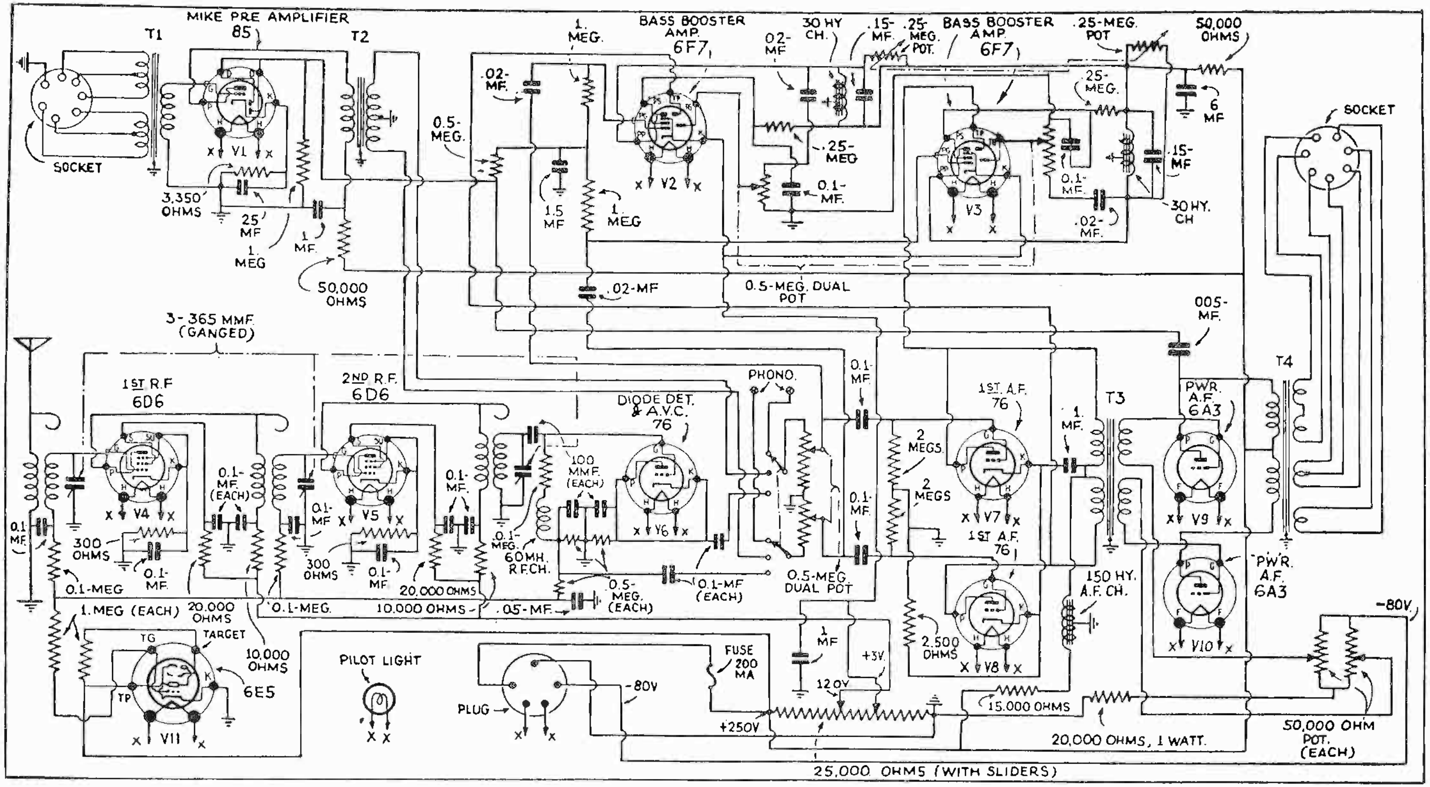
The power stage employs two 6A3s in class A (not A prime), with a fixed bias source supplied by a separate bias rectifier circuit in the power supply.

The values of bias and plate voltage for the 6A3s in push-pull class A are different from the usual values. The bias is approximately 45 V. The plate voltage is 250. The plate current of each tube should be carefully adjusted so that both tubes balance at 60 ma. per tube. Adjusting the grid bias potentiometers mounted under the chassis serves to balance the plate current of the 6A3s.

The output transformer employed has a primary impedance of 8,000 ohms, plate-to-plate. The secondaries are arranged to feed a 500-ohm device or the voice coil of any speaker from 1.75 to



Under chassis view of tuner. The power pack is a separate unit.



15 ohms. (Taps are provided on the low-impedance winding to give an exact impedance match to any particular speaker.) The output transformer has a frequency response flat within 1 db. from 30 to 15,000 cycles. The primary winding should be made to carry 60 ma. per leg continuously.

The undistorted output of the amplifier is approximately 10 W. lower than with the "A prime" arrangement but producing much less distortion than the "A prime" system. An output of 10 W. is adequate for ordinary home use; and the lowered

(*Continued on next page*)

distortion makes the drop in power output well worth while in a high-fidelity set.

THE "BASS BOOSTER"

The bass booster is a 2-stage A.F. amplifier which has a peaked frequency response. It is sharply resonant in the neighborhood of 70 cycles. When turned "up" the result is that the bass register is amplified much more than the other frequencies. This device is only for use when the set is playing at low-volume level.

When operated under this condition there is with any receiver not compensated for the effect, a lack of bass response. Reproduction sounds "tinny." The bass booster however restores to a considerable extent the missing bass. It does this by means of an A.V.C. system connected to the power stage. On loud signals the A.V.C. action overbiases the bass booster and there is little amplification. The response of the set is then governed only by the regular amplifier, and substantially flat response is obtained. When volume is turned down to a low level the A.V.C. action decreases the bias on the bass booster and its gain increases, feeding the boosted bass into the regular amplifier and mixing the two to give a frequency response with the bass predominating and thus neutralizing to a considerable degree the low-volume thinness of reproduction.

The mike preamplifier is conventional and needs no discussion.

THE POWER PACK UNIT

The power supply is a separate unit and employs 2 rectifier tubes, a type 83V, and a 45 with plate and grid tied together, as shown in Fig. 3. The 83V, because of its low internal resistance and consequent low voltage drop even with heavy current drain, is used as the main "B" supply rectifier. Its "choke input" arrangement (as against "condenser input," utilizing a 4 mf. unit,) improves the "regulation" of the power supply. That is, the output voltage does not vary greatly, even with large changes in the amount of current drain. The type 45 is used only as a bias rectifier for supplying "C" bias voltage for the power stage of the receiver. Here, condenser input is employed, since voltage regulation is unimportant (the current drain is fixed at 2 ma. by the value of the voltage divider across the bias source).

The power transformer should be cased in a heavy shield to prevent stray magnetic pick-up by the receiver. It should also contain an electrostatic shield between the primary and secondary to reduce line-noise pick-up. The two 10-hy. chokes are thoroughly shielded heavy-duty units. The D.C. resistance of each should be 160 ohms, or less, with rated inductance at the full operating current drain of 160 ma. (a "10 hy." choke rated only to carry 160 ma. without burning out would have an A.C. inductance of only about 1 hy.).

The 4- and 8-mf. filter condensers in the high-voltage circuit should be rated at 500 V. (or higher) working volt to insure against breakdown in service.

ADJUSTMENT OF THE TUNER BY MEANS OF THE VISUAL INDICATOR

The set should be turned on and the volume control turned up. The R.F. trimmer condensers (in shunt to the respective tuning condensers, but not shown in the schematic diagram) are of air-tuned type to insure permanence of alignment. These units, which are mounted in such way that the adjustment screws project through the top of the chassis, should be set at about ⅓ full capacity.

Now tune the set to a station carrier or service oscillator signal at about 1,400 kc.; at resonance, the cathode-ray tuning indicator beam should narrow. Now adjust the trimmers, starting with the antenna unit, until the tuning beam is least broad. Repeat this procedure at a 600 kc. (approx.) setting of the receiver. With a matched set of coils the position of each trimmer should be almost identical and very little change in adjustment should be necessary at 600 kc. as compared with 1,400 kc.

ADJUSTING THE BASS BOOSTER

On the diagram of the tuner there are two dual potentiometers indicated in the bass-booster circuit; one unit has a resistance of .5-meg. per section, and the other, 25-meg. per section. The .25-meg. control is mounted under the chassis and once adjusted is left fixed.

The .5-meg. unit is controlled by a knob on the front of the panel, and is used to vary the degree of bass boosting. To adjust the bass-booster circuit, turn the main volume control to the off position and turn up the bass-booster control to the full-on position. Next adjust the .25-meg. control for maximum resistance. In this condition a low-pitched motorboating or purring should be heard from the reproducer. Finally, adjust the .25-meg. control until this sound just disappears.

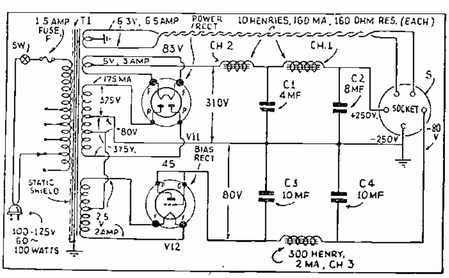
SPEAKERS

A single, high-fidelity type dynamic reproducer in this radio set should give much better reproduction than it would in the average set. The addition of a "tweeter" of the dynamic or crystal type is recommended.

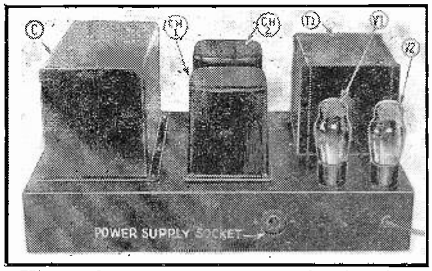
The power transformer has a tapped primary winding enabling adjustment for proper line voltages from 100 to 125 at 60 cycles. The total power consumption of the set is about 100 W. The high-voltage secondary must be capable of supplying 310 V. under a load of 175 ma.

LIST OF PARTS FOR THE TUNER

One I.R.C. resistor, 3,350 ohms, ½-W.;
Two I.R.C. resistors, 50,000 ohms, ½-W.;
Four I.R.C. resistors, 0.5-meg., ½-W.;
Five I.R.C. resistors, 1.0 meg., ½-W.;
Two I.R.C. resistors, .25-meg., ½-W.;
Three I.R.C. resistors, 0.1-meg., ½-W.;
Two I.R.C. resistors, 300 ohms, ½-W.;
Two I.R.C. resistors, 20,000 ohms, ½-W.;
Two I.R.C. resistors, 10,000 ohms, ½-W.;
Two I.R.C. resistors, 2 megs., ½-W.;
One I.R.C. resistor, 2,500-ohms, ½-W.;
One I.R.C. resistor, 20,000 ohms, 1.0 W.;
One I.R.C. resistor, 15,000 ohms, ½-W.;
One Electrad resistor, with slider, 20,000 ohms, 25 W.;
One Electrad resistor, with slider, 5,000 ohms, 25 W.;
Two Electrad potentiometers, 50,000 ohms;
Two Electrad dual potentiometers, 0.5-meg.;
One Electrad dual potentiometer, .25-meg.;
One Cornell-Dubilier electrolytic condenser, 25 mf., 25 V.;
Three Cornell-Dubilier paper condensers, 1.0 mf., 400 V.;



Schematic circuit of power unit. Note the two rectifiers.



View of separate power unit showing placement of parts.

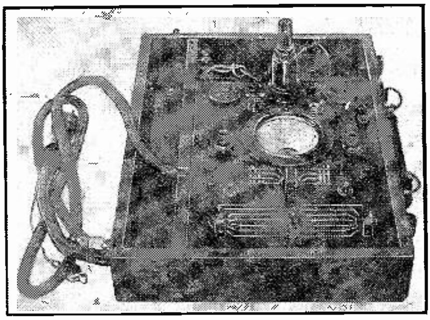
Four Cornell-Dubilier paper condensers, .02-mf., 400 V.;
Eleven Cornell-Dubilier paper condensers, 1.5 mf., 200 V.;
Fourteen Cornell-Dubilier paper condensers, 0.1-mf., 400 V.;
Two Cornell-Dubilier paper condensers, .15-mf., 200 V.;
One Cornell-Dubilier paper condenser, 2 mf., 400 V.;
One Cornell-Dubilier paper condenser, .05-mf., 400 V.;
Three Cornell-Dubilier mica condensers, 100 mmf.;
*Three T.R.F. coils, 1,750 to 530 kc.;
One 3-gang tuning condenser, 365 mmf. per section;
Three Hammarlund air-dielectric trimmer condensers, 50 mmf.;
Two A.F. chokes, 30 hy., 30 ma.;
*One A.F. choke, 50 hy., 10 ma.;
*One A.F. transformer (push-pull plates to pushpull grids), T3;
*One output transformer (plate-to-plate—8,000 ohms), T4;
*One A.F. transformer (single plate to push-pull grids), T2;
*One transformer (tapped primary—500 ohms—to single-grid), T1;
One Na-Ald 6-prong special socket (for 6E5);
Three Eby 6-prong wafer sockets;
Four Eby 7-prong small wafer sockets;
Four Eby 5-prong wafer sockets;
Two Eby 4-prong wafer sockets;
One Raytheon, Sylvania or RCA type 85 tube;
Two Raytheon Sylvania or RCA type 6F7 tubes;
Two Raytheon, Sylvania or RCA tube 6D6 tubes;
Three Raytheon, Sylvania or RCA type 76 tubes;
Two Raytheon, Sylvania or RCA type 6A3 tubes;
One Raytheon, Sylvania or RCA type 6E5 cathode-ray tube;
*One chassis;
*One tuning dial.
(*Names of manufacturers will be sent upon request.)

LIST OF PARTS FOR POWER UNIT

*One special power transformer, T1;
*Two special shielded A.F. chokes, 10 hy., 150 ma., 160 ohms each. Ch.1, Ch.2;
One unshielded choke, 300 hy., 2 ma., Ch.3;
Two Cornell-Dubilier paper condensers, 10 mf., 150 V. (working), C3, C4;
One Cornell-Dubilier paper condenser, 8 mf., 500 V. (working), C2;
One Cornell-Dubilier oil-impregnated paper condenser, 4 mf., 600 V., C1;
*One chassis;
One RCA or Raytheon type 83 tube, V1;
One RCA or Raytheon type 45 tube, V2;
Two Eby 4-prong wafer sockets, V1, V2;
One Eby 5-prong wafer socket;
One 1.5A fuse and fuse mount, F.
*Names of manufacturers will be sent upon request.

CHAPTER II

SERVICE INSTRUMENTS



Appearance of completed tester.

HOW TO MAKE A Free-Reference-Point MULTI-PURPOSE SET ANALYZER

Set analyzer and tube tester which will accommodate the latest set as well as the oldest. You will find it unusually flexible.

THIS testing instrument consists, essentially, of a universal volt-milliammeter, Fig. 2, and a free-reference-point unit, Fig. 1. Three sockets are available for current readings of all modern tubes.

Voltage scales, A.C. and D.C. of 10, 100, 500 and 1,000 are selected, as shown in Fig. 2, by means of a rotary selector-switch, Sw.6. Rotating the same switch in the reverse direction, selects current scales of 10, 100, 500 and 1,000 ma. Setting the toggle switch Sw.10, cuts a 10-A. shunt directly across the meter.

Jack switch Sw.4 selects current or voltage; Sw.5, A.C. or D.C.

Resistors R5 and R10 convert the meter to a 0-5 voltmeter; R6 then completes the total resistance for the 10-V. scale.

(Carbon resistors having a 5 per cent tolerance were found accurate enough for ordinary service work.)

The current shunts, with the exception of the 10-A. shunt, are hand-calibrated from wire-wound resistors, for a 5-V. meter. The 10-ma., 550-ohm shunts are obtained by moving the clips of a standard, 500-ohm size, bare-wire-wound resistor closer to the ends. The extra value of 50 ohms is readily obtainable.

The 10-A. shunt is a stock size for this meter. The 10-ma. shunts are connected in the plate leads between the socket selector switches. To make current readings on this scale with the test leads, it is necessary to set the socket-selector switches across one of these shunt.

Switch Sw.7, in Fig. 1, is in positive lead, and Sw.8 the negative. To measure plate voltage from the cable, Sw.7 should be set at P, or, according to the RMA socket numbering system to 3, while the Sw.8 is set at K or H (or 7 or 8), depending on the type of tube. To measure plate current of the same tube, both switches should be set at P, the jack switches thrown to their proper position, and the correct scale selected.

Several dead points remain on the socket selector switches for future tubes, and on the scale selector for other scales.

All types of tubes may be tested in

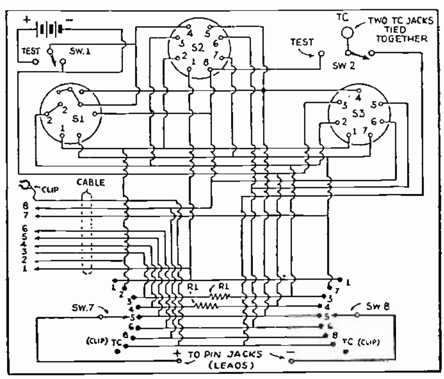


Fig. 1. Schematic diagram of free-reference-point unit.

the analyzer, using the grid-shift method. For tubes with the grid at the socket pin, Sw.1 is thrown to "TEST." When the control-grid is at the top cap, Sw.2 is thrown to S.-G. (Toggle switch "NOR" on the panel is an "extra" for future use.)

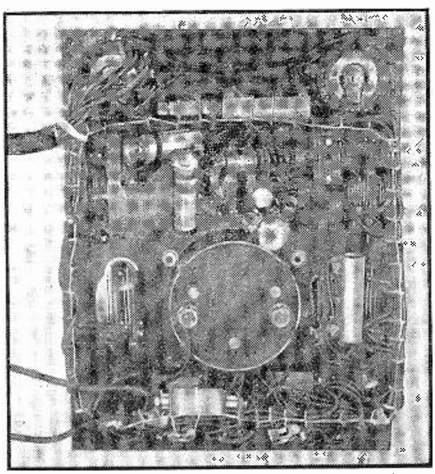
The 5Z4 rectifier tube, having one different filament post, need cause no worry, because the cable feeds straight through, so that the filament posts in the set under test will occupy the same pins in the analyzer socket. To read the filament voltage of the 5Z4, set Sw.7 at 2, and Sw.8 at 8.

Current shunts are connected in leads 3 and 4. This may be extended to include all the leads, or toggle switches may be connected in several leads, and opened for current readings, the shunt then being connected to the scale-selector switch.

The R-C tip jacks are used for resistance and capacity measurements. Throwing Sw.5 to D.C. gives a scale of 0-1. ma. at these points.

A small battery and a variable resistor may then be used as an ohmmeter adapter. Five adapters are required, and should be connected exactly as shown in the diagram, so that the pin connections will be the same as the analyzer sockets. They may be made by bolting adapter sockets on tube bases or adapter bases.

This flexible set tester will more than suffice for every day radio service work.



Under-panel view of analyzer showing wiring.

It will accommodate both metal tube sets and glass tube sets.

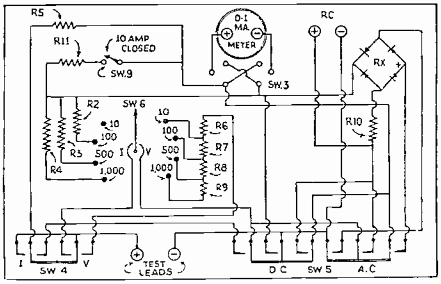


Fig. 2. The analyzer volt-milliammeter unit schematic diagram. Refer to List of Parts below for values of all resistors.

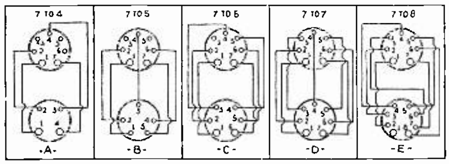
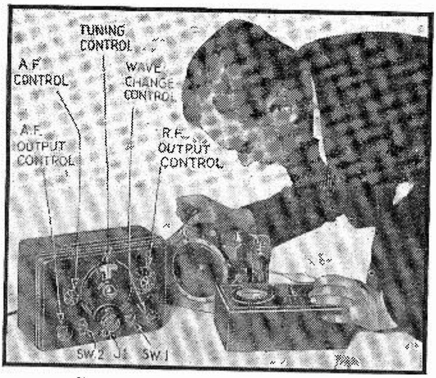


Fig. 3. The adapters for permitting 4-, 5-, 6-, 7-, or octal-prong tubes to be tested and connected to the unit.

LIST OF PARTS

One Jewell No. 88, 0.1 ma. meter;
One Na-Ald No. 456E composite socket 4-5-6 prong, S1;
One Na-Ald No. 477E socket 7-7 prong, S3;
One Na-Ald octal socket, S2;
Two Yaxley No. 422 tip jacks, TC;
Two Yaxley No. 422 tip jacks, test leads;
Two Yaxley No. 422 tip jacks, R-C leads;
Four S.P.D.T. toggle switches, Sw.1, Sw.2, Sw.9, Sw.10;
One D.P.D.T. toggle switch, Sw.3;
One Yaxley No. 762 jack switch, Sw.4;
One Yaxley No. 763 jack switch, Sw.5;
Two Readrite No. 27 rotary switches, Sw.7, Sw.8;
One Readrite No. 34 rotary switch, Sw.6;
Two Electrad meter shunts, 500 ohms, R1;
One Electrad meter shunt, 55 ohms, R2;
One Electrad meter shunt, 10 ohms, R3;
One Electrad meter shunt, 5 ohms, R4;
One Weston 10-A. meter shunt, R11;
One Shallcross multiplier resistor, 4,970 ohms (unwind 30 ohms from 5,000 ohm precision resistor), R5;
One Continental Carbon multiplier resistor, 5,000 ohms, R6;
One Continental Carbon multiplier resistor, 90,000 ohms, R7;
One Continental Carbon multiplier resistor, 0.4-meg., R8;
One Continental Carbon multiplier resistor, 0.5-meg., R9;
One Aerovox multiplier resistor, 4,500 ohms (unwind 500 ohms from 5,000 ohm precision resistor), R10;
One Taurex meter rectifier, RX;
One bakelite panel, 7 x 9 ins.;
One analyzer cable, 9 wires;
One dual S.G. cap and lead;
Three Radio City 1¼-in. pointer knobs;
Five 7-hole 4-5-6-7S and 8-prong adapter sockets;
Five 4-, 5-, 6-, 7S- and 8-prong adapter bases.



Completed oscillator in use.

HOW TO MAKE A RADIO-CRAFT Metal-Tube All-Wave OSCILLATOR

An ultra-modern "signal generator" unit which covers all requirements for service and experimental work; it is an extremely flexible unit, which works on any A.C. or D.C. line.

THE *Radio-Craft* ultra-modern signal generator covers all frequencies between 90 kc. and 25,000 kc. (25 mcs.) in 7 bands; the output is variable from a portion of a microvolt to approximately 0.1-V. (r.m.s.), in two steps; a high-mu triode 6F5 tube is used as a modulator, the frequency of which is adjusted by a "tapped condenser" having capacities varying between 50 mmf. and .01-mf. Seven audio frequencies are thus produced between (approx.) 100 and 7,500 cycles. A jack is incorporated in the circuit so that a "wobbler" can be plugged in.

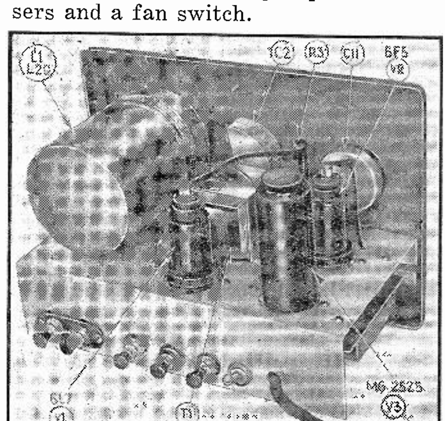
THE CIRCUIT

A 6L7 injection-grid frequency-converter tube is used as the R.F. oscillator. (Further details about this interesting tube will be found in the October 1935, issue of *Radio-Craft* on page 204 —Editor)

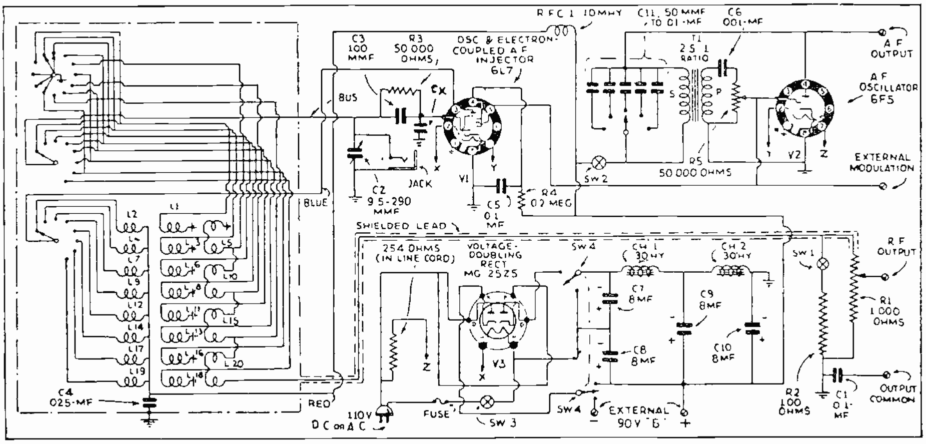
A conventional regenerative circuit is used for the R.F. oscillator, the 7 frequency bands being made possible by the use of an RCA all-wave oscillator coil. Since this coil assembly is calibrated for use with the condenser which is used, the problem of calibration—which has stumped so many radio men when making oscillators and frequency meters—is eliminated. A trial or two against known standards (such as broadcast stations) is all that is needed to properly set the dial scale. One small additional compensation is needed. Since the coil and condenser were calibrated for use with a type 30 tube which has an input capacity of 3 mmf. and we are using a 6L7 having an input capacity of 1.9 mmf., we must add 1.1 mmf. to the input capacity to make the circuit constants match. This is accomplished by taking two pieces of cotton braid hookup wire about 3 ins. long and twisting them tightly together, leaving one end of each wire open and connecting the other end to the cap and cathode of the tube (see Cx which represents this additional capacity).

The output of the oscillator is fed through a shielded line to a 1,000 ohm potentiometer. shunted by a 100 ohm resistor and a switch. When this switch, Sw.1, is open, the greatest output is obtained, and when closed, the low range is in effect.

The A.F. oscillator consists of a low-ratio A.F. transformer connected backwards; that is, with the usual secondary in the plate circuit and the primary in the grid circuit. This is done to obtain the greatest output and the widest frequency range. The frequency of this oscillator (modulator) is controlled by a unit consisting of a group of condensers and a fan switch.



Rear open view of oscillator.



Complete schematic diagram of the oscillator.

The construction of the signal generator is not difficult, if the specified parts are used. The dial should be converted first, by removing the scale disc and pasting the paper scale which comes with the coil assembly over the original one.

ADJUSTMENTS

The adjustments necessary are few in number. When the unit has been completed, connect it to a 110 V. line and connect a shielded wire to the R.F. output terminal and the "Output Common" terminal, which, by the way is isolated from the unit by a .1-mf. condenser so that "fire works" are not seen when the line plug is inserted in the socket the wrong way. Connect the shielded wire to the aerial binding post of a receiver and tune the set carefully to a number of broadcast stations one after the other, the frequencies of which are known; and on the basis of this, set the dial of the oscillator to the correct point and lock the set screw on the dial tightly in place.

If it is desired to use only the R.F. oscillator without modulation, the modulation switch, Sw.2, should be snapped to the **off** position.

If the A.F. oscillator only is desired, this switch should be in the on position but the output should be taken from the "A.F. Output" terminal and the "Output Common" terminal.

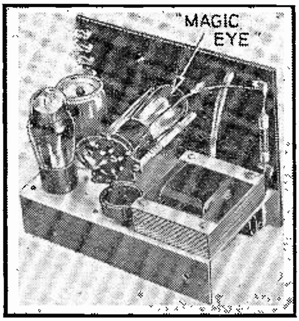
If wider A.F. modulation is needed than provided by the modulations of the A.F. oscillator, additional condensers can be shunted across C11. Or, if for any reason a separate modulator is to be coupled to the R.F. signal generator, the "External Modulation" terminal should be used and Sw.2 should be placed in the **off** position.

A little study of the circuit and this rather sketchy description of the construction and operation of the unit will reveal how really flexible the unit is.

LIST OF PARTS

One RCA oscillator coil kit, L1 to L20, type 9559, (including dial scale, two snap switches Sw.1 and Sw.2, and jack J1);
One RCA cond., 9.5 to 290 mmf., type 3980, C2;
Two .1-mf. Cornell-Dubilier 400 V. condensers, C1, C5;
One Cornell-Dubilier 100 mmf. condenser, C3;
One Cornell-Dubilier .001-mf. condenser, C6;
Four Aerovox 8 mf. 250 V. electrolytic condensers, C7, C8, C9, C10;
*One tapped condenser bank 50 mmf. to .01-mf. type 1200TA C11;
One Clarostat 1,000 ohm non-inductive potentiometer with switch, Sw.3, R1;
One Aerovox 100 ohm, 5-W. carbon resistor, R2;
One Aerovox 50,000 ohm 5-W. resistor, R3;
One Aerovox .2-meg. 5-W. carbon resistor, R4;
*One 50,000 ohm potentiometer, R5;
One Blan power cord, with 254 ohm resistor, R6;
One Hammarlund 10 mhy. RF choke, type CH10-S, R.F.C.1;
*Two midget filter chokes, Ch.1, Ch.2;
*One midget A.F. transformer, T1;
Three ICA Insulite octal sockets;
One Blan D.P.D.T. snap switch, Sw. 4;
One Blan aluminum chassis, 8¾ x 4½ x 2¼ ins. high;
*One type B dial;
*One cabinet;
One National Union type 6L7 metal tube, V1;
One National Union type 6F5 metal tube, V2;
*One MG25Z5 metal-glass tube, V3;
Five Blan binding posts;
One 1-A. fuse;
As needed, screws, hookup wire, etc.

(*Name of manufacturer sent upon request.)



Back view of tester.

HOW TO MAKE A VERSATILE "MAGIC EYE" LEAKAGE and Resistance TESTER

This inexpensive precision tester takes the place of neon leakage testers and does a better job.

THE NEED FOR HIGH-OHM TESTS

THE introduction of the 6E5 cathode-ray tuning indicator tube which was described fully in December, 1935, *Radio-Craft* makes possible many new test devices; the one described here will undoubtedly be used to replace the unsatisfactory high-voltage tests for the determination of high resistance values and the location of current leakage.

In operation the 50,000-ohm variable resistor, R4, supplies the normal 8 V. negative bias to the control-grid of the 6E5 through the 1. meg. gridleak R3; this normal bias causes the ray screen to be completely luminous. This normal bias is reduced by virtue of the positive component of voltage present on the grid when some resistance is inserted between binding posts P1 and P2. A reduction in bias causes the formation of a dark sector on the luminous screen; the greater the reduction in bias the greater the size of the sector up to zero bias. A scale placed over the tube top permits the use of this sector variation as an accurate index of the resistance value between posts P1 and P2.

The range of the circuit may be changed by having taps on the bucking battery, E. If the battery, E, is removed from the circuit, the useful range of the instrument will be approximately between 0.1-meg. and 2 megs. If a 1.5 V. battery is used the useful range will be from .25-meg. to 5.0 megs. If a battery of 15 V. is used, the useful range will be from 2.5 to 50 megs. Resistor R4 is variable to permit a zero adjustment to take care of wide variations in line voltage.

In addition to leakage testing, the tester can be used as an output meter in aligning receivers. This use requires that there must be at least 1. V. across the circuit to be measured. The load of this circuit is practically nil and for this reason does not affect tone quality. The "E" battery is omitted in this test. Resistor R4 should be set at zero resistance.

Another use is in the alignment of receivers with A.V.C. In this case terminal P1 of V1 is connected to the receiver A.V.C. line at a convenient point and alignment made on the same basis as with any other output meter. The gridleak included in the tester is removed for this test. The "E" battery also is omitted. Resistor R4 should be set at zero resistance.

CONSTRUCTION

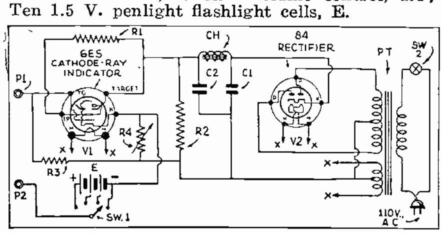
All of the parts used are standard. The power supply must deliver from 200 to 250 V. D.C. and may be made from any junk at hand.

The "E" battery is composed of 10 "penlite" flashlight cells in order that the desired 1.5 V. and 15 V. can be tapped off for range change.

LIST OF PARTS

The following list is given for parts which are actually necessary for operation of the 6E5 tube. The parts for the chassis and power pack can be picked to suit the experimenter.

One RCA Radiotron or Sylvania 6E5 Cathode-Ray tuning Indicator, V1;
One Bud 6-prong wafer socket for V2;
One I.R.C. 1.-meg. gridleak, R3;
One I.R.C. 1.-meg. plate resistor, R1;
One Electrad 50,000 ohm volume control, R4;
Ten 1.5 V. penlight flashlight cells, E.



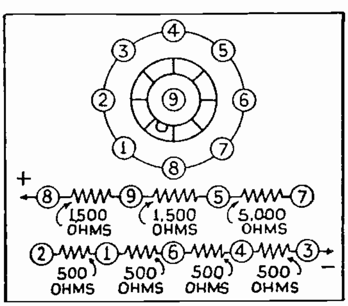
Schematic diagram of "Magic Eye" tester.

"SHORT" and "OPEN" TESTER for METAL TUBES

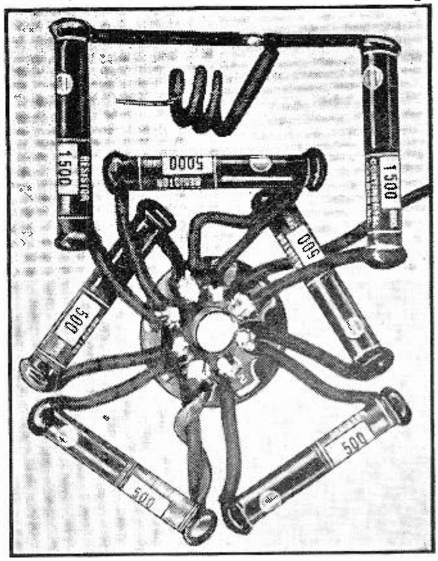
THE new octal-base tube socket lends itself to the design of a series-resistance type metal tube short tester. The only parts required are an octal-base tube socket, 4—500-ohm insulated resistors, 2—1,500-ohm insulated resistors, and 1—5,000-ohm insulated resistor.

In the circuit diagram, the terminals, as numbered in the resistor circuits, connect to the respective numbers in the tube-base diagram. The illustration shows the under-socket appearance of this arrangement with 1-W. insulated resistors connected to the socket terminals. The junction between the 2—1,500-ohm resistors is connected to a flexible lead to which must be attached a small grid-cap for tubes with top-cap connections. Terminals 3 and 8 have additional flexible leads for connection to an ohmmeter.

Practically all of the metal tubes have heater terminals in positions 2 and 7. As may be observed from the diagram, the heater filament of a tube would complete a circuit from terminal 3 to terminal 8 through the resistors. Neglecting the small resistance of the tube heater, the sum of the resistors in the circuit is 10,000 ohms. An ohmmeter connected to terminals 3 and 8 should indicate 10,000 ohms when a good tube is inserted in the socket. If the heater circuit of the tube is open, the reading will be above 10,000 ohms.



Schematic diagram of inexpensive practical "short" and "open" tester.



Simple resistor network constitutes the "tester."

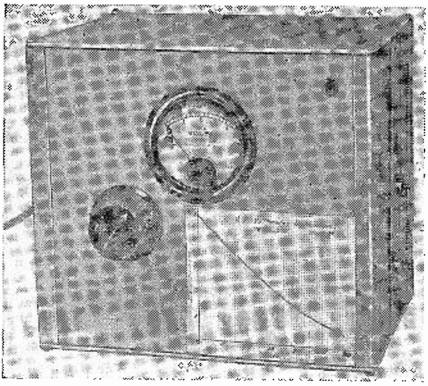
If the heater circuit is intact and a leakage exists between elements of the tube, the reading on the ohmmeter will be less than 10,000 ohms—because that leakage would be in shunt with one or more of the resistors.

Defects, due to the mechanical displacements within a metal tube, usually form a low-resistance short which may be easily detected with this arrangement. As will be observed on the diagram, the cathode and heater—terminals 8 and 7—are separated by 8,000 ohms. Most ohmmeters capable of reading 10,000 ohms will plainly distinguish a difference of 500 ohms; thus a leakage of 120,000 ohms shunting with 8,000 ohms will cause that circuit to show a net 7,500 ohms. This degree of sensitivity is adequate for metal tube cathode-to-heater leakage testing.

The 5Z4 tube uses terminals 2 and 8 for its heater circuit. The arrangement of the resistors is such that the 5Z4 tube will give a reading of 2,000 ohms if its heater is intact, and if no internal short-circuits exist.

The polarity indicated at terminals 3 and 8 is recommended so that tubes may be tested while their cathodes are hot. The current applied in the test opposes the natural electronic emission of the cathode, thus avoiding the appearance of leakage which the electrons might ordinarily cause.

Due to fact that the resistor circuit is open until a tube is inserted in the socket, an ohmmeter may be permanently connected when the short tester is mounted in a bench test panel; in a tube tester; or in a portable ohmmeter.



LOW-COST A.C.-D.C. Vacuum-Tube VOLTMETER

Here is a unit which is made from parts found in most radio "junk boxes"—it has many uses in the shop and lab.

AN invaluable addition to any experimenter's laboratory, is a vacuum-tube voltmeter. This is an instrument which many have desired to possess, yet have been deprived of owning, because of the costly, delicate meters and elaborate apparatus required in one as dictated by most of the available circuit requirements and by the high cost of upkeep of such an instrument due to the use of batteries for supply purposes.

To surmount both of these difficulties, yet to produce an instrument of sufficient precision to meet most of the experimenters' requirements, the following circuit has been developed. In this, low cost and simplicity of operation and construction have been the dominating factors considered in its design.

Since most D.C. meters available to the experimenter are usually of the insensitive type, having a range in the order of 20 ma. for full scale deflection, such a meter was employed in the circuit.

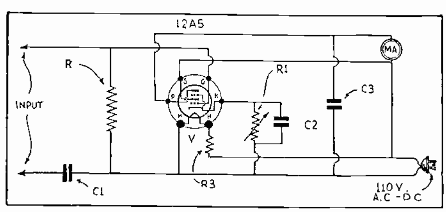
In order to obtain high-power sensitivity, as is necessary because of the use of such a high-range plate milliammeter, a 12A5 tube was selected, due to its high transconductance and also to its low filament current consumption; which enabled the selection of a convenient filament divider resistance and in addition the losses in this divider were minimized. The divider employed, R3, is a 35-W. standard mazda lamp. Condenser C1 is a 1-mf. paper condenser; C2 is an 8 mf. electrolytic condenser; and C3 is a 0.5-mf. paper condenser. Resistor R is 0.1-meg., ¼-W. resistor, and R2 is a 600-ohm, 1-W. rheostat. This completes the equipment, all of which is either in the possession of or is readily accessible to any radio experimenter. Using the above circuit constants a range of 0—30 volts (effective) will be obtained.

While the set-up is operative on either 110 volts A.C. or D.C., calibration of the instrument on A.C. is rendered invalid on D.C.

The V.-T. voltmeter may be conveniently calibrated by comparison with a standard A.C. voltmeter, using 60-cycle current for the grid excitation. In order to avoid reverse reading of the plate milliammeter in this connection, however, the phase of the grid-exciting E.M.F. should be opposite to that of the power-supply source. This may be done by connecting these leads in the manner which results in a decrease of plate current instead of an increase upon their application to the voltmeter.

The versatility and uses of the V.-T. voltmeter are well-known.

In setting the instrument up for calibration and for use, R_1 is adjusted for full scale deflection of (M.A.), resulting in a decrease of plate current with the application of a grid E.M.F. instead of the inverse, as found in the usual type of V.T. voltmeter.



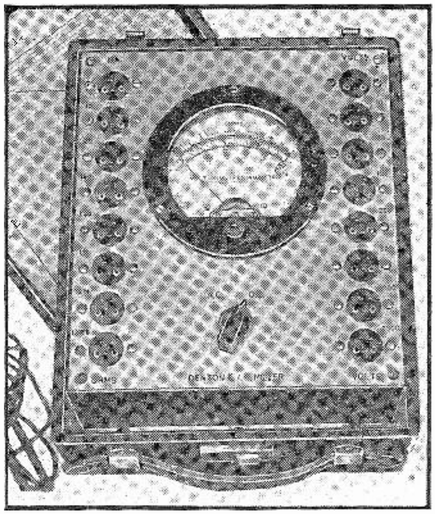
Circuit of A.C.-D.C. VT voltmeter.

HOW TO MAKE A "EIR" TESTER

WHILE this meter was primarily designed for the measurement of voltage, resistance, and current, other uses indicate themselves to those familiar with such equipment.

A fortunate discovery of a very compact miniature three-prong socket and a small compact three-prong plug solved the method of selecting any range at will with a minimum of switching. It will be noted that in this unit all switching is done with a single switch and this switch simply throws the rectifier unit in or out of the circuit as required. The use of the three socket contacts permits automatic connection of the shunts, R1, R2, and R3 respectively, in the circuit.

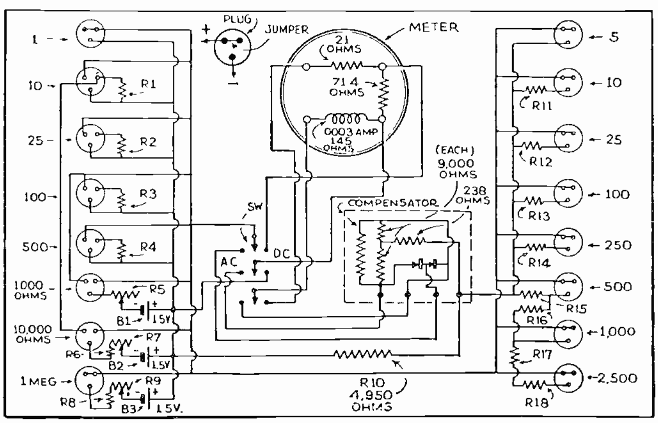
This new meter has A.C. and D.C. voltage ranges of 0-5, 0-10, 0-25, 0-100, 0-250, 0-500, 0-1000, 0-2,500 V. The meter selected being a milliammeter of fairly high sensitivity made it a simple matter to include shunts so that ranges of 10, 25, 100 and 500 ma. could be obtained readily. Three resistance measurement ranges were included having ranges of 0-1,000 ohms, 0-10,000 ohms, 0-1. meg.



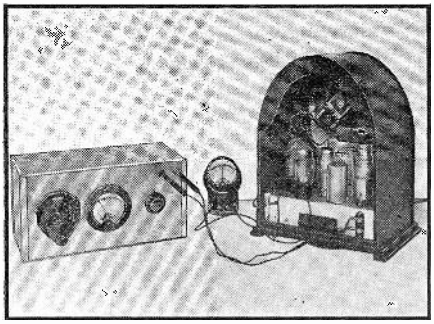
Appearance of the completed tester.

LIST OF PARTS

One Hickock Model 49X meter, 50 mv. drop, with M rectifier panel;
One ICA drilled and engraved metal panel;
Sixteen three contact sockets;
One plug;
One ICA small bar knob;
One pair ICA test leads;
One three-circuit, two-position switch, Sw;
One Electrad 20 ohm potentiometer, shaft slotted for screwdriver adjustment, R5;
One Electrad 100 ohm potentiometer, shaft slotted for screwdriver adjustment, R7;
One Electrad 2,500 ohm potentiometer, shaft slotted for screwdriver adjustment, R9;
One Electrad 100 ohm flexible resistor, R6;
One Electrad 13,500 ohm resistor, R8;
Four meter shunts for 10, 25, 100 and 500 ma., R1, R2, R3, R4;
One Shallcross resistor, 4,950 ohms, R10;
One Shallcross resistor, 5,000 ohms, R11;
One Shallcross resistor, 20,000 ohms, R12;
One Shallcross resistor, 95,000 ohms, R13;
One Shallcross resistor, .245-meg., R14;
One Shallcross resistor, .495-meg., R15;
One Shallcross resistor, 0.5-meg., R16;
Two Shallcross resistors, 0.75-meg., R17, R18;
One aluminum bracket.
One carrying case.
One 1.5 V. flashlight cell, tubular type, B1;
Two "C" batteries, B2, B3.



Schematic diagram of the tester. The jumper in the plug also picks up the required battery and meter current shunt circuits for the various ohmmeter ranges, thus eliminating switches of any kind in these circuits.



The oscillator being calibrated.

CALIBRATING an OSCILLATOR with a BROADCAST RECEIVER

ALTHOUGH any service oscillator may be calibrated by this method, we will briefly describe the one which we actually used—See Fig. 1.

It is a self-modulated oscillator employing a type 30 tube, batteries and everything self-contained, but includes an 0-1 ma. milliammeter in the plate circuit to indicate the existing output when the oscillator switch is turned "on." Due to the low plate voltage applied to the tube (45 V. maximum, although 22½ V. is sufficient in most cases) the plate current will never exceed 1 ma. and may be regulated by the filament rheostat which is included in the design of the unit.

The frequency range is from approximately 100 kc. to 1,500 kc., the higher frequencies being harmonics of fundamental frequencies in the tuning range of the coil and condenser. The coil used in the construction of this oscillator was from an I.F. transformer whose peak was 350 kc. (and from which the padding condensers were removed).

The value of the coupling condenser in the output (plate) circuit which connects to the receiver should be low. Approximately 50 mmf. will be sufficient for the average set, and 100 mmf. for old or insensitive receivers.

By tuning-in various broadcast stations on a standard receiver of good design, accurate frequencies are available, especially from crystal-controlled broadcast stations; these are used for calibrating the oscillator. The simplest procedure is to first plot an accurate calibration curve of the broadcast receiver. Such a curve is illustrated in Fig. 3. Frequency in kc. is plotted against tuning dial settings.

The first step is to disconnect the aerial from the broadcast receiver and connect the insulated output post of the oscillator to the aerial post of the receiver and connect the other post to the ground of the receiver. By switching on the oscillator, a series of harmonics may be heard by turning either the oscillator dial or the broadcast receiver dial. We are now prepared to make a very accurate set of calibration curves of the oscillator, after which the calibration can be further checked by heterodyning with crystal-controlled broadcast station waves.

The next step is to set the oscillator dial at its maximum or 150. Then tune in a harmonic of the oscillator at the highest dial setting heard on the broadcast receiver. Turn the volume-control of the oscillator until the harmonic signal is very weak and an accurate dial reading of the receiver is obtained. On this particular set, a harmonic was heard at 87 on the receiver dial. This indicated, from Fig. 3, a frequency of 593 kc.

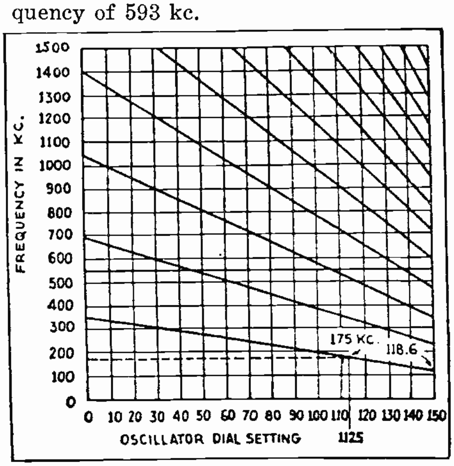


Fig. 2. The plotted calibration curves of the oscillator.

Now slowly decrease the tuning dial setting of the broadcast receiver (leaving the oscillator setting as it was) until another harmonic is heard. In this case one was heard at 70 on the receiver dial and from Fig. 3 indicated a frequency of 711.5 kc. The former figure subtracted from the latter, or 711.5 minus 93 equals 118.5. This is **the fundamental frequency of the oscillator because each harmonic differs from adjacent ones by an amount equal to the fundamental.**

We can check the accuracy by dividing 593 by 118.5, which gives 5 and a slight amount over indicating that our readings were not exact. Evidently we were working on the 5th and 6th harmonics. Dividing 593 by 5 gives 118.6 as the fundamental. Six times 118.6 would give a frequency of 711.6 for the 6th harmonic instead of 711.5, which was obtained from the curve.

Knowing that the fundamental frequency is 118.6 at the 150 degree setting of the oscillator dial, we can mark off on the calibration chart, Fig. 4, harmonics up to the 12th, spaced 118.6 kc. apart.

The same procedure can be carried out at the zero setting of the oscillator dial. In this case the frequencies worked out accurately at the first trial. A harmonic was tuned in at 72 on the tuner dial, indicating a frequency of

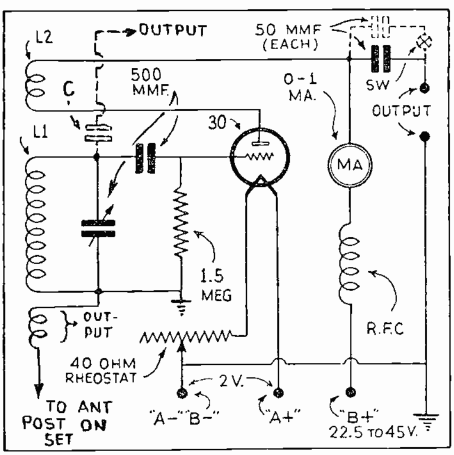


Fig. 1. The pick-up coil may consist of about 5 to 20 turns of bell wire wound around the ground end of L1; the "output" condenser, if used instead, may be adjustable between 10 and 100 mmf.

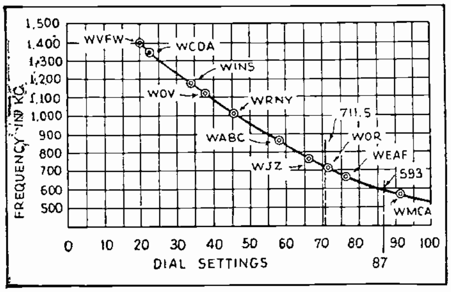


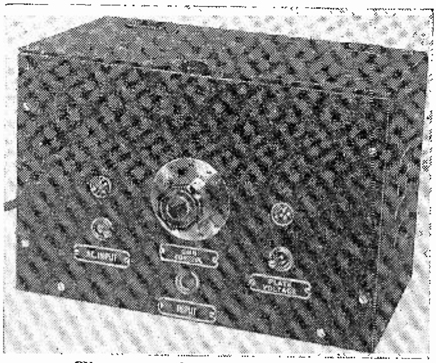
Fig. 3. Receiver tuning curve plotted on graph.

700 kc., and at 43, indicating a frequency of 1,050. The difference, 350 kc., is the fundamental frequency of the oscillator at this setting. The second, third and fourth harmonics are marked on the graph of Fig. 2. This procedure was carried out at every 10 degree setting of the oscillator dial. A series of curves, as shown on the chart of Fig. 2 were plotted. It was found that the curves were actually straight lines, due to the straight-line-frequency charac-teristic of the oscillator condenser.

To make an accurate check of the calibration curves of the oscillator, one of the side plates should be removed and a piece of wire connected across the grid condenser so as to short-circuit it. Then the side plate should be replaced. In this condition the oscillator will generate a non-modulated wave which can be used to heterodyne the wave of a crystal-controlled station tuned in on the receiver. When making this test a short indoor aerial, just sufficient to pick up the broadcast station, should be connected to the aerial post of the receiver. The oscillator is left connected to the receiver. By tuning-in a station as WOR at 710 kc., (the test was performed in New York City) the oscillator should cause a heterodyne squeal at 73, 112½, and 135½ (dial settings of the oscillator) working on the third, fourth and fifth harmonics respectively. Tune the oscillator dial for zero-beat adjustment and the calibration will be exact. Several stations may be tuned-in in this manner and slight corrections can then be made to the previous plotted curves if necessary, after which the short-circuiting wire connected across the grid condenser may be removed.

CHAPTER III

AUDIO EQUIPMENT



The complete preamplifier.

HOW TO MAKE A MICROPHONE PREAMPLIFIER

The metal tubes offer the advantages of compactness and good shielding, and so are used in preference to the glass type.

MANY P.A. systems are now in use which have been designed only with sufficient gain for carbon microphones. When the owner of one wishes to use the newer type "mikes," he is faced either with the prospect of extensive rebuilding or of purchasing a new high-gain amplifier.

The **preamplifier unit** here described is designed to have sufficient gain to allow the use of a "condenser head" (condenser-type microphone) with any amplifier which has sufficient gain to operate with a carbon microphone. It is compact and self-contained, and the output can be connected directly to the microphone transformer of the regular amplifier, or it can be fed into a 500-ohm line.

POWER SUPPLY

The power supply is built-in, and uses a type 25Z6 tube in a "voltage doubling" circuit. The series filament circuit employs a regulation line-cord resistor such as is used on many midget receivers. All the electrolytic filter condensers are of the 1-in. diameter type, so the total capacity used is very high, about 50 mf. The 2 filter chokes and the output transformer are housed in special cast alloy cases to minimize hum in the output.

A volume control is provided as a convenience. The arm connects to the grid of the 6C5, which is biased with the usual cathode resistor. The bias system of the 6F5 is quite different. Here, one of the new 1V. bias cells is used and proves very effective and simple. This cell in its holder, together with all other components in the input circuit, are mounted directly on the input terminal strip, which may be seen in Fig. B, attached to one end of the case.

As is usual with this type circuit, all components in the circuit are insulated

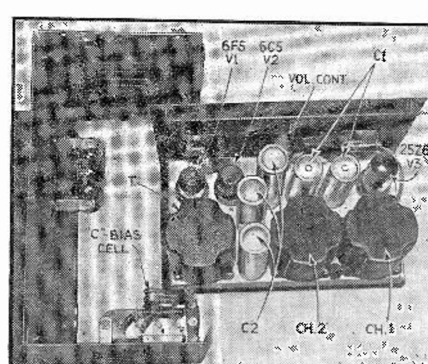


Fig. B. Inside view of instrument showing placement of parts.

from the chassis and metal case. Thus, even the electrolytic condensers **must** be insulated. The **only** connection to the chassis is the 0.25-mf. condenser between "B—" and the chassis.

There are 2 pilot lights, one burning whenever the heaters are lighted, and the other only when the high-voltage switch is operated. This second lamp is shorted by the same switch which opens the high-voltage lead. Since 3.2 V. bulbs are used, this slight change in total voltage cannot be noticed. Be certain the bulbs used are 3.2 V. and 0.3-A., as these can be used without a parallel resistor. The 10,000-ohm resistor which precedes the 2 filter chokes serves to drop the high voltage to about 150 V., which is sufficient for all needs, and which is as high as should be applied to most condenser mikes. The resistor also serves as additional filtering.

The microphone cable enters at the bottom of the front panel, while the output is at the upper rear of the case, although the arrangements may be changed to suit individual requirements.

CONSTRUCTION

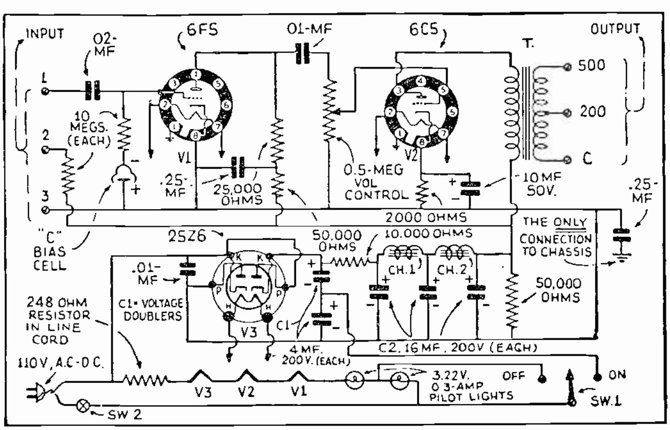
Construction of the unit is almost self-explanatory. The case comes knocked down, and is assembled with self-tapping metal screws. Since some constructors will wish to use parts that are on hand, other than those specified, no dimensions are given. However, the placement of parts should be followed as closely as possible to secure proper operation.

There are no adjustments needed, and after a careful check of all wiring, the power may be turned on and the performance tried out. The preliminary tests may be made with a pair of low-impedance headphones connected to the output transformer, or high-impedance phones used in series with 0.1-mf. condensers in each lead and connected directly across the primary of the output transformer. There should be no detectable hum in the phones with the volume control on full, and even a low-level condenser head should give a good loud signal.

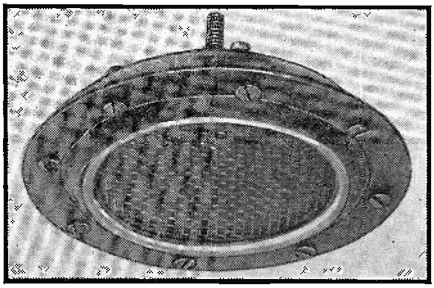
LIST OF PARTS

One National Union type 6F5 tube, V1;
One National Union type 6C5 tube, V2;
One National Union type 25Z6 tube, V3;
Three I.C.A. 8-prong sockets;
One I.C.A. steel cabinet 5x6x9 ins. long;
One I.C.A. S.P.S.T. toggle switch;
One I.C.A. S.P.D.T. toggle switch;
One I.C.A. dial plate with knob;
One I.C.A. 4-post terminal strip;
One I.C.A. 3-post terminal strip;
Five I.C.A. name plates;
One Electrad volume control, 0.5-meg;
One Aalloy output transformer (in case), T.;
Two Aalloy filter chokes in cases, Ch. 1, Ch. 2;
One Blan power cord, 248 ohms;
Two Blan pilot lamp sockets with 3.2 V., 0.3-A. bulbs;
Two Solar electrolytic condensers, 4 mf.;
Three Solar electrolytic condensers, 16 mf.;
Two Solar paper condensers, 0.25-mf.;
Two Solar mica condensers, .01-mf.;
One Solar electrolytic condenser, 10 mf., 50 V.;
*One "C"-bias cell with holder;
Two I.R.C. 10-meg. carbon resistors;
Two I.R.C. 50,000-ohm carbon resistors;
One I.R.C. 0.25-meg. carbon resistors;
One I.R.C. 2,000-ohm carbon resistors;
One I.R.C. 10,000-ohm carbon resistor.

(*Name of manufacturer will be sent upon request; kindly enclose a stamped and self-addressed envelope.)



The wiring is very simple. It should be remembered that there are extra unused contact prongs on most of the metal tube sockets and these may be used to advantage to support small condensers, resistors and the like.



HOW TO MAKE A CONDENSER MICROPHONE

Constructed from an old Kellogg hand microphone.

OUR basic unit, a Kellogg hand microphone, as first obtained, is a single-button, **stretched - diaphragm** type; the tension of the diaphragm being adjustable, thus makes it excellent for use as a condenser head. If we now suppose the reader has obtained one of these mikes, and is desirous of using it as a condenser mike, the following then are the necessary steps:

First, remove the 3 machine screws in the back-cover. This permits the cover and handle to be removed and the cord to be unsoldered. Now, put the mike in a vise, with the mouthpiece down, and punch out the 8 rivets around the flange; take care to cut only the rivets. Next, grasp the mike by its flange and front cover, turn the mouthpiece upward, and carefully remove the front-cover; take care not to injure either the diaphragm or its 2 gaskets, as these later will be needed. It is now possible to empty the carbon cup of its granules. Keep the cup but discard the carbon disc (since it is of no further use).

Next, remove the 3 rivets in the front-cover; this permits the screen and mouthpiece to be removed. Cut away all excess metal. Now, the opening in the front-cover should measure 1 11/16 ins. Care should be taken, not to cut away too much metal, since the protecting screen must be soldered to the back of the remaining shoulder metal.

After this, ream the holes in the front-cover until they will take size 6-32 machine screws. Tap to size 6-32, corresponding holes in the rear flange. Tap the carbon cup to take a 6-32 machine screw, replace the cup in its proper place, and tighten the set-screw.

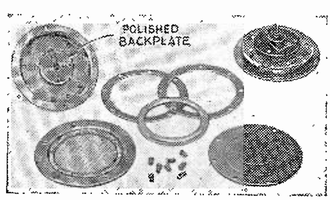
The next move is to obtain a steel washer, 1 in. in dia., by 1/16 in. thick. Countersink the center hole and tap it for a 6-32 flathead machine screw, 1¼ ins. long. Mark off the resulting plate evenly, and drill 20 or 25 1/32-in. holes through it, as shown at upper-left.

Polish this "back plate" by using fine sandpaper, or emery dust and oil on glass. Important—use a **circular motion in order to keep the plate as flat as possible.** Thread this backplate into the carbon cup (previously threaded for this purpose).

Next, enlarge the 8 holes in the diaphragm and gaskets sufficiently to pass the 6-32 machine screws. Then, replace the **tension ring** (for stretching the diaphragm) that fits on the 6 screws in the back chamber; and the gaskets, diaphragm, and front-cover. Draw up the screws evenly.

A CRITICAL ADJUSTMENT

You are now ready to make the necessary adjustments. First, tighten the 6 screws that stretch the diaphragm. Next, adjust the backplate by turning the 1¼ in. machine screw that was placed on this plate and threaded through the carbon cup. This stage of the adjustment is **critical**, as the space between the diaphragm and the backplate should be .005-in. When this distance is attained (as indicated by maximum sensitivity and tone quality), a 6-32 lock nut may be run up on the set-screw in order to make the adjustment permanent.



All parts necessary to build the condenser mike.

HOW TO MAKE A VELOCITY MICROPHONE

YOU will require two motorcycle-magneto magnets. These may be obtained from an automobile wrecker's store; they should measure 4½ ins. long, and 3 ins. wide, and they should be an exact fit when placed end-to-end. Each magnet should be provided with one or two holes through the end of each pole-piece. You will also require two pieces of soft-iron bar, 5 ins. long and 1 in. x ½-in. These bars are the 2 pole-pieces which fit inside when the magnets are laid end-to-end. They should leave a gap of approximately ¼-in. It is in this gap that the ribbon is suspended.

Place the magnets end-to-end, like poles together (opposing); place the bars in position and mark the places where holes must be drilled and tapped for the retaining bolts. Referring to the diagram, the two end ribbon supports are of shellacked wood and are fastened to the pole-pieces by means of "aluminum cement"—the kind that is sold in tubes.

HOW TO MAKE THE RIBBON

For excellent results one cannot do better than to use tinfoil of the kind that is brittle and thin. It can be obtained from cigarette-packing in the small boxes. Care should be taken in smoothing it out; avoid wrinkling or putting cuts in it through creasing. Determine the maximum permissible width of your ribbon, allowing about 1/16-in. clearance between the pole-pieces; use a stiff piece of cardboard for a straight-edge and cut the foil with a keen safety-razor blade. The result should be a ribbon not over ¼-in. wide, and about 6 ins. long—allowing for the succeeding steps of crimping and fitting. To obtain the necessary corrugations in the ribbon, which makes the device non-resonant, run the ribbon in a straight line through a small pair of gearwheels (Meccano gears will do nicely).

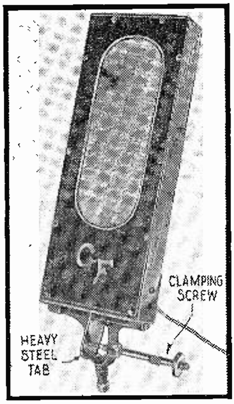


Fig. A. Right. The appearance of the complete velocity microphone with its "line" transformer all mounted in a neat case are readily seen.

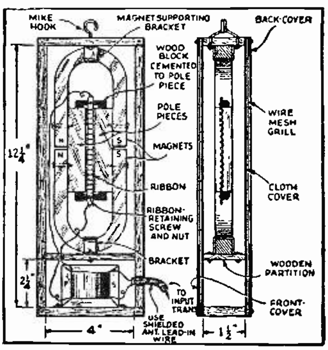
Use small brass screws for fastening the ribbon in the air gap. Fasten one end first, then, with a pair of tweezers, draw the other end to the anchoring screw-hole and fasten it firmly. There should be very little tension on the ribbon when in place. It should move freely when you blow on it gently.

Mount the completed mike in a case, such as the one shown. In the openings at the front and back of the microphone-case, use only copper screen, and place one or two layers of cotton mesh between each screen and the case.

RIBBON TO MIKE TRANSFORMER

A mike transformer, from the ribbon to the preamplifier is best for proper matching and maximum transfer of energy.

Get any good-quality core from an A.F. transformer (the better ones have thin laminations) and wind 60 turns of No. 22 enameled wire for the primary, tapping at 30, 40, 50 and 60 turns. For the secondary, wind 390 turns of No. 30 enameled wire. When your mike is assembled, test for best response and volume using the different taps to the ribbon side of the mike.



The parts which make up the microphone are all labeled for the convenience of the constructor. Note particularly that the fixed magnets are placed with "like poles" together.

METAL TUBES in a HIGH-FIDELITY AMPLIFIER

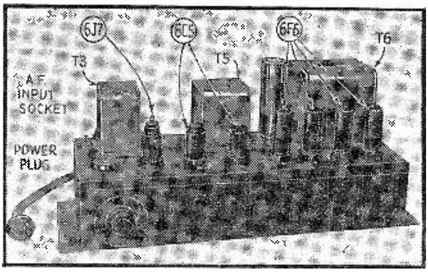


Fig. A. The amplifier showing placement of parts.

TO those of us who have watched the progress of radio from its inception, the forward movement of the industry to produce at a reasonable cost, practical high-fidelity amplifiers has proven a most difficult feat. The new metal tubes, however, have removed some of the most stubborn difficulties in the way of producing an A.F. amplifier with high-quality output, adequate for either a P.A. system or the audio output system of a fine radio set.

These difficulties all boil down to four: (1), gain; (2), hum; (3), fidelity; and (4), power-capacity. It has been unfortunate that most of our tubes with fairly high gain were not of the separate-cathode type, so that they tended to introduce hum, or else they failed to provide enough output to swing the grids of a final push-pull output stage wide enough. The **metal tubes provide everything needed.**

The general details of the amplifier circuit are standard. However, there are a number of features which are new and of interest. After careful consideration of all the metal tubes available, the following tubes were finally chosen as being the cream of the crop and also the most suitable for this type of amplifier. One 6J7, two 6C5s, two or four 6F6s, and three 5Z4 rectifying tubes.

The amplifier, Figs. A and 1, consist of three stages of transformer coupled amplification. The output stage uses four 6F6 tubes connected in a push-pull parallel arrangement that will deliver an output of 40 W. with only 5 per cent harmonic distortion present. For those who do not require this amount of power, two of the 6F6 tubes may be omitted, thus making the output stage straight push-pull. This will provide an output of 20 W. The only difference between the 40 and 20 W. amplifiers are the power and the output transformers.

As noted in Fig. 1, the 6F6 tubes are connected as triodes in class A prime. This provides high A.F. power and low distortion. The static plate current is only 20 ma. per tube, but when it is driven, it increases to almost 55 ma. This is a factor in the economical side of class A prime operation. It means that the average plate power is half that which would be taken by an equivalent straight class A amplifier. This economy is not obtained at the expense of fidelity. The fine quality delivered is due almost entirely to the transformers used.

The unusual simplicity of construction and wiring is apparent at a glance. The input transformer has primary terminations to match a universal line. This transformer is coupled to the grid of a 6J7 tube triode connected. The 6J7 tube has the unusual good amplification factor of 22 and is non-microphonic. This tube is again transformer coupled to the 6C5s. The input transformer from the 6C5s to the 6F6s is of a special type designed specifically for the purpose. The output transformer is also critical and should be the exact impedance to match the tubes. This transformer is quite a husky affair and will handle the entire output without saturation. Output is provided for 4, 8, 16 and 500 ohms.

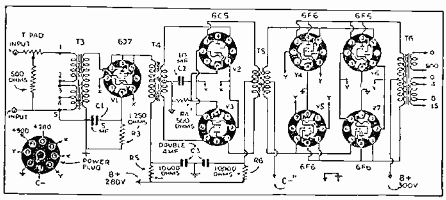


Fig. 1. Schematic diagram of the amplifier.

It is, of course, necessary to have a power supply with good regulation because of the difference of plate current at no-signal and full output. See Figs. B and 2. This also explains why self-biasing is not used. The power supply has been especially designed to take care of this requirement. The internal resistance of the plate supply is quite low and the D.C. regulation does not exceed 10 per cent. The resistance of the grid supply for the 6F6s is essentially zero, since fixed bias is used. Bias voltage is obtained through a separate rectifier system using a 5Z4 rectifier in a half-wave circuit.

The amplifier is extremely flexible, both electrically and mechanically. By placing the A.F. amplifier and the power supply on separate chassis, the possibility of hum pick-up is made negligible. It can be used for rack or table mounting.

It is a difficult proposition to find a suitable volume control that will not introduce distortion. In fact, it is really impossible, without resorting to a "pad." The T pad as shown in the diagram is a 500-ohm unit. If a mixer circuit is required it may be connected as shown in Fig 3 A and B. Care should be exercised in the choice of the T pads. They should be of the tap switch variety, utilizing self-cleaning contacts that are noiseless in operation, furthermore they should be non-inductive, low capacity and wire-wound. In operation, the T pads used safely carry 8 W. of signal energy.

Tonal control is just as necessary in high-fidelity systems as in any other amplifier. The need for tone correction is to compensate for defects in the original program or record fidelity and for the wide range of acoustic conditions that are encountered in various locations. For tone compensation, the reader is referred to the article "High Fidelity by Equalization," *Radio-Craft*, Jun, 1935.

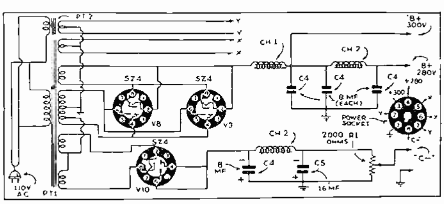


Fig. 2. Schematic circuit of power supply.

To feed an R.F. tuner to this amplifier it is suggested that this be accomplished through the use of a suitable plate-to-line transformer and the volume can then be controlled with the T pad as shown.

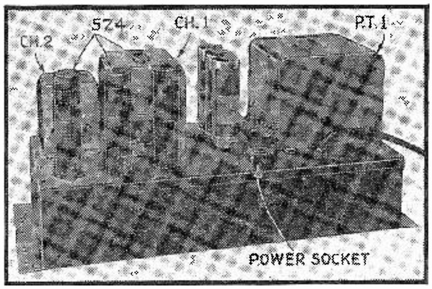


Fig. B. Power supply showing placement of parts.

LIST OF PARTS

*One transformer, T1;
*One transformer, T2;
*One transformer, T3;
*One transformer, T4;
*One transformer, T5;
*One transformer, T6;
*One choke, CH1;
*One choke, CH2;
One Electrad transformer pad, type 8AT500, T;
One Electrad resistor, 2,000 ohms, type B20, R1;
One Electrad resistor, 1,250 ohms, type 1G1250, R3;
One Electrad resistor, 500 ohms, type IG500, R4;
Two I.R.C. resistors, 10,000 ohms, R5, R6;
One Aerovox condenser, 5 mf., type MM25, C1;
One Aerovox condenser, 10 mf. type MM25, C2;
One Aerovox condenser, double 4 mf., type GG5, C3;
One Aerovox condenser, 8 mf., type 15-525, C4;
One Aerovox condenser, 16 mf., type PB2-200, C5;
*Two drilled chassis;
Ten Blan metal tube sockets;
One Blan off-on line switch;
One kit of RCA, Raytheon, or Sylvania metal tubes.
(*Names of manufacturers upon request.)

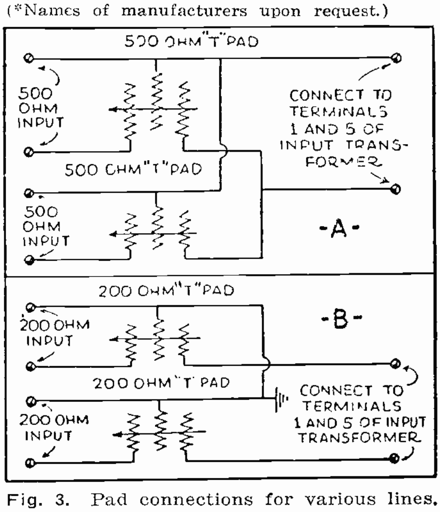
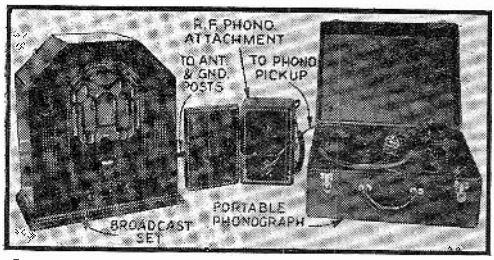


Fig. 3. Pad connections for various lines.



The phono attachment ready for use.

HOW TO MAKE A R. F. PHONOGRAPH and PUBLIC ADDRESS ATTACHMENT

WITH this little device you can, in a moment, take any phonograph record and reproduce it **electrically** through your regular radio receiver—**without touching the interior of the set or using any type of "adapters"** and by adding a microphone transformer and a carbon mike, any broadcast receiver can be converted into a public address system.

To use the portable R.F. phonograph attachment, first remove the antenna wire from its binding post on the broadcast set, and permit the wire to lie unused. Next, connect a wire from "ANT" of the attachment to the antenna post of the broadcast set; and another wire from the "GND" post of the attachment to the ground post of the set (the latter, in addition to the regular ground wire, which is permitted to remain on the ground post of the radio set).

Finally, connect a phonograph pickup (or a microphone transformer, if a microphone is to be used) to the attachment terminals marked PICKUP; start the motor of the phonograph with which the pickup is to be used; and then tune the broadcast set until the phonograph program is heard.

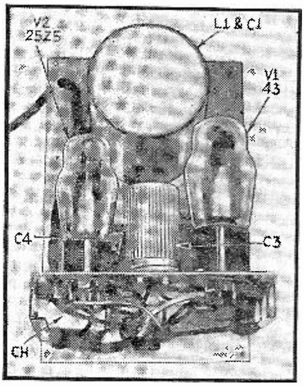
If there is available only a phonograph not equipped with a phonograph pickup, this unit must be provided. By selecting a slightly larger carrying case a phonograph pickup could be carried along with the "attachment," and used as necessary.

The reader will not be bored with a lengthy description of **why** the circuit works. Instead, only a short, general description will be given.

Although the ways in which circuit oscillation may be obtained are legion, the circuit utilized in our R.F. phonograph attachment is one of the most simple and, for our purpose, efficient. In this instrument the plate of the oscillator-mixer pentode, tube V1, is connected to one end of an R.F. circuit comprising variable condenser C1, and center-tapped secondary S. of coil L1; the screen-grid of V1 is connected to the other end of this circuit (which is resonant in the broadcast band). The center-tap on L1 is connected to the maximum available voltage supply. Upon grounding the control-grid of V1, as shown (only for the purpose of this discussion) dotted, at X, circuit oscillation is obtained; the R.F. output may be taken off by means of a pick-up coil (primary P. of L1), and fed to the antenna and ground connections of any radio set, producing a whistle when the set is tuned to a broadcast station within the operating range of the attachment. Vary the value of R1 for minimum hum.

However, unless the broadcast set is tuned to a broadcast station, neither the whistle or anything else can be heard. It now remains to merely "modulate" this R.F. output, in some manner, at audio frequency, and our R.F. phonograph attachment will be complete and functioning as a miniature home broadcast station.

Audio modulation is conveniently accomplished by breaking the control-grid



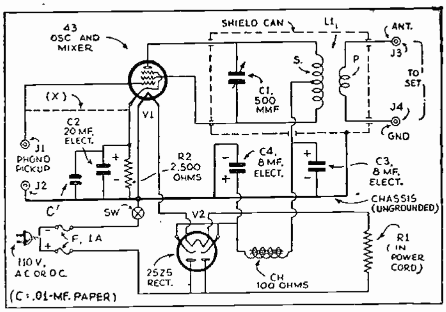
Rear view of phono attachment showing placement of components. Note the oscillator coil shield.

lead of the 43 and inserting a phonograph pickup into the circuit, at connections J1 and J2. The plate and screen-grid currents must pass through resistor R2 and in so doing establish across its terminals a voltage which becomes the "C" bias for the tube. Condenser C2 bypasses the R.F. and A.F. around the grid bias resistor unit R2, thus eliminating its tendency to reduce the A.F. modulated R.F. output of the tube; C3 acts as both a power supply filter condenser, and power supply R.F. bypass; C4 eliminates hum when the attachment is operated on A.C. power lines. We now have a miniature radio transmitter functioning full-blast—it only remains to utilize the signal.

A convenient manner of utilizing the "signal" is to run leads from the primary winding P., located at the center of the secondary of L1, to the antenna and ground posts of any radio set. As most broadcast receivers are more sensitive at the lower end of the wavelength range, this attachment was designed to be operated within approximately the first one-third section of the tuning range. Just tune the broadcast set to a "dead" point on the scale, within this range, at which a broadcast station cannot be heard, and then adjust the setting of C1 on the R.F. phonograph attachment until the phonograph program can be heard. Finally, adjust the volume control on the phonograph pickup for optimum volume and maximum tone quality, and the volume control on the radio set for the desired output volume.

A direct ground connection to the chassis must not be made since, in the reversed position of the line plug, the power line would be shorted, on D.C. power circuits.

To secure operation on A.C. power lines a rectifier is required to furnish the necessary D.C. for the plate and screen-grid of V1. A type 25Z5 tube, V2, was selected for several reasons. First, it has a 25 V. filament and, in conjunction with V1, a tube that has a 30 V. filament, accounts for 55V., which requires the filament limiting resistor R1 to "absorb" only 60 V.. thus the power cord heats to the minimum degree. Second, although this tube is of the high-vacuum type, it has a very low



Schematic diagram of phono attachment.

internal resistance and therefore will deliver to the 43 much more current than would other type tubes.

A special filter choke, designed for A.C.-D.C. sets and having a resistance of only 100 ohms, is used as "Ch." in order to obtain maximum voltage on D.C. power supplies.

If the chassis of the attachment is grounded accidentally in the reversed position of the line plug, fuses F. inside the line plug, will act as safety devices.

Almost any center-tapped R.F. broadcast coil having a centrally-located primary may be used. The authors' coil was made by winding 100 T., center-tapped, of No. 28 wire on a tube 2½ x 1½ ins. in dia., for the secondary; the primary was made by winding 25 T. of No. 32 wire over a layer of empire cloth at the center of the secondary.

LIST OF PARTS

One specially-wound antenna coil (see text), L1;
One variodenser, 500 mmf., C1;
One Tobe Deutschmann electrolytic condenser, 20 mf., 35 V., C2;
One Concourse high-temperature electrolytic condenser, 8 mf. (or two 4 mf. units, to save space), 500 V., C3;
One Concourse electrolytic condenser, 8 mf., 500 V., C4;
One General Transformer Corp. special A.C.-D.C. choke, 100 ohms, Ch.;
One Blan power cord (to drop 60 V.), R1;
One I.R.C. resistor, 2,500 ohms, 2 W., R2;
One RCA Radiotron, Sylvania or National Union pentode, type 43, V1;
One RCA Radiotron, Sylvania or National Union rectifier, type 25Z5, V2;
Two Na-Ald 6 prong sockets, for V1, V2;
One Blan power switch, Sw.;
One fused power plug;
Two fuses, 1. A., F;
Four insulated tip jacks, J1 to J4;
One Blan aluminum panel, 5½ x 8½ x 1/16-in. thick;
One Blan aluminum base, 4 x 5½ x 1/16-in. thick;
One Blan aluminum shield can (for coil);
One pair sub-panel brackets, cut to fit;
One carrying case, 5½ x 8½ x 5½ ins. deep (inside dimensions);

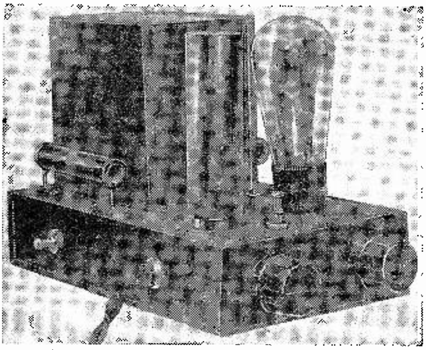


Fig. A. The complete field supply.

HOW TO MAKE A SPEAKER FIELD SUPPLY

Hundreds of radio men will be greatly interested in this practical construction article on a "field coil exciter."

IN its finished form this unit, illustrated in Fig. A, will furnish field excitation to three 1000-ohm speaker fields, or six 2,500-ohm fields; it is also adaptable to many odd values of field-coil resistance and current drain. In addition, when it is not performing its regular job it may be used as a source of rectified A.C. (needing only a filter to allow it to be used as a power supply for experimental equipment, or what-have-you).

In order to fulfill the requirement for economy the parts on hand were examined to see if any were suitable. This search brought to light a power transformer, delivering some 300 V. each side of the center-tap, as well as various filament voltages, and an 8 mf. electrolytic condenser. Using these two units as a starter the basic circuit was developed as in Fig. 1A. This necessitated the additional purchase of one 1,000-ohm resistor which amounted to some 29c. (This need only be of the 15-20 W. variety since it will only dissipate 10 W., as will be shown.)

The basic circuit of Fig. 1 consists merely of the transformer feeding into a full-wave rectifier circuit, the condenser for a filter, and the two fields and the resistor in series for the load. As the two fields each require a potential of 100 V. at 100 ma. for excitation, the two fields in series will provide a voltage drop of 200 V. when that current is flowing. Since, by Ohm's law, the total resistance to provide a voltage drop of 300 V. with 100 ma. current is 3,000 ohms, resistor R1 becomes 1,000 ohms to provide the remaining drop of 100 V.

This circuit proved to be very satisfactory in use so it was decided to build the unit in such a way that one, two, or three fields could be accommodated by switching. Fig. 1B shows the circuit arrangement used for this. To place a field other than the first one in the circuit it is only necessary to open the switch connecting the corresponding resistor into the circuit and plug in the field desired.

If it is desired to use 2,500-ohm fields instead, the series resistors would have a value of 2,500 ohms each and the fields would be excited by 100 V. at 40 ma. This means, assuming that the same transformer with a current capacity of at least 100 ma. (more for 1,000-ohm fields, to provide a safety factor) is used, that another series group of three may be excited by connecting the second group in parallel with the first.

By disconnecting the fields and resistors and using a filter, a power supply for experimental use is formed. See Fig. 1C for details and added connections.

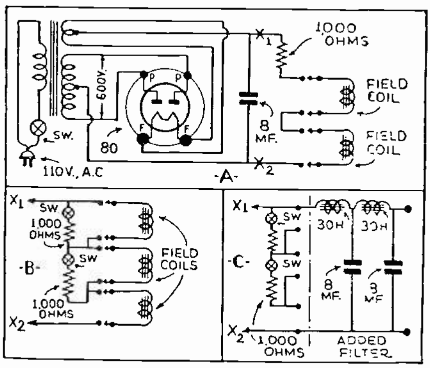
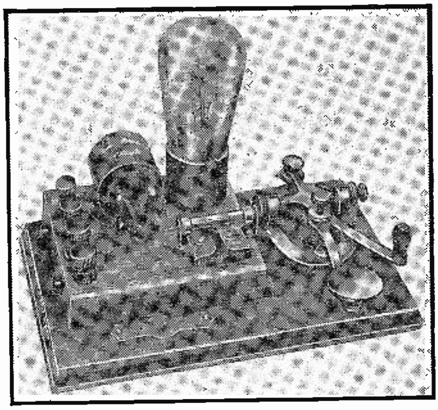


Fig. 1. Schematic diagrams of the circuits used in this practical field supply.

CHAPTER IV
GENERAL INTEREST ARTICLES

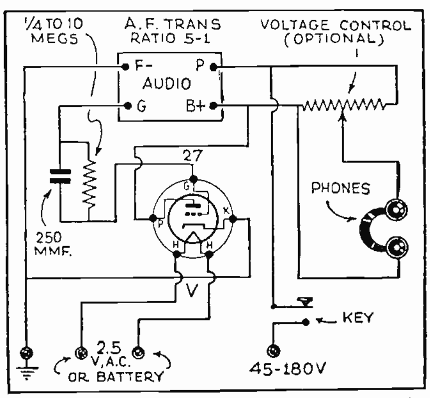
HOW TO MAKE A VARIABLE TONE CODE PRACTICE SET



THIS code practice oscillator is designed for the beginner or even the licensed ham. It can be made into a very compact job, having a variable tone which can be controlled by the variable grid resistor. If one likes to copy a high-pitched note it can be so adjusted; or a low tone can be obtained or any pleasing tone the operator wishes to copy.

If one doesn't have a variable grid-leak, the tone can be varied by using a variable grid condenser instead of a fixed condenser. In this case a fixed grid-leak should be used, ranging anywhere from three to ten megohms. The variable condenser should be about 250 mmf. maximum.

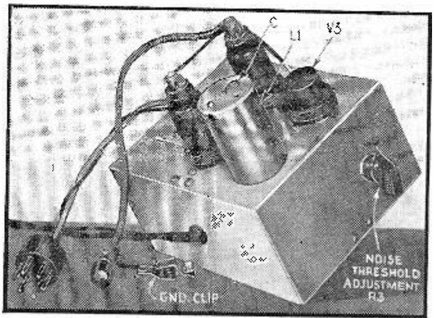
Either one of these arrangements can be used depending on what parts the builder has or if he wants a compact job.



Schematic diagram of the code practice set.

This all-A.C. oscillator was designed for beginners unable to buy expensive batteries. One can purchase an old "B" box at a reasonable price and filament transformers can also be obtained very cheaply, or if one has a small receiver the "A" and "B" supply can be tapped from its powerpack ("B—" connects to ground).

The oscillator in the picture is made on a 3½-in. x 4-in. aluminum pan ¾-in. deep. The binding posts on the end are for power-supply taps. The two small ones are for the filament supply, and the two large ones for the positive and negative "B" supply. The audio transformer is of the midget type with a ratio of 1-to-5, but almost any old transformer will work. The variable grid-leak has a range varying from ¼ to 10 megohms and the grid condenser has a capacity of about 250 mmf. The tube used is a type 27. (Note—A 27 with poor filament emission will operate much more satisfactorily than a new tube, so any old tube will do that isn't shorted.) This oscillator will give a pure D.C. signal.



Appearance of noise silencer unit (Photo-"QST")

EFFECTIVE NOISE SILENCER

A new, clever, yet very simple device that really cuts out man-made static, ignition noises, dial telephone clicks, and interference from motors such as oil burners, vacuum cleaners and fans.

THE following circuit—reproduced by special permission of *QST Publishing Co.*—was developed by J. J. Lamb of *QST* magazine. This is one of the most successful methods so far developed for eliminating man-made static, ignition noises, dial telephone clicks, and interference from motors such as oil burners, vacuum cleaners and the like. While it does not entirely cut out the interference, it does, nevertheless, cut it down to such an extent as to make hitherto unintelligible reception clear, clean and enjoyable.

The action of the **noise-silencer** is to cut off the receiver momentarily during the peaks, so that they never reach the detector tube. Thus, there are periods of silence lasting about one-thousandths of a second and recurring with the frequency of the noise. These silent periods are actually not heard by the ears. The simple analogy of motion pictures will clarify this. Although "movies" consist of 16 different pictures flashed separately on the screen every second, we see one continuous moving picture. This is the persistence or lag of vision. Similarly, in the noise silencer, we do not notice these periods of silence but hear a continuous unbroken signal.

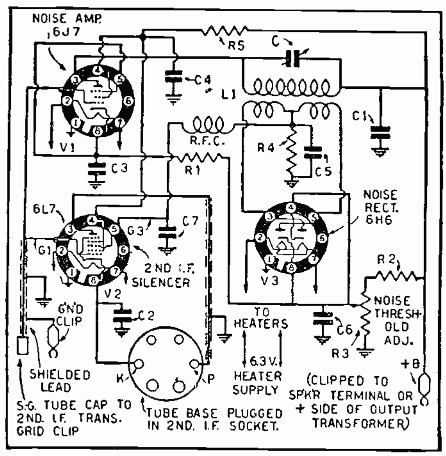
The circuit devised by Mr. Lamb amplifies at radio frequency the noise wave peaks extending above the desired signal amplitude, then rectifies them and uses the rectified voltage to control a subsequent radio frequency stage, automatically and instantaneously.

The desired signal and the noise signal are both applied to the grid of the 6L7. The signal is amplified and passed on to the succeeding stages. At the same time, however, it is also applied to the 6J7. It is amplified here and passed on to the 6H6 plates. If the noise is of sufficient intensity, it is rectified and a corresponding negative bias applied back to the 6L7, cutting off this tube during the noise peaks. The amplifying and silencing action occurs simultaneously and instantaneously, so that the set cuts off on every undesirable noise properly.

The unit illustrated may be plugged into an existing receiver or it may be built into a new one. In the latter case the clips and plug naturally will be omitted.

LIST OF ESSENTIAL PARTS

C1, 0.01-mf., 400 V.;
C2, 0.1-mf., 200 V.;
C3, 0.1-mf., 200 V.;
C4, 0.1-mf., 400 V.;
C5, 250 mmf., midget mica;
C6, 0.1-mf., 200 V.;
C7, 50 mmf., midget mica;
R1, 600 ohms, ½-W.;
R2, 20,000 ohms, 1 W.;
R3, 5,000 ohm potentiometer;
R4, 0.1-meg., ½-W.;
R5, 0.1-meg., ½-W.;
L1, diode-type I.F. transformer;
RFC, 20 mh. R.F. choke.



Schematic diagram of the noise silencer unit.

HOW TO MAKE AN A.C.-D.C. 1-TUBE "DEAF AID"

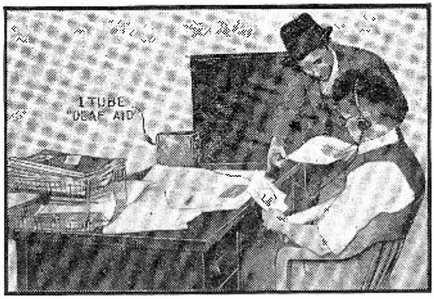


Fig. A. Deaf Aid in use.

AFTER a careful study of the equipment requirements for such service, this 1-tube amplifier "deaf aid" was designed which enables even very deaf people to hear just as distinctly as those possessed with the finest hearing.

Fundamentally the device is a 1-tube A.F. amplifier utilizing the type 12A7 dual-purpose tube in conjunction with a microphone and headphone. The refinements of the completed design warrant the following detailed description.

Inasmuch as this unit will be used only indoors—often in the manner shown in the heading illustration—there is no pressing need for portability. Nevertheless, the unit described is quite compact. May we offer a suggestion—use the specified parts for best results, inasmuch as each one has been selected for a specific reason. (There is to be considered, for instance, the "rising frequency characteristic" essential in deaf-aids for the average person.) The circuit is shown in Fig. 1; Figs. A and B show, respectively, the set in use and inside top view.

Following the circuit from input to output, we have first the microphone. This is a sensitive, high-grade, single-button type, **made especially for this type of work.** Input transformer T1 delivers a relatively large input to the tube grid.

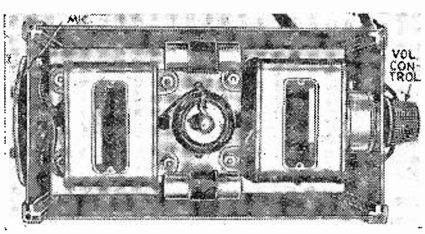


Fig. B. Inside top view.

Output transformer T2 offers impedance of 50, 200, 500 ohms, and a number of combinations that may be used simultaneously to operate one or several headphones. (This feature makes this device adaptable to either individual or multi-aid use.)

The single headphone used—and known as "featherweight" on account of its extreme lightness—when used as an individual unit has an impedance of about 500 ohms; when used as a multi-unit in a church or theatre the impedance value required will depend upon the number of phones desired.

LIST OF PARTS

Two Aerovox condensers, 25 mf., type P.R. 50, C1, C2;
Two Aerovox condensers, 8 mf., type B.P. 2, C3;
One Aerovox condenser, 0.5-mf., type 1140; C4;
*One microphone, type A-sensitive, M;
One Electrad volume control, type 205, R2;
One Kenyon transformer, type BLG, T1;
One Kenyon transformer, type BPL, T2;
One Kenyon choke, type KC-200, Ch. 1;
One Kenyon choke, type KOC, Ch. 2;
One I.R.C. metallized resistor 1,500 ohms, ½-W., R1;
One I.R.C. metallized resistor, 5,000 ohms, 1. W., R4;
*One line cord resistor, 322 ohms, R3;
*One drilled chassis and aluminum case;
*One single-pole power switch; Sw.;
*One single headphone; 500 ohms impedance;
One Sylvania, Ken-Rad or National Union type 12A7 tube, V;
One 7-prong socket (for tube V).

*Names of manufacturers sent upon request.

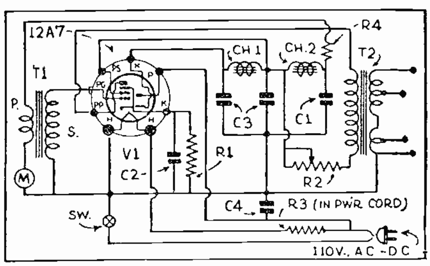
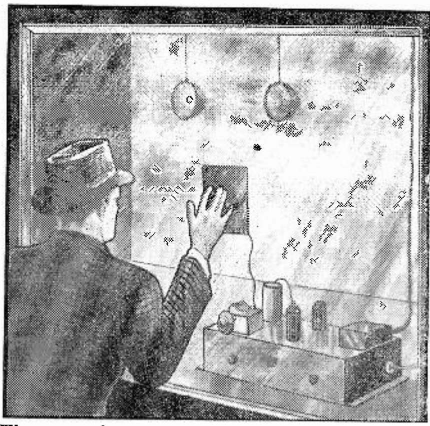


Fig. 1. Schematic diagram of circuit.



The completed electronic relay system in operation. A movement of the hand controls the window lights.

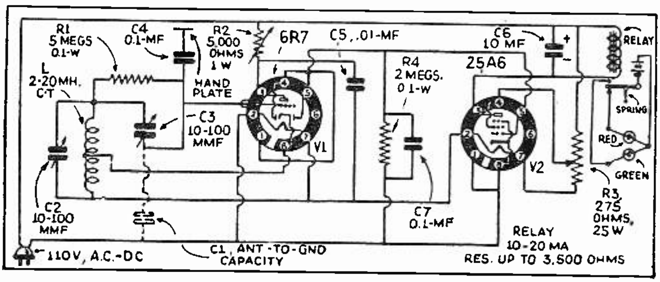
AN A.C. - D.C. ELECTRONIC RELAY

Radio dealers and Service Men will find this simple circuit an exceptionally fine way to attract customers to their store windows. Very effective displays can be made.

HERE is an inexpensive piece of electrical magic that will draw a crowd to a radio dealer's show window. It enables people on the street to turn on an array of light or an electric fan, or to start a toy electric train in the show window, merely by placing a hand close to the window glass.

The circuit (which was designed by Mr. F. G. Shepard, Jr., of **RCA Manufacturing Company**) is shown in the diagram. It operates on the change in output of an oscillator, caused by a change in the oscillator's feedback capacity when a prospective customer puts his hand near an "antenna," or capacity plate, in the window. The triode section of V1 is the oscillator. Feedback depends on the capacity, represented by C1 in the diagram, between the antenna and ground. If a hand is brought close to the antenna, capacity C1 is increased and the output of the oscillator falls. The diode section of V1 rectifies the 6R7's triode-section oscillator's output and applies to the control grid of V2 a D.C. voltage, the magnitude of which depends on the strength of oscillations. When the oscillations are at full strength a negative bias is applied to the control-grid of V2, which makes the plate current of V2 fall. When someone in front of the window places a hand close to the antenna, the output of the oscillator is diminished and the voltage applied to the control-grid of V2 is less negative, thus raising the plate current of V2 sufficiently to operate the relay.

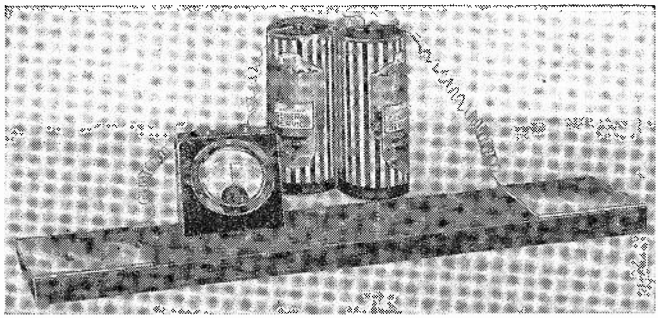
The sensitivity of the circuit, that is, the distance between hand and antenna at which the relay operates, is controlled by adjustment of C3 and R2. The maximum plate current of V2 is adjusted to a value sufficient to close the relay by adjustment of R3. The oscillator coil can be a commercial type of 8-mhy. center-tapped R.F. choke. This coil should be mounted close to the 6R7 socket so that leads can be short. It will be seen that since the circuit operates directly from a 110-V. line, no power pack is necessary. However, because of the direct connection to the line, the whole circuit, except the antenna and antenna-lead, should be enclosed in a box so that there is no danger of shock or of shorting the power line to ground.



The schematic circuit of the oscillator and relay. Resistor R2 controls the sensitivity of the device. Two new metal-tube types are incorporated in this useful device.

A "RADIO LIE DETECTOR"

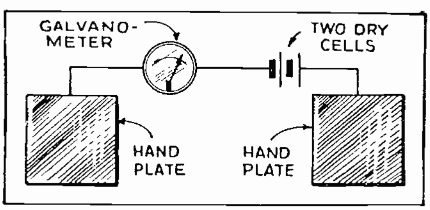
The ohmmeter, known to every experimenter and radio man, finds a new and novel application.



THE "lie detector" here illustrated and described is used at Cortland Normal School (Cortland, New York), for personal interest rather than its academic electrical value. This makes it desirable that there should be no confusing electrical parts. Even though it has been reduced to a minimum of equipment it is amazingly effective in detecting trivial lies. Aside from its use in the Normal School it has excited great interest at several private parties.

In principle, the lie detector is a "psycho-galvanometer":—that is, it indicates the electrical resistance of the subject's body. This resistance changes in response to emotions, and is beyond the control of the mind. The emotion involved in telling a lie lowers the body resistance, while emotional relief raises it.

The lit detector itself is merely a series circuit involving two dry cells, a moderately sensitive galvanometer, and the body of the subject. (This is similar to the ohmmeters used by many experimenters and Service Men.) Modifications and improvements will suggest themselves to every reader. Contact with the subject is established through two metal plates, about 4 ins. square, upon which he (or she) places the palms of his (or her) hands.

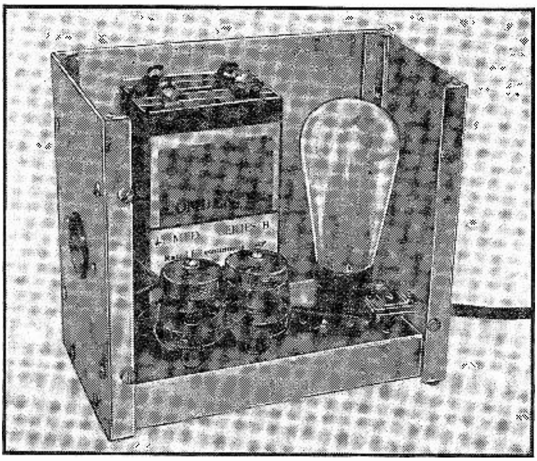


The circuit of the simple galvanometer (milliammeter) and battery is shown here. The appearance of the unit is shown in the photo.

In practice, when the subject places his hands on the metal squares, the galvanometer will read about 20 divisions on a scale of 30. A slight rise in the reading, even a quarter-point, will indicate the mental activity usually associated with the telling of a lie. Lowering of the reading indicates relief after the lie has been told, or that the question asked did not call for a lie in answer.

Two situations involving lies are easy to set up. In one case the subject is seated at the detector, and requested to pick out one of five cards. The operator is not told which card has been chosen. The operator now shows the cards to the subject one at a time, asking, "Is this the one?", for each of the cards. The subject answers "No" for all of them, thus making only one lie to detect. The operator watches the galvanometer for signs of emotion or relief. With small, serious groups of observers this device will detect nearly all of such lies!

The other situation takes the form of a game similar to "Forfeits." The subject chooses some object in the room. He must watch while some person hunts for the object, but remains silent during the whole search. The operator keeps the searcher posted by calling "warm" for the slightest rise in the galvanometer reading, and "cold!" for the slightest fall. The object is usually easily located if the person hunting for it explores the room rapidly and thoroughly.



A TUNED ALL-WAVE LINE NOISE ELIMINATOR

Line noise filters are an essential item with all-wave receivers, particularly for eliminating noise on short-wave stations that many times seeps in through the power line.

THE methods used to alleviate noise pick-up, especially for short-wave reception, have been confined mostly to antenna systems. The popular doublet, with transposed lead-in when properly installed is very effective in reducing noise pick-up by way of the aerial and is one of the outstanding achievements in this field. There are, however, two other ways of noise entering the receiver. They are:

(1) Tubes, wiring and any portion of the receiver that is not shielded.

(2) The power supply source.

As shielding is part of the receiver design, it is often very difficult to make any changes. The easiest method to increase the effective shielding efficiency is to enclose the entire receiver in a grounded metal box.

The power supply line is often more effective in transferring interference to the receiver than an aerial in the noisiest of locations. Most of this noise is produced by manmade static from motors, generators, sparking and kindred other devices. Some of this inter ference is radiated, but the larger portion is fed back directly to the power line and is often carried for miles. The easiest way of eliminating this type of interference is at the source, but this is often impractical to accomplish, and the alternative is to prevent it from entering the receiver.

Another trouble arising from the power line is voltage fluctuations, which may overload resistors and result in internal noise from expansion and contraction of these parts.

The common line filter, consisting of two chokes, bypassed with condensers, used very successfully for the ordinary broadcast receiver, was found to be totally inadequate when used with short-wave receivers.

After a number of experiments it was determined that by using a tuned resonant trap the noise could be quite effectively eliminated. The circuit shown in Fig. 1A makes an ideal filter for the short-wave regenerative set, but is not recommended for the superheterodyne. Chokes L1 are heavy commercial wound coils made especially for this purpose. However, these can be made by winding about 100 turns of No. 17 wire on a 1 in. cardboard form. Two are placed in series with each wire of the power line, the windings wound in the same direction and placed side by side in inductive relation to each other. Condensers C1 are non-inductive high-voltage filter condensers and C2 are the bypass type. The coil L2 is a Litz wire wound coil taken from an intermediate frequency transformer that happened to be lying around, but any small coil can be used, providing the ohmic resistance is low. Condensers C3 are small equalizing condensers with mica dielectric and are provided with an adjustment screw to change their respective capacities.

Tube V1 is a line voltage regulator tube and is connected as shown. This tube consists of an iron filament wire having a high temperature coefficient of resistance, through which all current flows. The filament is inclosed in a glass bulb which contains nitrogen gas. When the line voltage rises the voltage drop across the tube varies, due to its change in resistance and the effective voltage to the receiver is practically constant. In general, with a 10% increase in current through the regulator tube the voltage drop across it increases 200%. The type of tube used in each particular filter depends upon the number of tubes used in the receiver or to be more correct the current consumption of the receiver. The selection of the proper regulator tube is important if good regulation is desired.

To install this filter, remove the aerial lead-in from the receiver and install the filter in the power line, turn up the volume control in the set and tune condenser C2 until the noise diminishes. If no difference is noticeable take off a few turns of wire from the coil L2 and continue this procedure until trap is resonated with the noise frequency.

When this filter was tried with various superheterodynes it was not as effective in reducing all the noises, and as the receivers were known to be in perfect condition it was apparent that another noise source was present that did not show itself when a regenerative receiver was used.

Associated with the new all-wave sensitive superheterodynes are the noises from tubes such as thermal agitation and other inherent tube noises. Not wishing to debate on this subject it suffices to say that most of the noises present were not caused by any of the above effects, but from power line pickup.

Figure 1B shows the circuit that was finally used for superheterodyne receivers. The only difference to the previous filter is the inclusion of an additional tuned trap circuit. When the trap was tuned to the same frequency as the receiver's intermediate frequency amplifiers, the noise was reduced sufficiently to warrant the above statement. This effect is logical when one considers that the I.F. stages of these sets are usually worked at a very high gain, and any noise pickup on this frequency is enormously amplified.

Both circuits are sound in engineering practice and extremely simple, being devoid of any tricks or fancy frills, and may be used with A.C. or D.C.

The parts are mounted on an aluminum chassis and the entire unit is inclosed in a totally shielded aluminum box. A power line receptacle outlet socket for the receiver power plug is fastened to one of the sides of the filter shield can.

LIST OF PARTS

One Amperite voltage regulator tube and socket, V1;
Two 25-80 mmfs. Hammarlund equalizing condensers, C3;
One set of coils from any I.F. transformer, L2;
Four Blan line filter chokes, L1;
Four Cornell-Dubilier .5-mf. filter condensers, C1, 400 V. rating;
Two .075-mf. bypass condensers, C2;
One chassis;
One shield can;
One fuse holder and fuse;
One receptacle socket;
One Blan power line cord and plug.

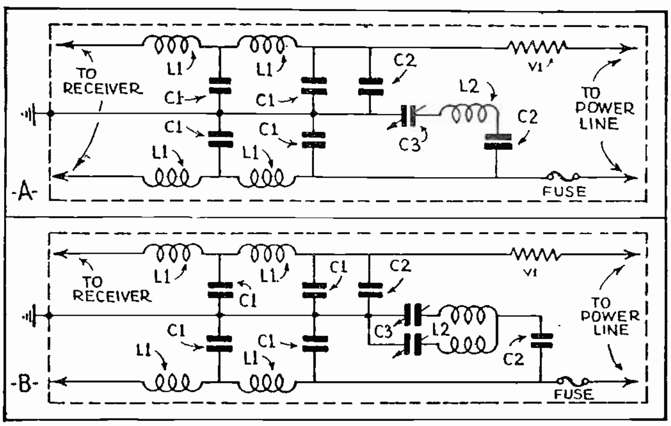
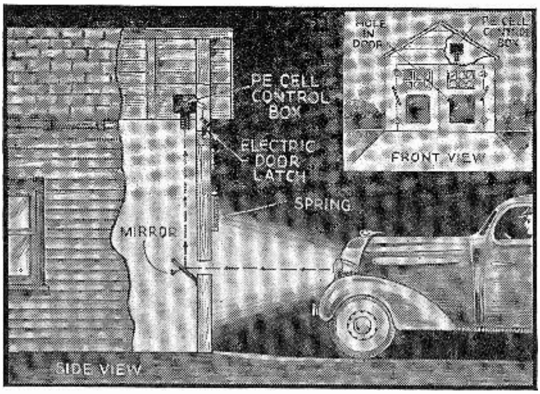


Fig. 1

This line noise eliminator employs tuned resonant traps. The construction of the R. F. chokes is described in the text. Wiring diagram of two units shown on right.



HOW TO OPEN DOORS AUTOMATICALLY

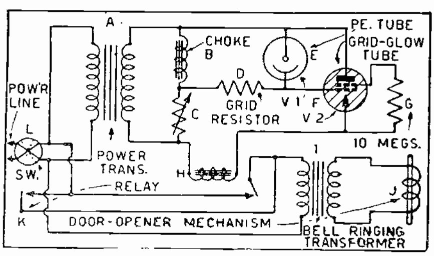
A new device operating with a grid-glow relay tube which is positive in action and low in cost. It will find many practical uses.

SIMPLE mechanical features involve two main pieces of equipment. A door-opener, or release, is electrically operated and a set of springs mechanically opens the door.

The door-opener, like that commonly used on apartment house doors, may be placed on the framework above the doors. It is electrically operated so that the latch releases when current from a bell-ringing transformer flows through the winding. Catches on the doors should engage the opener and hold the doors closed. When an impulse is sent through the coil, it releases the latch, allowing the doors to open.

The mechanism which swings the doors open consists of heavy-coil door springs. They should be mounted along the hinged edges so that they can exert their full force against the doors as they are released. Since these springs generally are used to close doors, they must be installed opposite to the usual manner, so as to **open** the doors—(which previously had been manually closed).

The electrical circuit operates directly from the regular 60-cycle lightning line (see below). The transformer, A,



Schematic diagram.

converts 110-120 V. lighting power to 440 V. Since the load on the secondary of this transformer is extremely light, well under 1.W., it does not require a very high power rating.

Choke coil B should have a fairly high inductance, say of the order of 100 hy.

The adjustable resistance, C, should have a maximum value in the order of 20,000 to 50,000 ohms. Screen-grid resistor D should have a resistance of 50 to 100 megs.

The photo-tube at E is an SR-50 type. A cardboard or metal tube, approximately 2 ins. in dia. and from 8 to 12 ins. long, may be mounted vertically below the sensitive cathode of the photo-tube, which rests in a horizontal position in the control box. Directed so as to pick up the reflection of the headlight beam, such a tube will tend to prevent operation of the photo-tube by extraneous light from one side or the other.

The heart of the device (F, in the schematic diagram) is a Westinghouse type KU-618 grid-glow tube of the cold-cathode type. It has no filament, and operates by breakdown or ionization of the neon gas within.

As soon as light falls on the SR-50 phototube, the grid voltage is increased and current passes between the anode and cathode.

This current passes through relay winding H; this winding should have a resistance of between 200 and 1,000 ohms across this winding to prevent chattering. The contacts of the relay will close the circuit through transformer, I, and energize the winding of the door-opener indicated at J.

CHAPTER V

USEFUL SHORT-CUTS AND WRINKLES

THESE short-cuts and wrinkles have been carefully selected from among those submitted to Radio Craft by its many readers. Most of them have won prizes for their contributors. The rest have received honorable mention. All, no doubt, will prove to be of considerable use to radio men.

Antenna Tester

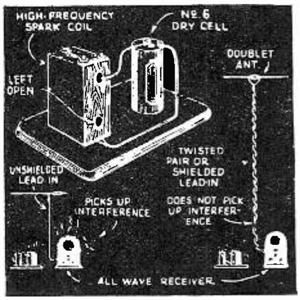


Fig. 1

After installing an all-wave antenna the Service Man is never sure that it is a perfect job. The device shown enables a test to be made immediately! (See fig. 1.)

It consists of a model T Ford spark coil and a single dry cell. These may be mounted compactly (see Fig. 1), so that they can be put in the tool kit. The apparatus is simply placed near the receiver or lead-in and turned on. Disconnect one lead of a transposed feeder system, use the other as the antenna, and the noise will come in strong, but, if a good job has been done on the antenna, the regular doublet connection will give a minimum of noise.

A. WARD HOWE

• • •

Lightning Arrester

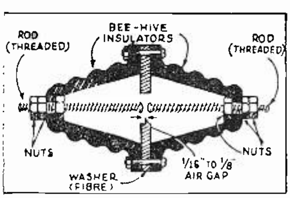


Fig. 2

An arrester is sometimes not at hand when an installation is being made. On one such occasion the arrester shown in Fig. 2 was made up and proved very satisfactory. It is made from 2 bee-hive-shaped stand-off insulators separated by a 1/4-in. sheet of bakelite and held together by bolts, as illustrated. The gap between the two brass-rod ends may be between 1/16- and 1/8-in.

JOS. G. TABACYZNSKI

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Moisture Seal

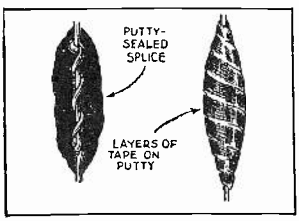

Fig. 3

In connection with some types of antenna installation in which soldered connections are desired, such as joints to be made on the roof, it is often very difficult to use a soldering iron or blow torch. In such cases it is often the practice to merely make a twist joint and tape it for protection. This is obviously very poor practice, and the writer has found that the use of common putty will provide a weatherproof covering under all conditions. Tape is used over the putty for protection. See Fig. 3.

LOUIS B. SKLAR

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Simple Field Exciter

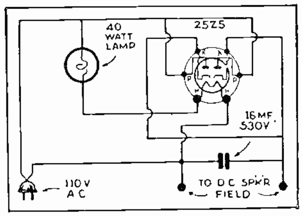

Fig. 4

This exciter (see Fig. 4) costs almost nothing to build and is an extremely handy unit to have at hand. The output voltage under load of about 80 ma. will be around 145 V. Only a 40 W. lamp should be used, as this provides the correct voltage drop for the filament of the 25Z5 rectifier.

H. P. KELLY

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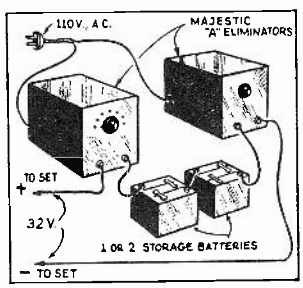
32-Volt Power Supply



Many Service Men are at a loss when called upon to test, or do work in their shops on, 32 V. radio sets. Ample power for the purpose may be secured from the arrangement shown in Fig. 5. The old Majestic "A" eliminators deliver between 12 and 15 V. when the chokes are removed. Hooked in series with one or two 6 V. storage batteries, a handy 32 V. power supply is available.

HERBERT MALVIN

Cold Soldering Iron

The 5V.-secondary of a power transformer from an old radio set is used to supply the energy for the "iron" (which, unlike the usual "copper," is made of "carbon"!) illustrated in Fig. 6.

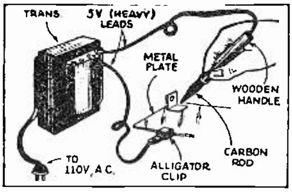


Fig. 6

One heavy, flexible lead terminates in a heavy alligator clip which is used as the ground connection. The other lead, which terminates in a holder, fastens to an electrode—a piece of carbon rod about 2 ins. long and ¼-in. in dia. (The type of rod used in arc lamps will do, or it may be taken from a flashlight cell.)

The clip is fastened to the material to be soldered and the rod placed on the part where soldering is to be done. When the part heats up, solder is applied. This iron is particularly handy, since there is no wait for heating up and it is always ready for use.

OSCAR O. BOUCHER

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Fixing Soldering Tip

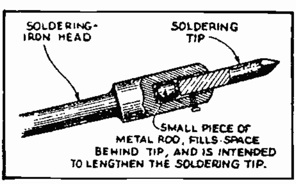

Fig. 7

A small length of copper rod the same diameter as the tip is inserted in the space behind the tip. This insures that the tip will remain tight in the seat. Simple as this idea may seem, it is very effective. See Fig. 7.

EUGENE KINGREY

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Soldering Iron Case

In order to eliminate the usual wait for the soldering iron to cool off, when ready to leave a service job, the iron holder illustrated in Fig. 8 was built. It is constructed of No. 20 gauge sheet metal, lined throughout with ⅛-in. sheet asbestos. A slot is provided for the cord to pass through. The 2 pieces of metal used to hold the iron in place are riveted to the case. A single wide rubber band is used to hold the 2 halves together. A case of the dimensions shown is large enough to hold a large industrial iron.

The ambitious Service Man may well build up a few of these boxes for sale to his friends. A little study will show how other equipment which is needed for soldering may be included in the

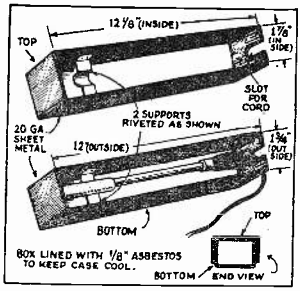

Fig. 8

same box. For example, a small spool of solder could be fastened at the handle end of the box which stays relatively cool.

R. T. SCHULTZ

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Handy Test Leads

The test cords (see Fig. 9) are 3 ft. in length and fastened to the end of a 3 ft. x ⅜-in. tube which is supported on an angle bracket formed to make a bearing for a ¼-in. shaft which is set horizontally 44 ins. above the service bench. The weights are discs from an old RCA or Westinghouse disc rectifier. Add discs to the arm until the weight is sufficient so that the arm and cord will remain stationary to whatever the position the leads are brought.

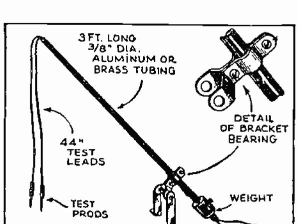

Fig. 9

Flashlight Ohmmeter

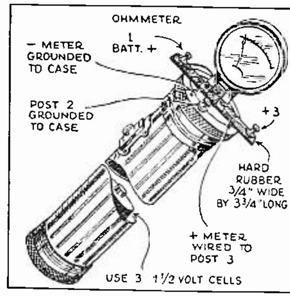

Fig. 10

This handy instrument (see Fig. 10) is made from a 3-cell flashlight case. The lens and reflector are removed and a disc of hard rubber fitted in the end of the case. The meter brackets and the binding posts are mounted on the rubber. Posts 1 and 3 are used for resistance and continuity: 1 and 2 give 4½ V. for "C" battery use. Posts 2 and 3 enable the meter to be used for reading up to 4½ V.

N. A. LAMB

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Low Cost Output Meter

Here is the circuit (see Fig. 11) of an output meter which is efficient and inexpensive. The meter used is a Weston model 506 0-8 voltmeter with a lead brought out between the move-

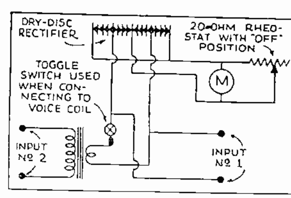

Fig. 11

ment and the multiplier to permit it to be used as a milliammeter. Any milliammeter with a low range may be used.

The rectifier is one out of an old Elkon 3 A. charger which had worn out. The rheostat is 20 ohms, and is used as a shunt when necessary. A "dynamic" output transformer is used, though none is needed when connecting to the voice-coil leads of the radio set.

(Such a transformer may be made by removing the secondary from an A.F. transformer and winding about 50 turns over the primary.)

CARROLL S. WHITE

Metal Tube Adapter

A metal-tube adapter. Now that these tubes are generally available, an adapter will be necessary for test purposes. The simple one shown is made of an "instrument"-type 8-prong sock-

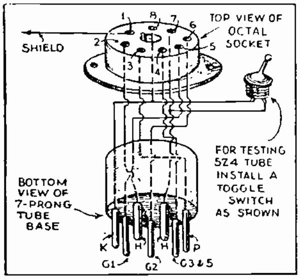

Fig. 12

et fastened to a 7-prong tube base by means of small brass angles (as the picture shows). Before fastening together, the wiring must be installed and the S.P.-S.T. toggle switch fastened in place. The wiring is done with flexible wire, each piece being about 3 ins. long. All connections may then be made to the socket and switch, the ends being threaded through the pins of the tube base. The shield pin may be left open. The two parts are bolted together, and the leads soldered in the pins. The toggle switch is used only when testing 5Z4 rectifier tubes, since these have the heaters connected to prongs Nos. 2 and 8. (Fig. 12)

PAUL K. HARLAN

The type 6F5 tube necessitates the use of a second snap switch to swing the octal socket plate connection from terminal 3 to terminal 4.—Editor)

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Meter Needle

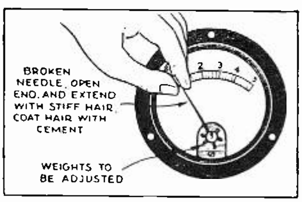

Fig. 13

Meter repair. While using my ohmmeter in a hurry, I accidentally touched the prods to high voltage and made an "S" out of the pointer! It was of the knife-edge type, and while trying to straighten it out, ½-in. broke off. Since the pointer was hollow, I carefully opened the end with a needle. Then a piece of stiff hair was dipped into a thin solution of speaker cement and stuck into the opened end of the pointer. When dry the hair was cut to the proper length, and the repaired indicator rebalanced with the 3 weights. This repair is very light and allows the needle to act perfectly. See Fig. 13.

F. H. RAST

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Conductivity Tester

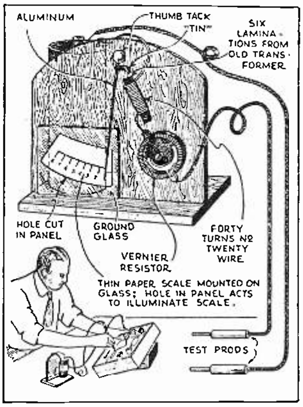

Fig. 14

Desiring to test the conductivity of some seemingly poor connections, and not wishing to invest in a milliammeter at the moment, the qualitative unit shown in Fig. 14 was made. It "reads" the resistance of a 1-in. length of wire.—MARK JONES

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Versatile Tester

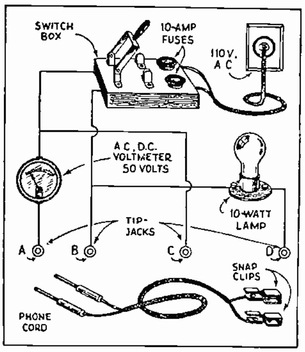

Fig. 15

Tip-jacks A, B, (see Fig. 15) test transformer primaries for counter E. M. F.; B, C, full current supply; C, D, condenser and continuity tests; A, C, battery-voltage tests.

CURTISS NEILSON

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Comparison Meter

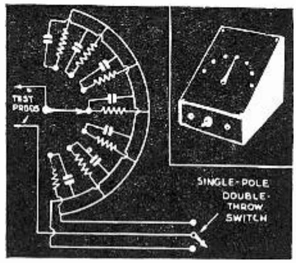

Fig. 16

Resistor and condenser comparison meter, illustrated in Fig. 16 is a very practical instrument for the radio laboratory. It is a comparison meter for determining the values of resistors and condensers. The instrument has a range from 500 ohms to 1. meg. on the resistance scale and 0.005-mf. to 8 mf. capacity on the capacity scale. In making the instrument I would like to suggest that the inclined cabinet is the best as it will give full vision of the panel while working on the set. This saves the time of walking back and forth to observe the value.

DAVID CERVANTES

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Detecting Unmatched Push-Pull Tubes

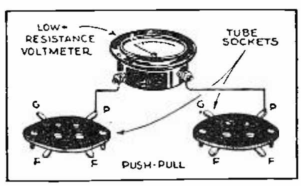

Fig. 17

A perfect match will be shown by zero reading. If meter reads backwards, reverse the connections. A reading of more than 1 volt indicates that a new tube should be put in. (Fig. 17.)

ERNEST J. CHRISTIANS

Electrolytic Condenser Tester

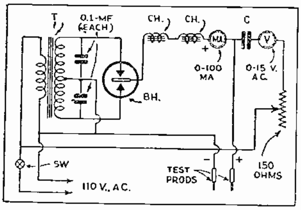

Fig. 18

This tester will measure the capacity of a condenser and at the same time measure its leakage. To measure the capacity we must use alternating current and as we cannot use A.C. alone on an electrolytic condenser a rectifier is employed (a "B" eliminator will do as a substitute), as shown in Fig. 18. The voltmeter measures the capacity by calibrating the scale against known condensers and the leakage should not be more than 1. ma. per mf.

E. A. REDMON

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Simple Ohmmeter

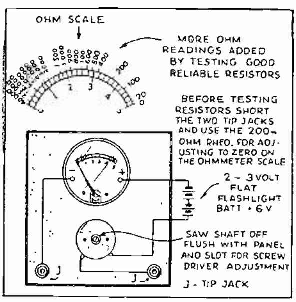

Fig. 19

A very inexpensive ohmmeter can be made from a discarded filament meter of the type used in old battery sets generally having a 0 to 5 volt range. Simply add a scale, calibrated from standard resistors, and hook it up with a 200-ohm rheostat and a pair of tip-jacks as shown in Fig. 19.

Before testing resistors, short the 2 tip-jacks and use the rheostat for adjusting to zero on the scale.

L. W. FIELD

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Service Oscillator

A simple service oscillator can be built from odd parts that most radio experimenters always have—and in a few minutes, too. See Fig. 20. All that is necessary is an ordinary inductance such as used for T.R.F. purposes, a variable condenser to suit, a low-current-consuming buzzer, a switch, a small "C" battery, and a shield can to house the unit, as shown. This type of oscillator was called a wave-meter in the "old days."

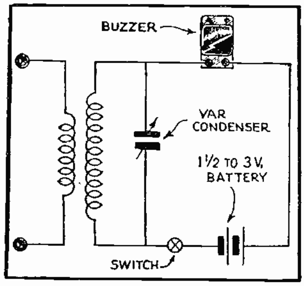

Fig. 20

The oscillations are produced by the sparking of the buzzer contacts and are of an undamped nature. For that reason the unit must be completely shielded.

N. ALLEN

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Direct-Reading Meter

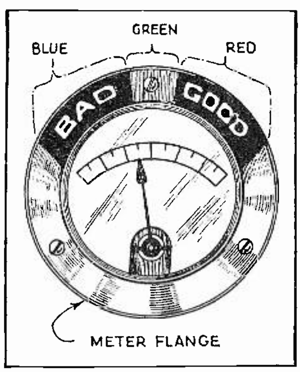

Fig. 21

It is easy to make an English (direct) reading scale on your regular milliammeter. See Fig. 21. Merely wipe the flange clean with a cloth dipped in alcohol. Apply two coats of colored enamel. Lettering is then added. To protect the scale add a coat of clear varnish or shellac. (If you wish to try it over again, the enamel may be removed with alcohol or thinner.)

This tube checker clears up any doubt concerning tube condition, and when included in a standard analyzer, completes the equipment.

HERB. JONES

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Simple Test Lamp

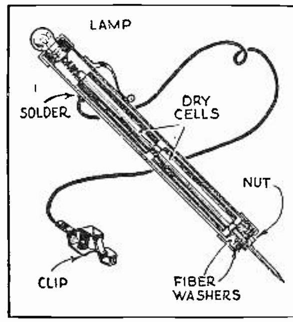

Fig. 22

By arranging a fountain pen type of flashlight in the manner illustrated a serviceable test lamp was made, for moderately low resistance circuits. See Fig. 22.

JOHN RILEY

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Oscillation Tester

Here is a practical tool for servicing superhets. It indicates if the set oscillator is functioning or not. The hook-up is shown in Fig. 23. In order to test for oscillation place one test prod on the plate of the oscillator tube and the other prod to the chassis. If the oscillator is working the bulb will light.

MRS. OLE FUGLESTAD

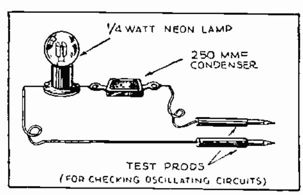
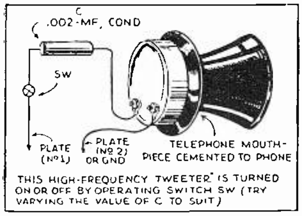


Fig. 23

Adding A Tweeter



THIS HIGH-FREQUENCY TWEETER IS TURNED ON OR OFF BY OPERATING SWITCH SW (TRY VARYING THE VALUE OF C TO SUIT)

Fig. 24

This high frequency speaker can be used with any set to increase the high-frequency response. It is simply a single headphone of any standard make, with a microphone mouthpiece cemented to the cap. This unit may be used with single-ended or push-pull output stages. (Fig. 24.)

H. PUTNAM

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Replacing Speakers

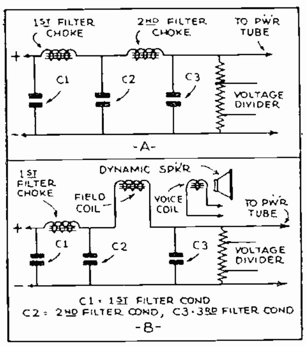

Fig. 25

There are many old A.C. sets in use today, whose owners would like to have the advantages of dynamic speaker results, but can't afford new sets. Figure 25 shows how this can be accomplished on the old sets, without much change being necessary, yet the results are very satisfactory. The field of the new speaker is put in the circuit as a second choke. The transformer on the new speaker connects directly to the posts which formerly went to the magnetic speaker. If the new field causes too great a voltage drop, run the high-voltage lead from the output tubes to the connection between the field and the choke.

WM. CLARK

Speaker Tester

Many midget sets which can barely be heard with the volume full-on, will be found to have a faulty reproducer. A rapid test for this condition is shown in Fig. 26. It merely consists of a 2 mf. paper condenser in

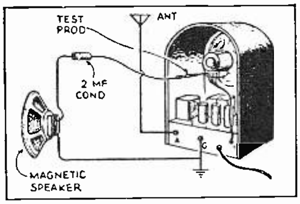

Fig. 26

series with a small magnetic speaker and a set of test prods. With the set turned on and tuned to a local station, touch all the terminals on the speaker with one of the prods, the other being grounded. If the set is in good condition otherwise, a signal will be heard in the magnetic speaker.

HARRY E. WESSEL

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Improvised Output Transformer

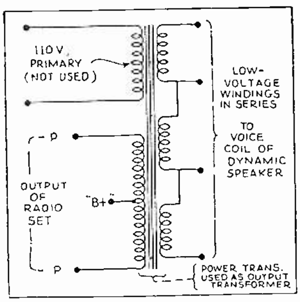

Fig. 27

An ordinary radio power transformer will be found useful as an emergency output transformer. Using the high-voltage secondary as the primary and the low-voltage secondaries as voice-coil windings, considerable flexibility is possible in matching dynamic speakers. See Fig. 27.

GERALD BATES

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Pickup Repair

Other than actual burn-out, trouble in pickups is usually caused by drying of the rubber armature dampers. Repairs can

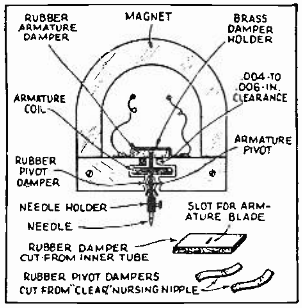

Fig. 28

easily be made (see Fig. 28) with rubber from an inner tube which still has good resiliency, and bits from a (transparent) rubber nursing nipple. Use care, when taking the assembly apart as the fine wires from the coil break off with the slightest pull.

RALPH BILLS

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Increasing Bass Response

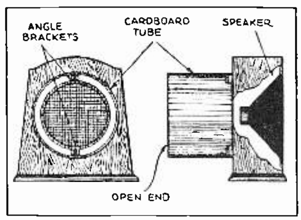

Fig. 29

A cardboard paper basket, with the bottom removed, and fixed to the back of a speaker cabinet as shown in Fig. 29, greatly increases its baffle area and therefore increases the bass response of the speaker. A substitute for the basket may be constructed from a clothes box by cutting and bending the cardboard into a tube of the right diameter.

CLYDE J. DAY

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Speaker Alignment

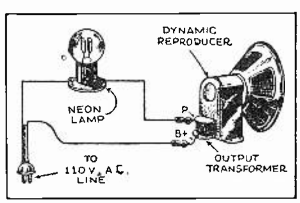

Fig. 30

Producing a strong signal for lining-up loudspeakers. When centering voice coils of dynamic speakers a good strong signal is necessary. It can be obtained as shown in Fig. 30 by connecting a neon lamp in series with a 110 V. line. Alligator clips should be used for quick connection to the output transformer.

R. C. RICKARD

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Home-Made Dynamic Microphone

The microphone here described is particularly useful because it gives faithful reproduction over the entire audible musical range. Obtain a small dynamic speaker field coil, such as an old 6-V. Magnavox field and voice coil. The field, however, must be re-

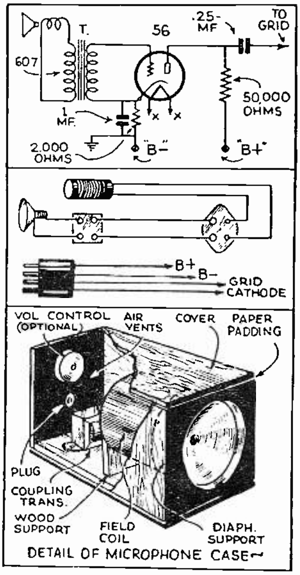

Fig. 31A

wound with No. 38 wire, to add sensitivity.

Obtain a heavy tobacco tin, about 4 ins. in dia. Drill some ⅜-in. holes around the sides and back, to prevent air cushioning. Connections to the voice coil should be very flexible. The diaphragm must be extremely light, but tough. Using water-color paper of light weight, make a cone with 3 ins. overlap. Moisten the edges of the cone. Place the diaphragm and trim the edges so that it will slip freely in as far as the voice coil spider. Make a small hole in the diaphragm through which the nut on the voice coil may project slightly. A little sealing wax will secure the diaphragm to the can. Make a case as illustrated. Get a good A.F. transformer with a heavy core. Remove the core, and cut through the outer layers of the coil. Wind on 60 turns No. 24 wire. When used with a good ampli-

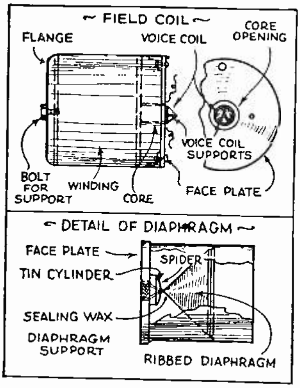

Fig. 31B

fier, it is perfect with the spoken word. It has wide-angle pickup and hence is excellent for orchestral work.

Illustrations 31A and 31B on this page show all necessary details, and a little care will produce a fine job.

G. E. FAULKNER

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Home-Made Lapel Microphone

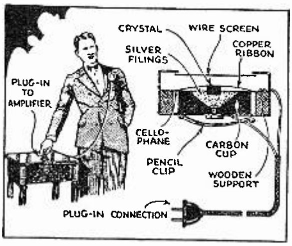

Fig. 32

An excellent lapel microphone may be made from a tin box, a block of wood, a piece of carbon rod salvaged from a defunct dry cell, a piece of cellophane, and a few miscellaneous items as shown. See Fig. 32.

A disc ¼-in. thick is cut from a carbon rod and shaped as shown in the illustration. Around the top rim of the cup thus formed, glue a felt or cotton washer. Fill the cup half-full of silver filings. Lash a piece of radio crystal, such as galena or silicon, to a strip of copper foil by means of very fine copper wire. Make a cellophane diaphragm to fit the block of wood (balsa is best). Force the crystal through a hole in the diaphragm made by means of 2 short razor slits at right-angles. Glue the cellophane diaphragm to the felt washer and wooden rim. Draw taut and hold in position until the glue has set. A piece of fine screening may be put over the finished instrument to protect the diaphragm. Connect into circuit the same as a regular carbon microphone.

BILL BARTLETT

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Auto Remote Control

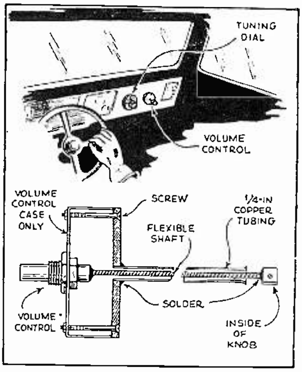

Fig. 33

Remove wiper and resistor from a volume control unit and fasten to the case a metal plate to which is soldered a copper guide tube. Solder a flexible shaft to the volume control shaft and to the opposite end of the flexible shaft solder a dial collar and set-screw. See Fig. 33.

O. E. PAYNE

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Phonograph Motor

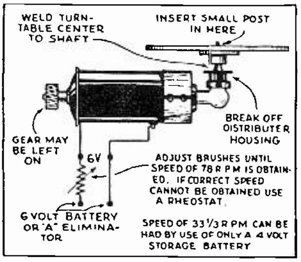

Fig. 34

This motor is made from junk parts, but works very well. It is made from a Chevrolet generator, and is used for both recording and playback work. There is plenty of power available and the unit may be used in a sound truck very nicely, since it operates on 6 V. The only real work to be done is to break off the distributor housing and weld the turntable to the shaft. Any speed may be obtained by adjustment of the rheostat. See Fig. 34.

JOE YEAGER

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Color Code Guide

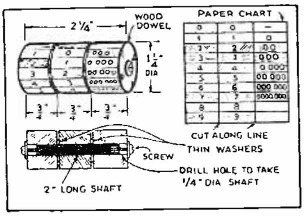

Fig. 35

All resistors under 5 W. rating are marked with a color code in place of the actual value. In order to determine the resistance it is necessary to have a color chart. Figure 35 illustrates how to make a revolving chart that will save much time. Complete construction details are shown. It is only necessary to twirl the various colors into position for the body, tip and dot, and the resistance is instantly indicated.

HAROLD J. CLARK

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Plug-In Coil Hint

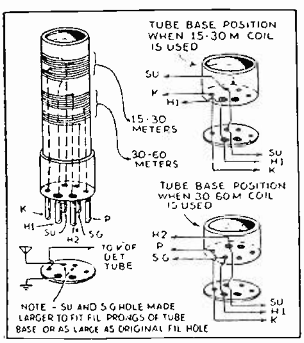

Fig. 36

Plug-in coils are a nuisance, especially when used with a portable set. The form shown in Fig. 36 can be made from a tube base and a piece of insulating tubing, or may be an ordinary 6-prong commercial coil form. The windings for any two bands are put in place and wired up as shown. The socket has only 3 connections to it, and the suppressor- and screen-grid holes are made large enough to fit the filament prongs of the coils, so that when the latter are reversed, another set of windings is connected to the 3 prongs of the socket. (The coils shown are for use with a detector, a cathode tap being employed for regeneration.)

TRANQUILINO M. NAVARRO

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Low Cost Mixer

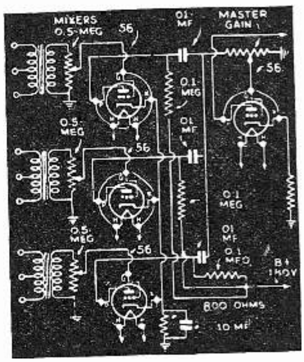

Fig. 37

By this means, several sources of input may be mixed and any may be varied without disturbing the others. Ordinary 0.5-meg. potentiometers are used for the individual volume controls. The cost of the extra tubes and associated equipment is less than that of the expensive, constant-impedance type mixers that are ordinary used. (Fig. 37.)

CHARLES M. DIBRELL

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Vernier Dial

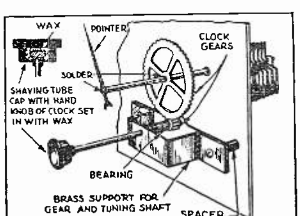

Fig. 38

By using a couple of clock gears, strips of brass, battery wax and a shaving-tube cap, a fairly serviceable tuning control can be fashioned to resemble an airplane dial, shown in Fig. 38.

In the event that the condensers have a bakelite frame and the rotor is grounded, it will be necessary to ground the brass strips, as the latter will change the capacity of the condenser slightly. Also the gears make a poor electrical connection. Wherever possible it is best to make connections by means of pigtails.

If plastic wood is available it will make a more firm bond for the shaving-tube cap to the shaft. The easiest way of mounting the pointer is to solder it on to the upper shaft.

JAMES M. GORDON

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Tube Puller

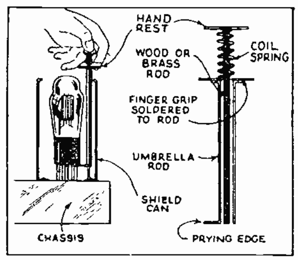

Fig. 39

After loosening or pulling off several grid caps and spending many embarrassing moments, the tube puller shown in Fig. 39 was constructed and found to be highly satisfactory. In operation, the tube is wiggled slightly to allow the bent finger on the tubing to fit under the tube base. Then, a little pressure on the grips and the tube pops out of the socket.

HERBERT E. EHRET

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Burglar Alarm

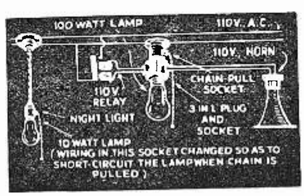

Fig. 40

This arrangement was rigged up after our radio store was robbed, to prevent a similar occurrence. The night light is lit by using a long stick with a hook to pull the chain of the ceiling socket. If the cord hanging from the night light is pulled, the large bulb lights and remains lighted, and the horn blows continuously. They cannot be turned off, since the relay locks in and must be manually released! The night light socket is changed so that the switch shorts the 10-W. lamp, thus closing the circuit for the 100-W lamp and horn, and the relay. See Fig. 40.

A. B. DUNGAN

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Cabinet Polisher

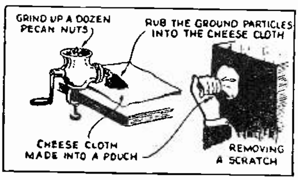

Fig. 41

This idea, shown in Fig 41, is a remover that will eradicate the worst scratch, yet costs only a few cents to make. Grind up about a dozen pecan kernels, taken fresh from the shells and rub them into a piece of cheese cloth. You now have one of the finest scratch removers it is possible to make. The cloth will last for a year or more before needing renewal of the pecan oil. Simply rub the cloth over the scratch, let the oil dry a few moments, and polish with a clean, dry cloth.

MORRIS DORSEY

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Added Sensitivity

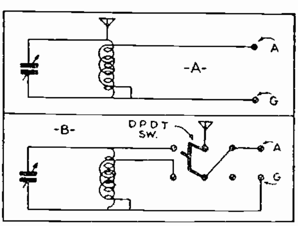

Fig. 42

Many of the popular 4-tube midget sets with a single stage of R.F. are somewhat lacking in selectivity and sensitivity, and may be improved by the addition of a tuned antenna stage. The size of the coil will depend on the set and antenna used, but as a rule 70 T. of No. 30 D.C.C. wire on a 1¼-in. form will be about right when tuned by a 350 mmf. condenser. The coupling coil consists of 10 or 15 turns of the same size wire wound on top of the other coil. "A" and "G" of Fig. 42 go to the antenna and ground connections of the set. If the set has no ground connection, the "G" post may be connected to chassis. In Fig. 42 B, the same circuit is shown with a switch added to cut out the tuner if desired.

Service Men should find this gadget an excellent demonstrator to aid in showing the need for modernizing older sets.

G. H. BAIRD

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Insulating Coupling

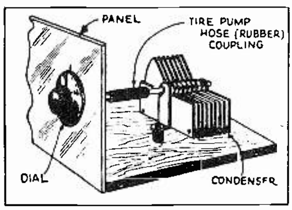

Fig. 43

A piece of tire pump hose inexpensively serves as a flexible coupling for remote operation of a tuning condenser. Refer to Fig. 43.

CHESTER STINE

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Home-Made Resistor

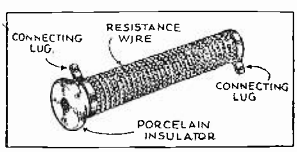

Fig. 44

Obtain a porcelain tube such as used in house wiring; this tube may be snipped either to reduce the length or it may be ground off on an emery wheel. Fit lugs on each end; wind wire to suit your needs, leaving space between turns. Then dip assembled resistor in a paste made of water and plaster of paris. See Fig. 44.

This makes a resistor that will stand plenty heat; and can be mounted with a bolt through the center.

O. E. PAYNE

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Variable A. V. L. Action

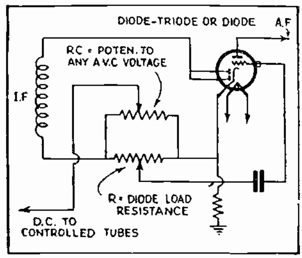

Fig. 45

Here is a kink for carrying the A.V.C. control voltage which is handy when hunting for DX stations, especially if the receiver does not have delayed A.V.C. This is also useful in cutting out noise when tuning. The potentiometer (Fig. 45) should have a high value (about 2 megs.) to prevent changing the diode load and cutting down the input to the first A.F. section.

HENRY WEIMAR

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Emergency Test Clip

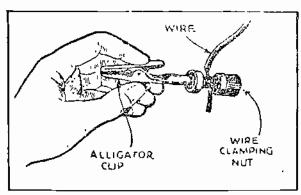

Fig. 46

Many times when testing or experimenting with circuits it is necessary to make some connections in a hurry. The test clip shown in Fig. 46 will readily solve this problem.

JOHN MODNONSKY

CHAPTER VI

HANDY REFERENCE DATA

* USEFUL FORMULAS

CURRENT, VOLTAGE AND RESISTANCE (Ohm's Law)

$$I = \frac{E}{R}$$

Where: I is current in **Amperes.**
E is potential difference in **Volts.**
R is resistance in **Ohms.**

Example: What current will pass through a resistor having a value of 20,000 ohms when the potential difference between its ends is 100 volts?

$$I = \frac{100}{20{,}000} = 0.005 \text{ ampere} = 5 \text{ ma.}$$

$$E = IR$$

Example: What will be the voltage drop in a filter choke having a D.C. resistance of 700 ohms when the current passing through it is 40 milliamperes?

$$E = 0.04 \times 700 = 28 \text{ volts (V.)}$$

$$R = \frac{E}{I}$$

Example: What value of decoupling resistance is required to drop 80 volts when the current passing through it is 10 milliamperes?

$$R = \frac{80}{0.01} = 8{,}000 \text{ ohms}$$

RESISTANCES IN SERIES

$$R_t = R_1 + R_2 + R_3 \ldots . R_n$$

Where: R_t is the total value of all resistors connected in series.
R_1, R_2, etc. are the individual resistors.

RESISTANCES IN PARALLEL

$$R_t = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2}} = \frac{R_1 \times R_2}{R_1 + R_2}$$

Where: R_t is the effective value of all the resistors connected in parallel.
R_1, R_2 are the individual resistors.

Example: What is the effective value of resistance of a circuit having resistors of 30,000 and 60,000 ohms connected in parallel?

$$R_t = \frac{30{,}000 \times 60{,}000}{30{,}000 + 60{,}000} = 20{,}000 \text{ ohms}$$

REACTANCE (INDUCTIVE) OF A COIL

$$2\pi fL = \text{Reactance (ohms)}$$

Where: $\pi = 3.14$
f = frequency in **cycles per second.**
L = inductance in **henries.**

Example: What is the reactance of a 20-henry choke at 50 cycles?

$$6.3 \times 50 \times 20 = 6{,}300 \text{ ohms}$$

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*Courtesy Wireless World

REACTANCE (CAPACITATIVE) OF A CONDENSER

$$\frac{10^6}{2\pi f C} = \text{Reactance (ohms)}$$

Where: $\pi = 3.14$
f=frequency in **cycles per second.**
C=capacity in **microfarads.**

Example: What is the reactance of a 2-mf. condenser at 50 cycles?

$$\frac{10^6}{6.3 \times 50 \times 2} = 1{,}590 \text{ ohms}$$

WAVELENGTH

$$\lambda = 1{,}885 \sqrt{LC}$$

Where: λ=wavelength in **meters.**
L=inductance in **microhenries.**
C=capacity in **microfarads (mf.).**

Example: To what wavelength will a 0.0005-mf. (500 mmf.) condenser, in parallel with a 180-microhenry coil, tune?

$$1{,}885 \sqrt{180 \times 0.0005} = 565 \text{ meters}$$

FREQUENCY

$$f = \frac{10^6}{2\pi\sqrt{LC}}$$

Where: f= frequency in **cycles.**
$\pi = 3.14$
L=inductance in **microhenries.**
C=capacity in **microfarads** (mf.)

Example: To what frequency will a 0.0005-mf (500 mmf.) condenser, in parallel with a 180-microhenry coil, tune?

$$\frac{10^6}{6.3\sqrt{180 \times 0.0005}} = 530{,}000 \text{ cycles} =$$

530 kilocycles = 565 meters.

IMPEDANCE OF A CIRCUIT

When an inductance, capacity and a resistance are connected in series, the combined effect is called the **impedance** of the circuit.

$$Z = \sqrt{R^2 + (X_l - X_c)^2}$$

Where: Z=impedance in **ohms.**
R=resistance in **ohms.**
X_l=reactance of inductance in **ohms.**
X_c=reactance of capacity in **ohms.**

OHM'S LAW FOR A.C. CIRCUITS

$$E = IZ \qquad Z = \frac{E}{I} \qquad I = \frac{E}{Z}$$

Where: Z=impedance of circuit in **ohms.**
E=potential difference in **volts** (V.)
I=current in **amperes** (A.)

THE DECIBEL

The number of decibels corresponding to a given power ratio is 10 times the common logarithm of the ratio.

$$N = 10 \log_{10} \frac{P_2}{P_1}$$

Where: N=decibels.
$\frac{P_2}{P_1}$=power ratio.

In the case of voltage or current the number of decibels corresponds to 20 times the common logarithm of the ratio.

Example: What gain in decibels will there be if the voltage in an amplifier rises to 7 times the normal level at a certain frequency?

$N = 20 \log_{10} 7 = 20 \times 0.845 = 17$ decibels.

*HANDY FORMULAS FOR DETERMINING POWER, CURRENT and RESISTANCE

When making resistor calculations, two fundamental formulas are employed. One, known as Ohm's Law, shows the relation between voltage, current, and resistance in the circuit while the other gives the power consumed in the circuit. By combining these two formulas, 12 equations are obtained, that will give directly either the voltage, current, resistance, or power if any 2 of the 3 remaining quantities are known. As most resistors used in radio equipment carry current of an order of magnitude best measured in milliamperes, these equations, as given in the following chart, include correction factors where necessary so that the current values may be substituted directly in milliamperes.

Voltage in Volts	Current in MA.	Resistance in Ohms	Power in Watts
KNOWN	KNOWN	$\frac{1000 \times \text{Volts}}{\text{MA.}}$	$\frac{\text{Volts} \times \text{MA.}}{1000}$
KNOWN	$\frac{1000 \times \text{Volts}}{\text{Ohms}}$	KNOWN	$\frac{\text{Volts} \times \text{Volts}}{\text{Ohms}}$
KNOWN	$\frac{1000 \times \text{Watts}}{\text{Volts}}$	$\frac{\text{Volts} \times \text{Volts}}{\text{Watts}}$	KNOWN
$\frac{\text{MA} \times \text{Ohms}}{1000}$	KNOWN	KNOWN	$\frac{\text{MA.} \times \text{MA.} \times \text{Ohms}}{1{,}000{,}000}$
$\frac{1000 \times \text{Watts}}{\text{MA}}$	KNOWN	$\frac{1{,}000{,}000 \times \text{Watts}}{\text{MA.} \times \text{MA.}}$	KNOWN
$\sqrt{\text{Ohms} \times \text{Watts}}$	$1000\sqrt{\frac{\text{Watts}}{\text{Ohms}}}$	KNOWN	KNOWN

When using the chart find the horizontal line in which the two known values are marked "KNOWN" and the formula for either of the two remaining values will be found in the proper column.

Courtesy International Resistance Company

R. M. A. COLOR CODE For RESISTORS

Unit—OHMS

Body Color		End Color		Dot Color	
Black	0	Black	0		
Brown	1	Brown	1	Brown	0
Red	2	Red	2	Red	00
Orange	3	Orange	3	Orange	000
Yellow	4	Yellow	4	Yellow	0,000
Green	5	Green	5	Green	00,000
Blue	6	Blue	6	Blue	000,000
Purple	7	Purple	7	Purple	0,000,000
Gray	8	Gray	8	Gray	00,000,000
White	9	White	9	White	000,000,000

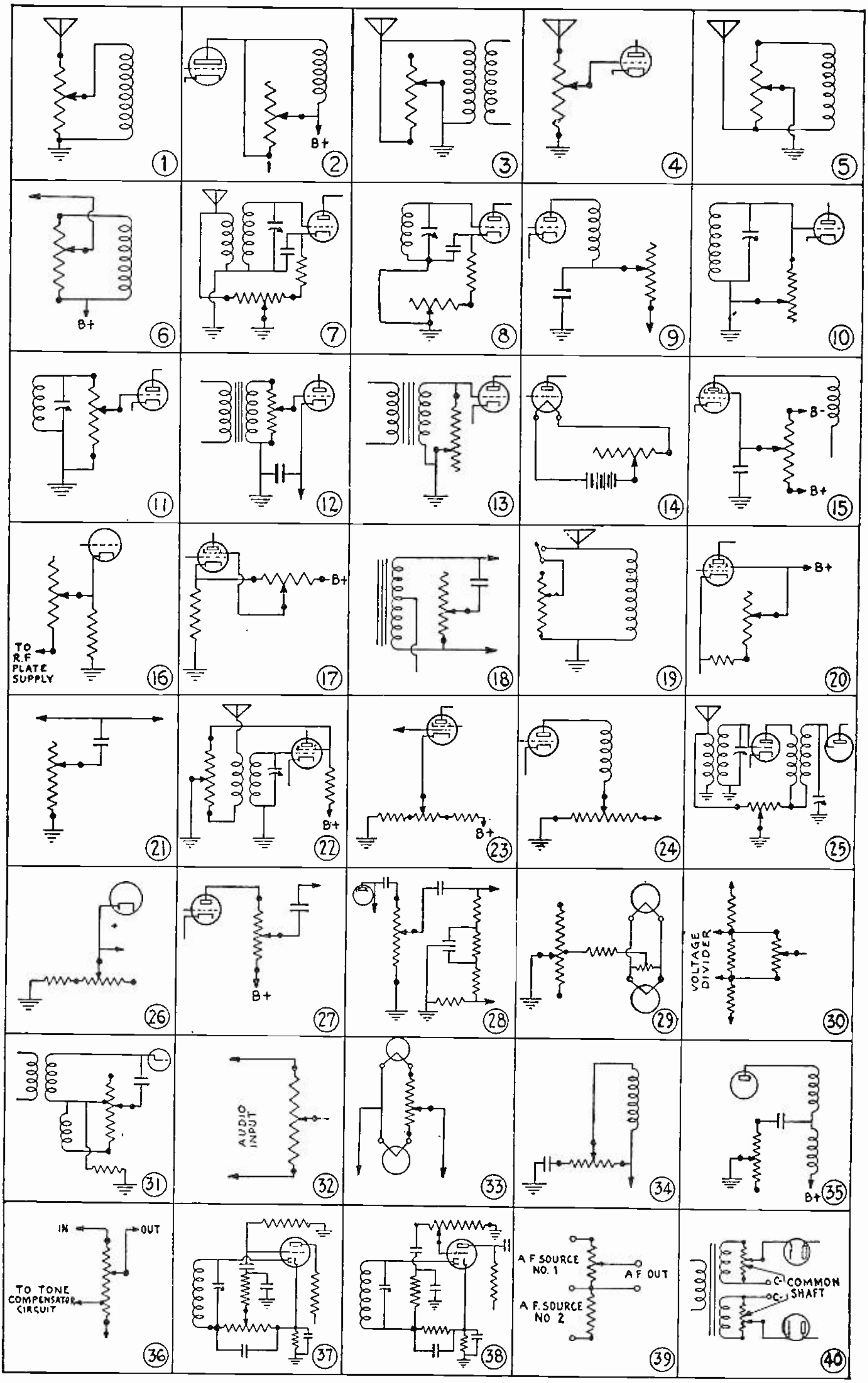
R. M. A. COLOR CODE For CONDENSERS

Unit—mmf.

Micro-microfarad

First Dot		Second Dot		Third Dot	
Black	0	Black	0		
Brown	1	Brown	1	Brown	0
Red	2	Red	2	Red	00
Orange	3	Orange	3	Orange	000
Yellow	4	Yellow	4	Yellow	0,000
Green	5	Green	5	Green	00,000
Blue	6	Blue	6	Blue	000,000
Purple	7	Purple	7	Purple	0,000,000
Gray	8	Gray	8	Gray	00,000,000
White	9	White	9	White	000,000,000

VOLUME AND TONE CONTROL CIRCUITS



* Explanation of Tone and Volume-Control Circuits

Circuits No. 1, No. 3, No. 4 and No. 5 show various antenna control applications.

Circuit No. 2 shows a volume-control method used on many receivers during the year 1930 and previous to that time.

Circuit No. 6 is similar to circuit No. 2 except for the fact that a potentiometer is used.

Circuit No. 7 illustrates the use of one of the most popular methods of volume control, namely: antenna-cathode control. The control in this position tends to shunt the antenna coil mainly at low volume level while affecting the trans-conductance of the first R.F. tube by varying the control grid bias.

Circuits No. 8 and 16 show the use of a variable resistance to increase the bias of a R.F. stage by raising the potential of the cathode with respect to grid.

Circuits No. 9 and No. 24 are effective by virtue of decreasing the plate voltage of the R.F. amplifier.

Circuit No. 10 shunts the detector input circuit, thus lowering the R.F. load.

Circuit No. 11 shows the application of a potentiometer to vary the voltage impressed on the grid of an R.F. stage.

Circuit No. 12 accomplishes the same affect for audio frequencies.

Circuit No. 13 shunts the secondary of an A.F. transformer, lowering the voltage impressed on the control grid by increasing the secondary load.

Circuit No. 14 shows the conventional filament current control.

Circuits No. 15, 17 and 20 lower the trans-conductance of an R.F. amplifier by decreasing the screen-grid voltage.

Circuit No. 18 is a conventional tone control arrangement, attenuating the high frequencies by bypassing them in the control grid circuit of an A.F. amplifier.

Circuit No. 19 is a local-distance switch arrangement to vary the input antenna voltage.

Circuit No. 21 is the tone control circuit most generally used. It attenuates the "highs" by lowering the load impedance of the output for those frequencies.

Circuit No. 22 is a screen-grid antenna control, wherein the voltage on the screen-grid is lowered in combination with the introduction of resistance in the antenna coil.

Circuit No. 23 varies the cathode potential above ground by moving the cathode along a bleeder arrangement.

Circuit No. 25 shows the antenna—control-grid control. In this circuit for decreasing volume, the antenna primary is shunted, while resistance is introduced in series with the secondary of a tuned circuit.

Circuit No. 26 shows the application of circuit No. 23 when several tubes are controlled, simultaneously.

Circuit No. 27 illustrates a potentiometer used as the load circuit of an A.F. amplifier.

Circuits No. 28 and 32 illustrate the use of a potentiometer as an A.F. grid-leak.

Circuit No. 29 shows a scheme for balancing 2 push-pull tubes by varying the individual control-grid biases.

Circuit No. 30 shows a potentiometer connected so as to secure a variable voltage between two limits.

In circuit No. 31 use is made of an auxiliary or tertiary winding in inductive opposition to the tuned secondary circuit of a R.F. amplifier.

Circuit No. 33 balances the plate currents of 2 push-pull tubes by varying the space-charge currents brought about by changing the filament current.

Circuit No. 34 bypasses the R.F. load by shunting it with a capacity.

Circuit No. 35 shows the use of a bucking coil whose effectiveness is lowered by reduction of resistance in the control.

Circuit No. 36 is a tone-compensating volume control circuit. At low volume level the high frequencies are bypassed to ground, thus improving the response.

Circuit No. 37 employs a volume control as a diode load.

Circuit No. 38 shows the use of a potentiometer to control the triode control-grid.

Circuit No. 39 shows the connections for a fader control whereby 2 signal sources are faded into a common input.

Circuit No. 40 shows the tandem audio control used to vary the voltage impressed on the control-grids of 2 push-pull tubes.

*Courtesy Electrad Inc.

*Conversion and Extension of Meter Ranges

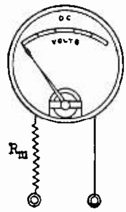


Fig. 1

Extending the Range of a D. C. Voltmeter

Rv=Resistance of the voltmeter in ohms, or, if ohms-per-volt is given, Rv can be found by multiplying the ohms-per-volt by the maximum reading in volts of the voltmeter.

V1=Original maximum reading of the meter in volts.

V2=The desired new maximum reading of the voltmeter in volts.

$$N = \text{Multiplying factor} = \frac{V2}{V1}$$

Rm=Resistance in ohms required in the meter multiplier as an external resistor.

Then: $Rm = Rv \times (N-1)$
See Fig. 1.

Converting a D. C. Milliammeter into a D. C. Voltmeter

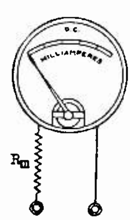


Fig. 2

I = Original maximum reading in milliamperes.
V = Desired maximum reading in volts.
Rm=Resistance of multiplier required, in ohms.
Then:

$$Rm = \frac{V \times 1{,}000}{I}$$

Note: The internal resistance of the milliammeter may be neglected without seriously affecting the result, for all practical purposes. See Fig. 2.

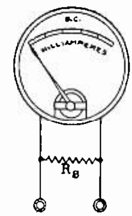


Fig. 3

Finding the Shunt Required to Extend the Range of a D.C. Milliammeter

Rm=Resistance of the meter in ohms.

Im = The original maximum reading, in milliamperes.

I = The desired new maximum reading, in milliamperes.

$$N = \text{Multiplying factor} = \frac{I}{Im}$$

Rs= The value of resistance in ohms of the shunt required.

Then:

$$Rs = \frac{Rm}{N-1}$$

In using the above method, the resistance of the meter must be accurately known. Fig. 3.

If the meter resistance is not accurately known, greater accuracy in scale conversion may be obtained by using two precision wire-wound resistors as shown in the accompanying illustration, Fig. 4. The use of this circuit arrangement considerably reduces the error that otherwise would occur when the resistance of the meter is not accurately known.

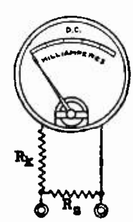


Fig. 4

Rm=Approximate meter resistance, as from manufacturer's catalog.

Rk=A resistor, equal in ohms, to 9 times Rm.

Then:

$$Rs = \frac{Rk + Rm}{N-1} = \frac{10 \times RM}{N-1}$$

*Courtesy International Resistor Co.

*GRID-BIAS RESISTOR CALCULATION

THE radio Service Man often finds it necessary to replace the grid-bias resistor in receivers employing a self-biasing arrangement for obtaining the proper control-grid voltage. When the resistance value is not known, it may be calculated by dividing the control-grid voltage required at the plate voltage at which the tube is operating, by the plate current in amperes plus the screen-grid current in amperes times the number of tubes passing current through the resistor.

Under the above rule, the control-grid bias resistor value is given by the following formula.

$$R = \frac{E_{c1} \times 1{,}000}{(I_B + I_{c2})\, n}$$

where: R=Control-grid bias resistor value in ohms.

E_{c1}=Control-grid bias required in volts (V.).

I_B=Plate current of a single tube in milliamperes (ma.).

I_{c2}=Screen-grid current of a single tube in milliamperes ma.).

n=The number of tubes passing current through the resistor.

Example:

It is desired to determine the value of control-bias resistor used to obtain the proper value of control-grid bias on 3 type 35 tubes working in the R.F. stages of a radio receiver.

First determine the plate and screen-grid voltages employed in this set. Suppose, in this case, it is found that the plate supply voltage is 250 and the screen-grid voltage is 90. Looking in the characteristics chart, it is found that the proper control-grid bias for the 35 under these conditions is —3.0 V. In addition, the plate current is 6.5 ma. and the screen-grid current is 2.5 ma. Substituting in the formula,

$$R = \frac{3.0 \times 1{,}000}{(6.5 + 2.5)3} = 111 \text{ ohms.}$$

The value of grid bias resistors can be calculated in this manner for any type and any number of tubes. In the case of triodes, the screen-grid current term drops out entirely.

Be sure to determine the plate voltage at which the tubes are working, the number of tubes being supplied from the control-grid bias resistor, the screen-grid voltage (if a tetrode or pentode), the correct value of control-grid bias voltage required (whether the tube cathode is operated from A.C. or D.C. will affect the value of bias voltage), and the plate and screen-grid current for the given plate voltage.

In the case of resistance-coupled amplifiers which employ high-grid resistance in the plate circuit, it must be remembered that the plate voltage is equal to the plate supply voltage minus the voltage drop in the plate load resistance caused by the plate current. The net plate voltage alone determines the correct value of control-grid bias.

The foregoing methods of calculations cannot be used in connection with radio sets and other equipment employing a bleeder circuit to obtain control-grid bias.

*Courtesy RCA Manufacturing Co.

FACTORS FOR CONVERSION

Multiply	By	To Get
Amperes	× 1,000,000	microamperes
Amperes	× 1,000	milliamperes
Cycles	× .000,001	megacycles
Cycles	× .001	kilocycles
Farads	× 1,000,000,000,000	micromicro-farads
Farads	× 1,000,000	microfarads
Henries	× 1,000,000	microhenries
Henries	× 1,000	millihenries
Kilocycles	× 1,000	cycles
Kilovolts	× 1,000	volts
Kilowatts	× 1,000	watts
Megacycles	× 1,000,000	cycles
Microfarads	× .000,001	farads
Microfarads	× 1,000,000	micromicro-farads
Microhenries	× .000,001	henries
Microvolts	× .000,001	volts
Micromicro-farads	× .000,000,000,001	farads
Milliamperes	× .001	amperes
Millihenries	× .001	henries
Millivolts	× .001	volts
Ohms	× .000,001	megohms
Ohms	× 1,000	milliohms
Volts	× 1,000,000	microvolts
Volts	× 1,000	millivolts
Watts	× 1,000	milliwatts
Watts	× .001	kilowatts

RADIO-CRAFT'S AUGMEN

Gauge No. B.&S.	Diam. in mils.*	Diam. in m m.	Cross-sectional area Cir. mils	Sq. Inches	Sq. m m.	Turns per linear inch[2] D.C.C.	D.S.C. or S.C.C.	Enamel	S.S.C.
0000	460.0	11.68	211600	.1662	107.2	—	—	—	—
000	409.6	10.40	167800	.1318	85.03	—	—	—	—
00	364.8	9.266	133100	.1045	67.43	—	—	—	—
0	324.9	8.252	105500	.08289	53.48	—	—	—	—
1	289.3	7.348	83690	.06573	42.41	—	—	—	—
2	257.6	6.544	66370	.05213	33.63	—	—	—	—
3	229.4	5.827	52640	.04134	26.67	—	—	—	—
4	204.3	5.189	41740	.03278	21.15	—	—	—	—
5	181.9	4.621	33100	.02600	16.77	—	—	—	—
6	162.0	4.115	26250	.02062	13.3	—	—	—	—
7	144.3	3.665	20820	.01635	10.55	—	—	—	—
8	128.5	3.264	16510	.01297	8.36	7.1	7.4	7.6	—
9	114.4	2.906	13090	.01028	6.63	7.8	8.2	8.6	—
10	101.9	2.588	10380	.008155	5.26	8.9	9.3	9.6	—
11	90.74	2.305	8234	.006467	4.17	9.8	10.3	10.7	—
12	80.81	2.053	6530	.005129	3.31	10.9	11.5	12.0	—
13	71.96	1.828	5178	.004067	2.62	12.0	12.8	13.5	—
14	64.08	1.628	4107	.003225	2.08	13.3	14.2	15.0	—
15	57.07	1.450	3257	.002558	1.65	14.7	15.8	16.8	—
16	50.82	1.291	2583	.002028	1.31	16.4	17.9	18.9	18.9
17	45.26	1.150	2048	.001609	1.04	18.1	19.9	21.2	21.2
18	40.30	1.024	1624	.001276	.82	19.8	22.0	23.6	23.6
19	35.89	.9116	1288	.001012	.65	21.8	24.4	26.4	26.4
20	31.96	.8118	1022	.0008023	.52	23.8	27.0	29.4	29.4
21	28.46	.7230	810.1	.0006363	.41	26.0	29.8	33.1	32.7
22	25.35	.6438	642.4	.0005046	.33	30.0	34.1	37.0	36.5
23	22.57	.5733	509.5	.0004002	.26	31.6	37.6	41.3	40.6
24	20.10	.5106	404.0	.0003173	.20	35.6	41.5	46.3	45.3
25	17.90	.4547	320.4	.0002517	.16	38.6	45.6	51.7	50.4
26	15.94	.4049	254.1	.0001996	.13	41.8	50.2	58.0	55.6
27	14.20	.3606	201.5	.0001583	.10	45.0	55.0	64.9	61.5
28	12.64	.3211	159.8	.0001255	.08	48.5	60.2	72.7	68.6
29	11.26	.2859	126.7	.00009953	.064	51.8	65.4	81.6	74.8
30	10.03	.2546	100.5	.00007894	.051	55.5	71.5	90.5	83.3
31	8.928	.2268	79.70	.00006260	.040	59.2	77.5	101.	92.0
32	7.950	.2019	63.21	.00004964	.032	62.6	83.6	113.	101.
33	7.080	.1798	50.13	.00003937	.0254	66.3	90.3	127.	110.
34	6.305	.1601	39.75	.00003122	.0201	70.0	97.0	143.	120.
35	5.615	.1426	31.52	.00002476	.0159	73.5	104.	158.	132.
36	5.000	.1270	25.00	.00001964	.0127	77.0	111.	175.	143.
37	4.453	.1131	19.83	.00001557	.0100	80.3	118.	198.	154.
38	3.965	.1007	15.72	.00001235	.0079	83.6	126.	224.	166.
39	3.531	.0897	12.47	.000009793	.0063	86.6	133.	248.	181.
40	3.134	.0799	9.888	.000007766	.0050	89.7	140.	282.	194.
41	2.75	.0711	7.841	.000006160	.0040	—	—	—	—
42	2.50	.0633	6.220	.000004885	.0032	—	—	—	—
43	2.25	.0564	4.933	.000003873	.0025	—	—	—	—
44	2.00	.0502	3.910	.000003073	.0020	—	—	—	—
45	1.75	—	3.66	—	—	—	—	—	—
46	1.50	—	2.25	—	—	—	—	—	—
50	1.00	—	—	—	—	—	—	—	—

*A mil is 1-1000 of an inch. **For hard drawn copper, increase resistance values 2%.

TED COPPER WIRE TABLE

Turns per Square Inch[2]			Feet per pound			Resistance of wires (ohms per 1000 ft)		Copper wire carrying capacity (amperes)	
S.C.C.	Enamel S.C.C.	D.C.C.	D.C.C.	(copper) S.C.C.	Bare	Copper**	Advance (approx)	at 1000 C.M. per amp	at 1500 C.M. per amp
—	—	—	—	—	1.561	.0499	—	211.6	140.7
—	—	—	—	—	1.968	.0629	—	167.8	111.3
—	—	—	—	—	2.482	.0793	—	133.1	88.9
—	—	—	—	—	3.130	.1000	—	105.5	70.3
—	—	—	—	—	3.947	.1260	—	83.7	55.7
—	—	—	—	—	4.977	.1592	—	66.4	44.1
—	—	—	—	—	6.276	.2004	—	52.6	35.0
—	—	—	—	—	7.914	.2536	—	41.7	27.7
—	—	—	—	—	9.980	.3192	8.88	33.1	22.0
—	—	—	—	—	12.58	.4028	11.21	26.3	17.5
—	—	—	—	—	15.87	.5080	14.19	20.8	13.8
—	—	—	19.6	19.9	20.01	.6045	17.9	16.5	11.0
—	—	—	24.6	25.1	25.23	.8077	22.6	13.1	8.7
87.5	84.8	80.0	30.9	31.6	31.82	1.018	28.0	10.4	6.9
110	105	95.5	38.8	39.8	40.12	1.284	35.5	8.2	5.5
136	131	121	48.9	50.2	50.59	1.619	44.8	6.5	4.4
170	162	150	61.5	63.2	63.80	2.042	56.7	5.2	3.5
211	198	183	77.3	79.6	80.44	2.575	71.7	4.1	2.7
262	250	223	97.3	100	101.4	3.247	90.4	3.3	2.2
321	306	271	119	124	127.9	4.094	113.0	2.6	1.7
397	372	329	150	155	161.3	5.163	145.0	2.0	1.3
493	454	399	188	196	203.4	6.510	184.0	1.6	1.1
592	553	479	237	247	256.5	8.210	226.0	1.3	.86
775	725	625	298	311	323.4	10.35	287.0	1.0	.68
940	895	754	370	389	407.8	13.05	362.0	.81	.54
1150	1070	910	461	491	514.8	16.46	460.0	.64	.43
1400	1300	1080	584	624	648.4	20.76	575.0	.51	.34
1700	1570	1260	745	778	817.7	26.17	725.0	.41	.27
2060	1910	1510	903	958	1031	33.00	919.0	.32	.21
2500	2300	1750	1118	1188	1300	41.62	1162	.25	.17
3030	2780	2020	1422	1533	1639	52.48	1455	.20	.13
3670	3350	2310	1759	1903	2067	66.17	1850	.16	.11
4300	3900	2700	2207	2461	2607	83.44	2300	.13	.084
5040	4660	3020	2534	2893	3287	105.20	2940	.10	.067
5920	5280	—	2768	3483	4145	132.70	3680	.079	.053
7060	6250	—	3137	4414	5227	167.30	4600	.063	.042
8120	7360	—	4697	5688	6591	211.00	5830	.050	.033
9600	8310	—	6168	6400	8310	266.00	7400	.039	.026
10900	8700	—	6737	8393	10480	335.00	9360	.032	.021
12200	10700	—	7877	9846	13210	423.00	11760	.025	.017
14000	13400	6510	9309	11636	16660	533.40	14550	.020	.013
16600	15150	6950	10666	13848	21010	672.60	18395	.016	0.10
18000	16750	7450	11907	18286	26500	848.10	24100	.012	.008
—	—	—	14222	24381	33410	1069.00	32660	.009	.006
—	—	—	17920	30610	42130	1323.00	38880	.008	.005
—	—	—	22600	38700	53100	1667.00	47040	.006	.004
—	—	—	28410	48600	66970	2105.00	58070	.005	.003
—	—	—	35950	61400	84460	2655.00	75500	.004	.0025
—	—	—	—	—	—	—	96000	—	—
—	—	—	—	—	—	—	130700	—	—
—	—	—	—	—	—	—	—	—	—

[2]The figures given are approximate only, since the thickness of the insulation varies with different manufacturers.

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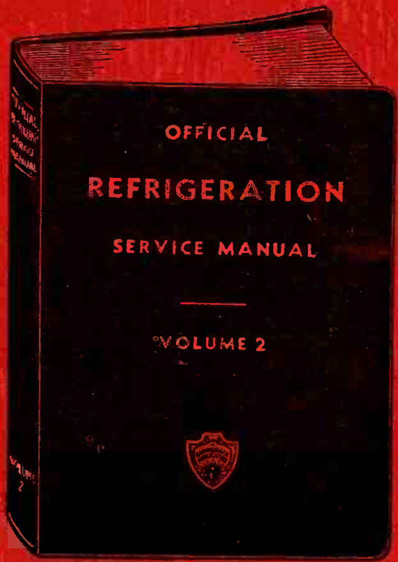

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