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MODERN BATTERY RADIO SETS

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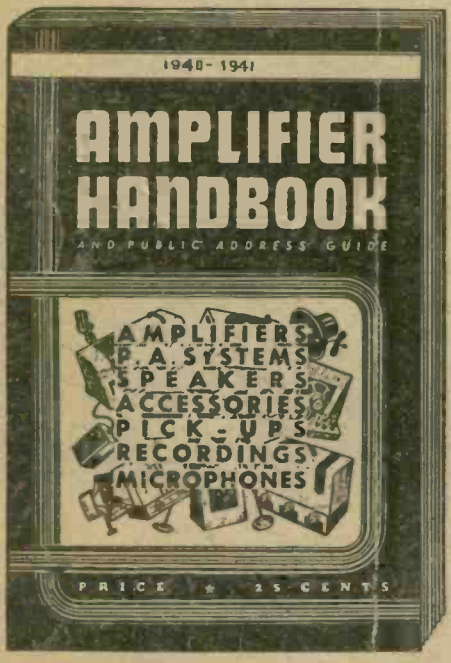

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A Resume of the Contents of the

Amplifier Handbook

AND PUBLIC ADDRESS GUIDE

MODERN BATTERY RADIO SETS

Mudell Reynolds

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BY THE EDITORS OF

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Contents

Preface

THE articles in Modern Battery Radio Sets have been carefully selected by the compilers from past issues of *Radio-Craft* magazine. For a number of reasons these articles have been found to be of interest to a wide cross-section of radio men.

First, the radio man who is taking his first steps—the beginner—will find in these articles basic circuit arrangements of elementary radio receivers which serve the dual role of teaching the elements of radio reception, and of making available perfectly-operating 1- and 2-tube radio receivers. Picture diagrams and breadboard layouts characterize the more simple constructions.

Second, advanced radio set-builders are offered somewhat more complicated arrangements that afford greater utility and convenience than is possible in less complex designs. Portable radio sets, all-wave receivers, marine direction finders, these and many more types are illustrated and described in detail.

Third, laboratory workers and engineers will find exemplified in many of these articles circuit and constructional features which subsequently became commercial practice; and many ideas which undoubtedly will be modified to suit manufacturing requirements. Among the new ideas that appeared for the first time in *Radio-Craft* articles and which are now conveniently available in this issue of Modern Battery Radio Sets, are the following: use of miniature (midget) tubes, pentagrid 2nd-detector, capacity and loop antennas, superregeneration with a single dual-purpose tube, permeability-tuned receivers, radio — phono battery-portable, and many other circuit and constructional features involving the use of new tubes and other components.

Lists of recommended components, specified exactly by make and model number and coded to the diagrams by identifying numbers, make it comparatively easy for even the student radio man to obtain proper parts for each design; and chassis layouts, suggestions as to proper sequence of assembly and wiring, all give average builders greater assurance that the completed set will operate with maximum efficiency.

Whether you are tyro or expert, Modern Battery Radio Sets contains educational, entertaining articles for you.

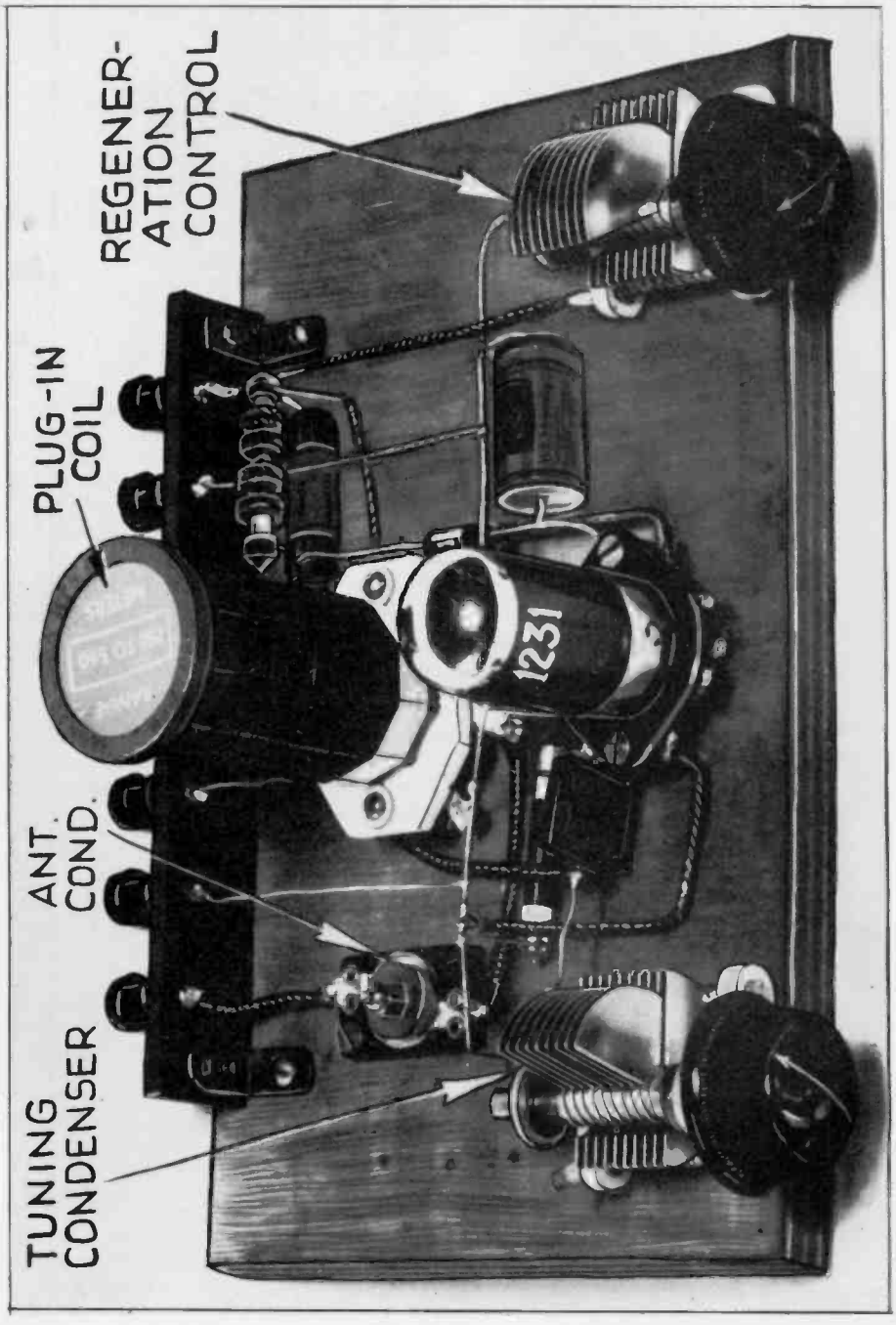


Fig. A. Here's the 1-tuber; perks beautifully on b'cast and all short-wave bands; uses new type 1231 television tube as high-gain detector.

BEGINNER'S A 1-TUBE HIGH-GAIN ALL-WAVE RECEIVER

IF there is anything a radio editor likes a little less than a toothache it's being told to design and construct a new receiver just when the magazine is ready to go to press. Such was the fate of the writer. Something new, something good, something that is a lead-pipe cinch for the beginner to construct—and all at a minimum cost.

We then took a saw, a hammer, some midnight oil and a trip to the cellar workshop.

We were fortunate enough to find a decent board from which we buzzed off a piece measuring about 6 x 10 ins., we had a baseboard! Searching through the junkbox we had enough luck to find a binding post strip with 7 binding posts thereon, and a length of hookup wire.

That formed our foundation kit—all we had to do was get the parts, a list of which concludes this article.

PLACEMENT AND WIRING

First, we mounted the 2 midget variable condensers about equidistant from the ends of the panel, as seen in Fig. A. Halfway between them we mounted the special socket for Sylvania's type 1231 television tube, and about an inch behind it, the isolantite-type socket for the 3-circuit plug-in coil.

A length of copper bus was used to connect the requisite coil terminals, tube prongs and condenser rotors to ground, thus getting rid of about 25 per cent of the connections at a single lick. A pair of lengths and push-back wire were then twisted together for the filament circuit, and we felt that the set was practically complete. All that remained was to connect a trimmer in the antenna lead and to wire the grid and plate circuits as shown in circuit diagram Fig. 1. Another half-hour saw that job done and the set finished, but . . . .

We then learned that we had forgotten the condenser stators, so hooked them up, too. Finally we connected a 0.1-mf. condenser between the plate and one of the output binding posts as we intended to use crystal phones which, of course, might have been damaged by the passage of plate current.

After all this was done we connected the 6-V. filament battery where it should be and saw that the filament lit. We next connected the same battery across the "B" terminal and were overjoyed to find out that the filament did *not* light. This is a test we always make and it has saved us enough money in tubes so that we could buy a yacht if we hadn't spent the money for something else.

Everything having checked OK, we applied the "B" voltage and were dismayed to get no results. We sat down and checked the set and found out that we had forgotten to attach the aerial and ground. When we put them on, the stations began coming in like poor relations during a depression—gangs and gangs of them, one right after another. The stations logged with merely a piece of wire hanging out of the window included those of the 20-, 40-, 80-, and 160-amateur bands, as well as broadcasting stations.

Thus we found that we had constructed a pretty decent 1-tube, all-wave battery receiver.

Then, at 4 A.M. in the morning, we sat down to write this article, which as you'll agree, is pretty "whoosie".

DETAILS

The excellent success of the set we may attribute mainly to the use of the

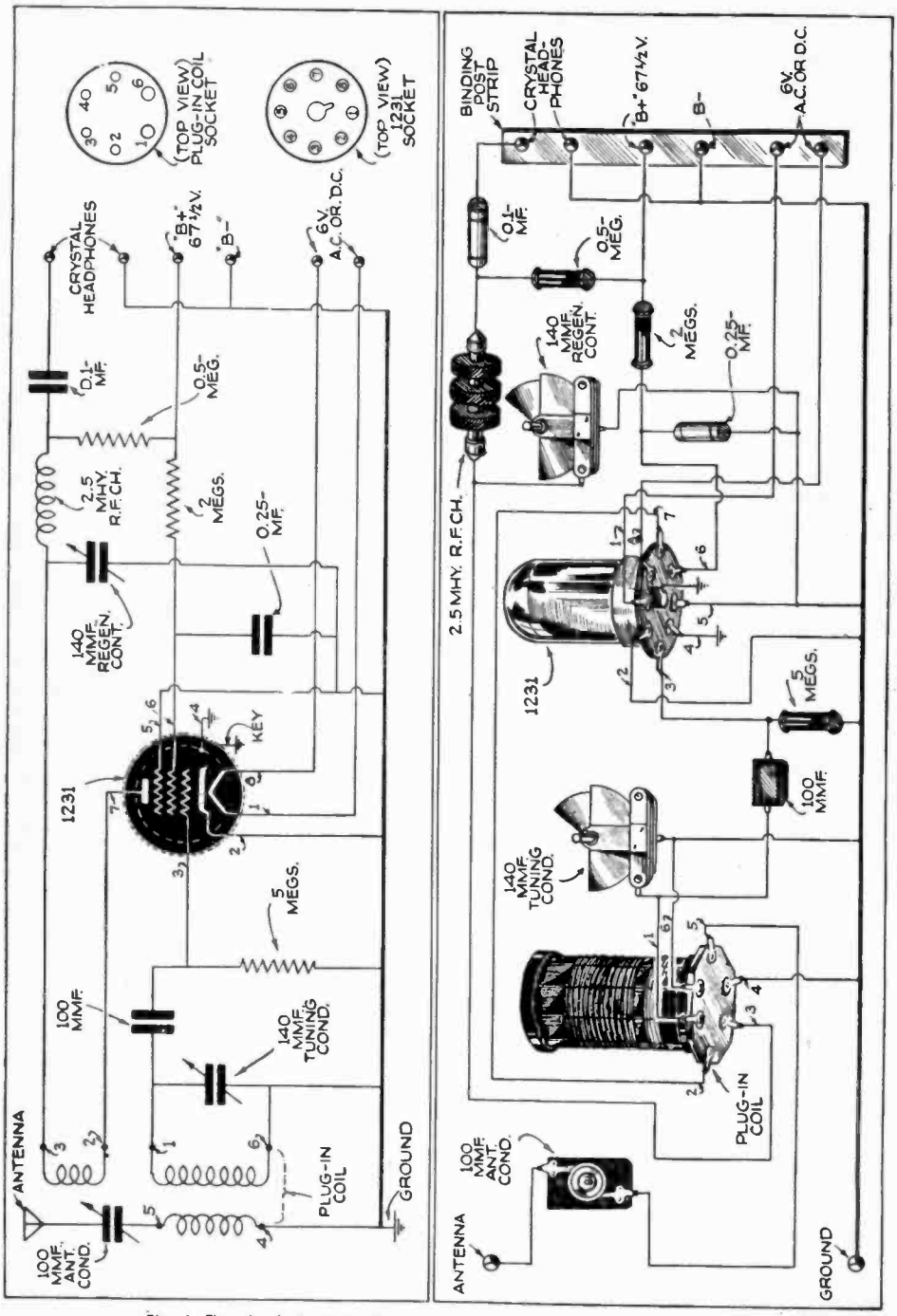


Fig. 1. The circuit is straightforward regenerative, with high-gain 1231 detector.

Note that the socket numbering is not R.M.A. but arbitrary.

type 1231 video amplifier tube. This high-gain television tube is here used for the first time as a high-gain detector. The volume which this little set afforded in a modern steel building and with only a short wire dangling out of the window as an antenna, is amazing. Broadcast and short-wave stations alike, including code, came in with remarkable clarity. Regeneration was smooth and easily controllable. Secondary credit for excellent performance must go to the high-quality parts used. In order to keep R.F. losses at a minimum isolantite-insulated variable condensers and coil socket were used as well as low-loss plug-in coils. Tertiary credit should go to the author for his excellent design and construction (hi!).

The radio beginner has a real mark to shoot for in this 1-tube all-wave battery receiver—but he shouldn't stay up until 4 A.M. in the morning building it.

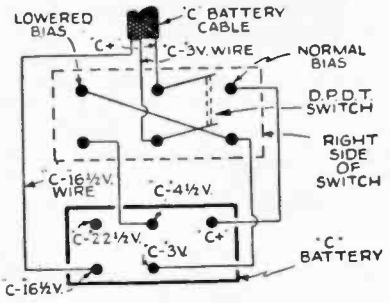
List of Parts

Two *Hammarlund* type MC-140-M variable condensers, 140 mmf.;
One set of *Hammarlund* Short-Wave plug-in coils, type SWK-6, 17 to 270 meters;
One *Hammarlund* Broadcast plug-in coil, type BCC-6, 250 to 560 meters;
One *Hammarlund* R.F. choke, type CHX, 2.5 mhy.;
One *Sprague* 0.25-mf. fixed condenser;
One *Sprague* 0.1-mf. fixed condenser;
One *IRC* resistor, 5 meg., ½-W.;
One *IRC* resistor 0.5 megs., ½-W.;
One *IRC* resistor, 2 megs.. ½-W.;
One Micamold trimmer condenser, 100 mmf.;
One *Aerovox* mica condenser, 100 mmf.;
One *Hammarlund* 6-prong isolantite socket, type S-6;
One *Sylvania* type 1231 tube;
One *Sylvania* Special Octal Socket for above tube;
One 7-post binding-post strip;
One home-made baseboard;
Two knobs with pointers;

SWITCH FOR VARYING "C" BIAS ON BATTERY RADIO SETS

● WHEN a set of "B" batteries has been used for some time they drop in voltage from 45 volts to about 30 volts; when this happens the "C" bias becomes too high, thus blocking the plate current of the tube so that the output is weak and distorted.

I hWe found that if the "C" bias can be lowered, a month or more of additional service can be obtained from these same batteries. The average user does not know how to accomplish this, but any Serviceman can easily do it by inserting a double-pole, double-throw toggle switch into the "C"-bias circuit so that all the radio user need do when his batteries begin to get weak is throw the switch to lower the bias. This switch is so wired that when the batteries are new and the switch is thrown to the right the entire bias is normal. (See accompanying sketch.) When the switch is thrown to the left the "C" bias is lowered.



This switch and its connections are shown in the accompanying illustration. One wire is designated "C+," another "C-3," and the other is –16½ volts. This is the "Normal Bias." When the switch is thrown to the left "C+" is switched to "C-3" and the other half of the switch changes the "C-3" wire from "C-3" to "C-4½"; this arrangement automatically changes the 16½-volt bias to 13½ volts or "C-P.W.R."

This arrangement can be revised to work in any individual radio sets having different "C" bias.

BEGINNER'S
BUILD THIS 1-TUBE LOOP RECEIVER

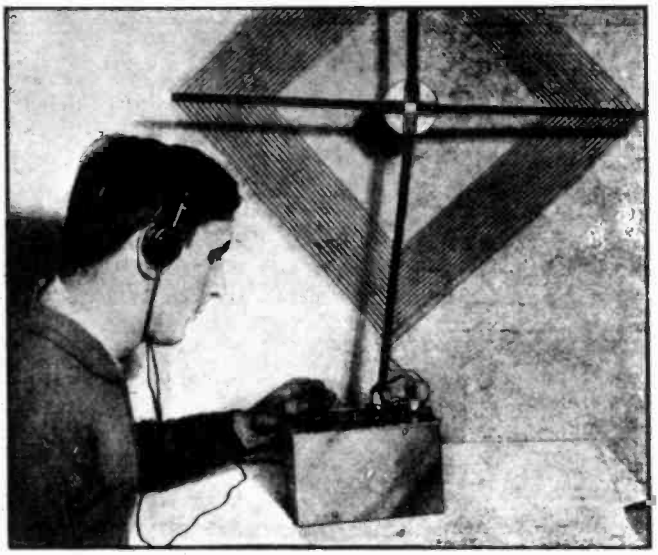


Fig. A The 1-tube loop receiver being used. Tried out in a modern steel building, the volume was sufficient to rattle the earphones

NO originality is claimed for either the circuit or style of this receiver. Its main claim to existence is merely to provide a simple receiver which beginners in radio may easily follow. Employing a simple non-tricky circuit, 1 tube, dry batteries, and the familiar "loop antenna," it will afford many pleasant hours of construction crowned by the thrill and satisfaction of ultimate success when radio programs come ringing through.

The receiver is easily portable, making itself especially useful at picnics and similar outings;—it may be used at sport arenas to hear as well as see play-by-play descriptions. Finally (although not designed specifically for this purpose), it makes an excellent interference locator.

INTERFERENCE LOCATOR

Myriad types of electrical equipment now in use all over the world tend to radiate radio waves when they are used. These waves manifest themselves in the form of noise (called man-made static) in receivers. To trace the origin of such noise, a receiver only of the loop type must be used because of its highly directive reception characteristics. In other words, the loop antenna is rotated in its socket until the noise (as heard in the phones) is at its greatest volume. In this position, the end of the loop points in the approximate direction from which the noise is emanating. If you walk in that direction you will notice that the noise intensity increases until, when you come to the electric sign or other electrical apparatus which is causing the disturbance, the noise in the ear-

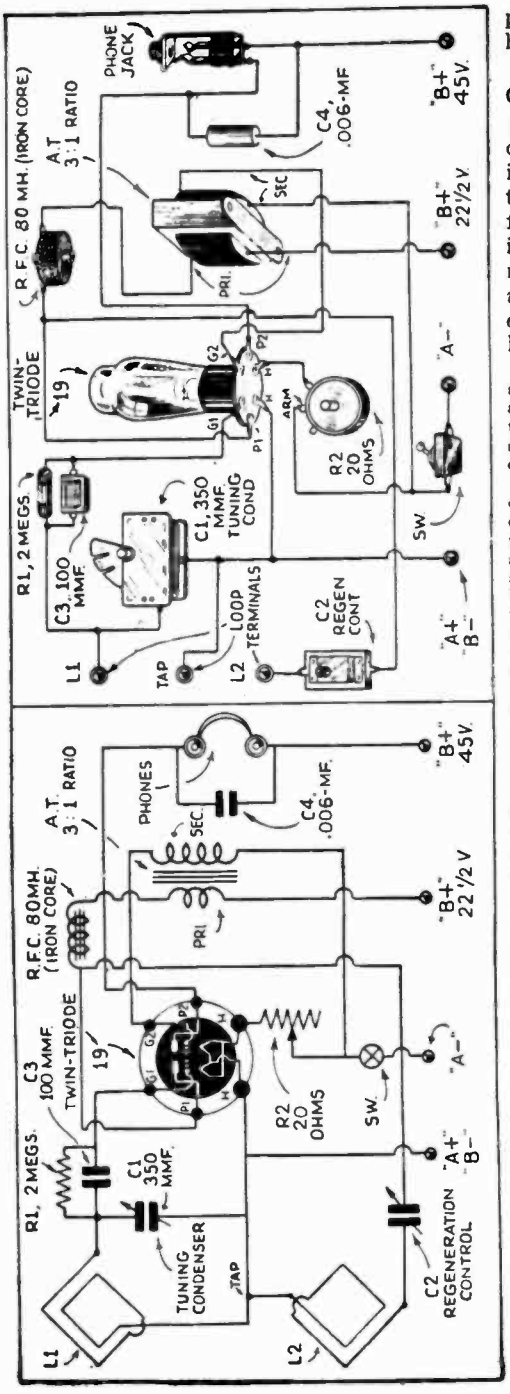


Fig. 1. Left—schematic circuit of the 1-tube 1000 receiver. An outside antenna may be used in place of the loop by substituting a standard antenna coil and adding several turns as a tickler winding. Right—pictorial diagram of the receiver for those who find it inconvenient to follow a schematic.

phones is at its maximum and you then have located the source.

CONSTRUCTION OF THE SET

Reference to the schematic diagram, or the pictorial diagram, both shown in Fig. 1, will show that a single tube, type 19, is used. However, this tube performs as 2 separate tubes inasmuch as it contains a double set of triode elements. *The first section of the tube is used as a detector, the second section as an audio amplifier.* This affords excellent earphone reception.

Now, by adding *regeneration* to the detector stage (we do it in the simplest manner imaginable), we can strengthen the signal sufficiently to operate a loudspeaker with fair volume! This speaker, a magnetic type, is connected in place of the earphones.

At the end of this article is appended a List of Parts. Collect all this material, lay out the components in the approximate positions which they will assume when mounted on the panel, and then decide upon the measurements of the aluminum box in which the receiver will be housed. It is not necessary to adhere strictly to the author's measurements, merely choose a size which will permit both the receiver and the "A" and "B" batteries to be housed in the same metal container. See Fig. B.

The loop is held in an upright position by means of a bracket. See Fig. 2.

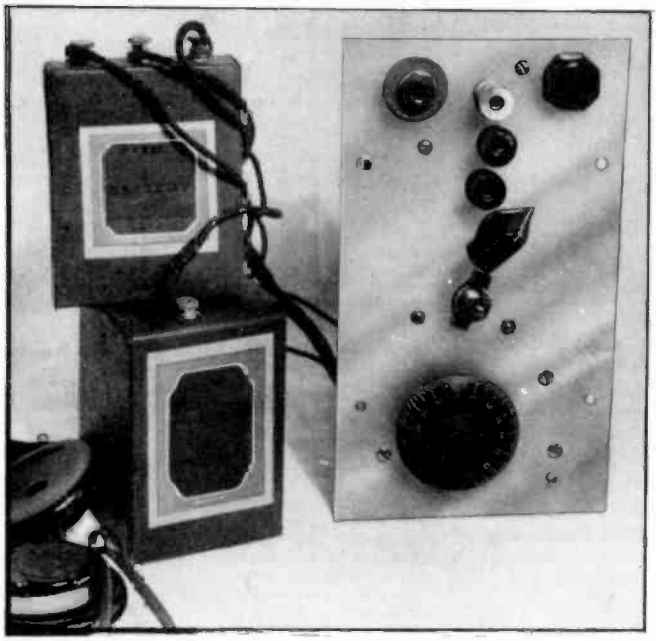
ANALYSIS OF CIRCUIT

The action of the circuit is as follows:

That part of the loop, marked L1, in combination with variable condenser C1 constitutes the tuned circuit which "pulls in" the signal. This signal is fed to the *detector section* of the tube which rectifies it, i.e., separates the "voice" part from the "carrier" part and amplifies it to a certain extent. Some of this signal is then "fed-back" through the medium of condenser C2, into that section of the loop called L2, thereby once more impressing it upon the detector section of the tube. This *regeneration* action increases the strength of the signal, which is then transformer-coupled (for further voltage gain) into the audio amplifying section of the type 19 tube.

If the diagrams are followed carefully and the batteries connected as shown in the pictorial diagram, then, the receiver will work "right off the bat." *Caution.*—**At no time must the tube be permitted to get over 2 volts on the filament. A voltmeter will be useful to you.**

Turn condenser C2 until you hear the purring sound which is characteristic of a regenerative receiver, or a whistle. If you hear a whistle turn the loop to such a position as to make the whistle loudest and then manipulate condenser C1 to bring in the whistle louder still. Now turn condenser C2 until the whistle just about disappears and your station will come in with amazing clarity.



Front view of the Beginners' 1-Tube Loop Receiver. Notice that the panel was not laid out with an eye towards perfect harmony. The primary thought in the layout of parts was that of shortest possible leads; which makes for circuit stability. The 2 batteries shown are new miniature type "A" and "B" units. When not used they are contained in the same box which houses the set. Upper-left on the panel is the headphone jack; upper-right, regeneration control. The tuning dial is at the bottom of the panel.

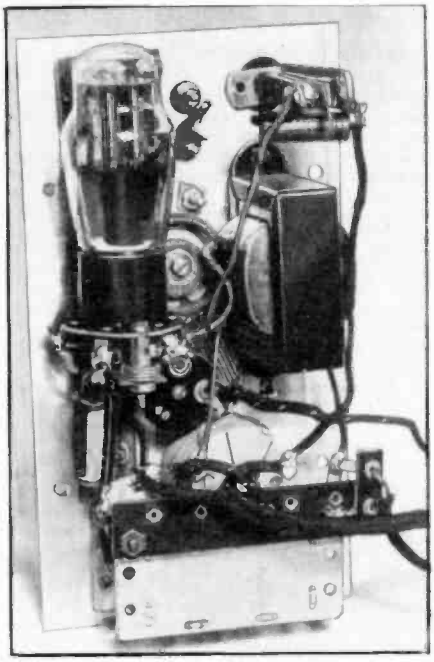


Fig. B. Internal view of the compact 1-tube set. All parts are mounted behind the top panel of the box and are therefore readily accessible.

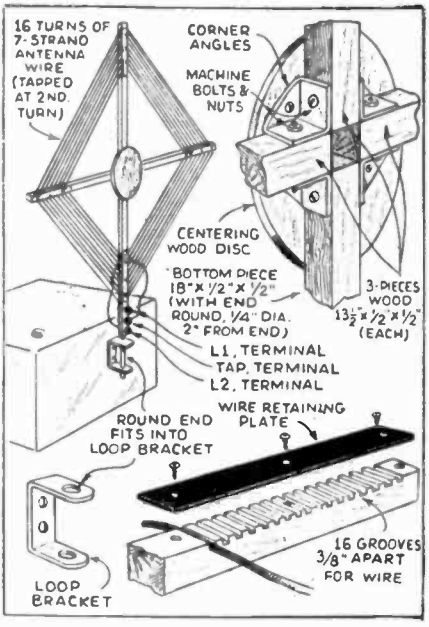


Fig. 2. Details of the collapsible loop.

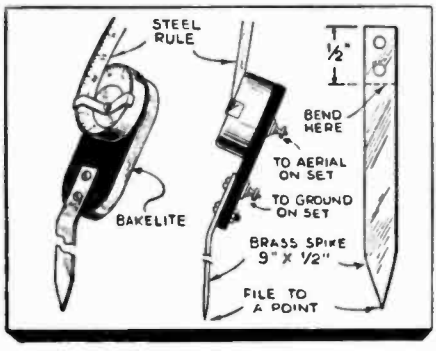
LIST OF PARTS

One variable condenser, midget type, 350 mmf., C1;
One loop antenna (see text);
One filament rheostat, 20 ohms, R2;
One Meissner type 17028 trimmer-type (regeneration) condenser, 80-225 mmf., C2;
One fixed mica condenser, 100 mmf., C3;
One fixed paper condenser, 600 mmf., C4;
One Meissner type 6846 R.F. choke, 80 mhy., R.F.C.;
One Kenyon audio transformer, 3-to-1 ratio, A.T.;
One I.R.C. carbon resistor, 2 megs., ½-W., R1;
One filament on-off switch, Sw.;
One 6-prong wafer socket;
One single-circuit phone jack;
One National Union type 19 tube;
One Eveready "B" battery, No. 733, 45 V.;
One Eveready "A" battery, No. 723, 3 V.;
One metal box, any suitable size.

A SIMPLE PORTABLE AERIAL

● A SIMPLE aerial—ground unit for a portable set can be constructed as follows:—

A cheap 6 ft. steel rule of the concave-convex cup type is obtained, and the rivet passing through the center drilled-out and replaced by an old type terminal. This in turn is passed through a hole drilled in a piece of bakelite about 4 ins. long and 2 ins. wide.

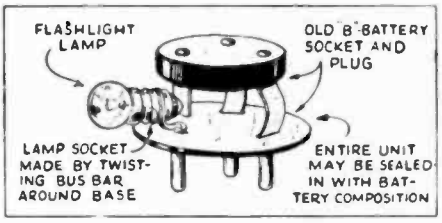


Now take a strip of brass 9 ins. long and ½-in. wide. This is bent and bolted to the bakelite as shown in the sketch. A terminal is also provided. In use, the pointed end of the brass strip is pushed into the ground, which should be dampened if it is dry, and the rule extended. The aerial and ground leads are taken to "Ant." and "Gnd.," respectively, on the set.

If the rule is tilted slightly backward, it will remain rigid in anything but a strong wind.

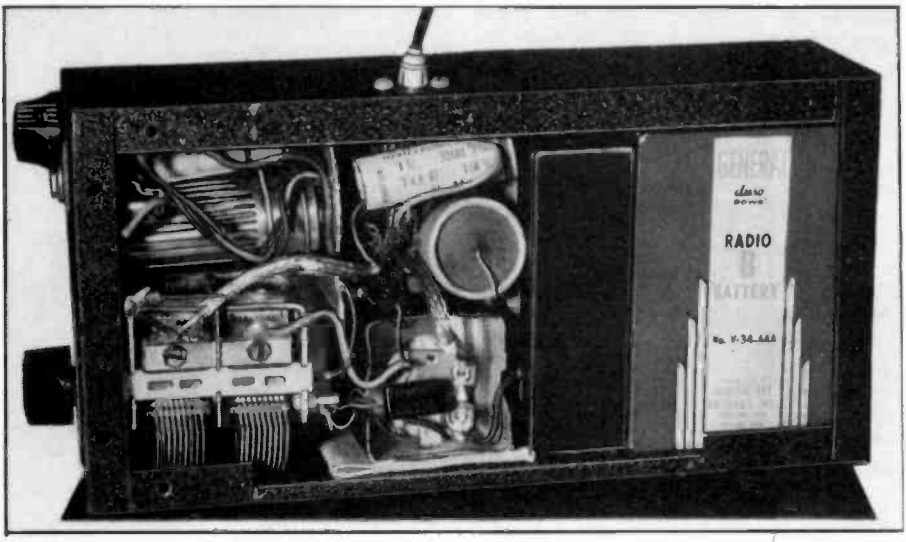
PILOT-LIGHT FUSE

● THE little gadget sketched here has saved quite a few sets of tubes in battery radio sets that had a short in the "B"-battery circuit going through the filaments (as it seems to mostly). The gadget is made from the socket out of an old "B"-battery and a "B"-battery plug. It is plugged into the 1st "B"-battery and the set plugged into it, thus the "B"-return



goes through the flashlight lamp. In case of a short the lamp burns out before anything can happen elsewhere. The lamp must of course have a current rating less than the total filament drain of the tubes being protected. The lamp must be bypassed by a condenser; 2 mf. ordinarily is about the right value (to prevent motorboating).

A "3-IN-1" BATTERY PORTABLE



View of the completed "3-in-1" Battery Portable with the bottom plate removed.

THE 1D8GT tube lends itself to many applications some of which may suggest to technicians newer and better ways of doing things. The 1D8GT has 3 separate tubes within one glass envelope, a triode portion suitable for either R.F. or A.F. amplification; a diode suitable for detection and automatic volume control; and, a pentode for the power audio-frequency output circuit. The filament only consumes 1/10 of an ampere direct from a 1½ volt "A" cell. The total plate consumption at a maximum of 90 volts is only slightly over 6 milliamperes.

Following is a description of a compact portable receiver centered around this tube. The overall dimensions of the receiver are comparatively small—10 x 5 x 3 ins.—so that the unit can be carried in an overcoat pocket, a briefcase or an overnight bag.

THE 3-IN-1 CIRCUIT

The multi-unit tube is used as per the circuit diagram given in Fig. 1 wherein the triode is the tuned R.F. amplifier, the diode is a detector and A.V.C., and the pentode is the audio output amplifier. The antenna transformer T1 and detector transformer T2 are both high-gain type and accordingly the sensitivity is relatively high. By holding an antenna lead a foot or so long it is possible to obtain ample volume from local broadcast stations. Using an indoor antenna 15 to 25 feet long, out-of-town stations can be received at night, in addition to all locals. The receiver can be used with a single or double headphone, or with a 5-in. permanent-magnet dynamic speaker; the latter is optional and can be mounted in a separate case.

The schematic diagram given in Fig. 1 is self-explanatory. The 800-ohm resistor in the "B" negative lead is used to obtain a drop in potential to apply to the pentode control-grid for the necessary bias. The 2,000-ohm resistor and 0.1-mf. condenser in the detector transformer plate-return lead is an R.F. filter or decoupler to eliminate parasitic feedback. The balance of the circuit is strictly conventional.

PARTS PLACEMENT

Figure 2 gives the essential dimensions. The carrying case is a standard unit finished in black wrinkle baked enamel. The receiver components are mounted on a sub-base, a piece of 1/16-in. sheet aluminum 5¼ ins. x 4¾ ins. wide. The double gang condenser is mounted on this base, using the center-lines shown. The octal socket and volume control switch are mounted on brackets according to the dimensions given.

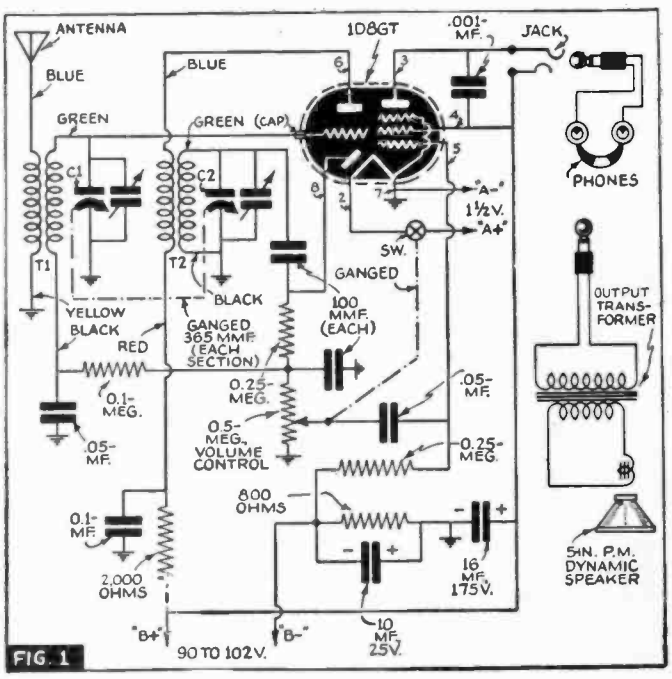


FIG. 1

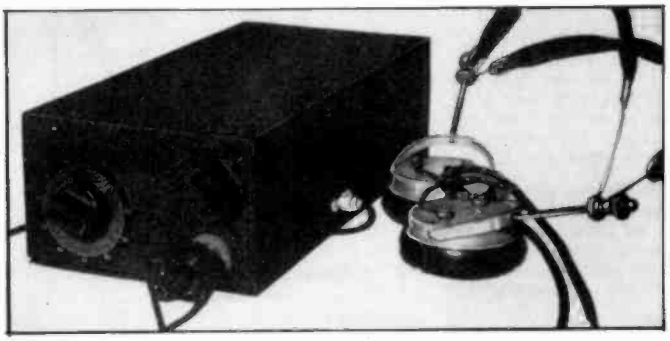
At right, diagram of the "3-in-1" set. It is just a straight-forward stage of T.R.F. feeding a diode detector driving an A.F. pentode.

The antenna transformer, T1, is used without the shielding case; but the detector transformer, T2, is left in its metal container and mounted as shown. The remaining parts—resistors, condensers, etc.—can be located in any desired arrangement that lends itself to short connections.

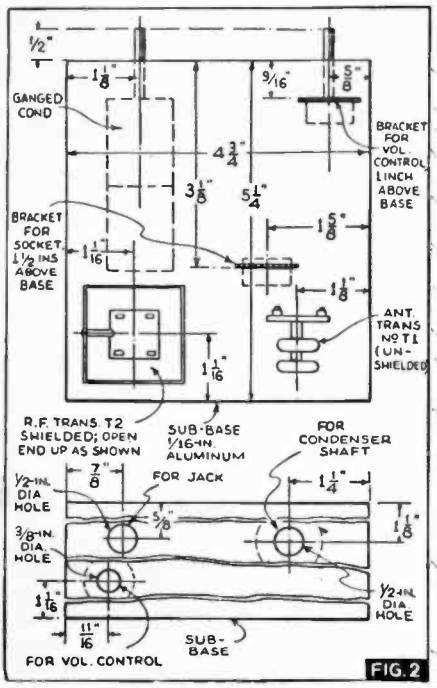
Figure 2 also gives the center-line locations for the condenser tuning shaft, volume control shaft and phone jack.

After completing the wiring, the receiver can be tested outside the container case. After satisfactory tests, the complete receiver on its sub-base is mounted within the cabinet first, the 2 "B" batteries are inserted next and the "A"– cell — last. The battery leads should be long enough so the batteries can be inserted in place without difficulty. Before screwing the cover of the case into place, small pieces of cardboard should be inserted to hold the batteries rigid. The sub-base can be held to the container case with one or two machine screws if desired.

A complete bill of materials is given showing the parts used. Equivalent substitutes may be used if the electrical values are identical and the physical dimensions of each part are not exceeded. Transformers T1 and T2, must be *iron-core* and capable of high gain and uniform response over the entire tuning range if good results are to be expected.



View of completed "3-in-1" Portable; antenna plugs into jack on right side. Set fits into overcoat pocket or a briefcase.



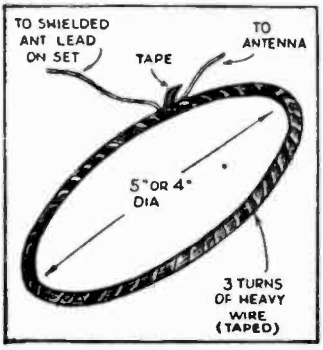
LIST OF PARTS

One RCA type 1D8GT tube;
One Meissner antenna R.F. transformer, No. 14-1496, T1;
One Meissner detector transformer, No. 14-1497, T2;
One Meissner compact 2-gang tuning condenser, No. 21-5214, each section 356 mmf., C1, C2;
One Clarostat 0.5-meg. volume control, with switch (V.C.-SW.);
One Centralab resistor, 800 ohms, ½-W.;
Two Centralab resistors, 0.25-meg., ½-W.;
One Centralab resistor, 2,000 ohms, ½-W.;
One Centralab resistor, 0.1-meg., ½-W.;
Two Cornell-Dubilier paper condensers, 0.05-mf., 200 V.;
One Cornell-Dubilier paper condenser, 0.1-mf., 200 V.;
One Cornell-Dubilier dry electrolytic condenser, 10 mf., 25 V.;
One Cornell-Dubilier dry electrolytic condenser, 16 mf., 175 V.;
Two Cornell-Dubilier mica condensers, 100 mmf.;
One Cornell-Dubilier mica condenser, 0.001-mf.;
One General "A" cell, No. 2-F-1, 1½ V.;
Two General "B" batteries, No. V-34-AAA, 51 V.;
One Parmetal case, 10 x 5 x 3 ins., No. B4508 and cover No. BP4508;
One American Phenolic Co. octal socket;
One P.R. Mallory open-circuit jack, No. 701;
One P.R. Mallory phone plug, No. 75;
One pair Cannonball headphones;
One Utah 5-in. P.M. dynamic speaker (optional);
Two Meissner tuning knobs, No. 25-8221;
Miscellaneous: 1 grid clip, 1 tube shield, 10-ft. pushback wire No. 18, 2 "B" and 1 "A" battery plug connectors, 1 antenna plug and socket, 1 tuning indicator plate, 1 piece 1/16-in. sheet aluminum 5¼ x 4¾ ins., 4 ft. No. 16 flexible rubber-covered wire for battery leads, 1 roll resin-core solder.

CAR-RADIO NOISE BALANCER. Recently We installed a radio set in a car and was unable to entirely eliminate the motor noise by the ordinary methods of shielding and suppressing. After some experimenting we found that the motor noise could be eliminated by mounting a bucking-coil, in the antenna circuit, under the dash of the car. This coil is only about 5 ins. in diameter and consists of 3 turns of heavy bell-wire, one end of which is connected to the shielded antenna lead of the radio, the other end to the antenna lead-in. By means of very little experimenting, while set is in operation and the car running, the exact plane or position in which the coil should be mounted can be determined.

When this position is found the coil can be clamped to the speedometer cable by means of 2 metal straps. The coil should be taped together all the way around to make it stiff.

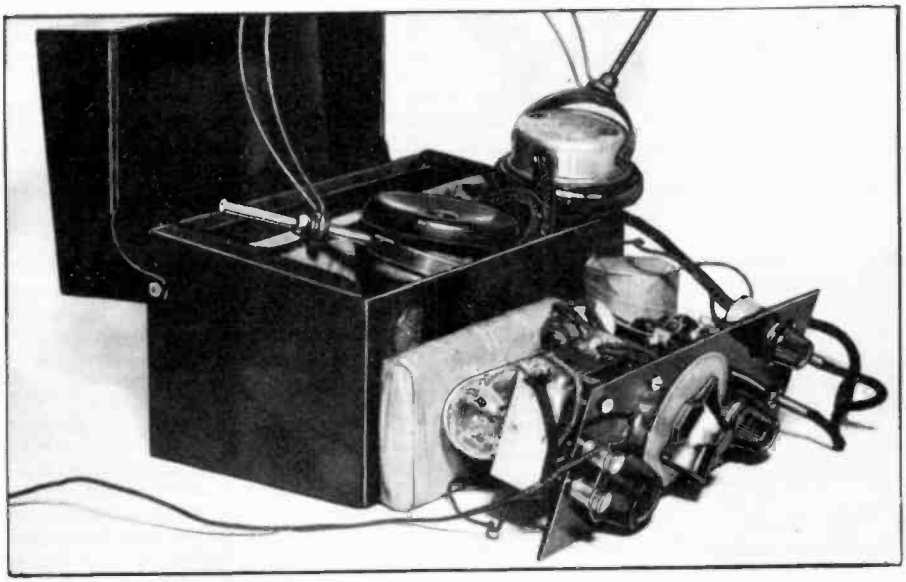
The voltages set up in the coil bucks that set up in the antenna and lead-in. No suppressors or shielding is needed.



Noise-bucking pick-up coil for car radio.

An Easily-Built "Flewelling Superregenerative"

2-in-1 "CARD FILE" BATTERY SET



The 2-in-1 Superregenerative Receiver, with the instrument panel removed from the "card file."

THE writer had an occasion of emergency arise in which a small, self-contained receiver was needed. The greatest sensitivity, selectivity and volume possibly obtainable were required.

Review was made of the art even back to the 1920-'21 broadcast era, in which the regenerative receivers enjoyed such popularity. All possible circuit combinations were analyzed and all possible components considered.

From that study evolved the development of the small, simple receiver illustrated in this article. The receiver is entirely self-contained as to the receiver proper, its "A" and "B" battery supply, the phones or headset, and the throw-out antenna lead (which is provided with a clip).

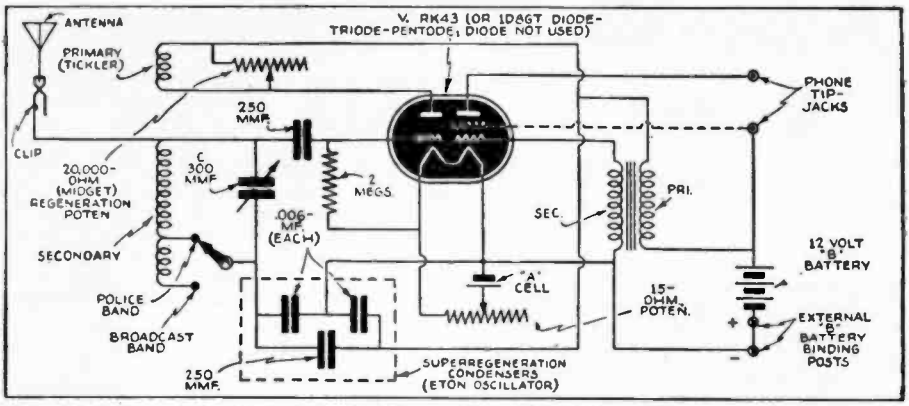
Considering that a potential of only 13.5 V., measured between the plate and negative filament of the tube, is used, it is surprising as to the remarkable performance of the receiver.

As can be seen by inspection, provision has been made for additional external "B"- battery supply, when a more permanent installation and greater volume is desired. The volume seems to increase in direct ratio as the plate voltage increases.

From the standpoint of selectivity it is not recommended that line voltage supply devices be used. Contrary to opinion, actual tests will prove that any supply other than batteries is not satisfactory for superregenerative receivers, and leads to erratic and unstable operation as well as to a decrease in selectivity.

THE "NEW FLEWELLING" CIRCUIT

The "Flewelling Superregenerative"



Schematic circuit of the 2-in-J "Card File" Battery Set. If tube V is a 1D8GT, connect the screen-grid as shown dotted. Condenser C is a revamped 15-plate Cardwell midget unit. Volume increases with increase of "B" voltage. Use a short aerial or a suitable condenser in series with the aerial.

circuit was adapted as most suitable for the requirements. As can be seen by inspection, it is a combination of the old reliable Armstrong tickler feedback regenerative circuit to which has been added the old-time "Eaton oscillator," used during the World War by the Army and Navy. Little mention has ever been made of the Eaton oscillator except as a part of the Flewelling circuit.

The Eaton oscillator supplies the quenching frequency to the control-grid of the tube to prevent self-sustained oscillation, therefore allowing greater energy to be fed back to the grid of the tube without instability or self-sustained oscillation.

In this connection it will be noted that the tickler turns for the "Flewelling Super." are approximately 30 to 50 per cent *greater* than the secondary turns whereas in the ordinary regenerative circuit the tickler turns are from 50 to 66 per cent *less* than the secondary turns.

For development purposes the circuit was wired without the Eaton oscillator components; that is, the two 0.006-mf. condensers shunted by the 250 mmf. condenser, and the return end of the secondary connecting directly to the minus filament. After stable and satisfactory operation was obtained, the condensers were added.

Without the use of measuring instruments, judging volume only by ear, there was a perceptible increase in volume (nearly 100 per cent). By attention to critical adjustment—as to regeneration, and the grid-leak value—this percentage figure was slightly increased. All of the foregoing statements the constructor may verify for himself.

COMPONENTS

The use of the RCA or English single-element midget tubes would require the same space as the Raytheon RK43 or standard 1D8GT, so the midget tubes were not used because of mechanical complications as to sockets and mounting.

The variable condenser is a revamped Cardwell midget of 15 plates, in which the capacity of 100 mmf. has been increased to approximately 300 mmf. by the use of mica or celluloid dielectric rather than air. The resistance thus introduced into the secondary or grid circuit is naturally compensated-for by the feedback from the plate circuit. The revamping is described in a later paragraph.

The chassis itself is only a simple bracket which is fastened to the bakelite panel by the mounting bushing of the tuning condenser. A metal panel may be used and in some instances may be of advantage if there is body capacity.

The audio transformer is a standard 3½ to 1 (ratio) midget. The regeneration control may be any of the 1-in. diameter midget type so long as a satisfactory value and taper are used. These are not in the least critical.

The Yaxley 2-W. 1-in. diameter 15-ohm rheostat serves the triple purpose of filament switch, a means of conserving "A" battery life, and as a vernier control for regeneration.

The fixed condensers are of the postage-stamp size. The special coil which has a tap for the amateur phone - police band is min-

iature in size, the construction being described in a later paragraph. It is mounted on the frame of the A.F. transformer by simply soldering its mounting bracket thereto.

The "B" battery is an assembly of 8 fountain-pen flashlight cells into a flat, compact unit, as is described in a later paragraph. The life of this unit will be considerable as the drain, by the plates of the dual-element tube, will not exceed 4 milliamperes at the voltage used.

The writer naturally appreciates that many constructors will use parts already on hand and therefore has allowed a great deal of latitude in the selection of components other than those specified. It must be remembered however that every inch counts towards the ultimate size of the receiver.

MAKING THE COILS

As shown in illustration A, the secondary consists of 3 pies of 65 turns, each of No. 10/41 Litz wire on ⅜-in. I.D. tubing into which is inserted a polyiron core of ⅜-in. dia. by 1-in. long. Each pie is 3/16-in. long. The coils are wound lateral, with approximately 3/32-in. spacing between pies. The first pie of 65 turns is used for the S.-W. police band. The mutual conductance between pies may be varied to match the inductance to the special variable condenser by increasing or decreasing the spacing between pies.

The primary or tickler winding consists of approximately 260 turns of No. 36 double silk (D.S.C.) or single-cotton covered S.C.C. wire, wound laterally and at the grid end of the secondary. The ⅜-in. inside diameter plus wall of the tubing is used for the secondary; length or width of winding is 3/16-in.

If the constructor does not desire to lateral-wind the coils they may be slot-wound on a form which may then be knocked down and the coils doped. In this manner when coils are in pies the distributed capacity is very little more than lateral windings. With correct modification of the condenser (a Cardwell 15-plate midget) the distributed capacity of the coils should be low enough to tune from 1,500 to 570 kc.; that is, when spacing between pies is correct (variometer fashion of tuning).

To modify the Cardwell condenser, the plates are disassembled from the rotor shaft, and the stator plates from the isolantite end insulation plate; 14 pieces of celluloid (used in side curtains of open cars) are cut to the pattern. The large center hole should clear (freely) the rotor spacing washers. The smaller holes should freely clear the stator plate spacing washers. See illustration B.

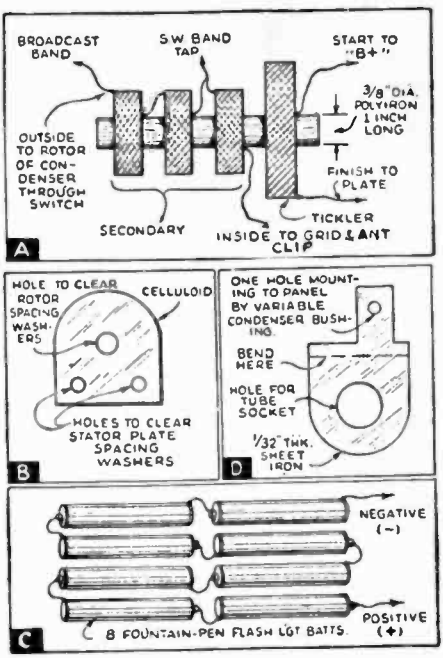
The condenser plates are now reassembled, first a stator plate, then spacing washers, then celluloid spacer, then rotor plate, then celluloid spacer, then rotor plate spacer washer, then another stator plate, and so on, until all are assembled. Clamp the rotor shaft in a vise, line up the rotor plates, and tighten the nut. Use a lock-washer under the nut as the rotor assembly must be tight enough to withstand the drag or friction of the plates against the celluloid spacers. If celluloid is not available, mica of equal thickness may be used. Both have a dielectric factor of from 3 to 4 as compared to air. The celluloid spacers should occupy nearly all of the air space between the plates.

Note: If polyiron cores are not used for the coils, approximately 4 pies of 65 turns will be required with a corresponding increase in the number of tickler turns.

The 12-V. "B" battery is assembled by connecting 8 fountain-pen flashlight cells in series. Solder each positive terminal (center tap) to the zinc shell of each succeeding cell as shown at C.

After the cells have been soldered together each cell is insulated where a possible short might occur; and then made into a flat package approximately 2 ins. wide, 4 ins long and ⅝-in. thick, using scotch or gummed tape.

Note: Cabinet or container is standard size and was purchased from a Woolworth store for 25c. A metal partition is soldered in position if space for phones is desired.



Otherwise the space may be used for additional "B" batteries, and the panel extended to the back of the cabinet.

NOTES

(A) The receiver has been designed for a very small antenna such as a large window or door flyscreen, bed spring, or approximately 25 ft. of wire.

Should a larger antenna of greater capacity be employed, a mica compression condenser should be placed in series with the antenna lead of the set.

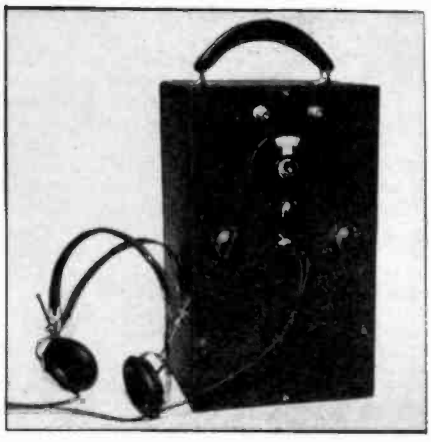
(B) Under certain conditions of operation, the A.F. tube may oscillate due to a low "B" battery; the writer suggests reversing the secondary leads of the A.F. transformer.

(C) For smooth regeneration a larger or smaller grid leak may be necessary.

(D) The tube socket bracket is one hole mounting made if desired from one piece of metal shaped as shown at D.

A 2-TUBE SUPERHET.—

With Pentagrid Regenerative 2nd-Detector



The 2-Tube Superhet., (See Fig. 2 for identification of controls.) with crystal headphones. The tuning range is about 540 to 1,600 kc.

EARLY superheterodynes were complicated affairs employing many tubes. The introduction of the *pentagrid converter* (combined oscillator and 1st-detector in one envelope) was a blessing which permitted much-needed simplification and economy. Now a new application has been devised for the converter which points the way to further simplification. The latest circuit uses a pentagrid converter as a regenerative 2nd-detector so effectively that it is possible to build a superheterodyne which consists only of a converter and a 2nd-detector, and which has no intermediate frequency amplifier as such, but still has sufficient overall gain to be practicable for many uses, and is therefore almost the last word in superheterodyne simplicity.

The receiver which is the subject of this article was built according to the foregoing principles. To utilize the economies which its unconventional circuit makes possible, it was decided to construct the set in portable, self-contained form. The National Union 1A7G was selected for both converter (oscillator—1st-detector), and 2nd-detector applications because of its high conversion gain, small size, and battery economy.

STABLE REGENERATION

The resultant receiver is compact and as simple as a T.R.F. set, having a minimum of parts and tubes, while at the same time retaining all the advantages of a superheterodyne in the form of high, uniform selectivity, and sensitivity, with the added advantages of *stable regeneration* in a tube which operates at a constant frequency and the possibility of using this regeneration for the reception of C.W. telegraph signals; or, to assist in locating and tuning-in weak, modulated signals, as in any T.R.F. set having a regenerative detector and utilizing it to locate DX stations by "beat reception."

The features of this "pioneer" set are listed as follows:

FEATURES OF 2-TUBE SUPERHET.

(1) Full superheterodyne operation with only 2 tubes.

(2) Introduces, for the first time, the use of 2 pentagrid tubes—1 as a converter or oscillator - modulator (1st-detector), and the other as an "inverter" or regenerator - demodulator (2nd-detector)—only.

(3) Amplification in 2nd-detector due to what may be termed "inversion gain".

(4) Electron-coupled regeneration.

(5) Constant regeneration at the intermediate frequency (456 kc.), at any predetermined level, regardless of changes in tuning (signal frequency—540 kc. to about 1,600 kc.).

(6) Non-radiating zero-beat reception permits C.W. code reception, and DX broadcast pick-up, without producing a whistle in nearby receivers.

(7) Completely self-contained battery-portable; may be used as an experimental or emergency set.

(8) Minimum current drain of any superhet. receiver.

(9) Fully shielded.

(10) Highly selective (can be made to cut sidebands by using variable-selectivity I.F. transformers; selectivity remains fixed regardless of changes in tuning, changing only with signal intensity as with any superhet.).

(11) High fidelity (2nd-detector feeds directly into Rochelle-salt crystal headphones—the resulting tone quality is a revelation even to radio "old-timers", and suggests crystal-detector fidelity).

A 2-Tube Superheterodyne in which, For the First Time, a Pentagrid Converter Tube is utilized as a Second-Detector at the Same Time Retaining a Portion of its "Conversion Gain" Factor.

WHY A PENTAGRID CONVERTER AS 2ND-DETECTOR?

The unorthodox method here described of using a pentagrid converter as a 2nd-detector was developed with a view to pointing the way toward more compact radio receiver design. With the recent advent of small-space components—primarily, miniature tubes—it was felt that more attention should be paid to means for obtaining augmented performance from whatever tubes were eventually chosen to compose a small-space radio receiver.

Starting with the knowledge that the "pentagrid converter" successfully and efficiently combines in 1 envelope the function of mixing or modulation that previously required 2 tubes, it was felt that the inverse operation of "unmixing" or demodulation could be accomplished with comparable efficiency in a second tube of roughly equivalent design operating as a "pentagrid inverter." As the nearest available tube was—another tube of the same type, a duplicate of the modulator tube was selected as the demodulator tube; it then remained only to find in the demodulator circuit a substitute for the local oscillator in the modulator circuit. It was elected to utilize regeneration in the 2nd-detector circuit for the several reasons previously mentioned in this article, and to depend upon this action to establish the dynamic characteristics necessary for obtaining in the demodulator, an approximate equivalent (or "inversion gain") of the "conversion gain" which helps make the pentagrid converter such an efficient tube as a modulator.

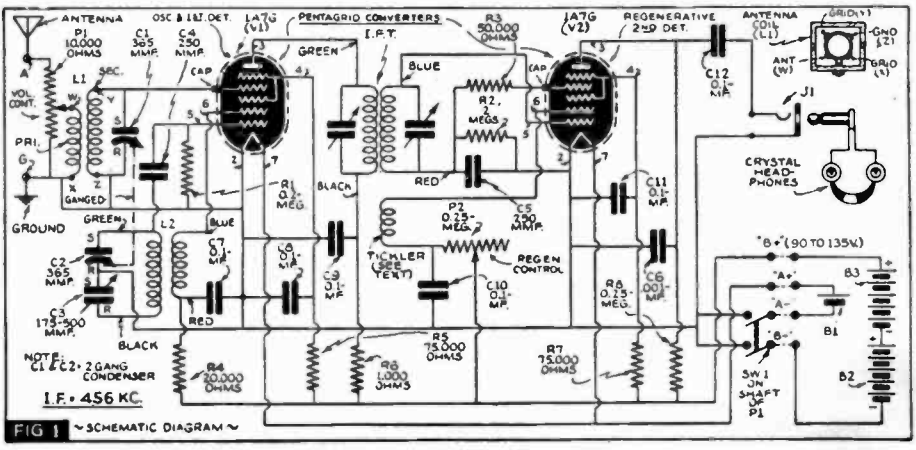


FIG 1 ~ SCHEMATIC DIAGRAM ~

The results were so promising that experiments are continuing in this direction. However, it should be apparent to even the casual reader that what is needed is a special tube having characteristics that more nearly suit the requirements of service as a 2nd-detector; a tube that has, for example, interelectrode characteristics more suitable to receiving an intermediate frequency on the control-grid, and plate characteristics better adapted to feeding an audio-frequency output from the plate of the tube to a succeeding, A.F. power amplifier. Even using existing tubes, though, as here described, better results have been obtained than could be secured with any other known circuit using 2 tubes; the expression "better results" takes into account the selectivity, operating ease, sensitivity and headphone volume (using crystal phones) achieved in the 2-Tube Superhet.

CIRCUIT

As may be seen from a study of the circuit diagram, Fig. 1. the 1st tube is used in a strictly conventional frequency converter arrangement. The 2nd tube serves as combined I.F. amplifier and demodulator. The 2 tubes are coupled by a standard I.F. transformer to which has been added a tickler winding. The fact that there is only 1 I.F. transformer is in itself an economy because high-quality I.F. transformers are relatively expensive. Resistance-capacity coupling is provided to the crystal earphones, which because of their high impedance permit of a reasonably high plate load impedance and hence maximum audio output volume.

I.F. TRANSFORMER

The I.F. transformer is a standard unit to which a tickler coil has been added. The operation which must be performed on the I.F. transformer is not as difficult as it may sound.

The coil is removed from its shell by taking off the cap-nut on top of the can and pulling the unit out of the bottom by its leads. The tickler consists of 12 turns of No. 20 D.C.C. wire random-wound on the lower end of the coil form.

Since the coils on the transformer are covered completely with wax, it is difficult to determine the direction in which they are wound. Therefore, the tickler may be wound in either direction, and its leads connected later so that oscillation is obtained; if the 2nd-detector circuit refuses to oscillate when the set is completed, reverse the tickler leads. The tickler coil should be wound right next to the lower coil of the transformer. The turns may be held in place by painting with Duco cement. The ends of the coil are insulated with spaghetti and brought out of the bottom of the can with the other leads. No special lugs or terminals are needed.

The I.F. transformer, as supplied, is intended to be connected into the circuit so that the upper coil (next to the condensers) will be the grid coil and the lower coil, the plate coil. However, in the present case these functions are reversed and the lower coil, to which the tickler is close-coupled, is the grid coil. To do this the color-coded leads should be connected as shown in the circuit diagram, rather than according to the manufacturer's instruction sheet. When the operation has been completed, the transformer is replaced in its can. Care should be taken in handling the coil so as not to damage it.

CONSTRUCTION

Aside from the I.F. transformer, which is modified as just described, the other parts are standard. The antenna and oscillator coils were selected to cover the broadcast band, although other frequency ranges may be covered with suitable coils.

The set was built up in professional fashion with all parts, including the batteries, mounted on the front panel. The chassis is attached to the front panel by the mounting studs of the volume and regeneration controls. (See Figs. 2 and 3 for drilling specs.) The batteries are strapped to the front panel with a 1/16 x 1 in.

LIST OF PARTS

COILS

One Meissner Antenna Coil, No. 14-2436, L1,
One Meissner Oscillator Coil, No. 14-4243, L2;
One Meissner I.F. Transformer, No. 16-5714, I.F.T.

CONDENSERS

One Meissner 365 mmf., 2-section variable, No. 21-5214, C1, C2;
One Meissner 175-500 mmf. padding, No. 22-7005, C3;
Two Aerovox 250 mmf., mica, type 1466, C4, C5;
One Aerovox 0.001-mf. mica, type 1466, C6;
Six Aerovox 0.1-mf. 200 V. paper tubular, type 284, C7, C8, C9, C10, C11, C12.

RESISTORS

One I.R.C. 10,000 ohms, type D14-116 midget potentiometer, P1;
One I.R.C. 0.25-meg., type D13-130 midget potentiometer, P2;
One I.R.C. 0.2-meg., ½-watt, type BT½, R1;
One I.R.C. 2 megs., ½-watt, type BT½, R2;

One I.R.C. 50,000 ohms, ½-watt, type BT½, R3;
One I.R.C. 20,000 ohms, ½-watt, type BT½, R4;
Two I.R.C. 75,000 ohms, ½-watt, type BT½, R5, R7;
One I.R.C. 1,000 ohms, ½-watt, type BT½, R6;
One I.R.C. 0.25-meg., ½-watt, type BT½, R8.

TUBES

Two National Union type 1A7G, V1, V2.

MISCELLANEOUS

One pair Brush Development Co. feather-weight, wafer-thin, high-impedance (80,000 ohms), high-fidelity (60 to 10,000 cycles), Rochelle-salt crystal headphones;
Two Amphenol octal sockets, type MIP;
One Yaxley headphone jack, No. 704, J1;
One National dial, type BM with No. 1 scale;
One I.R.C., D.P.S.T. switch, No. 42, S1;
One Burgess 1½-volt "A" cell, No. 4FA, B1;
Two (or 3) Burgess 45-volt "B" batteries, No. Z30N, B2, B3;
Cabinet, knobs, hardware, phone plug, binding-posts, etc.

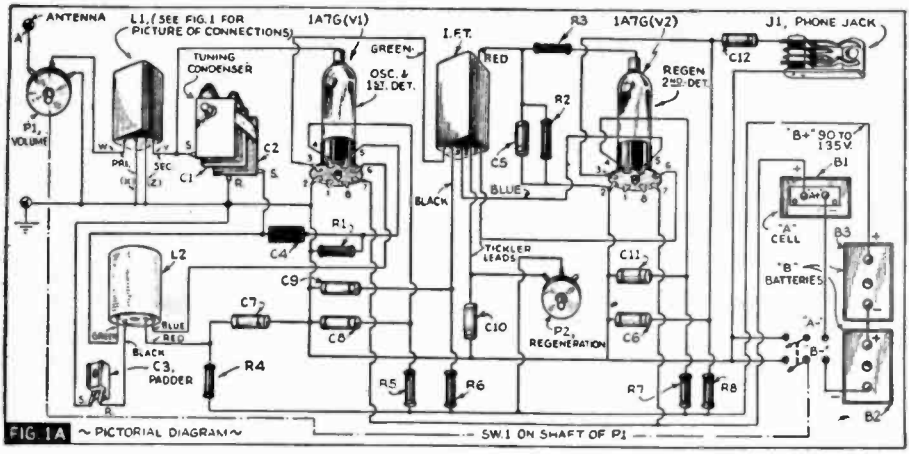
Rear view of completed 2-Tube Superhet. (See Fig. 3 for layout details.)

aluminum band which is suitably bent. A 12 x 6 x 7 in. steel cabinet which should withstand much rough handling is amply large. No special shielding or other precautions were found to be necessary. The pictorial diagram, Fig. 1A, will help you wire the receiver. Use 135 V. of "B" voltage if you want more volume.

ADJUSTMENT

In placing the set in operation for the first time, the following procedure should be used: First determine that the 2nd-detector circuit can oscillate properly. This may be done by listening for a slight hiss in the phones as the tube goes into oscillation when the regeneration control, P2, is turned up. If no oscillation is apparent the tickler connections should be reversed. No difficulty should be encountered in making the circuit oscillate.

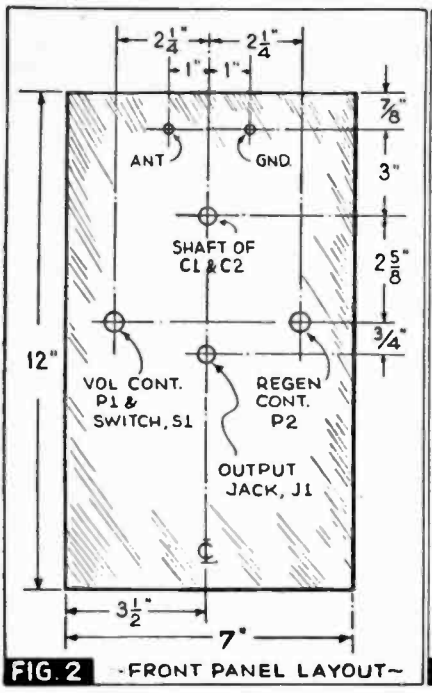
Then with the circuit just oscillating a signal should be tuned-in. The usual beat note will be heard. The I.F. transformer should then be adjusted to give maximum output volume. This may be conveniently done by placing the 2nd-detector circuit on the edge of oscillation and adjusting 1 of the I.F. transformer tuning condensers until the circuit falls out of oscillation. The regeneration

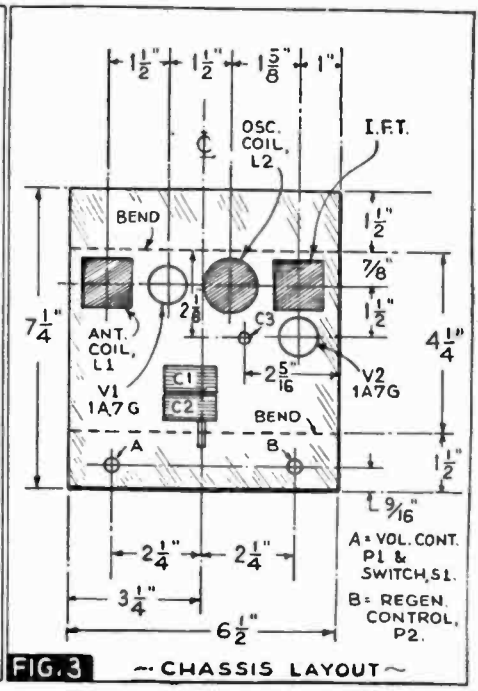


control is then advanced until the circuit is again just oscillating, and the I.F. transformer again adjusted until oscillation ceases. This procedure should be repeated until the primary and secondary are tuned to precisely the same frequency.

The intermediate frequency is nominally 456 kc. However, any frequency within the range of the transformer may be used if desired. It will be found that at the lowest frequency at which the transformer may be set, the 2nd-detector circuit refuses to oscillate at all. Progressively higher frequencies should be tried until satisfactory oscillation is obtained. In general the I.F. should be the lowest at which the 2nd-detector circuit oscillates uniformly while the tuning condensers are tuned over the broadcast band, because at this intermediate frequency the gain of the set seems to be at maximum.

This is equivalent to requiring that the number of tickler turns be the minimum necessary for satisfactory oscillation at any





particular intermediate frequency. It is of course easier to adjust the intermediate frequency to the number of tickler turns than vice versa. Since the gain and selectivity of the set depend largely on the adjustments of the I.F. transformer, these adjustments should be made with great care.

After the I.F. transformer is properly tuned, the padder condenser, C3, may be adjusted so that the broadcast band is covered by the tuning range of the variable condensers, C1 and C2. Then finally the trimmer condensers are adjusted so that C1 and C2 are in alignment, this adjustment being made with the set tuned-in on a signal at the high-frequency end of the broadcast band. These adjustments are easy.

OPERATION

In operation the set performs just like any other, more conventional superheterodyne. For ordinary broadcast reception the regeneration control is set at a point just below that at which oscillation begins, and the set is tuned in the same manner as any other. In fact the circuit need never actually oscillate at all. *It would be possible to mount the regeneration control on the chassis inside the set instead of on the front panel; once set,* you need *hardly ever touch it!* A person operating the set would then seldom bother about the regeneration. However, the regeneration control was mounted on the front panel in the set shown in the photographs for possible use if a beat note should be desired, and also so as to be handy for adjustment to compensate for battery wear. The ability to secure a beat note comes in handy for receiving C.W. (continuous wave) code signals, or for locating DX broadcast stations.

For best results a good antenna and ground should be used. However, satisfactory operation may be obtained using only a "hank" or short length of wire for an antenna; and no ground. The trimmer condenser on C1 should preferably be adjusted with the antenna connected, as its setting changes slightly with the length of the antenna used.

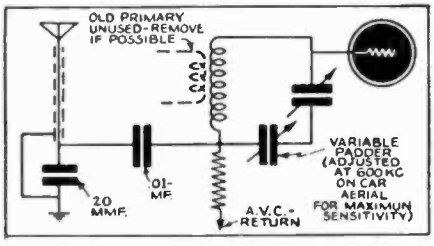
APPLICATIONS

The set described in this article may be used just as is. as a convenient portable broadcast receiver. It is compact and easily carried.

But the real significance of this set with its unusual circuit is that it shows the way to new superheterodynes employing fewer tubes and built with greater economy than ever before achieved.

OLD AUTO SETS FOR NEW CARS

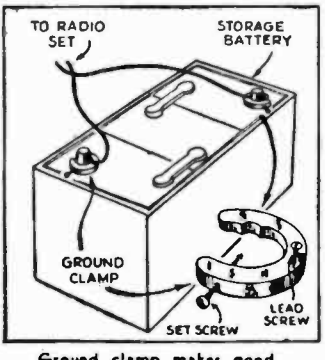
● A GREAT many people purchase used auto-radios, 3 to 6 years old, and want them installed in late-model cars with metal tops. Such an installation, especially with a whip aerial, is seldom satisfactory.



Rather than lose his initial investment, usually $8 to $15, he will gladly pay $2 or $3 to have the input of his set changed as shown in the diagram reproduced here.

We have changed several RCA's, G.E.'s, a Knight, etc., and find they operate very well on a hinge aerial.

PERMANENT BATTERY CLAMP. In servicing car radio and other 6-volt jobs we often misplaced our battery terminal clamps. It was on one of these occasion wetried using a ground clamp that was lying on the bench. We found that this worked out swell. Nowwejust leave two clamps permanently on the battery. (See Figure.) They do not pop off when you turn the set over for voltage readings.



Ground clamp makes good battery terminal.

THE 4-TUBE SHORT-WAVE SPECIAL

THERE IS ALWAYS a field for a small, inexpensive all-wave receiver that may be made by the Ham constructor. Such a set must be simple but efficient; it must be easy to "line-up" without the necessity of using a test oscillator.

The little receiver described here ably fulfills these requirements. It is quite straightforward in design using a simple superhet. circuit with only a few departures from the usual. A system—the simplest type—of bandspread is used *which makes it unnecessary to employ variable padding or trimming condensers.* (See Fig. 1A for the schematic circuit.) The use of parallel tuning makes it easy to line the detector and oscillator circuits *on any band.*

CIRCUIT FEATURES

Iron-core I.F. transformers provide a high order of gain for the single I.F. stage used. This gain can be increased even higher by the use of the *regeneration control* which is connected from the plate of V2 to the plate of V3. When advanced to the point of oscillation, the receiver is able to pull in C. W. ("continuous-wave" or code) signals. It may be necessary to reverse the connections to the primary of I.F.T.2 in order to obtain regeneration and oscillation in the 2nd-detector, V3.

The greatest novelty of the set is the use of a 6E5 as 2nd-detector. (See Figs. A and C.) Such use for this tube was described in the May 1937 issue of *Radio-Craft* (in an article titled "Build 'The Cyclops', A Beginner's 1-Tube Set") and the tube was found to be an exceptionally efficient detector. This use provides a certain amount of tuning-indicator effect on the fluorescent screen of the 6E5, although of course the action cannot be compared to that obtained in a receiver incorporating A.V.C. Nevertheless, a moderate carrier will cause a noticeable deflection. The 'eye" also acts as an indicator pilot light.

Plug-in coils are used since they are simple and efficient. A ready-made set of coils is listed but slight changes must be made in some of the windings. Figure 3 contains all the necessary coil information. Although only 2 windings are required on each coil, the factory-made 6-prong coils have 3 windings. The winding on the bottom of the coil is not used and is disregarded, although it is not necessary to remove it. If the coils are home-wound, only 2 windings need be put on.

No broadcast band coils are mentioned, but the largest coil of the set covers a considerable portion at the high-frequency end of the broadcast band. Another set of coils is needed to cover the remainder of this band.

LIST OF PARTS

One Hammarlund set of coils, No. SWK6;
One Hammarlund set of coils, No. SWK4;
One Hammarlund coil, No. 40;
One Hammarlund coil, No. 60;
One Hammarlund tuning condenser, No. HFD30X 30 mmf.;
Two Hammarlund tuning condensers, No. HF140, 140 mmf.;
One Hammarlund tuning condenser, No. HF35, 35 mmf.;
Three Hammarlund octal sockets, No. S8;
One Hammarlund 4-prong socket, No. S4;
One Hammarlund 6-prong socket, No. S6;
One Hammarlund choke, 85 mhy.;
One Hammarlund iron-core I.F. transformer, I.F.T.1;
One Hammarlund iron-core I.F. transformer, I.F.T.2;
One "tuning eye" panel socket;
One 4-in. vernier dial;
Two dials, 2¾ ins.;

(Continued on page 27)

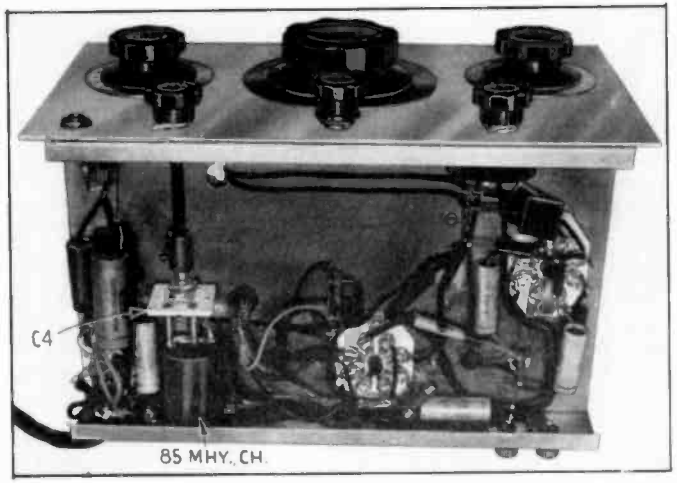


Fig. B. Under-chassis view showing the wiring and placement of parts.

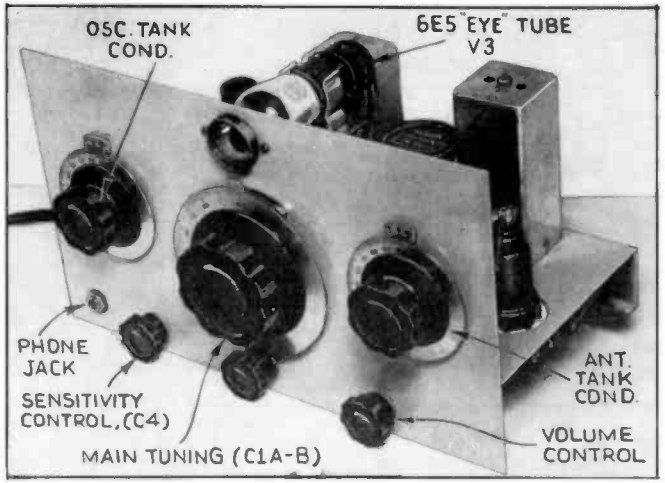


Fig. A. The neat appearance of the "Short-Wave Special." On the higher frequencies the main tuning dial affords excellent bandspread.

CONSTRUCTION

Construction is started by drilling the panel and chassis according to the specifications given in Fig. 2. It is possible to buy a steel chassis of the dimensions shown, but aluminum or electralloy is much easier to work with. After drilling, the original panel and chassis were given a coat of French gray duco enamel. This serves to cover any scratches on the metal.

The 2-gang main tuning condenser is fastened by its shaft nut to the front panel. Also a screw holds it steady to the chassis at the rear.

The tube sockets are mounted below the chassis while those for the coils are set up on the bushings provided and mount above the chassis.

The 35-mmf. regeneration condenser is mounted by its bracket beneath and to the rear of the chassis, and is controlled by a bakelite shaft from the front panel. Note that the mounting bracket must be set up on insulating washers since both sides of this condenser are above ground potential.

The 6E5 socket is held by a bracket from the front panel. If a manufactured assembly is used to mount this tube, it will be necessary to remove a small resistor usually found in these units connected from the plate to target prongs. Also a lead should be brought out from the plate prong. All the leads from this socket are bunched and run through a piece of shielding to the underside of the chassis.

The first point in putting the set into operation is to make sure the regeneration control on V3 works properly. Next check for I.F. alignment. If a vacuum cleaner or electric fan is in operation the all-wave brush-static may be heard

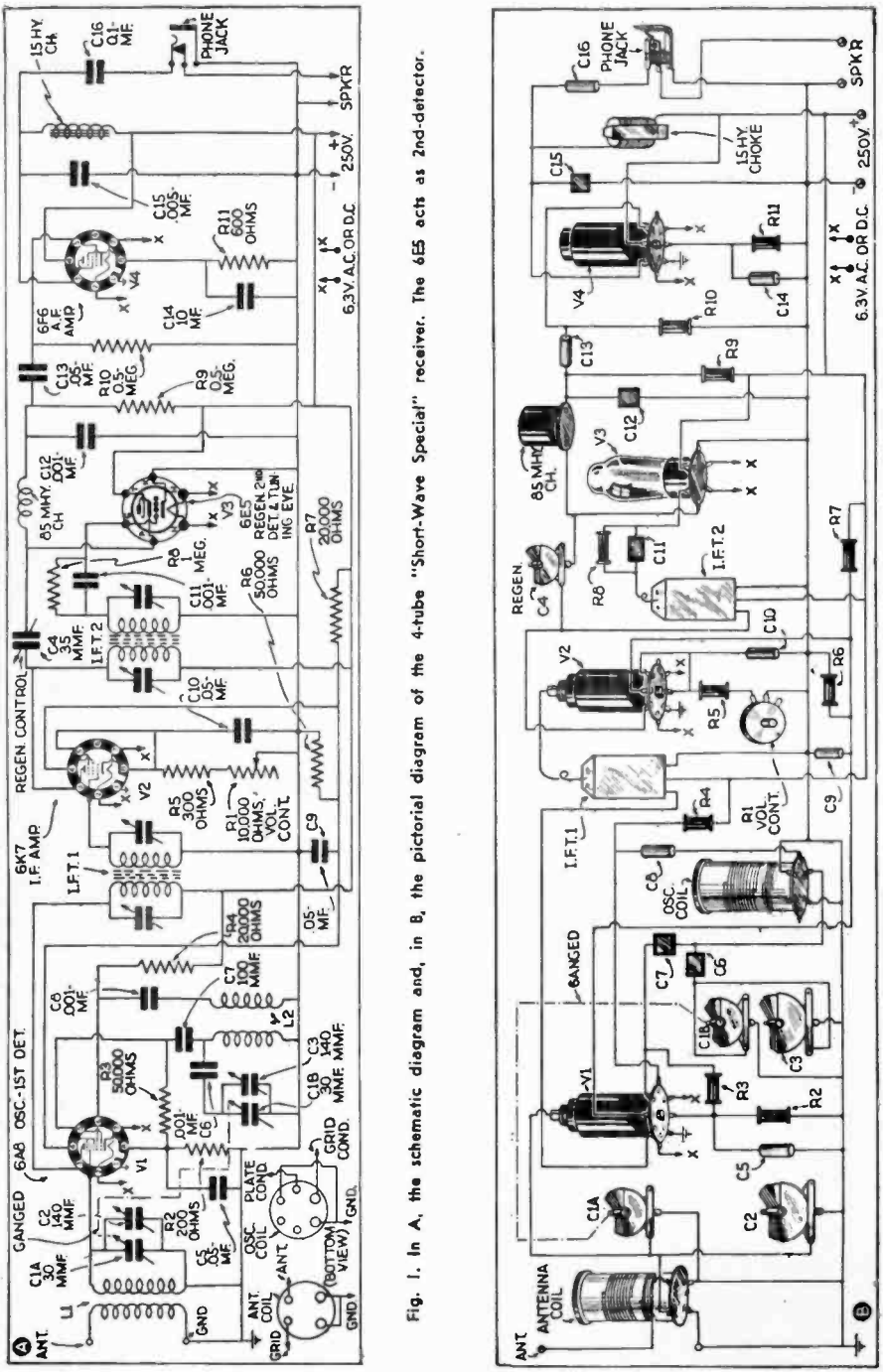


Fig. 1. In A, the schematic diagram and, in B, the pictorial diagram of the 4-tube "Short-Wave Special" receiver. The 6E5 acts as 2nd-detector.

One I.R.C. resistor, 200 ohms, ½-W.;
One I.R.C. resistor, 20,000 ohms, ½-W. R4;
One I.R.C. resistor, 50,000 ohms, ½-W. R3;
One I.R.C. resistor, 1 meg., ½-W.;
Two I.R.C. resistors, 0.5-meg., ½-W.;
One I.R.C. resistor, 50,000 ohms, 1 W. R6;
One I.R.C. resistor, 20,000 ohms, 1 W. R7;
One I.R.C. resistor, 600 ohms, 1 W.;
One Standard Transformer Corp. midget-type;
One aluminum panel, 12 x 7 x 1/16 ins. thick;
One aluminum chassis, 11 x 6 x 1½ ins. high;
One midget jack.
One Solar tubular condenser, 0.1-mf.;
One I.R.C. variable resistor, 10,000 ohms, R1;
One I.R.C. resistor, 300 ohms, ½-W.;
One RCA type 6A8 tube;
One RCA type 6K7 tube;
One RCA type 6E5 "magic eye" tube;
One RCA type 6F6 tube;
Four Solar mica condensers, 0.001-mf.;
One Solar mica condenser, 0.005-mf.;
One Solar mica condenser, 100 mmf.;
One Solar electrolytic condenser, 10 mf., 35 V.;
Four Solar tubular condensers, 0.05-mf.;

and can be used to line up the 4 trimmers in the I.F.T. cases! Do not touch the trimmers, before first listening-in, as they are set at the factory to the proper frequency. After the noise is heard the final trimming for loudest response may be made.

Now rotate the two 140-mmf. condensers very slowly until a signal is heard, then turn the oscillator dial to the lowest of the 2 points at which the signal can be picked up. These 2 points will be found quite close together on the dial and the one received when the condenser plates are farthest out is the correct point. Once the 2 small dials are set the main tuning dial will give fine tuning or *bandspread* over a portion of the band. The bandspread becomes increasingly important as the frequency goes higher. When tuning in the

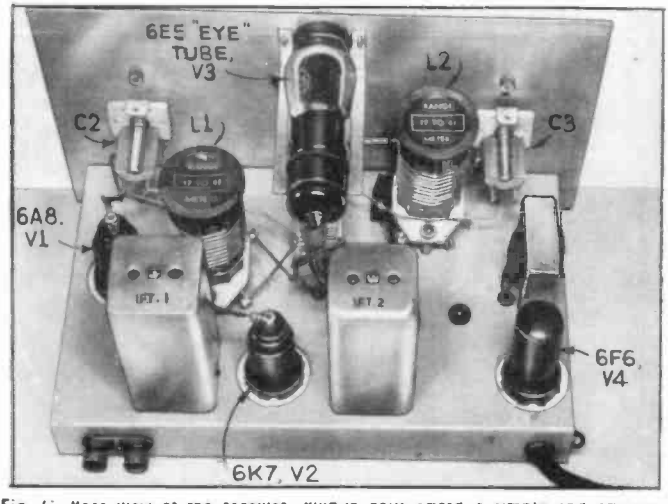


Fig. C. Rear view of the receiver. Plug-in coils afford a simple and efficient means of changing bands.

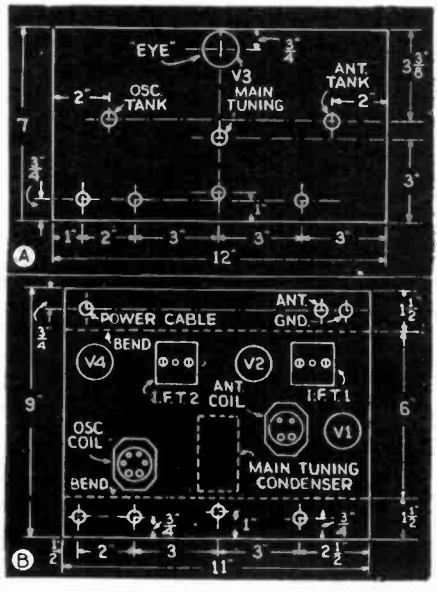
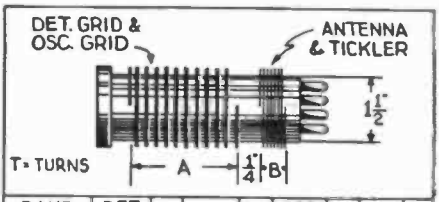


Fig. 2. Specifications for making (A) the front panel, and (B) the chassis.



BAND (METERS)	DET. GRID	A	ANT.	B	OSC. GRID	A	TICKLER	B
10–20 *	3¼ T.	1"	2 T.	C.W.	3¼ T.	1"	3 T.	C.W.
17–41 *	8¾ T	1½"	3 T.	C.W.	8¾ T	1½"	5 T.	C.W.
33–75 *	18 T.	1½"	4 T.	C.W.	17 T.	1½"	6 T.	C.W.
66–150	38 T.	C.W.	6 T.	C.W.	35 T	C.W.	10 T	C.W.
135–270	80 T	C.W.	10 T.	C.W.	73 T	C.W.	20 T	C.W.

* WOUND WITH Nº 14 BARE WIRE; ALL OTHERS WOUND WITH Nº 28 INSULATED WIRE.
C.W.-CLOSE WOUND

Fig. 3. Here's the data to make your own coils.

lower-frequency bands, the 140-mmf. condensers will be found more convenient.

Any power supply capable of supplying 6.3 V. at about 1.5 A. and 250 V. at 50 ma. may be used, as may batteries. Any type of loudspeaker or phones may be used since no D.C. passes through them. If, instead of batteries, an A.C. power supply is used, it should be as hum-free as possible. This goes for noise, too. A power pack designed for broadcast receiver work may not be sufficiently filtered for short-wave receiver operation since any residual hum will be easily picked up by the receiver especially when it is operated near or at the point of regeneration.

An aerial 50 ft. long and as high as possible will enable the builder to get good results from this "baby communication-type receiver." Beginners will find the picture diagram easy to follow.

BEGINNERS' 4-TUBE SUPERHET.

VACATION PORTABLE

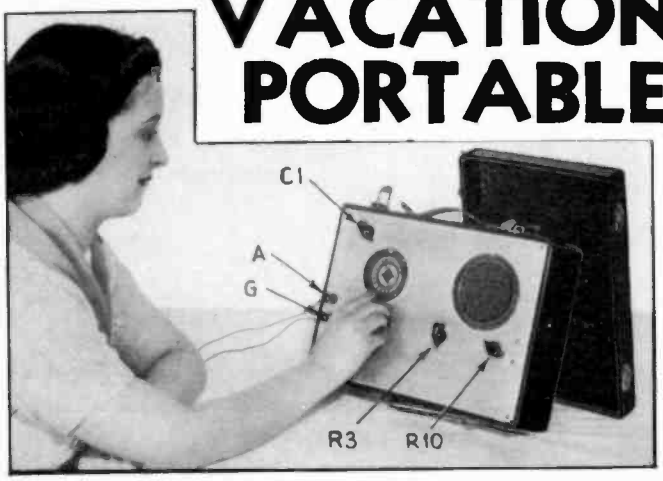


Fig. A. The completed "Vacation Portable" is stable and easy to operat

WITH the outdoor season it is only natural that the experimenter's thoughts turn to portable equipment.

This effect is always produced upon the writer at this time of year and the result is usually a portable broadcast receiver of some description! Running true to form this year, the outfit shown herewith was produced. Due to a lack of time it was decided to build a simple job with frills and trick gadgets, which virtually always cause troubles that require tedious ironing-out. See Fig. A.

THE BATTERY PROBLEM

The superhet. Fig. 1A 1B,) was selected since it is very little if any harder to get into operation than a T.R.F. job, and, the added sensitivity and selectivity are a big help in a small set. Batteries are used, of course, a size being chosen which is a compromise between long life and light weight. If the rig is to be used for any length of time, as for example,

LIST OF PARTS

One Raytheon 1D7G tube;
One Raytheon 1D5GP tube;
One Raytheon 1E5GP tube;
One Raytheon 1F6G tube;
Two 45-volt batteries;
One 3-volt battery;
One 7½-volt battery;
One 5-inch P.M. dynamic speaker, with transformer to match;
One Meissner I.F. transformer, No. 5740;
One Meissner I.F. transformer, No. 6131;
One Meissner antenna transformer, No. 1496;
One Meissner oscillator coil, No. 7560;

(Continued on page 33)

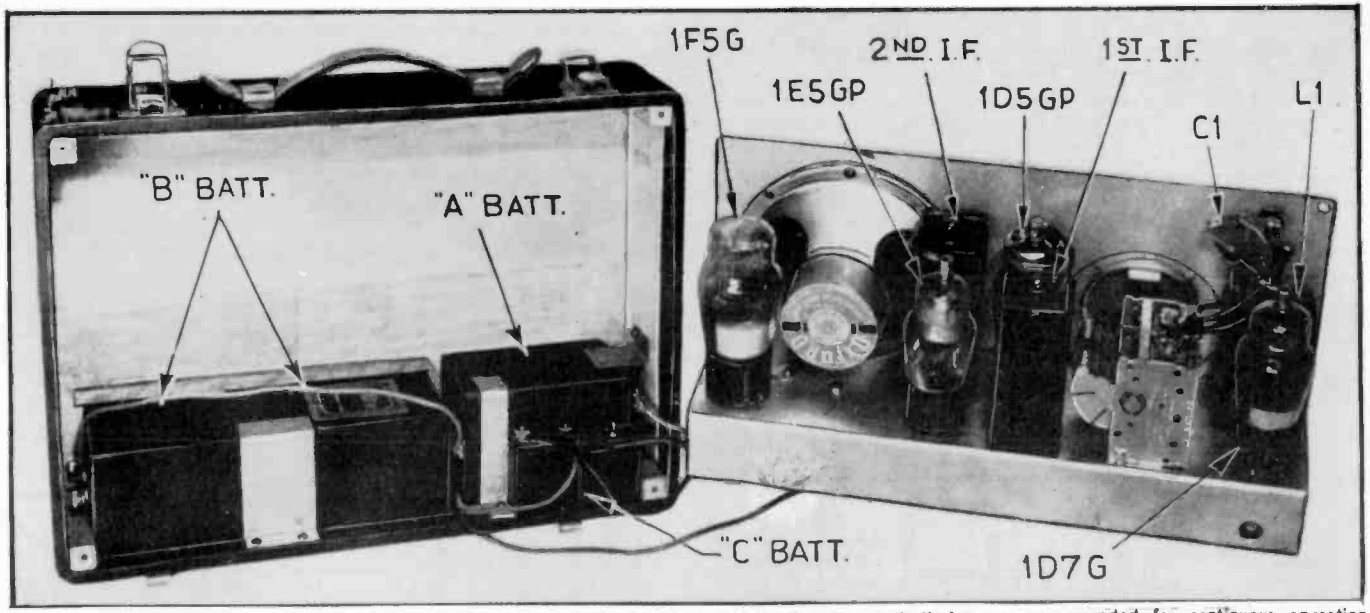


Fig. 8. *Compactness* is the word; both in the layout of parts and placement of batteries. Larger batteries are recommended for continuous operation.

at a summer camp, it would be more economical to use large batteries. A plug arrangement could easily be worked out so that the portable batteries could be used for true portable use while the heavier-duty batteries could be plugged-in when the set was used in any one place for a fair length of time. The current drain is quite low, measuring only about 300 ma. on the filament batteries and between 10 and 15 ma. on the "B" batteries. The "C" battery, of course, has no drain on it, and lasts as long as its shelf life allows.

If all the tubes (except the 2nd-detector) are run with 3 V. minus on the grids, the "B" current will be about 15 ma. With 4½ V. grid bias this drops to about 10 ma., with, however, a considerable drop in output.

Since the case available offered a fair amount of space, a 5-inch speaker was decided upon, as it gives considerably better tone quality han .he 3-inch size. Good tone quality made it imperative to use a P.M. dynamic speaker, and as a result the output sounds very respectable.

COIL SELECTION

Iron-core transformers and chokes are used throughout and contribute to compactness and high efficiency.

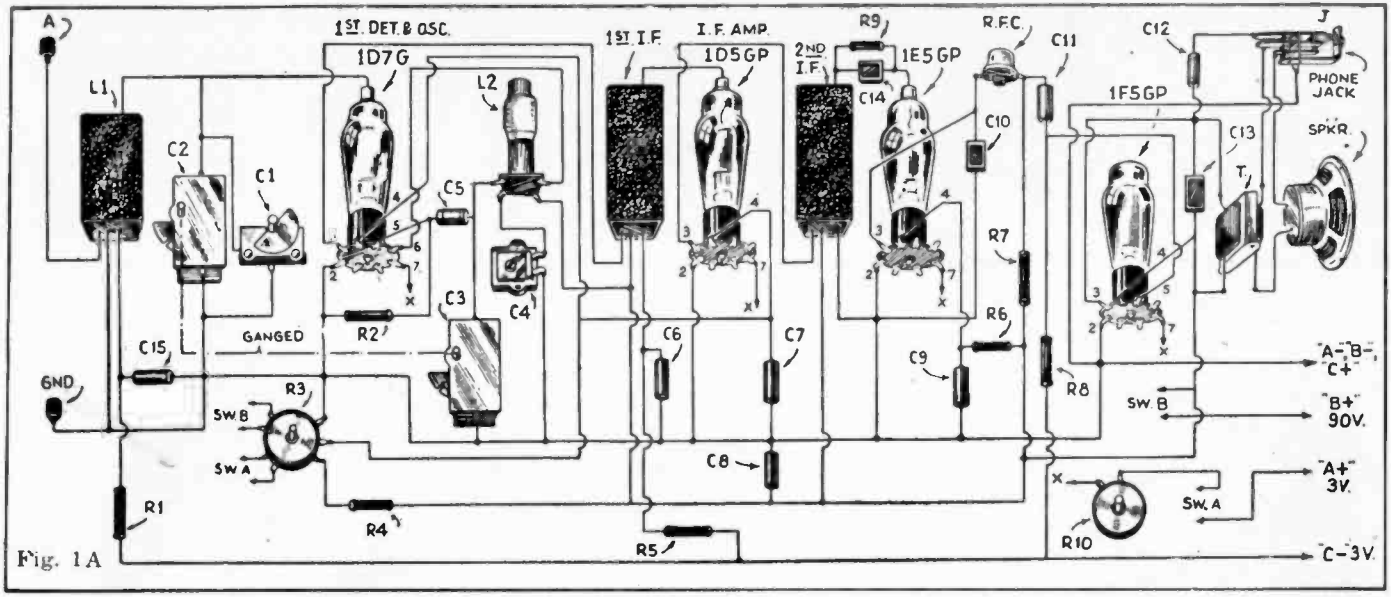


Fig. 1A

The tubes are all of standard types, the only concession to "the latest thing" being the use of octal base types. These are just as convenient and efficient as their older counterparts, and the extra lugs on the sockets are certainly useful.

The oscillator coil is beneath the chassis (see Fig. C) with the antenna and I.F. transformers above (see Fig. B). Although the parts are not excessively crowded, some care must be used in layout so that no parts interfere mechanically with each other.

The case used, which has dimensions as shown in the illustration (Fig. 2) is one which was intended to house one of the *Radio-Craft* analyzers. It may still be possible to get a ready-made case of this size. Otherwise, one may be quite easily made up, or the receiver can be adapted to fit whatever case is on hand.

Construction is straightforward and no unusual kinks should be encountered. Both panel and chassis are of 1/16-in. aluminum, the latter being bent after the desired bending lines have been deeply scribed in the surface. A

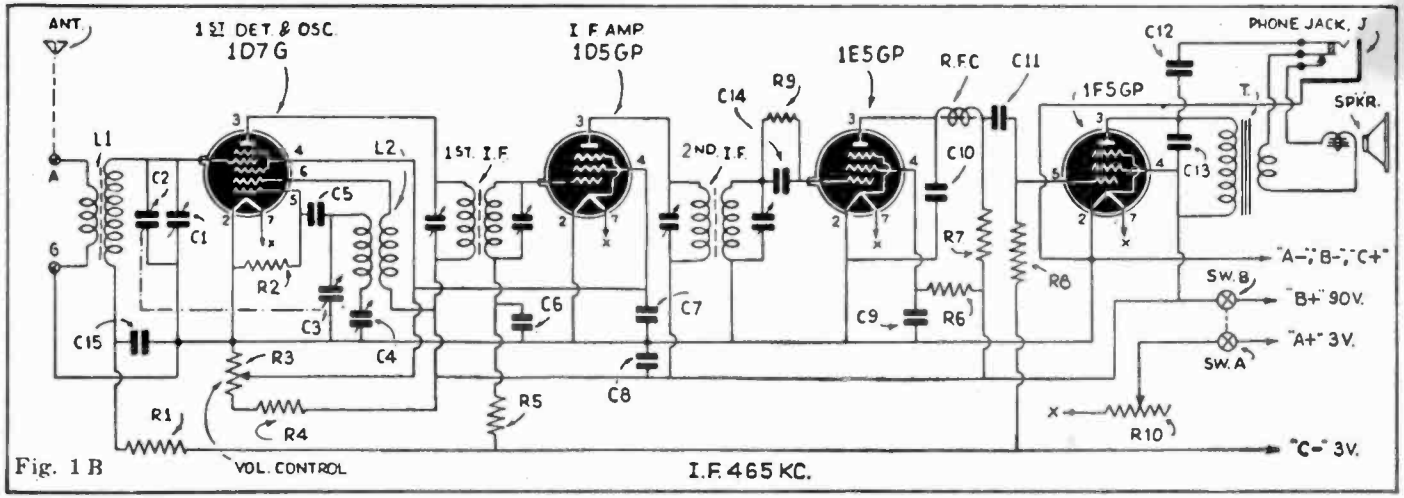


Fig. 1 B

C1—50-mmf.	C9—0.25-mf.	R3—75,000 ohms V.C.	R10—6 ohms
C2, C3—2-gang, 350-mmf.	C10—500-mmf. C14, 250 mmf.,	R4—10,000 ohms	L1—Antenna coil
C4—Padder	C11—0.25-mf.	R5—50,000 ohms	L2—Oscillator coil
C5—100-mmf.	C12—0.25-mf.	R6—1 meg.	J—Phone jack
C15, C6—0.01-mf.	C13—0.004-mf.	R7—150,000 ohms	T—Output trans.
C7—0.25-mf.	R1—50,000 ohms	R8—0.5-meg.	R.F.C.—R.F. choke
C8—12-mf.	R2—50,000 ohms	R9—2 megs.	

nice grain finish may be imparted by applying powdered pumice and water to the surface in long, straight strokes. An alternate suggestion is to dip the pieces in a strong lye solution, which will impart the familiar satin finish. Either finish should be applied after all work of cutting and drilling is finished.

All components are mounted on the chassis except the speaker and antenna trimming condenser, which are fastened to the panel only. When all construction work is completed, wiring may proceed according to the diagrams in Fig. 1, A and B. Wiring should be very carefully checked when finished. Remember that a misconnection in a powerline-operated receiver usually means, at most, a little smoke or a blown fuse, but on a battery-operated receiver, a wrong connection very often means a new set of tubes and batteries.

Use rather heavy wire for the filament circuit, Nos. 14 or 16 being about the right size.

ALIGNMENT

If a powerful broadcast station is

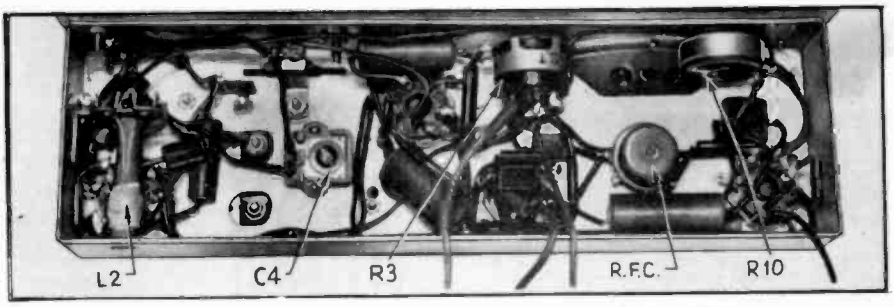


Fig. C. Under-chassis view showing the placement of parts and wiring.

located nearby, the receiver may be lined up without the use of a signal generator, although use of the latter is recommended in any case. The I.F. transformers come from the manufacturer peaked at a definite frequency so that it is usually possible to get a strong signal through, after which it is only a matter of trimmer adjustment. During initial I.F. line-up a stronger

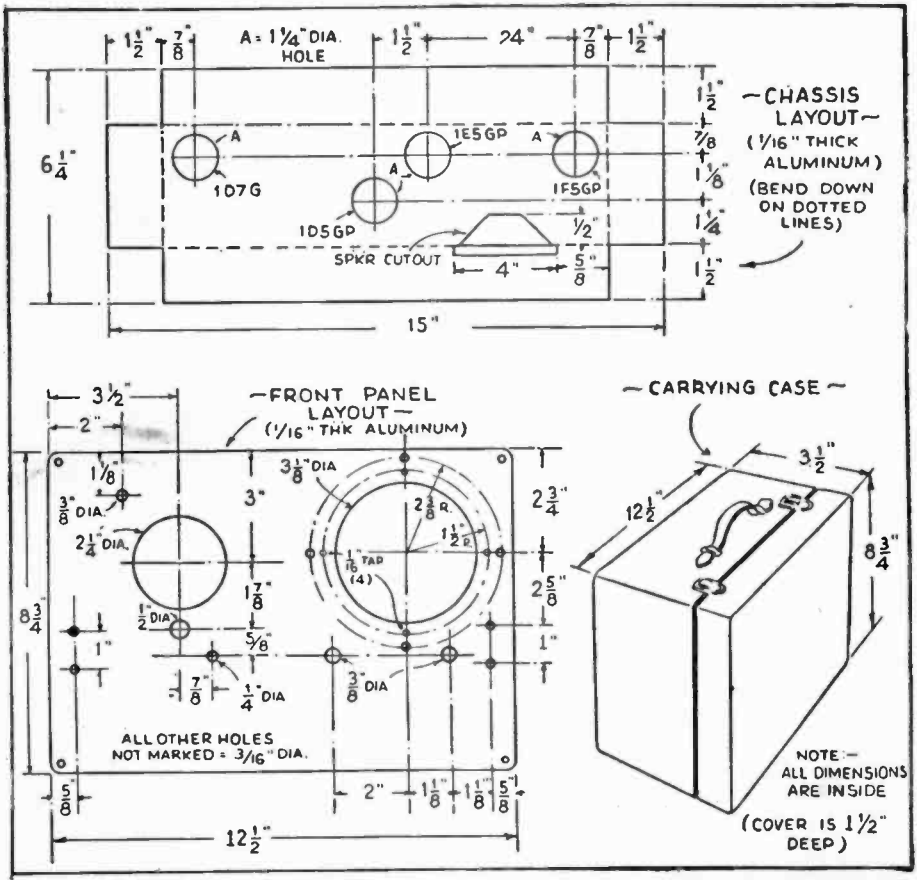


Fig. 2. Although of course any desired metal may be used for the chassis of the "Vacation Portable," aluminum is particularly recommended in view of its lightness; it's easy to work, too. The carrying case can be made from cigarbox wood, but, the sizes are fairly standard and little trouble should be experienced in obtaining the case already made. It should be fairly sturdy, however, because the batteries add considerable weight.

signal will be obtained if the antenna is temporarily hooked directly on the grid of the 1D7G.

When I.F. alignment is complete, R.F. alignment may be taken care of. An R.F. trimmer condenser is brought out on the panel. A portable receiver is called upon to work with every conceivable type of "aerial" from the fabled bedspring to and including a water pipe. No input circuit can be expected to tune efficiently with such a variety, so the trimmer is used to compensate for the mismatch. The R.F. trimmer on the gang condenser should be opened wide, since the manual trimmer takes its place. Alignment should be made with the manual trimmer set at about mid-scale and with an antenna of moderate length. The variable core of the oscillator coil may be found helpful in getting the tuning range set satisfactorily.

Note that the screen-grid of the 1D7G is varied together with the screen-grid of the 1D5GP. This is somewhat contrary to general practice, but it overcomes a certain blocking or overloading of the 1D7G which occurs if the latter is run at full screen-grid voltage when very strong signals are being received.

Although no provision was made on this set for headphone operation, this feature may be desired for some applications, so a headphone jack is shown on the circuit diagram. When the phones are plugged in, the speaker is cut out. Due to the fact that no D.C. can reach the headphones, crystal phones may be employed as well as the more common types.

General case and chassis dimensions are given (Fig. 2) to guide those who are starting construction from scratch.

(Continued from page 28)

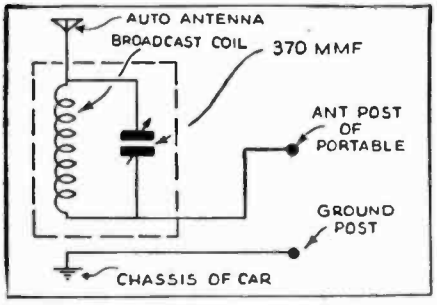
LIST OF PARTS

One Meissner R.F. choke, No. 6844;
One Meissner dial, No. 18248;
One Meissner tuning condenser, No. 15114;
One Meissner trimmer condenser, No. 15165;
One Meissner padding condenser, No. 17025;
Four Meissner octal sockets;
Three Meissner knobs;
One Cornell-Dubilier 500 mmf. mica condenser;
One Cornell-Dubilier 0.004-mf. mica condenser.
One Cornell-Dubilier 100 mmf. mica condenser;
One Cornell-Dubilier 250 mmf. mica condenser;
Four Cornell-Dubilier 0.25-mf., 400-V. paper condenser;
One Cornell-Dubilier type BR, 12-mf., 150-V. electrolytic condenser;
Two Cornell-Dubilier 0.01-mf., 400-V. paper condensers;
One I.R.C. 75,000-ohm potentiometer with D.P.S.T. switch;
Three I.R.C. 50,000-ohm, ½-W. resistors;
One I.R.C. 2 megohm, ½-W. resistor;
One I.R.C. .5-megohm, ½-W. resistor;
One I.R.C. .15-megohm, ½-W. resistor;
One I.R.C. 1 megohm, ½-W. resistor;
One I.R.C. 10,000 ohm, 1 W. resistor;

MISCELLANEOUS

One carrying case to dimension shown
One aluminum panel
One aluminum chassis
One jack
One 6-ohm filament rheostat
Wire, hardware, etc.

USING "LOOP" PORTABLE IN CAR



Having purchased a portable receiver of the loop-antenna type we were confronted with the problem of getting it to operate in the car, since the all-steel body and turret top shielded all signal from the loop. Adding an auto antenna made it sufficiently sensitive to bring WJR (about 125 miles distant) in a little, though it was barely audible when connected directly to the set. When connected through the coupler described here the sensitivity was equal to that of the average home receiver. The size coil will depend on the set and antenna used and therefore must be obtained by experimentation (a standard B.C. plug-in coil was used in the original model).

To operate the set, tune the radio set to any desired station and adjust the control on this unit for maximum volume.

THE "LUNCHBOX 5" BATTERY PORTABLE

THE writer was planning a fishing trip into Canada where supplies had to be packed on foot and by canoe which created the need and the inspiration for a very small, lightweight, efficient portable battery radio set, sensitive enough to give good reception in that isolated section.

LUNCHBOX

Much thought was given to obtaining a practical case that would be as small and light of weight as possible yet strong enough to stand the abuse given a portable. The ordinary *lunchbox* was finally decided upon and one was purchased at the retail store of a leading mail order house.

The inside dimensions of the lower unit were 9-13/14 x 4-19/32 x 3-28/32 ins. deep. The oval cover was a perfect design for a standard No. 6 drycell replacing the space occupied by the thermos bottle with room at one end to spare for the 3½-in. permanent-magnet speaker. A size of "B" batteries was found that fit the exact width and height of the lower unit. The problem then was to completely encase a 5-tube superheterodyne including 1 radio-frequency stage, its own antenna, and speaker, so that with the box closed it would be practically weatherproof, with the appearance of just a lunchbox.

LAYOUT

The parts layout was carefully planned to give a commercial appearance with precaution to have all aligned circuits dependent only on the chassis and partition for support and not on the lightweight case.

Size .030 sheet steel was selected for the chassis and formed into speaker panel, receiver panel, partition and subchassis as per photos and drawing. All chassis-to-case mounting holes in the chassis and partition were tapped for 6/36 machine screws, and countersunk to allow the screw heads to draw the lightweight case into the countersink and to present a flat, finished appearance.

It was necessary to mount the tubes horizontally as shown in Fig. B. Bakelite sockets that press-fit into holes cut into the sub-chassis were used as space did not permit use of sockets requiring mounting rivets or bolts. These tubes do not require external shielding if the layout is correctly planned. Referring to Fig. B, the layout starting at the upper-left-hand corner and proceeding in a clockwise direction is as follows: 2nd-detector and 1st audio tube, 2nd I.F. transformer, I.F. tube, R.F. tube, oscillator coil, converter-oscillator tube, output tube and in the center the 1st I.F. transformer. The output transformer can't be seen, but it is behind the 2nd-detector tube.

CIRCUIT

The superheterodyne circuit as per Fig. 1 is quite conventional and regeneration is not used. The antenna coil, L1, is

LIST OF PARTS

One lunchbox of standard size (available at any hardware or department store);
One Radiart 13-in. 6-section telescope-type antenna;

Coils

One Meissner iron-core antenna coil and shield, to match 27 mmf. capacity antenna and gang (We constructed ours)
One Meissner R.F. coil and shield to match gang;
One Meissner oscillator coil for 260 kc. I.F.;
One Meissner 1.F. transformer, for 260 kc., No. 1 (any 260 kc. auto-radio type should be satisfactory);
One Meissner I.F. transformer, for 260 kc., No. 2 (any 260 kc. auto-radio type should

be satisfactory);

RESISTORS

One Centralab volume control (and switch), 0.5-meg., (Any standard make with grid-circuit curve may be used.);
One I.R.C. resistor, 450 ohms, ½-W.;
One I.R.C. resistor, 6,000 ohms, ½-W.;
One I.R.C. resistor, 20,000 ohms, ½-W.;
Two I.R.C. resistors, 50,000 ohms, ½-W.;
Two I.R.C. resistors, 0.1-meg., ½-W.;
One I.R.C. resistor, 0.25-meg., ½-W.;
Two I.R.C. resistors, 0.5-meg., ½-W.;
One I.R.C. resistor, 1 meg., ½-W.;

CONDENSERS

One American Steel Package midget-type 3 gang T.R.F. condenser, 350 mmf. per section, counterclockwise rotation, trimmers on short end;
One Micamold variable oscillator padder, 600 to 1,000 mmf. (order by specs.);
One Cornell-Dubilier condenser, 0.01-mf., 100 V.;
Three Cornell-Dubilier condensers, 0.05-mf., 100 V.;
One Sprague flat (auto-radio type) condenser, 0.5-mf., 100 V.;

(Continued on page **39** *)*

Fig. A. This humble-appearing "lunchbox" is a radio set!—complete with self-contained power supply and extensible antenna—ready to operate, at a moment's notice, and at loudspeaker volume.

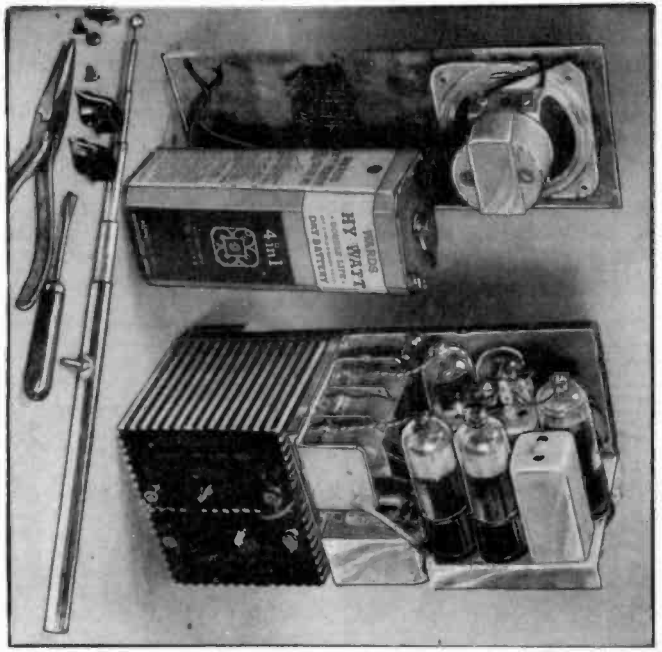


Fig. B. The "innards" of the Lunchbox Portable. One No. 6 drycell will run the set for months. Note the P.-M. dynamic speaker above the cell; and note the telescoping fishpole-type antenna which plugs into the front panel and extends to 45 ins.

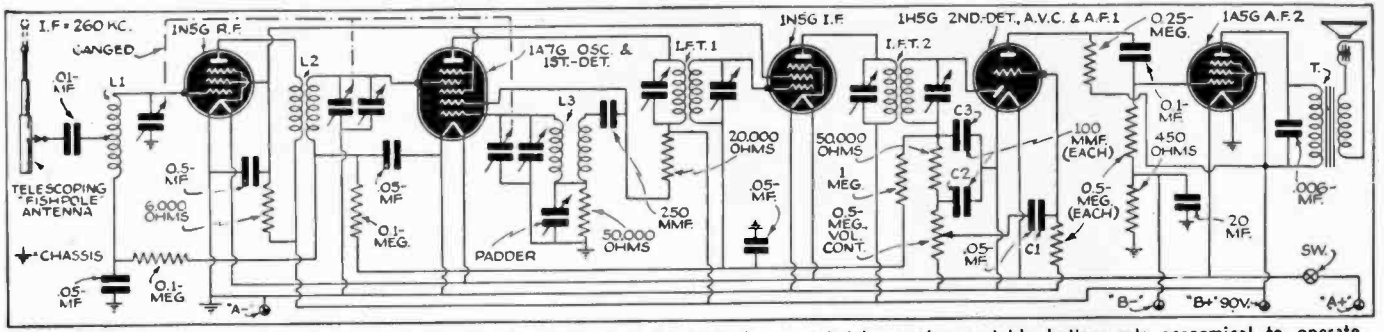


Fig. 1. Schematic diagram of the battery portable. The development of the 1.4-V. low-current tubes makes portable battery sets economical to operate.

exactly matched to the telescopic antenna when it is extended to 45 ins.; the addition of a longer aerial or ground is a detriment and unnecessary. This coil is of iron-core, high-gain type. The R.F. coil is capacity- as well as inductance-coupled to increase that stage's gain at the 600 kc. end and thus compensate for loss at that end in the antenna coil caused by the small amount of coupling offered by the telescopic antenna (which measures 27 mmf. capacity).

The grids of all the tubes except the output tube are returned to ground. The self-bias is desirable on the output tube as it removes only 4½ V. from the "B" supply to that tube and the bias remains of right proportion as the "B" batteries run down.

Automatic volume control is used to compensate for fading of signals. The sensitivity measured with a General Radio output meter and a signal generator was 3 microvolts at the 1,500 kc. end, with a linear drop to 10 microvolts at 600 kc. This was at 50 milliwatts which is ½ the rated output of the 1A5G tube; with distortion, about 150 milliwatts can be obtained. The total "B" current drain was very low, measuring 8¾ ma.; the "A" drain was only 250 ma. The estimated life of the batteries using the radio set 3 hrs. per day is approximately 2 months (that is, using a "double life" drycell).

The center section of the 3-gang condenser should be used as the oscillator tuner separating the R.F. and the antenna sections and thus prevent regeneration of the high-gain circuits. The R.F. section is the one nearest the shaft end. The trimmer should be removed from the antenna section with side-cutters (pliers), or by employing a similar method.

The gang condenser may be mounted without rubber washers as, due to the speaker being mounted in the top away from the tubes and gang, no microphonic howl was encountered.

COILS

The antenna, L1, coil is wound on a good grade of iron core, and with 15/44 litz wire. Use the universal type of winding in a 7/32-in. pie. The grid end should be the start or inside of the winding and a tap brought out between 60 and 65 microhenries from the grid end. The overall inductance should match a condenser gang having a capacity of approximately 350 mmf. per

section. The inductance value given above is the effective value with the coil in the shield can.

The radio frequency coil, L2, should be of high-gain (auto-radio) type and the beginner might find it much better to purchase one, from some auto-radio service department or supply house, which is matched for a T.R.F. gang of 350 mmf. rather than try to construct one. It should be designed for a shield can of 1⅜ ins. outside diameter, or less. Capacity coupling should be added if it doesn't have it. For this, wind 5 or 6 turns of No. 40 S.S.E. over the secondary, using a suitable insulating material between (such as cellophane), and connect one end of this coil to the plate end of the primary winding (leaving the other end free).

The oscillator coil, L3, of No. 32 wire, is wound on a ¾-in. form, with the secondary inductance matched to a 350 mmf., T.R.F. gang. The primary consists of about 15 turns, wound over the grid end. Insulate with cellophane, and mount in a shield can of not more than 1⅜ ins. outside diameter.

The intermediate-frequency transformers, I.F.T.1 and I.F.T.2, should be designed for 260 kc. and should be of high-gain type. They must have their trimmers mounted in the top of the can (of not more than 1¼ ins. outside diameter). They do not have to be of iron-core type.

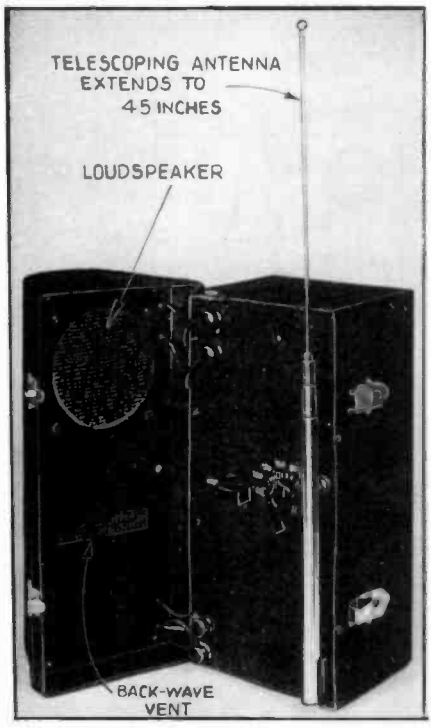


Fig. C. The selectivity of this little receiver is surprising. We were able to receive numerous stations in the editorial offices of *Radio-Craft*, located in a modern steel building in New York City, without interference. The "A" battery is located with the speaker where the thermos bottle is usually contained—in the cover.

CHASSIS

For the speaker panel, cut from the sheet steel a piece 4-3/16 x 10-1/16 ins. For the center of the speaker hole measure 2-5/32 ins. from the top edge and cut a 3-1/16 in. diameter hole. The speaker mounting holes can be drilled by using the speaker as a template. About 6 ins. from the top edge cut a "back-wave" speaker vent ½-in. wide and extending within ¾-in. of both sides. Drill holes ¼-in. in from the side to accommodate the speaker and "A" battery wires, as per the photos. Solder 6 angle brackets, tapped for 6/32 threads, into the box cover in each corner and in the middle, and drill the panel to match. Cover the vent with grille cloth and place a wire mesh under the cloth for the speaker front.

The receiver panel is cut from sheet steel to 10-5/16 x 5-3/32 ins. This will allow a ¼-in. turn-down on 4 sides, leaving a top panel 9-13/16 x 4-19/32 ins. At a point 4-25/32 ins. from the top edge and 1½ ins. from both sides (see photo) drill two ⅜-in. holes for the condenser shaft and the volume control. At a point 5-15/16 ins. from the top edge and ¼-in. in from both sides drill 2 holes to mount partition. Add holes for binding posts to match lead holes in speaker panel.

The partition is cut to 4-27/32 x 4-11/32 ins., and turned down ¼-in. on panel edge and both sides, leaving a partition measuring 4-19/32 x 3-27/32 ins. The bent-down portion is placed toward the chassis side. Drill holes for gang condenser mounting as follows: one 1-11/16 ins. from side and 20/32-ins. from panel edge. Another 1-11/16 ins. from side and 2-20/32 ins. from panel edge. The third, 13/16-in. from side and 1-20/32 ins. from panel edge.

The sub-chassis, dimensions for which are given in Fig. 2, when completely assembled, mounts to the upper-left corner of the receiver panel (see photo) with 2 self-tapping

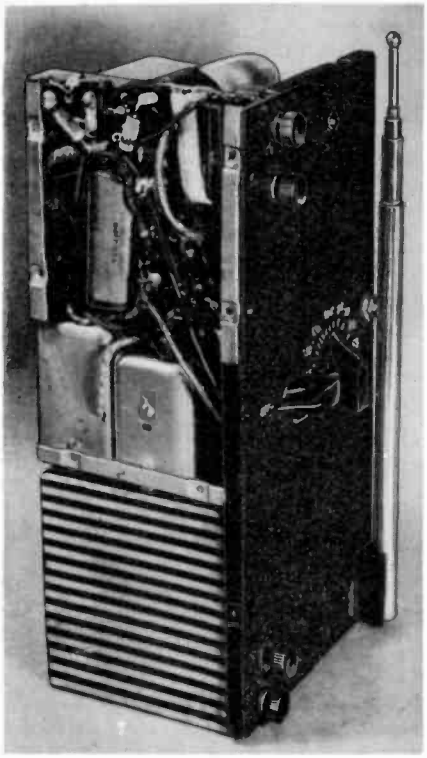


Fig. D. This under-chassis view of the portable gives you an idea of its compactness. The front panel controls are simple: one for tuning, and one for volume and on-off.

screws. As coil mountings and shields vary, no dimensions are given; the layout can be completed by reference to the photos. The antenna coil and R.F. coil shields can be seen in one photo; the antenna coil being the smaller one.

WIRING

Having constructed and mounted all chassis parts, proceed by connecting all filaments in parallel and ground the negative "A" side (either side).

Wire-in the screen-grids of the R.F. and I.F. tubes, and place terminal strips, resistors and condensers per photos. The first two 0.05-mf. A.V.C. bypass condensers and the 0.1-meg. isolating resistor, are mounted under the antenna section of the gang and on the R.F. coil shield by a 3-lug terminal strip. This is necessary because of limited space. The oscillator padder mounts together with a 50,000-ohm resistor atop the oscillator coil can; and a terminal strip holds a 0.5 meg. audio grid-leak and volume control coupling condenser (fastened under the mounting nut atop the I.F. can, per one of the photos).

A 3-lug terminal strip is mounted in the upper-left-hand corner of the sub-chassis in one photo, and the two 100 mmf. mica condensers and the 50,000-ohm resistor used as A.V.C. filter are connected to it. In the upper-right-hand corner of the same photo are the 20 mf. audio bypass condenser and the 0.1-mf. audio coupling condenser. The latter is a flat, moulded-in-rubber type now on the market. On the left side of this photo is the flat, 0.5-mf. screen-grid bypass.

TELESCOPIC ANTENNA

The antenna was purchased as a standard 13-in., 6-section telescopic antenna. It was necessary to cut each section down to an overall length, when closed, of 9½ ins. (extended, 45 ins.). A roll of solder on each section may be substituted for the die roll which is cut off when shortening the antenna.

A General Radio type banana plug was filed to fit the curved antenna and soldered securely about mid-way of the outside section. This plugs into a jack mounted to the receiver panel. A piece of hardrubber, formed so the antenna could clip into it on 3 sides, was cemented to the panel at the base of the antenna.

Binding posts mounted to the receiver panel facilitate ease of battery removal; and chassis likewise. It is only necessary to insulate 2 of these, as "A–" and one side of the voice coil can be grounded. It was necessary to cut down the standard posts and also the bar knobs to clear the speaker panel.

ALIGNMENT

To align, connect an output meter to speaker binding posts and from a 260 kc. signal generator connect a lead through a 0.1-mf. condenser to the converter tube. Align, in order, the I.F.T.2 and I.F.T.1 trimmers.

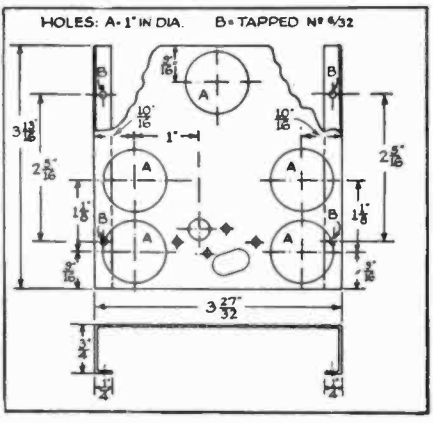


Fig. 2. Sub-chassis dimensions.

Then, with a 1,500 kc. signal generator connected to the antenna input (be sure antenna is removed) through a 27 mmf. condenser, rock the gang, and align the oscillator and R.F. trimmers to the fixed antenna section. Using parts as described you should reach a maximum frequency of 1,850 kc. Next, turn the dial to 600 kc. and rock the gang while adjusting the oscillator for greatest gain.

With a 100 kc. signal, checked against a known broadcast frequency, calibrate the dial onto the receiver panel. Punch with a letter-and-number set, and after painting, fill-in with white ink. Fish-paper should be cemented to the underside of the receiver panel where the "B" battery terminals are and to the side of the "lunchbox" where the grid caps come close. The grid leads were soldered to the sides of the caps to make space and to prevent poor connection.

Drill one hole through each of the 2 carrying handle supports and through the case to take a large-headed 6/32 machine screw. This will prevent the handle accidentally pulling out. Case and panel are finished in black crackle paint.

The pleasures and advantages of the portable are numerous. For instance, it may be used on fishing trips, in canoes or boats, on hunting parties, beach parties or just sun bathing, and on picnics; at football games and other sports events you can hear as well as see, if the event is being broadcast; and at the lake cottage, trailer or in a parked car viewing important events that are broadcast, or for just plain romantic reasons its use helps save the car battery; and lastly, it provides very practical room-to-room radio reception without the bother of messy wires.

LIST OF PARTS

(Continued from page 35 *)*

One Aerovox flat condenser, moulded in rubber, 0.1-mf., 400 V.;
One Cornell-Dubilier condenser, 0.006-mf., 400 V.;
One Cornell-Dubilier condenser, 0.05-mf., 400 V., C1;
One Micamold mica condenser, 250 mmf.;
Two Micamold mica condensers, 100 mmf., C2, C3;
One Mallory or Magnavox small electrolytic condenser, fabricated plate (Mallanode) type, 20 mf., 25 V.;
One 6-section telescopic antenna.

TUBES

Two Sylvania type 1N5G tubes;
One Sylvania type 1A7G tube;
One Sylvania type 1A5G tube;
One Sylvania type 1H5G tube;

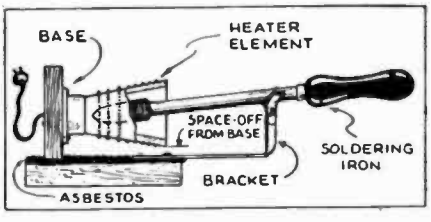
MISCELLANEOUS

Five Meissner bakelite press-fit-type sockets, octal base;
One Oxford-Tartak Co. 3½-in. P.-M. dynamic speaker, 3-ohm voice coil (order by specs.);
One Cinch 6-point terminal strip;
Three Cinch 3-point terminal strips;
Two Eby small bar knobs (cut down to fit);
Four Eby binding posts (cut down to fit);
One General Radio type banana jack and plug;
One Magnavox output transformer, 25,000 to 3 ohms, ½- x ⅝-in. stack (order by specifications);
One standard, No. 6 drycell (or preferably, with 4-cell—long-life—construction);
Two Burgess "B" batteries, type 230BP;
One length of .030 sheet steel sufficient for panels, partition, sub-chassis (see article for dimensions), obtainable at any steel warehouse or tin shop;
One assortment of hardware, fish-paper, flexible and hookup wire, and solder lugs.

QUASI-ELECTRIC SOLDERING IRON

● FIRST, get the heating element from an electric heater and mount it (with a porcelain-base socket) on a board that is covered with some asbestos. Place this board at about an 85-degree angle and connect the heater element to the 110-V. main.

The fellow who uses this idea will have the next best thing to an electric iron, merely by carefully placing his ordinary, flame-heated iron into the open end of the heater unit.



"THE SEAFARER" LOOP-TYPE BOAT RADIO SET

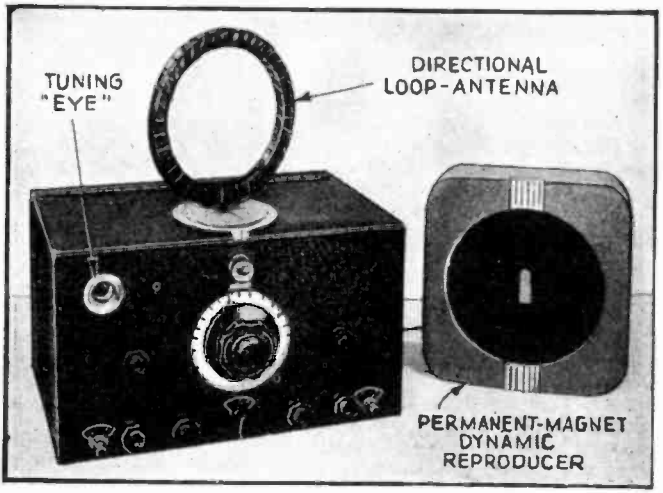


Fig. A. Appearance of "The Seafarer" radio set and direction finder.

"THE SEAFARER" is primarily designed for sensitive, directional-reception of broadcast-station signals, but it is further provided with a means for switching to both low-frequency ranges covering the regular shore and airways beacon stations, and high-frequency ranges for short-wave DX-ing.

ADDITIONAL FEATURES

As a matter of fact, its only radical departure from ordinary mobile ("car-radio") receiver design is its use of a small tuned plug-in "loop" (see Fig. A) replacing the usual antenna and antenna coil. Its circuit is simple and easily understood, so that any radio-builder, familiar with the principles of standard superheterodyne construction, should be able to duplicate the laboratory model.

The average radio receiver, with a few minor and unimportant alterations here and there, may be easily adapted to direction finding and general maritime service. Conversely, the typical, modern-day and non-commercial direction finder may be revamped, without much trouble, for broadcast reception. This does not imply that equipment manufactured for home use will stand up properly in extremely humid and salt atmospheres, but it does imply that a circuit basically suitable for the one type of instrument remains fundamentally proper for the other; and that a combination job involves no great complexities, either of circuit or construction.

A crackle-finish metal cabinet, true vernier dial, self-contained genemotor power supply, full, all-wave superhet. hookup, high gain (amplification) and sensitivity, loudspeaker output, visual tuning (by means of the electronic "eye"), and permanent-magnet dynamic reproducer; these are some of the features of this instrument. It costs very little to construct, and compares favorably with $200 commercial "finder" jobs. It stands up with the best of competitive supers., and affords the professional set-builder an opening to

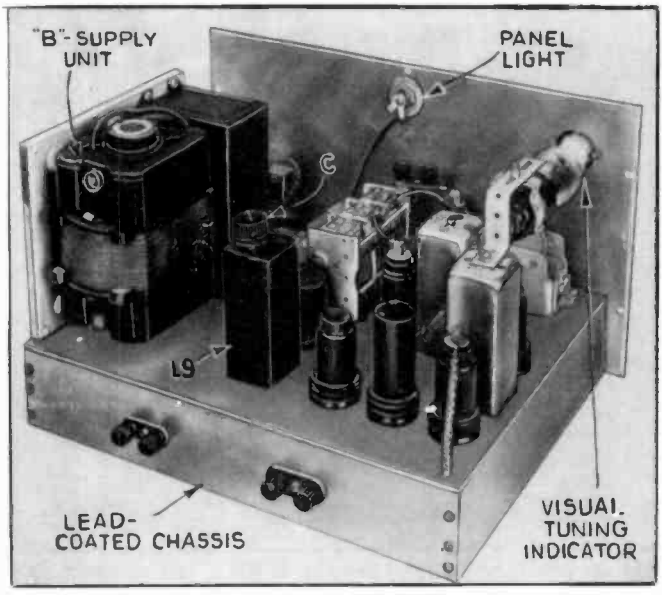


Fig. 8. Rear view showing placement of parts and power pack.

profitable sales in a relatively untouched field.

THE CIRCUIT

Six tubes are employed in a straight (except for the input part) all-wave superhet. circuit. The 1st-detector and high-frequency oscillator stages are equipped with the usual shielded broadcast coils, and a switch permitting a shift to either the 140 to 400 kc. beacon band or to such short-wave bands for which the individual builder secures coils. (In the laboratory model, coils for the 5.9 to 18 mc. band have been installed and are shown in the under-chassis photograph.)

The loop circuit supplants the conventional R.F. coil set-up and antenna, as previously mentioned. It is roughly tuned by one section of the 3-gang condenser that governs signal selection. A 150 mf. separate variable condenser bridged across this section permits exact tuning to the desired signal frequency. The use of a rather low-inductance loop makes possible the sharp, clean-cut signal so necessary to accurate direction finding. (Antenna coils may, of course, be wired-in for the short-wave band or bands, as shown in the schematic diagram, Fig. 1, through the designation "L optional". Their use would call for a separate antenna post, to which a short-wave aerial may be conveniently connected. Removal of such an antenna would be desirable when tuning to broadcast or long-wave signals, especially when direction-finding.)

We will not discuss the conventional R.F. and mixer tube circuits except to say that neither tube is A.V.C. controlled (A.V.C. being confined to the I.F. stage); and to mention the fact that both stages are designed to work at fullest possible efficiency. The 6K7 R.F. tube cathode-limiting resistor is returned, not to chassis, but to a potentiometer for manual control of sensitivity—a convenience we simply must have for adjusting the visual resonance indicator or tuning "eye" shadow to an optimum point for either maximum or minimum finder reading. (See Fig. 5 for detail of tuning "eye" connections.) The screen-grids of both the 6K7 and the 6A8 mixer are series-fed, and plate circuits are adequately decoupled and bypassed. *Perfect R.F. stability is imperative.*

Both I.F. transformers are of the ferrocart iron-core variety, assuring us of highest possible gain and selectivity in a single stage using a 6K7. Like the cathode in the R.F. stage, the I.F. tube's cathode is returned to the sensitivity potentiometer. Its screen-grid is series-fed, and its plate circuit is decoupled and bypassed.

The 6Q7 2nd-detector supplies both

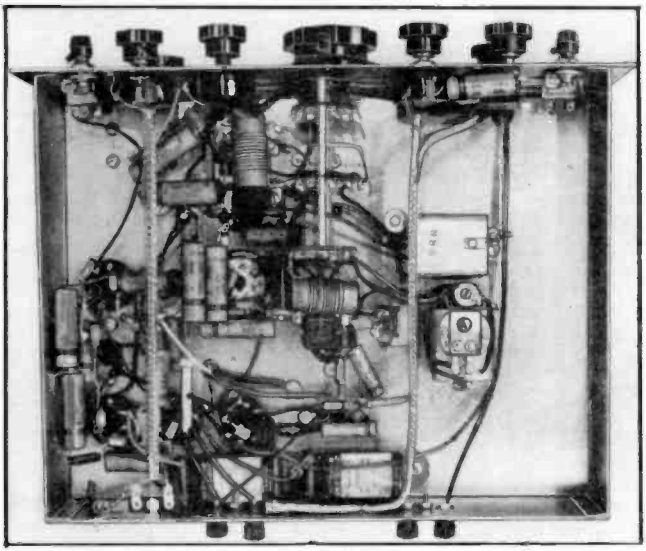


Fig. C. Under-chassis view showing wiring and positions of small components.

(1) an A.V.C. voltage to the single I.F. stage and (2) a self-amplified A.F. voltage to the output pentode. The 6F6, connected for the familiar pentode operation, feeds a 3-W. output into the permanent-magnet, high-efficiency speaker, with which the impregnated and protected output transformer is an integral part.

Fig. D. A Gloucester fisherman is here shown using a commercial make of marine radio direction finder. The position of a school of fish is charted for future reference by the use of this Bloodwell direction finder. Various lighthouses constantly broadcast (as part of their regular routine) a dot-dash signal. The direction of 2 or more of these houses is located (with the "finder") and spotted on a chart. The point of intersection of straight lines drawn through these spots indicates the position of the ship and hence the school of fish; this prevents wasting hours in a search (on the next fishing trip) covering many miles.

As there are times when a modulated signal level may be so weak as to be inaudible and at the same time unreadable on the tuning "eye" 6E5, a beat-frequency oscillator stage has been added for carrier reception. The circuit uses a 6C5, with the output capacity-coupled to the 2nd-detector circuit. This is accomplished by means of an insulated wire, one end of which connects to the triode plate; the other end is wrapped a few times around the 6Q7 diode lead.

The power supply is approximately 300 V. at 70 ma. from a selected genemotor or dynamotor unit (the terms are synonymous)—sufficient to permit additional filtering through a 400-ohm choke in the "B"-plus line, if such filtering is found necessary in individual cases. Tube filaments and genemotor are operated from a regular storage battery of 6.3 V. output rating. Leads to the power supply from the battery may or may not require R.F. filtering, largely depending upon whether or not short-wave reception is to be had.

Similarly, the "B"-plus lead may or may not require an R.F. choke at the output of the dynamotor.

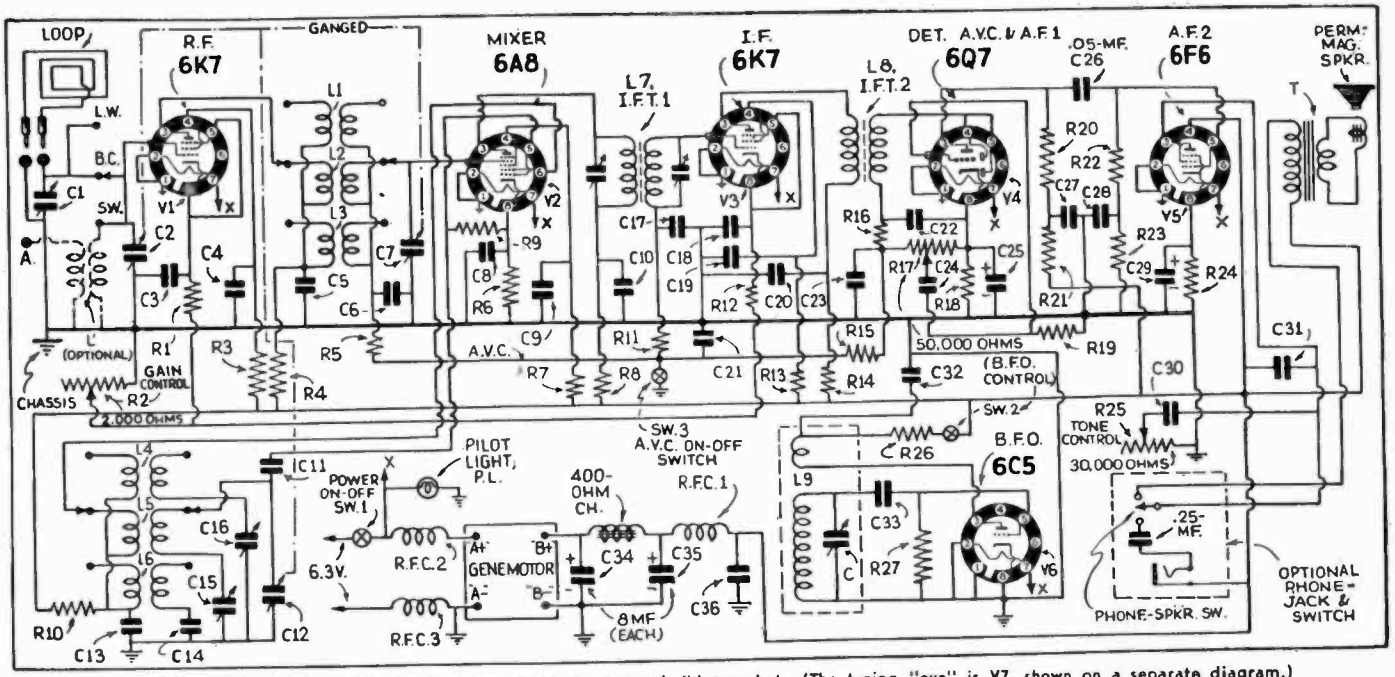


Fig. 1. Schematic circuit of "The Seafarer"—a standard, easy-to-build superhet. (The tuning "eye" is V7, shown on a separate diagram.)

MARINE SERVICE DEMANDS SPECIAL EQUIPMENT

The circuit may be conventional enough, but the materials used in this maritime receiver, however much they may seem to be of ordinary manufacture, have been especially selected and prepared for efficient service in salt, humid atmospheres. Bearing this clearly in mind, the importance of the following description then becomes more forcible.

It cannot be too frequently stated that "regular-run" components may not stand up in prolonged maritime service. Sea air is wet, corrosive, laden with chemicals; it breaks down insulation, and causes electrolytic action. No metal, particularly if unplated or poorly plated, will afford ample protection to delicate parts. Transformers "go to pot." Dielectric conduction increases through moisture absorption. Water—salt water—gets in everywhere; it

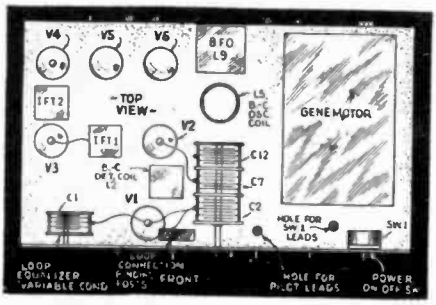


Fig. 2. Layout of parts on the chassis.

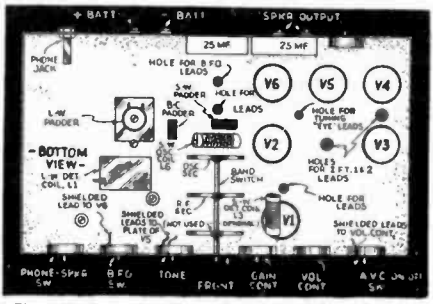


Fig. 3. Layout of parts under the chassis.

fairly saturates every minutely porous thing in the radio set, causing shorts and general breakdown.

Consider what would happen to an unprotected carbon resistor, to unwashed and untreated wire insulation, to coil components, to A.F. transformers, to speaker cones—unless some very definite steps were taken to insure their freedom from the effects of electrolysis, or corrosion, or just plain water absorption. The following precautions were taken:

(1) We secured a *LEAD-COATED CHASSIS*—and a cabinet with similarly leaded interior—if for no other reason than to assure us of *PERFECT SOLDERED CONTACTS TO CHASSIS GROUND.* (ALL contacts throughout the set are soldered carefully, by the way, to prevent possible corrosion, increased resistance, perhaps contact DETECTION.)

(2) We used *INSULATED* resistors throughout—resistors protected by heavy bakelite coatings. All values are rated at ½-W. They are small but able to withstand full load and maintain tolerances over long periods of time.

(3) We selected bypass and other condensers which are exceptionally well impregnated and cased.

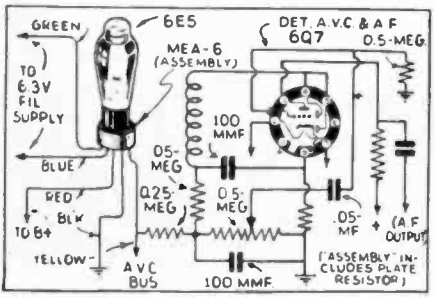


Fig. 5. Connections for the 6E5 "eye" tube, V7.

(4) We employed R.F. and I.F. coil components with windings thoroughly protected by wax dip. (Before building the receiver, we went over each and every terminal-to-winding connection, reimpregnating where necessary, and seeing to it that all strands of Litz were cleanly soldered-in.)

(5) We wired up the complete instrument with a special conductor designed for no-loss R.F. service (the nearest thing in dielectric efficiency we've been able to find to bare copper) and insulated with a washed and specially-treated textile which will not absorb moisture. This conductor maintains its dielectric resistance, and does not permit corrosive and electrolytic action due to water-salt-current effects.

(6) We reduced the number of wire-wound A.F. components to 2, one of which is the output transformer (a specially-protected item integral with the speaker); and the other an optional and perhaps unnecessary filter choke in the "B"-plus lead. Thus we have nothing at all to worry about in the way of possible primary winding breakdown—common to transformer-coupled receivers used in humid, salty atmospheres.

(7) We used a genemotor-type (combined motor and generator) power supply. We have every confidence in a well-made vibrator pack and do not wish to imply here anything to the contrary. But it just so happens that the dynamotor (as it is also called) as presently manufactured will stand up best in sea service—vibrators being, naturally, rather delicate components which might stick and require frequent attention in prolonged maritime operation.

(8) We engineered the complete set-up for proper operation with a special speaker. This speaker (which is not only proper for seafaring service but well adapted to general outdoor, vehicular, and seashore use) is an efficient permanent-magnet or "nokoil" job, complete with coil-impregnated and wax-dipped output transformer. Its cone has been carefully waterproofed on both front and rear sides, its cadmium-plated metal parts have been protected with lacquer clearcoats, and its voice coil is isolated with the usual "nokoil" solid-center cone spider—itself waterproofed and protected.

We might note at this point, before we forget it, that the particular cabinet used for the laboratory model has no louvres for ventilation but simply a narrow slit in the back for access to battery input and speaker output binding post assemblies and phone plug, if one is de-

sired. Further, use of a metal "front-of-panel" true micrometer dial has obviated any necessity for the usual large cutout. Thus the receiver becomes really *well shielded*.—A DISTINCTLY ESSENTIAL DIRECTION-FINDER FEATURE—so well shielded, in fact, that with the cover closed and no loop plugged in, and with gain and sensitivity controls advanced to full position, *powerful local broadcasters* will show not so much as an indicating hiss when we are tuned to their precise frequency! Figure 4 gives all its physical specifications for building the panel and chassis.

PARTS PLACEMENT AND LAYOUT

The 3-gang condenser is centered on the chassis pan. To the left of it are the R.F., I.F., A.F., and B.F.O. tube sockets—with I.F. and broadcast band coil components above the chassis and clearly distinguishable as to exact position (see Figs. 2 and 3). To the right is the power supply unit, with the on-off power switch on the front panel and, lined-up with the shaft (on the left) the loop-tuning trimmer condenser (which is also on the front panel). The 6E5 tuning "eye" direction and general signal indicator is mounted in its assembly, which is positioned at upper-left and secured to the output I.F. transformer shield can. Note that the broadcast band oscillator coil (in the round can) is behind the tuning variable and between it and the B.F.O. transformer.

The 2 shielded long-wave coils are mounted beneath the chassis (soldered, by the way, to the pan rather than bolted) and at one side of the wave-change switch. They are best placed in the exact position as shown and at right angles to each other.

Short-wave coils (in our case 2 for a single band) are mounted directly on the switch for rigidity and short leads. They may or may not require a shield partition between them.

On the lift cover is mounted the loop jack, to which is connected a short shielded lead for control-grid and ground tie to a 2-post assembly soldered to the variable condenser frame. The lead is made just long enough so that sufficient play will be had to permit reaching in and disconnecting control-grid and ground loop wires from the binding post assembly with the cover lifted about 6 ins. This feature enables us to conveniently break the tie when we wish to lift the cover completely or remove the front panel.

BUILDING THE RECEIVER

Layout specifications refer to the components mentioned in the List of Parts, and substitutions should be made with great care lest a completely different set-up be made imperative. It would be the wisest policy to use the designated items; they are all available through standard jobbing sources.

Wire up the set, first, for broadcast-band operation, connecting the coils in, of course, for switch selection. Shield the leads as shown in Fig. 1 (schematic diagram), particularly those running across the width of the chassis from volume and tone controls, those from the tuning "eye", and the grid lead for the loop jack. Ground these shields firmly to chassis. *SOLDER ALL CONNECTIONS CAREFULLY AND PERFECTLY.* Connect one filament terminal at each socket to chassis. Use isolating resistors and bypass condensers in the plate and other circuits as shown in the schematic circuit, as the gain of this receiver is high and *STABILITY MUST BE MAINTAINED.*

Before adding the power unit, connect the tuner, if possible, to an exterior A.C. power pack capable of supplying well-filtered 250 V. at approximately 70 ma. Make sure that the power transformer filament winding (for 6.3 V. operation) is not center-tapped and then

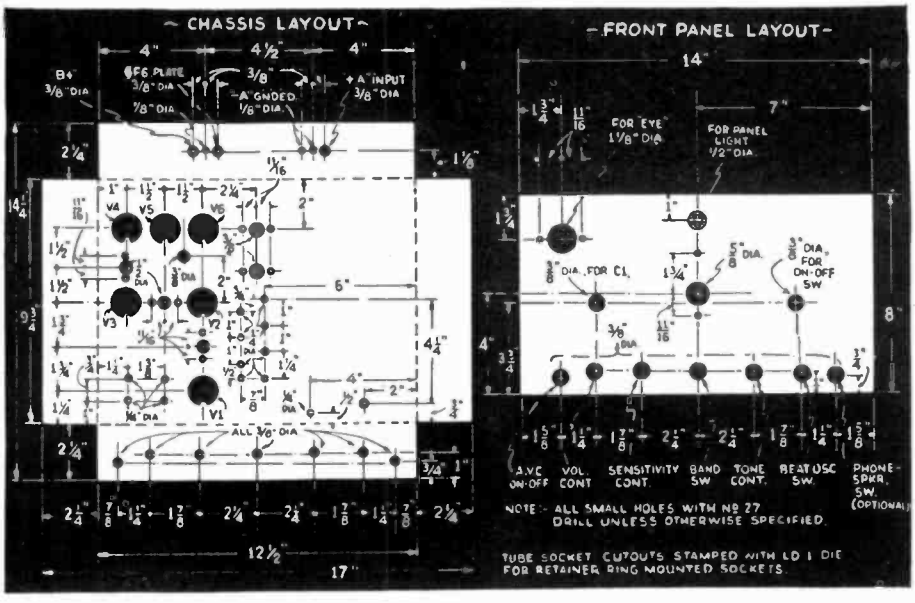


Fig. 4. Physical specifications for making the front panel and chassis for "The Seafarer."

test the receiver for opens, shorts, proper voltages, alignment, etc.

Connect a short antenna through a small coupling device, such as a trimmer condenser or a few turns of insulated wire, to the 1st-detector signal-grid lead, and tune for broadcast signals. These should come in strongly (although not sharply, due to absence of preselection). Remove the antenna, close the cover, turn controls on for full R.F. gain and audio level. *NO SIGNALS SHOULD BE HEARD.* If they are intercepted, then the required perfect shielding is not being afforded by your cabinet.

The long-wave coils may now be added and connected in to the switch. Test for proper switching and general continuity, and add an antenna as for broadcast tests. You should hear ship and other code signals without difficulty—as well as airport weather phone if you are located reasonably close to a major field.

PART II

LOOP-ANTENNA building is a matter of trial and error. We have used a very small one for general broadcast—one which works very well. Some builders may prefer to experiment somewhat before deciding upon definite jobs for service—but we shall describe the construction of the one shown in Figs. A, 1 and 2, with the comment that it will do a very good job as a *direction finder.*

LOOP CONSTRUCTION DETAILS

Secure 2 ordinary embroidery hoops, one about 8 ins. and one about 7½ ins. in dia. To the larger, securely affix a phone plug. Around the entire rim of the smaller one, drill a series of size No. 27 holes ½-in. apart. Insert small, round matches in these holes, with an inch or so of each match protruding outwardly, and then stagger-wind about 50 ft. of No. 24 D.S.C. wire around the loop—working back and forth between the sticks (as shown in Fig. 2) and in one direction until the winding is completed. Cut off the ends of the matches so that the smaller loop will fit tightly into the larger, tie the 2 hoops securely together, connect the leads to the phone plug.

See that the jack on the lift cover (described in Part I of this article) is connected to the input control-grid—ground binding posts. Plug in the loop and tune in a signal somewhere around 1,400 kc. using the tuning dial control. Vary the setting of the auxiliary loop trimmer and note whether or not resonance for the R.F. circuit is obtained and where it is obtained. If not enough capacity is had to tune the loop circuit to resonance with the signal, add wire to the loop itself until a "hit" is made with the trimmer set for approximately minimum setting. If too much capacity is indicated—then reduce the number of turns until a proper condition obtains.

Now tune to a 550 kc. signal. Nearly maximum trimmer capacity should be required for resonance here. If the tuning will NOT go up to resonance—your trimmer is too small, and a larger capacity will be required. Much depends, of course, upon loopsize and number of turns.

OBTAINING DIRECTIONAL OPERATION

With the loop built and found tunable to broadcast band limits, tape it securely together and give it a couple coats of protective lacquer. Try it out on weak signals.

When pointed *directly at* such signals—that is, *endwise*—the broadcast signal will come in at maximum level. With the loop *broadside* to the signals, the signal level should be noticeably less, at times inaudible and unreadable on the 6E5 "eye". Even on strong locals—loop turning should afford a definite point of maximum and minimum reading on the

LIST OF PARTS

One Meissner shielded broadcast R.F. coil, No. 2437, L2;
One Meissner shielded broadcast oscillator coil, No. 4243, L5;
One Meissner shielded long-wave coil, No. 7688, L1;
One Meissner shielded long-wave oscillator coil, with padder, No. 7680, L4-C16;
One Meissner padder for broadcast oscillator, No. D-2500, C15;
One Meissner R.F. coil, police, RF3, or short-wave band, RF4, L3;
One Meissner oscillator coil, police, 03, or short-wave, 04, L6;
One Meissner special trimmer for police band, or Aerovox 0.002-mf. fixed mica condenser for short-wave-band padder, No. 1427, C14;

tuning "eye"—with the point of minimum pick-up being the more easily and accurately defined.

Build a loop for the long-wave band— making it somewhat larger in size and of such inductance that with available trimmer capacity input resonance with the detector circuit is obtained. Sometimes it is good policy—and easy construction—to simply work out a job with a minimum number of turns and load it up to high-frequency resonance with the trimmer at zero setting by means of fixed capacities bridged across it. Build a loop for the selected short-wave band or bands—or, if you prefer, add antenna coils for these bands and a chassis binding post to which an antenna may be connected.

One Meissner police-band antenna coil, A3, or short-wave coil, A4, if desired, L optional; One Meissner 3-gang variable condenser, types 15115 or 15117, C2, C7, C12; One Meisner waveband change switch, No. 16263; One Meissner input I.F. transformer, type 5740, 456 kc., L7; One Meissner output I.F. transformer, type 5742, L8; One Meissner B.F.O. transformer, type 6753, L9; One Meissner variable condenser, type 15106, or condenser, type 968, 150 mmf., C1; Six Aerovox condensers, type 484, 0.1-mf., C5, C10, C20, C27, C36 C32 Seven Aerovox condensers, type 284, 0.1-mf., C3, C4, C8, C9, C18, C19, C28; Three Aerovox condensers, type 284, 0.05-mf., C6, C17, C21; One Aerovox condenser, type 484, 0.01-mf., C13; Three Aerovox condensers, type 484, 0.05-mf., C24, C26, C30; One Aerovox condenser, type 484, 0.006-mf., C31; Three Aerovox mica condensers, type 1468, 100 mmf., C11, C22, C23; One Aerovox condenser, type 1468, 250 mmf., C33; Two Aerovox electrolytic condensers, type PB25, 52 mf., C25, C29;

(Continued on page 48)

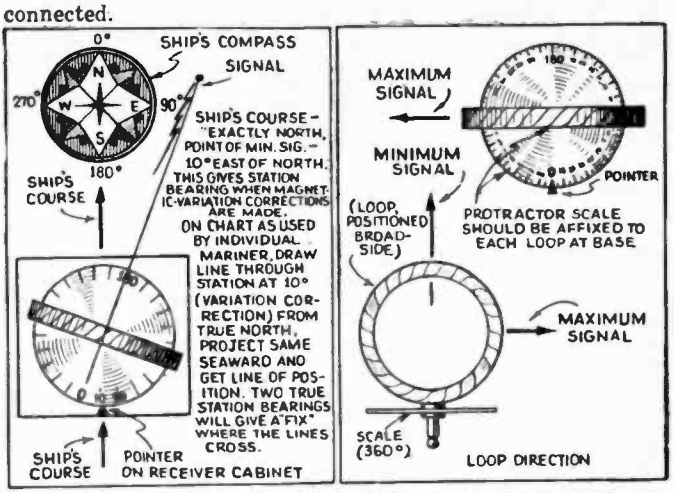


Fig. 1. Details of how the direction-finding loop antenna operates.

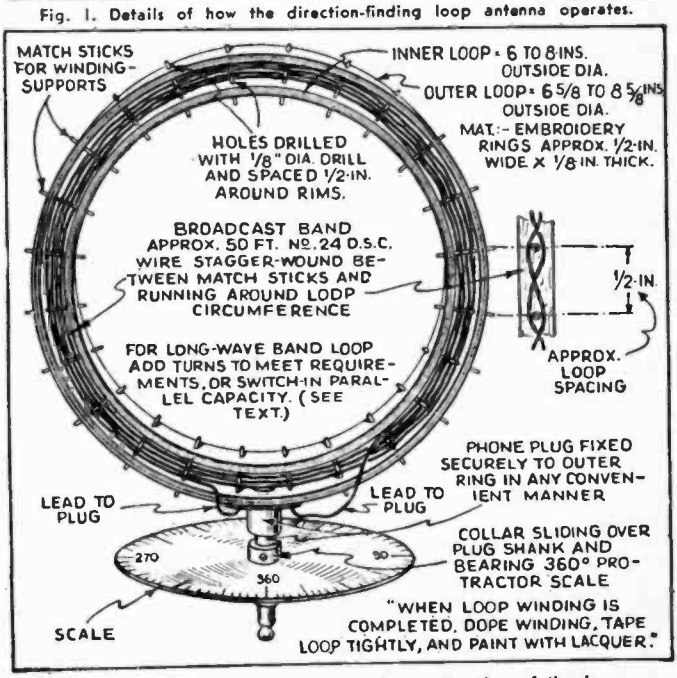


Fig. 2. Detailed specifications on the construction of the loop.

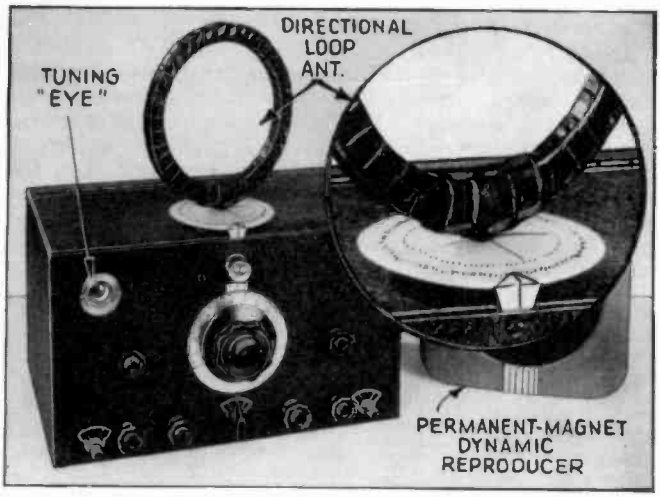


Fig. A. The Boat Radio Set and (inset) relationship of loop to scale.

LOOP-POSITION INDICATION

For each loop, secure or accurately draw a 360-degree protractor of convenient size. (See Fig. 1.) Cardboard affairs will do nicely. Center the protractor on the loop plug and fix it in position in such a way that its 0- and 180-deg. markings are broadside to the loop (90 and 270 deg. markings therefore in line with the endwise plane of the loop antenna). Make definitely sure that the scale will not slip and will turn *only* when loop and plug are turned.

Place a pointer on the front of the cabinet's cover so that it will record against the scale. Adjust the position carefully, making sure that when the loop is turned to read zero (deg.) or 360 (deg.) against the pointer, the finder is *exactly* parallel—endwise—to the length, left to right, of the cabinet.

OPERATION

In operation, the radio-direction finder is positioned in direct line with the course of the vessel. That is, the instrument heads directly toward the ship and the pointer indicates this line of direction of travel.

A chart of local waters will be required—a knowledge of magnetic variation figures for these particular waters, and a ship's compass. These, of course, are common enough to any mariner's store of seafaring apparatus and intelligence.

All bearings and positions are taken with reference to a ship's course.

Bearing-station on-course. Is station ZZZZ, which is coming in strongly, known to be exactly in line with a desired course? Is its position right where we want to go? Then we simply take a bearing on it with our finder, adjusting the loop for *minimum* reading or inaudibility. (The *maximum*-response reading is not as accurate.) Our pointer will read against the scale and indicate the number of degrees this station lies away from our present line of direction. We note our course on the ship's compass and then simply correct our heading until course and signal are in line. We may now "ride the signal" into port without "much of any" trouble.

Bearing-station off-course. Is the bearing of station ZZZZ unknown and do we wish this bearing? Then we note our course of direction, as shown by our ship's compass, correct it for magnetic variation, get a direction reading on the signal with our finder, find out its bearing from our present course by noting the degrees difference between the 2 lines of direction, add our own bearing from true-North to this difference—and get an actual true bearing on the signal. By extending this line seaward on our chart we will have something to work on, for we'll at least know we are on this line!

Do we want a "true position"? Then we take a bearing on 2 stations, if such bearings are not known, "triangulate" or extend both lines seaward, and note on our chart where they cross. That cross or "fix" is our true position and we know exactly where we are!

But these are matters for mariners. Your job as a radio builder will be to construct a model receiver, get it into proper working order, and scamper down to the nearest yacht club for an exhibition. When you do—if you do—make such a trip, you may take along plenty of advance assurance of an immediate sale and some profitable orders for the season.

LIST OF PARTS

(Continued from page 47)

One Aerovox dual electrolytic condenser, 8-8 mf., type PBS-5, optional, C34, C35;
One Continental Carbon bakelite insulated resistor, type M-5, ½-W., 1 meg., R15;
Two Continental Carbon bakelite insulated resistors, type M-5, ½-W., 0.5-meg., R19, R22;
Three Continental Carbon bakelite insulated resistors, type M-5, ½-W., 0.25-meg., R5, R11, R20;
Five Continental Carbon bakelite insulated resistors, type M-5, ½-W., 0.1-meg., R3, R7, R13, R21, R23;
Three Continental Carbon bakelite insulated resistors, type M-5, ½-W., 0.05-meg., R9, R16, R27;
Two Continental Carbon bakelite insulated resistors, type M-5, ½-W., 30,000 ohms, R10, R26;

One Continental Carbon bakelite insulated resistor, type M-5, ½-W., 5,000 ohms, R18;
Three Continental Carbon bakelite insulated resistors, type M-5, ½-W., 1,000 ohms, R4, R8, R14;
Two Continental Carbon bakelite insulated resistors, type M-5, ½-W., 400 ohms, R6, R24;
Two Continental Carbon bakelite insulated resistors, type M-5, ½-W., 300 ohms, R1, R12;
One Electrad potentiometer, type 573, 12,000 ohms, R2;
One Electrad potentiometer, type 203, 50,000 ohms, R17;
One Electrad potentiometer, type 241, 30,000 ohms, R25;
One genemotor, type 2775;
One Wright-DeCoster model 1196, speaker housing, with 980 Nokoil reproducer especially released for maritime service;
One Kenyon filter choke, No. KC200, optional;
Two rotary on-off switches, line type Sw.1, Sw.2;
Two midget switches, type 10, Sw.3, and one (optional) for speaker-phones switchover;
One phone jack for loop plugs, type 1;
One phone jack, type 3A (optional) for headphone;
One pilot-light mounting, type 330 (for P.L.);
One instrument-type vernier dial, type 296;
Six knobs, type 294;
One knob, type 286;
Two plates, type 274;
One tuning "eye" assembly, PF6;
Two sockets, RSS-8;
Four sockets, S8;
Two 2-post assemblies, A-G, and one 2-post speaker assembly;
Cabinet and chassis (as per specifications);
Two National Union type 6K7 tubes, V1, V3;
Four National Union tubes, one each of types 6A8, 6Q7, 6F6, and 6C5, V2, V4, V5, V6 (respectively);
One National Union type 6E5 visual tuning indicator, or "eye", V7;
Special R.F. hookup wire (q.s.);
One pilot lamp, 6.3 V., P.L.;
Loop materials (per specifications in Part II), etc.

4-TUBE PERMEABILITY PORTABLE

BATTERY portables are quite the vogue today. In fact, they seem to be the only item in the radio industry which is selling—thanks to the new series of low-drain 1.4-V. battery-type tubes. Most of these portables are 4- and 5-tube superhets., using automatic volume control, tone control, pushbutton tuning, permanent-magnet dynamic speakers, and all the other accoutrements of modern radio. They are really fine jobs and the radio manufacturers are to be congratulated on their fine engineering—but not on their physical design. And here is where we come in.

The battery Permeability Portable described in this article not only is half the cubic dimension of the average commercial job but, more important, less than half its weight (only 6½ lbs.). It is really a "package" of radio since it can be thrown into one corner of the vacation luggage and taken and operated anywhere; or, it may be carried by its own handle.

Incidentally, talking about its handle, the carrying case for this portable may be any convenient-size box or case which you may have on hand. The author did not take the time to have one built inasmuch as the various constructors will probably exercise their own choice or utilize existing cases—they always do.

CAPACITY ANTENNA

Construction of this set has been greatly simplified, too, in an entirely new direction. No longer is it necessary to laboriously wind a loop antenna, in order to secure the advantages of a built-in aerial, and then spend perhaps hours trying to secure tracking of the tuning system over the entire tuning range.

Instead, a *capacity antenna* is used. Tested in *Radio-Craft* offices, inside a steel building, this novel, built-in

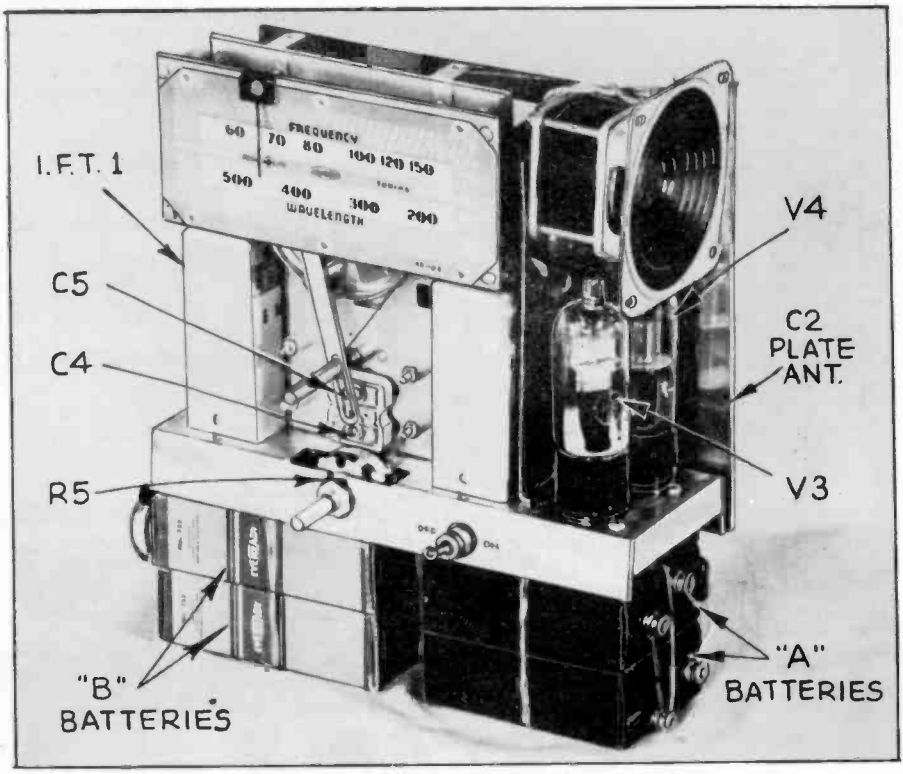


Fig. A. The "permeability portable" is about ½ the size of the average commercial portable and less than ½ its weight. All components are compactly arranged, but not overcrowded, on the chassis with the P.M. dynamic speaker taking advantage of the space over 2 of the tubes. Build your own carrying case around it or slip it into any convenient-sized case or box you may have on hand. The small size "A" and "B" batteries used will last for a considerable time with average use.

antenna worked perfectly! We predict that this "capacity antenna" will soon obsolesce the present loop antenna, for many types of radio receivers!

CONDENSER-LESS TUNING

Besides these features, our portable is built around the new Aladdin *permeability tuner*. The old variable tuning condenser can now peacefully repose in the "junk-box." Tuning is obtained by varying the inductance of the R.F. and oscillator coils through the medium of movable R.F.-iron cores.

The principle of permeability (inductance) tuning, is not new. It was used way back in the gay '20's in the form of variocouplers, etc. However this is the first time that a really practicable unit has been successfully designed and made available to the public. The development of an iron core which can be used in coils at radio frequencies is mainly responsible for this achievement. By inserting or removing these cores, the effective inductance values of the coils are varied—making these coils and their associated circuits resonant to different frequencies. An ingenious lever system operates the iron cores.

THE CIRCUIT

As can be seen from the schematic diagram, Fig. 1, the circuit is a conventional superhet., employing a type 1A7G tube as oscillator, mixer, and 1st-detector, a type 1N5G as 1st I.F., a type 1H5G as automatic volume control and 2nd-detector, and finally a 1A5G as power output. The use of permeability tuning together with iron-core I.F transformers affords considerable overall gain, over the entire tuning range, which results in excellent volume. Selec-

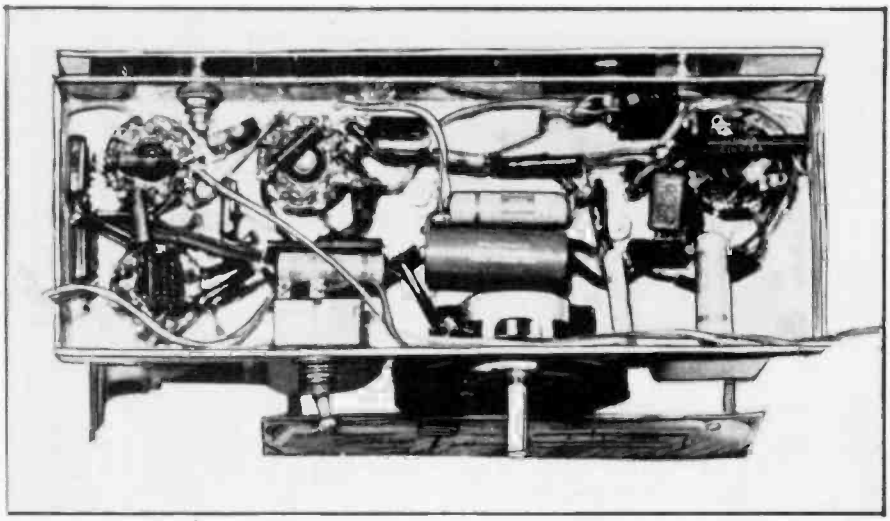


Fig.C. Underside view of the portable showing arrangement of resistors and condensers.

tivity is too good, being slightly better than 10 kc. This results in slight sideband cutting of the audio signal but is not serious at all. The circuit also makes use of its high sensitivity by employing the previously-mentioned "capacity antenna"—a built-in aluminum plate—for local reception. In suburban areas a larger antenna will be required to afford greater signal input. This may take the form of a 20 ft. length of wire strung out on the ground and attached to an antenna binding post provided on the chassis.

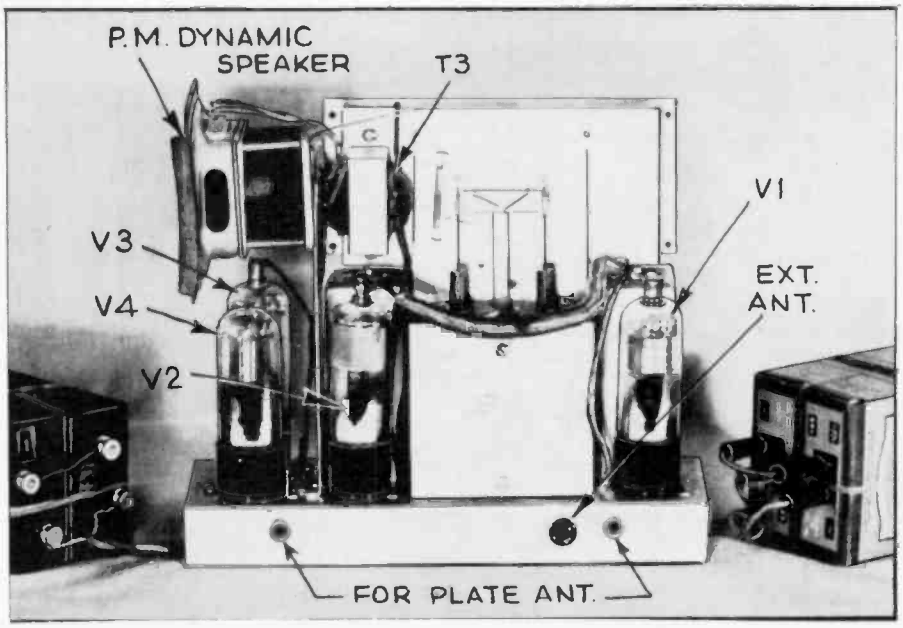


Fig. B. Rear view of the portabe showing the locations of the tubes and other components with respect to the permeability tuner. The antenna plate plugs into the 2 extreme jacks and may be used for local reception. When in the country, away from stations, use a 20-ft. length of wire plugged into the remaining jack.

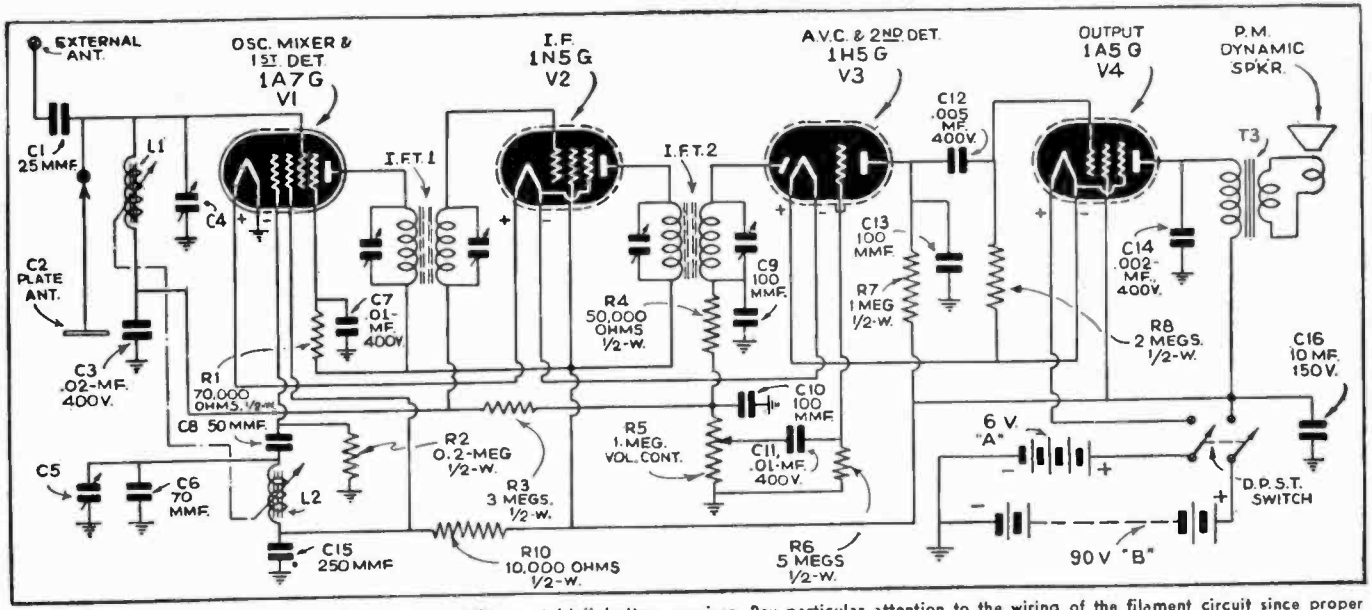


Fig. 1. Complete schematic diagram of the "permeability portable" battery receiver. Pay particular attention to the wiring of the filament circuit since proper "C" bias for the output tube depends upon it. C2 is the plate antenna which establishes a capacity to the chassis by virtue of its proximity to it.

The filament circuit is novel in that all tube filaments are connected in series and obtain power from a 6-V. battery. This enables us to take advantage of the voltage drop to provide a 4-V. negative bias voltage for the control-grid of the power output tube thereby eliminating the need for either a separate bias resistor or "C"-bias battery. However, more important, the use of a series filament circuit makes possible, if we so desire, to quickly and easily electrify the entire portable without any additional circuit changes. In a subsequent article we will give complete details for building a 1-tube power supply which furnishes both "A" and "B" power to *any* type of battery portable, including our Permeability Portable, using the 1.4-V. tubes.

CONSTRUCTION HINTS

At the end of this article is a complete List of Parts used in the construction of our handy little radio set. Your author recommends that these parts alone and no substitutes be used if the same excellent performance of the original model is to be obtained. Don't use any "junk box" I.F. transformers. Use only those which come with the permeability

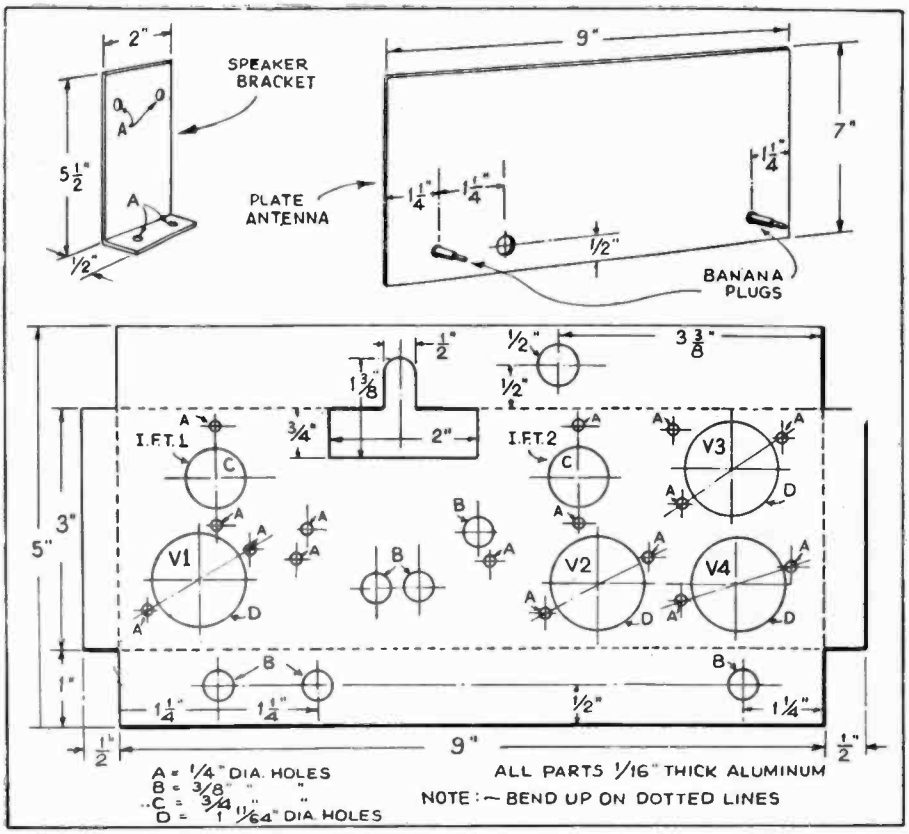


Fig. 2. Complete specifications for making the sub-chassis, speaker bracket and plate antenna for the "permeability portable."

tuner since they are specially matched. Do not fool with or attempt to "adjust" the iron cores in the permeability tuner. These are pre-set at the factory and should not be disturbed. Trimmer condensers, mounted directly on the permeability unit, are used to align the coils.

Figures A and B show the front and rear view of the receiver and the locations of all the main components. The 1A7G and the 1N5G should be shielded (the shields are not shown in the photographs). The P.M. dynamic speaker is held in position by an aluminum bracket which also acts as a shield between the I.F. tube, and the 2nd-detector and output tubes. In Fig. B can be seen 3 tip-jacks mounted on the rear skirt of the sub-chassis. The 2 extreme jacks are used for both mounting onto and making connection to the self-contained metal plate antenna while the remaining jack is used for an outside antenna as explained in a preceding paragraph.

Complete specifications for drilling and punching the sub-chassis, speaker bracket and antenna plate are given in Fig. II. The holes for the sockets were punched out by means of an Amphenol type LD-1 socket-hole die. All other holes were drilled according to the sizes given in Fig. 2. Do not mount the speaker and bracket until all the wiring has been completed.

ALIGNMENT

If the parts specified at the end of this article are used and the circuit diagrams carefully followed the set should feel "alive" when the batteries are connected and the switch turned on. To align the set you will need an oscillator which can produce frequencies of 465 and 1,400 kc. Keep the gain of the service oscillator signal as low as possible. Feed a 465 kc. signal through a 200 mmf. condenser (dummy antenna) through the grid cap of the 1N5G tube and adjust the trimmers of the 2nd I.F. transformer for maximum response. The final adjustment

of any trimmer should always be in the closing (clockwise) direction. Repeat the same operation with the signal applied to the grid-cap of the 1A7G tube and adjust the trimmers of the 1st I.F. transformer for maximum response. Now set the dial pointer of the permeability tuner to exactly 1,400 kc. on the dial scale and apply a signal of 1,400 kc. from the service oscillator to the external antenna post through a 200 mmf. dummy antenna, and adjust the oscillator trimming condenser for maximum response. That completed, adjust the R.F. trimmer (directly below the oscillator trimmer) for maximum response. Now repeat the entire procedure for greater accuracy. Finally, disconnect the service oscillator, plug in the plate antenna and the set is rarin' to go!

LIST OF PARTS

One Aladdin permeability tuner (this includes C4, C5, L1 and L2).

Condensers

One Cornell-Dubilier, 25 mmf., C1;
One antenna plate (see text), C2;
One Cornell-Dubilier, 0.02-mf., 400 V., C3;
One Aladdin, type 8-161, 70 mmf., C6;
Two Cornell-Dubilier, 0.01-mf., 400 V., C7, C11;
One Cornell-Dubilier molded, 50 mmf., C8;
Three Cornell-Dubilier molded, 100 mmf. C9, C10, C13;
One Cornell-Dubilier, 0.005-mf., 400 V., C12;
One Cornell-Dubilier, 0.002-mf., 400 V., C14;
One Cornell-Dubilier molded, 250 mmf. C15;
One Cornell-Dubilier, 10 mf., 150 V., C16.

Resistors

One I.R.C., 70,000 ohms, ½-W., R1;
One I.R.C., 0.2-meg., ½-W., R2;
One I.R.C., 3 megs., ½-W., R3;
One I.R.C., 50,000 ohms, ½-W., R4;
One volume control, 1 meg., R5;
One I.R.C., 5 megs., ½-W., R6;
One I.R.C., 1 meg., ½-W., R7;
One I.R.C.. 2 megs., ½-W., R8;
One I.R.C., 10,000 ohms, ½-W., R10.

Coils

One Aladdin I.F. transformer, type S-101, 465 kc.,
One Aladdin I.F. transformer, type S-200, 465 kc.,

Tubes

One Raytheon type 1A7G, V1;
One Raytheon type 1N5G, V2;
One Raytheon type 1H5G, V3;
One Raytheon type 1A5G, V4.

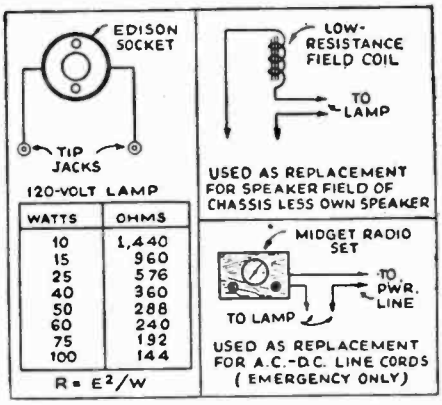
Miscellaneous

Two Type G1227 Goat tube shields;
One Utah type 3P P.M. dynamic speaker;
One Utah output transformer to match a single type 1A5G tube (25,000-ohm plate load);
Four Amphenol type MIP8 sockets;
Two aluminum panels 7" x 10" (supplied by Wholesale Radio Service Co., Inc.);
Miscellaneous hardware, jacks, grid caps, etc.;
Two Eveready Type 723 3-volt "A" Batteries;
Two Eveready Type 733 45-volt "B" Batteries.

LAMP BULBS AS RESISTORS

• ORDINARY lamps of the types commonly obtainable may be used to take the place of more expensive resistors. This is illustrated in the accompanying sketch, which shows the various uses to which the bulb idea may be put.

Of course, the resistance of the bulbs is not fixed, if the current through them should approximate that for which they were designed originally. That is, at first application of any voltage there will be a sudden rush of current, decreasing as the filament of the bulb warms up. When they are used as resistors of low-watts loading the above condition will not be encountered.



The resistances given in the table are for 120-volt lamps and this data is intended as only approximate. You must experiment to get just the right lamp for the particular application you wish.

AN ALL-PURPOSE PORTABLE

A pretty girl, music anywhere by means of this battery-powered portable electric phonograph (or, you may have a radio program, if you prefer!)—well, what are we waiting for, on with the dance!

Applications

(1.) Portable radio set for camping trips, etc.
(2.) Direction finder for small boats, and for locating sources of interference (in service work, when customer complains of "static"), and so-on.
(3.) Public address unit for use in store windows, etc.
(4.) Hearing aid.
(5.) "Quiet" radio set (headphone reception) for sick-rooms, hotel rooms, for children's educational and entertainment programs (so as not to tie-up the regular home set tuned to adult programs), etc.
(6.) Amplifier for electronic music set-ups, using contact mike.
(7.) "Wireless" phonograph for adding phono facilities to any radio set without internal connections being necessary.
(8.) Call system, for paging, etc., with the unit's removable loudspeaker placed at the end of its 25-ft. cable.
(9.) Detective phone (using mike for pick-up and phones for listening).
(10.) Portable phonograph for use where radio set will not operate, or when radio programs or program hours do not suit requirements.
(11.) "Wireless" public address unit for mock broadcasts (using standard home radio set), and other entertainment ideas of a similar nature.
(12.) Sound reinforcement unit, as in a small orchestra or at a lecture.
(13.) "Wireless" detective phone for sending sounds a short distance through walls to a nearby set, and wherever such a short-distance phone is wanted.
(14.) Emergency radio set for use when regular electric set becomes inoperative due to storm, flood, etc.
(15.) May be used to complete a 2-way communication system in conjunction with a home radio set provided with tip-jacks for "home broadcasting" and home recording.
(16.) Placed in child's room, it may be used as a "radio nurse" to warn when baby is ready for a feeding, etc. The loudspeaker may be extended the required distance, for this service, or unit may be operated as a "wireless" P.A. device.
(17.) As a service oscillator for emergency work where a regular calibrated, modulated oscillator working in the broadcast band for set-testing, is not available or is inoperative.

EVERYBODY is "swinging" these days—but stop jitter-bugging and alley-catting around long enough to look over the newest and most unusual entertainment ensemble ever designed. You name it—we can't! It's a radio, a phonograph, a "wireless" phonograph, a P.A. system, and a hearing device, plus space for about 20 records, all tucked compactly into a smart piece of airplane luggage, ready to put a new zip and thrill into your summer playtime hours.

Whoever you are, after you've read this article you'll want to pay a visit to your favorite radio man and start him building this combination for you—and, if you are the radio man, you'll be eager to build one for yourself with the profits of your handiwork. (The writers wonder how long it will take the radio industry to catch up with this new and novel Ideal 6-Tube All-Purpose Battery-Portable?)

As shown in the illustration, the combination is built within a piece of luggage 18 x 14 x 8½ ins. deep. There is no aerial or ground wire necessary; the antenna is built into the cover. No preparation whatsoever—just open the cover, turn on the set, and make the slight adjustment for the type of reception you want.

USES

More Modern Than the Newest Commercial A.C.-D.C. Phono-Radio Portables! This All-Purpose Instrument Can Very Well Be a Swell Money-Maker for Many Enterprising Radio Men.

Easy to carry, it requires little space in an automobile or boat. Inside, you'll find everything you want in the nature of musical entertainment for a moonlight picnic on the beach, for a weekend at the lakes, and for all the varied activities of an entire summer vacation.

And, after you've taken it with you fishing, canoeing, camping, picnicking; after you've whiled away idle, vacation hours in a trailer, on a boat deck, or on a cottage veranda, bring it home and use the wireless phonograph to recapture summer memories by playing your favorite records through the larger home radio without even attaching a wire to same. This operation utilizes only 1 tube, and the drain on the battery is negligible.

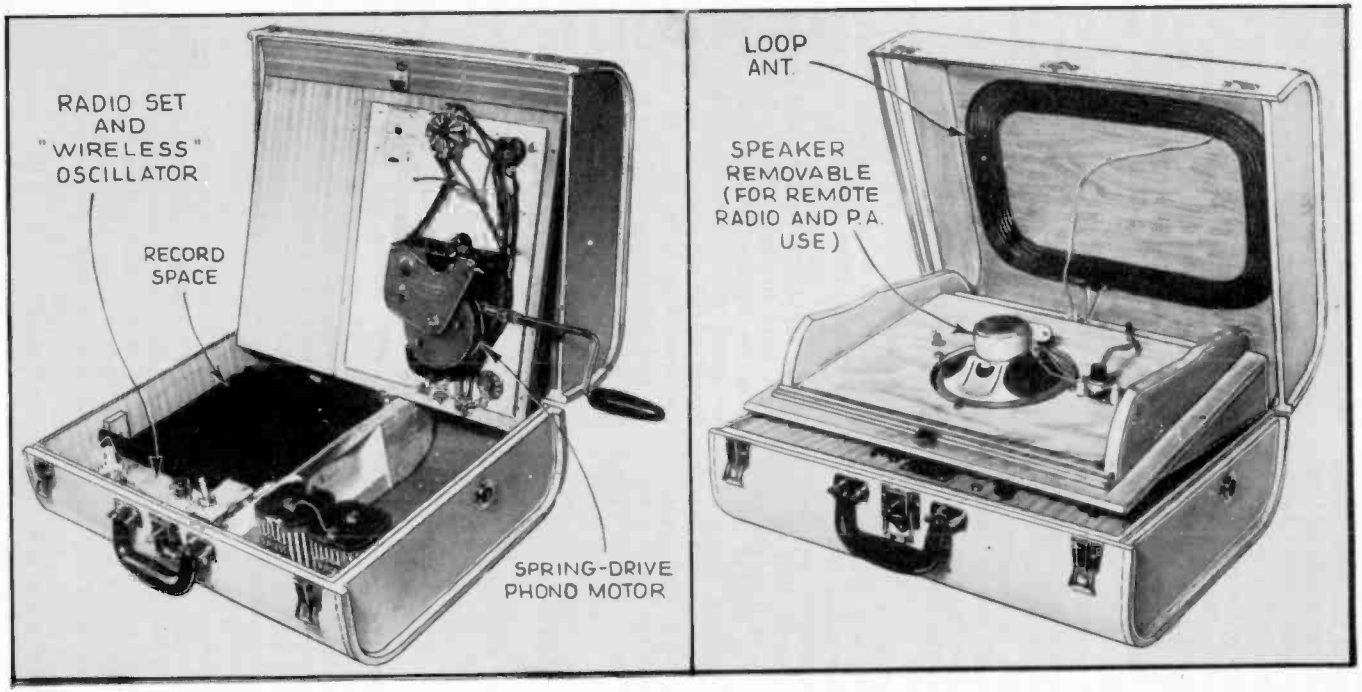
Should grandma be hard of hearing—we've thought of her, too—a pair of headphones and a microphone may be attached as a hearing aid. And, when a party reaches the zero hour and it's a question of "what can we do now?", rig up a mock broadcast from the closet and fool and entertain your guests. If it's "after-hours" in your apartment or hotel, and "Quiet is requested for the comfort of all guests," thumb your nose at the rules, attach enough headphones for the family, and enjoy your favorite program or records, no matter what

To make the combination doubly valuable, it has a more far-reaching use than just as a "having-fun-helper." Battery-operated, it makes an ideal unit for any community group in a locality not electrified. A rural school would find it invaluable for both entertainment and musical appreciation classes—a country church or Farm Bureau would discover it a welcome addition to their social functions. The speaker and baffle may be removed for a distance up to 25 feet, simply by 2 thumb-screws, making a splendid and effective P A system

That gives you a brief idea of why it's a "handy little gadget to have around the house." It has about all that any portable or phonograph on the market has, plus a number of added features. Its sensitivity of reception gives more than average professional performance — its size and compactness make it convenient and practical to transport—and its smart appearance makes it an ensemble you'll be proud to carry anywhere. Open, it offers any type of music you may want—closed, it might be a weekend bag, trim, compact, weather-proof. At home or traveling, enhance your pleasure with your own, specially-built "IDEAL" ALL-PURPOSE PORTABLE. It will do anything except perhaps get you to work on time—and, if you add to it a circuit-closing clock, it may even help to do that!

THE CASE

The case is purchased as a complete mechanical portable phonograph. The soundboard in the cover comes with



Left, showing the manner in which the spring-driven phono motor (which comes with the case), and the removable loudspeaker, are mounted. Right, general arrangement of the loop antenna is shown. This type of antenna, it will be recalled, is particularly useful for direction-finding work (locating interference, on a boat for taking bearings during a fog, etc.). The completed unit, tested by *Radio-Craft*, was found to do all that was claimed for it.

the necessary openings required to mount the P.M. speaker and its baffle. Carefully remove the side supports of the soundboard, which releases the same. It is necessary to remove the tin backing which forms the air chamber. Remove the 3 screws fastening the mechanical tone arm. Cover this opening with a metal plate 2 x 1⅞ ins. A hole should be drilled ⅝-in. from the front edge and at the center-line of the ends: and 5/16-in. mounting holes should be drilled in each corner ¼-in. from edges.

Replace the two soundboard supports directly on to the soundboard only with

½-in. wood-screws. Hinge the soundboard to the case at respective intervals to facilitate removal of the soundboard to extend the speaker for public address use. Next fasten the spring clamp to the case cover and sounding board.

Cut a baffle from ply-wood 13½ x 10½ ins. and mark off center for speaker opening. Cut out two 2 x 2 in. squares, one on each side of speaker 5¼ ins. from top and 2¼ ins. from side, the latter for back-wave.

Next, remove the partitions from the record compartment but leave the partition between the motor and the record compartment. Chisel a square (for the "A" supply and volume control cable) 3 ins. from the top-rear end of the partition between the motor and the record compartment.

Remove the right-hand needle cup from the motorboard and drill a hole, using the needle cup screw hole as a center, to take the microphone-phonograph switch. On center line of the motorboard and ¾-in. in from the back cover side, drill a ⅜-in. hole to accommodate the microphone jack. The tuning control shaft hole (⅜-in.) is located 2 ins. from the record compartment cover by 1¾ ins. from the front or lock end. The change-over switch hole (⅜-in.) is located on center line to the sides and 1 5/16 ins. from the front edge. The volume control mounting hole is located 2 ins. from the crank side and 1¾ ins. from the front end.

RADIO CHASSIS

The chassis proper is bent out of 36/1000-in. sheet steel, cut to 10 x 11 31/32 ins. Bend down 1 31/32 ins. with a brake or between blocks, leaving a top surface of 10 x 11 ins. The R.F. sub-base from the same material is cut to 9⅞ x 2½ ins. Before bending cut out the 1⅛-in. socket holes, the 1st center ¾-in. from the turn-down end. Then, 3½ ins. from the 1st center, drill the 2nd hole. And 3 ins. from the 2nd hole, drill the 3rd hole. Then with a No. 30 drill, drill the socket mounting holes with 1½-in. centers.

Punch out ¾-in. holes for R.F. and I.F. coil leads, the 1st 2 5/16 ins. from the turned-down end, the 2nd 3¼ ins. from the 1st, and the 3rd 3 ins. from the 2nd. The R.F. coil hole is 15/16-in. from the top edge. Both I.F.'s are 15/16-in. from the top edge. The dimensions for the mounting lug holes may be taken directly from the coils. Now turn down to a right-angle 17/32-in. to form the riveting bracket. Five holes size No. 30 should be drilled 3 13/16 ins. from the motorboard side of the main chassis equal distances apart. Drill corresponding holes in the R.F. bracket sub-base.

The audio sub-base is bent out of a 6½ x 2½ in. piece of the same material used above. Two 1⅛ in. holes are punched for the 1st audio-diode and output tubes.

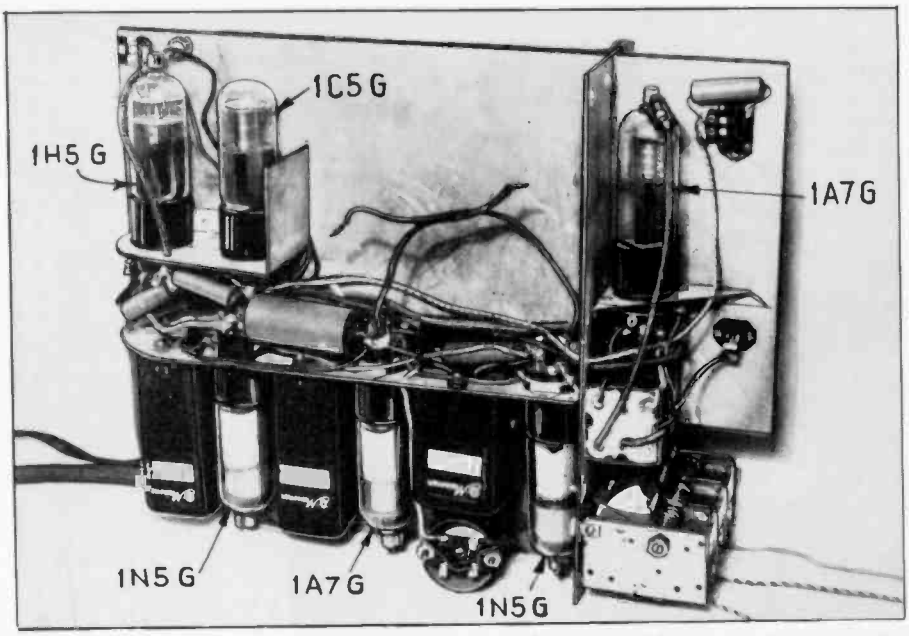
Draw a center line for socket holes 31/32-in. from either long edge and mark off No. 1 center 1⅛ ins. from case cover end; and No. 2 center 2 ins. from No. 1. Locate socket mounting holes for No. 30 drill which have 1½ in. centers. Bend up at right-angles 3⅞ ins.; use as the "B"-battery guide and support. Next bend to right-angles 17/32-in. to form the riveting bracket. Drill 3 holes in same, with No. 30 drill, spaced evenly at either end and center. Drill corresponding holes 3 13/16 ins. from the left side facing the front of the case and to the rear of the main chassis. Drill 1 No. 26 hole to the rear and chassis edge for connection for the headphone and radio coupling condenser lead. After riveting both R.F. and audio sub-bases in place, cut a rounded edge with tin snips corresponding to the radius of the case.

Earphone tip-jack holes are located ¼-in. from one edge and 1½ ins. from the other. Mount S.P.D.T. switch as near to the corner as is possible.

The "A" supply and volume control cable hole is drilled ⅜ x ⅝-in. from the corner.

PHONO-OSCILLATOR CHASSIS

For the phono-oscillator ("wireless" phonograph) and record bumper chassis, cut a piece of sheet steel 7⅞ x 7 3/16 ins. Then 3¼ ins. from either long side, fold the material back upon itself to form the record bumper. Next, bend the folded piece out at right-angles ¾-in. from the folded edge, which forms the panel for the phono-oscillator coil and selector.



Here's the way the radio and sound equipment shapes-up. Simple as A-B-C, yes, but it represents the expenditure of much midnight electricity before all the bugs were eliminated, and the authors could say, "Here it is—go to it!"

Turn up the ⅞-in. strip of the phono-oscillator panel nearest the gang side at right-angles. This will clear the gang rotor and form protection for the gang plates. Drill two 5/16-in. holes for trimmer shaft and screw on center line ¾-in. from folded edge. First hole is ⅜-in. from the gang edge. Locate others from phono-oscillator coil. Drill hole for phono-osc. antenna tip-jack 1 x 2½ ins. from corner. Drill 4 holes on main chassis side of this sub-base with No. 26 drill to clear a 6/32 drive-screw. Drill corresponding holes in the main chassis with No. 33 drill to mount sub-base to main chassis. Bend up triangular single socket sub-base 3⅛ x 2⅛ ins., leaving outside of these ⅜-in. on the 2 panel sides for riveting. These are bent at right-angles to form the riveting bracket. Drill 3 No. 30 drill holes on ends and center and corresponding holes on the phono-oscillator panel and folded end 2½-ins. from the gang end of the panel and square to the folded side. Locate holes for the tone control switch 1 x 1½ ins. from corner.

Fashion a gang condenser bracket from a piece of sheet steel 3⅞ x 1⅞ ins. Cut and bend the material at right-angles ⅝-in. to form the gang condenser bracket. Drill 5/16-in. hole for oscillator-padder. Drill 3 No. 30 holes in bent-up portion and locate on main chassis, drilling corresponding holes in chassis, and rivet same. Drill No. 26 hole in main chassis to mount spade lug on the back of the gang condenser, and remove the two spade lugs near the shaft end. Drill holes in gang-mounting bracket corresponding to holes on back of the gang.

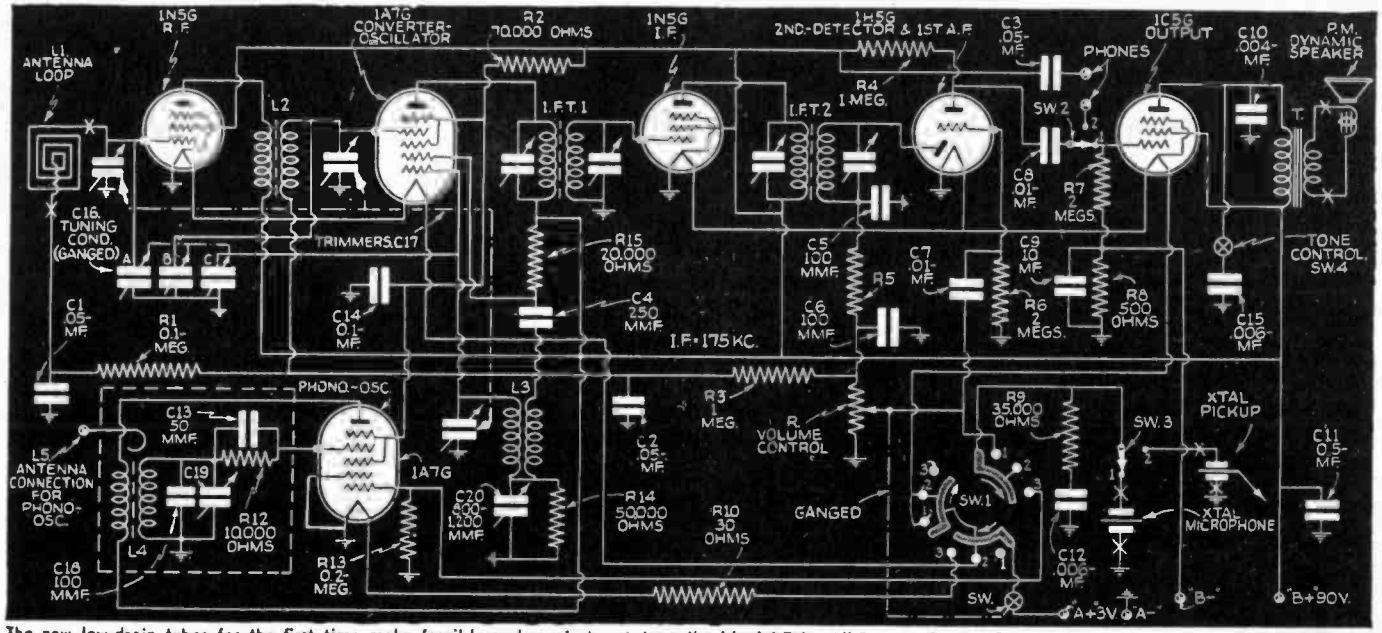
From a piece of sheet steel 5¼ x 1½ ins. bend into a right-angle a bracket to use as an "A"-battery bracket. This prevents the "A" batteries from engaging and injuring the motor mechanism.

COMPONENTS

Although most of the components are easily located by the preceding paragraphs and the figures, in some instances it is necessary to revamp the following:

The radio oscillator coil shield must be mounted directly on top of the R.F. coil and mounted to the main chassis by means of a ⅛-in. rivet. A No. 30 drill is used for this hole in the top of the shield and main chassis.

The phono-oscillator coil shield must be cut off 1¼ ins. from the open end. The 50 mmf. condenser attached to the phono-oscillator coil bracket must be removed and replaced on the inner side of the terminal bracket. Also at this stage connect the R12, 10,000-ohm resistor across (or parallel to) the above condenser. Disregard the manufacturer's color coding on this coil, as it is used differently in this circuit.



The new low-drain tubes for the first time make feasible such an instrument as the Ideal 6-Tube All-Purpose Battery-Operated Portable shown by diagram above. If you don't want to build it yourself, why not have it built for you? It's one of the most useful devices we've ever encountered.

The change-over switch must be bent on the side of the partition to clear it. The selector shaft is supplied long and may be cut off to the desired length. The same is true with the volume control shaft.

The crystal pickup drop-stop *must* be bent down enough to enable the head to rest upon the record. A shielded extension lead must be added from the phono tip-jacks to reach the change-over switch.

The phono-motor must be grounded by means of shielded braid to the volume control ground lug. This is necessary to prevent audio feedback. The turntable brake must be bent upward and to one side to clear the dial.

There will be a comparatively shallow space in which to mount the speaker. Fitting it into this space is possible only by mounting the speaker on the front of the removable baffle board. This can be accomplished by the well-known "cut-and-try" system, making the cone edge fit flush with the baffle.

ANTENNA

The loop antenna is constructed from a high Q standard R.F. wire. Thumbtacks were placed 6 x 10½ ins. to form a rectangle. These form the center or start of winding,

and as each successive layer is added, melt a good grade of R.F.-coil wax and brush at the corners to hold the wire in place firmly during the winding process. It is well to wind about 28 layers and coat them heavily with orange shellac. This does not materially affect the Q but it does provide a method of holding the loop firmly in place and fastening it securely to the case. Make the adjustment as listed under Instructions, and then solder the inside of the loop to the outside of the antenna connector, which has been mounted on the front of the hinged baffleboard. The outside of the loop, naturally, hooks to the inside of the connection.

CABLES AND WIRING

The "A" supply and volume control cable contains 8 wires covered with a shielded braid and cotton serving. Attached to one end is an 8-pronged octal plug. An old tube base may be used for this. The socket is an 8-pronged octal tube socket mounted with spacers and wood-screws to the bottom of the motorboard. The 2-pronged speaker socket and speaker cable is so designed that a 25-foot rubber-molded (lamp cord) cable may be inserted for extension use. Tip-jacks are provided for the pickup cable.

As noted in schematic the filaments are connected in a unique series-parallel circuit. This represents economy of battery drain from the two little No. 6 drycells as the individual tube drain is from 3 volts instead of 1½ volts; thus increasing the battery "hours of service" curve. Then, too, one-half of the 3 volts is used as part of the output tube bias. You actually gain, however, about 2 volts to the center of the filament and to the "B" supply.

INSTRUCTIONS

After all the constructional work is completed, align the receiver by first connecting a 175 kc. signal from an oscillator through a 0.1-mf. condenser to the 1A7G grid. Align in order the No. 2 and No. 1 I.F. trimmers. Then, with connections in same order, change the signal generator to a frequency of 1,650 kc. and, with the gang wide open, align the oscillator trimmer to the signal. Transfer the signal lead to the R.F. grid and align at 1,400 kc. the 1st-detector trimmer. Tune the oscillator and the gang condenser to the 600 kc. and align the padder by rocking the gang for maximum gain. Then re-align at 1,400 kc.

Remove the signal generator lead and tune as weak a station as is in the vicinity of 1,400 kc. Rotate the portable to maximum volume, and with the volume control on full, track the loop antenna—*with loudspeaker in place* (otherwise, inductance value of loop will be altered)—by removing the turns until the antenna trimmer trims properly. Make sure that the antenna trimmer is in track at the 600 kc. end. If the trimmer screw has to be loosened, this means too many loop turns; and if it is necessary to tighten, vice versa.

When operating the receiver in remote areas, it may be necessary to rotate the loop in the direction of the station for a maximum efficiency. Should you find a longer aerial necessary in remote areas, a single turn of wire wound next to the loop winding with one end connected to the aerial and the other to the ground will suffice.

A dial plate 2 x 2 ins. may be used, under which you may place a white piece of celluloid calibrated for facility in station location. This calibration may be made directly from stations of known frequency, or by using a 100 kc. signal. Drive is direct.

The main chassis may now be securely fastened by 4 small wooden blocks in each corner, held by a ½-in. wood-screw.

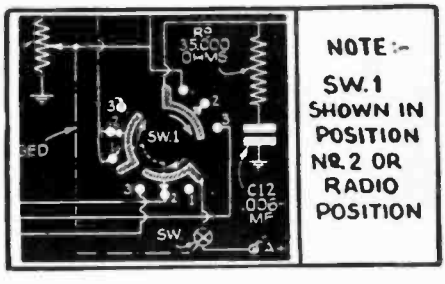
Cover the main chassis, which forms the record compartment and bumper, with felt, using rubber cement to hold it in place.

The phono-crank may be placed in the compartment above the phono-oscillator chassis when not in use. The phono-oscillator trimmer knob, incidentally, should be turned to a dead spot on the receiver dial for phono-oscillator operation. If the household receiver is insensitive it may be necessary to add the (A.C.-D.C.) type flexible wire antenna to phono-osc. tip-jack.

CONCLUSION

The combination described in detail above provides a maximum of types of entertainment at a minimum cost. Practical to construct, it is economical to operate, in that all the tubes are not in operation simultaneously. *For instance, 1 tube only is used for "wireless" phono—3 tubes only for phono and P.A. use—5 tubes for radio use—etc.*

Builders will save time, expense and headaches by using the parts used and recommended by the authors. In several cases, a substitution is impossible because of the limited space in the portable case.



NOTES

Switch Sw. 1, shown below in a close-up circuit, in conjunction with other switches selects the services, as follows:

Sw. 1, position No. 1 (Phono-audio). Set Sw. 3 in No. 2 pos. (pickup connection) for record use; or, in No. 1 pos. (microphone connection), and microphone plugged into jack on motorboard, for P.A. use.

Sw. 1, position No. 2 (Radio). Set Sw. 2 in No. 1 pos. for loudspeaker use; or, in No. 2 pos. for headphone use.

Sw. 1, position No. 3 ("Wireless" Phono). Set Sw. 3 in No. 2 pos. for record playing; or, No. 1 pos. for microphone use.

Condenser C18 is variable, but once adjusted does not require readjustment. C16, 350 mmf. (max.); trimmers C17, 20 mmf. (max., approx.); C19, 110 mmf. (max., approx.; and controlled by the "Wireless" Phono knob).

LIST OF PARTS

One Montgomery Ward Portable Phonograph.

Coils

One Meissner R.F. coil No. 14-1497, L2;
One Meissner oscillator coil No. 14-4242, L3;
One Meissner No. 1 I.F. coil No. 16-5728, I.F.T. 1;
One Meissner No. 2 I.F. coil No. 16-5730, I.F.T. 2;
One Meissner phono-osc. coil No. 17-9373, L4.

Resistors

One Centralab resistor 0.1-meg., ¼-W., R1;
One Centralab resistor, 70,000 ohm ¼-W., type 710, R2;
Two Centralab resistors, 1 meg., ¼-W., type 710, R3, R4;
Two Centralab resistors, 50,000 ohm ¼-W., type 710, R5, R14;
Two Centralab resistors, 2 megs. ¼-W., type 710, R6, R7;
One Centralab resistor, 0.5-meg., ¼-W., type 710, R8;
One Centralab resistor, 35,000 ohm ¼-W., type 710, R9;
One Centralab resistor, 30 ohm ¼-W., type 710, R10;
One Centralab resistor, 10,000 ohm ¼-W., type 710, R12;
One Centralab resistor, 0.2-meg., ¼-W., type 710, R13;
One Centralab resistor, 20,000 ohms, ¼-W., type 710, R15.

Condensers

Three Cornell-Dubilier condensers, 0.05-mf., 400 V., No. DT-4S5 C1, C2, C3;
One Cornell-Dubilier mica condenser, 250 mmf., No. 5 W-5T25 C4;
Two Cornell-Dubilier mica condensers, 100 mmf., No. 5W-5T1 C5, C6;
Two Cornell-Dubilier paper condensers, 0.01-mf., 400 V., No. DT-4S1 C7, C8;
One Cornell-Dubilier electrolytic condenser, 10 mf., 25 V., No. BR102 C9;
One Cornell-Dubilier paper condenser, 0.004-mf., 600 V., No. DT-6D4 C10;
One Cornell-Dubilier paper condenser, 0.5-mf., 400 V., No. DT-4T5 C11;
One Cornell-Dubilier paper condenser, 0.006-mf., 600 V., No. DT-6D6 C12, C15;
One Cornell-Dubilier mica condenser, 50 mmf. (comes with phono-oscillator coil), C13;
One Cornell-Dubilier paper condenser, 0.1-mf., 400 V., No. DT-4P1, C14.

Switches

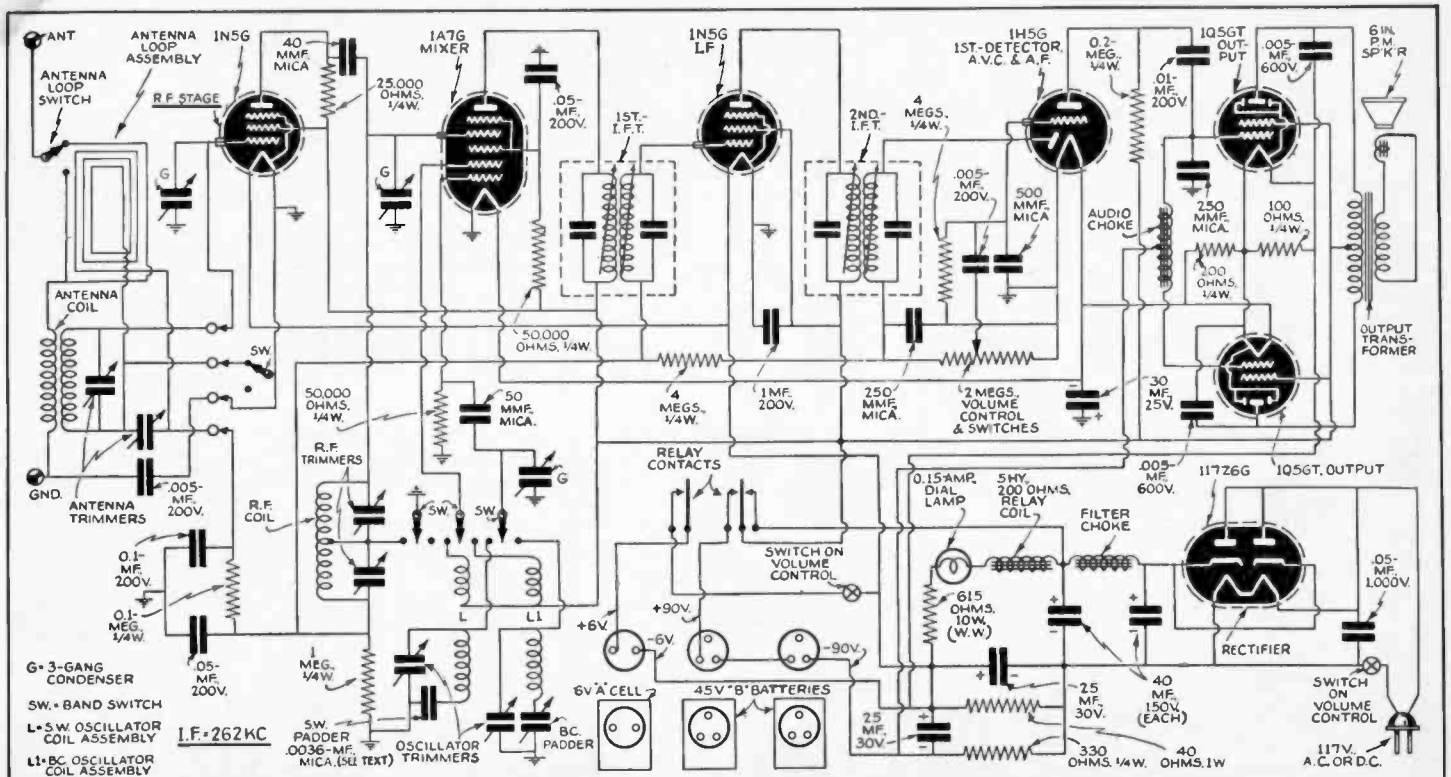
One Mallory-Yaxley rotor switch, No. 1313L Sw. 1;
Two Mallory-Yaxley S.P.D.T. switch, No. 11, Sw. 2, Sw. 3;
One Mallory-Yaxley S.P.S.T. switch, No. 10, Sw. 4.

Tubes

Two Sylvania type 1N5G tubes;
Two Sylvania type 1A7G tubes;
One Sylvania type 1C5G tube;
One Sylvania type 1H5G tube.

Miscellaneous

One Oxford-Tartak 6½-in. P.M. dynamic reproducer with 9,000-ohm (pri.) transformer, No. 6YMPT, T.;
One Meissner gang condenser, No. 21-5215;
One Meissner oscillator padder, No. 22-7009, C20;
Two Meissner bar knobs, No. 25-8,222;
One Shure Bros. crystal pickup model, 94A;
One Shure Bros. crystal microphone;
One Brush Labs. high-fidelity crystal phones;
One Mallory-Yaxley microphone plug, No. 75TC;
One Mallory-Yaxley microphone jack, No. 701;
One Centralab 0.5-meg. volume control, with switch No. P-103 R-Sw.;
Five Mallory-Yaxley tip-jacks for headphones, and pickup connection No. 419;
Two Mallory-Yaxley tip-plugs for pickup, No. 415;
Seven Meissner octal sockets No. 25-8209;
Two Burgess "B" batteries No. Z30NX;
Two Burgess "A" batteries No. 4FA;
One piece of felt 10 x 15 ins.;
One assortment of hardware, hook-up wire, cable, battery terminal lugs, ⅛" x ⅛" rivets, and celluloid for dial;
One hank of (A.C.-D.C. type) flexible antenna wire for phono-osc. antenna, L5.



PILOT MODELS X-1452 AND X-1453 DUAL-WAVE 3-WAY PORTABLES

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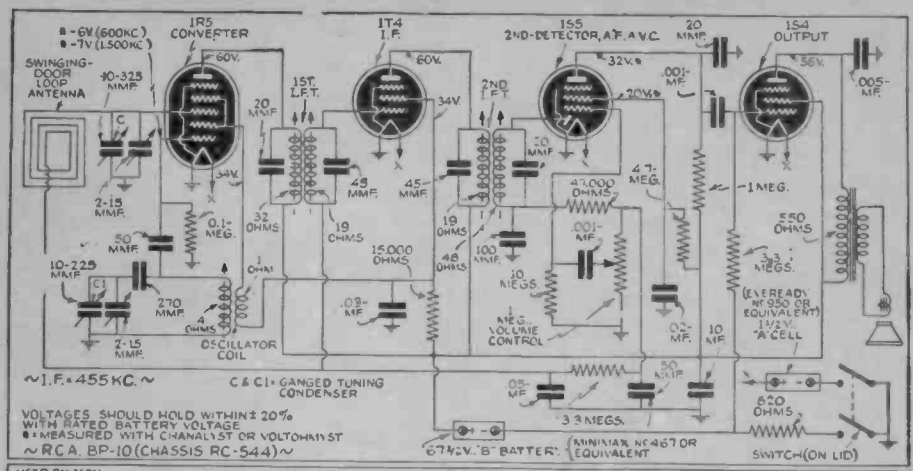
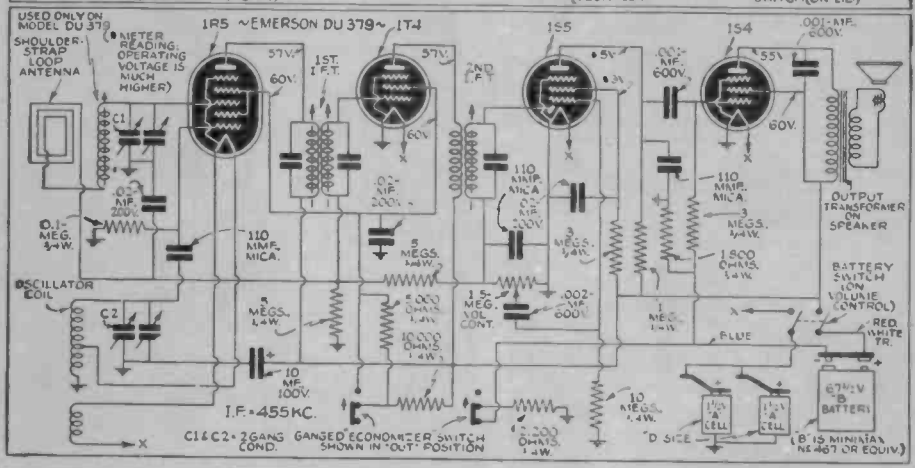
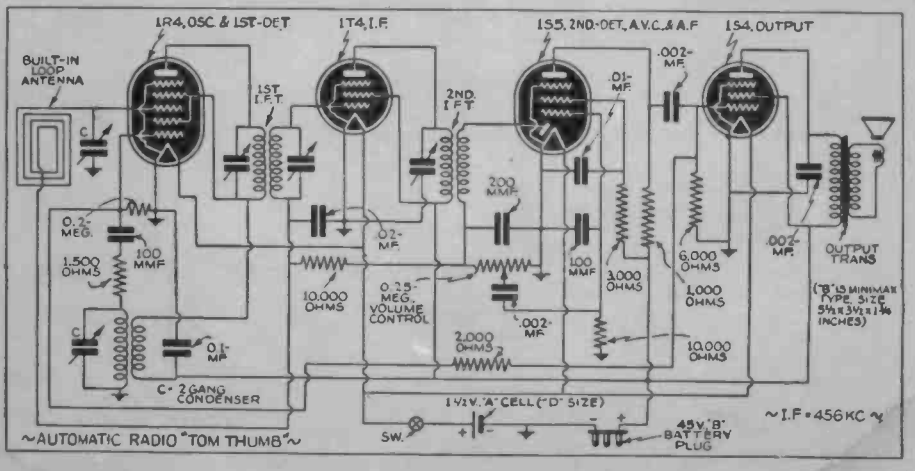
MINIATURE PORTABLES







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