10 MOST POPULAR SHORT WAVE RECEIVERS

HOW TO MAKE AND WORK THEM

25¢

PUBLISHED BY

SHORT WAVE & TELEVISION

99 HUDSON ST. NEW YORK

10 MOST POPULAR SHORT WAVE RECEIVERS

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The short wave receivers, boosters and other devices here described have all been proven practical in actual tests and have been carefully selected by the Editors of
SHORT WAVE & TELEVISION.

. . . ● . . .

The short-wave beginner will find that the receiving apparatus here illustrated and described will fulfill all his requirements. Valuable data on short-wave antenna construction is included.

. . . ● . . .

Published by
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1938

PREFACE

• SHORT-WAVE receiving apparatus has taken a long step forward in design in the past few years. The receiving sets described in the present book have received the approval of an exprienced radio amateur who operates a regularly licensed Ham station. Furthermore, all of these sets have actually been built and tested successfully in practice.

Probably the most important point to remember if you wish to obtain the utmost efficiency from any short-wave receiver, whether it is a one-tube battery set, or a larger model, is that only the best parts that you can afford should be incorporated in its construction. All joints should be soldered with a non-corrosive flux, and if you are a beginner—don't fail to test the filament or heater circuit first, before applying the plate current, as this may save you the cost of replacing several burned-out tubes.

The Editors have endeavored to make this of the utmost value to the short-wave Ham, Fan and Beginner, and we are sure that you will be more than pleased with the results you will obtain with any one of these excellent receivers.

May, 1938.

THE EDITORS

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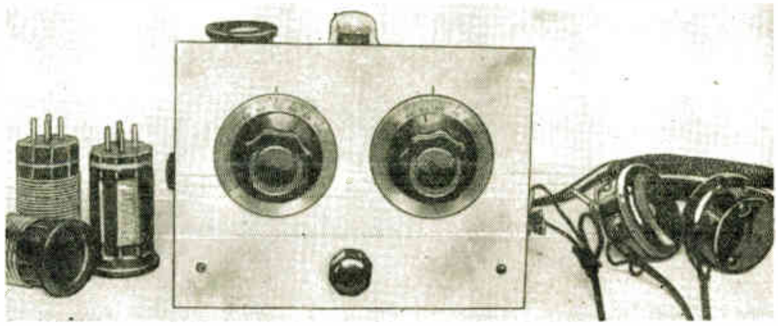
CONTENTS

Here's a 1-tube receiver which will delight the heart of every short-wave beginner. The circuit is easy to follow and one tube performs the functions of two tubes. Band-spread is provided and with high quality parts very fine receiving results are assured.



FOR THE BEGINNER . . . .

By G. W. SHUART, W2AMN

A TWIN—PENTODE RECEIVER

• WE have had twin diodes, twin triodes, and many other types of twin combinations of tubes, around which various receivers have been built by the short-wave experimenter. The tube engineers have now presented us with the 1E7G which is a twin-pentode battery type tube. This tube is similar to the type 33, except that there are two sets of pentode elements in the one couple.

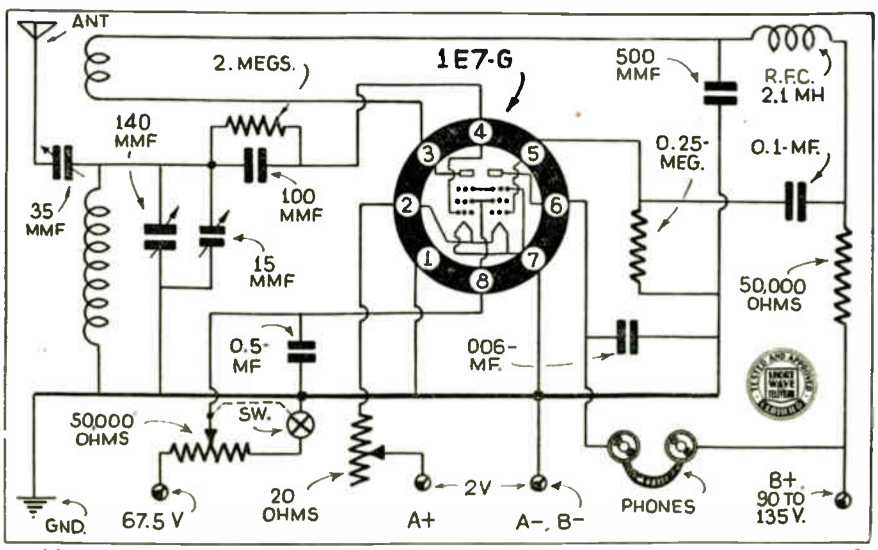
Bearing in mind the excellent results thousands of readers obtained with the Twinplex receiver using the type 19 tube, we believe this set will be destined to attain great popularity, inasmuch as it provides considerably more volume than the one using the type 19.

The circuit diagram of the new twin-pentode receiver is essentially the same as the Twinplex, and should offer no difficulty in construction or operation to even the most inexperienced beginner.

Referring to the diagram we find that the conventional pentode detector circuit is employed, with plate feed-back for regeneration and a screen-grid potentiometer for controlling regeneration. The audio stage is resistance-coupled to the detector. However, should the experimenter desire to employ transformer coupling, one may be incorporated with a slight increase in over-all volume. The screen-grid regeneration control provides the smoothest operation, although it necessitated the use of quite a low voltage on the screen of the audio stage, due to the fact that the screen-grids of the two-tubes are connected in parallel within the tube, and are represented by a single prong in the base.

An alternative method for controlling regeneration would be in the plate circuit of the detector. This could be either in the form of a potentiometer or a variable condenser in place of the .0005 mf. fixed plate by-pass condenser, which is employed in the diagram shown. In this case the full 67½ to 90 volts may be applied to the screen-grids, although with higher voltage on the grids, the audio stage functions more efficiently but the detector tube is a little more awkward to handle.

We would advise that you follow the arrangement shown in the diagram, with the choice of transformer or resistance coupling being left to the builder. These other methods of controlling regeneration are given in order to provide material for the experimenter who wishes to try different arrangements. It will be noted that the suppressor of the tubes is connected to the negative side of the filament and not to the center, therefore all grid

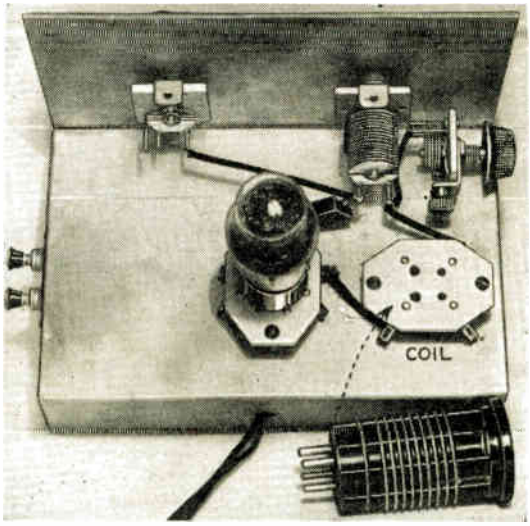


Wiring diagram of the Twin-Pentode receiver. It uses but one tube, but has a number of valuable features including an extremely smooth regeneration control.

leads are made to the negative side of the circuit to which is also connected the B negative. This provides no bias voltage on the grid of the audio amplifier and for operation with 90 volts on the plate, the bias battery does not seem to be necessary however, with 135 volts on the plate, the bias battery should be connected in series with the ¼-meg. grid resistor in the audio stage. This battery should have a value of 4.5 volts.

Returning to the regeneration control again for a moment, we find that the control has a switch attached; this switch is connected in series with the control and the connections are such that when the control is entirely off the switch opens. This is done to eliminate any drain from the 50,000 ohm potentiometer on the B batteries when the set is not in use.

Band-spread is provided by two condensers; one large one for bandsetting, and one very small one for **band-spread tuning.** By employing 15 mmf. for **band-spread,** it is possible to use a straight dial which has no vernier attachment. When wiring up this condenser the rotors should be grounded independent of the chassis; do not depend upon the chassis for connections in the R.F. circuit. All connections in the diagram which go to the B negative on a negative side of the circuit should be connected to one point, preferably to a lug on one of the screws holding the tube socket. This will eliminate all signs of body capacity and will improve the stability of the receiver.



A rear view of the Twin-Pentode receiver showing "band-setting" and "band-spread" tuning condensers, as well as the "antenna tuner" at the right.

The antenna employed with this receiver should be one preferably 75 ft. long, that is the over-all length from the receiver to the far end. However, if a long lead-in is used, it should be as much in the clear as possible, for remember this also counts as part of the antenna. For those interested in extreme DXing in a certain direction, we might offer the suggestion that they employ a long antenna, one 150 to 200 ft. long or even longer providing space is available; point this antenna right at the section of the globe from which reception is desired. This is the simplest form of directional antenna that one can erect and it has proved to be surprisingly effective.

PARTS LIST

Hammarlund
1—35 mmf. condenser, HF style
1—140 mmf. condenser, HF style
1—15 mmf. condenser, HF style
1—2.1 mh. R. F. choke
1—octal socket, isolantite
1—4-prong socket, isolantite
1—set of plug-in coils

Cornell-Dubilier
1—.0001 mf. mica condenser
1—.0005 mf. mica condenser
1—.5 mf. by-pass condenser 100 or 200 V. rating
1—.1 mmf. by-pass condenser 100 or 200 V. rating
1—.006 mf. mica condenser

I.R.C.
1—2 meg. ½-watt resistor
1—50,000 ohm potentiometer with switch
1—¼ meg. ½-watt resistor
1—50,000 ohm ½-watt resistor

Raytheon
1—1E7G Twin-Pentode tube

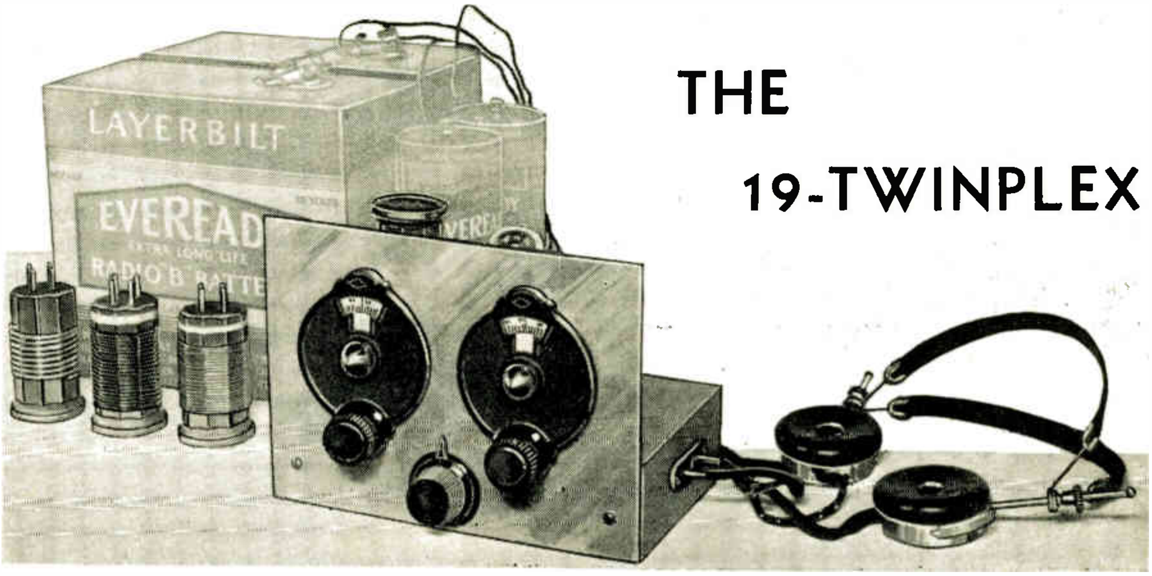
Miscellaneous

The set was constructed on a 5"x8"x2" chassis, with a 6"x8" panel. There are two dials, plain non-vernier type and one twin-binding post assembly for earphones.

1—20 ohm rheostat.

1-Tube, 2-Stage Receiver

THE 19-TWINPLEX



The 1-tube receiver around which this first beginner's article is written. This set really "pulls them in!"

• THIS article is devoted especially to the Short-Wave **Beginner**. We will endeavor to point out in clear language the most prominent factors in successfully getting started in short-wave radio.

His first and greatest problem is of course, choosing the receiver with which to start. Many beginners will, or have purchased their receivers ready-made, while many others will construct their own, for we all admit there is a certain satisfaction in obtaining results with a set constructed with one's own hands. The beginner who has purchased his receiver will find many valuable hints in this series of articles, and we believe that he should follow them as closely as the man who wishes to construct his own.

We have chosen the famous "19 Twin-Plex" with a few modifications, as the first example in the line of amateur construction. This receiver is extremely simple to construct, and at the same time produces excellent results. The "19" tube, as our tube chart tells us, is a **twin-triode**; that is, two, **three-element** tubes are contained within a single glass envelope. In the receiver to be described, one set of elements in this tube acts as a **regenerative detector**, and the other set of elements as a stage of **audio amplification**. We have presented both schematic and physical diagrams of the receiver in order that there will be no danger of the beginner not being able to follow the diagram.

WHAT DIAGRAMS SHOW

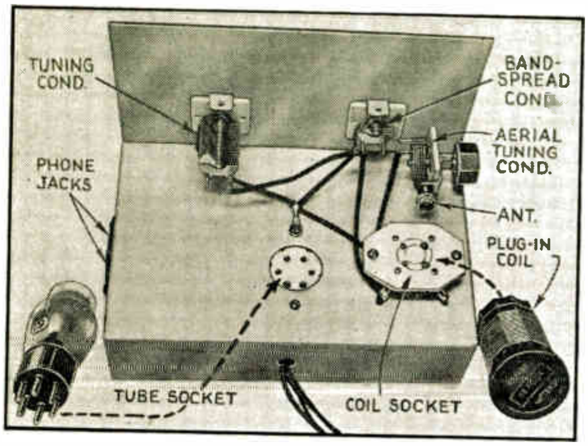
One word about diagrams: Diagrams merely serve to indicate what terminals are connected together, and this may be done in several ways, usually in diagrams such as ours, the connections are drawn in a manner most convenient to the draftsman and also to lend symmetry to the diagram. enabling it to be clearly read. Where two or three terminals are connected together along a single line, the proper procedure is to make the leads as **short** and **direct** as possible. For instance, the draftsman may have carried one lead over three or four other leads and through a certain course in the diagram. Of course, this should not be done in the construction of the receiver. The leads should be run directly to the points concerned. In figure 1, we have endeavored to show what we mean by running the wires in a **direct fashion** rather than as the usual diagram indicates. In many cases, and particularly with this receiver, the chassis and panel is made of metal and serves as the low potential or grounded portion of the circuit.

For instance, the **rotors** of the two tuning condensers are not insulated from the chassis, and therefore are connected together electrically through the metal panel. However we recommend that a **separate** connection be made with hook-up wire. The condensers do not have to be insulated from the panel, but they should be treated as though they were, and the necessary connections indicated in the diagram should be carried out with hook-up wires.

The reason this is done is to eliminate the use of the panel as the sole connecting agent for the simple reason that there may be radio frequency currents flowing in the panel, due to its serving as an electrical connection, and therefore when the operator's hand or body comes near, or in contact with the panel, a serious **de-tuning** effect will be noticed, just the same as though the operator's hand were brought in close proximity to the coil, although perhaps not so pronounced. So much for diagrams.

FOLLOW VALUES OF PARTS SPECIFIED

The values of the various parts indicated in the diagram should be followed exactly if proper results are



Rear view of set.

to be obtained. Slight deviation from the values shown is possible in many cases without serious effect, but it is not recommended that the beginner make these changes until he is thoroughly familiar with the particular values which are not critical.

The **power-supply** for this receiver consists of two 45 volt "B" batteries, and two 1½-volt dry cells. The 19 tube requires two volts for the filament, therefore it is necessary to use a rheostat in order to reduce the voltage supplied by the three-volt battery unit. No voltmeter is required for measuring the voltage applied to the tube if the operator always remembers to operate the filament with the lowest voltage consistent with good reception. In the schematic diagram, figure 1, we have shown alternate methods of connecting the antenna to the receiver. The **solid** connections shown connect the antenna to the plate side of the tickler coil. In this manner we are using the tickler coil for obtaining regeneration and also as an **antenna coupling coil.**

This system has certain advantages, the most pronounced being the fact that adjustment of the 35 mmf. condenser does **not** de-tune the circuit as much as when the condenser and antenna are coupled directly to the grid side of the grid coil as indicated by the **dotted** lines.

OTHER METHODS OF COUPLING ANTENNA

Two other methods of connecting the antenna are shown in figure 3. One shows the use of a separate coupling coil which must be employed when a doublet is used. The coil should be so mounted that the distance between it and the grid coil may be varied. The other method shown in figure 3, shows the antenna tapped on to the grid coil at some point between its two extremities. The most satisfactory position has been found to be a distance from the B negative or **grid side** of the coil, equal to between 1/4 and 1/3 the length of the entire coil, or the total number of turns.

COIL CONNECTIONS

Another source of trouble for the beginner is in the connections of the coils. Most satisfactory results are obtained when the tickler coil is at the B negative side of the grid coil. The tickler coil being the smaller winding and the grid coil, the larger. A simple rule to follow so that the connections will always be made properly is to employ that terminal of the grid coil which is nearest to the tickler as ground or B negative side of the circuit. The terminal of the grid coil farthest from the tickler is used as the grid connection. In this case it goes to the grid-leak and grid condenser. In some circuits where a grid-leak and circuit are not employed, this farthermost connection goes directly to the grid in the tube. Now, the extreme terminal of the tickler or small winding goes directly to the plate of the detector. This is the terminal farthest away from the grid coil. The other terminal of the tickler winding will naturally go to the B plus through the output circuit of the detector. The above rules are only true when plate feed-back is employed, and when the two coils are wound in the **same** direction. If the ticklers were wound in the **opposite** direction, then the two connections to the tickler would be the reverse of the previous explanation.

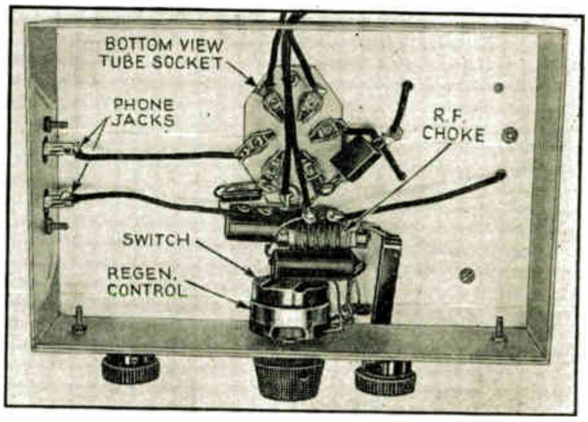
CONTROLLING REGENERATION

Regeneration is controlled in this receiver by varying the plate voltage to the detector tube through the aid of a **potentiometer.** This potentiometer should have a switch attached to the back of it, so that when it is turned **off** the connection between the potentiometer and the B negative side of the circuit is broken. This is done because the potentiometer or regeneration control is short-circuiting a part of the battery, and therefore if it were not disconnected when the set were not in use, there would be constant drain on the battery. While this drain is a very small value, it nevertheless is important. So much for the diagram; there is no need of explaining in detail where each lead goes because this can be clearly seen in the drawing. Complete data is given on the coils and chassis dimensions together with layout as evidenced by the part which are labeled. If they are followed carefully one is absolutely certaining of obtaining results.

The tuning procedure is just about as important as the constructional details, and regardless of how much instruction we give, best results will only be obtained after a considerable period of operation, during which the operator gets the feel of the receiver, much the same as one develops the technique of any other operation—driving an auto for instance.

HOW TO TUNE THE RECEIVER

To start with, we might suggest that the antenna condenser be set at minimum capacity, that is with



Bottom vi.w of set.

the plates all the way out, and the regeneration control advanced toward the B plus connection until the receiver breaks into oscillation. Then tuning the various dials will bring forth a great number of whistles, in most cases these whistles will be commercial code or phone stations. Retarding the regeneration control or moving it toward the B negative terminal until the whistle disappears will bring out the voice or music if such is present.

The grid tuning condensers should be re-adjusted for best results, then a series of adjustments taking in the antenna control, regeneration control, and the grid tuning condenser will bring about a condition where **loudest and clearest signals** will be had. This really amounts to **juggling all of the controls.** That is why we said previously that only experience can teach one how to operate a short-wave set.

In order to make tuning as simple as possible, we have incorporated **band-spread** in this receiver. The large condenser marked 140mmf. is the **band-setting** condenser and the small one marked 20 mmf. is the **band-spread** tuning condenser. The best procedure to follow with these two controls is to set the dial on the smaller condenser to mid-scale, then adjust the large condenser to the particular band in which we wish to receive and do all further tuning with the small condenser. It will be found to perform something like this; the 49 meter broadcast band will take up about 5 or 6 points on the dial of the large condenser, and with the large condenser set in the middle of the band we find that it can then be covered with the small condenser. This band will occupy a good portion of the dial, probably 50 or 60 degrees thus making the adjustment less critical.

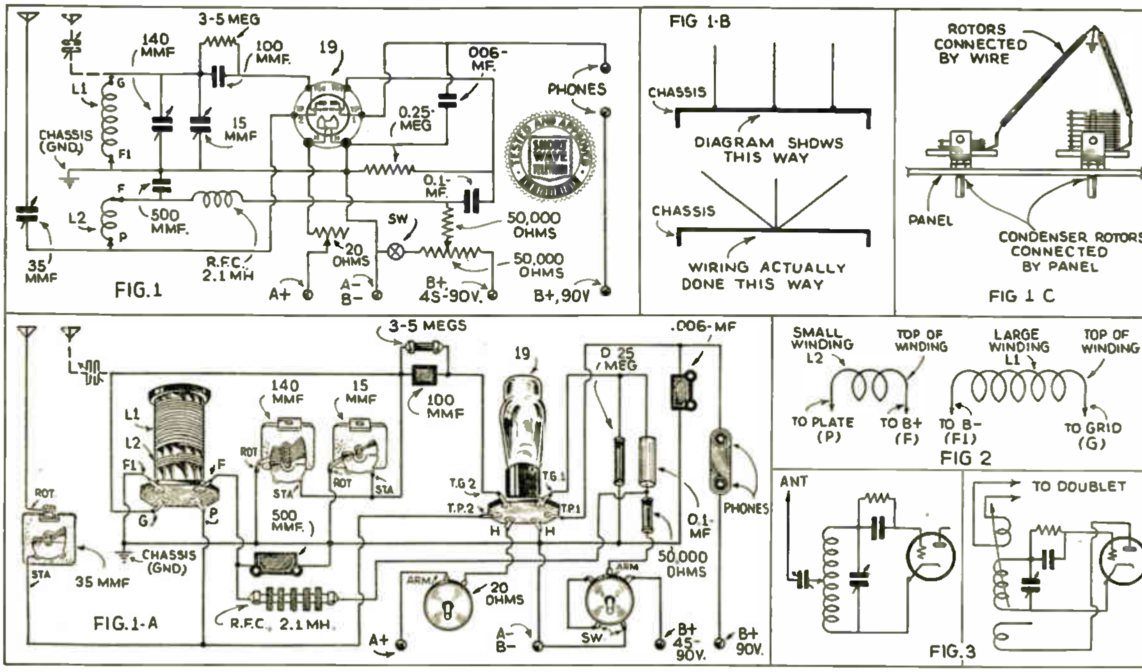


Diagram of 1-tube set giving 2-tube results.

BEGINNERS SET—PARTS LIST

Hammarlund
- 1—140 mmf. condenser HF-140
- 1—15 mmf. condenser HF-15
- 1—set of coils 17-270 meters (SWK4)
- 1—2.1 mh. R.F. choke
- 1—35 mmf. condenser HF-35
- 1—6-prong Isolantite socket
- 1—4-prong Isolantite socket

Cornell-Dubilier
- 1—.0001 mf. mica condenser
- 1—.0005 mf. mica condenser
- 1—.006 mf. mica condenser
- 1—.1 mf. paper condenser

Resistors
- 1—3 meg. ½-watt
- 1—¼ meg. ½-watt
- 1—50,000 ohm ½-watt
- 1—20 ohm rheostat
- 1—50,000 ohm potentiometer, with switch

Raytheon
- 1—19 tube

Hardware
- 1—aluminum chassis—8 x 5 x 2 inches
- 1—aluminum panel—8 x 6 inches.

BAND (meters)	GRID COIL	WIRE	L.W.	TICKLER (close wound)
135-270	82 T.	No. 28 enam.	1⅞"	16 T. No. 30 DSC.
66-150	38 T.	No. 26 tinned	1⅝"	11 T. No. 30 DSC.
35-75	18 T.	No. 24 tinned	1½"	6 T. No. 30 DSC.
17-41	9 T.	No. 16 tinned	1¼"	5 T. No. 30 DSC.

L. W.—Length of winding: All coils wound on 1½" 4-prong ribbed form. Space between grid and tickler ¼".

The author is shown tuning in a station on the "smallest" Pocket Receiver. Even a short aerial brings in lots of stations.

A REAL POCKET-SIZE S-W RECEIVER

By H. G. McENTEE, W2FHP

Here is the smallest "complete" 2-tube short-wave receiver the editors have seen! The tiny receiver shown in the picture contains all the tuning apparatus, also the "A" and "B" batteries. It can easily be built to cover any desired range.

• IT has long been the writer's ambition to build a really small "vest pocket size" radio receiver. And, it had to be one that would contain all the batteries and not require a large overcoat pocket to fit in. It would necessarily have to contain all batteries, because really tiny sets have been built many times, but they were not truly vest pocket size—as another and much larger pocket was always required for the batteries!

Up until a short time ago the batteries, and especially the "B" battery, have always been the stumbling point, but with the advent of the special layer-built batteries intended for "weather balloon" use, the midget set-builder's troubles have come to an end. This 45 volt unit is just about the size of a single large flashlight cell. Of course the life is not very great, but it is quite sufficient when we consider that the current drain is only one milliampere or so.

Naturally, the smallest possible parts have been used throughout. The Hivac small-size tubes are highly efficient, yet of very small dimensions. It was originally intended that the tubes, which come with long prongs, should be used with the corresponding sockets. With the smallest possible dimensions as the goal, it was decided, however, to dispense with the sockets. Accordingly, the tube prongs were carefully sawed part way through, then bent until they came off. Connections are soldered directly to the stubs thus formed. Incidentally, these tubes are also made with short prongs, in which case the above work would be unnecessary.

The tubes are bound with thread to an aluminum bracket, which in turn is screwed to the side of the case. The thread binding is smeared with Duco cement to hold it firmly.

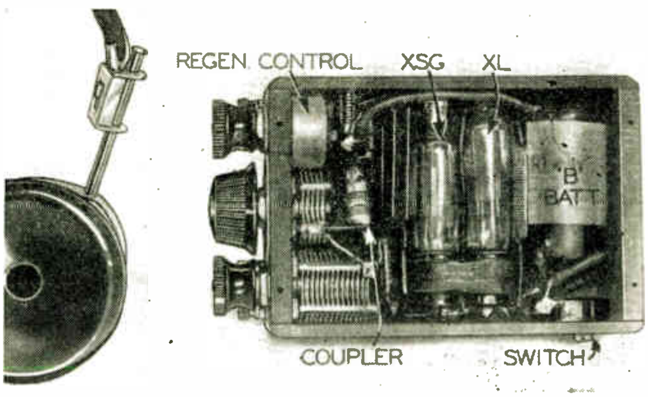
There are two tuning condensers, a 100 mmf., and a 35 mmf., the latter being used for bandspread. Both are dismounted from their isolantite end-plates and fastened directly to the "panel" end of the case. The stator plate tie-rods are threaded to permit small nuts to be used for the purpose.

The "off-on" switch is a regular S.P.S.T. type as used on volume controls. A screw-head is soldered to the operating lever, and projects about 1/16" out from the slot in the case.

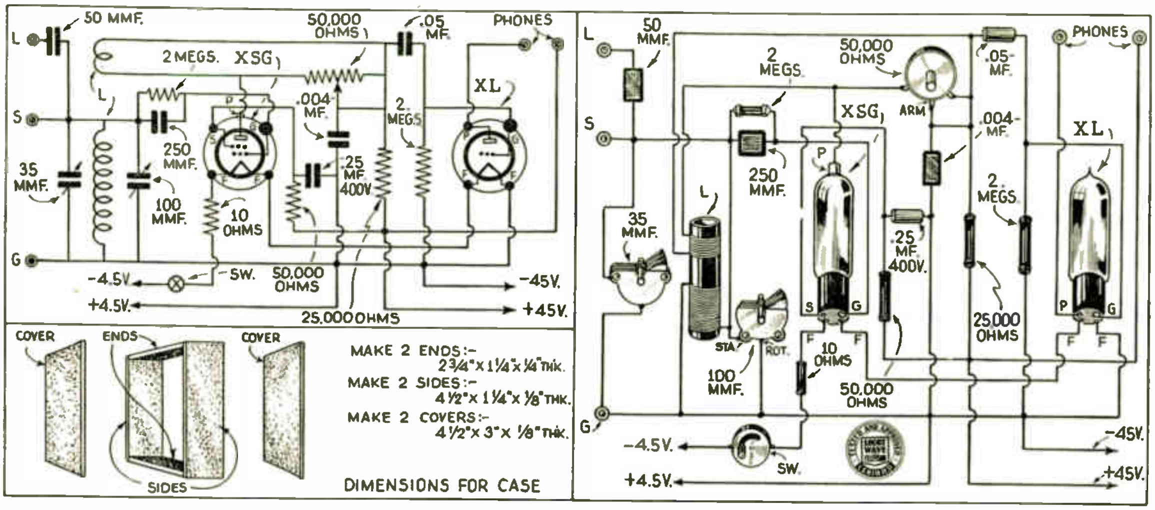
The case is made of pressed wood, all parts 1/8" thick, except the ends which are 1/4". The frame is glued together first, then the sides are attached with tiny wood screws. The finish is obtained by two separate coats of clear lacquer, with sandings between and a final rub-down with powdered pumice. The surface is then given a coat of auto wax. All holes should be made before the finishing, so that the surface will not be marred.

The circuit is quite simple with no tricks whatsoever. Regeneration is controlled by a midget potentiometer connected across the tickler. The coils are made from a five-section R.F. choke. Only two are used, so the others are removed and the insolantite rod is nicked in the center and broken in half. The number of turns used depends upon the band one desires to cover. With the two full coils in use, one as secondary and one as tickler, about the lower 2/5 of the broadcast band (200 to 340 meters) may be covered. With this as a starter, simply remove turns equally from both coils until the desired frequency is reached. Be sure to have the outside of one coil go to plate, and the inside of the other to grid condenser, or vice versa. Otherwise no oscillation will take place. Depending on the antenna used, it is usually possible to obtain super-regeneration from the B.C. band right on down, simply by turning in all resistance on the regeneration control.

The only other special item needed is the 10 ohm resistor in series with the filaments. It is made from a wire-wound unit of the type constructed on a flat piece of fibre. Note that the filaments are in series



The headphone at left of picture shows by comparison the small size of this "pocket" receiver. It is essentially a headphone job, but plenty of "sock" is assured.



Wiring diagram of pocket set.

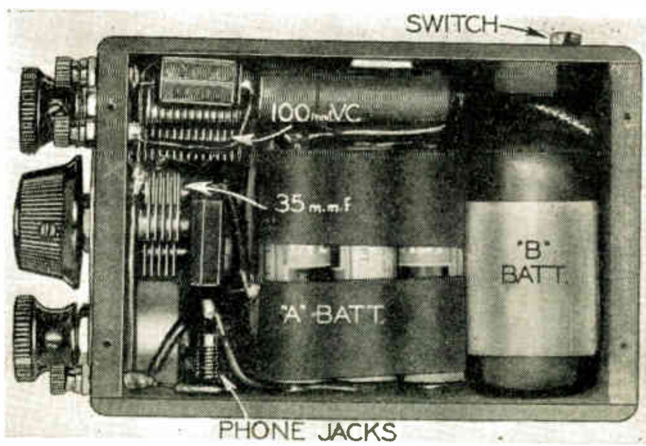
as are the three pen-light cells that constitute the "A" battery.

Two antenna posts are provided, one of which has a series condenser for use with a long antenna. A very short antenna may be connected directly to the grid.

COIL TO COVER ABOUT 40-70 METERS

Secondary 35T, No. 30 enamel on form ⅜" diameter.

Tickler 45T, No. 30 enamel wound over secondary, with paper layer between.



View showing construction.

LIST OF PARTS

Wholesale Radio Service Co., Inc.
One Hivac type XSG tube.
One Hivac type XL tube.

National Carbon Co.
One Eveready Type X-180. 45 V. battery.
Three Eveready pen-light cells.

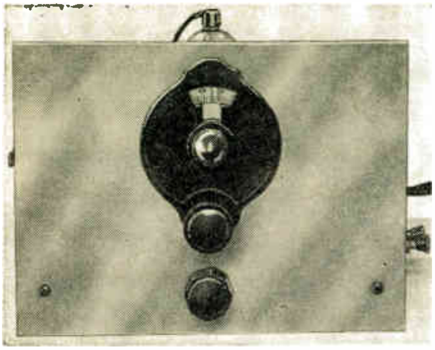
Hammarlund
One CHX choke.
One HF 100 condenser
One HF 35 condenser.

Utah
One 50,000 ohm midget potentiometer.

Cornell-Dubilier
One 50 mmf. mica condenser.
One 250 mmf. mica condenser.
One .004 mf. mica condenser.
One .05 mf. 200 V. tubular paper condenser.
One .25 mf. 200 V. condenser.

I.R.C.
Two 2 meg. ½ W. resistor.
One 25,000 ohm ½ W. resistor.
One 50,000 ohm ½ W. resistor.

Miscellaneous
One 10 ohm resistor (see text).
One "on-off" switch.
Case material.
Three knobs, hardware, wire, etc.
Two pin jacks.

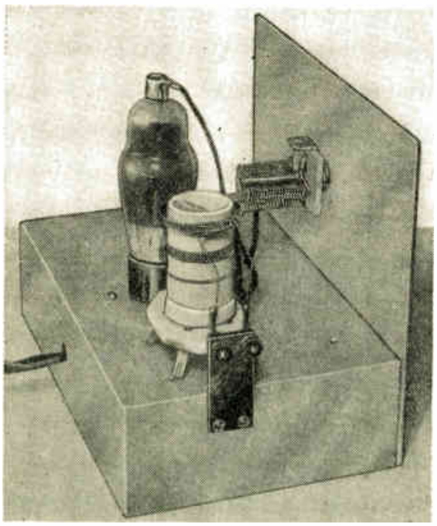


The 1-tube R.F. booster viewed from the front.

Simple 1-Tube Booster Aids the "DX" Fan

• THERE are undoubtedly many short-wave "fans," amateurs, or experimenters who now possess receivers which can well make use of additional amplification. The booster or preamplifier about which we are presently concerned offers a method of improving the operation of certain types of receivers in many ways. For instance, the main advantage is in the additional amplification made possible through its use. The greatest difference will be noticed in the strength of the very weak signals. Also there will be a somewhat better ratio of signal-to-noise. In certain types of superheterodynes the addition of the preselector of this type goes a long way toward reducing, or eliminating images. Then again, receivers not provided with coupling arrangements suitable for doublet antennas will benefit in that a doublet may easily be used with this instrument.

The main consideration was whether or not regeneration should be used in the booster. The addition of regeneration provides an extra control, however, its cost is very small and its addition provides greatly increased selectivity and sensitivity. In fact, the regeneration control may be set at a point where it need not be changed over the entire tuning range of the booster or it may be adjusted to a more critical point for maximum sensitivity. The flexibility in this regard favored its being incorporated. The method of obtaining regeneration is via the conventional cathode tap commonly referred to as electron **coupling.**



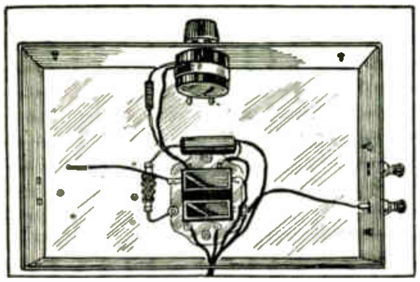
A rear view of the "weak signal" booster.

In the photograph we note that the antenna coupling coil is mounted so that it may be varied with respect to the grid coil. This adjustable coupling is really essential for maximum efficiency. In the diagram we find that there are two methods of coupling this booster to the present receiver, that is, the one with which it is to be used. Most receivers of later design employ a separate antenna coil in the input stage, while others employ the capacitive method which means that the antennas are coupled through a very small capacity connected directly to the grid side of the input circuit. In either case, the connection "A" from the converter will go to the antenna position on the receiver, and the "B" negative side of the converter should go to the ground position. In the case of a receiver having doublet input connections, one side of the antenna coil should be grounded when the booster is employed. This connection will be the same when a common antenna and ground are used with the original receiver.

There are a number of antenna systems which may be used with this booster, four of the most prominent and effective ones are shown in the diagram; one is a half-wave doublet with spaced feeders. The other employs a twisted pair for feeders or lead-in. The twisted lead-in arrangement is more convenient, although its electrical operation is not as flexible as the other. The spaced feed-line will provide a wider frequency response than the twisted pair, inasmuch as a condenser may be employed to tune the spaced line.

In another sketch, we have shown the Zeppelin or single wire with antenna having spaced feeders at the end. Twisted feeders should not be used with this type of antenna. While they will work to some extent, they will not provide as efficient operation as the spaced pair. The spacing on either type of antenna may be from two to six inches. The two-inch type insulator or transposition block would seem to be the best arrangement. The remaining antenna shown in the diagram is a half-wave antenna with a single-wire feed system. The distance between the center of the antenna and the point at which the lead-in is attached should be equal to 14% of the total length of the antenna. With this antenna one connection of the input coil is grounded as shown in the diagram.

The operation of this amplifier is exactly the same as a regenerative detector—however the tube is never



Bottom view of booster.

Did you ever attempt to tune in a distant short-wave station, and finally give up in disgust, because your set could not bring in the voice loud enough? This very simple 1-tube booster will solve the problem for you, and greatly increase the range of the average short wave receiver.

permitted to oscillate. This means that the regeneration control should always be set below the point where the tube breaks into oscillation. The mechanical details are shown in the photograph, and should offer no difficulty to the constructor.

PARTS LIST FOR BOOSTER

Hammarlund
- 1—midget 140 mmf. variable condenser (HF)
- 1—5 prong isolantite socket
- 4—small isolantite coil forms (CF-M)
- 1—6 prong isolantite socket
- 1—2.1 mh. R.F.

Sprague
- 3—.1 mf. by-pass condensers
- 1—100 mmf. condenser

I. R. C.
- 1—500 ohm ½-watt resistor
- 1—.1 meg. ½-watt resistor
- 1—50,000 ohm potentiometer

Raytheon
- 1—6D6 or 57 tube.

Coil Data
- No. 1—5 turns No. 24 osc. close wound, tap at 1 turn
- No. 2—10 turns No. 24 osc. close wound, tap at 1 turn
- No. 3—24 turns No. 24 osc. close wound, tap at 2 turns
- No. 4—45 turns No. 24 osc. close wound, tap at 2 turns

The antenna coil is not critical and may consist of 2-5 turns, the smaller number used with the twisted feeders and the larger with the spaced feeders.

The diagrams to the right show how the set is wired. Also antenna suggestions are given. All four methods of coupling work well with this receiver.

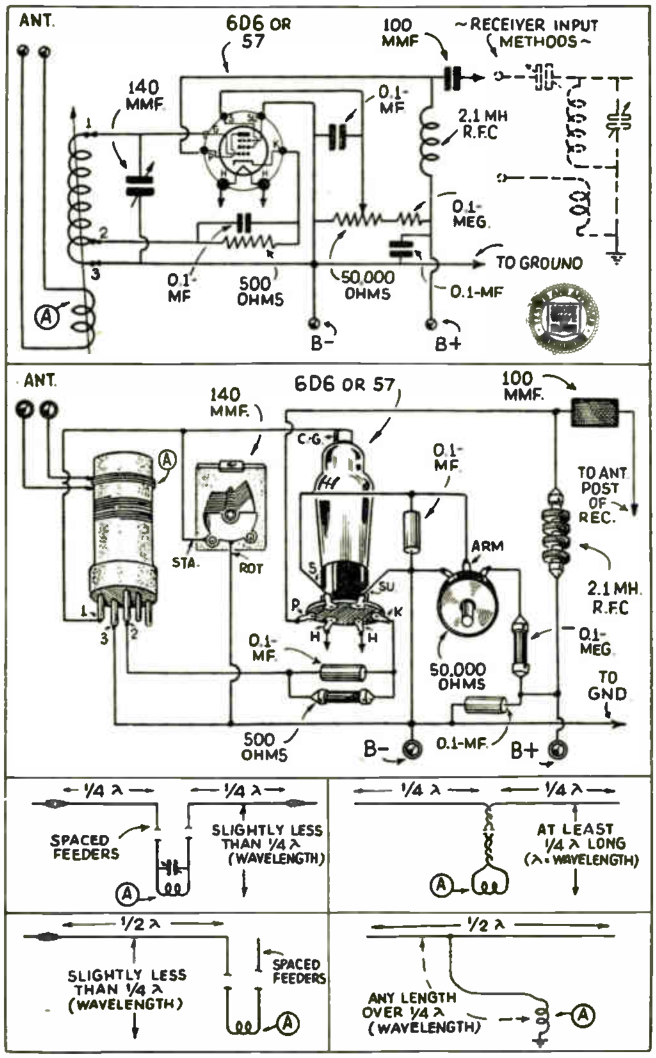
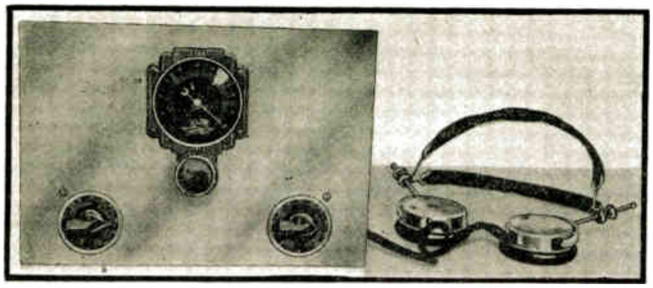


Diagram of pre-amplifier and improved antenna connections.



Front of receiver, with Cannon-ball head-phones. Yes, it has band-spread!

A Novel "Regen." 2-Tuber

H. D. HOOTON, W8KPX

• SINCE the early days of broadcast radio the "throttle-condenser" has been the beginner's favorite method of regeneration control because of its simplicity and extreme quietness. After the advent of the electron-coupled detector, however, with the tickler placed in the cathode circuit, this type of control dropped out of use in favor of the potentiometer method. The author decided to try out a circuit in which the smoothness of the condenser regeneration control and the advantages of the electron-coupled detector were combined. The results were surprisingly good and the two-tube receiver that developed from the experiment is illustrated and described in this article.

TICKLER IN SCREEN-GRID CIRCUIT

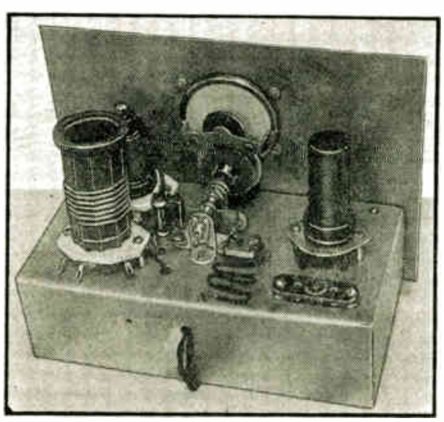
As the schematic diagram, Fig. 1, shows, the chief difference between this circuit and the conventional electron-coupled arrangement, is due to the fact that the tickler is placed directly in the screen-grid circuit instead of the cathode lead. The 100,000 ohm carbon resistor' serves a dual purpose inasmuch as it is used to block the R.F. currents and force them through the 250 mmf. regeneration condenser to ground, and also to drop the screen-grid voltage to its correct value. In case the screen voltage is obtained from a tap on the power-supply voltage-divider, an R.F. choke of about 2.5 mh. rating should be substituted for the resistor. The remainder of the circuit is more or less conventional, consisting of a single pentode audio amplifier resistance-capacity coupled to the plate of the detector tube.

CHASSIS AND PANEL EASILY MADE

This receiver, as the photographs and drawings show, is very small and compact, being built up on a 4½ x 9 inch chassis and a 7 x 10 inch panel. These are made from either electralloy or aluminum sheeting and are laid out, cut and drilled as shown in Fig. 2. Before the chassis is bent, make a cut with a pointed instrument along the dotted lines as shown. This will allow the side and ends of the chassis to bend square which gives a better appearance to the finished receiver. If the builder does not care to construct his own chassis, the manufactured type can be used. Small bases of approximately this size in both steel and electralloy construction are carried by most radio supply houses.

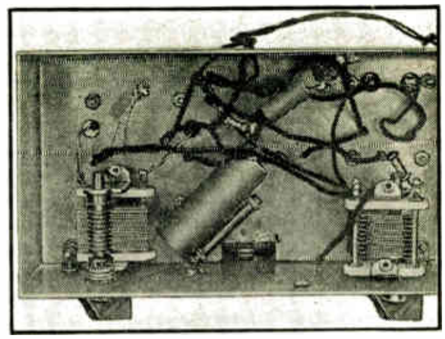
LAYOUT OF PARTS

The arrangement of the various parts on the chassis and panel should be followed exactly if maximum results are to be obtained. The regeneration control is placed at the left of the tuning dial; the band-setting condenser is at the right directly underneath the detector tube socket where the "hot" leads to the coil and the grid circuits will be short and direct. The sockets for the two tubes and the coil are not placed underneath the chassis as is the usual custom, but are mounted above the metal base on ¾ inch brass bushings. This eliminates the labor of cutting the socket holes in the chassis and gives very short wiring between the sockets and the other parts of the set. The socket for the plug-in coils has been placed at the rear of the chassis as far away from the metal panel as possible. This is desirable because metal objects inside the coil field frequently cause considerable R.F. losses in small sets of this type. The antenna is coupled directly to the grid side of the tuned circuit through the small 35 mmf. trimmer condenser as shown at "1" in Fig. 1. The 6-prong Hammarlund coils have interwound primaries, however, and the coupling, especially if a doublet antenna is to be used,



Rear view of set, showing plug-in coil and two tubes in place.

may be made as indicated by the figures "2" and "3" on the diagram.



Bottom View of Receiver.

KEEP WIRES SHORT

All wiring between the various parts of the circuit must be kept as short and direct as possible. Solder each connection carefully with a hot, clean iron and resin-core solder. All lead holes in the chassis, especially the grid and screen-grid lead holes, must be large—⅜ inch at least. Do not use the metal chassis as a common "ground" return; connect all of the negative terminals together by means of a single piece of insulated wire and solder this to the chassis at one point only. This eliminates the poorly soldered connections and high-resistance returns which might result if this precaution is not observed.

OPERATION HINTS

The operation of the set is simple. Connect the heater and "B" supply voltages, as shown in Fig. 1, and an antenna and ground to their respective leads. The antenna should be short for best results—25 or 30 feet being a convenient length. Set the tuning dial at about 50 and rotate the **band-setting** condenser until the desired band is heard. Adjust the **band-setter** to the center of the band and tune in the stations with dial in the usual manner. The exact amount of "spread" obtained will depend somewhat upon the band in use and the adjustment of the band-setting condenser.

On the 19. 25 and 31 meter broadcast bands and the 20 meter amateur band, the spreading is about twenty to forty degrees on the 270 degree dial; the 49 meter broadcast and the 40, 80 and 160 meter amateur bands are spread the full 270 degrees.

Although the 6.3 volt tubes are shown in connection with the set, it is not absolutely necessary to use these. The tubes in the 2.5 volt series or battery-operated tubes can be used with equally as good results. The parts values remain the same in either case.

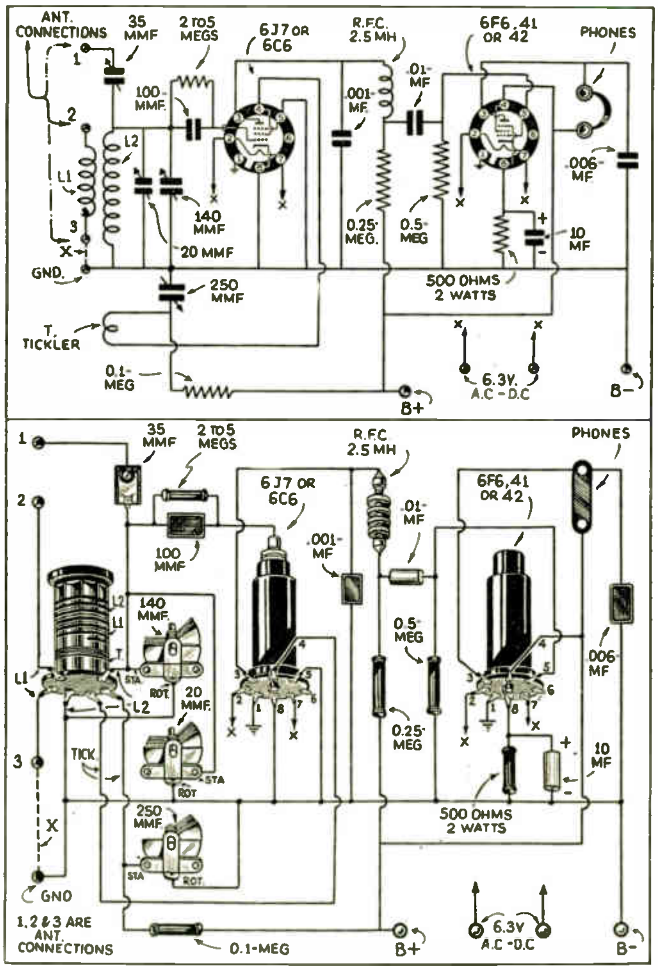


Fig. 1. Hook-up of 2 tube regeneration receiver.

LIST OF PARTS—2-TUBE SET

Hammarlund Mfg. Co.

One 140 mmf. tuning condenser
One 20 mmf. tuning condenser
One 250 mmf. tuning condenser
One set four or six prong XP-53 plug-in coils
One 35 mmf. trimmer condenser
One isolantite socket, metal-tube 8-prong type
One isolantite socket, 4 or 6 prong type (for coils)
One R.F. choke, 2.5 mh. Cap and Midget type

Cornell-Dubilier

One mica condenser, 0.0001 mf.
One mica condenser, 0.001 mf.
One mica condenser, 0.006 mf.
One paper condenser, 0.01 mf., 400 w.v.
One electrolytic condenser, 10 mf., 50 w.v.

Aerovox

One 3 meg. resistor, carbon, ¼ watt
One 0.5 meg. resistor, carbon, ¼ watt
One 0.25 meg. resistor, carbon, 1 watt
One 0.1 meg. resistor, carbon, 1 watt
One 500 ohm resistor, carbon or wire-wound, 2 watts or larger

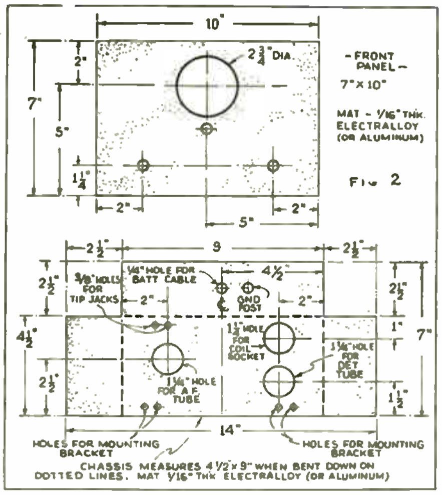


Fig. 2, Layout and drilling dimensions

Chassis

One 7x10 inch electralloy panel

One 4½x9 inch chassis (see text)

COIL DATA

Range Meters	Grid Turns	Tickler	Primary	Spacing	Wire
135-270	82	16	47	1⅞"	No. 28
66-150	38	11	25	1⅝"	No. 26
33- 75	18	6	11	1½"	No. 24
17- 41	9	5	6	1¼"	No. 16
9- 20	3½	3	2	1"	No. 14

All coils wound on 1½" ribbed forms. Space between grid coil and tickler ¼". Spacing is length of winding. Primary is wound between turns of grid coil. All ticklers wound with No. 30 D.S.C. wire.

Two head-phone tip-jacks

Dial, Etc.

One 270 degree airplane dial, counter-clockwise, ¼ inch shaft

Two "Change-O-Name" dial plates, 180 degree calibration

Two pointer type knobs

One bakelite socket, metal-tube 8-prong type

FACTS WORTH KNOWING

TYPES OF S-W STATIONS

An amateur is one operated by an experimenter for his own pleasure or education. Amateur stations may send out either voice or dots and dashes (code). The various governments of the world have set aside certain frequencies for the exclusive use of amateur stations. Amateurs generally use their stations for the purpose of communicating with other amateurs. It is for this reason that if you pick up one of these stations you generally hear one end of a conversation. They do not broadcast entertainment of any sort, as they are forbidden by law to do this is most countries.

Short-wave broadcast stations send out regular programs of entertainment in a manner similar to the ordinary long-wave broadcast station. Special frequency bands have been allotted for the exclusive use of short-wave "broadcasting" stations by international agreement, as is the case with amateur agreement. However, a good many countries do not abide bv these international agreements and operate short-wave broadcasting stations on frequencies which are not within the limits of the prescribed bands. But by far the greater number of short-wave broadcasters are to be found in these various broadcast bands.

The third class of stations are the "commercial" stations. These are operated by commercial communication companies for the purpose of maintaining communication lines between various parts of the world. These stations either send out telephone or dots and dashes. The telephony stations are used to carry telephone conversations overseas and to ships-at-sea and are connected with the regular wire telephone circuits in each country. To insure privacy on these stations, special devices are employed at the transmitter to render all speech transmitted unintelligible to anyone listening in on an ordinary receiver.

METERS VERSUS MEGACYCLES

A radio station sends out invisible waves. These waves have a definite length. It would be quite possible to measure these different wavelengths in feet or inches, but it has become customary to measure the waves by the metric system in meters. So if a station operates with a wavelength of 30 meters it means that the waves sent out by that station have a length of 30 meters (or 98.4 ft.).

The speed at which these waves travel is approximately equal to the speed of light—186,000 miles (or 300,000,000 meters) per second, regardless of the length of the wave. At any given point a certain fixed number of these waves will pass in one second. Since the speed at which they travel is constant but the length of the waves is variable, the number of waves passing the given point per second will vary as the length of the wave is varied.

For example, if a station transmits a wave having a length of 30 meters, a little simple arithmetic (dividing the speed of the waves, 300,000,000 meters/sec., by the length of the waves, 30 meters) will show that ten million of these waves will pass a given point in a second, or. stated otherwise the wave has a frequency of ten million cycles per second. However, in radio the use of such large numbers to express the frequency is cumbersome so instead of saying ten million cycles the term kilocycle (kc.) is used—meaning 1,000 cycles . Therefore, ten million cycles is the same as 10,000 kilocycles, so a wave having a length of 30 meters has a frequency of 10,000 kilocycles. Even this is a rather cumbersome figure to handle, especially when dealing with short waves or higher frequencies; therefore, it has become customary to further abbreviate and use the term megacycles (mc.). One megacycle is equal to one million cycles or 1,000 kc. So ten million cycles is equal to 10,000 kc., which is equal to 10 mc. This is not difficult to follow if you just remember that you can call a mile 5,280 ft. or 63,360 inches. In the United States it has become customary to use the frequency terms as a means of stating the channel on which a station operates; while in Europe until recently it was customary to use the wavelength method to state a station's operating channel.

A 2-Tuber the S-W "Fan" has been waiting for. It operates on batteries. Simple switch enables operator to change instantly from one band to another. Range 16 to 550 meters.

Photo at left shows neat appearance of the band-switching, 2-volt receiver here described by Mr. Hooton.

A 16 TO 550 METER, BAND-SWITCHING 2-VOLT RECEIVER

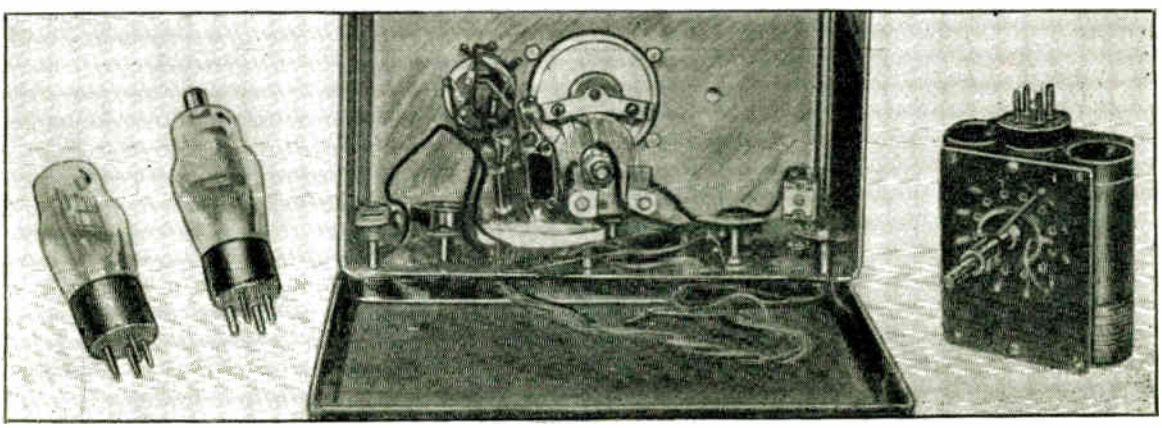
By HARRY D. HOOTON, W8KPX

• THE little two-tube **short** and **long-wave** receiver described here has been designed to meet the need of a good, yet simple set of the band-switching type using 2-volt tubes. Covering a range from 16 to 550 meters, in six positions of the coil switch, **without skips**, this set effectively eliminates one of the most annoying features of the average simple short-wave receiver—the necessity of continually changing plug-in coils each time the listener desires to receive on another band.

As the schematic diagram, Fig. 1, shows, the circuit is conventional in every detail, consisting of a regenerative detector, using a 1B4/951, and a single resistance-coupled stage of audio frequency amplification, using either a 950 or a 1F4 as output pentode. These tubes are all of rather recent release and are somewhat similar to the older 32 and 33 types except that the 1B4 is smaller in physical size and the other two have a much lower drain on both the "A" and "B" batteries. The regeneration is controlled by varying the voltage applied to the screen-grid of the 1B4 tube by means of the usual 50,000 ohm potentiometer, this control being the one at the right of the tuning dial. The antenna is coupled to the grid circuit of the detector through the usual 35 mmf. trimmer condenser connected to the fixed plates of the tuning condenser.

SWITCHING COIL COVERS 16 TO 550 METERS

The coil and switch system used in this receiver covers the range, as stated above, from 16 to 550 meters. This range by bands is as follows: Position "1" (coil switch), 16-32 meters; position "2," 30-60 meters; position "3," 55-115 meters; position "4," 105-185 meters; position "5," 175-330 meters; position "6," 270-550 meters. The entire coil and switch unit is completely wired at the factory, only four connections being brought out to a standard 4-prong tube base. When used with a standard 4-prong socket, the switch-coil unit may be removed, if desired, and standard plug-in coils substituted for it. This is convenient if the listener desires to receive on a frequency outside the 16-550 meter range and also simplifies the wiring of the set.



Above—an interesting view of the 2-volt band-switching receiver designed and constructed by Harry D. Hooton.

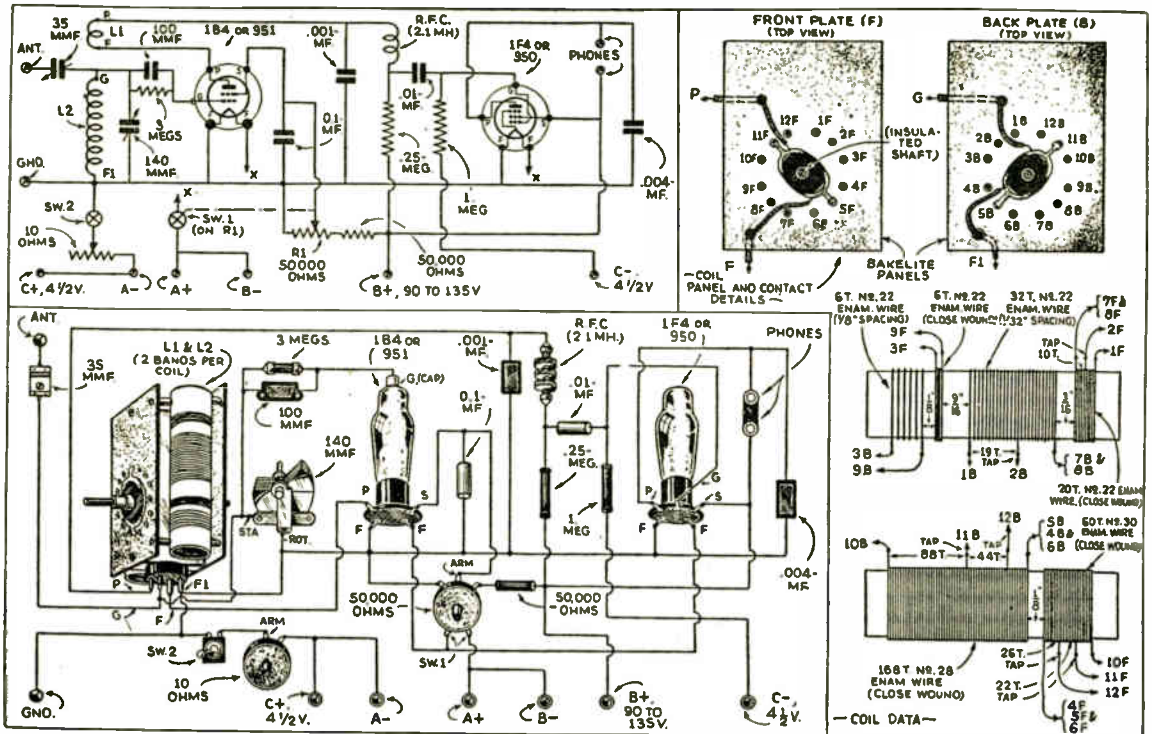


Fig. 1. Complete wiring diagrams both in schematic and picture form are given above for the 2-volt receiver.

The construction of the set is not at all difficult or complicated in any way. However, the instructions given here should be followed carefully in order to facilitate the job of wiring. First, remove the screws that hold the bottom and rear of the metal cabinet in place and drill the various holes in the bottom plate as shown in Fig. 2. Mount the tube and coil sockets, the tuning condenser and the antenna-ground and tip-jack binding post strips on their ¾ inch brass bushings and, using either the flexible or solid push-back hook-up wire, make the connections between these parts before replacing the plate in the cabinet. The leads from the screen-grid, the negative filament, etc., are left long and are then cut to their proper length and soldered into tho circuit after the bottom plate is back in its place. The dial is merely mounted on the shaft of the tuning condenser, no additional support being required.

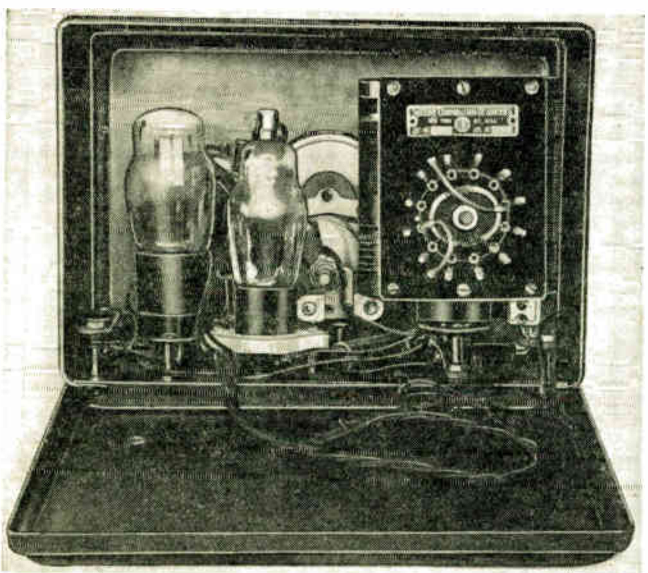


Photo above shows a rear view of the 2-volt receiver, which covers 16 to 550 meters with a handy band-switch

TEST FOR "SHORTS" WITH PHONES AND A "C" BATTERY

After all of the parts have been mounted and the circuit is completely wired, place the coil and the two tubes in their respective sockets and connect the "A" battery (two 1½-volt dry cells in series connection) to its leads. Now, by means of a pair of headphones and a 4½-volt "C" battery, test from each "B" plus and "C" minus lead to the negative filament in order to determine whether a short-circuit exists. **A short-circuit will cause a loud click to be heard in the headphones every time the connection is made and broken**; if no short-circuit exists, a loud click may be heard the first time and very weak ones or none at all thereafter.

If everything appears to be correct, the "B" and "C" batteries may be connected as shown in Fig. 1. Place the **range-switch** on the **16-32** meter band or position "one" and turn the potentiometer knob to the right to close the "A" and "B" battery switch. Adjust the 10 ohm rheostat in series with the negative "A" lead until the filaments of the two tubes glow at a dull cherry-red color. The antenna and ground and the phones are now connected to the binding post and tip-jack strips at the rear of the cabinet and the knob of the potentiometer is turned to the right until the familiar rushing sound of regeneration is heard.

With an insulated screwdriver or similar tool, tighten or loosen the screw in the small 35 mmf. antenna-series until oscillation over the entire 16-32 meter range is obtained. Turn to the 30-60 and the 55-115 meter bands and repeat the process. As the trimmer is not readily accessible for frequent adjustments, it will be necessary to strike a "happy medium" which will be fairly satisfactory for all of the bands covered by the receiver. A better arrangement would be to place the trimmer on the outside of the cabinet or use a standard 35 mmf. tuning condenser, mounted in such a way that it may be reached for the more precise adjustments required for best results.

As mentioned above, either the 950 or the 1F4 tube may be used as output, the socket connections being the same. The 1F4, however, has a much higher amplification factor, which means low "C" bias (4½-volts), and is therefore the best where portability is desired. Best results are obtained from the 1F4 when high-impedance headphones, such as the Brush type "A" crystal units, are used.

Either standard or midget "B" batteries may be used with this receiver as the drain is not excessive. With 135 volts of "B" power the combined plate and screen currents are only about 9 milliamperes; reducing the voltage to 90 drops the current to less than 6 milliamperes, which is economically handled by the midget blocks. Best results will be obtained, especially on the standard 200-550 meter broadcast band, with a fairly short antenna 35 to 50 feet in length. Antennas longer than this reduce the selectivity excessively in this region.

If the above instructions are carefully followed, no difficulty should be experienced.

LIST OF PARTS, SWITCH-COIL RECEIVER

Hammarlund Mfg. Co.

One Midget tuning condenser, 140 mmf., type MC-140-M

One Equalizing or trimmer condenser, 35 mmf., type MEX

One Midget R.F. choke, 2.1 millihenries, type CH-X

Aerovox Corporation

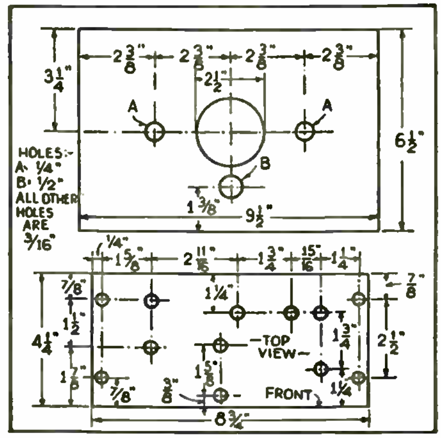
One Mica condenser, 0.0001 mf., type 1468

One Mica condenser, 0.001 mf., type 1460

One Mica condenser, 0.004 mf., type 1450

One Paper condenser, 0.1 mf., type 484 (400 volts)

Fig. 2. Complete drilling dimensions for the chassis.



One Paper condenser, 0.01 mf., type 484 (400 volts)

One Carbon resistor, ¼ watt, 3 megohms, type 1096

One Carbon resistor, ¼ watt, 1 megohm, type 1096

One Carbon resistor, 1 watt, ¼ megohm (250,000), type 1094

Miscell.

One Potentiometer, 50,000 ohms, with d.p.s.t. switch, type 205

One Filament rheostat, 10 ohms, type 204-W

Hardware

One Steel cabinet, size 9¼x6 5/16x4⅞ inches, type 245, pierced

One Airplane dial, ¼" shaft, 0-100 scale, type 124

Two "Change-O-Name" dial plates, type 541-A

Two Pointer knobs, 1⅛", type 286

ICA

One "Band-switching" coil unit, type 1415

One Ceramic socket, 4-prong, type 2600

One Bakelite socket, 5-prong, type 2485

Two Tip-Jacks, insulated, type 1890

Eveready (Batteries)

Two or three type 772 or 762, 45-volt "B" blocks (see text)

One type 761 or type 783 "C" battery (see text)

Two type 7111, 1½-volt "A" batteries (dry cells)

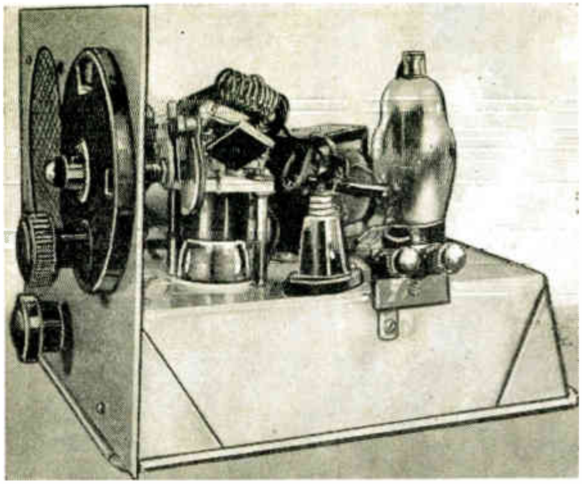
Raytheon

One type 950 tube or one type 1F4 tube (see text)

One type 951/1B4 tube

A 5-METER A. C.-D. C. RECEIVER

By JACK BARNETTE, W3GHQ



A bread-pan serves as a chassis for this 5-meter A.C.-D.C. Receiver. It works a loud-speaker, yes sir!

• HERE is a five meter receiver for the Ham or SWL who wishes to look into the possibilities of the 56 megacycle band at little expense, but who wants a receiver capable of giving reasonably satisfactory performance. The circuit is not new. It is the now well known "Minute Man," famous for its sensitivity and selectivity. Its adaptation to a two tube A.C.-D.C. circuit is new. It has been in use here at W3GHQ for several months.

The use of the popular 12A7 permits reasonable volume on the tiny speaker. On some signals it can be heard all over a medium-sized apartment—much to the disgust of the ex-YL. The set is very simple to construct. The hum level on AC is quite low. In fact it is not audible when the set is in regeneration, or on a signal.

The panel is 7 x 12 inches or made to fit your particular chassis. The chassis may be almost anything you have handy. The set shown is built on a tin bread-pan from the 5 and 10.

The 37 tube is mounted in an inverted position to permit the shortest possible leads to grid and plate. The coil should be soldered directly to the plate prong contact on the isolantite socket, as should one lug of the tuning condenser. The other end of the coil—and the other running condenser connection—should be soldered to one lug of the tiny variable grid condenser. This in turn has the remaining lug soldered to the socket grid contact. The 10 megohm grid-leak is connected across the grid condenser at the same time.

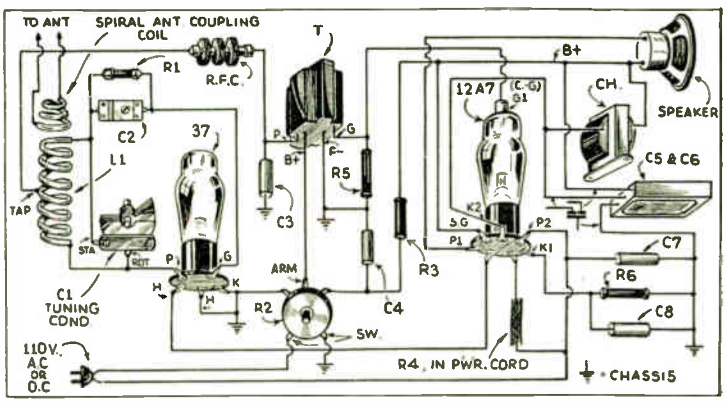
The best point for the tap on the coil is near the center. **The exact spot must be found by experiment!** C3 is .002 to .006 mf. Again the proper value must be determined by experiment. R6 may or may not be necessary. Do not overlook the fact that neither side of the tuning condenser shaft is at ground potential. An insulated shaft extension should be used to prevent a panel-to-shaft short. As is the case with all A.C.-D.C. sets, no direct ground connection is permissible. Use a condenser in series.

The only really critical adjustments are the grid condenser and the spiral antenna coupling. A regular 5-meter antenna is recommended, although the set seems to work on any piece of wire that is handy. If the quality of the received signal is very poor, do not jump to the conclusion that something is the matter with the receiver. The writer has contacted several stations using transceivers that were frequency-modulating so badly as to be practically unreadable on this receiver.

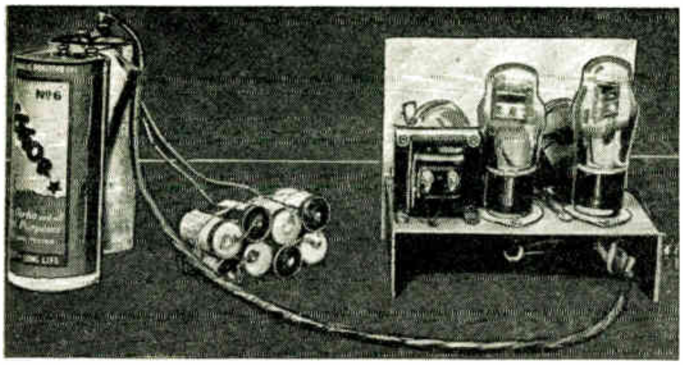
All "ground" connections should be made to one point or connected by a copper wire. Do not trust the chassis to act as a connection.

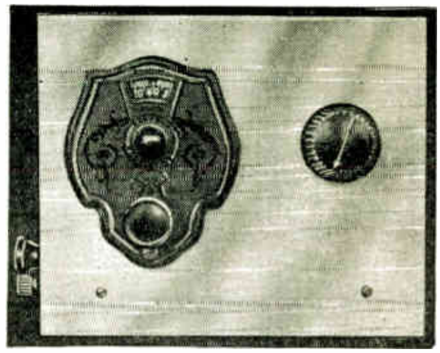
PARTS LIST

L1—8 turns of No. 18 wire on ½inch dia. form, spaced about the diameter of the wire. Form removed.
L2—5 turn spiral antenna coupling coil with adjustable support.
C1—15 mmf. variable condenser.
C2—Equalizer type condenser, 80 mmf.
C3—.002 to .006 mf. fixed condenser.
C4, 5, 6—8 mf. electrolytics, 150 volt type.
C7—.02 mf.
C8—10 to 25 mf. low voltage electrolytic
R1—10 megohms
R2—50,000 ohm potentiometer—with switch
R3—12,000 ohm fixed resistor, 1 watt
R4—line cord resistor—330 ohms
R5—1 megohm
R6—1500 ohms
R.F.C.—50 turns of No. 26 D.C.C. wound on a ¼ inch dia. form. Form removed.
T—a good audio transformer—about 1:3 ratio.
Ch—Midget filter choke—not over 500 ohms resistance.
Sockets, speaker, panel and etc.
1—37 tube
1—12A7 tube



Simple to build? We'll say so! Look at the diagram—and it furnishes its own plate supply current too!





Front and rear views of the "forty-niner."

The "FORTY-NINER"

A Receiver for the Lean Purses

By STANLEY JOHNSON

• THE cost of the power-supply is too seldom considered in the design of so-called "inexpensive" sets. Most simple receivers require a power supply which—whether it be a string of "B" batteries or a power pack—costs practically as much as the receiver itself! It was in an effort to reduce this power supply cost that this new short-wave receiver was designed. The compact set operates very efficiently with less than a dollar's worth of batteries furnishing the power. Although extremely simple to assemble and wire, when completed it demonstrates a "DX" getting ability which compares surprisingly well, even with that of complex superheterodynes.

49's USED AS DET. AND A.F. AMPLIFIER

The receiver uses a type 49 tube as a regenerative detector transformer coupled to another 49, which serves as an audio amplifier. By the application of a positive potential to the inner grids of the tubes, the "space charge" is partially canceled and the tubes operate very efficiently on the twelve volt "B" supply, furnished by a handful of inexpensive flashlight batteries. A Canadian amateur, VE4EA, deserves the credit for first applying the space-idea to the type 49 tubes.

In order to avoid "inductive hum" from house wiring and to improve appearance, the set is built up on a metal chassis and panel. The 6½x7 inch metal panel was cut from a piece of scrap automobile body aluminum. It is often possible to purchase large sheets of this metal from junk dealers for a few cents. Boiling the panel for a few minutes in a strong solution of washing soda removes the paint and gives the metal a satin-like finish. If the builder desires, the 2x4½x7 inch chassis may be made from the same metal, although in order to avoid metal work the writer used one-half of a standard 2x7x9 inch cadmium-plated chassis, of the type available at most radio-supply stores at nominal cost.

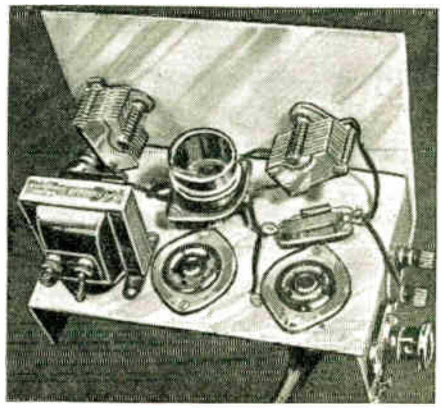
LINE-UP OF PARTS ON CHASSIS

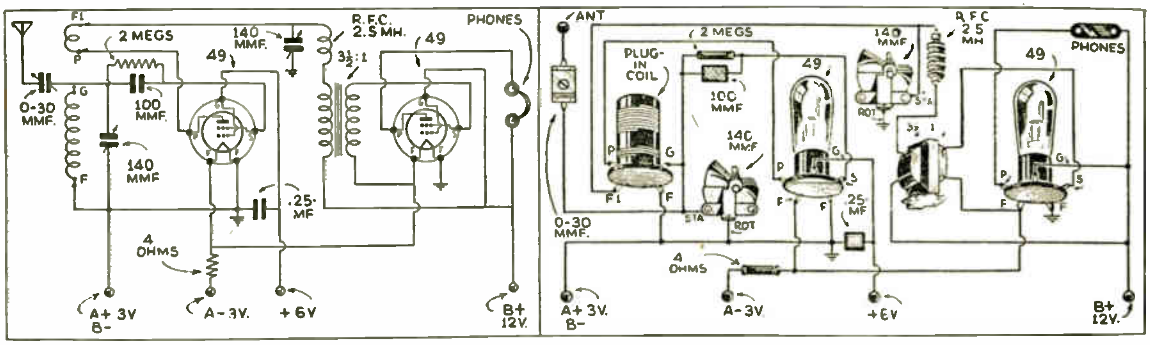
Looking at the photo which shows the top view of the chassis, we see the tube sockets and the audio transformer at the back of the chassis. At one end of the chassis are the antenna trimming condenser—fitted with a knob cemented on with china cement—and the two binding posts for headphones. The grid condenser and grid-leak, the coil socket, and the R.F. choke are also above the chassis. The two variable condensers are the only parts mounted on the panel. One serves for tuning and the other for regeneration. Most of the wiring, and two of the parts, the filament voltage-dropping resistor and the inner grid by-pass condenser, are underneath the chassis.

The wiring is perfectly straightforward and there is nothing about it which should cause trouble even for a novice. Of course, since this is a short-wave set, it is wise to observe the usual precautions: short leads, well soldered joints, all ground connections to a single point on the chassis.

The "B" battery consists of 8 (eight) 1½-volt flashlight batteries soldered together, with a tap at "plus six volts." These cells may be purchased from radio-supply companies for as little as 3½c each. Although the small No. 2 cells are shown in the photo, the larger

Rear view of the 2-tube receiver.





Wiring diagram of the Forty-Niner receiver—it uses two 49 tubes hooked up in "space-charge" style.

No. 1 cells cost no more and have greater life. However, since the plate current drain is low, the life even with the small cells is quite satisfactory.

COILS

It will be noticed in the coil chart that the "tickler" coil windings are rather large. It is suggested that the builder experiment with different coils, in order to obtain the best results and smoothest regeneration. The smaller coils may be wound on tube bases.

HOW SET TUNES

The set tunes much the same as any regenerative set. The regeneration control is advanced until oscillation—as shown by a soft hiss—is obtained and then stations are tuned in by rotating the tuning condenser. A regenerative whistle indicates that the set is tuned to the carrier wave of a station. Then the regeneration control is turned until oscillation stops and the station becomes intelligible.

With some tubes, there is a possibility of a peculiar "fringe howl" occuring at the point where oscillation begins. This may be eliminated by raising the plate voltage to 12½ or 15 volts. The inner grid voltage on the detector should remain at 6 volts. Since the set will operate on such low voltage, it is admirably suited for portable or emergency use. Four flashlight batteries connected in series-parallel can supply the filament voltage with four of the very small 3 volt "pen-lite" batteries serving as the "B" battery. Both the beginner and the old-timer, who may be a licensed amateur, can find use for a receiver of this type; when wind or flood or storm leaves communication lines a tangled mess, it literally may be a lifesaver to have a receiver powered by batteries found on the shelf of the corner drug store.

TRANS-OCEANIC RANGE

Despite the low voltage, the sensitivity and output of the receiver is surprising. When testing the set the first afternoon, the writer picked up Berlin at 1:00 o'clock C.S.T. and listened for nearly three hours to a program which included interviews with members of the American Olympic team. Daytime reception of Germany is always "good DX" in central Nebraska and the reception is doubly remarkable, considering that it took place on a scorching July day when the temperature reached a maximum of 117 degrees. And as if this wasn't enough to discourage DX, the antenna in use at the time was a badly corroded inverted "L" broadcast antenna pointed in the general direction of Tokio!

PARTS LIST

2—.00014 mf. variable condensers.
1—.0001 mf. fixed condenser.
1—0.30 mmf. trimmer condenser.
1—.25 mf. by pass condenser.
1—meg. grid resistor (½ watt).
1—4 ohm resistor.
1—2½ mh. R.F. choke.
1—3½ to 1 audio transformer.
2—5 prong wafer sockets.
2—type 49 tubes, RCA Radiotron.
1—metal chassis.

COIL DATA

20 meters
- grid 5 turns
- tickler 4 turns

40 meters
- grid 10 turns
- tickler 7 turns

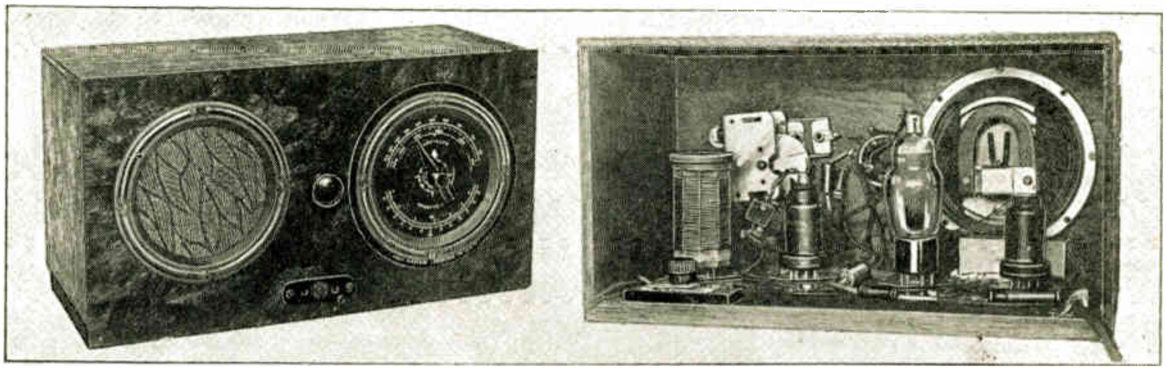
80 meters
- grid 22 turns
- tickler 11 turns

160 meters
- grid 45 turns
- tickler 18 turns

All coils close wound on 1¼ inch dia. coil forms with number 26 D.C.C. wire. The four coils cover a continuous range of approximately 18 to 200 meters.

JUNIOR ALL-WAVE "SPACE-EXPLORER"

By H. G. CISIN, M.E.

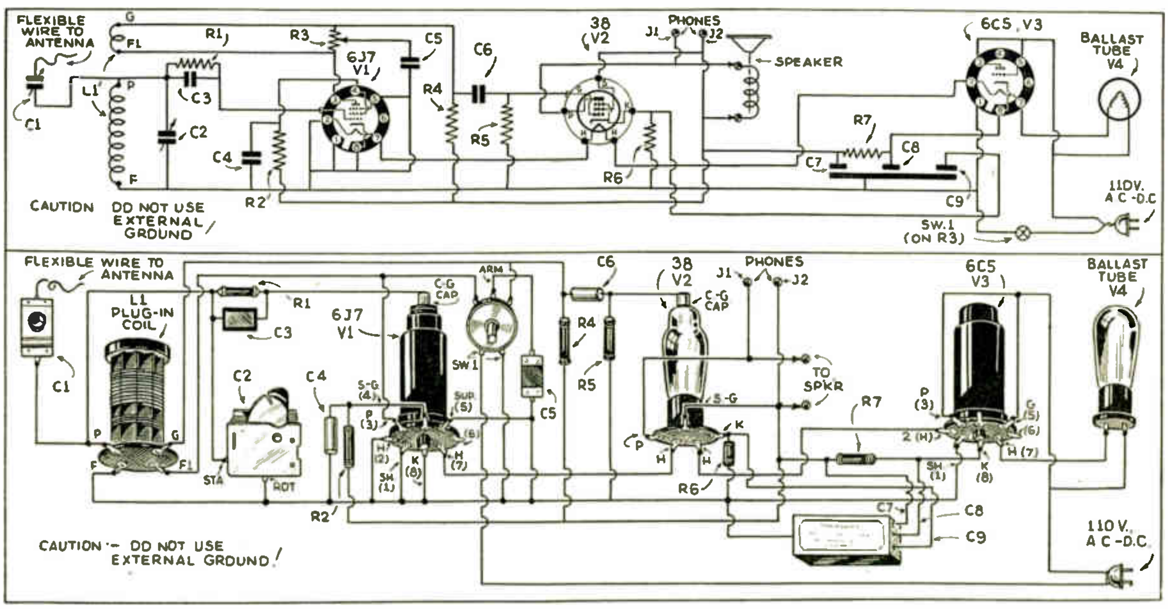


Front and rear views of receiver.

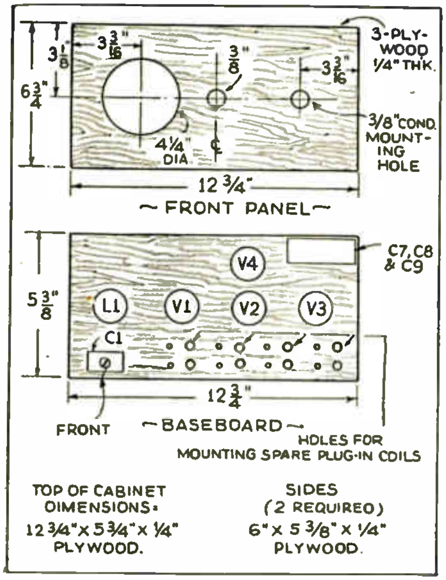
• REALLY excellent performance, unusually attractive appearance and amazingly low cost are the triple features destined to win thousands of loyal friends for the Junior "Space-Explorer" All-Wave 4.

In spite of its Spartan simplicity this well-designed receiver has "what it takes" to bring in the distant "foreign" short-wave stations. With "professional" ease, the Space-Explorer tunes in not only European stations, but also Australian and Asiatic broadcasts.

The performance of a radio receiver depends first upon circuit design and then upon the type of tubes utilized. Many "trick" circuits have come and gone, but the "time-tried" standard regenerative detector used in this receiver remains unsurpassed in its ability to reach out and bring in stations from the far-off corners of the world. At the risk of "gilding the lily" certain refinements have been added. However, these are not experiments, but worthwhile features. As far as the metal tubes are concerned, there is no longer any question as to their desirability. From the stand-



Wiring diagram for the Jr. "Space-Explorer"



Front panel and baseboard drilling dimensions.

point of adequate shielding alone, without considering their other obvious advantages, metal tubes have earned their place in the sun, particularly as regards short-wave reception.

In the Junior Space-Explorer, a 6J7 tube is used as the regenerative detector. Both the suppressor grid and the cathode are grounded directly to the common negative, without the use of bias resistors. A 1-meg. resistor in the screen circuit reduces the screen voltage to approximately one-third that of the plate. While the screen voltage is not highly critical, it has been found that best results are obtained by maintaining this definite ratio between plate and screen. Naturally, it is necessary to use a by-pass condenser between the screen-grid and the negative return.

REGENERATION CONTROL

Several methods of regeneration control are available, but the one employed seems to give smoothest results in this particular type of circuit. It consists of a potentiometer shunted across the tickler, with the center arm of the potentiometer connected to one side of a .0005 mf. fixed condenser. The other side of the condenser goes to the common negative.

The Junior Space-Explorer uses a system of overlapping plug-in coils. The shorter leads made possible with plug-in coils result in lower losses which, in the last analysis, are a deciding factor in determining the distance range of a receiver.

38 PENTODE USED AS POWER TUBE

The detector, V1, is resistively coupled to the first audio stage, which is also the power output stage. A 38 type pentode tube is used as the power tube. This has an undistorted power output of 1/2 watt on A.C., more than sufficient to drive the five inch magnetic speaker employed. The necessary cathode bias of 13 1/2 volts is obtained by means of the voltage drop across a 1,000 ohm resistor in series with the cathode circuit.

Provision is made for earphone reception, the twin phone-jack being located at the front of the panel. A metal 6C5 tube provides the necessary rectification. The economical A.C.-D.C. circuit employed permits operation of this receiver on any type of house-lighting circuit. An additional advantage is the fact that when this set is plugged into an A.C. circuit, it will operate on 25 or 40 cycles as well as on the more usual 60 cycles. Through the use of an inexpensive and easily applied adapter, the same receiver can also be used on 220-volt A.C. or D.C. lines as well as on standard 110 volt circuits. An inexpensive but efficient method of filtering is used. This eliminates the usual choke in the high-tension circuit, substituting a resistor, R7, by-passed at either end by sections of an electrolytic condenser. The cathode by-pass condenser, C9, for the power tube, V2, is enclosed within the same cardboard container as the filter condensers, C7 and C8.

BALLAST RESISTOR TUBE A NEW FEATURE

The Junior Space-Explorer introduces a new and desirable feature in the utilization of a metal ballast tube, V4. This contains the voltage reducing resistance required to reduce the line voltage to the exact value necessary for the heaters of the other three tubes. The ballast tube and heaters of the tubes are connected in series across the 110-115 volt line. This new ballast tube has many advantages. It eliminates the line-cord resistor which constituted a fire hazard. It concentrates and localizes the heat necessary for the required voltage drop, keeping it away from delicate parts such as electrolytic condensers, but radiating it readily because of the metal construction. Added advantages of the ballast tube are the fact that it provides protection against over-voltage due to line surges, thus improving operation and increasing the life span of the other tubes. Furthermore, in case of a short-circuit, the ballast tube acts as an automatic fuse, opening the circuit and protecting the other tubes. Since it can be replaced at a relatively low cost and without any trouble whatsoever, merely by plugging in another tube ,this feature alone makes it a most valuable addition to the modern A.C.-D.C. receiver.

NEW IDEA IN CABINETS—MADE OF WOOD

A new and noteworthy idea has been developed in the construction of the Junior Space-Explorer. Looking carefully at the front view illustration, one gets the impression that this receiver is housed in an expensive, factory-made metal cabinet of the "Professional-Communication" type. As a matter of fact, this cabinet is made of wood, painted with a new type of crystalline black lacquer. This is put on with a brush, just like any other paint or varnish, but when it dries, it crystallizes, producing a beautiful crackle finish equal or superior in appearance to finishes sprayed on metal by professionals. The wood cabinet can be made at very low cost from 3/16" plywood which, of course can be obtained almost anywhere, cut to the desired sizes. After being nailed with thin brads or glued together, and painted with the crystalline lacquer, the finished product provides a housing for the receiver which not only costs much less than a metal cabinet, but also is far superior in many ways.

Years ago, when radio was in its infancy, the metal cabinet was standard equipment with many manufacturers. As radio and acoustical knowledge progressed, however, the metal cabinet was soon discarded in all broadcast receivers, in favor of wood, until at present, only short-wave sets are encased in metal cabinets. Up to about a year ago the metal cabinet served a definite purpose in a short-wave receiver, since it acted as a shield. With the advent of the metal tubes, this type of shielding is no longer necessary. Hence, the metal cabinet has outlived its usefulness and its retention at present is due to a type of inertia which often accounts for lack of progress.

The wood cabinet of the Junior Space-Explored acts like the sounding board of a violin, making the loudspeaker tones richer and fuller and eliminating the tinny effect so noticeable with a metal cabinet. Glancing at the front view, one is impressed with the dignified simplicity of the controls. The station selector bar-knob at the right is located in a natural position for easy tuning. The combined switch and regeneration control is in the center of the panel, between the speaker and the station selector. Below this, is the earphone jack, in a conveniently accessible position.

In constructing the Space-Explorer, the first step is to nail the panel to the baseboard. Since the latter is of wood, no sub-panel or additional chassis is required. The five sockets are fastened to the baseboard by means of wood screws with the coil socket nearest the variable condenser. The coils not being used are inserted in holes drilled for them at the rear of the baseboard. The antenna trimmer is also fastened to the baseboard near the coil socket. The variable condenser, potentiometer, speaker and phone jacks are mounted on the panel. Other parts, such as fixed resistors and condensers, are soldered in place near the terminals of the parts with which they function, this being done as the set is wired. Due to the extreme simplicity of the circuit, no skill or experience is required to produce a perfect job.

LIST OF PARTS FOR JUNIOR "SPACE-EXPLORER"

Hammarlund

C1—Antenna Trimmer, 10 to 70 mmf., type MICS-70.

C2—Midget Variable Condenser, type MC-140-M.

L1—One set of four prong Short Wave Coils, 17 to 270 meters, type SWK4.

L1—One four prong Broadcast Coil, 250 to 560 meters, type BCC4.

Cornell-Dubilier

C3—.0001 mf. Mica Condenser, type 3L.

C4—.1 mf. 400 volt "Cub" tubular Condenser, type BA-4P1.

C5—.0005 mf. Mica Condenser, type 1W.

C6—.01 mf., 400 volt "Cub" tubular Condenser, type BA-4S1.

C7, C8, C9—dry Electrolytic Condenser, cardboard container, three sections, section C7—4 mf., section C8—8 mf., section C9—5 mf. type MA—11117, 150 to 200 volts.

Miscellaneous

R1—1 meg. ½ watt metallized Resistor.

R2—1 meg. ½ watt Metallized Resistor.

R3—50,000 ohm Potentiometer and switch (SW1), type P-185, 50,000.

R4—175,000 ohm, ½ watt Metallized Resistor.

R5—1 meg. ½ watt Metallized Resistor.

R6—1,000 ohm, 1 watt Metallized Resistor.

R7—5,000 ohm, 1 watt Metallized Resistor.

One four-prong Wafer Socket for Plug-in Coils.

Three octal Wafer Sockets for metal tubes.

One five-prong Wafer Socket for 38 tube.

V4—Ballast Metal Tube, type K105-A. Res. 350 ohms, current rating 50 watts. (Name of manufacturer furnished on request.)

One Roll push-back hook-up wire

SW1—Switch on R3.
(SW1), type P-185, 50,000.

J1, J2, Twin earphone Jacks.

1—Five-inch Find-All Magnetic Speaker.

2—4¾" diameter ornamental Metal Rings for dial and speaker.

1—Calibrated Dial.

1—Bar Knob, two small control knobs.

Cloth grille for speaker opening.

Wood baseboard, panel, cabinet top and sides (see sketches).

General Cement Mfg. Co.

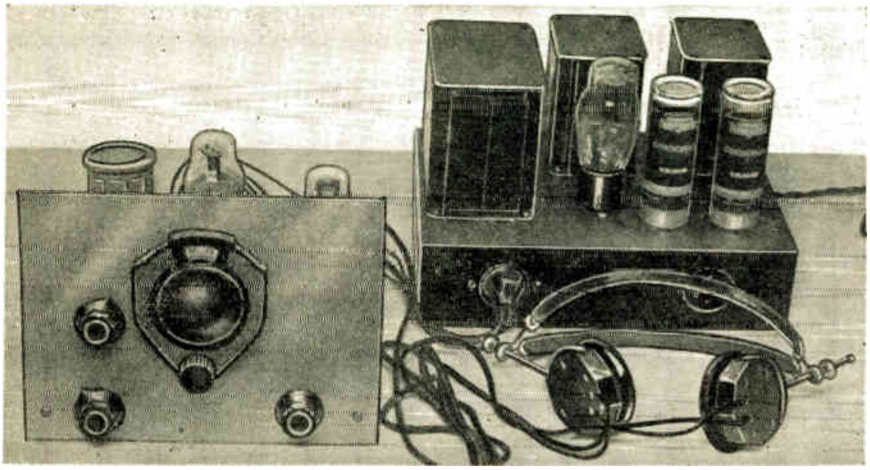
1—jar Crystalline black lacquer.

RCA Radiotron

V1—6J7 Tube, RCA Radiotron.

V2—38 Tube, RCA Radiotron.

V3—6C5 Tube, RCA Radiotron.



FEATURES

All-wave Reception—2.5 270 meters!
A.C. Operation—110 Vt. 60 Cycle A.C.
Headphones or Speaker.
Bandspread on All Waves.
Power-supply Unit Data Given; also Coil Data, List of Parts, Tuning Hints, etc.

All set to "listen in" on the world!

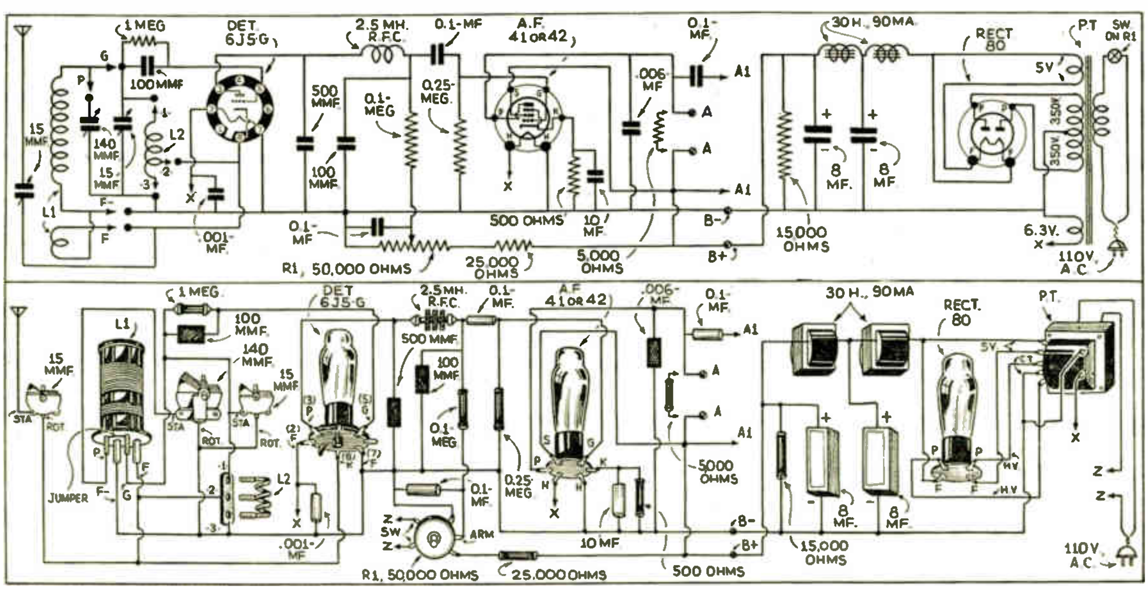
Beginners' A.C. Receiver—2.5 to 270 Meters!

• IN a previous article in this book we discussed a battery-operated receiver for the Short-Wave Beginner. Undoubtedly there are a good many beginners who desire to start out with a simple battery-operated receiver because of its simplicity and low cost. On the other hand, we are sure that a great many can afford the **electrified** type of received, which operates directly from the power mains.

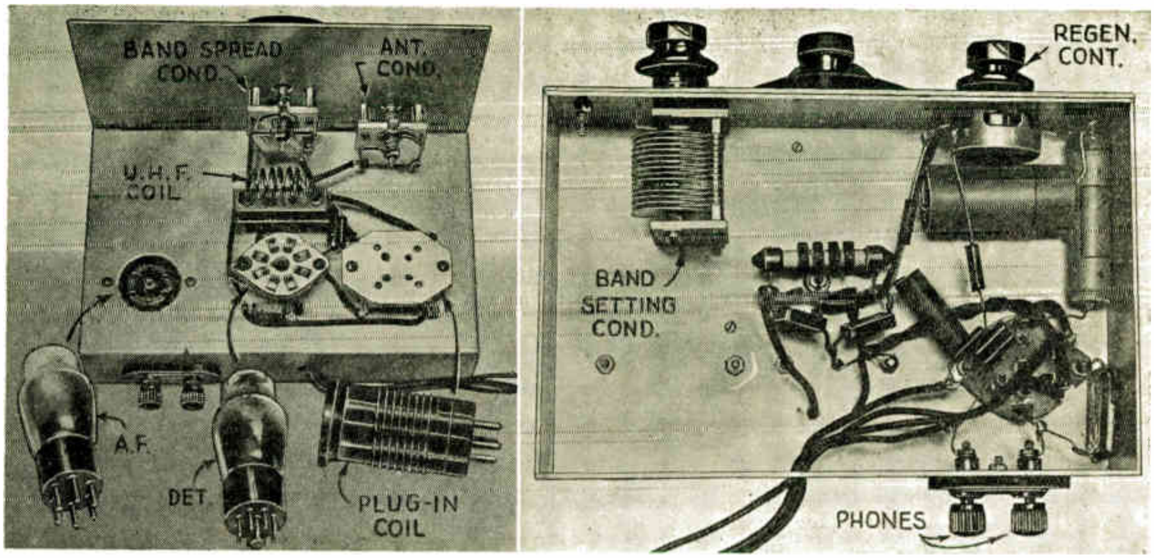
The **electrified** receiver offers a good many advantages that cannot be found in the battery-type receiver. The electric set is much more flexible and it is possible to obtain a greater amount of sensitivity, because of the higher voltage at which the more sturdy A.C. tubes operate. In the past, most electrified beginner's receivers have been limited to covering the short-wave bands from 15 to 200-meters. Today, with the increased activity in the shorter wave bands, for instance, in the **10-meter Amateur** Band, the **nine-meter Police** band, and the **six-meter Television** band, together with the **five-meter Amateur** band, there is considerable diversion from DXing in the ordinary short-wave channels.

One might frown upon this statement, but consider that after you've been listening on the ordinary short-waves for a certain length of time and have heard most of the "hard-to-get" stations, and the urge for adventure strikes you, you can go down to the 10-meter **amateur** band and hear stations that otherwise you could not hear.

The interest in these real **short-wave** bands lies in



Wiring diagram of the "multi-band 2" receiver. The tubes selected for this set ensure the maximum results.



Left Rear view of the "Multi-band 2" an ideal A.C. operated set for the beginner. Right—Bottom view of the receiver.

the fact that they are not consistent, and therefore it requires diligence and "stick-to-it-iveness," so that when conditions are right you will hear the stations. Then again, some of these stations only have a power of from 25 to 30 watts and it is really DX when you hear them from Africa or Asia with such low power; recently "foreign" stations have been heard on the five-meter Amateur band! There again lies an opportunity for the old DX thrill! And how!

WE GO DOWN TO 2.5 METERS

For the above reasons we have designed this receiver to operate all the way down to approximately 2½-meters by the simple expedient of **plug-in** coils. The detector used is a 6J5G. This is a triode of the glass type with an octal base recently designed for high and ultra-high frequency service. The output tube can be any one of a number of pentodes; the 41 or 42 being used in this receiver. The complication in the design of the receiver lies in the change from the **high to the ultra-high** frequencies. But, by employing a separate socket for the ultra-high frequency coils, and juggling the connections in the regular plug-in coil, the problem was worked out very satisfactorily. For instance, on the regular short-wave bands we needed a 140 mmf. tuning condenser and a 15mmf. condenser for band-spread tuning. By referring to the diagram it will be seen that one prong in the four prong coils is used for two connections—they are the common grounds.

STANDARD PLUG-IN COILS USED

The blank prong thus made available is connected to the grid side of the winding, so that when this coil is removed only the small condenser is connected in the tuning circuit. When the large coil is inserted and the ultra-high frequency coil is removed, both condensers are **paralleled** in the grid circuit. Data is given the coil table for both sets of coils. Standard Hammarlund coils may be used for the ordinary high-frequency bands, by some alteration in the number of tickler turns which are now employed in the cathode circuit, in order to obtain satisfactory results. On the average it will be found that three or four turns in this coil will be satisfactory on all bands. Some "cut-and-try" will be necessary, on the larger coils; remove one or two turns at a time until satisfactory results are obtained. The receiver may be operated as a super-regenerator or straight regenerator on the bands from 10-meters down. On all other bands the set operates as a straight regenerative receiver. For satisfactory results in the ultra short-wave bands one plate was removed from the 15mmf. Trim-Air condenser, leaving four plates, two rotors, and two stators.

ANTENNA COUPLING

The antenna is coupled directly to the cathode, the cathode coil being employed as an **antenna coupling** coil. The operation of the receiver is exactly the same as explained in the previous article, regarding the beginner's battery operated receiver. Tuning instructions there explained will hold true for this receiver, **except on the ultra-high frequency bands.** On these bands the regeneration control is adjusted to a point when the detector will **hiss** strongly. When the station is tuned in there will be a noticeable decrease in the hiss. One word of warning must be given at this point, and that is, **a super-regenerator of this type will radiate strong and interfering signals at the frequency of operation, if the following points are not carefully observed:**

Never adjust the regeneration control beyond a point where the detector **just begins to hiss!** In other words, **operate the receiver with the regeneration control set as near as possible to the point where the hiss will** stop! This will practically eliminate interference with other receivers.

"GROUND" CONNECTIONS IMPORTANT

In laying out the receiver, a central point should be established in the chassis for the ground and all leads associated with the detector that are connected to the "B" negative circuit should be run to this point. Anything concerned with the audio amplifier need not be treated in this manner.

In constructing this receiver we selected one of the screws which fastened the detector socket to the chassis for the purpose. Under the top and bottom of this screw, that is, above and below the chassis, we placed a soldering lug for these ground connections. It will be noticed that the mounting bushings available with the Trim-Air condensers are used for mounting them. In the case of the antenna trimmer and the small tuning condenser, both are thus insulated from the panel. In the photo the large tuning condenser, that is the 140mmf. unit, is not shown insulated through the use of these mounting studs, but this should be treated in the same manner as the others and all the ground connections from the condenser should go to the soldering lug on the socket which has been established as the common "ground" point.

For earphone operation, connect a 4,000 or 5,000 ohm 20-watt resistor across the phone terminals and operate the earphones through the .1 mf. condenser by connecting them to terminals marked "A-1" in the diagram. For loud-speaker operation use terminals marked "A" and disconnect the resistor. The power-supply diagram is also given and is extremely easy to follow; it is conventional in all respects and one should have no trouble with it. We recommend the use of best quality parts, for while this particular receiver may be changed or discarded at a future date, the power-supply will always serve as a permanent piece of apparatus in the experimenter's shack.

ANTENNA TO USE

The antenna employed with this receiver was a single 8 ft. vertical wire with about 40ft. of lead-in. This lead-in was connected to the top of the vertical section. This serves excellently for both short and ultra short wave operation. For ordinary short-wave work, the 8 ft. section would not be needed, but its use improves the operation of the receiver on the ultra-high frequencies to a very marked degree.

PARTS LIST—BEGINNER'S SET

Cardwell
- 1—140 mmf. Trim-Air condenser
- 2—15 mmf. Trim-Air condensers

Hammarlund
- 1—SWK-4 coil kit
- 1—4 prong isolantite socket
- 1—8 prong (octal) isolantite socket
- 1—2.1 mh .R.F. choke

Cornell-Dubilier
- 1—.001 mf. mica condenser
- 2—.0001 mf. mica condenser
- 1—.0005 mf. mica condenser
- 1—.006 mf. mica condenser

Sprague
- 3—.1 mf. tubular condensers
- 1—10 mf. electrolytic condenser (Low Voltage)
- 2—8 mf. electrolytic condensers (500 Volts)

IRC
- 1—1 meg. ½ watt resistor
- 1—¼ meg. ½ watt resistor
- 1—.1 meg. ½ watt resistor
- 1—25,000 ohm ½ watt resistor
- 1—500 ohm 1 watt resistor
- 1—5,000 ohm 20 watt resistor
- 1—15,000 ohm 50 watt resistor

Kenyon
- 1—power trans. (see diagram T 205)
- 2—filter chokes (T 153)

Raytheon
- 1—6J5G tube
- 1—41 or 42 tube

Brush Devel. Co.
- 1—pair crystal head-phones

Miscellaneous
- 1—50,000 ohm potentiometer
- 1—Panel 6x8 inches
- 1—Chassis 2x5x8 inches
- 1—4 prong wafer socket
- 1—6 prong wafer socket
- 1—dial
- 3—knobs

COIL DATA FOR "MULTI-BAND 2" RECEIVER

BAND (meters)	GRID Coil	Wire	L.W.	TICKLER (close wound)
135-270	82 T.	No. 28 enam.	1⅞"	16 T. No. 30 DSC.
66-150	38 T.	No. 26 tinned	1⅝"	11 T. No. 30 DSC.
35-75	18 T.	No. 24 tinned	1½"	6 T. No. 30 DSC.
17-41	9 T.	No. 16 tinned	1¼"	5 T. No. 30 DSC.

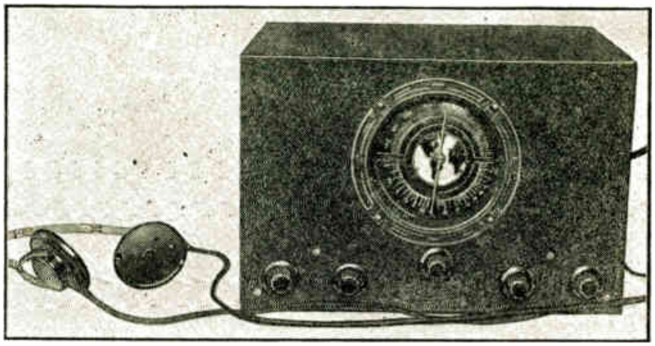
L. W.—Length of winding; All coils wound on 1½" 4-prong ribbed form. Space between grid and tickler ¼".

Remove enough tickler turns from the above standard data, to obtain smooth regeneration.

The five meter coil consists of 7 turns, ½ inch in diameter, tapped at 2nd turns. Space turns to place band in center of dial.

IMPROVED 3-TUBE DOERLE

For Battery Operation



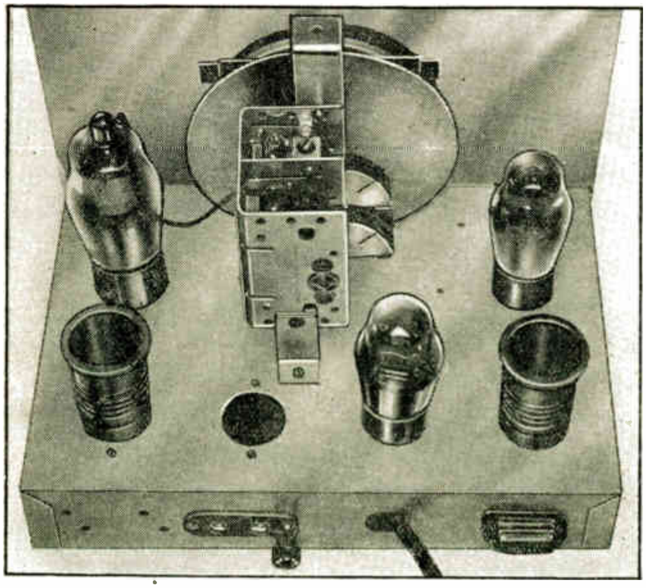
Front view of the 3-tube battery-operated receiver, which gives 4-tube performance.

• WHILE electrified receivers, i. e., receivers operated directly from the A.C. house circuit, have become the standard in performance, there are still many short-wave "fans" who either are not equipped to build and operate an A.C. receiver, or prefer battery-operated sets because of their quiet operation.

With the present-day tubes, a very satisfactory battery-operated receiver can be constructed at an extremely low cost. It can be built in the old breadboard fashion, with remodeled broadcast receiver parts. However, if the results obtained with the modern electrified sets are to be duplicated, the battery-operated receiver should be constructed, with the same high-quality parts and using the conventional A.C. receiver design.

The battery-operated received, or any receiver for that matter, using more than one or two tubes, should, by all means, employ a tuned radio frequency amplifier. This amplifier, while it does not increase the selectivity, does increase the sensitivity tremendously, and allows more efficiency and stable operation of the regenerative detector. The receiver shown in the photographs, and outlined in the accompanying circuit diagram, employs three tubes, although 4-tube performance is obtained. Glancing at the diagram, we find that a type 34 R.F. pentode is used in the T.R.F. stage; inductive coupling is used, to increase gain and stability, between the R.F. stage and the detector. This detector is a type 30 triode.

In the audio portion of the receiver, we have two stages of resistance-capacity coupled amplification; a single 19, which is a twin triode, serves for the two stages. Tremendous amplification is obtained with this tube lineup, and even the weakest stations can be brought in with full earphone volume. The stronger stations will operate a magnetic speaker. However, no power output stage is used, and the best results would be obtained with the use of earphones, rather than a speaker.

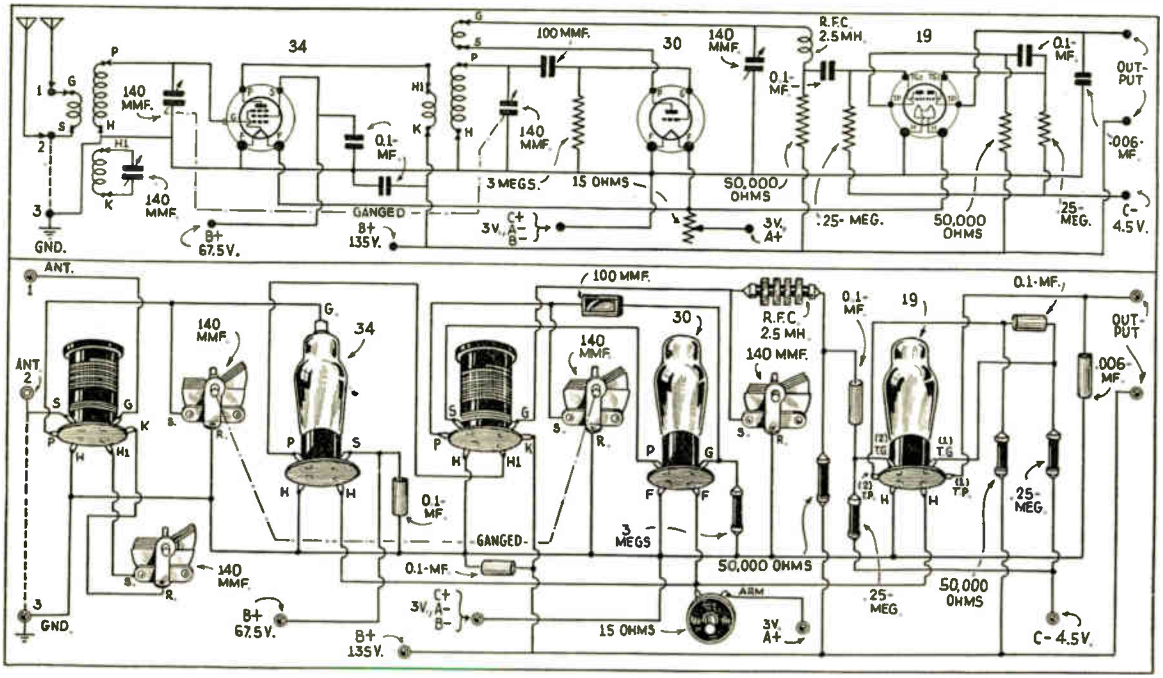


Rear view showing placement of the various parts.

HAS R.F. STAGE

The radio frequency and detector stages are tuned with a two-gang 140 mmf. condenser assembly, allowing single dial tuning. Padding in the R.F. stage is accomplished through the loading effect obtained by adjusting the small condenser connected across the interwound winding of the antenna coil. This is the same winding that is used as primary or R.F. plate coil in the detector circuit. The entire receiver is built on a commercially available, stamped and drilled chassis. This chassis has six tube holes, but only five of them are used.

Looking at the front of the receiver, we see the large airplane type tuning dial in the center. This dial can be of the "dual-ratio" type if band-spread is desired. The small knobs along the bottom of the panel are used as follows: From left to right, on-and-off switch, antenna trimmer, throttle condenser for regeneration control, and filament rheostat. In the rear view, we have the two six prong-3 winding plug-in coils on either side of the chassis. Behind the left-hand plug-in coil is the 34-R.F. amplifier. Behind the right-hand coil, is the regenerative detector; the "19" is between the two plug-in coils. For smoothness in operation, regeneration is controlled through the use of a "throttle" condenser.



This diagram very clearly shows how to wire the improved battery-operated Doerle receiver.

The underneath view of the receiver shows the various resistors and by-pass condensers. Note the absence of transformers. Through the use of resistance coupling, quite a saving is brought about in the cost of construction, and the tone quality is all that could be expected of any good short-wave receiver. The particular chassis used, measurer 10½ inches long, 7 inches deep, and it fits into a cabinet which is finished in black crackle enamel, to match the front panel. Building receivers on metal chassis, and using metal cabinets, not only enhances the appearance of the receiver, but increases the efficiency considerably. It also simplifies tuning because serious body capacity effects are eliminated.

Standard plug-in coils are used. These have three windings, and cover a range from 15 to 200 meters. On the plug-in coils, the small winding at the base of the coil is used as the antenna coupling coil in the RF stage, and as the tickler or feed-back coil in the detector stage. The largest winding is used as the grid coil in both cases. The interwound winding is used in the R.F. stage as the trimming coil, and in the detector stage, as the plate coupling coil of the R.F. stage. In connecting up these coils, remember that the top of the largest winding always connects to the grids. The top of the interwound Winding in the detector coil connects to the plate of the R.F. tube, and the bottom of the tickler winding goes to the plate of the detector tube.

Any antenna having a length approximating 75-feet, or over, will give satisfactory results. The length of the antenna should be considered directly from the receiver to its farthest end. If a doublet is used, the one set of the antenna coil indicated by the dotted line, is not grounded. In other words, the connections marked "1," "2," and "3," are connected as follows: No. 1 to the antenna, and Nos. 2 and 3, shorted, i.e., with an antenna and ground combination. With a doublet, the connection between "2" and "3" is eliminated, and the two leads of the feeders or lead-in's connect to the terminals "1" and "2."

PART LIST FOR "3 TUBES EQUAL 4"

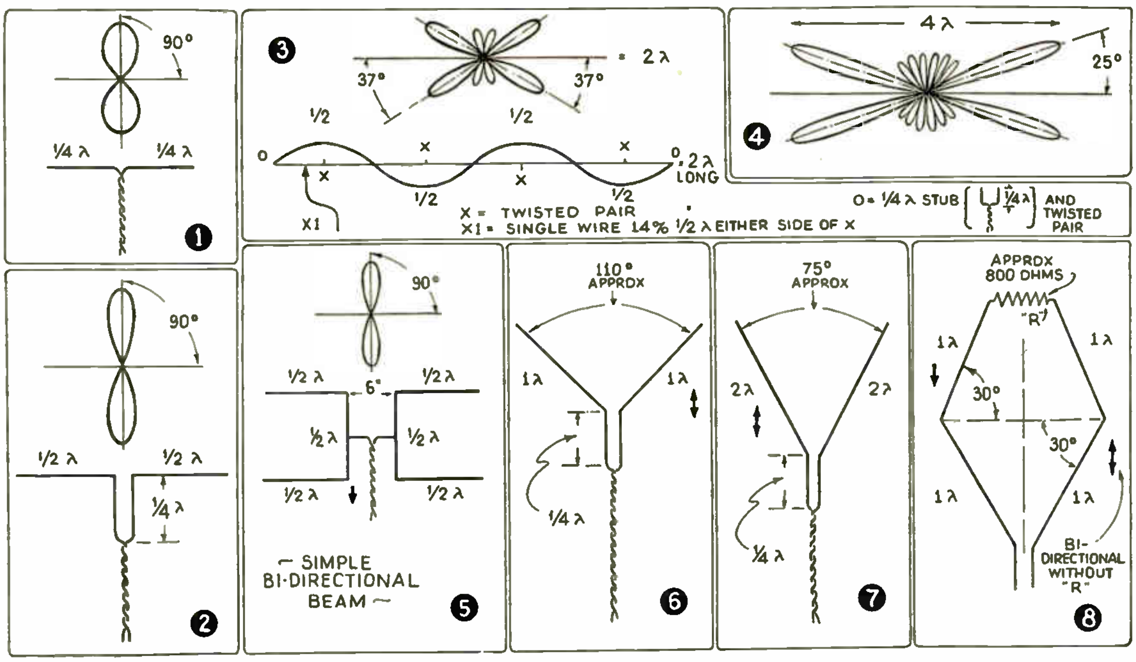
1—2-gang 140 mmf. condensers.
2—140 mmf. variable condensers. Hammarlund.
4—.1 mf. by-pass condensers, Cornell-Dubilier
1—100 mmf. mica condenser, Carnell-Dubilier.
1—.006 mf. mica condenser, Cornell-Dubilier.
1—3 meg. ½ watt resistor, I.R.C.
2—50,000 ohm resistors, ½ watt, I.R.C.
2—250,000 ohm resistors, I.R.C.
1—2.5 mh. R.F. choke, Hammarlund.
2—sets of 4, 6 prong plug-in coils, Na-Ald.
2—4-prong wafer sockets, Na-Ald.
2—6-prong wafer sockets, Na-Ald.
1—15 ohm rheostat.
1—4 inch airplane type dial.
1 metal Chassis and Cabinet.
1—type 34 tube.
1—type 30 tube.
1—type 19 tube.
3—45 volt "B" batteries, Burgess.
2—1½ volt dry cells, Burgess.

SIMPLE DIRECTIONAL ANTENNAS for the S-W Fan

• UNDOUBTEDLY the greatest part of radio as a hobby is in **short-wave listening and DXing,** for with the ever increasing number of short-wave broadcasting stations and the tremendous increase in the number of enthusiastic "fans," listening and DXing has come to win its place in radio the same as the well established group of amateur operators. Like amateur operating, listening and DXing has become an art in which haphazard, haywire and junk receiving equipment has almost completely vanished.

Today, the S-W listener is frequently equipped with communications type short-wave receivers of the latest design and of high sensitivity.

Assuming that no further improvement can easily be made in the receiver itself, the next stage, of course, is the proper choice of the most efficient type of receiving antenna. Of course, the entire discussion can be ended by merely stating that the conventional transmitting type antenna could be employed. However, the listener does not require an antenna constructed in accordance with such rigid specifications, and we proposed to speak in more or less general terms and discuss **simple** receiving antennas which provide tremendous improvement in reception.



Various types of simple "directional" antennas.

TWO IMPORTANT FACTORS FOR RECEIVING AERIAL

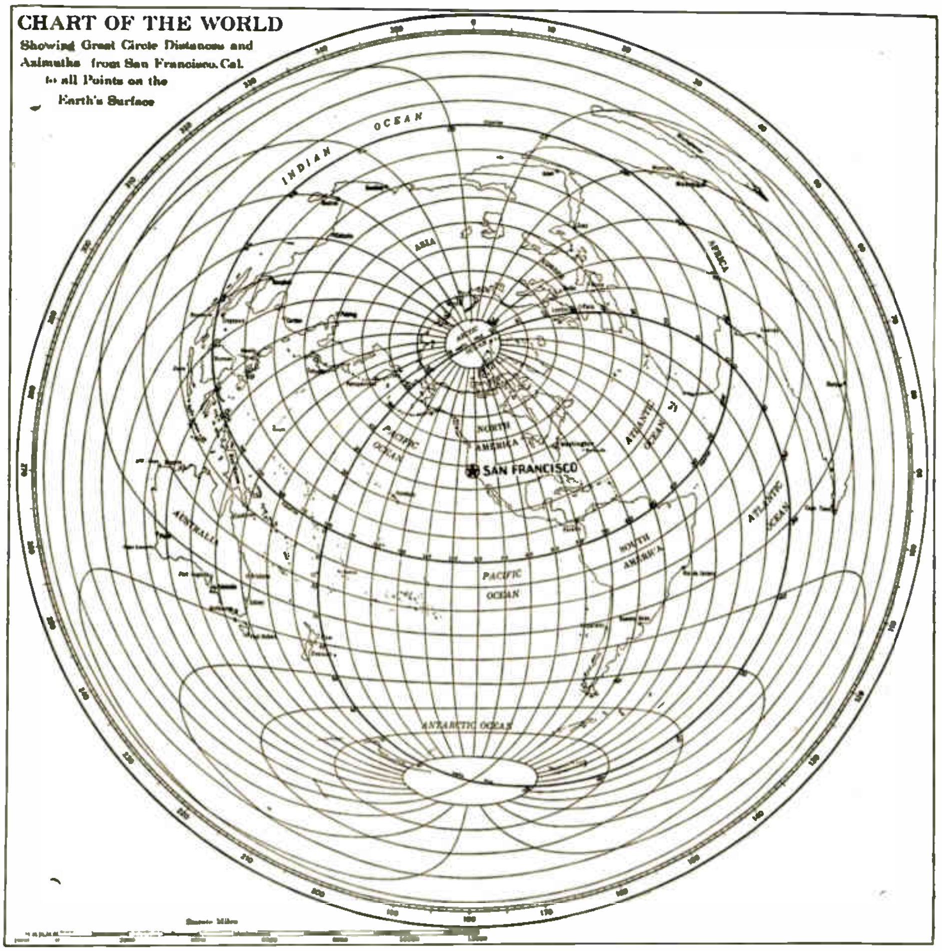
The two most important items that should be considered in the selection of receiving antennas are its **length** and its **directional** qualities, which are very closely related as will be pointed out later.

NO BEST ANTENNA FOR ALL WAVES

First, let us say that there is no **best** all-wave antenna. There are a good many compromises but few of these are any better than a single 75-ft. piece of wire. Whether we desire it or not, every antenna has directional qualities; the vertical antenna, however, is probably the least directional of all, and under ordinary circumstances when absolutely in the clear, it is omni-directional, that is it will receive signals equally as well from all directions. Most vertical antennas, however, are not in the clear and do have directional qualities. It is almost impossible for the listener or "Fan" to measure the directional qualities of an antenna and therefore, he must construct an antenna according to theory and trust that it will somewhat approach the objective.

THE "SIMPLEST" S-W ANTENNA

The simplest of all antennas, of course, is the single



Washington, D. C., published May, 1928 at the Hydrographic Office, under the authority of the SECRETARY OF THE NAVY

IMPROVING "HALF-WAVE" DOUBLET

This half-wave doublet can be improved upon by increasing its length and changing slightly the method of connecting the lead-in. In Fig. 2, we find that the two halves are equal to one-half wavelength each, instead of ¼-wave-length as in Fig. 1, and the total length is a full wave-length. The twisted lead-in is not attached directly to the center of this antenna, but to what is termed a **¼ wave matching stub,** which is nothing more than two wires spaced from 4" to 6" apart and running away from the antenna for a distance of ¼ wave-length. The directional qualities of this antenna are the same as in Fig. 1, except that they are more pronounced and it will have less endwise pick-up. This antenna system is commonly termed 2-½-waves **in phase.** This antenna will also function on a wavelength equal to twice its total length in meters. In other words, this antenna, cut for 19 meter operation, will also function on 38 meters, while the lead-in will then operate approximately the same as the one shown in Fig. 1.

half-wave doublet antenna. This should have a length equal to **one-half the wavelength in meters** of the band in which we wish to receive. In Fig. 1, we see this half-wave antenna with which almost everyone is now thoroughly familiar. It's directions of reception are at right angles to the axis of the wire. By all means, if such an antenna is used, and it is horizontally mounted it should be positioned so that it receives signals best from that portion of the globe in which we are particularly interested. If the broad side of this antenna faces the hard-to-get stations, we will have a much better chance of attaining general coverage, for while the easy-to-get stations are not received so well, the fact that they are easy-to-get will permit them to be received regardless of the position of the wire. It is the very weak stations which we are mostly concerned, or rather we should say, the stations in very remote parts of the world.

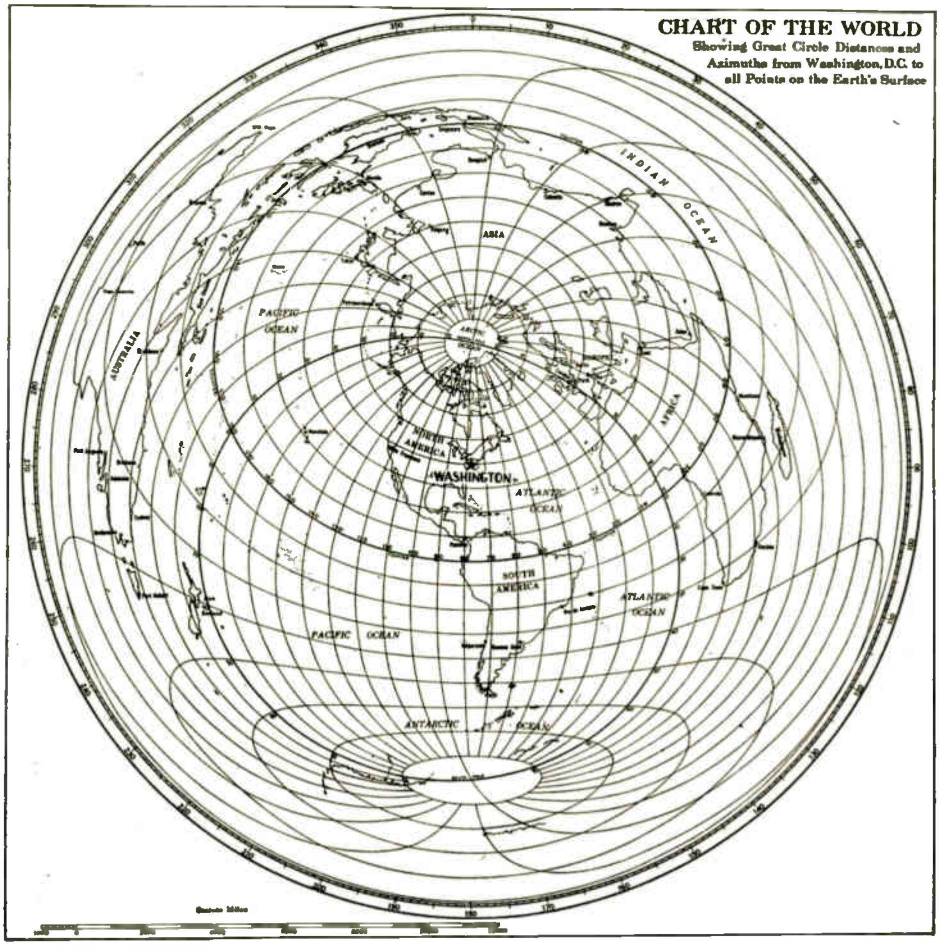
With signals greatly removed from the resonant frequency of this antenna will be received, it should be borne in mind that it will only function properly **at or near its natural wavelength,** which is **twice the length of the antenna. in meters.**

Considering a single wire, the longer it becomes the more directional it is—**endwise!** For instance, a single wire having a length equal to 4 times the wavelength it is operated on, will have a greater number of points of reception more closely associated with the end of the antenna.

4 HALF-WAVE ANTENNA!

In Fig. 3, we observe an antenna which is four half-waves long, or 2 full waves! Here we find there are 4 predominant directions of pick-up, and these form an angle with the axis of the antenna equal to 37 degrees. Such an antenna, of course, requires considerable space for erection, since the wire must run in a straight line. If one is fortunate in having enough space available for this antenna, it can be so positioned that it will receive in 2, 3 or possibly 4 of the directions, in which we are particularly interested.

The method of **feeding** this antenna is shown in the drawing. For instance, the ¼-wave matching section with the twisted pair previously referred to, can be attached to the end points marked "O"; a twisted pair alone may be connected to points marked "X," or a single wire may be attached to a point equal to 14% of a ½-wavelength, at either side of any of the points marked "X." Being able to connect the lead-in, in a number of places greatly facilitates matters, inasmuch as by careful selection of this point, a long lead-in may be eliminated.



By increasing the length of this antenna still further, as in Fig. 4, to 4 wavelengths or 8 ½-wavelengths it has become still more directional endwise. The 4 predominant points of reception are at an angle of 25 degrees with the axis of the wire. The main idea in the construction of such an antenna, as in Fig. 3 and 4, is to have one of these predominant lobes or points of maximum pick-up exactly at the section of the earth from which we wish to receive. Of course, as said before, if we can so position the antenna that 2 or more of them point at some of the hard-to get stations, we are just that much better off.

When we speak of a ½-wavelength we mean that the length of the antenna is equal to ½ the wave length in meters. Its length in feet then will be 468,000 divided by frequency in kilocycles, or 468 divided by the frequency in megacycles. This will give us the number of feet in a half-wavelength. Ordinarily a slight allowance would be made for what is termed end-effects but for general reception purposes that can be totally disregarded, for the listener and DX "Fan" is not willing to confine himself to one particular frequency, but rather one band of frequencies.

In Fig. 5, we have another type of directional antenna, which, of course, requires more effort in construction than the others previously described. It is bi-directional, that is, the pick-up is from 2 directions, these from an angle of 90 degrees with the axis of the antenna, the same as in the case of Fig. 1, and Fig. 2. This antenna consists of six ½-wave sections divided into 2 groups and shaped in the form of a "U," and the 2 "U's" are spaced approximately 6" apart. To the exact center we may connect a twisted pair. This antenna is merely a glorified example of that shown in Fig. 2 and due to its multiple element construction provides further gain, or in other words, exhibits more sensitivity by supplying more signal voltage to the receiver.

THE "V" ANTENNA

Aside from the single straight-wire antenna, the next easiest to construct for directional effects is the "V". We have shown 2 examples of such an antenna in fig. 6, and fig. 7. In fig. 6, the 2 side wires have a total length of 1 wavelength, and form an angle of 110 degrees. This also is used with a quarter-wave matching stub and a twisted pair, the same as shown in fig. 2. If the side wires become longer, the angle of the 2 wires becomes less. For example in fig 7, we have the same type of antenna with side wires 2 wavelengths long, and here the angle is approximately 75 degrees. If one should have sufficient space to construct such an antenna as shown in fig. 6 or 7, but finds for some reason the angle specified cannot be employed, a slight deviation of 5 or 10 degrees either way will not present any difficulty or change the operating characteristics noticeably, for these angles are computed for an antenna in free space and not surrounded by building, trees, etc.

THE "RHOMBIC" AERIAL

An improvement over the "V" antenna is shown in fig. 8. This is the **Rhombic**; these are considerably more difficult to construct and for all general purposes will not serve much better than the "V" antennas shown in fig. 6 and 7. However, the constructional data are given should anyone desire to construct such an affair. With a resistor at the end of this antenna it is **uni-directional.** The arrow on the left indicates the direction of the reception. Without the resistor, reception is bi-directional, the same as with the "V" or doublets.

The height above ground in an antenna of scientific construction would be an important consideration, however, for all general purposes, so long as the height above the earth is at least ½ wavelength, the listener and DXer can be thoroughly satisfied. It is important to keep antennas out in the clear, away from surrounding buildings and trees because these affect its **directional** qualities.

HOW TO "FOCUS" ANTENNA

In determining the position of the antenna in order to obtain best reception, in certain directions, we cannot use the ordinary flat map; either the world globe or a **great-circle** map must be used. When using the globe, the antenna should point the greatest circle around the globe. When employing a great circle map, you may use a straight edge, such as a ruler and merely extend it from the point where the antenna is located, to the point where the station is located, and the degrees east or west of the poles will be indicated around the outer edge of the map. Great circle maps are based on a particular center, for instance, one map may be based on Washington, D. C., as its center, and it will only serve for location near this point. In any event, they only hold true for the point on which they are centered. The best procedure is to use a world globe.

In closing, we might say one word about the previously mentioned **twisted-pair** lead-in. So long as it does not get wet and dirty, ordinary lamp cord will work satisfactorily. However, it is best to use any one of the well-known commercial varieties; Giant Killer Cable for instance, is an excellent form of lead-in.

How To Get Verification Cards

• First of all, write the letter neatly, typewritten or ink, never in pencil! Give the exact local time of reception, as well as Greenwich meridian time, which is figured as follows:

Greenwich time is five hours ahead of Eastern Standard Time; six hours ahead of Central Standard Time; seven hours ahead of Mountain Time; eight hours ahead of Pacific Time, etc. In other words, when it is six o'clock Eastern Standard Time, it is 11 o'clock Greenwich Meridian Time. **Always** give the Greenwich time, because the broadcasters will know that this is the correct time.

Be sure to mention that part of the program which you listen to; if instrumental music, state so; if a talk, do likewise, etc.

Be sure to tell the station manager how much pleasure you received by listening to his station.

Next, ask them to be kind enough to send you a verification card or letter, and don't be peremptory in your demand. Remember, that the station is doing you a favor because they have to answer thousands of such letters, and they are not obliged to do it.

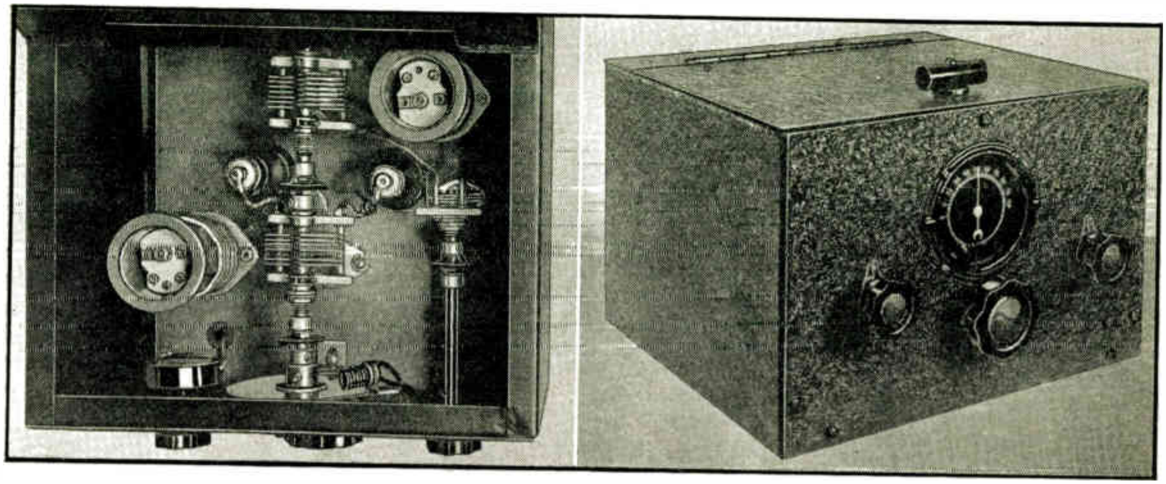
State in the letter that you enclose an **International Postage Reply Coupon.** Never send cash or stamps. The foreign stations cannot use them. The International Postage Reply Coupon costs 9c. You must buy it at your local Post Office; no one else sells it. This coupon is better pinned, not pasted, to your letter.

Print your address at the bottom of the letter, and print the same address on the envelope.

Next—and most important, where most fans fall down is the matter of postage. Letters to Europe, Australia, Asia, Africa and most of the foreign islands go at the rate of 5c, if the letter weighs less than an ounce. If it weighs above this, extra postage must be prepaid. We discourage the use of postal cards, because with the postal card you cannot send the International Money Coupon, and you will find that **only a small percentage of stations will answer your requests, unless the International Postage Reply Coupon is used!** The reason for this, of course, is that stations do not wish to lay out their own postage to send you verifications, while if you send them the International Postage Coupon they feel morally bound to answer your letter for verification.

If you do not have the exact address, most of your letters will reach their destination by just addressing them as per example:

Radio Station XXXYZ, Bangkok, Siam. This, in most cases, is sufficient, as the local post office authorities usually know the station and deliver your letter.



Front and top views of the short-wave "pre-selector."

AN EFFECTIVE S-W PRE-SELECTOR

By RAYMOND P. ADAMS

THE R.F. STAGE

• THE radio-frequency stage in most all-wave receivers tunes rather broadly, in spite of the use of a high C. Both signal and image selectivity suffer, therefore, and especially if the tuned detector circuit is a similarly inefficient discriminator. The image gets through to beat with the high frequency oscillator signal and ride in on the I.F. no matter how efficient the intermediate circuits may in themselves be. Signal gain—and after all it's the business of the R.F. stage to provide such gain—is made poor in effect, and all the more so if the input circuit and tube do not provide proper amplification. Last and certainly not least, over all noise-level is made high.

If there is no R.F. stage then these effects become all the more noticeable.

THAT "FIRST TUBE"

The first tube in any superhet line-up is the one which must, over and above all others, work at full gain efficiency. Noise voltages—caused by thermal agitation and random electron currents are generated within it and appear in both grid and plate circuits, to be amplified by all succeeding circuits, to be amplified by all succeeding tubes and circuits. To these noise voltages are added those brought in via the antenna. And where will the signal be if it is not amplified to every possible degree in this tube? Why, right down deep in the background mud!

THE TUNED R.F. CIRCUITS

In order to provide proper "gain" for the first tube, its own tuned circuit must be effective as a means of discriminating against undesired signals and image. Gain is not entirely unrelated to selectivity. If one tuned circuit will not afford such selectivity, then two, perhaps three are in order. Whether or not additional input circuits use R.F. tubes sometimes doesn't matter—so long as they work to bring a desired signal not only above incoming background noise, but above heterodyne and general interference.

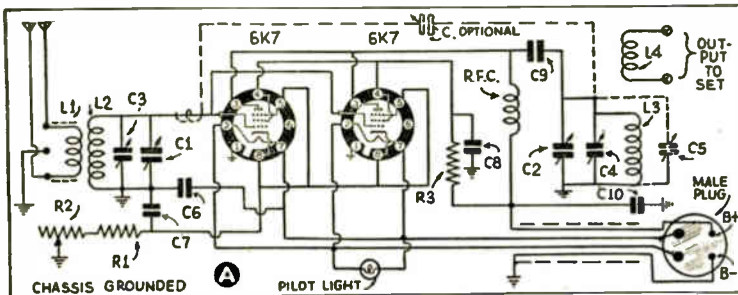
As we have stated, some superhets have no R.F. stage, perhaps no pre-selector circuits whatsoever. Thus their mixer tube is called upon to detect, to mix, and to provide inherent gain sufficient to bring the signal-level well above noise-level. Thus, too, their single-tuned circuit is called upon to afford the desired input selectivity. And it simply can't be done. Image and signal selectivity is not only poor, especially at high frequencies, but first-tube gain becomes entirely inadequate.

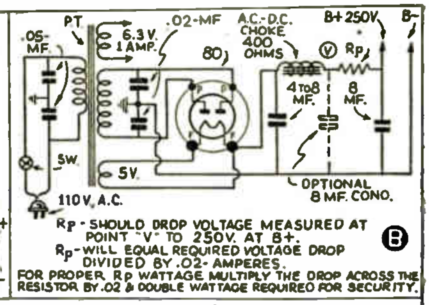
WHY A PRE-SELECTOR?

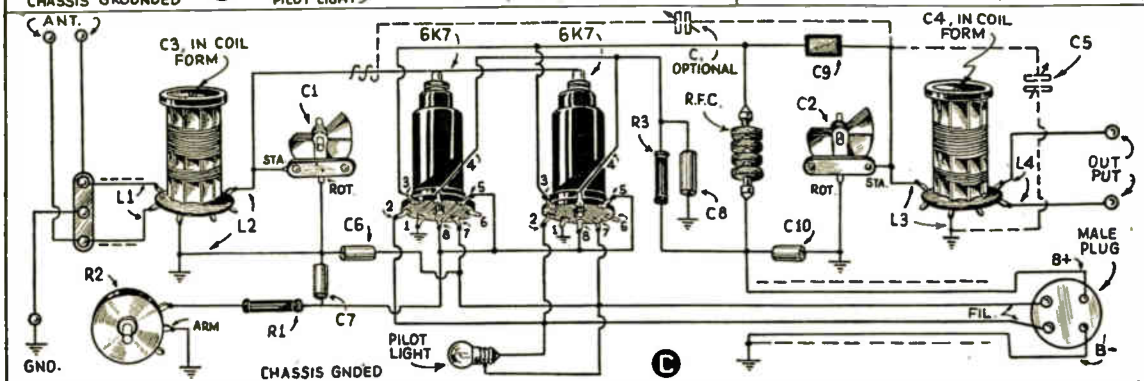
Our last paragraph made it fairly apparent that an R.F. stage is necessary to effective performance in any superhet. No one will argue that a pre-selector isn't really advisable where the receiver is not equipped with such a stage. But is a pre-selector desirable where a receiver is so equipped?

The writer believes that it is, especially where the receiver is of switched coil all-wave construction, or where the instrument is used for serious "DXing" or amateur operation on high frequency bands, or where poor image and signal selectivity and signal-to-noise ratio have been demonstrated. There is no receiver in this man's world, for that matter, which will not perform more effectively when a well engineered, high gain, selective external tuned R.F. stage is added as a refinement. It cannot be too frequently explained that peak receiver adjustments, increased I.F. selectivity, and trick antennas may have much to do with the capturing of that elusive signal—but that a highly selective and efficient R.F. stage is, above all things, most contributive to satisfactory performance.

HOOK-UP AND OTHER DETAILS OF PRE-SELECTOR







COIL DATA AND CONNECTIONS

COVERAGE IN METERS	L1	L2	L3	L4	REFERENCE LETTER
10-25.	3T	5½T.	5½T.	"X"	A
25-50	5 to 8T.	11½T.	11½T	"X"	A
35-100	10T.	20T.	20T.	"X"	B
100-250	10T	50T.	50T	"X"	B

L4 = (X) NUMBER OF TURNS SHOULD BE DETERMINED EXPERIMENTALLY FOR PROPER MATCHING TO THE RECEIVER INPUT CIRCUIT.

A = LENZ ELECTRIC SPECIAL NO. 20 INSULATED R.F. WIRE, CLOSE WOUND OR NO. 22 D.S.C. CLOSE WOUND FOR L1-L4, SPACED 1" FOR L2-L3

B = NO. 24 D.S.C CLOSE WOUND

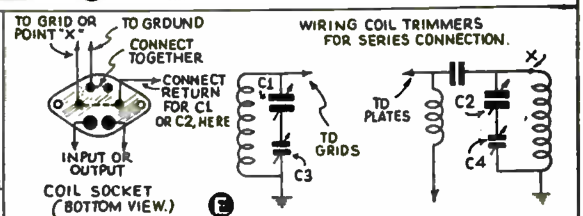
D

NOTE:- ABOVE COVERAGE DATA REFERS TO COILS BUILT ON HAMMARLUND XP-53 FORMS AND WITH INSTALLED TRIMMERS AT MINIMUM CAPACITY SETTING IN PARALLEL CONNECTION. ANY INCREASE IN TRIMMER CAPACITY WILL LOWER HIGH FREQUENCY LIMITS.

COIL SOCKET CONNECTIONS (BOTTOM VIEW)

OK. FOR GRID & PLATE SOCKETS.

WIRE COILS TO FORM TERMINALS TO MATCH

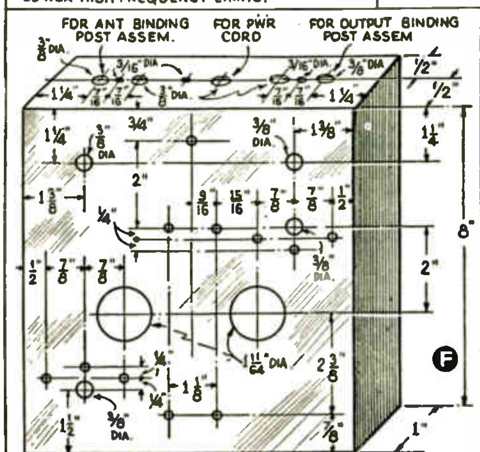


Diagrams for the pre-selector described on the opposite page are given at the top. B in the upper right corner shows hook-up of power-supply. Coil data and connection diagram are given at the left; optional hook-up for coil trimmers in series connection at the right. Chassis and front panel layout diagrams are given below.

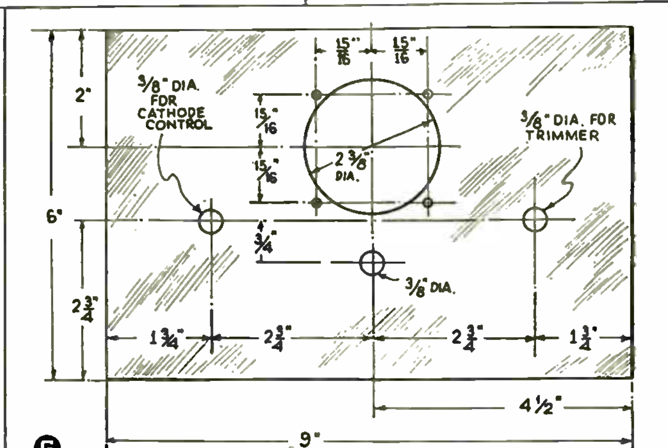
C5 SHOULD BE MADE EXTREMELY SMALL, OR BE DISCARDED.

BOTH L2 AND L3 WINDINGS MUST BE ACCURATELY MATCHED FOR SPOTTING AND ALIGNMENT.

C3 AND C4 SHOULD BE ADJUSTED TO GIVE BOTH DESIRED BANDSPREAD AND PROPER TRACKING.



CHASSIS LAYOUT CHASSIS = 8"x7½"x1"

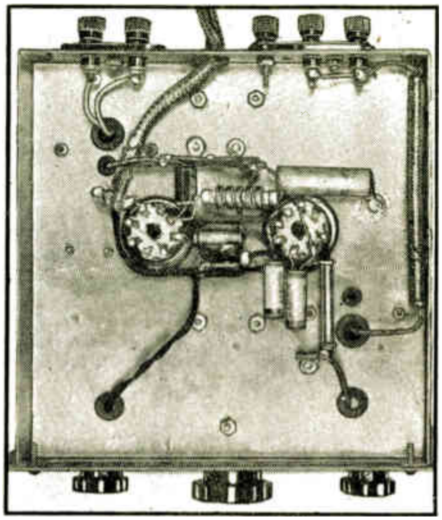


FRONT PANEL LAYOUT (FRONT VIEW)

PRE-SELECTOR REQUIREMENTS

An effective pre-selector should, as it will be largely used at the high frequencies, tune with a comparatively low C, use plug-in coils of high efficiency or a switch-band system having no-loss characteristics, employ steatite or isolantite insulating parts, and be in general designed in keeping with the demonstrated dictates of ultra high frequency constructional practice. It may or may not be **self-powered**, but in any circumstance it should be small, quite inexpensive, and so engineered that no loss in power will be effected in transfering the signal which it selects and amplifies to the input of the receiver.

This design of ours is really quite elementary and simplified—but it non-the-less meets requirements to a "T." It is extremely efficient, provides enormous R.F. signal gain, tunes sharply and cleanly, corrects image and signal selectivity maladjustments in the worst of receivers, and—which is highly important—features a thoroughly sound method of matching its output to the receiver. Powering voltages are obtained from the receiver or a separate "A" and "B" supply, and the coils are of the **plug-in** type.



Bottom view of the pre-selector.

THE CIRCUIT

The circuit is adapted from the familiar **tuned grid-tuned plate** hook-up and requires two sets of coils for each band to be covered. Both coils—that is, both **grid** and **plate** windings—are simultaneously tuned by a "two-gang" .0001 mf. (per section) variable condenser, and peak alignment is facilitated by the adjustment of Hammarlund APC air trimmers installed within the coil forms, and wired so that they be used in parallel or in series with the tuning capacities. (The series arrangement is desirable for full dial scale spreading of limited amateur and short-wave broad-cast bands).

The plate winding does not, it might be noted, carry DC, B plus to the tube plates being fed through a pie-wound short-wave choke.

This sort of scheme works out exceptionally well for pre-selector purposes and is well worth the additional cost of plate coils and the inconvenience of having to remove and replace two forms with each band-change. The tuned plate circuit places a positive load on the tubes, permits really effective amplification, and further facilitates the business of properly matching the instrument into the receiver and without signal loss. With regard to this last, it should be noted that output windings on the plate coil forms may be so adjusted, in number of turns, etc., that an exact match to receiver input coils may be effected. The windings may be made different on different coils and to match different inputs as determined by matters of individual receiver construction.

Some **regeneration** is, of course, desirable, and we have so arranged the placement of parts that the right amount of feedback coupling between plate coil and grid circuit is had without any necessity for a coupling device. Note that the grid cap of one R.F. tube is quite close to the plate winding.

The manually adjustable rheostat in the cathode to ground lead determines both regeneration and general gain. Two tubes, note, are employed in parallel connection, and it is suggested that the pair be used by the builder of a duplicate pre-selector. No difficulties in the way of "peak-loading" are experienced, no especial broadness of tuning is effected, and no noticeable tendency toward instability results when the two tubes are thus employed. As a matter of fact the gain is almost doubled over that for a single tube—as can be at least fairly well shown with the pre-selector in operation, by lifting one grid cap connector from tube contact and noticing the drop in signal level.

As maximum gain and selectivity are more or less dependent upon the exact alignment of grid and plate tuned circuits at a selected frequency, some means for manually peaking these circuits is made desirable. The air-trimmers in the coil-forms do, of course, effect alignment at the high frequency limits, but precise "tracking" calls for an additional trimmer mounted on the panel and bridged across either the grid or plate tuning condensers, exact placement depending upon matters of load as they affect the tuning curves for the two circuits. Some antennas may be such that they load up the grid coil; and here the trimmer might be required across the output circuit in order to compensate for the effect of such a load. Some connections may disturb the output tuning curve, requiring use of the trimmer in the grid circuit. Proper placement will be really a matter of trial and error experiment in individual instances.

CONSTRUCTION

Any small lift-cover cabinet will work out satisfactorily for this design, that used for the laboratory model being a made-up job 9" long and 6" high by 8" deep and provided with a rather shallow (1 inch high) chassis, spot-welded to the removable front panel. As constructional layout data must be referred to some particular chassis and cabinet, however, that used for the lab. model is suggested for exact reproduction by the reader.

The specified dial is small, very efficient, and certainly neat and professional looking, and is mounted on the chassis (for proper line-up with the front panel cutout) by means of its support, one-half inch of which is bent back and bolted down. The two tuning condensers are ganged together with a flexible coupler, and then mounted on stand-off insulators—with five-and ten-cent store fibre washers placed between frames and insulators until with the stand-offs fastened to the chassis the common condenser shaft lines up properly with the dial hub. Another flexible coupling is used to connect shaft and hub together, to facilitate alignment and to isolate the tuned circuit as much as possible from the grounded dial mechanism, whose bearings and wiping parts might cause tuning noises.

The two socket holes are stamped out so that the 6K7 tube grid caps will be really close to the stator terminals on the grid tuning condenser. Sockets as used in the laboratory model are suggested, not only because of their high dielectric efficiency (low power and loss factors) at ultra high frequencies, but because they take up little space and further may be positioned for shortest possible leads to associated components. (These sockets are retainer-ring mounted and will require no riveting or bolting to the chassis.)

Similar sockets mounted in the adapter plates with which they are regularly supplied are used for coil plug-in, and are elevated above the chassis by means of spacers and long machine screws until prong terminals are in the clear. (The resilient concentric retainer rings take on the full strain of repeated coil form insertion and removal and the plates the full strain of chassis mounting. This assures us against any possiblity of socket breakage.)

The gain or regeneration control and the manually adjustable tracking-trimmer are mounted on the front panel, to the right and left of the dial, and a 3-terminal moulded antenna assembly and two terminal output assembly are mounted on the rear wall of the chassis.

WIRING

Little information need be given regarding proper wiring procedure. Simply keep leads as short as conveniently possible—R.F. leads in particular—and use the tie-points where necessary to keep small parts from moving about and making chassis or other contact when they shouldn't. Use physically small by-pass condensers and make every effort to bring all returns to one common ground point.

Coil sockets should be wired as the accompanying diagram indicates. Leads from the antenna input posts to the grid coil socket should be brought across the chassis depth through low-capacity shield-tubing and leads from the plate coil socket to the output posts should be short and direct.

If the cabinet and chassis which we have recommended are used there will be no space on the rear chassis wall for either a power-supply connection plug, or for an alternative four post A and B tie assembly. For that reason it is suggested that four leads (two for filament, one for ground, and one for B plus connection) be brought out the rear and through a low-capacity shield tubing (as shown) for soldering to a male plug. Such a plug should be connected in after the chassis has been installed in the cabinet, by the way, unless an opening is provided in the back of this cabinet large enough to permit the passing through of the plug.

COILS

Coil winding data is given in an accompanying diagram. Both grid and plate coils for a given band may be exactly alike in adjustment and number of primary and secondary turns, in which case they will be interchangeable. However, though the grid and plate windings in themselves must be alike to insure proper tracking and spotting, primary windings may have unlike characteristics if dissimilarity is found advisable because of antenna and output load matters .

LIST OF PARTS AND MATERIALS

Coil Data

L1—Antenna winding on grid form.
L2—Grid winding.
L3—Plate winding—similar to L2.
L4—Output winding on plate form.
(See text for data on above windings.)

Hammarlund

C1 and C2—Type MC100-M variable condensers.
C3 and C4—APC air trimmers, two for each set of coil forms, maximum capacity as required.
C5—HF-15 midget variable.
C—Optional—HF-15 midget variable.
RFC—CH-X midget choke.
2—FC couplings or two ICA 2101 couplings.

Aerovox

C6, C7, C8—Type 284 .05 mfd. tubular condensers.
C9—Type 1467—.001 mfd.
C10—Type 484—.1 mfd.
R1—1 watt resistor—200 ohms.

Resistors

R2—Volume control type.
R3—½ watt 50,000 ohms.
P—6.3 volt dial light and socket (socket to be soldered to panel).
Male plug—Connector.

Other Items Required:

2—Round 8-pin steatite sockets.
2—Round 6-pin steatite sockets, with adapter plates.
1—Three-post antenna assembly (Two posts insulated).
1—Two-post output assembly (Both posts insulated).
2—Nameplate knobs.
1—Nameplate dial.
1—Cabinet and chassis, to layout specifications.

Raytheon

2—6K7 tubes, with isolantite insulation between shells and grid-cap terminals.
50 feet —No. 20 hook-up wire.
2 feet—Low-capacity shield tubing.
2 Stand-off insulators—1⅛" between mounting hole centers.
1—dial, airplane type.

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