How to Build and Operate Short Wave Receivers

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HOW TO BUILD
and
OPERATE
SHORT WAVE
RECEIVERS

Including

Receivers for the Beginners
Short Wave Converters
S-W Superheterodynes
Super - Regenerators
Television Receivers

Published by SHORT WAVE CRAFT
98 Park Place, N. Y. City
1932

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Preface

THE present volume is a combination of a great deal of the best constructional, Short Wave material that has come out during the past year. All of the circuits have been brought up to date, and there will be found here much that is new for the experimenter in short waves.

We have carefully sought to keep the contents up to the title of the book, and you will find that it is 100% "How to Make and Operate." In all instances, we have endeavored to give complete dimensions, coil winding data, etc.; to make certain that anyone of ordinary ingenuity and skill can build a short-wave set from the directions given here.

The authors of the various sets described in this book are all expert in the short wave field and, you may be sure, they know their business.

We intend to bring out, every year a similar volume, to keep abreast of the progress in the short-wave field which, at the present time, is seething with activity. We shall be glad to have your comments on this book, and will always be ready to forward, to the authors of articles herein, letters sent in care of this publication.

HUGO GERNSBACK
Editor, SHORT WAVE CRAFT
TELEVISION NEWS
RADIO-CRAFT

January, 1932

Contents

The "S.W.C." specially designed "short wave" portable in operation in the Editor's office. Works loud speaker on two tubes, battery operated, no plug-in coils, light in weight, and other features.

The "S. W. C." Two Tube PORTABLE

Works "Speaker"

By CLYDE FITCH

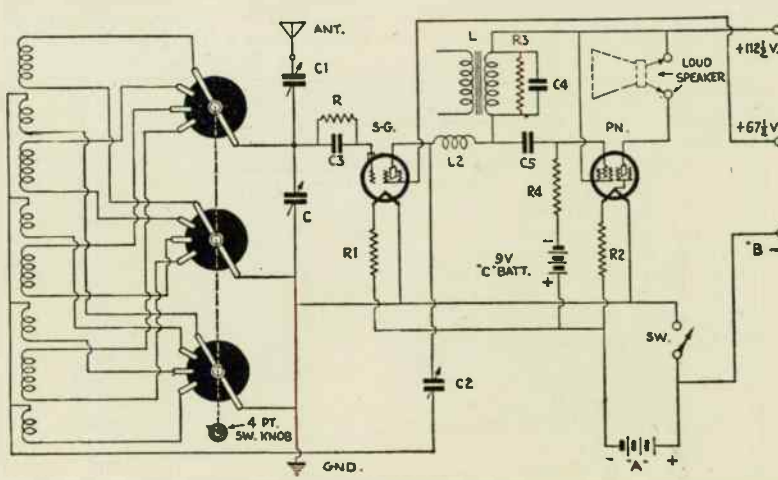
Two tubes, a screen grid and a pentode, working on batteries, give surprising loud-speaker volume on this portable. No plug-in coils are used, but a clever switching scheme instead.

WEIGHING but twelve pounds, and measuring only 6½" by 8½" by 11", this complete, self-contained, battery-type short wave *portable receiver* gave such remarkable results in sensitivity and volume on the short-wave stations, that it amazed all who had the pleasure of operating and listening to it. It seemed incredible that such enormous volume could be obtained from two tubes—a screen-grid type '32 and a pentode type '33—both battery-operated. Tuning from 15 to 250 meters (with the particular short-wave coils employed) it brought in some of the lower-wave broadcast stations with volume comparable to that of many of the best commercial five and six tube sets. This particular combination, fully shown in the circuit diagram, is recommended for all who contemplate building a short-wave receiver—portable or otherwise. It will out-perform many of the best "multi-tubers." Of course, the new dry-cell pentode makes this possible, giving great power in conjunction with the screen-grid's sensitivity.

No Plug-In Coils

Plug-in coils were considered a nuisance in a portable and therefore were eliminated in the design of this receiver; in spite of the fact that they are generally considered to be the most efficient. This point of superiority of the plug-ins is still questionable; many authorities have obtained some remarkable results without them. But the writer will not attempt to settle this question here; it is sufficient to say that, for convenience in handling and operating this set, a switching arrangement is employed—and it has given much better results than were originally anticipated.

The coils are of the Pilot type, only four being employed; the largest or "broadcast" coil of the usual set was not used. Of course, if the constructor desires to tune in the long-wave broadcast stations also, a broadcast (200-550 meter) coil may be substituted for one of the short-wave ones, but there is room for only four coils in this particular carrying case.



Hook-up of "S.W.C." short wave portable.

Chassis and battery compartment of "S.W.C." portable.

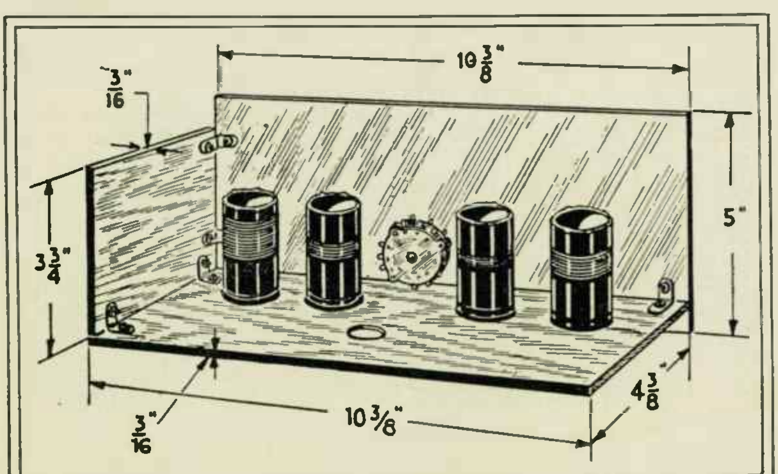
Tuning and control panel of portable short wave set.

The terminals and metal prongs were first detached from the coils; this had the effect of increasing their efficiency, since considerable metal was removed from the field of the coils and the leads were also made much shorter. The four coils are connected into the circuit, one at a time, by means of a "Best" three-pole, four-throw rotary switch.

Power Supply

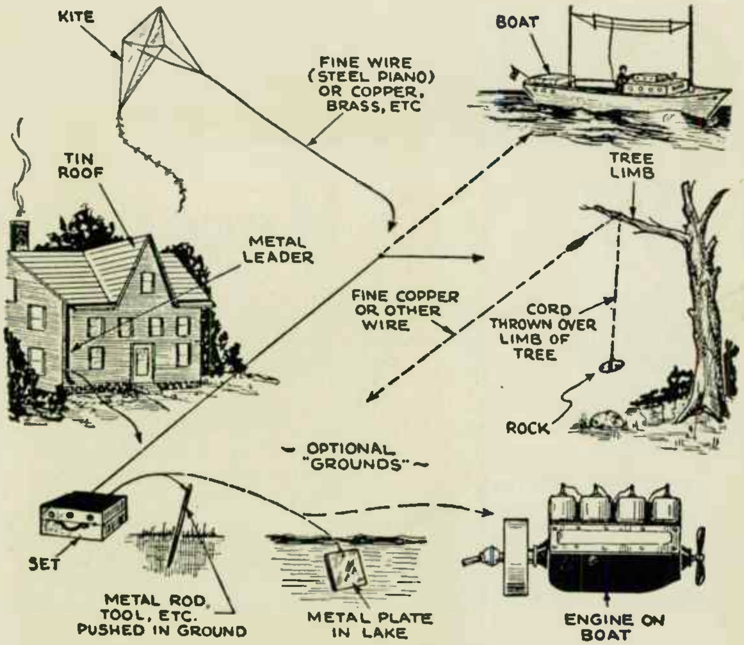
The power supply consists of five of the very smallest 22½ volt "B" batteries for the plate supply and eight large-size flashlight cells for the "A" or filament current. Two 4½-volt flashlight batteries supply the 9-volt "C" bias for the pentode power tube.

The "B" batteries are all connected in series, giving a total of 112½ volts. A tap is taken from the third battery, at 67½ volts, for the detector's screen voltage. The cells of the "A" battery are connected in series-parallel (four cells in parallel and two in series) giving a total of three volts. Since the total current drawn by the two tubes is only 0.32 ampere, the battery will last a long time—sufficient for any vacation needs.



The circuit is conventional. There is nothing new in it, and it has no trick connections. The results obtained are due entirely to correct design and taking full advantage of the amplification factors of the tubes. Fig. 1 gives the complete circuit, except for the batteries. The aerial is connected directly to the grid side of the grid coil, as shown, a small 140 mmf., series condenser, C1, being used. Regeneration is controlled by a throttle condenser, C2, of the same size. The switch and coil connections are clearly shown in the diagram. The tuning condenser, C, is of the Hammarlund midget type and has a capacity of 140 mmf. C4 is a fixed bypass condenser of .00025-mf. capacity. Grid leak and condenser detection is employed, by means of a .00025-mf. grid condenser, C3, and a 2-megohm grid leak, R.

The output of the screen-grid detector is coupled to the input of the pentode by means of an audio-frequency choke, L, shunted by a ¼-megohm resistor, R3. By this method the detector plate current is not limited, as it would be if straight resistance coupling were used; and the use of the shunt resistor flattens the characteristic curve, resulting in better tone quality on the phone stations. An .01-mf. coupling condenser, C5, and



Various forms of antennaa and grounds.

a ½-megohm grid leak, R4, are employed.

Fixed resistors are used in the filament circuits, since they are operated from a 3-volt battery. For the screen-grid tube the resistor R1 has a value of 15 ohms and, for the pentode, R2 has a value of 4 ohms.

Note that the coupling choke, L, is actually the secondary of an audio transformer, the primary of which is not used; it is shown disconnected in the diagram.

L2 is an R.F. choke of 80 millihenries, used for the purpose of obtaining regeneration through the throttle condenser C2.

Constructional Details

The first thing necessary, before construction can be started, is to procure a suitable carrying case; for the parts must fit within the case without too much crowding. It is not necessary to obtain or build a case of the exact size specified, for the parts may be arranged differently to fit some other case. The inside dimensions of the case are 10⅜ x 7½ x 6 inches. It is an "Insuline" case, as used in this company's portable *Companion* receiver, and was found ideal for the purpose because the batteries and other parts just fit, as the reproduced photographs show.

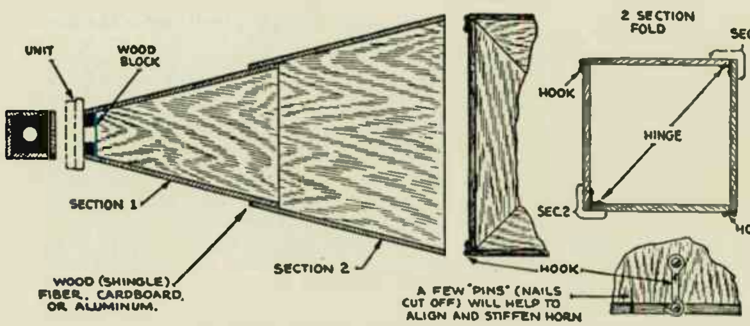
The photographs illustrate practically everything but the coils and switch, as these are concealed by the other apparatus; for this reason, they are shown in detail in one of the illustrations.

Loud Speaker

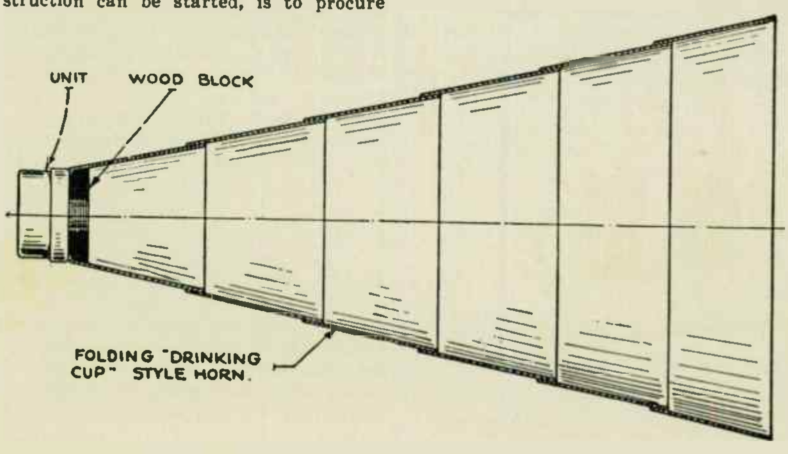
The loud speaker consists of a horn-type unit—one which works well with the pentode. Several different models were tried, and found to vary considerably as regards sensitivity and volume. This is because of the comparatively high impedance of the pentode which demands a load of 7000 to 8000 ohms for best results; a high-impedance unit therefore is desirable.

List of Parts

One *Insuline* "Companion" carrying case;
Four *Pilot* short-wave coils;
One *Best* rotary switch, 3-pole, 4-throw (type 3NS4);
Two *Hammarlund* midget condensers, 140 mmf. C1, C2;



One form of folding horn for loud speaker.



One *Hammarlund* midget condenser, 140 mmf., C;
One *Hammarlund* audio transformer, L;
Two fixed condensers, .00025-mf., C3 and C4;
One fixed condenser, .01-mf., C5;
One radio-frequency choke, 80 millihenries, L2;
One grid leak, 2 megohms, R;
One grid leak, ½-megohm, R4;
One plate resistor, 250,000 ohms, R3;
One filament resistor, 15 ohms, R1;
One filament resistor, 4 ohms, R2;
One filament switch;
Four binding posts;
One UX socket;
One UY socket;
One aluminum panel, 10⅜" by 5"; baseboard and end plate, as shown.

How to Operate a Short Wave Receiver

By ARTHUR J. GREEN
(President of the International Short Wave Club)

Mr. Green knows most of the foreign S-W stations by their "first name" and in this article he tells you how and when to listen in for them. In one month Mr. Green's club members reported hearing 72 "foreign" short-wave stations! In one month 22 new American S-W stations were heard. Are S-W's on the up-and-up? We'll say so!

TUNING a short-wave radio receiver is fast becoming a world favorite indoor sport. It opens a new field of entertainment for those who have an experimental turn of mind and a desire for adventure, but who must curb their desire to what adventure may be found in their own homes. As in most other sports, the results obtained by the short-wave listener depends much on his skill; and, when he has once attained a certain degree of efficiency, he is prone to call in his friends and proudly entertain them with music coming from many miles' distance.

Short-wave work is also instructive. Circumstances surrounding reception on short waves are entirely different than those found in operating a broadcast receiver. Our short-wave sets are not calibrated; stations are continually changing waves and schedules; new stations are going on the air at intervals; reception is world-wide and many different languages are heard; confusing harmonics of local stations are heard; time differences between the station and the listener must be taken into consideration; and, added to all this, short waves are peculiarly affected by light and dark —some being increased in their carrying power by light and others by darkness.

It may be said that there are three different classes interested in short waves Th.e first, and oldest, is the amateur. This group of experimenters in transmission and reception, distributed over the entire globe, comprises two types, the code and the phone man. Code is known to have a far greater carrying power than voice, and it is not in the least uncommon for an amateur on 20 or 40 meters to "work" several continents in a day's time. The phone man is confined to bands on 85 and 150 meters, but may be heard at all hours.

The commercial class, connected with stations transmitting and receiving news reports, business communications, weather and time signals, etc., also comprises two groups, the code and phone classes. For several years the ability of short waves to carry a signal over a long distance has been known, and recently many commercial companies have supplanted high-powered long-wave stations with medium-powered ones on short waves and find them more satisfactory. The phone class includes ships at sea conversing with shore stations and each other, airplanes and airport stations, and commercial telephone service between all parts of the world.

The third and most numerous class is that of the short-wave broadcaster and the short-wave broadcast listener. The quite frequent re-broadcast of overseas stations by our American stations have awakened thousands to the fact that they can receive these and other stations direct. In the tropical and sub-tropical countries, where a high static level is found on long waves, and regular broadcast entertainment has been limited to approximately two months out of a year, listeners have turned to short waves with tremendous interest. Short-wave broadcast stations have been installed in at least fifty of the countries of the world, and short-wave receivers are to be found everywhere.

Times Have Changed—And Sets Improved

The first short-wave receivers were, for the most part, haphazard affairs of poor quality. During this period thousands of listeners, failing in attempts to receive overseas stations, threw up their hands in disgust; and they have ever since been prejudiced against short waves as a medium of entertainment. If these same persons were now to operate modern receivers, with proper instructions, they would be greatly surprised. Short-wave receiver design has advanced rapidly during the past fifteen months, and the new sets are in every way more efficient and easy to tune.

It is also absolutely true that, even with this great advancement, many set owners are not enjoying success in tuning in foreign stations. In many cases, a listener with an old-style receiver is reaching out for stations that his better-equipped neighbor may not be able to hear. The difference lies in the skill of the operator and his knowledge of when and where to tune.

Several writers have attempted to draw up a list of so-called "dependable" short wave stations; they take into consideration the power the station uses and its distance from the U. S. A. Such a list is impractical and useless.

Many times a low-powered station will cover far greater distance than a high-powered one, because the the former has certain characteristics of short waves helping the signal along (viz.: light or darkness effects, atmospheric conditions, less interference, and the waves used being more adapted for distance). Some listeners wonder why reception of certain stations is not to be had all the year round and at any time they happen to be on the air. Such a condition is caused mostly by the effects of light and darkness. In winter, when nights are long and the days are shorter, many stations up above 33 meters may be picked up, though they cannot be heard during the summer months. To the contrary, stations below 25 meters are helped by daylight. A very helpful rule to follow when searching for stations is as follows:

When to Listen on Short Waves

From 14 to 20 meters, tune for stations from any direction from daybreak until about 4 p. m. After that, darkness effects take away the carrying power of these waves.

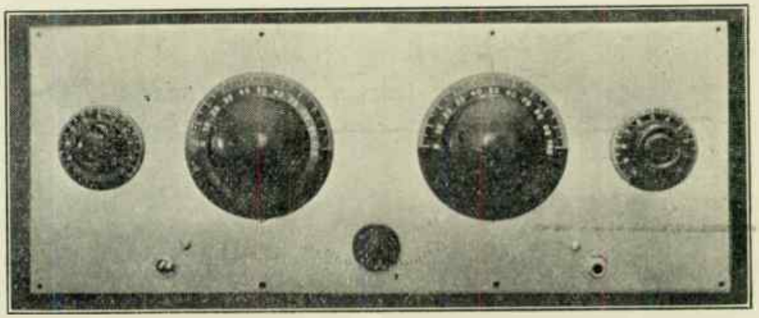
From 20 to 33 meters, stations in Europe can be heard from noon till about 10 p. m., reaching a peak of efficiency about three and keeping it until eight p. m. Stations to the west in this band are heard best from 10 p. m. until approximately two hours after daybreak.

From 33 to 70 meters, darkness is needed to give carrying power from any direction. This statement applies to distant stations only, for many "locals" and amateurs may be picked up at all hours. Above 70 meters there is little or nothing to be heard in the way of distant stations.

2 VOLT TUBE RECEIVER

By JOHN CARTER

DURING the past two years it has become more and more evident that the popularity of the short-wave receiver is gaining in its stride; and, probably in the near future, it will outdo the present broadcast receiver for popularity. While it is admitted that short-wave receivers are in the experimental stage and that the multi-stage short-wave receiver does not give the same gain per radio-frequency stage as the broadcast receiver, nevertheless we are past the one-tube "blooper" day; since sensitivity with selectivity is impossible of obtainment without a tuned circuit ahead of the detector.



Front view of short-wave receiver especially designed by the author for use with the new two-volt, battery type tubes.

With this thought in mind, the circuit shown in Fig. 1 was designed for amateurs who want a receiver which is more sensitive than most short-wave receivers and yet uses only three tubes. The success or failure of this circuit depends upon using high quality parts and components, for the filament voltage cannot be raised to force the tubes. Apparatus having very low losses should be used; shielding is absolutely essential, but its shielding must be large and thick enough to introduce no losses.

Why I Like Batteries

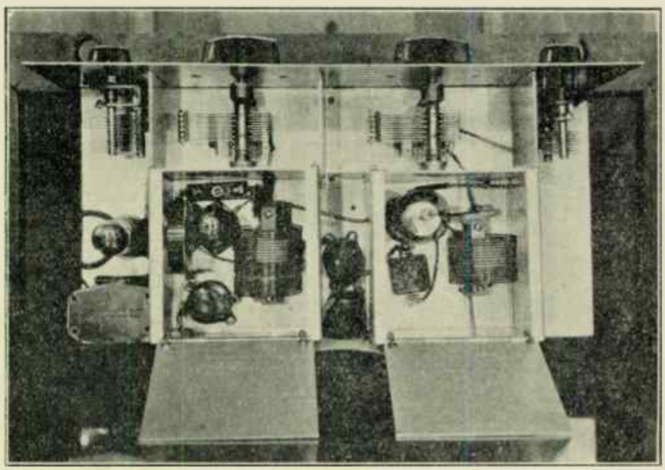
The two most important factors governing performance of a short-wave receiver are tubes and high-quality parts. It is rather difficult (almost impossible) to say whether A.C. or battery tubes are the best; as both have their good features. The A.C. tubes have more rugged filaments and better amplification qualities, also without the bother of troublesome batteries; but extraneous noises from the power-supply line frequently make distant reception impracticable and, sometimes, it is virtually impossible to eliminate these noises. The advent of the new two-volt battery tubes, however, does away with the difficulties experienced with A.C. tubes and their older brothers, the five-volt tubes, and simplifies everything.

The type '32 is ideally suited for the radio-frequency stage, having an amplification factor of 580; while its control-grid-to-plate capacity is only 0.020 mmf. This high amplification factor and low capacitance make possible a high voltage gain in this stage. In preliminary experiments the screen-grid tube was also used as a detector, but it proved very microphonic when coupled to a transformer stage of audio; which is quite objectionable, especially when trying to tune in distant stations. To eliminate these noises the transformer of the audio stage was changed to one of resistance coupling, but there was a noticeable drop in volume.

Since only one stage of audio amplification is used, a type '30 tube was substituted for the '32 in the detector stage; and great improvement, both in gain and quality, was noticed. A '30 is also used in the audio stage.

Filament and Biasing Voltages

All radio tubes (and especially the two-volt type with their finer filaments) are delicate precision instruments and should be handled accordingly. Over-voltage on any tube lowers the efficiency and length of life. A voltage of 2.5 volts applied to one of the new tubes overloads the tube 25% and impairs its life of usefulness; it is also apt to burn out the filament. The permissible voltage range for operating these tubes efficiently is from 1.8 volts to 2.2 volts.



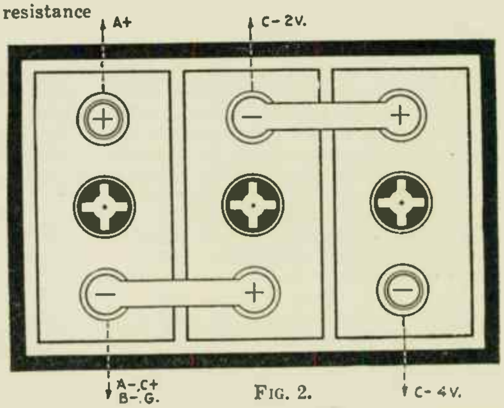


FIG. 2.

Diagram above shows how the author provides "A" current at 2 volts, also "C" voltages of 2 and 4 volts from standard, six-volt storage battery.

Left: Top view of two-volt, short-wave receiver with lids of shield boxes open.

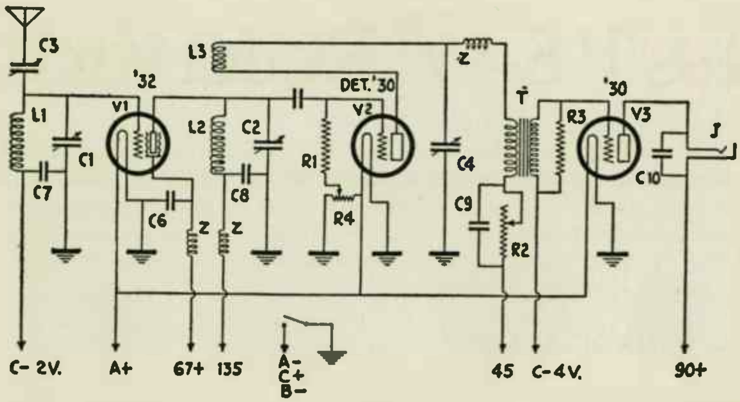


FIG. 1.

Wiring diagram for the two-volt, three-tube, short-wave receiver is shown above, and includes one shield grid R.F. stage, ahead of regenerative detector.

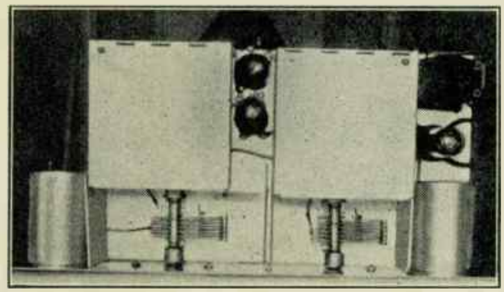
The usual method for controlling filament voltage is with a fixed resistor and a variable rheostat for critical adjustment, but without a voltmeter this is purely guesswork. To overcome this difficulty, and gain an advantage, the method of using a single storage cell has been adopted; this eliminates the use of all rheostats and resistors.

How Bias Current Is Obtained

The total current consumed by the filaments in this circuit is 0.18-ampere. Since a 6-volt storage battery is almost universally used, and only two volts are required for the filaments, we utilize the remaining 4 volts to obtain "C" bias in a novel way without resistors. The connections taken from the "A" battery are as follows (see Fig. 2); the highest positive lead is run to "A+" on the set. The negative terminal of the first cell connects to the "A—," "C+", and the ground connection of the set. The negative terminal of No. 2 cell provides the *"C" bias* for the radio-frequency tube; and the negative terminal of No. 3 cell supplies the *"C bias"* for the audio tube.

Trickle Charge Keeps Battery Up

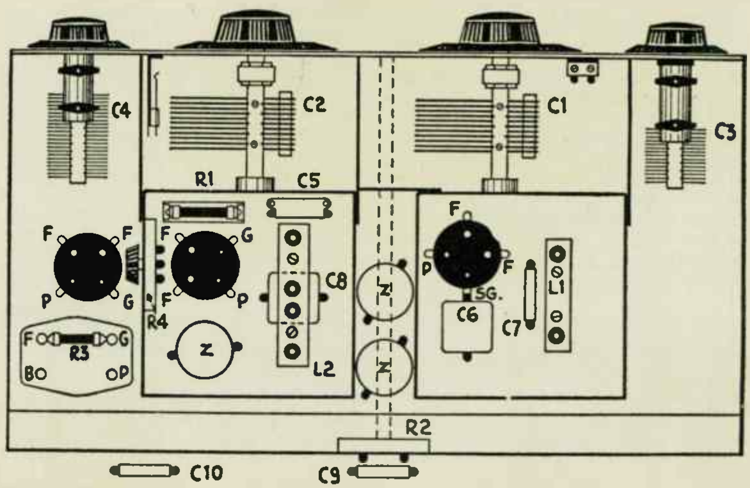
The load drain on a 100-ampere-hour storage battery is very small. The cell supplying the filament current has a drain of 0.18-ampere, and the two remaining cells used for the "C bias" supply only a few microamperes. Though the current drain is unequal, as regards one cell, it is compensated for by the internal losses produced by the inactivity of the other two cells. A battery lying idle loses about .08-amperes (or 1.92 ampere hours per day) and the current taken by this receiver if used 10 hours a day, amount to 1.8 ampere hours. A trickle-charge rate of about half an ampere, five hours a day, will always keep the battery fully charged. In using this method it is impossible to overload the filaments; since the voltage of a single cell, when discharging, never exceeds 2.2, and a cell of 100-ampere-hour capacity, in fairly good condition, will deliver a voltage of two volts at this discharge rate for a period of about three weeks without any charge.



Another view of the two-volt, three-tube receiver, showing shields over the midget condensers.

Layout of the principal parts of Mr. Carter's receiver is given below.

FIG. 3.



The circuit comprises a stage of radio-frequency amplification; a detector regenerative by means of the tickler or feed-back coil; and one stage of audio amplification, transformer coupled. Each circuit is completely shielded from the others. A very usual circuit; but the outstanding efficiency and sensitivity are due to the careful design and the use of modern parts, with their very low losses, which manufacturers have recently succeeded in developing. There is also a liberal use of chokes and condensers, each and every one an requisite

Of the capacities shown (Fig. 1) C6 is the usual by-pass condenser in the screen-grid lead; C7 is used to ground coil L1 and prevent short-circuiting the "A" battery; C8 is used as a blocking condenser; C9 is shunted across the rheostat in the detector plate lead and C10 across the headphones. Chokes (Z, Z) are used in the plate and screen-grid leads of the radio-frequency stage and the detector plate.

The detector's grid return connects to the arm of a 400-ohm potentiometer which is shunted across the filaments; this is well worthy of inclusion, as it aids greatly in securing selectivity—a very important factor in a short-wave receiver. A 100,000-ohm rheostat, R2, in series with the detector plate lead, controls the plate potential; it is mounted on a bakelite strip at the rear of the set and, by using an extension rod, is connected to the knob in the center of the panel.

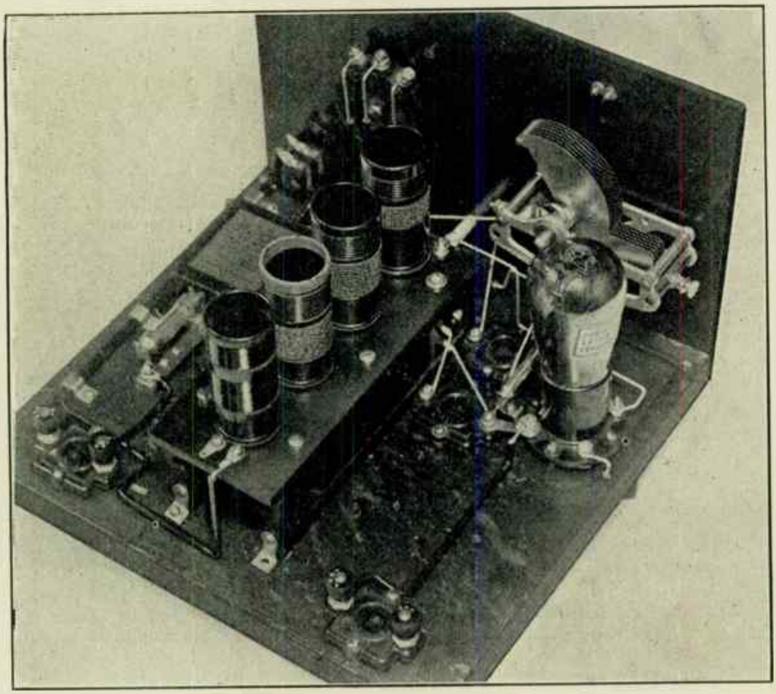
Condensers *C*1 and *C*2 are of 125 mmf. capacity, very ruggedly constructed, with extra wide spacing between the plates. When they are used with properly-designed space-wound coils (three inches in diameter) there is a maximum of inductance and relatively small capacity.

(Continued on page 70)

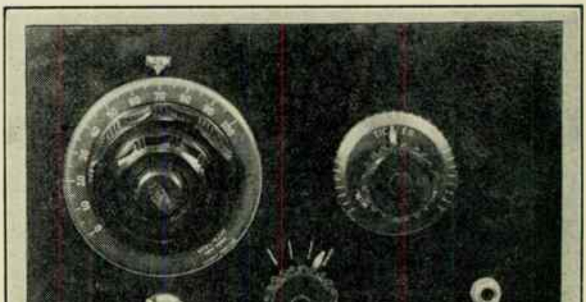
A "Plug-Less" S-W· Receiver

Mr. Avery, well-known radio engineer and author, here describes for our readers his latest brain-child—a "plug-less" short-wave receiver which uses switches to change from one wave-band coil to another. BUT none of the coils are idle, as the coils not in use are "put to work," thanks to the genius of Mr. Avery, and those not utilized for tuning serve as R.F. chokes. This set was built and tested very satisfactorily on both code and phone and showed excellent selectivity as well as fine pick-up range, with no dead spots.

By JOHN M. AVERY



Rear view of the Avery "Plug-Less" short-wave receiver, using special bi-pole switch to change inductances.



Front view—"tuning" dial at left; "regeneration" control at right; "inductance" switch knob at bottom.

EVERY radio experimenter of a few years' experience can recall when "plug-in" inductance coils seemed to be the only available method of efficiency tuning over the regular telegraph waveband (then 200 to 20,000 meters); the "plug-in" coils of that time taking the form of "honeycombs", "duo-laterals", etc.

There is as distinct a contrast between the old method of long-wave reception, utilizing a "table full of honeycombs", and a modern commercial all-wave receiver, as lies between the use of many plug-in coils for short waves and any method enabling the tuning of the whole short-wave spectrum without "opening the cabinet". In the writer's belief, perfection of methods to eliminate that nuisance will as surely cause the popularity of the "plug-in" method for short-wave reception to wane.

While it is true that there have been several coil-changing ideas presented in the immediate past, they nearly all present the same drawbacks; complicated, revolving-coil mechanisms with multi-contact switches or brushes; very large space required for installation; or use of parts not readily available to the average constructor. This last, is in my belief, the most serious; as but comparatively few have the facilities to make the special mechanical parts usually required.

No Idle Coils In This Receiver!

The inductance-changing method here presented is readily adaptable to practically all short-wave circuits, whether regenerative, radio-frequency amplifier or superheterodyne; it utilizes simple positive-contact switches for its operation. A most important feature of this method of changing the coils in use is that no coils are idle in the set, acting as energy-wasters. For any given wavelength, the *unused* coils are connected in series, and *add to the circuit's efficiency by acting as radio-frequency chokes.*

In order to make this action quite clear, an elementary fundamental circuit diagram is shown in Fig. 1.

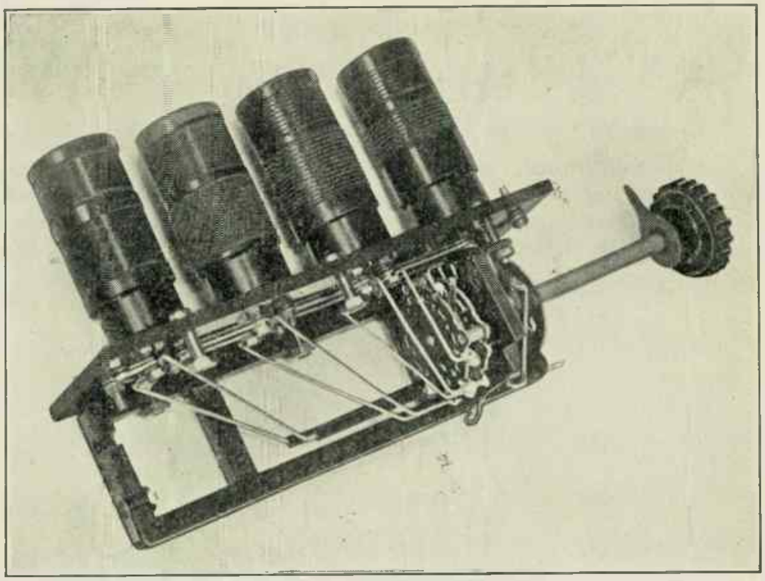
For sake of clarity, but two inductance changes are shown in this diagram; and the circuit is that of the simplest regenerative-detector type, coupled to the antenna through a midget condenser "C-5".

"A-1, A-2", are the two windings of the lowest waveband, while "B-1, B-2" are those of the next higher waveband. "S-1" and "S-2" are ordinary inductance switches, preferably with very low capacity between the points "X" and "Y". An examination of the diagram shows, then, that if the inductance switch "S-1" be placed on point "X", only the coil winding of the shortest waveband is in the plate feed-back or tickler circuit. The R.F. energy finds a path of but a fraction of an ohm's resistance, through condenser C-2 of .01-mf. capacity, to the filament circuit. Coil winding "B-1" has become a radio-frequency choke coil, preventing an escape of R.F. energy over into the phones or audio amplifier. Similarly, with switch "S-2" on its contact "X", only coil "A-2" is in the grid tuning circuit; the grid tuning condenser being placed directly across it, and a low-resistance path provided to the filament through the fixed condenser C-1. This condenser may take any value from about .01-mf., up.

It can readily be seen, that if three or four waveband changes are provided for, efficiency does not decrease; since the unused coils are drafted into active service.

Should a radio-frequency amplifier stage be used ahead of the detector, which is common practice at the present time, then the unused coils in the grid circuit perform the same function as chokes, in what then becomes the R.F. amplifier tube's plate lead. It is understood that the R.F. amplifier tube's plate would be connected to the same point in the circuit where midget condenser C-5 connects in this simple diagram, for a series plate feed, and that the R.F. amplifier's "B" potential would be applied at point "Y".

The dotted line in Fig. 1, between point "Y" and the filament, represents a connection that should be made if no R.F. amplifier is used; in order that the unused coils shall not be left on open circuit, where energy might be absorbed.



Side view of short-wave coil shelf, and double-pole switch with its extension handle.

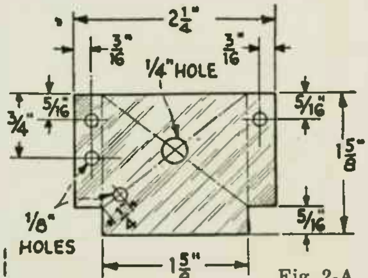


Fig. 2-A.

Fig. 2-A — Switch support member of insulating material.

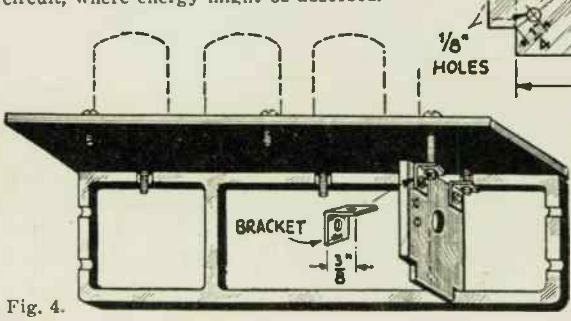


Fig. 4.

Fig. 4—Side view of coil shelf with one of the brackets and switch support.

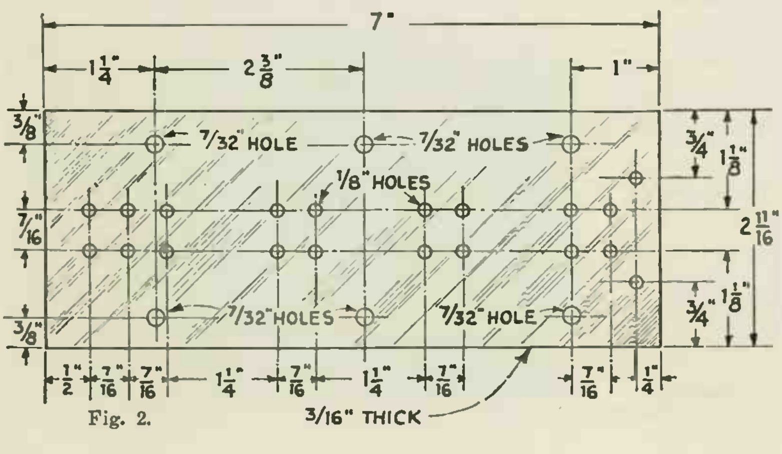


Fig. 2.

From the above it can readily be seen that, using the principle outlined, any type of short-wave receiver may be assembled, covering a wide range of frequencies, without resort to manually-interchanged plug-in coils.

Any Standard Plug-In Coils Adaptable

In order to make the new feature available to the greatest number of short-wave enthusiasts, the author has designed the inductance unit shown in the photograph, which can be easily incorporated in any receiver. Regular plug-in coils are used in this unit (which here happened to be the four-prong "Dresner" make) although regular "tube-base" or even five-prong coils can be used. Sockets are provided for each coil; so that the total frequency range of the receiver may be changed at will.

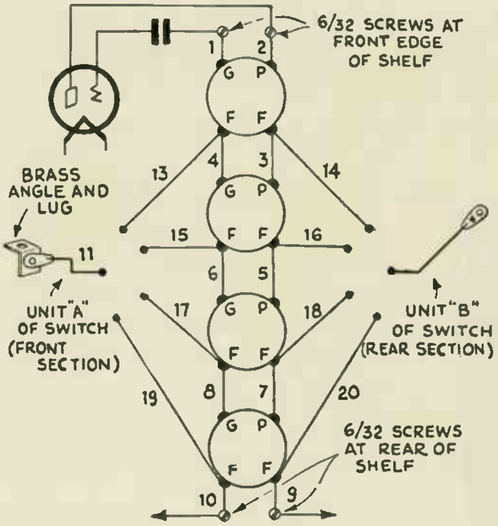


Fig. 3 — Diagram showing wiring of inductance change switches and coil sockets.

LIST OF PARTS

- *One Socket-mounting shelf, drilled as per sketch;*
- *One Switch supporting panel, as per sketch;*
- *Four Pilot No. 214 sockets;*
- *Two bakelite brackets, No. 34, two inches high;*
- *One "Dual" four-point switch. (That made by Best Mfg. Co., Irvington, N. J., was used by the author);*
- *Two ½-inch brass angles;*
- *One Pilot flexible insulated coupling;*
- *Six 8-32 R.H. brass machine-screws and nuts, ¾-inch long;*
- *Four 6-32 R.H. brass machine-screws with nuts, ½-inch long;*
- *Three 6-32 F.H. brass machine-screws with nuts, ½-inch long;*
- *One set of plug-in or other S.W. coils to cover bands desired;*
- *One tube (to suit experimenter's ideas; the author used a '71-A as a detector with very good results).*
- *A few feet of hard-drawn round bus-wire; a few inches of varnished cambric sleeve; 2 doz. lock-washers to fit 6-32 screws; and a few soldering lugs.*

Making the Coil and Switch Support

Only two specially cut and drilled pieces of insulating material are required. (See Fig. 2 for dimensions and drilling lay-out.) Bakelite is probably the most acceptable material from which to make these two pieces, because of its strength; although hard rubber, Insuline, etc., are materials more easily worked in the home shop.

Two "I.C.A." two-inch bakelite (Cat. No. 34) sub-panel brackets form the framework around which the unit pictured is assembled. The socket shelf is bolted to these brackets with 8-32 brass machine-screws. If the socket panel has been drilled to the dimensions shown, it will be found, upon assembly, that one end of it will be flush with one end of the bakelite brackets; the other end projecting over about one-fourth inch.

For sake of clarity in describing the assembly from this point on, the "flush" end will be called the "front" end; since in a completed receiver it is the end which is nearest the front panel, and the end to which the grid and plate leads connect.

Assemble the four Pilot four-prong No. 214 sockets in the holes provided; arranging them so that the "G" and "P" terminals are toward the front end of the panel or shelf. Two ½-inch 6-32 R.H. machine-screws are placed in the two holes at the very front edge of this sub-panel.

How to Wire the Set

Using fairly hard-drawn round bus-wire, make two small jumpers or connectors, connecting the two 6-32 screws with the nearest "G" and "P" terminals. In the switch wiring diagram these are connections "1" and "2".

Neatness in making every connection in this unit is of prime importance "Make haste slowly" is sound advice. Learn to make perfectly round loops at the end of each of the bus-wire connections, and see that the distance between the loops exactly matches the distance to be bridged, resulting in neat, firm connections.

Connect the "F" terminals of the first socket to the "G" and "P" terminals of its neighboring socket; and so on through the series of four sockets, terminating the series with two short jumpers to the two ½-inch 6-32 machine-screws placed in the two holes at the rear end of the socket shelf. These are connections "3" to "10" inclusive.

Mounting the Switch

Assemble the Best twin four-point switch on the small insulating panel, so that the connecting lugs of the switch will face down or away from the socket shelf after assembly. Two ⅜-inch flat-head 6-32 screws are used to mount two ½-inch brass angles to the switch panel; and a third ⅜-inch flat-head screw is placed in the vacant hole immediately below the left angle, secured with a small hex nut, with a soldering lug under its head.

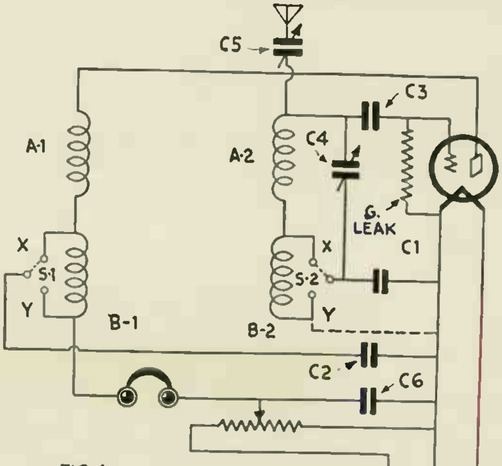


FIG. 1

Fig. 1 — Schematic wiring diagram of the Avery "Plug-Less" short-wave receiver.

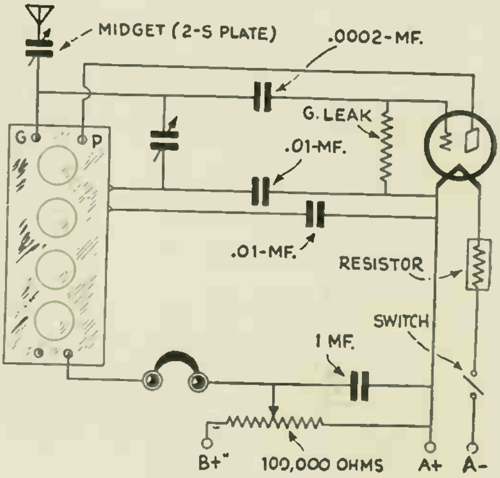


Fig. 5—Wiring external to the short-wave coil panel is shown above.

The SHORT

By BERYL BAKER BRYANT

This "Junk Box" short wave receiver is a compact little job and well suited to the average experimenter's pocketbook. It utilizes one '22 screen grid tube and two '99 tubes:

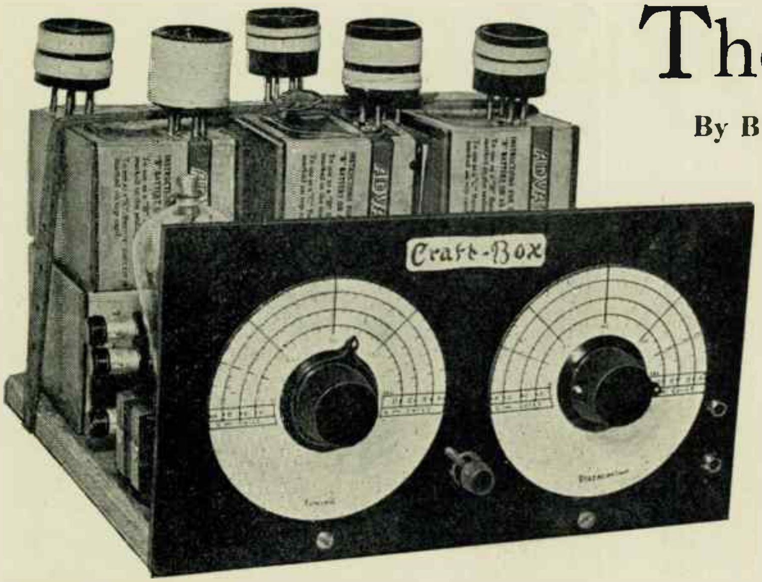


Fig. A. Front view of "The Short Wave Screen-Grid Craft Box."

THE unusual development of radio over a brief span of time has left the "junk-box," or drawer, of many radio experimenters well filled with obsolete parts which can no longer be used with any degree of satisfaction in a modern broadcast receiver. These parts have become obsolete not because of their lack of efficiency, but because of the alteration of broadcast conditions.

The vogue of short-wave code and broadcast transmission offers a purpose wherefore the experimenter or short-wave enthusiast may resurrect many of the parts he had relegated to his own private junk heap. With care of design and construction a short-wave receiver may be fashioned that will equal the performance and appearance of apparatus constructed of specially-designed and costly parts.

Junk-Box Craft

With this purpose in mind the author set about to design and construct a real short-wave receiver. The old junk box was fished out of the closet and its contents dumped on the floor. (A word of advice, place papers on the floor first; as this will preserve peace of mind later.) After a few minutes spent in selection of parts that might be used, the following were chosen:

2 seven-plate midget variable condensers, 32-mmf. capacity, with knobs, *C*1, *C*2 (formerly used as compensating condensers in a broadcast receiver).

4 UX-type sockets. (Not necessary that they match.)

1 unmounted A. F. transformer, vintage of 1922. (Although any of recent manufacture might work better) (*TR*).

85-millihenry R. F. choke. (There was some doubt as to the probable efficiency but, in any event, it proved without "dead spots"; as regeneration was obtained over all the short-wave bands. The inductance need not be as great as that used, but may be as low as five or ten millihenrys.)

1 battery or filament switch (*S.W.*).

2 mica fixed condensers, .006-mf. (*C*4, *C*5).

1 mica fixed condenser, .0001-mf. (*C*6).

2 grid-leak mountings.

1 grid leak, 2-megohm (*R*1).

1 grid leak, 5- or 6-megohm (*R*4)

3 binding posts.

2 cord-tip jacks (*J*).

1 filament resistor, 15-ohm wire, tapped at 5 ohms to provide grid bias for the '22 R. F. tube (*R*2, *R*3).

1 resistor, 10-ohm wire, for the '99 filaments (*R*5).

5 old tube bases, to be used for coils.

No. 28 D.C.C. magnet wire, ¼ pound, to be used for coils.

1 wooden baseboard, 10 inches long, 9 inches wide, and ½-inch thick.

1 hard-rubber (or bakelite) panel, 10

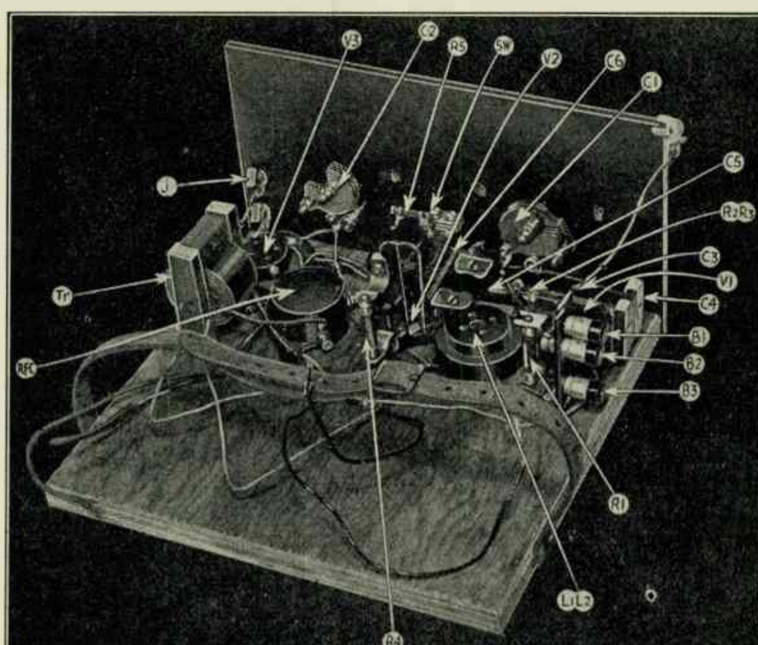


Fig. B. Rear view of the "Craft Box." All the parts, few in number, are easily seen. What parts would YOU use?

WAVE SCREEN GRID *CRAFT BOX*

inches long, 7 inches wide by 3/16-inch thick.
1 '22 screen-grid tube (*V1*).
2 '99 tubes (*V2*, *V3*).
5 small "B" batteries, 22½-volt portable.
2 "C" batteries, 4½-volt, for filament supply.
Hook-up wire, wood screws and other necessary hardware.

After the parts have been selected the constructor should carefully clean, inspect and tighten all parts as well as test the various parts for shorts or open circuits. Denatured alcohol and ether mixed in equal parts will remove dirt, oil or grease, when applied judiciously with a small, stiff bristle brush.

The Short-Wave Circuit

Inspection of the circuit diagram will show the circuit used for this short-wave receiver to be the same old standby—a single circuit regenerative detector preceded by a screen-grid R. F. stage, and followed by a conventional transformer-coupled A. F. stage. In regard to the latter, it was not deemed necessary to use two stages of A. F., as phones would be employed, and for this purpose sufficient volume would be obtained with one. The grid circuit of the R. F. stage is untuned, having a 2-megohm grid leak (*R1*) connected from the control grid cap to the bias tap on the series filament resistor (*R2*-*R3*); the grid leak serves only as a means of blocking the R. F. from the ground circuit, forcing the signal to be impressed on the control grid, while providing a means of applying the 1½-volt "C" bias to the control grid. (Otherwise, a negative charge would accumulate on the control grid, causing the tube to block.) The antenna may be coupled direct or through a small semi-variable homemade condenser (*C3*), to the control grid of the R. F. tube; the choice will depend upon the antenna used.

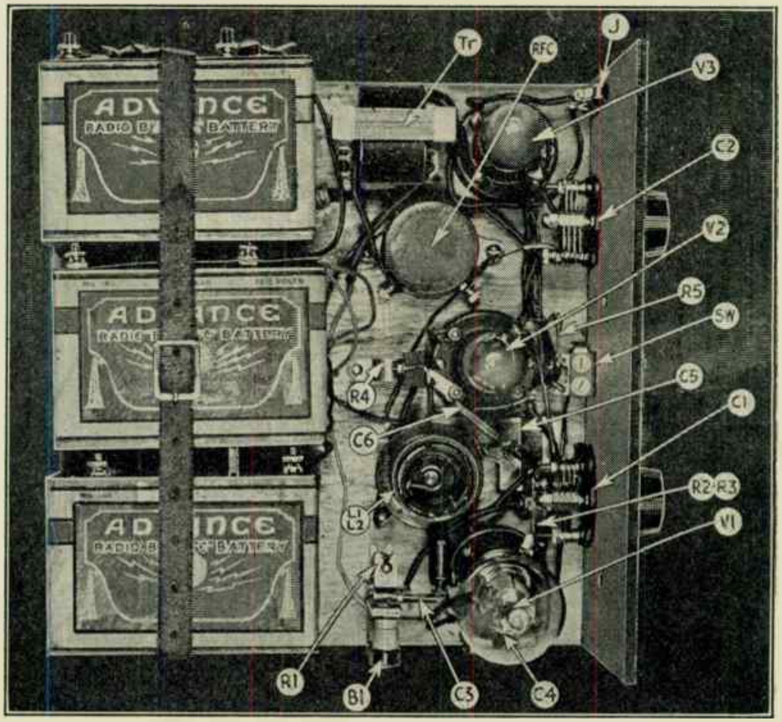


Fig. C. Batteries in place; all leads connected; tubes in their places.

Construction of Coils

The short-wave coils are of the plug-in type; five are used to cover the band from 25 to 100 meters. They are constructed from old tube bases; five of

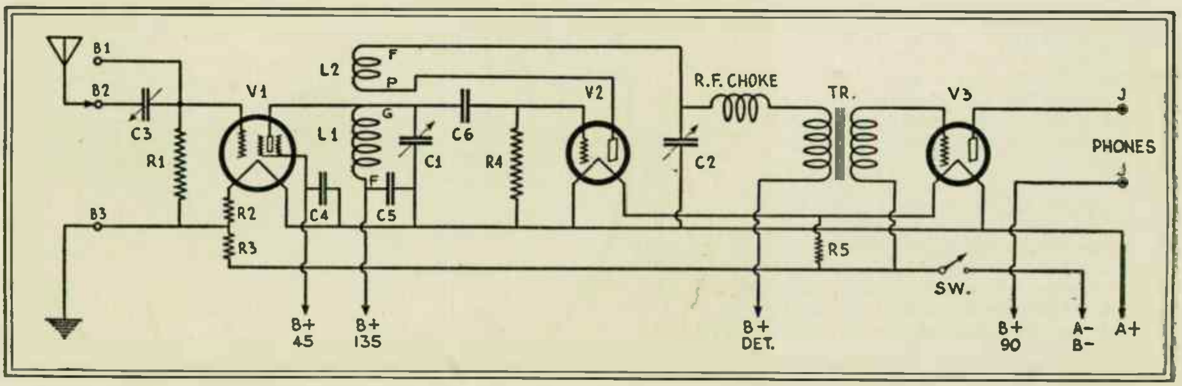


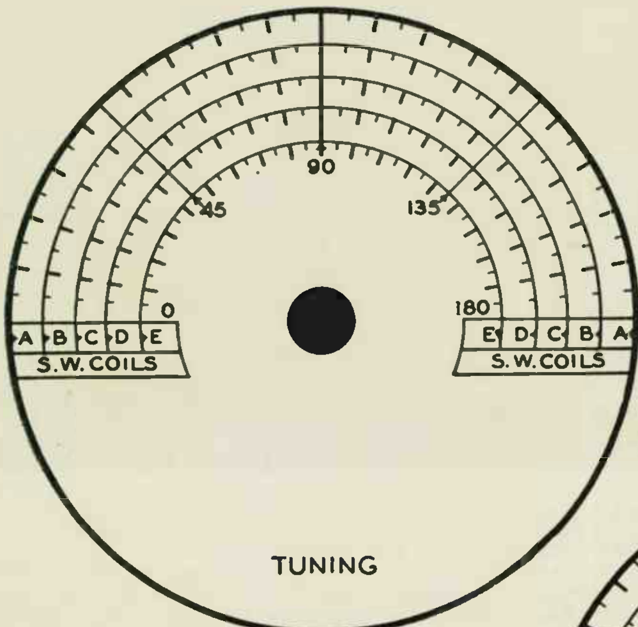
Fig. 1. Schematic circuit to be followed by those who want to dig into their junk box and ride the short waves via the "Craft Box." As 90% of construction is getting started, "it's up to you"; we have eliminated all the mechanical difficulties.

the UX type as listed above. There are two types of tube bases, the short and the long; if possible, the long should be obtained (especially for the "E" coil) as otherwise it will be difficult to accommodate the required turns on the base. If it should prove impossible to obtain the long type, thin cardboard may be wrapped and cemented around the short base to give the required winding space. Follow the winding specifications:

Coil A: Grid winding, 7 turns; tickler winding, 7 turns; shortest band, approximately 18 to 25 meters.

Coil B: Grid winding, 10 turns; tickler winding, 10 turns; tuning range, approximately 25 to 35 meters.

Coil C: Grid winding, 15 turns; tickler winding, 14 turns; tuning range, approximately 35 to 45 meters.



Dial for the "Craft Box." Copy, cut out and paste on panel. "Regeneration" dial appears below. A red ink dot on the right line and stations are quickly re-tuned in.

Coil D: Grid winding, 20 turns; tickler winding, 18 turns; tuning range, approximately 45 to 65 meters.

Coil E: Grid winding, 50 turns; tickler winding, 50 turns on a cardboard tube fitted inside the secondary winding; tuning range, approximately 63 to 100 meters.

Starting about 1/16-inch from the top edge of the form the grid winding ($L1$) is started and wound for the required number of turns; ⅛-inch space separates it from the tickler winding ($L2$). It is a good plan to prepare the bases before winding by drilling the holes to anchor the winding ends, which are also to be soldered to the prongs. The solder and wires should previously be removed from the prongs by the application of a soldering iron and a sharp knock. The distance at which the holes should be drilled is readily determined approximately as 48½ turns of No. 28 D.C.C. wire may be wound in one inch of space.

To start the grid winding, the end of the wire is passed through the hole drilled at the top of the base, then passed down through the *grid* prong and soldered. The proper number of turns is wound, breaking the wire but leaving about six inches free. The insulation is removed to within ½-inch of the point where the wire enters the hole; the wire is passed through the hole and down through the filament prong on the same side as the grid prong. Start the tickler winding ⅛-inch from the end of the secondary; the wire is again passed through the hole and soldered to the remaining filament prong and the proper turns are wound. Remove the insulation as before and pass the wire through the lower hole, through the plate prong, and solder.

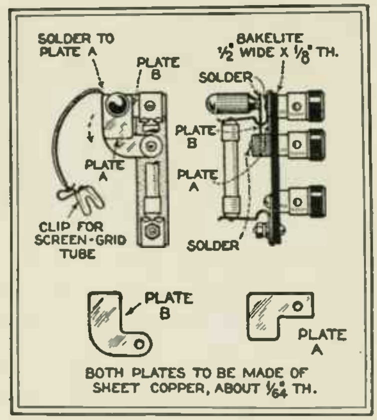
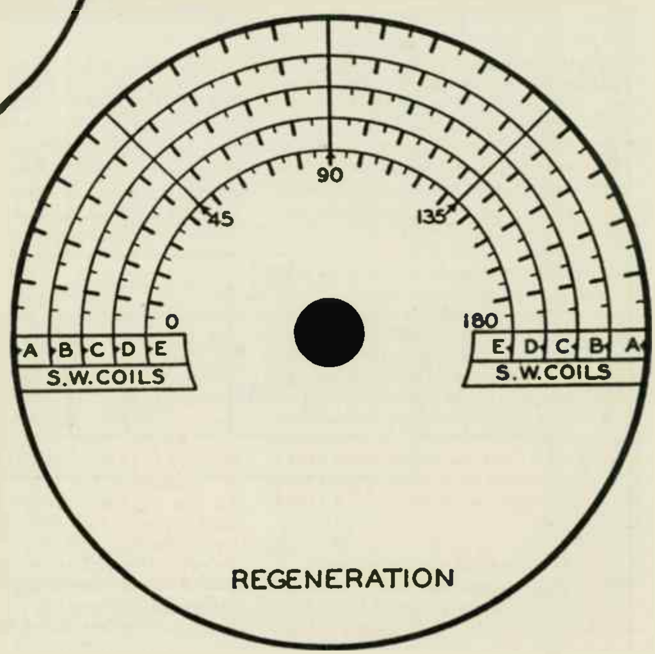


Fig. 2. Detail of the binding post plate in conjunction with which is the antenna variable series capacity.

The tickler of the "D" coil is wound double-layer. The tickler for the "E" coil is wound on a small length of cardboard tubing which is placed inside the secondary form. Care should be taken that the beginning of the tickler winding is connected to the filament prong on the side of the plate prong.

The hard-rubber or bakelite panel is first drilled for the mounting of the two midget variable condensers, the filament switch and the two cord-tip jacks. Two holes are also drilled near the lower edge for fastening the panel to the baseboard, which may be done at this time.

(*Continued on page* 70)



This is the design for the second dial of "The Craft Box." Trace, cut around outside edge and then paste the dial so made on the receiver panel. "Tuning" dial appears above.

"MY FAVORITE" SHORT WAVE RECEIVER

By
F. H. SCHNELL
Famous Short-wave Expert

Push-pull in both radio frequency and detector stages marks this outstanding short-wave receiver described in detail by Mr. Schnell.

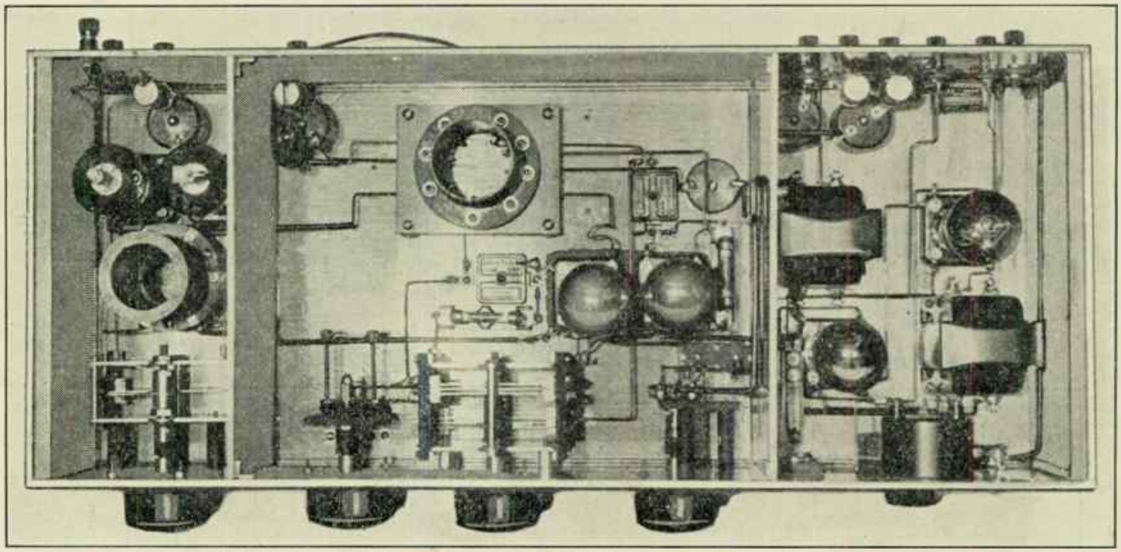


Fig. 2, herewith, shows view of interior of "My Favorite" short-wave receiver designed and constructed by Mr. Schnell after careful research. This receiver employs push-pull radio frequency stage, as well as a push-pull detector stage, which insure a very healthy signal being delivered to the audio stages.

THE design and construction of a good short-wave receiver depend a great deal upon the purpose for which it is to be used. No hard and fast rules can be set down unless the short-wave receiver is to be used for a limited purpose (like those used in commercial radio on fixed frequencies). Receivers, such as are used by the radio amateur and the short-wave broadcast enthusiast, are subject to many different requirements, and, accordingly, provisions have to be made to carry out each and every purpose with a certain degree of satisfaction. While some needs will be better satisfied than some others, a happy medium must be struck to bring about the greatest degree of all-around satisfaction.

Arrangement of Apparatus

The front panel of such a receiver is shown in Fig. 1. The dial on the extreme left is the radio-frequency control; the small dial controls the vernier condenser across the secondary tuning condenser which is operated by the third dial from the left; and the fourth dial is for the regeneration control. Phone jacks, filament rheostat, filament voltmeter and on-off switch are shown on the right. The appearance suggests that there are too many dials, but such is not the case. For all practical tuning, the radio-frequency dial and the regeneration control dial are set at some desirable spot, in or near one of the amateur bands. When a station is heard (by tuning with the secondary condenser) it is brought to the desired point of resonance for best signal strength, by use of that condenser, which is of such capacity that this can be done without difficulty. In the event of interference, the radio-frequency dial is adjusted to a point where that circuit comes into resonance. Many times this results in reducing the interference, but not eliminating it; interference in this case is probably that coming from other stations and not local power leaks or static or other atmospheric disturbances, etc. When the radio-frequency circuit fails to reduce the interference to a level which permits copying the desired signal, the vernier control condenser is used; and usually this makes it possible to creep to a position between the interference and the point where the desired signal can be copied.

Of course, if the interfering signal is broad and smothers the desired signal, it just "goes by the board." In extreme cases, a sharply-tuned audio stage, such as the Aero "Hi-Peak," will reduce some of the worst forms of interference.

For phone reception or short-wave broadcast reception, the extremely smooth regeneration control permits maximum signal strength, without oscillation in the detectors.

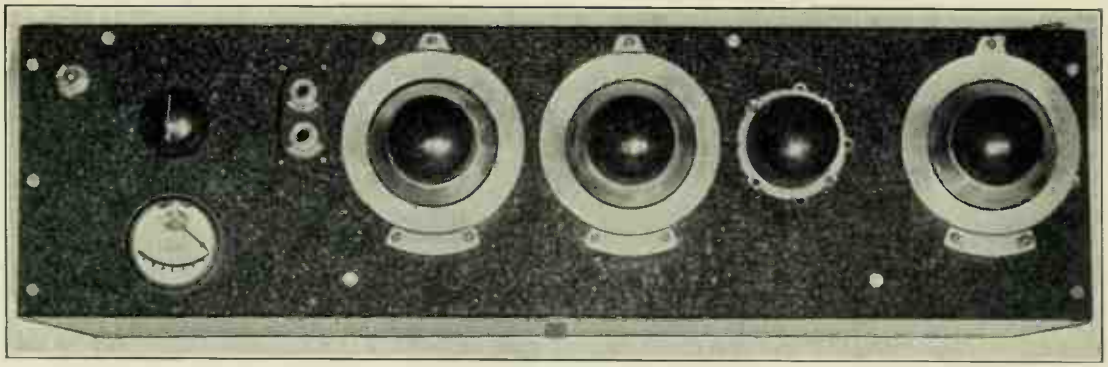


Fig. 1, above, shows front panel with dials, jacks, meter, rheostat and switches of Mr. Schnell's highly efficient short-wave receiver.

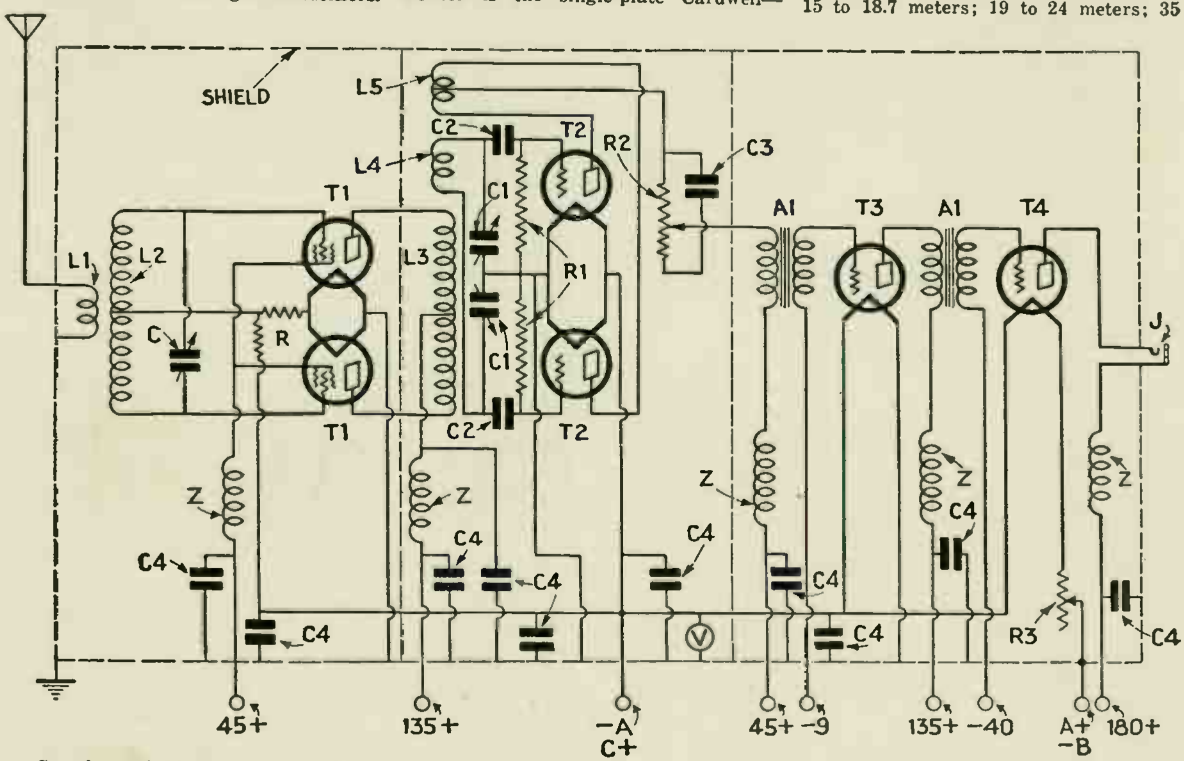
Inside Assembly

Fig. 2 shows the inside assembly, looking down from the top. In the shielded compartment, at the left, is the radio-frequency stage. Chokes and by-pass condensers are mounted in this compartment, where they are used in the radio-frequency leads of this circuit. The middle compartment includes the two detectors, their inductances, the tuning and vernier condensers, the regeneration control, grid leaks and grid condensers. The compartment on the right includes the two audio stages.

Fig. 3 shows a close-up of the radio-frequency stage in which the inductance is so mounted as to be at greatest distance from all shielding. The radio-frequency and the antenna coupling coils are wound on standard Silver-Marshall forms; and the socket is mounted on insulating posts of bakelite. The condenser is the single-plate Cardwell—shown just behind the panel, from which it is insulated.

In Fig. 4, the radio-frequency and antenna coils are visible at the left, and one of the secondaries to the right. The plate inductance coil (from the screen-grid tubes) is wound underneath the secondary coil and above these two windings is the tickler coil.

Fig. 5 illustrates a set of four coils: 15 to 18.7 meters; 19 to 24 meters; 35



Complete wiring diagram for Mr. Schnell's exceptionally efficient and selective short-wave receiver, in which he employs push-pull action for the radio frequency as well as the detector stages. The audio section comprises two stages of transformer coupled amplification.

to 44 meters and 72 to 90 meters. Their constants are given in the table. Other coils can be made to cover the other wavelengths or such of them as may be desired.

Fig. 6 shows the jack arrangement of eight connections; three for the plate inductance of the screen-grid tubes; two for the secondary and three for the tickler.

No Body Capacity

When the lid of the case is closed, there is not the slightest sign of body

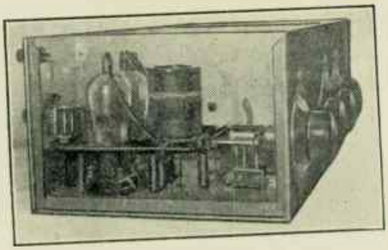


Fig. 3. View from the left-hand end of short-wave receiver with one side of shield box removed, showing push-pull radio frequency stage

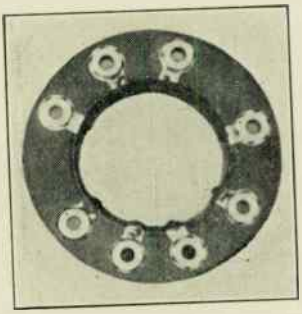


Fig. 6, above, shows the jack arrangement of eight connections, three for the plate inductance screen-grid tubes, two for the secondary, and three for the tickler.

capacity at any lead or any part of the receiver. The case is of ⅛-inch aluminum—top, bottom and sides—and provides quite satisfactory shielding. Space will not permit listing the stations heard on this receiver. For broadcast reception it is satisfactory, especially since it is designed to meet all requirements; though it was used particularly for amateur reception and communication.

A careful study of the circuit diagram reveals several different possible arrangements of the different parts; so that almost any sort of combination can be worked out to suit the particular requirements of the constructor. The components used were as follows:

List of Parts

L1, L2, L3, L4 and L5—see table;
C, 50-mmf. variable condenser;
C1, double (Cardwell) variable condenser, 50-mmf.;
C2, grid condensers, .00015-mf.;
C3, 0.5-mf. fixed by-pass condenser;
C4, 0.25-mf.; by-pass condensers;
Z, Aero choke coils.
T1, DeForest 422 (screen-grid) tubes;
T2, '01A detectors;
T3, '12A first audio amplifier;
T4, '71A output amplifier;
J, Loud speaker or phone jack;
A1, A2, Thordarson "R-300" audio transformers;
R, 15-ohm resistor, tapped at 5 ohms;
R1, 10-megohm grid leaks;
R2, 50,000-ohm Frost potentiometer, regeneration control;

Desirable to Spread Out Band

Particularly in amateur radio, where the frequency bands are limited, it is desirable to spread out the bands, for better control of secondary tuning. The several ways to do this provide for every practical case that may arise. If the secondary tuning condenser is of the order of 125- to 150-mmf. capacity, without question there should be a vernier tuning control, if the maximum results are to be obtained. One method of extremely fine tuning is to use a slow vernier dial; but, for the desired result, it would have to be geared to a ratio in the neighborhood of at least 100 to 1—a mechanical problem, backlash and all other things considered. Another is to use a very small vernier condenser shunted across the regular tuning condenser; and even this should be controlled by a vernier dial of the National "A," "B" or similar types. The latter method probably is the most satisfactory in use at present. Some short-wave receivers are made with a secondary tuning capacity of such value as to permit spreading each amateur band over a wide portion of the tuning dial. This type of short-wave receiver, in order to cover other wavelengths, would require a large number of inductances—far too many for general use. Instruments are now available whereby a reasonably satisfactory degree of coarse tuning is obtained with a high capacity while the fine tuning is done with a vernier plate which is built right into this type of condenser.

Regeneration Control

One other vitally important feature, in any type of short-wave receiver, is the regeneration control system. There are some five or six different combinations possible, whether the system be

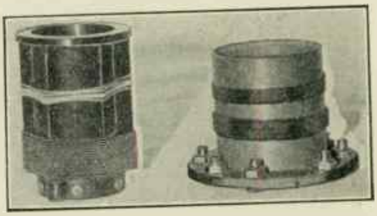


Fig. 4 shows the radio frequency and antenna coils at the left and one of the secondaries at the right.

capacity control or resistance control. Satisfactory regeneration control, regardless of the method used, depends largely upon the type of tube, the grid condenser and grid leak, and the tickler arrangement. A careful selection of the various parts used means just so much less trouble when it comes to putting the receiver into operation.

After all is said and done, a good short-wave receiver for amateur purposes is one which is simple in construction, and gives ease of control, smooth regeneration, sensitivity and fairly good appearance. All these things can be incorporated into a short-wave receiver.

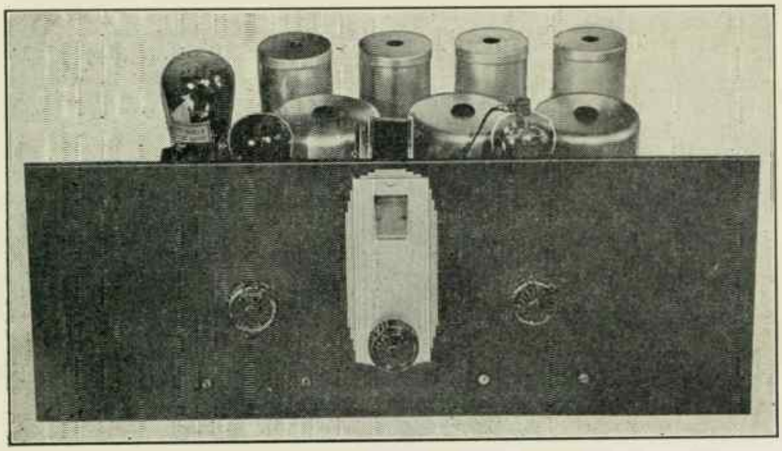
Fig. 5 illustrates a set of 4 coils covering from 15 to 90 meters, the constants of which are given in the accompanying table.

COIL WINDING DATA FOR AMATEUR BANDS

Wavelength in Meters	L1 *Ant. Coil*	L2 *Grid Coil*	L3 *Plate Coil*	L4 *Secondary Coil*	L5 *Tickler Coil*
19 to 24	4 turns	6 turns	5 turns	5 turns	5 turns
35 to 44	.7 turns	14 turns	10 turns	10 turns	10 turns
72 to 90	12 turns	26 turns	26 turns	25 turns	16 turns

NOTE—All coils are wound with No. 24 D. S. C. wire.

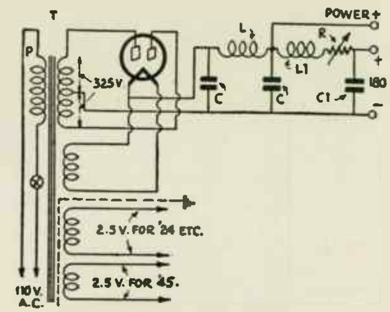
THE HY-7B SUPER-HET
for A. C. Operation



Front view of the single dial control, HY-7B "short-wave" super-het for A.C. operation.

By L. W. HATRY*

This article describes the Hatry A.C. Super-Het for short-wave reception, and our readers will no doubt be particularly interested in this description



Wiring diagrams of the HY-7B plate, filament and heater supply.

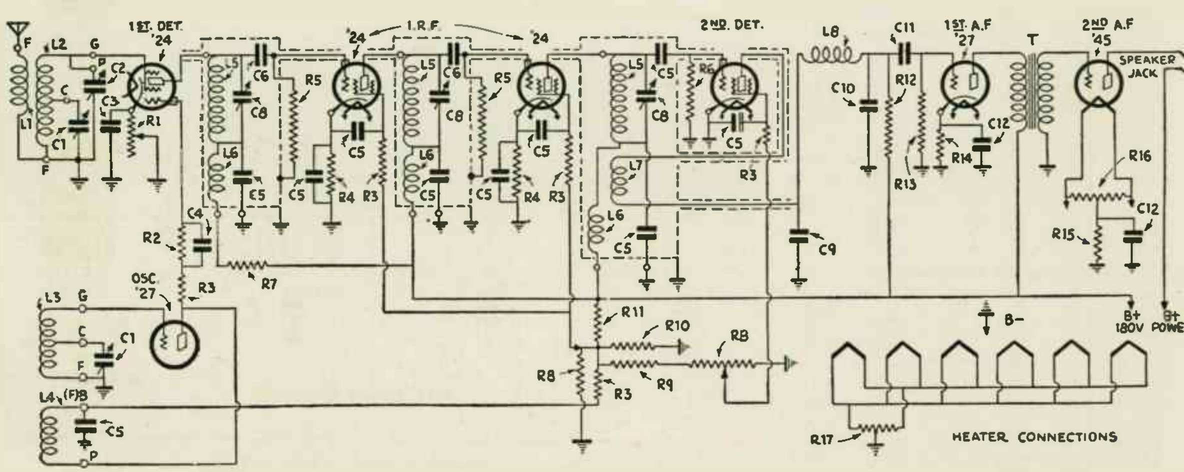
TWO main reasons exist for presenting the HY-7B receiver to SHORT-WAVE CRAFT readers; the great interest they took in the HY-7, and the fact that an A.C. form of this short-wave superheterodyne has not appeared in this magazine. The minor reasons are more or less obvious; since they are the differences between the old and new circuits which will be recognized by readers of my first article and, especially, by builders of the HY-7.

The HY-7 had but one audio stage and, though I tried to explain at some length in the article on the HY-7, that for best loud-speaker performance on broadcast reception a second A.F. stage is needed, many readers absorbed the information not at all, preferring instead to use up postage and time talking about it. Similarly, other design points of some importance escaped the careless observation of hundreds, judging by the correspondence. Hence the brief repetitions that will occur in this story, I feel, are quite necessary.

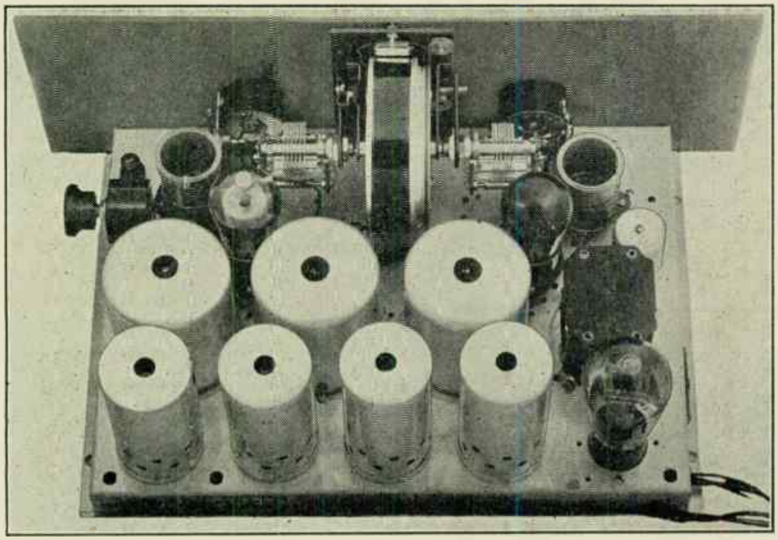
Strictly a "Short-Wave" Super

The HY-7B is strictly a *short-wave* superheterodyne. It will not give satisfactory performance in the 1500-550-kc. broadcast band without the rather radical changes represented by the re-design of the intermediate amplifier for a new operating frequency (preferably in the region of 450-kc.) and the consequent

* Hatry and Young, Inc.



Complete wiring diagram of the Hatry type HY-7B, short-wave super-het, designed for A.C. operation.



Rear view of the HY-7B super-het, showing shielded coils and tubes.

re-design of the plug-in coils. The standard chassis, however, has not room enough for the variable condensers required, because of their bulk; so that mechanical re-design also is necessary. All of this is possible of course.

The HY-7 is forced to be strictly short-wave by an intermediate frequency of about 1525-kc., which keeps the oscillator's repeat points so far apart that a repeat does not appear on the dial to upset selectivity and confuse the user. This frequency reduces the number of plug-in coils required, by permitting each oscillator coil to cover two short-wave tuning ranges.

Range	*Extent of Range*	*Coils*
2,000- 3,600 kc.	1,600 kc.	A1-01
3,400- 6,600 kc.	3,200 kc.	A2-023
6,450- 9,650 kc.	3,200 kc.	A3-023
9,200-12,400 kc.	3,200 kc.	A4-045
12,000-15,250 kc.	3,200 kc.	A5-045

Table of Coil Turns

OSCILLATOR COILS

Coil	L3*	L3 Tap	L4
01	28	None	14
023	18	None	10
045	10	6	5

ANTENNA OR DETECTOR COILS

Coil	L1	L2*	L2 Tap	Lv
A1	5	35**	None	None
A2	3	19	None	None
A3	2	12	5	None
A4	2	9	7	6
A5	2	7	4	4

* L3 and L2 are wound with No. 22 D.S.C.; all other windings are No. 30 D.S.C.

Windings are placed not more than an eighth-inch apart on National coil-forms and are wound as close to the bottoms of these forms as is reasonable.

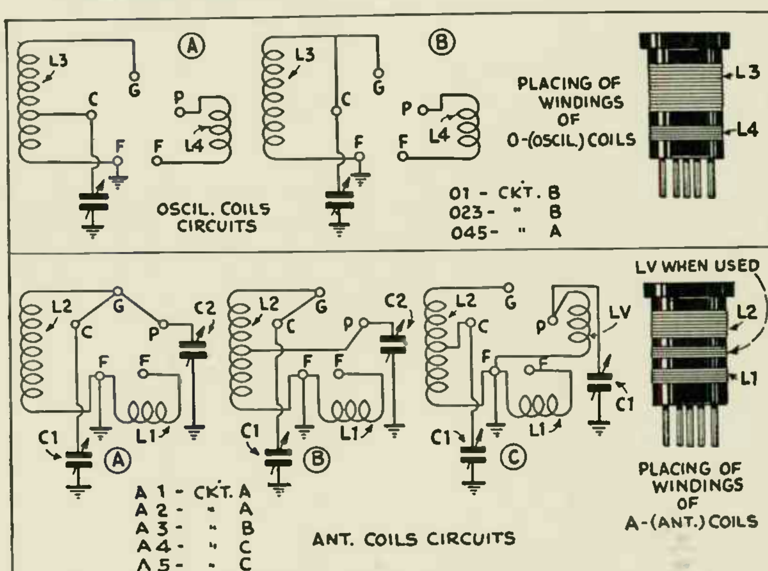
** For this coil L2 is 35 turns of 30 D.S.C. instead of 22 gauge.

Parts List for Hatry A.C. Super-Het.

Legend for Fig. 1 Circuit.

L1—Antenna winding of A coils.
L2—Grid winding of A coils.
L3—Grid winding of O coils.
L4—Plate winding of O coils.
L5-C6-C8-C5-L6-R5 comprise an intermediate R.F. transformer and are all included in one can. L5-C8 must tune to 1,500 kc. or slightly higher. See original HY-7 article for suitable dimensions.
L6—R.F. choke.
L7—Tickler in Detector I.F.T. which also includes L3-C8-L6-C5-C7.

L8—R.F. choke such as Hammarlunds 85mh. or SPC.
C1—National 50 Mmfd. midget short-wave condenser, ST- or SE-50.
C2—Same as C1 but used as vernier and range extender.
C3—Sangamo .01.
C4— .00025 Mfd.
C5— .25 Mfd. non-inductive 200v., Sprague.
C6— .0005 Sangamo.
C7— .0002 Mfd. Sangamo.
C8—100 Mmfd. Hammarlund equalizer EC-80.
C9— .0001 Mfd. Sangamo.
C10— .0005 Mfd. Sangamo.
C11— .01 Sangamo.
C12—1 Mfd. Flechtheim, 250v.
R1—5000 ohms Clarostat potentiometer.
R2— .25 megohm Electrad metallic leak.
R3—2000 ohms Electrad flexible.
R4—400 ohms bias resistor.
R5—2 megohm Electrad metallic leaks.
R6—3 megohms Electrad metallic leak.
R7— 1 megohms Electrad metallic leak.
R8—50,000 ohms Electrad Royalty potentiometer.
R9— .15 Megohms Electrad metallic leak.
R10— .01 Electrad metallic leak.
R11—5000 ohms Electrad Truvolt type B50.
R12— .25 Megohm Electrad metallic leak.
R13—1 Megohm Electrad metallic leak.
R14—2700 ohms 2 watt Durham resistor.
R15—1500 ohms Electrad B15.
R16—20 ohms centertapped, Clarostat.
R17—10 ohms centertapped, Clarostat.



Details of oscillator and antenna coil circuits.

The "Egert" SWS-9 Super-Het

By JOSEPH I. HELLER, E.E.*

This new short-wave receiver of the Super-Heterodyne type, has a range up to 550 meters. Shifting a single, shielded plug-in unit, changes the waveband to which the set responds. The receiver is all A.C. operated and receives phone as well as C.W

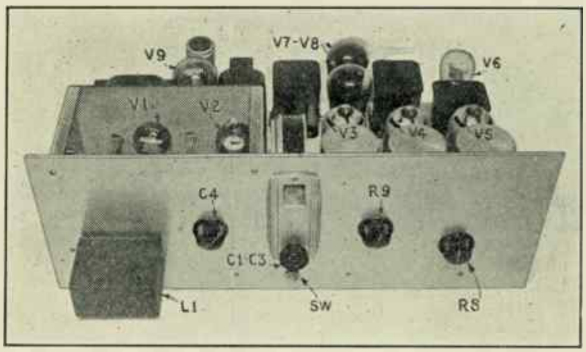


Fig. A
In this front view of the "SWS-9," the single plug-in inductance L1 is seen in its shield. This unit contains both oscillator and antenna coils, the details of which are shown in Fig. 4. The power pack, at the left, rear, introduces no perceptible hum. This set tunes with superb ease.

It has been conceded by many of the leading short-wave experts, that the super-heterodyne represents the last word in receivers of the high sensitivity, long range class. The short-wave super-heterodyne receiver about to be described embodies the results of over eight months of concentrated research. This receiver can be built up from a kit, with the assurance that it will work in a very satisfactory manner.

This super-heterodyne operates entirely from the 110 volt A.C. lighting circuit, without any disagreeable hum, thanks to the carefully designed amplifier circuits and plate supply filter.

One very important feature of any short-wave receiver, is that it should not be necessary to change more than one plug-in coil for each waveband desired. Furthermore the builder of such a receiver as this naturally expects sensitivity considerably above that of the ordinary short-wave set and also a selectivity sufficient to completely eliminate any chance of interference; with the gain at all frequencies practically the same in value. This receiver tunes in both short-wave broadcast and C.W. signals with equal facility and efficiency.

Simplification of All Controls

The disadvantages, of the ordinary set, to be overcome are as follows: absence of volume control; extremely critical and knife-edged regeneration control; a regeneration control whose setting varies with every frequency; plug-in coils that make necessary a major operation in changing; low output; and, in most cases, two dial controls. This article is intended to cover each point in the design and construction of the "SWS-9 set"; and thereby to enable any experimenter both to see the worth and desirability of the ideas incorporated, and to construct this receiver with a minimum expenditure of time and effort.

Let us take the features desired and show how it was possible to evolve a rather rough idea of the finished set, by merely making sure that all of the desirabilities were included in the design.

First, we have non-critical control. As anyone knows who has ever tuned a short-wave receiver, the regeneration control is probably the most temperamental adjustment ever conceived for use in any set, whether broadcast or short-wave. The most sensitive portion of the detector's characteristic is at such an extremely critical point that, by the time a station has been sufficiently well tuned in to be audible, most of the pleasure has been eliminated from the proceeding.

The answer to this problem is to incorporate the regeneration control in such a circuit that it will be isolated from the frequencies being received; by so doing, it may be adjusted at the point of greatest sensitivity. The superheterodyne principle immediately comes to mind; and so it was decided the receiver must be a superheterodyne and thus free from critical regeneration settings. This circuit, too, has other advantages.

The problem of the plug-in coils was a hard nut to crack. It was early decided that they would have to be operated from the front of the set, making it unnecessary to lift or remove any covers or to search around in the dark for sockets. Only one coil must be used. Since the design was a superheterodyne, and absolutely no hand-capacity effect from the coil was permissible, it became necessary to do two things: first, to put both oscillator and detector tuning inductances in the same unit; and, second, this unit had to be perfectly shielded. It will be seen, later, how neatly and effectively this last item was arranged.

Most manufacturers of short-wave receiver kits, for some strange reason, have repeatedly neglected to include volume controls, making it necessary either to detune the set, or lower the regeneration control (the latter expedient being impossible when receiving CW signals. Therefore, a volume control was included in the design.

In order to make the output equal to that of the ordinary broadcast set, it was decided that two type '45 tubes should be used in push-pull, preceded by a single '27 first A.F. amplifier. As a result, it was later found, after the construction and adjustments had been made, short-wave broadcast stations generally came

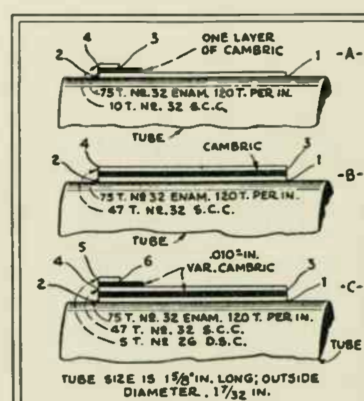


Fig. 2
Specifications of I.F. transformers, in the following order: A, L2; B, L3; C, L4—second-detector, with feed-back coil having terminals 5 and 6.

*Chief Engineer, Wireless Egert Engineering Co.

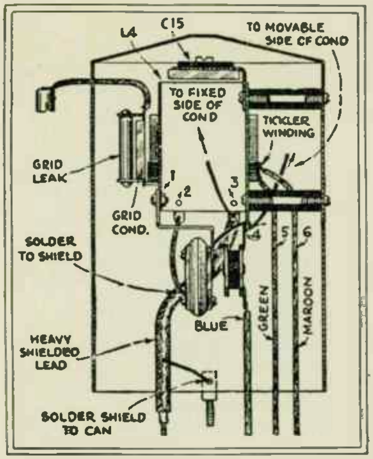


Fig. 3

Details of L4; the tickler winding, 5-6, does not appear on coils L2 and L3. The grid lead is shielded.

in with the same tone and volume as programs on the ordinary well-built broadcast receiver. This made possible, for the first time, the actual enjoyment of the program for its musical and entertainment value, in addition to the thrill of hearing a distant station.

When correctly used, the superheterodyne circuit is capable of exceptional sensitivity and selectivity. A major factor in obtaining both these effects is the use of the tuned air-core I.F. transformers L2, L3, L4 shown in Fig. 1

Since very little amplification is necessary at the frequency being received (merely enough energy being required to beat with the oscillator), the gain is the same for all signal frequencies.

The regeneration control takes care of CW, ICW, and voice reception. When considering the problem of hum resulting from A.C. operation, it was believed that, if a perfectly-shielded supply source were placed properly, there would be no pickup of the hum.

Assembly of the Receiver

Let us begin with the chassis, which consists of an inverted tray measuring 10 x 20 x 2 inches; it is made of 3/32-inch aluminum, bent over on all edges.

In the specifications which follow, both in the figures and in the text, dimensions for holes for audio transformers and chokes are not included; since it is felt that most constructors will prefer to use their own transformers. The placement of the transformers, in the factory model, however, is shown in the photograph reproduced here.

The shield can for the oscillator and first detector tubes and tuning condensers is made of 1/16-in. aluminum and measures 4⅞ x 5 1/5 x 8½ inches; it is provided with a cover.

The shield can for the inductances of the oscillator and first detector circuits is made of 12-ounce copper and measures 2 x 3 1/16 x 2½ inches deep; into its rectangular opening fits a bakelite plate 2 x 3 1/16 x ¼-inch thick, which is drilled for five General Radio pin-plugs (four of these being spaced 5/16-in., and the last one, to "polarize" the construction, 1 in.).

Since both oscillator and detector coils are wound on the same tube forms, the coupling between them is rather high. It is therefore necessary to use a high intermediate frequency (1,600 kc.) in order to prevent the detector from being blocked by the oscillator.

The specifications for the I.F. coils are given in Fig. 2; note that no two are alike. Care should be taken to wind exactly the specified number of turns in exactly the manner illustrated. It is not believed that any undue trouble will be experienced in the construction of these items; although, if you can buy them ready-made, this is preferable.

A detail illustration of one of the I.F. inductances, L4, serves to illustrate the general construction of all three I.F. transformers. (Fig. 3.)

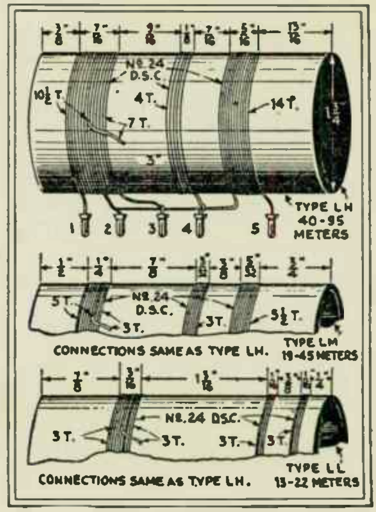


Fig. 4

Winding data for the short-wave oscillator and first-detector inductances, that are combined in one shielded coil unit, L1; this plugs into a front-of-panel receptacle, as shown in Fig. A.

It will be noticed also that the filtering system for each stage is included in all but the first radio-frequency coil. Screen-grid tubes are used for both first and second detectors. In Fig. 4 are given the specifications for the three plug-in coils; these should be made with extreme care, since upon them depends to a great extent the frequency coverage possible with this type of set. In the regular factory model, the shields for these coils are made of 12-ounce copper, suitably bent and seamed, and heavily coated with crystalline lacquer.

The top (over-all) cover is made of steel, .036-inch thick; it measures, inside, 6¾ x 10¼ x 20⅛ inches long (added to

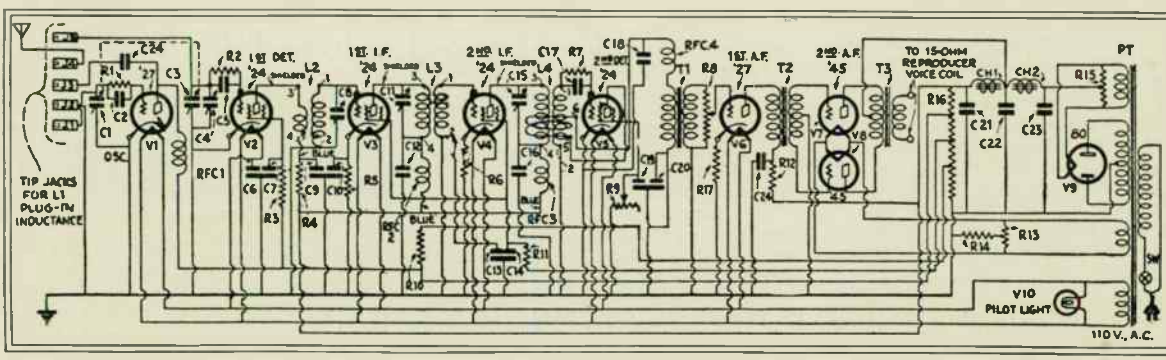


Fig. 1

Schematic circuit of the "SWS-9" short-wave-super; the volume control is potentiometer R8, in the first audio input. R9 is a regeneration control for the second detector. The oscillator condenser C1 and antenna tuning condenser C3 are ganged.

which is a mounting flange ¼-inch wide). Holes are drilled in one end for the antenna and ground binding posts.

Adjustment and Operation

Now a few words as to the adjustment of the receiver; turn all the I.F. adjusting condensers (which can be reached through the top of the I.F. transformer cans) all the way down. Put the tubes into their respective sockets. If everything has been wired correctly, it will be found that, on placing the hand on the first I.F. screen-grid tube and bringing the volume and regeneration controls on, loud "static" will be heard; it may be that a regular long-wave broadcast station will also be heard. Turn all the intermediate condensers out, about half a turn each, and plug in the largest coil. On tuning the main controls over their entire range, a point where a station is heard rather weakly will probably be reached. With the station tuned to the loudest possible volume, adjust all the intermediate condensers with a bakelite screw-driver until the station is as loud as you can get it, (Do not have the regeneration control all the way on; but leave it at some point below oscillation.)

List of Parts

Two *Hammarlund* "Type ML 7" 140-mf. variable condensers (C1, C3);
One *Tobe Deutschmann* .00015-mf. fixed condenser (C2—to be mounted directly on cap of screen-grid tube);
One *Pilot* "Type J-23" .0001-mf., variable condenser, (C4);
One *Dubilier* 00015-mf. fixed condenser, (C5);
Four *Polymet* "siamese" 0.25-mf., by-pass condensers (C6, C7 C9, C10, C13, C14, C19, C20);
Three *Hammarlund* "Type EC-80" 80-mmf equalizing condensers (C8, C11, C15);
Two *Sangamo* 01-mf. fixed condensers, (C12, C16);
One *Polymet* .0002-mf fixed condenser (C17);
Two *Polymet* 002-mf. fixed condensers, (C18, C24);
One *Dubilier* 1,000-volt 1-mf. fixed condenser (C21);
Two *Polymet* electrolytic 8-mf. fixed condensers (C22, C23),
One *Polymet* 0.5-mf fixed condenser, (C25);
One *Durham* 25,000-ohm fixed resistor (R1);
Two *Durham* 2-meg. resistors (R2, R7);
Three *Lynch* 10,000-ohm fixed resistors (R3, R4, R10),
Two *Durham* 500-ohm fixed resistors (R5, R6);
One *Clarostat* 500,000-ohm potentiometer (R8);
One *Clarostat* 50,000-ohm potentiometer (R9);
One *Durham* 5,000-ohm fixed resistor (R11);
One *Lynch* 10,000-ohm heavy duty limiting resistor (R12);
Two *Durham* 20-ohm center-tapped resistors (R13, R15);
One 780-ohm 25-watt resistor (R14);
One *Electrad* 20,000-ohm tapped voltage divider (R16);
One *Durham* 2,000-ohm resistor (R17);
Four *W.E E Co.* 115-millihenry R.F chokes (RFC1, RFC2, RFC3, RFC4);
Five *General Radio* plug-in jacks and plugs (J1, J2, J3, J4, J5; these must be insulated from the metal front panel.—*Technical Editor*);
One *National* "Type VIICC" drum dial;
One *Arrow-H.&H* toggle switch, Sw.;
One Metal front panel;
Three *W E E Co.* "Types LL, LM, and LH" shielded plug-in inductances, one each (L1 · see text);
Three *W E E.Co.* "Types IF1, IF2, IF3" shielded I F. transformers (one each L2, L3, L4: see text);
One *Amertran* first stage 'DeLuxe" A.F. transformer (T1);
One *Amertran* "Type 151" input push-pull A F transformer (T2);
One *Amertran* "Type 443" (for dynamic reproducer), or "Type 442" (magnetic reproducer), output push-pull A.F transformer (T3);
Two *Thordarson* 30-henry, 75-ma. filter chokes (Ch. 1, Ch. 2);
One *W E E Co* "Type PT 116" power transformer (PT);
Nine *Cinch* tube sockets, three UX and six UY

MY FAVORITE AUDIO AMPLIFIER

By MANDER BARNETT

AN audio amplifier must, if it is to be used with a short-wave tuner, possess as many as possible of the following features: A really high step-up gain and positively no audio fringe howl; it should be as compact as possible, and should have a really flat amplification curve over the whole audio frequencies. In my favorite audio amplifier, which is used in conjunction with a regenerative detector, an attempt has been made to make it conform to the above ideals as closely as possible. The circuit diagram is shown in Fig. 1. The amplifier itself, of course, comprises only V2 and V3, but, because the first audio tube is resistance-capacitively coupled, a screen-grid detector is used, as shown by V1.

By analyzing the above features set out for our ideal audio amplifier of a short-wave receiver we find that this amplifier has a relatively high gain, considering the small number of tubes used. V1 with the resistance-capacity coupling units R1-C2 and R3 produces a high gain—higher than that obtained with an ordinary tube as detector, of course—and a high-ratio transformer (7:1) can be used between V2 and V3 without detrimental effects on quality. The step-up gain, then, is possibly higher than it would have been if two transformer stages had been used, and the quality is better.

Battery coupling in an audio amplifier can be very annoying and cause motor-boating, as well as fringe-howl effects. So that battery coupling shall not take place between the detector and the audio amplifiers, the detector plate supply is de-coupled from the rest of the circuit by means of R2 and C1. R2 has a value of about 20,000 ohms, and C1 about 2 mf.

The plate resistance R1 is about 80,000 ohms or higher, but if a higher value is used it must not be forgotten that R2 is also in series with it, and this will help to lower the plate voltage so that a higher plate potential than usual will be necessary.

RFC, of course, is an ordinary short-wave R.F. choke. C2 has a value of .004-mf., which is not too large and not too small to pass audio currents. R3 is about 0.5-megohm, but the resistance is not very important and a 2-megohm leak will do, if one is on hand. C3 helps to smooth over noisy batteries and also keeps R.F. currents out of the batteries; it has a value of 2 mf. C4 keeps R.F. currents out of the output leads; its value is .001-mf. A larger condenser would tend to cut off the higher audio notes.

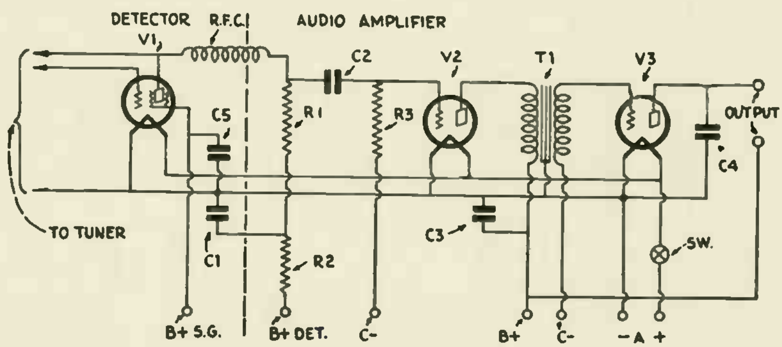


Diagram above shows Mr. Barnett's favorite audio amplifier hook-up for use in short-wave reception. Note that resistance coupling is used in the first audio stage to prevent "fringe howl".

The tubes, of course, are all battery tubes, V1 being a screen-grid tube, V2 a general-purpose tube, and V3 a small power tube. This amplifier is, of course, built in a metal case along with the tuner.

In practice it will be found that this amplifier actually does fill most of the ideals set out and is certainly a very useful audio channel for use with any type of short-wave tuner.

A SUPER-SENSITIVE Short Wave RECEIVER

By THOMAS A. MARSHALL,

Chief Radio Electrician, U. S. Navy,
Assistant to Battle Fleet Radio Officer

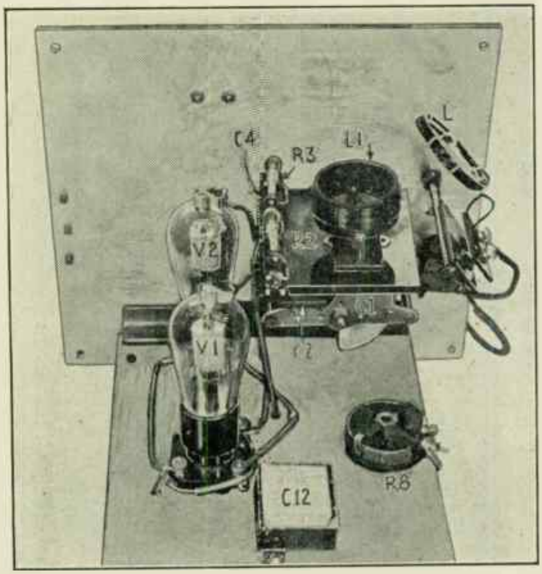


Fig. 2—Close-up of first R.F. stage in Mr. Marshall's S.W. receiver.

DEMANDS for an increase in sensitivity and selectivity have caused the writer to develop a push-pull receiver suitable and adaptable for reception of frequencies between 500 and 75,000 kilocycles. The complete receiver as described in this article gives a noticeable increase in amplification over the entire band.

While at San Pedro, California, he successfully communicated with an eastern station on 6.6 meters.

To the many experimenters who have been delving into the mysteries surrounding reception of extremely short wavelengths, we are pleased to present to our readers a complete description of Mr. Marshall's receiver which holds the world's record for reception of the shortest wavelength at the greatest distance.

Features

The receiver comprises several unique features, one of which is the symmetrical push-pull circuit throughout the radio-frequency amplifier stages and the detector stage. Another is the simplicity of tuning in a given station. In fact, the receiver is easier to handle than any conventional type. As a result of the performance of the push-pull circuits as described in this article, the sensitivity

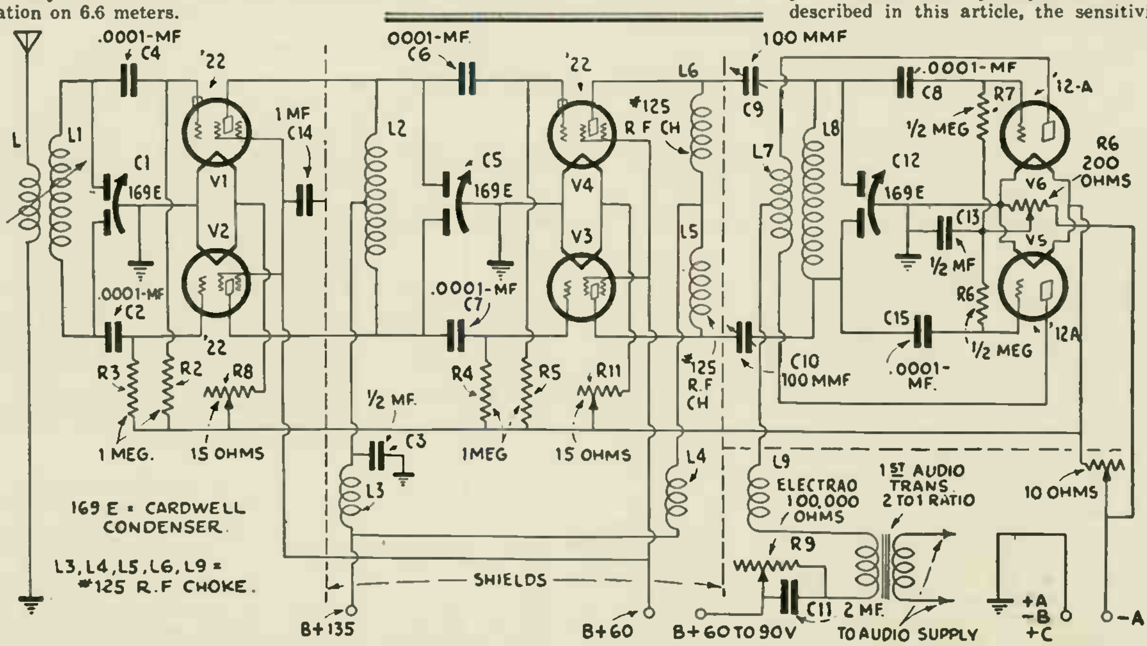


Fig. 1—Wiring diagram for Mr. Marshall's receiver, utilizing two push-pull R.F. stages, feeding into a push-pull detector stage, providing superior sensitivity and selectivity in short-wave reception.

This Letter Speaks for Itself

UNITED STATES FLEET
BATTLE FLEET
U. S. S. California, Flagship
Balboa, Canal Zone.

SHORT WAVE CRAFT,
96-98 *Park Place*
New York, N. Y.
Attention Mr. Gernsback.

DEAR SIR:

There is enclosed herewith an article on the Marshall Push-Pull Receiver for SHORT WAVE CRAFT.

While you were on board the "California" last year you probably saw this type of receiver. It is our standard short-wave set and was demonstrated to radio engineers at Riverhead, New York. I refer you to Mr. H. H. Beverage as to the efficiency of the complete set.

THOMAS A. MARSHALL.

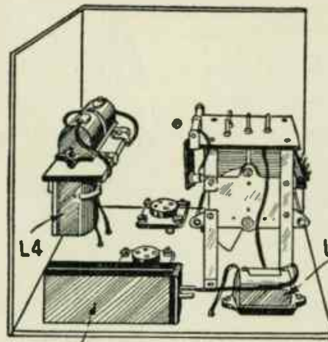


FIG. 3A

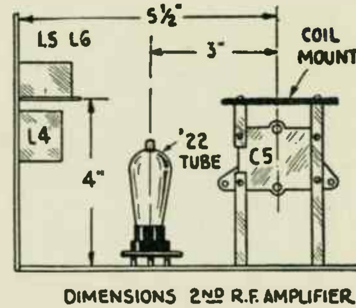


FIG. 3

Figs. 3 and 3A—Fig. 3 shows dimensions of 2nd R.F. amplifier stage. Fig. 3A: It is very important that the three R.F. chokes L4, L5 and L6 be mounted as illustrated.

of the receiver in general is materially better than that of a plain regenerative type, so much in use at present.

The Possibilities

The average short-wave receiver covers a band of from 50 to 15 meters. Below 15 meters is another band in which many stations may be heard operating by tuning in on the second harmonic value of the main transmitting frequency. An example of this condition may be given by receiving "WIY" on 13,880 kilocycles, and on 27,760 kilocycles. No better example of the sensitivity of the receiver could be given than to tell the reader that the writer, while at Port of Spain, Trinidad, received "KKP" (Honolulu, Hawaii) on 27,410 kilocycles. The distance is about 5,700 miles. There are a very great many more stations which can be heard. In fact, any station may be received, and distance takes on an entirely new meaning to the fan. Aside from the reception of many foreign stations, Rome and elsewhere, reliable reception of such short wave stations as "WENR," "WLW," "KDKA," "WGY," "WABC," and "KGO" may be enjoyed.

By carefully studying the diagram as shown in Fig. 1, one will readily see how the symmetrical push-pull circuit plays stellar roles in making it possible to tune very short waves. With '99 type tubes in the detector circuit, 100,000 kilocycles may be tuned with ease.

Method of Operation

As disclosed in the schematic diagram, Fig. 1, the circuit has two stages of tuned radio-frequency amplification, a tuned regenerative detector circuit, and two stages of audio-frequency amplification. The antenna coupling-coil system gives uniform results as to signal intensity, along with any desired degree of selectivity. Theoretically, the closer the coupling between the antenna and the first radio-frequency amplifier stage, the larger the fraction of signal energy which is transferred to the secondary. However, as the coupling is increased, the resistance of the primary is increased, resulting in a decrease in power taken by the first stage. In fact, the maximum power is transferred to the secondary when the increase in resistance of the primary, due to the coupling, is equal to the resistance of the primary by itself. Therefore, there is always an optimum coupling where the greatest signal strength is obtained along with increased selectivity.

In practice, the antenna coupling coil is set at a maximum coupling position, which has the effect of increasing the resistance of the first amplifier tuned stage. Thus, poor selectivity is made possible, which has the effect of broadening the circuit. Stations may, therefore, be heard when within 10 to 15 degrees of the point of resonance. For this reason, the first amplifier stage's tuning dial is not used when hunting for a given station; which reduces the receiver to two dials for tuning. After a station has been tuned to resonance on the detector and second radio-frequency amplifier stages, the antenna coupling is reduced and the first amplifier stage tuned to resonance. This procedure is followed until the greatest signal strength is obtained, with the noise level reduced to zero.

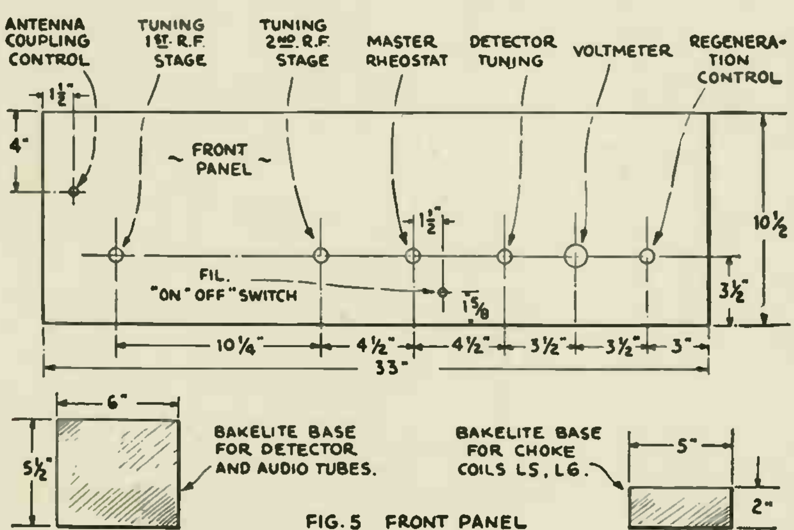


FIG. 5 FRONT PANEL

Fig. 5—View of front panel.

Features of the Circuit

The first radio-frequency amplifier stage employs tuned grid and tuned plate circuits, which increase the selectivity. The tuned plate circuit increases the plate load impedance, making it possible to get a much larger proportion of the voltage generated. The output of the plate circuit utilizes the input of the second radio-frequency stage through the condenser-coil combination L2 and C5. The plate voltage is ied at the center of the coil. The radio-frequency choke L3 serves to prevent the radio frequency energy from entering the battery supply system. C3 serves to bypass the radio-frequency energy to the ground.

L5, L6 and L4 are Samson No. 125 chokes. L4 is connected to the junction of the two plate chokes and in series with the plate voltage supply; this choke isolates the junction of the two chokes L5 and L6, permitting the output circuit to find its own electrical center. The three chokes are mounted inside the compartment for the second radio-frequency amplifier stage, and permit a certain amount of feedback to take place. Regeneration is therefore made possible, which increases the signal strength and selectivity of the receiver. Fig. 3 shows the arrangement of the second radio-frequency amplifier stage. The height of L5 and L6 corresponds very nearly to that of the tubes. The arrangements of the circuit are critical. For this reason, the dimensions as given in Fig. 3 should be followed carefully

It is to be noted that radio-frequency energy is fed to the detector circuit through the two condensers C9 and C10; these are approximately 70 micromicrofarads each. About 50 mmf. is required to pass the radio-frequency energy to the detector circuit without causing interaction between the two circuits. The value of capacity selected must be determined by trial, and not changed after the receiver has been calibrated. Where too much capacity is used at C9 and C10, the coupling between the stages becomes too great, resulting in unpleasant reaction. Not only will the reaction be too great, but it will also be difficult to keep the detector circuit oscillating when tuning the second radio-frequency amplifier to resonance.

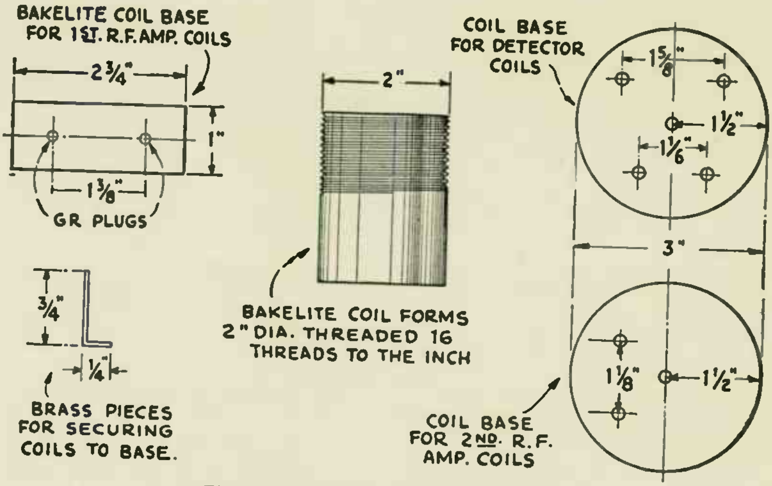


Fig. 6—Details of coils and coil bases.

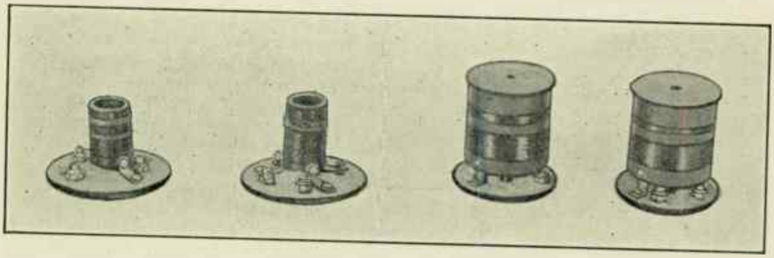


Fig. 6A—Photo of short-wave coils for Marshall receiver.

Smooth Regeneration Control

The tickler inductance L7 is tapped in the center, and the two ends are connected to the plates of the detector tubes. The plate voltage is fed through the radio-frequency choke L9, through the primary of the first audio stage, and through the high resistor R9. This method of regeneration control does not change the calibration of the receiver nor change the settings for a given station.

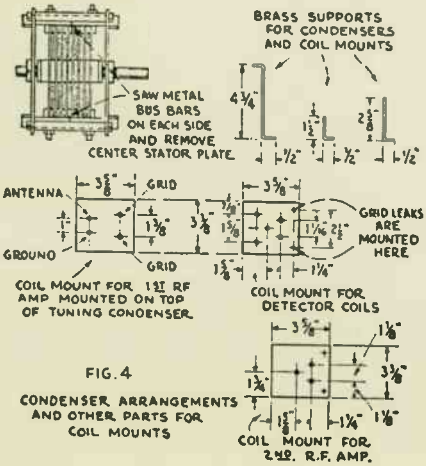


Fig. 4, at left—Detail of variable tuning condenser and brass supports for condensers and coil mounts.

Fig. 7, right—Shows how top panel, parts, and subpanel shielding are arranged.

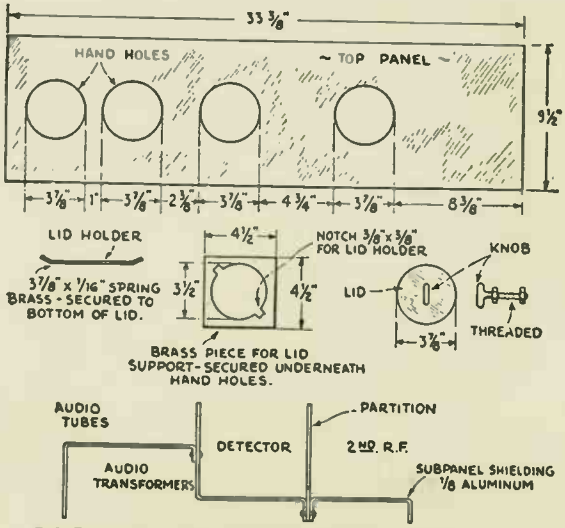


FIG. 7 — TOP PANEL, PARTS AND SUBPANEL SHIELDING.

The resistor R9 is a wire-bound resistor (Electrad type) not less than 100,000 ohms. The resistor is bypassed by a 2-mf. capacity C11. Do not substitute other resistors for R9 as the detector stage is super-sensitive and will respond to irregular voltage supply, which will cause a high noise level.

R6 is a 200-ohm Electrad potentiometer, used to obtain the correct bias for the detector tubes; with the proper bias, the detector will go in and out of oscillations without any trace of hang-over effect. The condensers C1, C5 and C12 are Cardwell "169-E type", and are split by sawing out a section of the side brackets. Fig. 4 shows how to arrange this type of condenser for a push-pull circuit. The rotor is grounded and tunes both halves of the circuit simultaneously.

Mechanical Details

The complete layout of the parts of the receiver, as described in this article, is the result of a choice of many circuits. For this reason, it will be inadvisable for the builder to vary from the design recommended. Under no condition should a substitution of parts be made. The aluminum shields are 3/16-inch in thickness; dimensions for them are as follows:

Front panel	33	x	10½"
Top and bottom...	33⅜	x	9½"
Ends and partitions	10½	x	9 5/16"
Back	10½	x	33⅜"

Dimensions of compartments:

First R.F amplifier stage..11"
Second R.F. amplifier stage. 9½"
Detector circuit and audio stages ....12½"

The input tube capacities of the circuit, as shown in Fig. 1, are in series across the input inductances L1, L2 and L8. The resultant inter-electrode capacities across each circuit are half the value of those in conventional circuits. For this reason, a greater number of turns may be used in both grid and plate circuits, resulting in a high input and output impedance.

In the detector there are more turns available for the grid and tickler circuits for a given frequency; which increases regeneration, making it an easy oscillator for the ultra-high frequencies. Due to the increased regenerative properties, the circuit has more sensitivity in the upper frequencies.

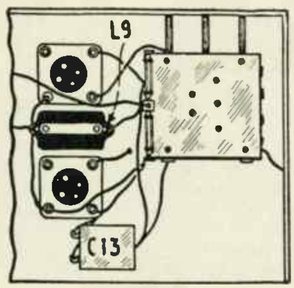


FIG. 8

Fig. 8—Top view of the apparatus in the detector circuit.

List of Parts Used

Three "Type 169-E" Cardwell variable condensers.
One 2-mf bypass condenser.
One ½-mf. bypass condenser;
One 1-mf. condenser;
One .01-mf. bypass condenser;
Five Samson No. 125 chokes;
Four 1-megohm metallized grid leaks;
Two ½-megohm metallized grid leaks;
Two 15-ohm rheostats;
One 6-ohm, 2-ampere rheostat.
One Electrad 100,000-ohm wire wound volume control.
One Electrad 200-ohm potentiometer,
Eight tube sockets;
Six grid-leak holders;
One voltmeter, 0-6 scale,
Three dials National "VV" type.
Two small dials for regeneration control and antenna coupling.
One filament "ON-OFF" switch,
Four grid cap connectors for UX '22 tubes;
Six .0001-mf Sangamo stopping condensers;
One 2-1 ratio audio transformer;
One 5-1 ratio audio transformer.
One telephone jack.
One 1-1 ratio output transformer (not essential)
Two 100-mmf. variable midget condensers;
Three dozen GR jacks,
One dozen GR plugs
Three pieces ⅛-inch bakelite, 3⅝x3⅝;
One piece ⅛-inch bakelite. 2x5.
One piece ⅛-inch bakelite, 5½x6.

Coil Data

Band in Meters	Coil No	L	L1	L2	L8	L7	Diameter
80	1	6	22	21	21	6	2
40	2	6	14	14	13	6	2
30	3	6	8	8	7¾	4	2
20	4	5	6	6	5	4	2
15	5	5	3¾	3¾	3	3¾	2
11	6	4	4	4	4	4	1
9	7	4	3	3	3	4	1
7	8	4	2½	2½	2	4	¾
5	9	4	2	2	2	4	¾

Tickler and grid coils for coils No. 1 to 5 inclusive are spaced ¼-inch. Tickler coils are wound 30 turns to the inch with No. 28 enamelled wire. The grid coils are wound 18 turns to the inch with No. 22 enamelled wire.

For coils No. 6 to 9 inclusive, use No. 22 D.S.C. wire, and wind coils without spacing turns. Tickler coils are spaced until the desired range in frequency is obtained.

Here's That 1-Tube S-W Receiver

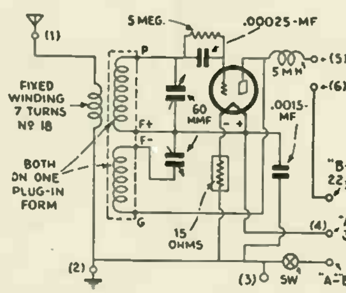
By J. P. LIEBERMAN

ONE of the attractive aspects of short-wave reception is that you can enjoy it without much cost, by building or buying a one-tube battery-operated set. This has excellent sensitivity; it is selective enough for short-wave use and it joins with its more imposing brethren in bringing in foreign stations.

So we now measure the sensitivity of a receiver by the response, in respect to a known gain, and the answer is stated in "microvolts per meter". A three-tube broadcast R.F. tuner, using a four-gang condenser and '27 tubes, with leak-condenser detector, was measured. It had a sensitivity of 15 microvolts per meter. There was no regeneration.

Now, here comes the big surprise. In the 80-meter band the one-tube device diagrammed in Fig. 1 had a sensitivity of 12 microvolts per meter! It does not seem possible, but it is so.

The antenna-ground circuit receives all waves; the secondary is tuned by a variable condenser of 60 mmf. (.00006 mfd.)



Hook-up of 1-tube S-W receiver of exceptional sensitivity.

which selects the desired wave:

The coils used are of the tube base plug-in type, and have secondary and tickler windings only. The 7-turn primary is wound with No. 18 wire to a diameter of 1½ inches, and removed from the form; being then slid between the coil-receptacle socket (UX) and the top panel.

The diameter of the coil forms for plugging in is 1 1/16 inches, the base having four prongs just like a UX tube. There are four coils to cover the bands from 18 to 210 meters; the data on these coils are:

No. 1 has a 5-turn secondary, 7-turn tickler, without any between windings; as one is begun ¼-inch from where the other ends. The form is pierced to bring the leadin wires to the prongs inside.

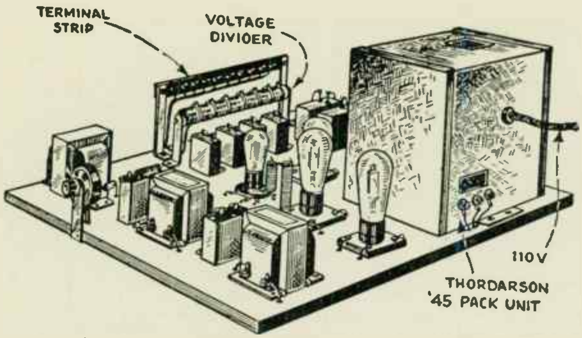
No. 2 has a 12-turn secondary, 9-turn tickler.

No. 3 has a 24-turn secondary, 12-turn tickler.

The wire on the foregoing coils is No. 24, single-cotton-covered.

No. 4 has a 50-turn secondary, 15-turn tickler; of No. 28 enamel wire.

Prong of Coil Form.	Connection to Tube in Set.
"F" minus	Stator of feedback condenser, and end of feedback coil.
"F" plus	"A" plus, rotors of feedback and tuning condensers.
Grid	Plate of tube, and one side of feedback coil.
Plate	Coil side of the grid leak, and stator of tuning condenser.



Appearance of the finished power amplifier.

For the Short-Wave Fans who desire greater power output from the second audio stage, this power amplifier will be found useful. It employs two '45 tubes in the push-pull output stage and '27 first audio tube. This amplifier is to be operated on 110 volt, 60 cycles, A.C., circuit. The plate supply furnishes the "B" current for the tubes in the R.F. and detector stages. Hum is reduced to a minimum by liberal size chokes and transformers.

A POWER AMPLIFIER

By H. W. SECOR

POWER AMPLIFIERS suitable for use with short wave receivers have to be very carefully designed and balanced, otherwise there is liable to be an objectionable "hum" noticeable in the loud speaker and not every power amplifier is sufficiently stable to operate on short wave signals.

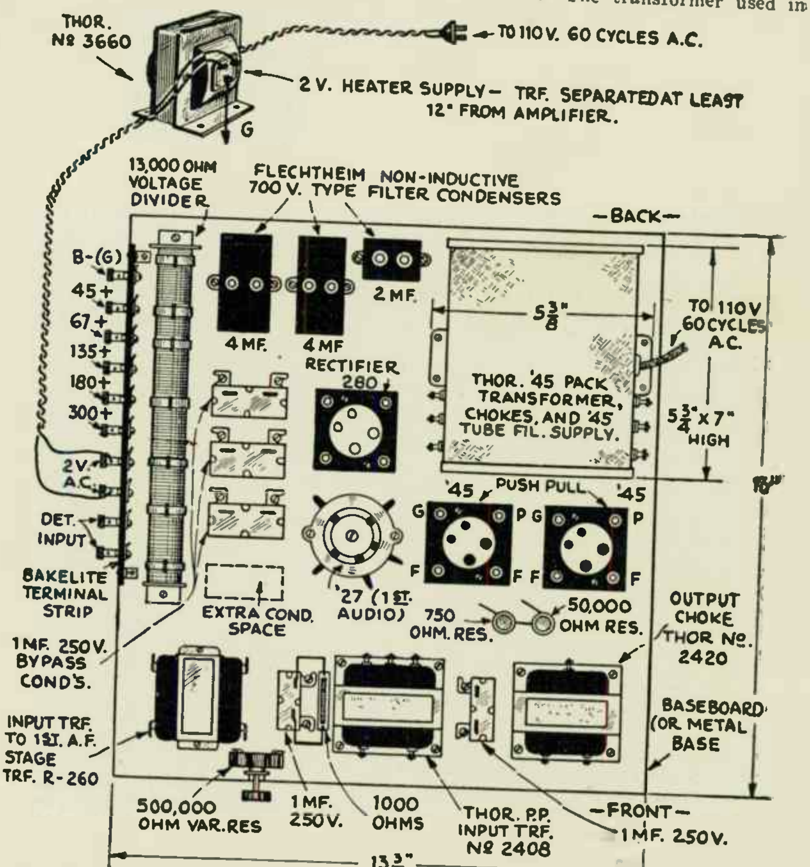
General Requirements

The two-stage, audio frequency, power amplifier here illustrated and described was constructed and tried out successfully, with practically no "hum" audible in the loud speaker and without audio frequency "howls" being set up. It is important to mention perhaps, in passing that the amplifier was tested in connection with a Hammarlund short wave receiver, employing one stage of tuned R.F. ahead of the detector, with the usual throttle condenser control of the regeneration.

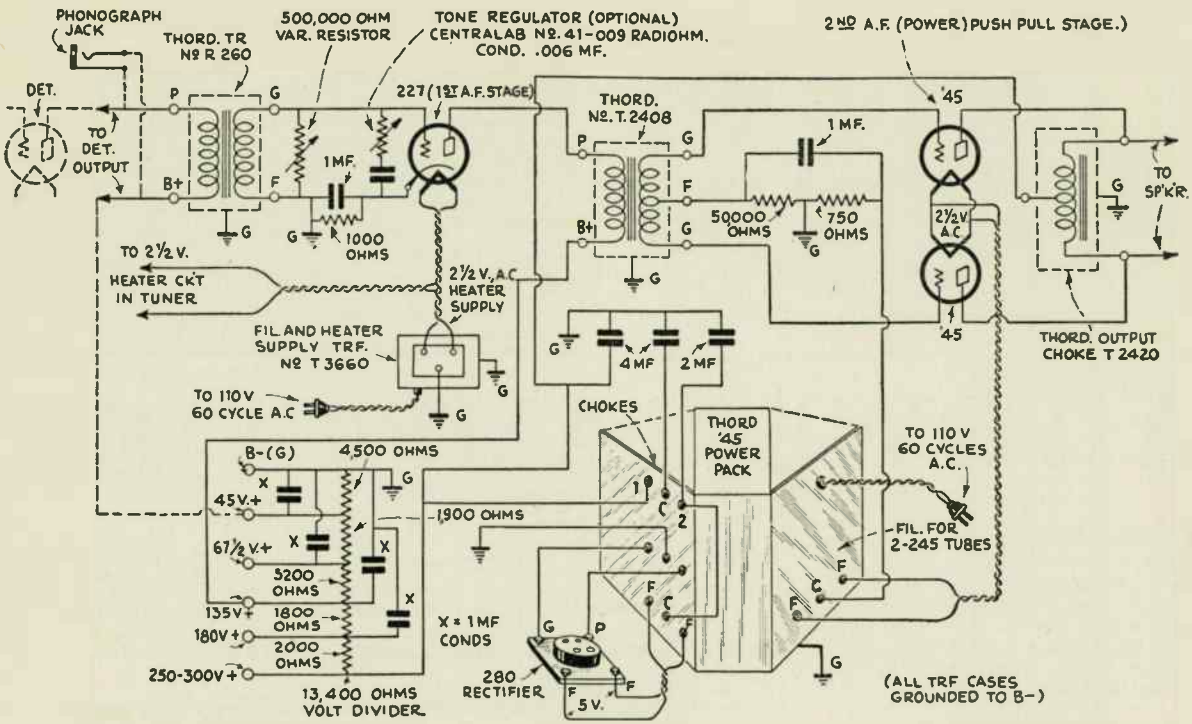
This amplifier is a good all-around piece of apparatus and can be used in conjunction with any broadcast receiver and also for amplifying phonograph pick-up signals, by connecting the output of the magnetic pick-up to the phonograph jack shunted across the input terminals of the first A.F. transformer. One of the most important points to watch out for in building any audio frequency amplifier, particularly those of the power type here described, is the proper positioning of the various transformers, choke coils, etc., so that the magnetic fields of the transformers do not interact on one another and thus constitute one of the frequent causes of an objectionable "hum" or other noise heard in the speaker as a "background" to the signal being received. It is therefore desirable that the inexperienced constructor follow the general layout of the apparatus comprising the amplifier as here illustrated.

The First Audio Stage

Looking at the wiring diagrams presented herewith the reader will see that there are two optional suggestions for building up the first audio stage, the first method involving the use of a Thordarson R260 (or its equivalent) A.F. transformer. The transformer used in



Plan view of power amplifier, showing exact position of the various parts as found best in the author's experiments.



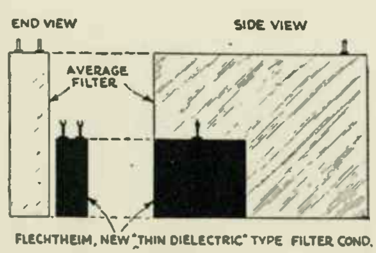
Complete wiring diagram of the A.C. operated power amplifier for short-wave reception, the amplifier using the Thordarson '45 "power compact" for the plate supply.

any case, should have a low ratio between the primary and secondary turns. The second method, and one which has received great favor at the hands of short wave enthusiasts, comprises an impedance or choke coil coupling as the optional diagram herewith delineates. The impedance used in tests by the writer was the Thordarson Autoformer, type R190, the detector plate lead being connected to the "P" terminal of the autoformer, the B plus feed wire to the "B" terminal and the grid terminal ("G") from the impedance connecting to one terminal of a .25 mf., fixed condenser (250 voltage rating). With impedance coupling of the first stage into the '27 tube, a 100,000 ohm potentiometer (Clarostat or other equivalent type), serves to balance the input to this tube. Grid bias for the first audio tube is provided by the 1800 ohm resistance, shunted by a 1 mf. condenser.

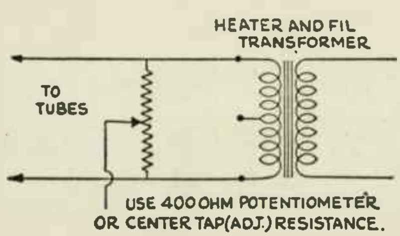
Tone Control Feature

A tone control circuit was tried out very successfully with this amplifier and the one tested comprised a fixed condenser of .006 mf., in series with a specially tapered, variable resistance (Centralab No. 41-009).

A number of ground connections are indicated in the diagram and where the various transformers, condensers, etc., are not mounted on a metal sub-base. all



Note the remarkable saving in space afforded by the use of the Flechtheim thin-dielectric type filter condensers.



In some cases the center tap on transformers is not at the exact electrical center of the winding, in which case the return lead is best connected as shown to the arm of a 400 ohm potentiometer. This permits adjustment for exact balance.

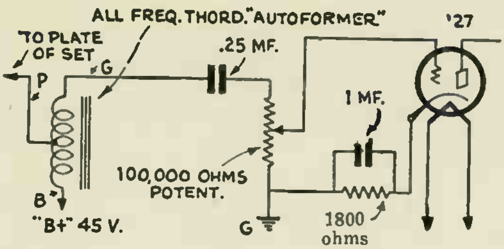
of the ground connections indicated are joined to one piece of wire, not smaller than No. 14 B & S gauge, and of course, all joints should be soldered. The outside metal casings of all transformers and condensers should be connected to the common ground wire, so as to minimize all noises or hum in the reproduction at the loud speaker.

Second Audio Stage Is Push-Pull

For building up the push-pull power stage, which involves the use of two '45 tubes, Thordarson input and output transformers or chokes were utilized. The input transformer is a regular Thordarson T2408 push-pull type, with center-tapped secondary, while the output unit was a Thordarson center-tapped choke coil, type T2420.

The grid return circuit from the '45 power tubes has a 50,000 ohm and 750 ohm resistance connected in series with the center-tap terminal "C" of the filament transformer winding, supplying the 2½ volt A.C. to the '45 tubes. One of the Thordarson '45 compact push-pull amplifier plate supply units was employed, as the diagrams show, this unit containing two filament supply windings, the high voltage winding for the plate supply and also the two, high impedance choke coils for the main B supply filter.

A word of caution to those building an amplifier of this type, is to test out all transformers, choke coils and resis-



Instead of coupling the detector output through a regular transformer to the first audio tube, a Thordarson all-frequency "Autoformer" (impedance) may be used as per hook-up herewith.

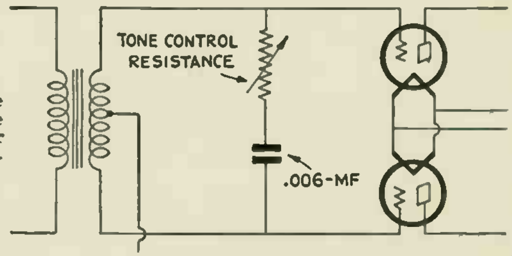
tances for electrical continuity. Most of these tests can be very well made with a milliammeter and a small B or C battery. If one of the resistances in the grid return circuit, such as the 50,000 ohm unit, should be open-circuited an objectionable hum would be heard in the loud speaker.

Source of Filament Supply

One of the important points about a good audio frequency amplifier is to see that not too many transformer windings are grouped together on one core. As a number of leading short wave experts have pointed out, it is better to have the filament supply transformers split up, so in this amplifier we find this condition. A Thordarson T-3660 filament supply transformer delivering 2.5 volts supplies the heater current for the R.F. and the detector tubes, as well as the first audio stage of the power amplifier. A separate filament transformer winding supplies the '45 tube current and a third separate filament supply winding furnishes the 5 volt current for the '80 rectifier tube. All of these points help to make a quiet operating amplifier and one of the leading radio engineers told the writer, that he never built any set, especially a power amplifier, unless he connected up the transformers on a "bread-board" and moved them around until the condition was found where a minimum hum was noticed in the loud speaker. Sometimes transformers have to be placed at right-angles or in other positions in order to prevent inter-action of their stray magnetic fields. It was found in the present case that in order to reduce the hum to the lowest possible limit that the heater supply transformer T-3660 had to be removed from the general layout of the amplifier and placed at least 12 inches away from the other transformers and amplifier apparatus to prevent pick-up of the magnetic field.

Details of the Filter

Looking at the filter circuit for a moment we see that the two chokes are connected to the terminals 1, C, and 2 at the top of the left side of the Thordarson '45 compact. Three high voltage condensers of the Flechtheim extremely compact type were used, having capacities respectively of 4, 4 and 2 mf. The great saving in space afforded by use of these Flechtheim compact type condensers is shown in one of the diagrams herewith



Optional connection of "tone control" variable resistance and its .006 m.f. condenser across the grids of the push-pull tubes.

The 13,400 ohm voltage divider resistance shown in the diagram is of the Ward Leonard baked enamel type and performs in very excellent fashion, without getting so hot that one can fry flapjacks on it, as some of these "19c special" resistances are wont to do. A potential of approximately 350 volts was measured with a Flechtheim voltmeter across the output terminals of the filter, or in other words across the end terminals of the voltage divider resistance. Each step or tap on the voltage divider is shunted by a 1 mf. condenser of the Flechtheim 250 volt type, (250 being the working voltage). If you should see the plates of your rectifier tube get red hot shut off the amplifier and start gunning for a short-circuited filter condenser.

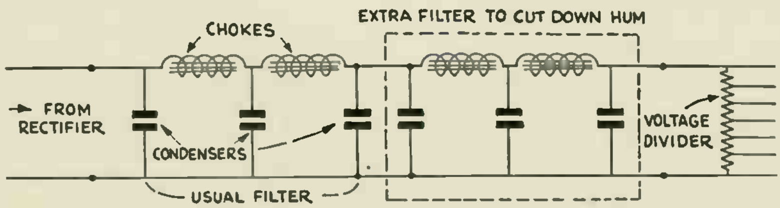
De Forest tubes were used with very gratifying success in all of the stages of the amplifier and very satisfactory performance in amplifiers during the past year has proven that they do stand up and give quality as well as service.

Hints On Eliminating "Hum"

1—Ground all transformer and condenser cases.
2—Test grid return bias resistors for "continuity" and by-pass condensers for "short-circuits".
3—Center tap on filament transformers may not always be at exact electrical center; connect 400 ohm potentiometer across filament winding and join grid return lead to arm of potentiometer.

List of Parts for Power Amplifier

1—Thordarson '45 power compact unit (Includes 2 chokes, high voltage plate winding, 5 volt fil. winding for rectifier, and 2.5 volt fil. winding for 2 '45 tubes.
1—Thordarson No. R260 input transformer
1—Thordarson No. R260 push-pull transformer.
1—Thordarson No T2420 push-pull output choke.
1—Thordarson No. T3660 filament-heater transformer
2—4 mf. (700 volt working voltage) Flechtheim compact filter condensers.
1—2 mf. ditto.
7—1 mf. Flechtheim by-pass (250 working voltage) condensers.
1—13,400 ohm, Ward Leonard, voltage divider resistance
1—50,000 ohm Ward Leonard resistance.
1—750 ohm Ward Leonard resistance.
1—1,000 ohm Ward Leonard resistance.
1—2 circuit (or other to suit builder's idea) jack for phonograph pick-up.
1—Baseboard (or metal sub-panel).
1—Terminal post strip—bakelite.
1—Set Terminal posts (X-L push posts used by author).
1 Coil No. 14 soft rubber covered wire for connecting apparatus.
1—.006 mf. condenser—tone control (Sangamo).



With some "B" eliminators (or when using some power-pack filter circuits) there is still an objectionable "hum"; the circuit herewith shows how to add an extra filter between the usual one and the voltage divider resistance. The chokes and condensers in the extra filter have values identical with those in the usual filter.

How to Obtain Smooth Regeneration in S-W Receivers

By ROBERT (BOB) HERTZBERG

The author explains, in simple terms, how to connect the apparatus in short-wave receivers so that regeneration will be smooth over the entire dial. The cause of "dead spots" on the dial is explained, as well as the best hook-ups for the regenerative circuit.

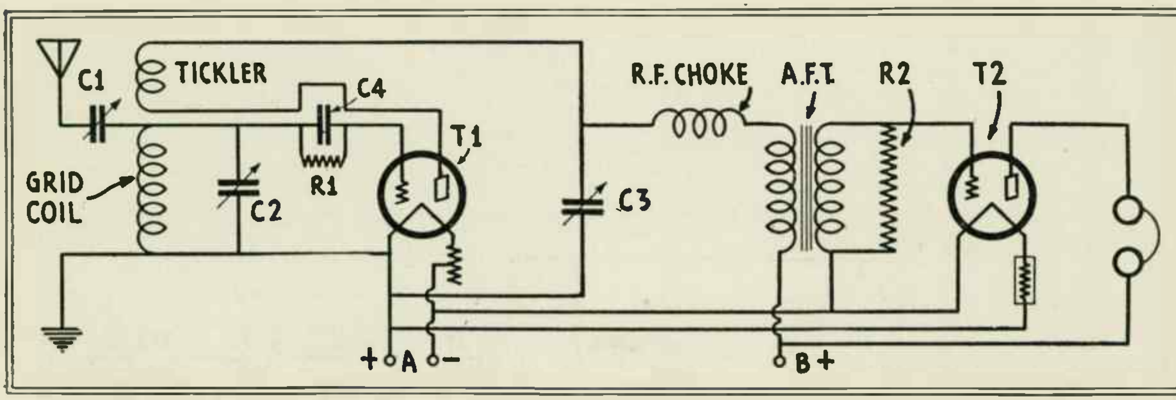


Fig. 1. The common regenerative circuit used for short wave reception is shown above. If the set breaks forth into a loud howl on the very point of oscillation, you should connect resistance R-2, of about 100,000 ohms value, across the secondary of the A. F. T.

CRITICAL, cranky regeneration controls are responsible more than any other single factor for the failure of short-wave receivers to produce satisfactory results. Many otherwise excellent sets are discarded in disgust by their purchasers when they show themselves to be difficult to operate, yet they can be adjusted properly without any trouble at all. An irregular regeneration control apparently makes the tuning unduly sharp, and even very high ratio tuning dials do not help.

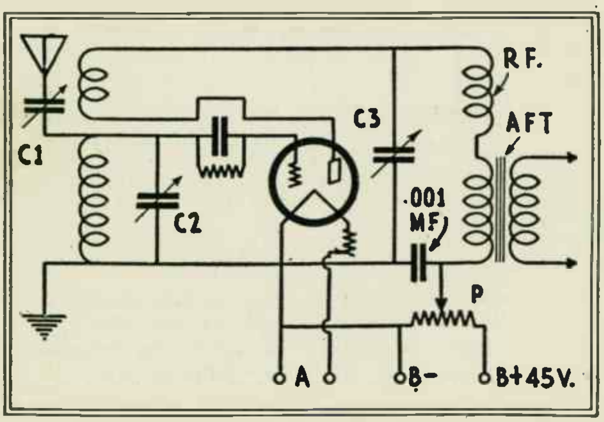


Fig. 2 above shows how to smooth up the regeneration control on short wave receivers—use a potentiometer at "P," to give fine control of the plate voltage.

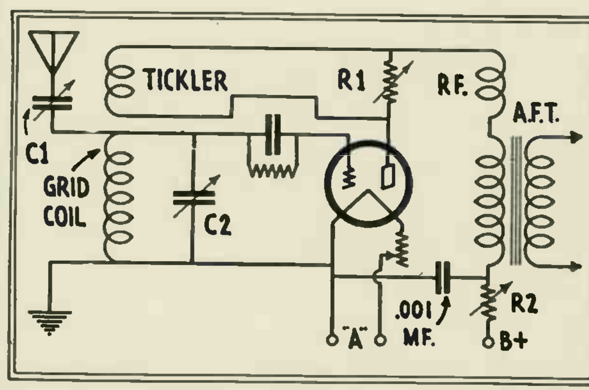


Fig. 3 shows still another way of controlling regeneration by varying the plate potential on the detector tube with a finely variable resistance R-2; and also by the variable resistor R-1.

It is best to provide a potentiometer P in the "B" circuit, as shown in Fig. 2. This should be of the 100,000 ohms size. One end goes to "B" plus 45, the other to "B" minus, and the arm to the "B" post of the audio transformer primary.

Many straight regenerative short-wave receivers have what are known as "dead spots"

The remedy is to adjust the antenna coupling condenser C1 or to use a smaller one.

This article will attempt to explain a few methods for taming down a too-lively circuit and for making it work smoothly and easily. The suggestions apply to all types of short-wave receivers, as they all use a regenerative detector, with and without tuned or untuned R.F. amplification and with one, two or three stages of resistance or transformer coupled A.F. amplification.

First let us study the diagram of Fig. 1. This shows the usual straight regenerative short-wave circuit, with one stage of audio for headphone reception. The antenna is coupled to the grid coil through a small condenser C1, the grid coil being tuned by a variable condenser C2, usually of .00016 mf. Regeneration is secured by means of a tickler coil wound over the same form holding the grid coil. The regenerative action is controlled by another variable condenser C3, of about .00025 mf. The detector T1 is led to an audio amplifier tube T2 through a standard A.F. transformer, AFT.

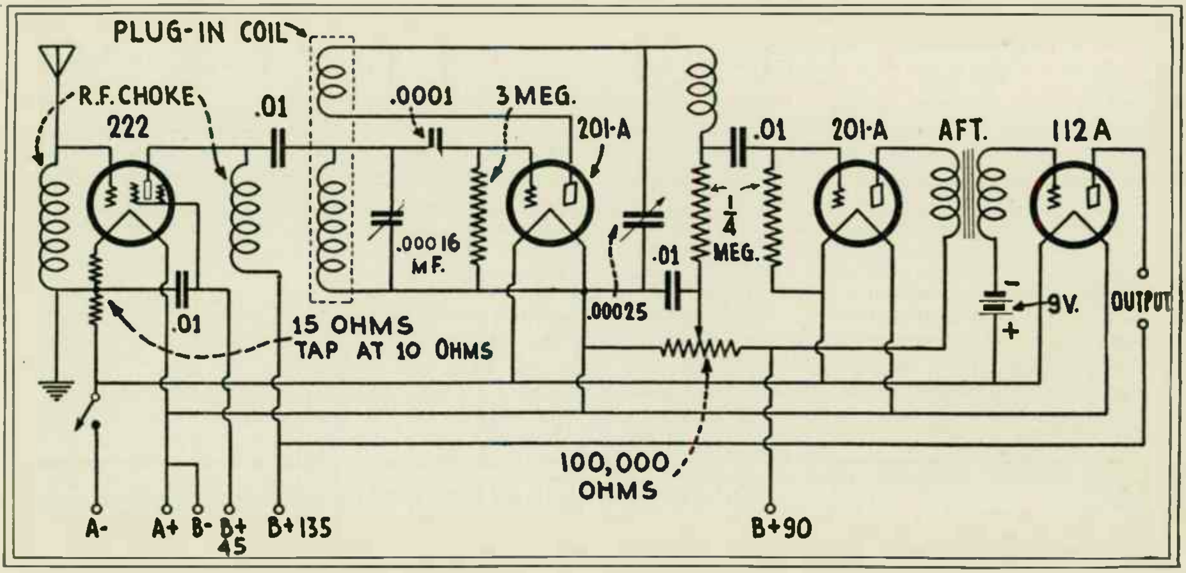


Fig. 4 above shows connection of a 222 tube in the RF circuit ahead of the detector, with detector feeding into a resistance-coupled stage of audio frequency amplification. The use of a screen grid tube eliminates dead spots on the tuning dial.

Causes of Regeneration

Now the tendency of the detector tube to regenerate is determined by several factors: the size of the tickler coil and its proximity to the grid coil, the value of the detector plate voltage, the setting of condenser C3, the characteristics of the particular tube, and to a lesser extent the quality of the R.F. choke in the transformer primary circuit. Contrary to general opinion, the grid leak is not at all critical, three megohms being just about right for practically all types of both battery and A.C. detector tubes.

If the tickler is of the right size and the plate voltage correct, the detector should slide into regeneration and finally oscillation with a soft, hushing sound as the condenser C3 is turned in. Furthermore, when the set is tuned to the high end of its wave range, with any particular plug-in coil in place, oscillation should take place as the condenser C3 reaches maximum

How to Eliminate Howling

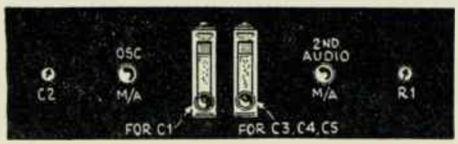
After the hushing sound has given way to the gentle "plunk" that indicates oscillation, you should hear nothing more than a few faint tube noises. If the set breaks forth into a loud howl on the very point of oscillation, you will have to connect a resistance R2 (Fig. 1) across the secondary of the audio transformer. This "fringe howl" effect is exceedingly annoying, as it occurs at the very point where weak stations are generally heard. The resistance R2 should be about 100,000 ohms (.1 megohm). Sometimes, but not always, adjustment of the grid leak R1 helps to eliminate this very undesirable howl.

If you find that the set jumps suddenly into oscillation, with little or no preliminary hushing sound, and with only a degree or two of condenser C3 dial movement, don't waste your time trying to tune for foreign stations, as you won't be successful. To smooth out the control, first try reducing the "B" voltage, if it is not already low Cut it down from 45 to 22½, and see if regeneration occurs more smoothly. If this reduction helps somewhat, but not enough, you must reduce it even more. It is quite surprising to see how easily most short-wave circuits oscillate with only eight or ten volts on the plate of the detector.

Every Broadcast Listener Will Be Interested in This

COMBINATION LONG and SHORT WAVER

By E. T. SOMERSET
Associate Member, Institute Radio Engineers.



Front view of the Somerset combination long and short wave receiver, having tremendous amplifying power.

This combination long and short wave receiving set possesses many excellent points. It operates as a regular tuned radio frequency set for receiving the broadcast band, while for short wave reception a frequency changer is utilized, which causes the T.R.F. stages to act as the intermediate-frequency amplifier of a superheterodyne. Data is given for winding the coils as well as operating the set.

IN spite of the perfected commercial receivers there are many who still get a real kick out of making their own receivers, be they for the short waves or normal broadcasting. It is to these enthusiasts that this receiver is dedicated. Take a look at the schematic diagram, and it will be seen that all to the right of C6 is a quite straightforward; normal T.R.F. broadcast receiver; while to the left of C6 is a *frequency changer.* Now, with everything made up and connected as shown, we have a superlative short-wave telephony receiver; but, by breaking the connection just to the right of C6 and attaching the antenna here, we immediately have a receiver that will bring in the longer-wave broadcast stations in an extremely satisfactory manner.

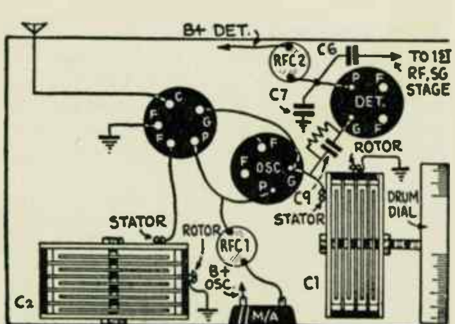
Some may say "But why not AC operation?": the answer is that many set owners may not have power in their homes or, again, there may be some who would like to use a transportable receiver, which this certainly is. To those who are on A.C. power lines, it is perfectly in order to wire up this receiver for such operation.

From the panel layout, it will be observed that two National dials are shown close together; the left-hand control is the detector tuner for short-wave work, and, that at the right is for broadcast work. For the ham, who wishes to spread the amateur frequency bands, the tuning into the band will be accomplished with the left dial, and the spreading by using the right dial; the latter varying the intermediate frequency in this case, (for it must be remembered that, when the whole receiver is working for short-wave use, the T.R.F. broadcast portion becomes the intermediate-frequency amplifier of a Superheterodyne). The three-gang condenser fitted to the right hand dial is of such maximum capacity as to suit the R.F. Transformers (L3, L4, L5) which the constructor decides to use. To the left-hand dial is fitted a National 100-mmf. short-wave condenser; and any suitable 200 or 250-mmf. instrument may be used for C2. An ordinary arrow-head knob can control this regeneration condenser, as it is not critical in its setting, but requires only alteration occasionally to keep the T1 oscillating. This will be shown up by the milliammeter, which will show about two milliamperes more with the oscillator functioning than it does when this tube is not oscillating.

Control of volume, whichever way the receiver may be used, is effected by R1 which varies the potential on the screen-grids of T3, T4 and T5. The various resistors shown in the "B+" leads may be looked upon as both voltage-dropping resistors and decoupling resistors and, in this latter sense, they play no mean part in keeping the receiver stable. Should it be found, however, that R.F. currents are getting into the audio amplifier, it will then be neseccary to decouple the grids of the audio tubes by inserting, in series with their grid leads, quarter-meg-ohm resistors.

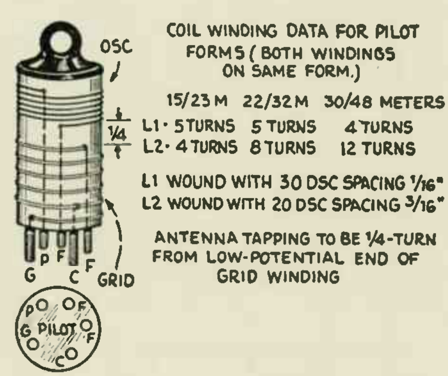
Operation as a Short-Wave Receiver

First test out the broadcast portion, and line up the trimmers on the three-gang condenser unit. When quite satis-

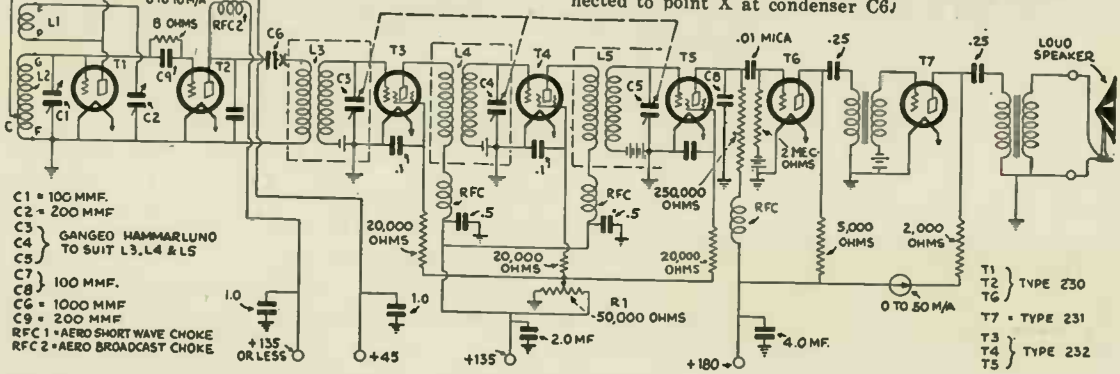


Baseboard layout of the frequency changer which enables the operator to hear short waves on a T.R.F. broadcast set.

Data on the plug-in coils used in the Somerset converter are given in the chart at the right.



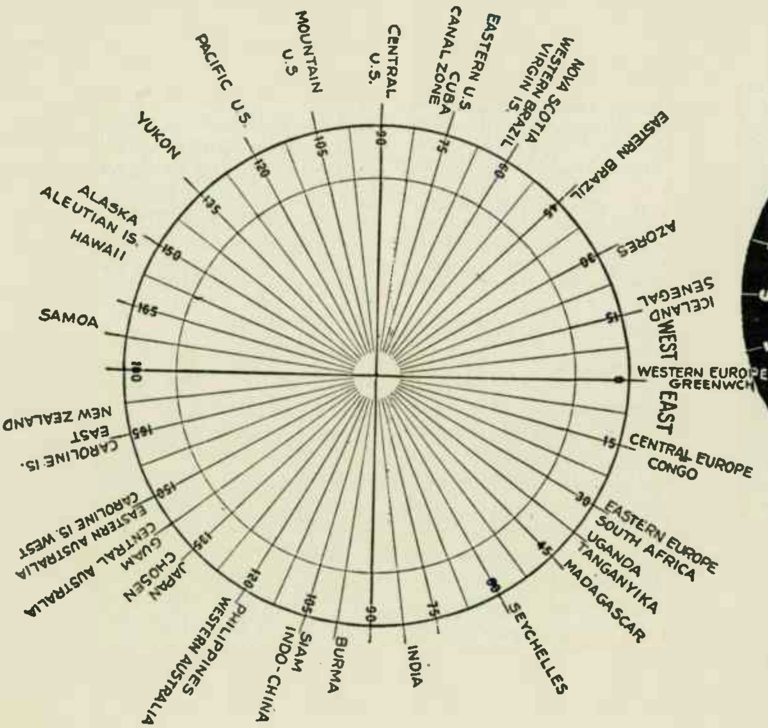
Complete hook-up of the Somerset "Long and Short Wave" receiver. To listen in on long wave stations, the tubes T1 and T2 are switched off and the antenna connected to point X at condenser C6.



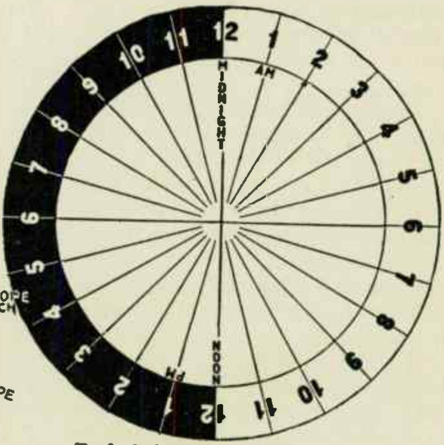
fied with the performance of this part of the receiver, the constructor can, with confidence, connect up the frequency-changer portion at the left of C6 and plug in the 8-turn Pilot coil (which will have been made up according to the sketch and winding data given.) With the rotors of C1 and C2 opened right out, take a note of the oscillator milliammeter's reading. Now gradually enmesh the rotors of C2 until the meter's needle kicks up. When this occurs it is a sign that all is well; and the constructor can proceed to tune in G5SW (or any strong short-wave station) on C1. If the milliammeter does not kick upwards, make sure that L1 and L2 are correctly wound. To continue—having discovered G5SW or any other station—it is merely necessary to tune him in accurately by means of the right-hand dial, where tuning will be broad, instead of the left-hand dial where tuning will be very sharp.

Generally speaking, it will be found that best results are to be obtained with the right-hand dial tuned to about 350 meters and clear of any powerful local broadcast station operating close to this wavelength.

When it is desired to listen to long-wave stations, all that is necessary is to switch off the filaments of T1 and T2; disconnect the frequency changer by means of a switch on the right side of C6; and attach here the antenna which had previously been connected to the binding post making connection at C on the Pilot form. Note that RFC1 MUST be a short-wave choke, and RFC2 a normal broadcast choke. If desired, a three-element tube may be used as second detector, and this followed by two audio transformers (instead of the plate-bend screen-grid detector T5 with resistance coupling and one transformer stage, as shown); but the quality of reproduction will suffer by this change although volume of output will, of course, be increased.



Time-Zone Chart



To find the hour at any place, take the time at your own station (use a clock or watch which is keeping *Standard Time*) and bring the corresponding hour on the rim of the inner circle to the place of your station, as marked on the larger card. The time at any place in the world, whose position is known, is then that on the smaller card at the point opposite the proper time zone or longitude on the outer card.

Short Wave Reception
with Super-Regeneration

One of the most interesting circuits for radio reception ever invented was the super-regenerator. This circuit is here described in detail by Mr. Tanner. in his special adaptation

By
R. WM. TANNER
W8AD

VERY little, if anything, has been written on the subject of super-regenerative reception on the short-wave bands. This method is very desirable below about 150 meters; for the gain increases with a decrease in wavelength.

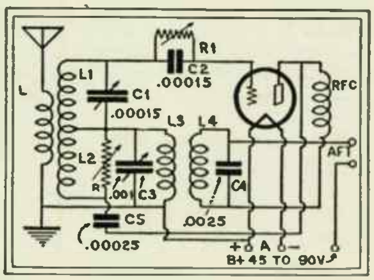
It is possible to employ a very low variation-frequency (approximately 10,000 cycles) and still obtain a great amount of amplification; for a super-regenerative detector gives a signal strength greater than is obtained with a screen-grid R.F. stage ahead of a straight detector. With proper tuning of the long-wave circuit and a correct adjustment of the grid leak, the quality of short-wave broadcast reproduction is excellent, with almost entire absence of the "mush" so prominent in the 200-600 meter super-regenerators of a few years back.

The only disadvantage is lack of selectivity. However, this desirable characteristic may be increased to a degree as high as (if not higher than) that obtained with the plain regenerative circuit; by mounting the short-wave components and tube in a shielded box and loose-coupling the antenna to the secondary.

A single-tube circuit is shown in the accompanying diagram. An '01A tube may be used successfully; but a '12A seems to give decidedly better results. The coils L1 and L2 are Silver-Marshall type-131 T, U and V; having a range of 17 to 110 meters when tuned by a variable condenser (C) with a maximum capacity of .00014-mf. The lower end (near the slot) of the grid coil and the finish of the slot winding are connected and made common to the filament.

Adjustments

The primary or antenna coil L is wound with 5 turns of No. 14 or 16 cotton-covered wire to a diameter of about 2½ inches, and tied with string in three or four places to insure rigidity. This is connected to the "A" and "G" binding posts and placed directly over the coil-mounting socket. Because of the stiffness of the wire, it is easily held in place.



The circuit of Mr. Tanner's short-wave superregenerator. Values and coil data are given in the accompanying text. A screen-grid stage may be added between L1 and the antenna.

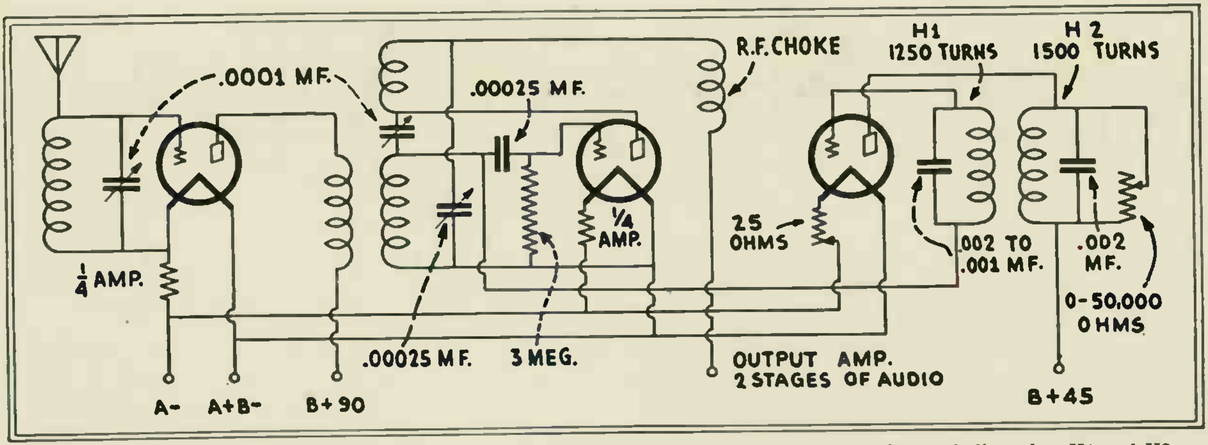
If a large antenna is employed, selectivity may not be good, and some points on the dial may be found where the tube will not oscillate with the 5-turn coupling coil. The number should then be cut down until the selectivity is satisfactory and the regeneration smooth over the entire range.

A higher degree of regeneration is required with this circuit; so the number of turns in the slot windings may not be sufficient when certain tubes are employed. If the set fails to function on the high end of the scale with any of the coils, it probably means that the tickler is too small and more turns will have to be added. Regeneration is controlled by means of a 50,000-ohm variable resistor (R) across the tickler.

The long-wave coils L3 and L4 may be 1250- and 1500-turn honeycombs respectively. An .001-mf. XL "Variodenser" (C3) is used to tune L3, and a .0025-mf. fixed condenser (C4) to tune L4. The coupling between the two coils should be variable over a comparatively wide range.

Some types of 45- or 30-kilocycle ironcore intermediate-frequency (superheterodyne) transformers may be used in place of honeycombs. The secondary will then be used as the primary, and vice versa; that is, the "G" terminal would go to "B+"; "F" to the plate; "P" to the center tap of L1-L2, and "B+" to the filament. It has been found that the Acme 30-kc. transformer functions perfectly; however, these are hard to procure as they are no longer manufactured.

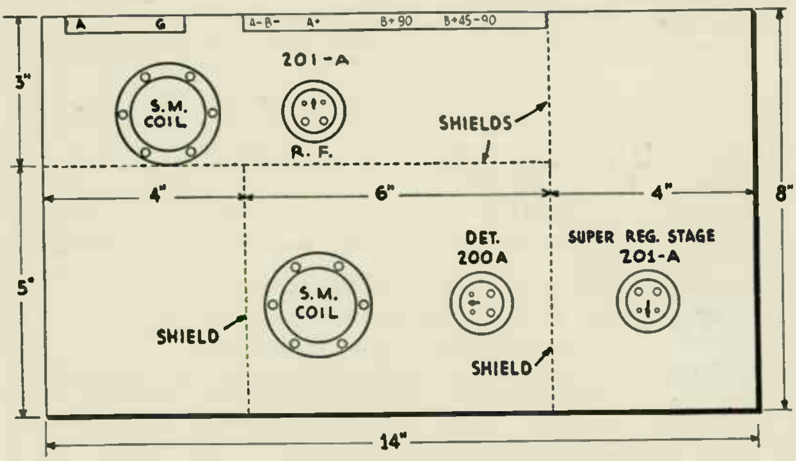
In the beginning of the writer's experimental work with short-wave super-regenerators, a great amount of trouble was experienced from a loud continuous roar which drowned out the signals almost completely. No adjustments of the long-wave coils or coupling seemed to help in the least. This roar was finally eliminated by employing a grid leak of lower value. As the leak R1 is rather critical, a Standard Clarostat was installed and proved very effective.—*Courtesy Radiocraft.*



Hook-up of Mr. Locke's super-regenerative receiver for short waves. The two honeycomb coils are indicated at H1 and H2.

Super-Regenerative Receiver

By BEN F. LOCKE



Layout of plug-in coil bases and vacuum tube sockets in super-regenerative S-W receiver.

THE receiver is fully screened and arranged in a brass cabinet, and the stage of radio frequency amplification is entirely separate from the detector and the super-regenerative stages. The detector and the super-regenerative stages are separated by a strip of brass. The shields are, of course, grounded to the "A—."

The honeycomb coils are mounted above the .00025-mf. tuning condenser, in the regular two-coil mounting unit, which is obtainable at most radio stores. The regenerative condenser is mounted on the right of the tuning condenser.

The variable condenser tuning the R. F. stage is mounted on the left of the tuning condenser.

The super-power rheostat is mounted on the right of the regenerative condenser.

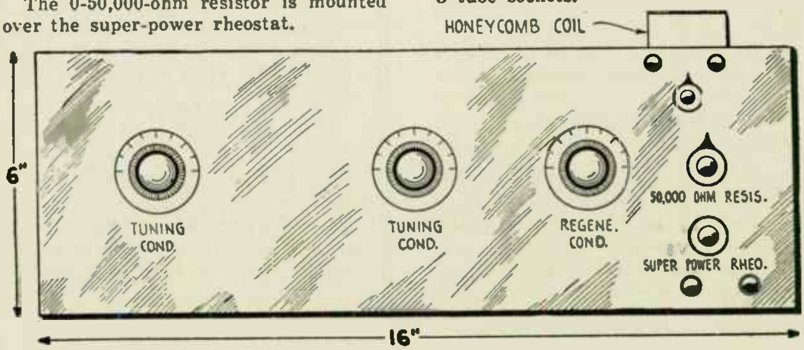
The 0-50,000-ohm resistor is mounted over the super-power rheostat.

The coils are of the Silver-Marshall type. They are as follows:

110B One 70-200 meters, which is used in the regenerative circuit.
110B One 70-200 meters; the tickler and the primary are taken off or not connected.
110C One 30-75 meters, which is used in the regenerative circuit.
110C One 30-75 meters; the tickler and the primary are taken off or not connected.

Parts required for this set:

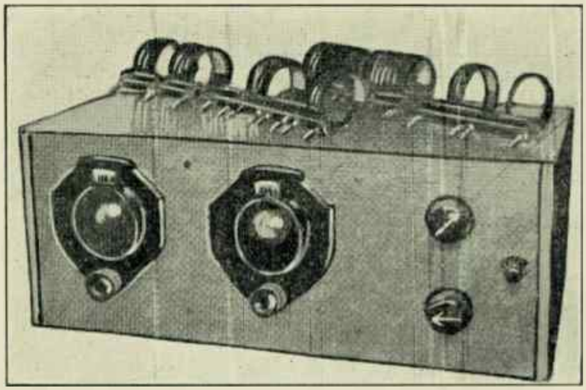
2 variable condensers, .0001-mf., midget type;
1 variable condenser, .00025-mf.;
1 3-meg. grid leak;
1 radio frequency choke;
2 amperites, ¼-ampere;
1 rheostat, 25-ohm;
1 condenser, .002-mf.;
1 condenser, .002-.0001-mf.
1 variable resistor, 0-50,000-ohm;
1 honeycomb coil, 1,250 turns (H1);
1 honeycomb coil, 1,500 turns (H2);
1 mounting for 2 honeycomb coils;
3 tube sockets.



Front panel view of super-regenerative receiver as designed by Mr. Locke.

NEW—SHORT WAVE

By CLIFFORD E. DENTON



A NEW super-regenerative circuit, with screen - grid detection and pentode output—sensitive and powerful.

Fig. A — The 14-110 - meter Superregenode with its plug-in coils. The lid lifts.

RECENT issues of SHORT WAVE CRAFT have contained interesting details of new devices and circuits that enable the technician to obtain the last bit of efficiency from them. Not the least of these is the Pentode power tube with its possibilities for exceptionally high audio-frequency amplification.

And speaking of things to become *la mode*, the author harks back to the time when E. H. Armstrong told of a new receiver the like of which had never before been seen, with a response far greater than could be obtained from even his famous regenerative circuit.

Superregeneration has been with us for nine years, but little of what has been done toward refining the circuit has so far reached print. Experimenters have from time to time brought forth receivers based on the standard circuit as originally designed; but short-wave sets using this principle of operation have not reached the pinnacle of performance which a theoretical consideration of the exceptional efficiency of this circuit, at the very shortest wavelengths, would seem to indicate is readily obtainable.

The Superregenode, however, incorporates the very latest advances in tube and circuit design for effective operation at wavelengths between 14 and 110 meters, including as it does screen-grid and pentode tubes in a superregenerative connection; and tube-for-tube, it far outstrips in performance any other radio set ever before offered to the short-wave fraternity. It opens up an entirely new playground for the short-wave enthusiast.

The Hows and Whys

The circuit shown in Fig. 1 is the familiar "3-circuit regenerative," wherein R.F. energy in the plate circuit is fed back to the grid circuit, through the inductive coupling between coils L1 and L2. By increasing this, additional energy may be fed into the grid circuit to augment by regeneration the strength of the incoming signal. Turning the regeneration control beyond the point of maximum regeneration will result in circuit oscillation; the tube then "plops over," and the signal disappears. In this condition, the circuit is useful for "C.W." or continuous-wave code

In the simplest terms, it may be said that the principle of the superregenerative circuit is to carry the regenerative action of the detector tube quite up to the point of oscillation; but to hold it under control by the periodical application of a *suppressor* voltage which checks the tendency to oscillate as soon as it sets in. This voltage may be applied in either the grid or the plate circuit or, in a four-element tube, to the screen-grid circuit, as shown here. (Fig. 2.)

The uniformity of this *periodical* application is obtained by the action of a local oscillator, the frequency of which determines the length of time during which a tube can approach the condition of oscillation without its being checked.

THE SUPERREGENODE RECEIVER

Puts Short-Wave Radio on the Map, and Solves Many of Its Reception Difficulties

WITH this story by the well-known radio engineer, Mr. Clifford E. Denton, we present to the radio world the most perfected short-wave receiver ever developed!

We challenge any radio constructor to equal its effectiveness, with any previously-known circuit, tube-for-tube.

On its "shake down" test in New York City, before a group of hard-boiled short-wave experimenters "from Missouri," distant short-wave 'phone stations were heard at loud-speaker volume throughout the largest room, there being sufficient power output from the battery-model SUPER-REGENODE to drive a standard dynamic reproducer.

Its ramifications are legion: high-power portable loop sets; automatic-volume-control short-wave sets; short-wave adapters; Police radio sets; television receivers; interference locators; super-quality designs incorporating direct-coupled audio amplifiers with single and push-pull pentode output; combination transmitter-receivers; quasi-optical frequency receivers; prospecting equipment, etc.

The astounding efficiency, which goes UP as the wavelength goes DOWN, of this ultra-new factor in short-wave reception, the "Superregen(-ative Pent-)ode," is due to the use of a superregenerative circuit and three new 2-volt tubes—the general-purpose '30, screen-grid '32, and pentode '33—in the battery model; or the standard '27, screen-grid '24, and pentode '47, in the high-power or A.C. model.

The battery model is conveniently powered from any available current supply; and is as compact as good efficiency will permit.

SUPERREGENODE

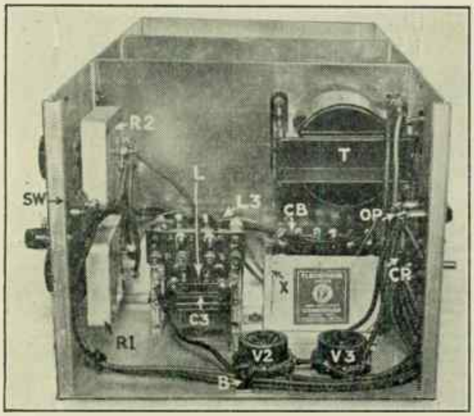


Fig. C—OP, output terminals 10-11; CR, battery-cable receptacle; CB, condenser bank; X, bare-wire "A—" common lead.

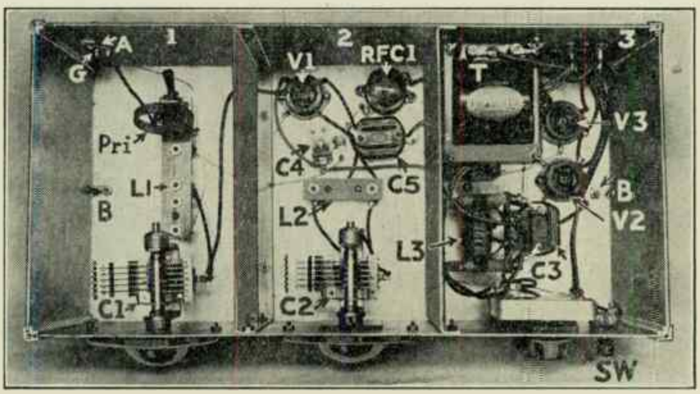


Fig. B—Bolts B hold the heavy aluminum case rigidly. The primary of L1 is hinged to the coil receptacles. L3, 30-kc. transformer; L, its 150-turn added winding.

For instance, if the local oscillator has a frequency of 10,000 cycles every 1/10,000 of a second it will apply to the detector tube a negative voltage which damps the oscillation of the latter; and then remove this potential, applying a positive voltage which increases sensitivity.

Thus the action of the local oscillator enables us to push the detector further into that state of sensitivity in which oscillation takes place in a normal regenerative detector. It is apparent that more signal energy thus reaches the plate circuit, and more will be fed back to the grid, before the tube can spill over. The result is tremendous gain in volume; and the effectiveness of this circuit increases greatly *as the frequency of the incoming signal increases*—that is, as the wavelength shortens.

Addressing the Institute of Radio Engineers, in June, 1922, Major Armstrong pointed out that the superregenerative principle is that "if a periodic variation be introduced in the relation between the negative and the positive resistances of a circuit containing inductance and capacity, in such manner that the negative resistance is alternately greater and less than the positive resistance, but the average value of resistance is positive, then the circuit will not of itself produce oscillation; but, *during those intervals when the negative resistance is greater than the positive, it will produce great amplification of an impressed E.M.F.*"

The latest laboratory development of this circuit is shown here for the first time in Fig. 3. It comprises a screen-grid detector or mixing tube V1; a suppressor - frequency "general - purpose" tube V2 which is coupled to V1 and working at a frequency which results in the desired blocking action; and a pentode power audio amplifier V3, which handles the audio output of the detector. (Hence the name, "Superregen[eration and pent-]ode.")

In Fig. 2 it will be noted, the tuning circuit is of the "tuned-grid tuned-plate" type; and, as the inductances L1, L2 are in separate shield cans, the only existing place for feed-back is through the ex-

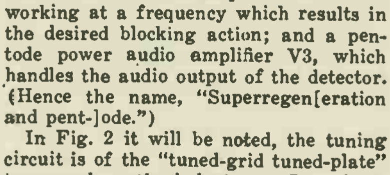


Fig. 1—The regenerative detector is extremely sensitive, but oscillation limits its effectiveness.

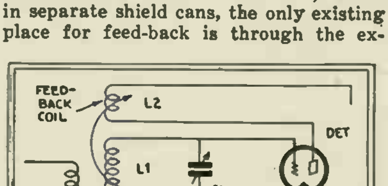


Fig. 2—Varying the screen-grid voltage prevents oscillation from feedback through the tube.

tremely low internal capacity of the screen-grid tube. At resonance, however, this tube will spill over into oscillation, if the screen-grid potential is correctly adjusted. Because both the grid and plate circuits are tuned, selectivity is exceptionally good; and every care must be taken to lay out, wire, and shield the receiver properly to keep circuit oscillation under control. Smooth action in this portion of the circuit was obtained through the use of a "Supertonatrol" variable resistor for R1, which controls the energy fed into the detector.

Tests of frequencies between 4,000 and 30,000 cycles show that the maximum gain is obtained in the Superregenode when the oscillator develops a suppressor-frequency between 4,000 and 8,000 cycles. Extremely interesting results were obtained with a fixed oscillator working at a frequency of 6,000 cycles.

In consideration of the pleasure that may be derived from experiments in unbeaten paths, two variations in oscillator design are shown in Figs. 4 and 5; the latter, as worked out by the writer, includes Pacent "honeycomb" coils.

In Fig. 4 is shown an unusual arrangement for obtaining low-frequency oscillations, without the detriment of excessive bulk. A push-pull A.F. transformer and a 30-henry choke coil are used to generate the desired frequency; without condenser C1, the circuit will oscillate at its natural frequency, approximately 6,000 cycles. The output of the oscillator is fed to the screen-grid tube through one half of the

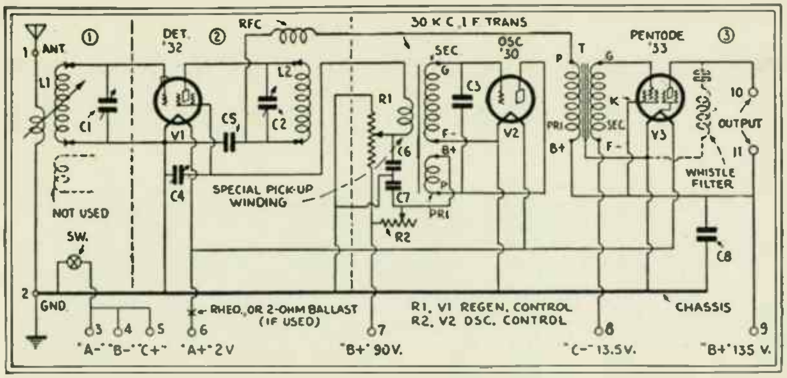


Fig. 3—The Superregenode circuit for battery operation; see Fig. 11 for the detail of the "whistle filter." A push-pull output transformer for '45s is a good match for the '33 pentode.

secondary. Resistor R1 functions as a means of throwing the modulated tube circuit into and out of oscillation; and R2 controls the power output of the local oscillator.

The circuit shown in Fig. 5 is conventional; it includes a 50,000-ohm grid leak and a .00025-mf. grid condenser. Tuning condenser C1 has the large capacity of .001-mf. An optional method of tuning is to place the variable condenser as shown in dotted lines.

Any one of these oscillator circuits is sure-fire and, by substituting different values of capacity, the frequency of oscillation may be raised or lowered; the latter effect resulting when the capacity is increased.

Some explanation is necessary, of the extremely novel, effective and compact oscillator inductance design which has been selected as the best—that illustrated in the photographs.

An old Acme 30-kc. superheterodyne I.F. transformer (appropriately enough) had its outer protective metal covering removed; and over the outside of the exposed winding (the original primary-secondary combination) was wound a third or tertiary pick-up coil L of 150 turns of No. 28 enamelled wire, random-wound. Condenser C3, .001-mf., tunes the oscillator circuit.

Construction and Wiring

The first part of the construction job is to drill the holes in the aluminum box as indicated in the drawings; which give the dimensions of the set illustrated.

If the constructor wishes to be certain that the parts will mount correctly the first time, he must use the components specified.

If substitution is made, it will change the drilling specifications.

Having drilled all the holes, the next step is to mount the antenna and ground binding posts on the rear panel (Fig. 6); making certain that the antenna post does not short to the panel. The male member of the 7-wire cable and the speaker's dual terminal are mounted at the opposite end. This completes the assembly.

Next let us mount the instruments that appear on the front panel (Fig. 7). At the right-hand side is placed the filament switch, and next to it the two 50,000-ohm "Tonatrols" R1 and R2, which are insulated by washers. The

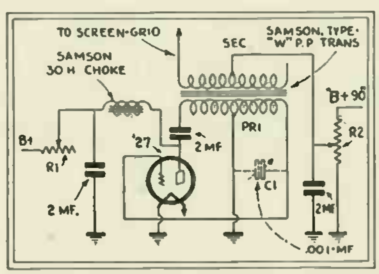


Fig. 4—One of the oscillators used experimentally to generate the suppressor-frequency.

plate circuit's tuning condenser C2 also must be insulated. There are numerous ways in which this may be accomplished.

On the base (Fig. 8) are to be fastened the coil mountings.

Wire in the antenna and ground connections, control-grid lead, and the leads of the tuning condenser. Place in position the first of two compartment interstage shields (Fig. 9) and lock it tightly. (In short-wave receivers, loose shielding is the source of great noise.)

In the second compartment, place the four-prong socket for the type '32 tube; the 80 mmf. equalizing condenser C4; and the 250-millihenry choke coil RFC1. The .001-mf. fixed condenser C5 is grounded to the chassis.

However, do not depend upon the chassis for connections, but run a wire to every point shown as grounded. This eliminates what would otherwise be a source of inter-unit connection, causing undesired effects.

Wire up all of the parts which so far have been assembled, and drill four small holes at the bottom of the second partition. One is for the plate lead to the A.F. transformer, one is an oscillator pick-up connection; another for the "A+" line; and the fourth for the "A—" lead and ground, a wire which should be bare. Pull these wires through the holes provided for them, after tightly bolting the second partition (also Fig. 9) in place.

Solder flexible leads to the filter block and fasten it in place. In this bank there are five one-microfarad condenser sections; one section bypasses the "B+135" lead; two more in parallel, the 50,000-ohm resistor R1; and the two remaining, also in parallel, at the moving arm of R2 bypass the plate supply of V2.

The sockets of V2 and V3 and the 30-kc. transformer L3, with its added winding, are mounted in position and wired.

To prevent the resistor R1 from shorting the plate supply when the receiver is not in use, and thus slowly draining the "B" batteries, "B—" and "C+" are connected to separate leads, which return to the chassis only through the filament switch.

Insert in their respective receptacles the requisite two coils for a given tuning range and turn the receiver's control switch to the "on" position. If the receiver is working, a thin high-pitched whistle will be heard in the background.

If this whistle is not evident, it is an indication that the oscillator is not functioning; and the first step is to reverse the leads to either the primary or secondary winding of the 30-kc. transformer (or the honeycomb coils, if used). This should correct the condition.

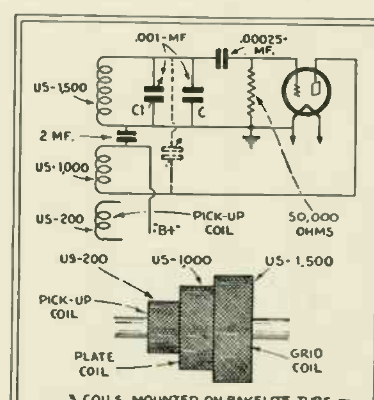
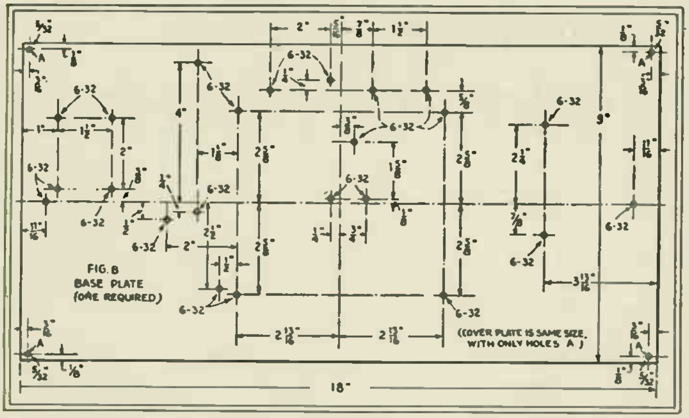
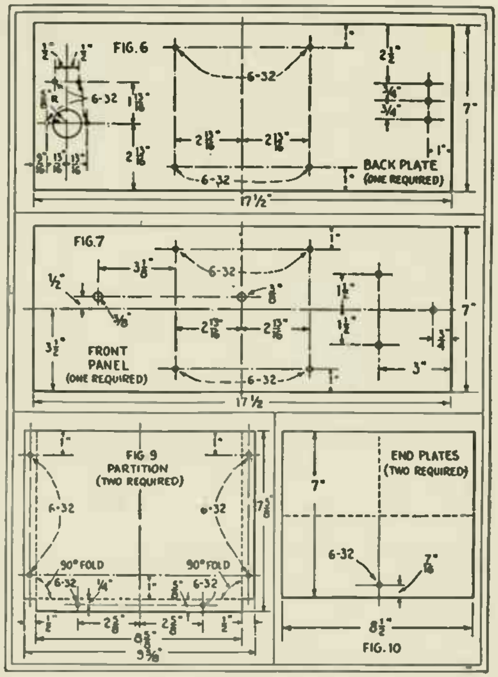


Fig. 5—A less compact oscillator design, using duo-lateral ("honeycomb") coils. This was tried experimentally, but is difficult to shield.





In Figs. 6 to 10, at right and above, the drilling measurements of the shields are indicated, for the receiver illustrated. They must be altered if necessary to suit the components selected by the constructor.

Vary the resistor R2; when volume of the whistle should change. Rotate the tuning control until a signal is heard; and, for 'phone reception, vary the voltage on the screen-grid of V1 until the circuit is just under the point of plop-over. For C.W. signals, let it plop. Simple?

Every short-wave receiver must be nursed along until the operator becomes conversant with its eccentricities; although it must be said that the Super-regenode handles very well; since once the setting for maximum volume has been determined the set may be tuned from one end of the range to the other, in either the oscillating (C.W.) or non-oscillating ('phone) condition.

When searching for 'phone signals tune by the chirps and then lower the screen voltage by means of the potentiometer R1.

The action of the battery and A.C. models is the same in tuning, but the R.F. gain and power output of the A.C. job is far greater.

For maximum efficiency, the load impedance in the plate circuit of the pentode in either case should be between 7000 and 8000 ohms at 60 cycles. Where headphones or a dynamic reproducer are used, a matching transformer of suitable design must be employed.

Trapping the Suppressor-Frequency

If, for reasons not evident in the receiver constructed by the writer, the high-pitched whistle is considered objectionable, it may be expedient to have recourse to the circuit arrangement shown in Fig. 11; the tone filter shown in this diagram consists of a coil and condenser in series, connected across the output; that is between pentode plate and ground. If the oscillator's output frequency is known, the values required for L and C may be determined in a minute from the following formula:

$$L \times C = 259{,}300 \div f^2$$

Here L is in henries, C in microfarads, and f is in cycles.

For example, if the oscillator frequency is 6,000 cycles, a result is obtained as follows:

$$LC = \frac{259{,}300}{6{,}000 \times 6\,000} = \frac{259{,}300}{36{,}000{,}000} = .00721$$

Since .0072 is the product of the value of the inductance and capacity, if we are using a 30-henry audio choke, we divide this L × C product by 30, as follows:

$$\frac{.0072}{30} = .00024\text{-mf.}$$

The nearest commercial condenser value is .00025—quite close enough for our purpose; for it will tune the circuit very close to 6,000 cycles and, acting as an acceptor-trap, it by-passes to ground the 6,000-cycle suppressor frequency

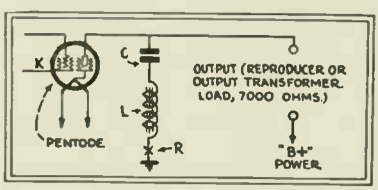


Fig. 11—The "whistle filter," or trap for the audible suppressor frequency.

that has served its usefulness in the receiver. If it is desired to broaden slightly the tuning of our acceptor-trap, a 5,000- to 10,000-ohm variable resistor R (Fig. 11) may also be connected in series at X and adjusted for best effect.

The thrill of working great distances is not a new one for the short-wave fan; but obtaining this result at excellent loudspeaker volume, with low current consumption and extreme circuit simplicity, is something further. The beauty of the design is that much may be learned through working with it.

Variations and Applications

Countless ideas can be developed by the fellow with a little inventive ability and the initiative to push them through. For instance, there is before us the use of variable-mu tubes in place of the more standard screen-grid type. Again, it is possible to modulate the screen-grid circuit with the output of a microphone amplifier and "mike"; when you will have a low-power speech transmitter.

Indeed, by suitable switching arrangement and parts selection it is possible to build up a portable combination transmitter and receiver with very great range for the tubes used and power expended; something in the order of 5 miles as a transmitter, and thousands as a receiver.

Instead of speech transmission, code may be sent by breaking with a key the detector circuit when adjusted for oscillation. The local oscillator, instead, may be keyed, if desired; and thus modulation of the oscillating detector's output signal may be obtained and varied by adjustment of the local oscillator.

Acknowledgement is here made of the courtesy of York Engineering Service for the use of their equipment and labo-

(*Continued on page* 41)

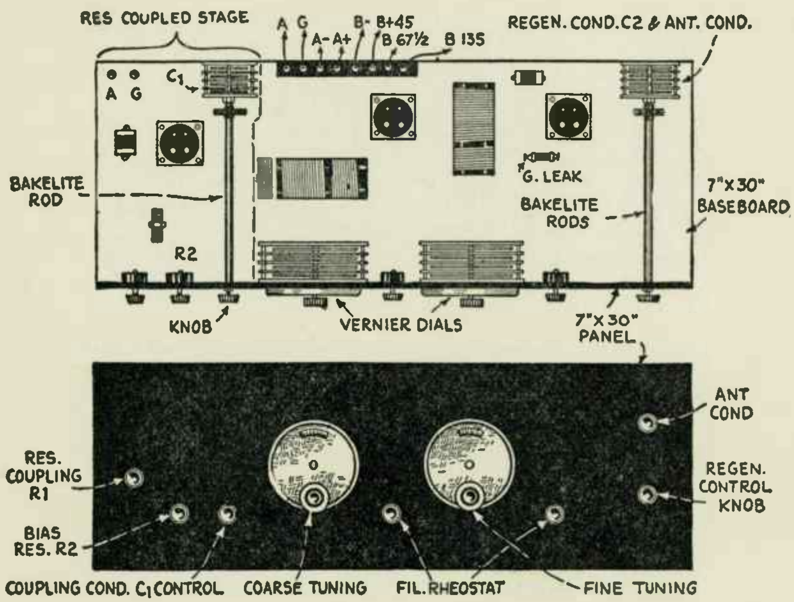
How to Add Two Radio Frequency Stages to

The Hammarlund S-W Receiver

By H. W. SECOR

The suggestions given in the accompanying article are the result of actual construction and tests. Excellent results were obtained in the reception of both code and phone short wave stations.

IN an effort to improve the sensitivity or pick-up range on my short wave receiver, the author, after reading all of the articles published in past issues of SHORT WAVE CRAFT, finally worked out the circuit herewith illustrated. There is nothing radically new or startling about this arrangement but considerable increase in signal strength results from this hook-up. It will be remembered that the ordinary Hammarlund short wave receiver circuit calls for one stage of shield-grid amplification ahead of the detector, this stage being an untuned stage. As is well known a tuned stage of radio frequency is always preferable to an untuned one, for when such a stage is tuned to the exact wave being received in a given instance, the circuit is then operating at full or maximum efficiency, in accordance with the well-known laws of electrical resonance. Of course the designer of a short wave circuit is always bothered in his conscience by two salient problems: One, the simplicity of tuning and two, the greatest sensitivity and selectivity possible at a nominal expense for apparatus.



Top and front views of the modified Hammarlund short wave receiver, having one untuned and one tuned stage of R.F. ahead of the detector. Once the set is adjusted, all the tuning is done with the two large vernier dials.

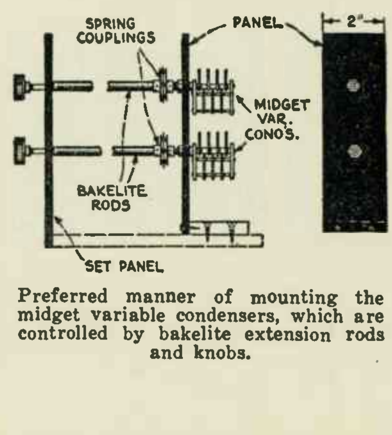
This circuit seems to supply both of these qualifications as there is practically one additional tuning control added, that of the variable condenser at C1, connected across the inductance S1.

To eliminate a third tuning condenser the first stage is either resistance or choke coil coupled to antenna and ground. From experiences of others as well as the author's the choice of a resistance or choke coil coupling to antenna and ground seems to be about even, a lot depending of course upon the form of resistance used and also upon the design of the choke coil you may select. The writer tried an 85 M.H., Hammarlund radio frequency choke for antenna coupling at R1 and the results seemed to be about the same as when using a Bradleyohm of from 10,000 to 100,000 ohms rating (variable). A Clarostat was used with equally good results.

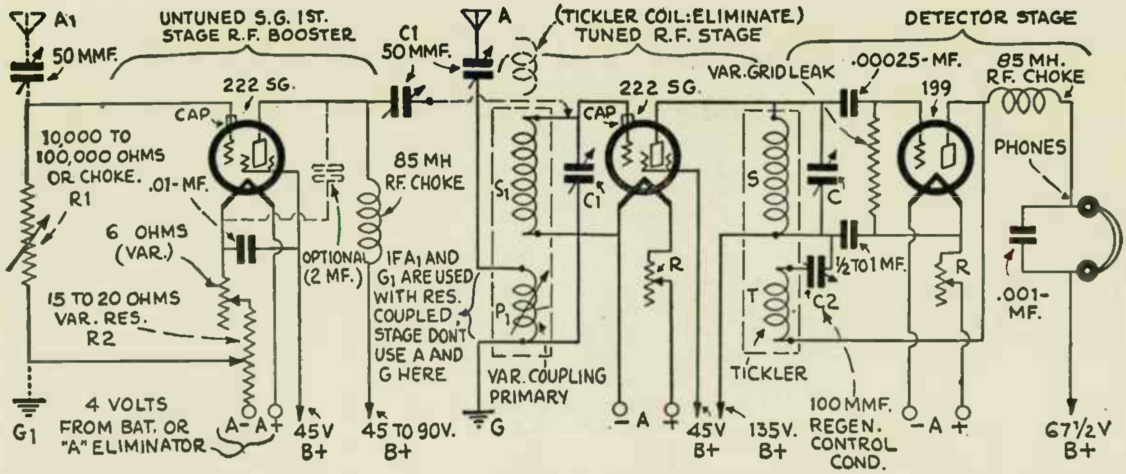
The untuned antenna stage of radio frequency is coupled through a 50 mmf. condenser C1, to the tuned radio frequency stage S1-C1. For those who do not care to bother with the untuned booster stage here shown, they may connect the aerial and ground to the variable coupling primary P1 of the tuned radio frequency stage. The main tuning controls are condensers C and C1, and the regeneration control condenser C2.

This circuit was tried out with '22 screen grid tubes in the radio frequency circuits and a '99 in the detector circuit. The author generally uses a Benjamin shock-proof socket and a great many noises and howls that operators complain of, especially when using '22 tubes, are entirely eliminated in this simple way. In the author's opinion no tube should be mounted on a solid socket as microphonic howls are liable to be built up when non-resilient sockets are used. By following some of the diagrams published in various previous issues of SHORT WAVE CRAFT, it is a simple matter to wire this circuit so that '24 A.C. screen grid tubes can be used and a '27 detector tube used in the detector stage. Very strong signals were received with this circuit in the phones without any audio amplification; the signals were then amplified and placed on the loud speaker by connecting the detector out-put to a two stage audio amplifier, comprising an impedance-coupled stage and transformer-coupled stage. The plug-in-coils used in this circuit were the regular set of Hammarlund coils, the plug-in-base in the tuned radio frequency stage being fitted with the Hammarlund variable coupling or pivoted primary. The tickler winding can be cut off the coils used in this stage, but this is not necessary when you are first trying out the circuit.

This circuit was tried out at first with A and B batteries and later tests were made with B eliminator (All-American, which has extra large choke coils in the filter. These were the standard coils furnished originally in the eliminator and not built special), while the A supply was furnished by an A eliminator similar to the Balkite or electrolytic rectifier type. In accordance with the



Preferred manner of mounting the midget variable condensers, which are controlled by bakelite extension rods and knobs.



Wiring diagram showing connections for one untuned, shield grid stage and one tuned, shield grid R.F. stage ahead of the detector, in a Hammarlund short wave receiver. Greater selectivity and sensitivity are produced, so that good readable signals are heard in the phones without an audio amplifier stage, the signals may also be passed on to an audio amplifier of any suitable type.

modern practice in commercial short wave receiver design, the tubes may be of the '24 shield-grid and '27 type with their heater current supplied from a filament transformer.

If a shield-grid tube such as the '24 is used in the detector stage a very fine and even control of the regeneration is then obtainable by utilizing a 50,000 ohm potentiometer to regulate the voltage supplied to the screen-grid of the detector tube, as is done very effectively in the new National A.C. short wave receiver circuit.

The drawings given herewith indicate the general arrangement of the apparatus as tried out by the author and while shielding may be used and experimented with, no shielding was employed in the experiment mentioned. It will be found very desirable to mount the midget condensers C1 and C2 at the rear of the sub-base and to connect these by means of bakelite rods with the knobs on the front of the panel. It is best to mount the plug-in-coil bases so that the coils will be at right angles to one another; metal shields may be placed over the tubes, or else the new Hyvac "self-shielding" tubes may be employed.

The following list of parts will be found valuable and practical for the circuit here described:

1—Variable resistor 10,000 to 100,000 ohms R1; Bradleyohm, Clarostat, etc.
2—50 MMF midget variable condensers; Hammarlund
1—6 to 10 ohm variable filament resistor; Electrad
1—Filament rheostat R2; Bradleystat or other make
1—.01 MF condenser; Sangamo
1—2 MF by-pass condenser, 250 volt rating; Aerovox
2—85 MH radio frequency chokes; Hammarlund
2—'22 screen grid tubes; any standard make
2—sets of short wave plug-in-coils; one set being preferably fitted with variable coupling primary; Hammarlund used by author.
2—125 MMF short wave type variable condensers; Hammarlund
2—Filament rheostats for tuned radio frequency and detector stages
1—100 MMF regeneration control condenser; Hammarlund midget
1—Grid condenser .00025; any well-known make
1—Variable grid leak; use Bradleyleak or else experiment with different metallized grid leaks such as Durham, from 2 to 5 megohms
1—Phone by-pass condenser .001; Sangamo
1—Condenser C3, of ½ to 1 MF; Aerovox

New—The Short Wave Superregenode

By CLIFFORD E. DENTON

(Continued from page 39)

ratory facilities for the construction and testing of this interesting receiver.

If any of the readers of SHORT WAVE CRAFT wish to write to obtain any assistance in the construction of the Superregenode, the writer will be glad to oblige if a stamped and return-addressed envelope is enclosed with the inquries. It is hoped that constructors will not deviate too greatly from the parts recommended and constructional data just completed, in their choice of apparatus, and the individual arrangement of the chassis. Nevertheless the ramifications of the Superregenode are legion, and the writer expects to receive some mighty interesting comments on the results obtained by some of the more advanced technicians.

List of Parts—Battery Model

Two Hammarlund "MLW-125" 125 mmf. Short Wave condensers, C1, C2, and two Kurz-Kasch vernier dials;

One Hammarlund 14-to-110 meter "Model LWT-4" short-wave kit, L1;

One Hammarlund 14-to-110 meter "Mode LWC1" short-wave kit, L2;

One Hammarlund "Type RFC 250" 250-mh. R.F. choke, RFC1;

One Hammarlund "Type EC 80" 80 mmf. equalizing condenser, C4;

One Flechtheim filter block (five 1-mf. units), C6, C7 (2 mf.), C8 (1 mf.);

One Ferranti "Type AF-5," 3.75-to-1 ratio audio transformer, T;

Two Sangamo .001-mf. fixed condensers, C3, C5;

Two Electrad 50,000-ohm "Super-Tonatrols," R1, R2;

One Acme 30-kc. I.F. transformer, L3 (see text);

One Yaxley 7-wire cable. 3 to 9;

Two Eby lettered binding posts, 1 and 2;

One output connection block. 10-11:

Two Pilot 4-prong UX sockets, V1, V2;

One Pilot 5-prong UY socket, V3;

One aluminum cabinet 7 x 9 x 18 x 3/32 in. thick;

Two aluminum sheets (partitions), 7⅝ x 9⅝ x 3/32 in. thick;

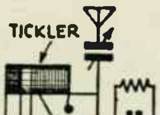
The kit of coils designated as LWC1 consists of single windings with the same number of turns as the secondary in the Type LWT4 kit. Data on the latter are as follows:

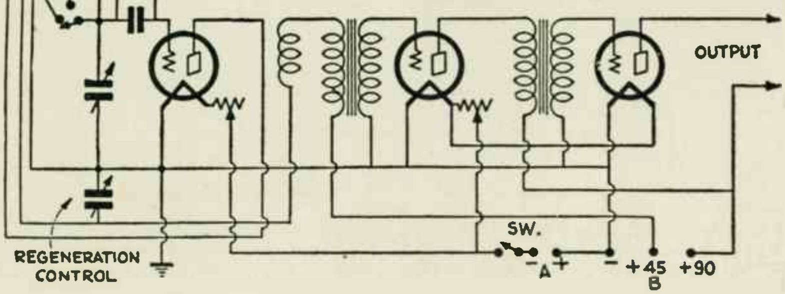
Meter Range	*Sec. Turns*
14- 24	3
22- 40	7
36- 65	15
60-110	24

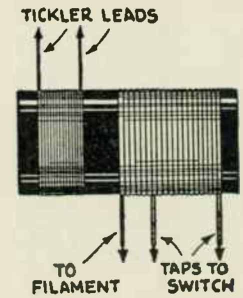
The first two coils are wound with No. 16 D.S.C. wire, 11 turns to the inch; the last two coils, No. 18 D.S.C., 17 turns to the inch; all on forms two inches in diameter. The adjustable antenna primary has 6 turns of No. 28 D.S.C. wire on a two-inch tube.

Fine Results With Tapped Coils

By RODERICK BERRY
Radio Operator, S.S.-S.M. Spalding







Wiring diagram and also detail of "tapped coil" construction for short-wave receiver, successfully using switch to change the wavelength instead of plug-in-coils.

AFTER reading the article in October-November SHORT WAVE CRAFT, concerning tapped inductances in the high-frequency receiver, I believe you would be interested in my own experiments with this type of inductance.

Various tests were made, using space wound, Lopez, self-supporting coils, etc.; but the most satisfactory results were obtained with coils made of No. 18 enameled wire space-wound an a 2½-inch skeleton form.

To successfully cover the band from 15 to 50 meters, 8 turns were used on the grid coil with a tap taken off at 3½ turns. The plate coil was wound with 4 turns of No. 22 cotton covered wire spaced ⅛-inch from the grid coil.

No Appreciable Dead-End Loss

This set has worked very satisfactorily and no less in volume is noticeable from dead-end effects. While going from Boston to Montevideo (Uruguay), Arlington (NAA), New Orleans (WNU), New York (HPN-WHD), and Rugby (GBR) were copied every night. As for broadcast reception, WGY, KDKA, and WBZ were heard while docked in Montevideo and consistently throughout the voyage. Many other code and broadcast stations from all over the world were logged with the same volume as when plug-in coils were used.

Both magnetic and capacity coupling were tried between the grid and antenna circuits, and about equal results were obtained. Twelve turns of No. 22 cotton-covered wire, wound on a 2-inch form, then made self-supporting, were used for the antenna coil when using magnetic coupling; and a midget variable condenser was placed in series with the antenna and the grid coil when a capacity-coupled circuit was desired. With this tapped coil, a detector and two-stage audio hook-up was used, with a variable condenser to tune the plate circuit of the detector.

Leads from the grid inductance must be kept as short as possible, and are brought out to a two-point switch on the side of the cabinet.

A .00016-mf. variable condenser was used across the grid coil, and a .00025-mf. in series with the plate coil.

Hints On the Beam Antenna

By J. M. REED, W6EIJ, WCDV

THE purpose of this article is to give a few fundamental ideas to help those experimenters wishing to construct a short-wave beam antenna and not knowing exactly how to start.

In the first place, it is necessary to decide what type of beam is desired. Perhaps the most common type is the so-called "Linear" or "Broadside" array. This consists of two or more antennas so spaced that their fields cancel in certain directions and reinforce each other in other directions; thus producing a "beam effect".

Fig. 1 shows an arrangement where "A" is the antenna, and "B" is the reflector; the arrow shows the direction of transmission. The distance between "A" and "B" has been found to be best when it is ¼-wavelength; this gives a phase difference of approximately ¼-period. A combination of one antenna and one reflector is called a "couplet". The couplets should be spaced ¼-wavelength apart, as shown in Fig. 1.

It has been found that, the longer the beam system (that is, the more couplets) the sharper will be the transmitted wave. This holds good up to a certain point where the system begins to transmit in other directions; however, the average person will not have enough ground space to reach that point. Up to sixteen or more couplets may be used without spoiling the directional effect.

Needless to say, considerable space is necessary for this type antenna.

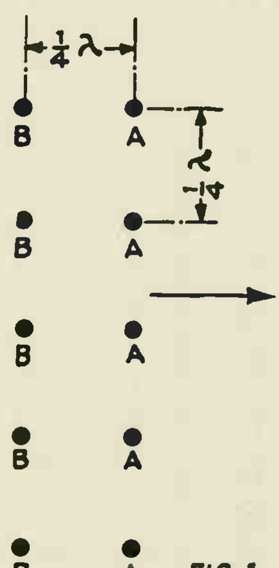


FIG. 1
Arrangement of simple beam antenna sections.

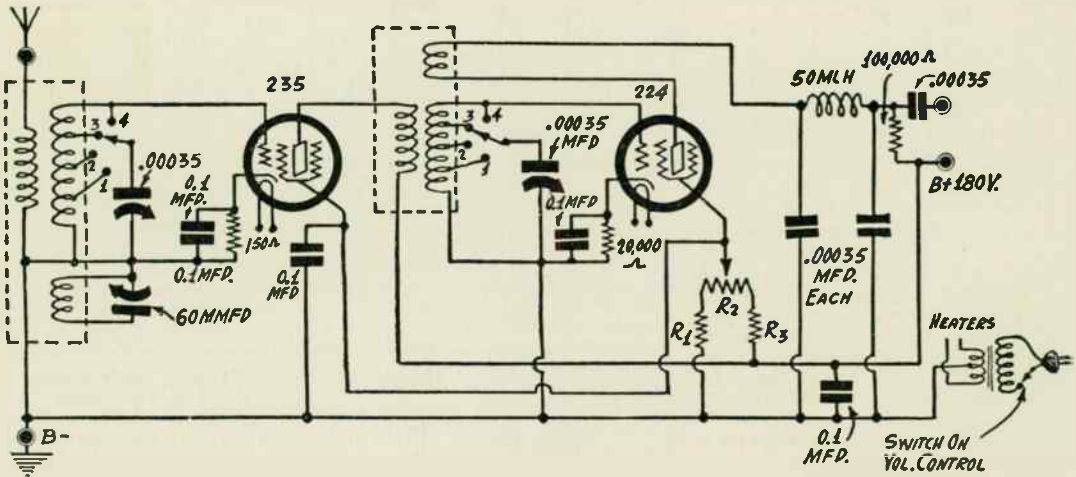
SHORT WAVE

The old "bogey man", the tapped coil and switch arrangement, for changing from one waveband to another, has had its ailments cured by the radio doctor, Mr. Bernard. Let's go! Boys—here's how to tune in all the various short-wave bands "without benefit of plug-in coils"!

TUNING LESS PLUG-IN COILS

By HERMAN BERNARD
Managing Editor of "Radio World"

Fig. 1—How to use tapped coils and switches in a regenerative receiving circuit having one stage of R. F. amplification (with variable Mu tube) ahead of it.



THE trend in short-wave reception is toward the use of a single switch, to control the band changing from the front panel. Since no resistance is desired or useful in the circuit, the solution resolves itself into the changing of inductance or capacity or both. Capacity changing has its mechanical difficulties; since complicated switches are needed to introduce some fixed or variable condensers in parallel and others in series with the tuning condensers. Yet inductive changing is very simply accomplished by the home constructor.

The band shift is accomplished by tying the stator of a tuning condenser to a switch which will select all of a coil or part of the coil for tuning; since the entire coil is always in the circuit, there are no dead end losses. In fact, just as soon as less than the entire coil is tuned by the condenser, there is established a set-up ratio, equal to the ratio of the number of turns in the tuned circuit to the total number of turns. That is, an auto-transformer is created. Hence (considering usual primary and secondary in their ordinary sense) you introduce a "second secondary" in the auto-transformer method, and the voltage step-up increases.

3-Tube Regenerative Receiver

Fig. 1 shows the coil-switch method adapted to the familiar pattern of a stage of screen grid, radio-frequency amplification and a regenerative detector. The output is filtered, so that the detector plate voltage will be certain; and also so that there can be no direct-current short, when plugging into a broadcast set to give speaker volume.

Four switch points are shown; that means there are three taps, besides the extremes of the coil.

This is a circuit where the two stages are tuned to the same frequency. The coils must be independent (not coupled to each other) and may be shielded. For shields, use copper or aluminum, not less than 3-inch diameter; in which case the total secondary for .00035-mf. tuning on 1¾-inch (diameter) tubing would be 91 turns, the taps being at the 68th, 85th and 89th turns from the grid end.

For .0005-mf. capacity, with shielded coils, of the same diameter, the total secondaries would have 85 turns, the taps being proportionate. In all instances, from 15 to at least 560 meters can be covered.

Without shielding, for the same diameter, the secondary for .0005-mf. tuning would be 60 turns, and for .00035-mf. 70 turns; the taps proportionate. R1 may be 1,000 ohms; R2 any potentiometer of 3,000 ohms or more; while R3 should be about twice the value of R2. The other values are given in the circuit diagram.

It will be noticed that the new "exponential" or "variable Mu" tube, the '35, is specified as the radio frequency amplifier. The method of volume control-sensitivity adjustment renders inclusion of the '35 pertinent.

All-Wave 1-Tube Set

The same system can be applied to an all-wave one-tube set, as in Fig. 2, where there are only 9½ volts of applied plate voltage (the voltage of a 7½-volt battery of the "C" battery type plus the filament voltage drop).

Since only low voltage is required for detection, 9½ volts are sufficient, and feedback will result in great gain, if properly established. A larger number of turns is required on the feedback coil, on account of the low voltage, than would otherwise be used.

The wavelength changing from band to band is done by a band-selector switch, which should be of the insulated-shaft type. The reason for requiring insulation of the shaft from the pointer is that the moving arm or pointer of the switch is at a "hot" R.F. potential. Even shielding a non-insulated switch would not prevent body capacity; for the effect would be introduced from hand to tube through

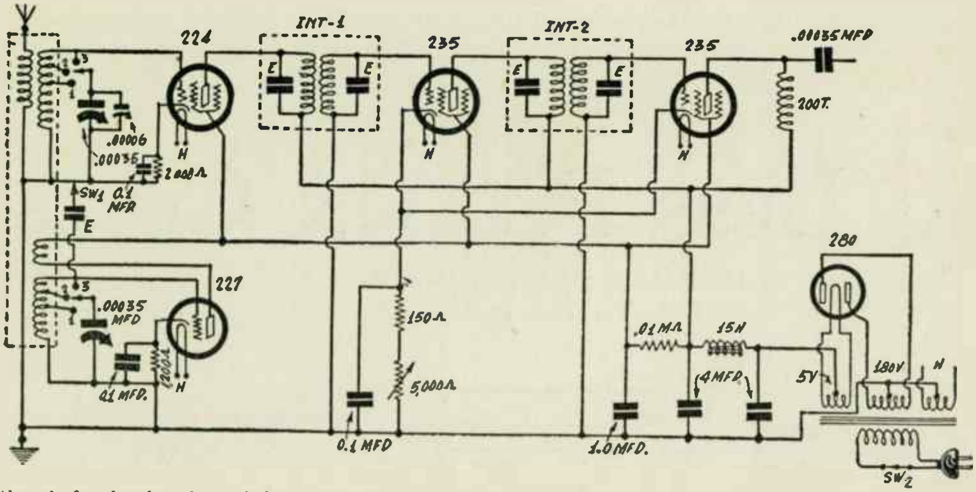


Fig. 3—Illustrating the use of tapped tuning inductances provided with switches for use with an "all-wave" converter. The oscillator employs a '27 tube.

the shaft, despite the bakelite knob on the shaft.

As the diagram reveals, the moving arm of the switch is connected to the stator of the tuning condenser. At one point incidentally, (it is actually point 4 on the diagram) the stator goes direct to grid, and the tuning condenser is across the entire grid winding. However, in all other instances, the stator is connected to a point lower down on the grid coil; and, the lower down the connection is, the less inductance is in the tuned circuit, and the higher are the frequencies for which the switch is set.

While the feedback winding L3 is entirely separate from the secondary L2 (which permits the interposition of the feedback condenser in grounded-rotor fashion, to prevent body capacity) the direction of the winding must be such as to afford regeneration. This means that the secondary L2 and the tickler winding L3 must be oppositely phased; since the radio frequencies in the grid and plate circuits are 180 degrees out of phase. If no oscillation results, simply reverse the connections to the tickler winding.

The tickler may have 20 turns, the antenna winding 12 turns. Wire gauges are not very important, except that the secondary should not have finer than No. 28 wire.

All-Wave Super-Het Without Plug-in Coils

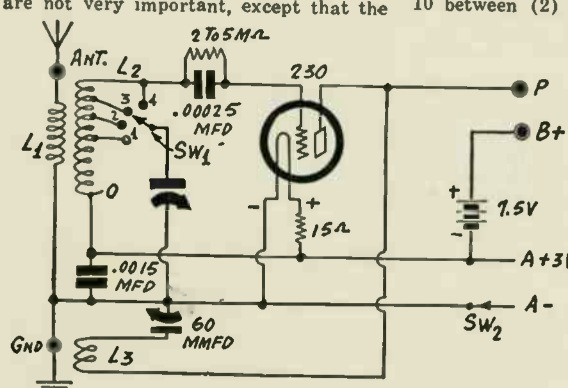
When one uses the switch system in the mixer of a superheterodyne, or of an all-wave converter which uses the superheterodyne method, the situation is a little different. In the broadcast band and in the lower-frequency region of the short waves, there is a substantial *percentage* difference in frequency between the modulator and the oscillator; the *absolute* difference equalling the intermediate frequency. To this extent the situation is just the opposite to that present in a tuned radio-frequency set, where there is only one frequency to consider for each circuit.

Fig. 3 shows an all-wave converter with two stages of amplification; the switched condenser E (a 20-100 mmf. equalizer), adjusted but once, takes care of the frequency difference. Built-in intermediate stages make "logging" practical. The set is to be tuned to the intermediate frequency also.

The oscillator winding consist of 28 turns: with 15 between (3) and (2); 10 between (2) and (1); and three between (1) and (0). The modulator has 68 turns between (3) and (2); 18 turns between (2) and (1); and 5 turns between (1) and (0).

These data are for .00035-mf. with shield, and a three-point double-throw switch is used. With that capacity, about the same wave band can be covered with three points as with four. The only difference is that four give greater "overlap"; which some prefer, because of the small capacity change in the first ten dial divisions or so, with a straight-frequency-line condenser.

There has been and still is considerable controversy among the short wave fraternity as to the efficacy of using tapped tuning inductances in short wave receivers, but the fact of the matter remains that the circuits here shown have been tried out successfully. Success with tapped coil circuits provided with switches for tuning in various wavelengths have been used by a number of experts, and if you have not already read the article by Mr. Roderick Berry, which appeared on page 23 of the June-July issue of this magazine, it would be to your advantage to do so. Also see p. 439, Apr.-May issue.



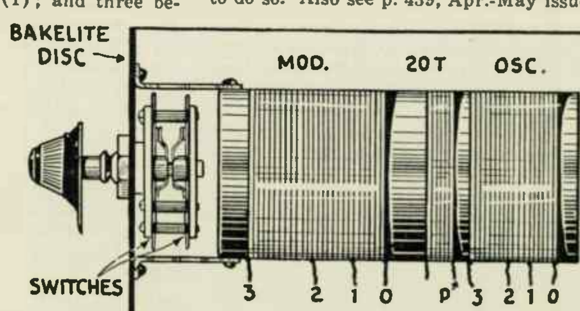


Fig. 2—Using the tapped coils and waveband change-over switch for an "all-wave" one-tube receiver.

Fig. 4—Shows how tapped inductances are wound and mounted.

How to Gain DETECTOR SENSITIVITY

By MANDER BARNETT

Several important factors bearing on detector operation and sensitivity are discussed; also the cause and cure of "howling".

WITH due respect to all the other parts which go to make up the average short-wave receiver, it can truthfully be said that the detector tube and its component parts, are the most important parts of *any* short-wave receiver and should, therefore, receive first attention.

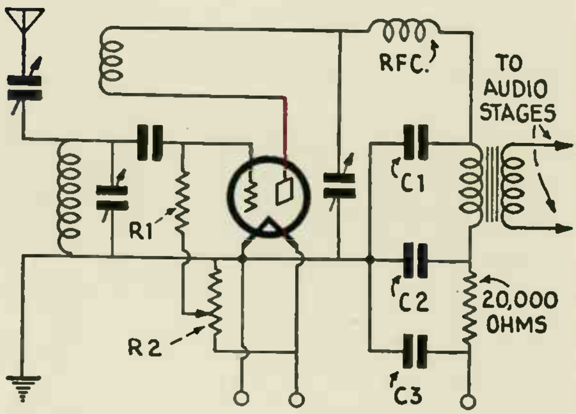
Again, the short-wave receiver has to make use of a regeneration control—the average broadcast receiver has none—and, therefore, we have to set about making this control as easy and smooth working as possible:—not always quite so easy as it sounds.

When somebody will design a short-wave R. F. amplifier with, say, three stages which will give as much amplification if they were being used on the ordinary broadcast band, then there will not be so much need to worry about extreme detector sensitivity as far as the short-waver is concerned. Nobody, however, seems to have done this yet, and we must devote our attention to the detector stage and spend much time and temper trying to make it perk.

At some time or other, practically every short-wave fan has met the receiver which stops oscillating at, say, 50 degrees on the regeneration dial (most modern short-wavers don't have the regeneration dial marked in degrees, but, for the sake of argument, we'll assume that they have) and then starts again at about 40. Well, it's absolutely hopeless trying to get China or Europe on a set that plays like that! So, if your own short-waver shows signs of this trouble, get down to it at once and see what can be done about it.

Grid Leak Value a Compromise

The commonest cause of trouble in this direction is the grid leak. Some short-wave fans prefer low resistance such as 2 megohms; while others always support the use of a much higher value, such as a 10 megohm leak. It is certainly true that the high value will practically always give you a smooth regeneration control; but, at the same time it results in a general loss of detector sensitivity and it will be found that the reproduction is not so clear-cut, because the higher notes of the musical range will be missing. The use of a 2 megohm leak cures this, but at the same time, very often introduces unstable regeneration effects. An excellent compromise between these two effects (or defects) is to use a low value (2 megs.) of grid-leak and, instead of connecting it directly to "A—" or "A+" (according to the type of detector used) connect it direct to the moving arm of a 200-ohm potentiometer R 2, the two remaining terminals of which are then connected across the "A" supply. The grid potential is then adjusted so as to coincide with the smoothest regeneration effects. The potentiometer may be of the baseboard-mounting type because, when the best adjustment has been found, it need not be altered very often. Thus, it does not mean an extra panel control, and the symmetrical appearance of the panel dials will not be upset.



A unique arrangement of by-pass condensers are used in this regenerative detector receiving circuit, which Mr. Barnett uses for short-wave reception in his English station. The detector circuit is the real heart of the short-wave receiver and we recommend all short-wave enthusiasts to read very carefully what Mr. Barnett has to say.

Other Problems of Regeneration Control

Too many turns on the tickler coil will cause unsteady regeneration effects and "regeneration-tuning" also; *i. e.*, a small adjustment of the regeneration control will cause a large change in wavelength, and this effect is *not* wanted in short-wavers!

Too much "B" supply on the detector tube will also prove a ready culprit. In this case, the remedy is obvious, plus a consequent saving in battery costs.

"Threshold howling" is generally prevalent in receivers which use one or more audio stages, if certain points are not observed. Frequently this fault is produced in the audio stages themselves, but sometimes it can be caused solely in the detector stage. A receiver which suffers from this fault is not much use at all, as the howl generally only occurs near the point of oscillation, when the receiver is in its most sensitive condition. The usual cure for this fault is to connect a high resistance across the secondary of the first audio transformer; but sometimes this resistance has to be of a fairly low value before the howl stops and this, of course, cuts down volume.

"Threshold howling" occurs sometimes in the detector stage when the antenna is too tightly coupled. Always have the antenna as loosely coupled as may be consistent with good results. This will also help to smooth out "dead spots" in the tuning, which are caused by the natural wavelength of the antenna. This trouble, of course, does not appear in receivers using a screen-grid tube in front of the detector.

In the accompanying diagram is shown a super-sensitive detector circuit in which every effort has been made to make it as smooth working as possible. R1 is a 2-meg. grid leak, and R2 is the 200-ohm potentiometer. C1 is a small by-pass condenser, about .0002-mf.; a larger capacity would possibly by-pass R. F. currents better, but would cause a cut-off in the notes of the higher musical scale. C2 is a 2-mf. condenser and this, together with the 20,000-ohm resistor, effectively decouples the detector circuit from the other audio and R. F. stages. C3 is merely for R. F. by-passing purposes and must be kept very small—.0002-mf will do again here. This must be kept very small or otherwise it would tend to cancel out the effects of C2. Both R. F. and A. F. stages may, of course, be added to this detector circuit as required.

How to Use R. F. Chokes

By R. WILLIAM TANNER, W8AD

When is a choke not a choke? It might easily be answered—"When it is used incorrectly." Mr. Tanner gives us some very practical information about radio frequency choke coils

MUCH has been written on the subject of coils, condensers, circuits, etc., as applied to short-wave transmitters and receivers; but the R.F. (radio-frequency) choke has been given little or no attention. Generally the experimenter, and

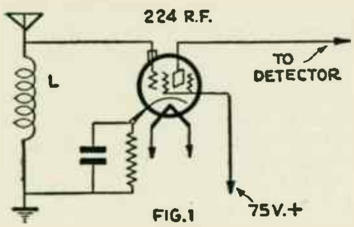


Fig. 1—Above shows usual form of circuit utilizing an untuned stage of R.F. amplification; "L" represents the choke coil.

often the manufacturer, winds some fine wire on a form and places it in circuit as a *radio frequency choke*, believing that it will block all of the R.F. energy, merely because it has many turns of wire.

Radio-frequency chokes are rated by their inductance, such as 10 mh., 85 mh., etc. Very little consideration is given to the distributed capacity upon which depends, almost entirely, whether the choke will be good or bad. The ideal choke would have zero distributed capacity and extremely high inductance—an impossible condition to attain.

Antenna R.F. Chokes

The antenna R.F. choke will be discussed first. In Fig. 1 is shown the circuit of an untuned R.F. stage of amplification, which precedes a regenerative detector; the arrangement employed in the majority of present-day short-wave tuners. The coil L may be thought of as an R.F. choke although, in reality, it is an untuned R.F. impedance or conductively-coupled transformer. Coils having inductance values as high as 85 mh. are specified for most circuits; but almost any coil of 30 turns or so (on a form one inch or more in diameter) will prove fairly effective on all waves from 10 to 200 meters.

Since the capacity of the antenna is in parallel with L, an inductance of .05-mh., or more (assuming an antenna capacity of .00025-mf.) will preclude the possibility of a "peak" occurring at some intermediate portion of the short-wave spectrum.

It is possible to utilize the effect of the shunt antenna to good advantage and increase sensitivity materially; this is accomplished by bringing out taps from the coil L to a multi-point switch; the exact number of turns in each section is an individual problem. The number of taps used should be the same as that of the different detector plug-in coils.

Determining Proper Number of Turns

In order to determine the number of turns, the experimenter may wind, say, 7 turns of No. 30 enamelled wire on a 1½-inch form, and plug in the 20-meter detector-coil. Shunt the 7-turn coil with a small midget condenser (capacity not over .000025-mf.) and tune in a station,

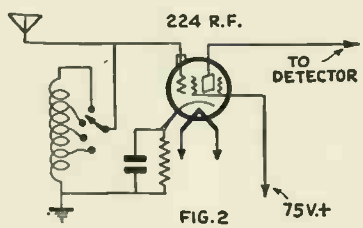


Fig. 2—This diagram shows the use of a tapped antenna choke coil, which greatly increases the sensitivity of the receiver. The tube indicated above serves as an R.F. amplifier.

either code or radiophone, at nearly the full capacity of the detector tuning condenser. Now, remove a half-turn at a time from the 7-turn coil until signal strength is greatest, with the plates of the midget condenser all out. If a higher setting of this condenser is required for maximum gain, more turns are needed.

Then plug in the next largest detector coil; wind 3 to 6 more turns close to the 7 turns, and proceed in the same manner as before. Continue this procedure on through the largest coil. When the coil is completed, solder the taps to the switch, which may be mounted on the front panel.

The R.F. stage then acts as a "peaked" amplifier, and will result in far greater sensitivity than the usual form of untuned R.F. stage. There is still another advantage; that the gain and selectivity will be more nearly uniform over the range of each band. This is because, in the detector tuned circuit, gain falls off as the wavelength is increased; while the effect is just the opposite in the "peaked" stage.

The coil L and the R.F. tube will, of course, require complete shielding, exactly as would a tuned stage.

Series-type Chokes

The next type of R.F. choke under discussion is what is generally referred to as the "series" type, such as are employed in plate and screen grid leads of R.F. amplifiers, as shown in Fig. 3.

These help to keep the R.F. currents out of the "B" supply, thereby reducing feedback. Such chokes are needed *only* when two or more R.F. stages are employed. With one R.F. stage, their absence can only increase feedback in the detector, where it is beneficial. The bypass condensers C are, of course, required without regard to the number of stages.

For series R.F. chokes, almost anything with a sufficient number of turns may be employed. Since the bypass condensers shunt most of the R.F. currents to ground, the chokes are not called upon to do much work. For this reason, distributed capacity is not so important.

Shunt-type R.F. Chokes MUST be Good!

The "shunt" type of R.F. choke *must* be good. High distributed capacity cannot be tolerated, since one end is at a

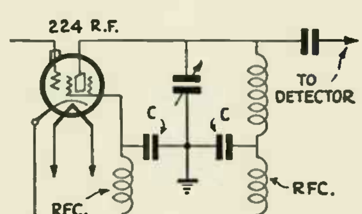


Fig. 3. Above—Series type of R.F. choke connection.

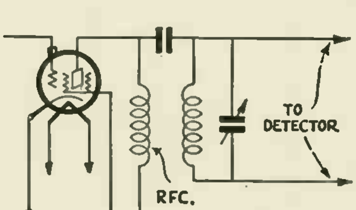


Fig. 4—Here we have the shunt type of R.F. choke.

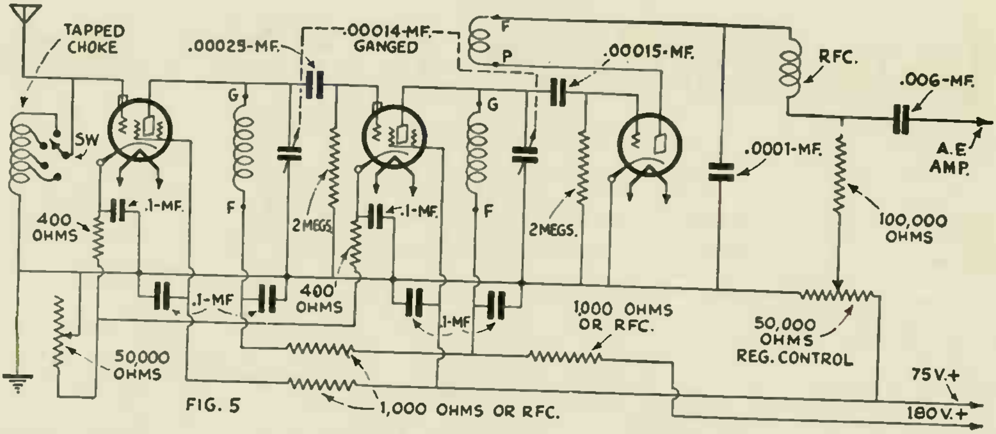


Fig 5—Schematic circuit of short-wave tuner using a peaked R.F. stage, a tuned stage and a regenerative detector with de-coupling resistors. Chokes may be used in place of the 1000 ohm resistors if desired.

relatively high R.F. potential. The connection for a shunt choke is shown in Fig. 4. A choke for use at this point would be, preferably, wound in a single layer; but this would take up too much space for a compact receiver; therefore a "pie" or sectional winding is required. Not less than three sections should be used.

A very efficient choke can be constructed by cutting six slots, separated ⅛-inch, in a ¾-inch wooden dowel; these should be about $\frac{1}{16}$-inch deep. A total of 600 turns of No. 36 enamelled wire is required; 100 turns per slot.

While the R.F. choke employed in the detector plate circuit is not of the shunt type, it should be just as effective; since even the slightest amount of R.F. energy, if allowed to reach the A.F. amplifier, will result in *howling*.

Use of "De-coupling" Chokes

Many short-wave fans are constructing tuners with more than one R.F. stage. Some connect an untuned stage ahead of the tuned stage, while others prefer to tune the antenna circuit. In either case, feedback is apt to be great enough to cause oscillation. The use of "decoupling" chokes will prove far more effective than merely placing chokes in the individual screen-grid or plate leads. In nearly every case, resistors of 1000 ohms can be used in place of chokes for this purpose, thus producing a more compact and less expensive layout.

Fig. 5 shows the use of decoupling chokes (or resistors) for reducing feedback through the "B" supply; all bypass condensers have a value of .006- to 0.1-mf. Volume is controlled by means of a 50,000-ohm variable resistor in the R.F. cathode circuits. This control is in series with 400-ohm resistors, the latter being used to limit the bias to a low value (about 2 volts) as well as to prevent the R.F. currents from one tube feeding back into the other.

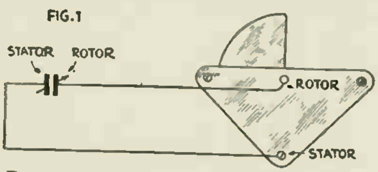
The regeneration control is another 50,000-ohm variable resistor between "B+75," "B—," with the return from the detector plate connected to the contact lever. This type of control has little reaction upon the detector's tuning.

It is well for the set-builder to remember, when purchasing R.F. chokes for use either in *shunt* circuits or in the *detector plate* circuit, *to select those designed especially for short-wave use!* For *series* circuits, almost anything will do.

Practical Hints on Reception

Smooth Regeneration

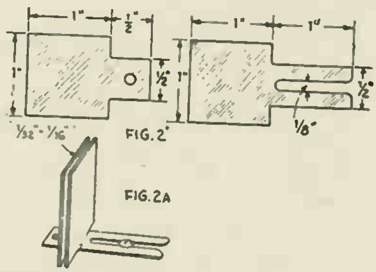
EVEN though the use of a variable condenser for controlling the regeneration in a short-wave receiver is considered best, there is a still finer degree of smoothness to be obtained in the following way. A small three or five-plate midget condenser is connected in parallel with the regeneration condenser; stator to stator, and rotor to rotor. When you have located the carrier wave of a station with the rotor plates of the midget clear of the stators, turn the main regeneration condenser until the set has stopped regenerating. Then slowly turn the midget, and you will notice how nicely and smoothly the volume builds up until you come to the regeneration point, which can be passed very smoothly. I have used this idea for a long time and have been able to receive stations without zero-beating them, even though the carrier wave was so weak it was barely audible in the phones.



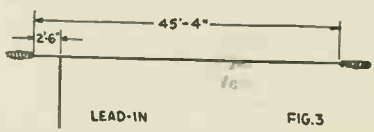
Regeneration control is made very smooth indeed by connecting a three-plate midget condenser, or its equivalent, across the usual regeneration control condenser as shown above.

To Eliminate Dead Spots

After considerable experimenting, I found that dead spots in the tuning range of a regenerative short-wave set were due to the type of antenna used and the method of coupling it to the receiver proper. For a three-tube receiver, using a condenser for coupling, I have found the best aerial, a seven-strand wire 45 feet, 4 inches long, at least twenty feet from the ground, with the lead-in coming in 2 feet 6 inches from one end. With a cold-water-pipe ground, this works with any set comprising one detector and any number of audio stages. But if the set is coupled with a condenser, this component should be of two copper plates, as shown; it should be experimentally adjusted, so that each coil can be used from the lowest wave-length to the highest. The best separation I have found is from $\frac{1}{32}$ to $\frac{1}{16}$ of an inch.—Paul Skitzki.



How to make a very small capacity condenser suitable for connecting in series with the antenna for short-wave reception. The two condenser plates are made out of copper, but brass or other non-magnetic metal will do.

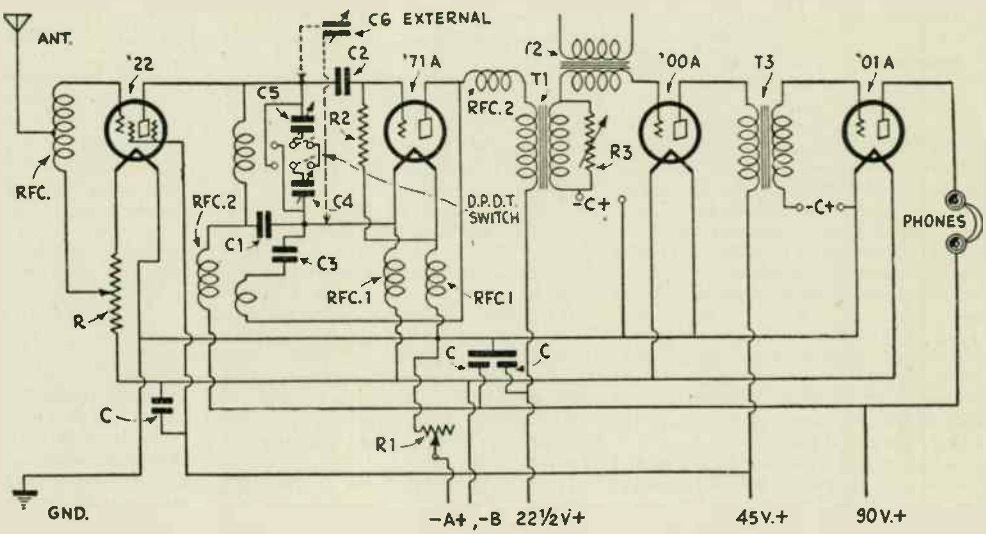


Dimensions of the best form of short-wave receiving antenna, as determined by the author, are shown above.

The "HAM'S OWN" Receiver

By NORMAN B. KRIM

This receiver has a "band-spreader," improved antenna coupling, a monitor circuit for use when transmitting, means to prevent howling and a range up to 700 meters.



Mr. Krim, the designer of this novel and improved short (and long) wave receiver has operated an amateur station and knows the points which a "ham" looks for in such a set. This set has a condenser switch which gives a "band - speaker" action when wanted, as on the amateur bands; improved antenna coupling through a tapped choke, and provision for tuning in the broadcast wavelengths, in fact waves up to 700 meters.

EACH year short-wave receivers have been designed and redesigned but, with radio in its present transient state, we can not decide on any particular type. New discoveries and new uses are constantly changing the short-wave receiver.

Considering these facts, a design has been formulated with evident appeal for both the licensed and the unlicensed amateurs who are searching for a receiver which has a number of new features. The set in mind was intended primarily for the transmitting amateur, who wants a single receiver to cover efficiently the waves from seven hundred down to five meters. Other features are a high-gain untuned stage of screen-grid R.F. amplification, adequate band spreading, very smooth control of regeneration and, lastly, excellent "DX" possibilities.

For anyone to guarantee distant reception on short waves is absurd; but to claim that, for given conditions, more distant reception is possible is well in order. The receiver to be described has proved itself selective by intercepting seventeen different Australian signals in one morning's operation, in a New York City apartment house—equipped with everything electrical from elevator to the Frigidaire.

Detailed constructional information is, many times, useless because each enthusiast assembles things according to his own methods. Nevertheless, there are a few salient features which must not be overlooked, if satisfactory operation is to be expected.

A modern four-tube screen-grid circuit has been redesigned to satisfy my needs. Either A.C. or D.C. power supply can be incorporated; although, on ultra-short waves, direct current is found to be better because of the objectionable hum A.C. supply introduces.

In these modern days of high power and selectivity, the receiving antenna is apt to be neglected; but reception can be seriously impaired by a poor aerial. A well-insulated wire, about fifty feet long, will suffice. On short waves the set operates more efficiently without a ground; on long waves a ground connection is requisite for good volume.

Some Circuit Details

The antenna choke coil is novel, because the antenna current is fed to the center tap instead of to the grid end. The effect of this change is an excellent increase in volume. The choke-coil constants are found to vary considerably for different sets. Below twenty meters, the efficiency of the entire R.F. stage is so low that the screen-grid tube is removed from its socket and the antenna is coupled to the detector in any one of the popular ways, either by induction, capacity, or directly per usual hook-up. The last method is employed here because the receiving antenna at the writer's station is a twenty-meter transmitting aerial. With such a condition, signal strength is increased considerably on harmonics of twenty meters where this system is used.

The detector circuit is heavily guarded, against radio-frequency current leakage, by numerous chokes and by-pass condensers. Taking this precaution is well worth while, for regeneration is smooth. A long lead to the "B —" is one of the little known causes of audio howl; by shortening this connection to a foot, or even two, and placing an R.F. choke in the lead this tendency is vastly reduced. The lead from the coil socket, to the grid condenser, to the grid must be extremely short. It is good policy to solder the grid condenser to these sockets. The grid leak should be mounted to the tube socket on metal clips, also soldered. All radio-frequency leads in the detector stage must be direct. Care should be taken to keep the grid and plate leads apart; for, the closer they are, the higher the effective capacity in the detector tank and the more difficult it will be to operate on ultra-short waves. Grid leaks and grid condensers have not been found critical. A five-megohm resistance proved to be satisfactory with a .00015-mf. capacity. The higher the value of the afore-mentioned grid leak, the better the control of regeneration though at a sacrifice of sensitivity due to an excessive grid bias.

How Wide Tuning Range Is Covered

The two tuning condensers are .0001-mf. midgets. The vernier tuning dial is placed on one shaft; the other variable condenser is mounted behind the panel, very near to the first and to the detector unit. A Muter midget double-throw, double-pole switch is suspended on copper pieces drilled to fit the condensers. By means of the switch, the capacities can be put either in series or in parallel, affording not only amateur-band spread but a great extension on both sides of the assigned bands. Interlapping reception, on waves from five up to seven hundred meters, is the result. Another advantage lies in the fact that a set of commercial short-wave coils could be used for all the frequencies except the very high twenty-eight and fifty-six megacycle bands.

A large variable .001-mf. condenser is mounted in its own wooden box outside the receiver; a twisted lamp cord with two clips carries its leads to the set. This capacity is connected across the proper terminals for reception up to seven hundred meters, on the 200-550-meter coil, with more turns added to the tickler. Tuning, in this case, is effected by the large condenser.

The coil socket should be as sturdy as possible; the inner contact arms should also be very durable, for they are subject to many strains and stresses when changing plug-in inductances often.

A Monitor for Transmission

The audio system is conventional, except for the extra audio transformer. The primary is to be connected to the monitor or the audio oscillator. By inserting a double-pole single-throw switch in the filament leads of the receiver and either added circuit, the effect of putting the set off for transmission will automatically supply reception of the code which is being sent. This condition is almost required with a D.C. note and an automatic key.

A variable resistance across the secondary of the first transformer serves as an adequate volume control. A sure cure for a howling audio system is the use of a 200A in the first stage; although no trouble in this respect should be experienced with this circuit.

The subject of plug-in inductances can not be treated fully here; since each set requires different numbers of turns to tune to the same wave, because each set has a different natural capacity and inductance due to the variations in the wiring and other changing components. Some information on the very high-frequency coils will not be amiss.

Calibration of Ultra-Short-Wave Coils

The secondaries of the two smallest coils, for five and ten meters, are about one and a half and three turns respectively. The windings are on an old tube base and are spaced about one-quarter inch. The tickler windings should be placed in between these secondary turns. No accurate data can be given for these coils. The most efficient method to have the receiver on ten and five meters is to roughly calibrate it from a simple 201A oscillator, with any low plate supply, such as the house main; a Hartley circuit is excellent. Set the transmitter on twenty and listen to the receiver on forty where a note of the set will be heard if the apparatus is functioning as it should. (You will be listening, not to the transmitter's harmonic, but to the receiver's because an oscillator can not have harmonics over the fundamental wavelength.) Then adjust the inductance of the ten-meter coil until the transmitter note is heard.

This process can be speeded by making use of the following procedure: Wind about three turns on the grid coil and about the same on the tickler, after having removed the screen-grid tube, of course, and also the antenna which can be attached later. Adjust the tickler coil until oscillation is secured; if the note is not heard, turn the transmitter dial until it is. By noting which way the capacity was varied the coil can then either be decreased or increased until reception of the note is gained. The procedure for the five-meter coil is similar, except that the oscillator or transmitter is operated on ten meters.

Adding Untuned Radio Frequency Stage to Walker Flexi-Unit

No additional tuning control is added, generally speaking, and the increased strength of signal that is obtained when this stage of resistance-coupled, shield-grid amplification is added ahead of the Walker Flexi-unit, (or any other one tube short wave receiver for that matter) is very surprising and gratifying.

Where a fairly long aerial is used or in the event that too many dead spots are noticed in the tuning, the midget condenser connected between the terminals 6 and 8 on the Walker Flexi-unit, may be connected in series with the antenna and by turning this condenser the dead spots can be eliminated. In the writer's case varying the coupling condenser served a similar purpose.

The list of parts needed in adding this untuned radio frequency stage to the Walker Flexi-unit is as follows:

1—Variable resistor 10,000 to 100,000 ohms; Bradleyohm, Clarostat, etc.
1—Adjustable 6 to 10 ohm resistor
1—15 to 20 ohm filament rheostat
1—2 M.F. by-pass condenser, 250 volt rating
1—85 M.H. radio frequency choke
1—50 MMF. midget condenser for coupling plate circuit to Walker Flexi-unit
1—0 to 1,000 ohm variable resistor; Bradleyohm or Clarostat, etc.
1—Bradleystat or other filament rheostat to add in series with A battery to Walker Flexi-unit
1—'22 Screen Grid tube
1—Detector tube, '99, etc., depending upon filament voltage used.

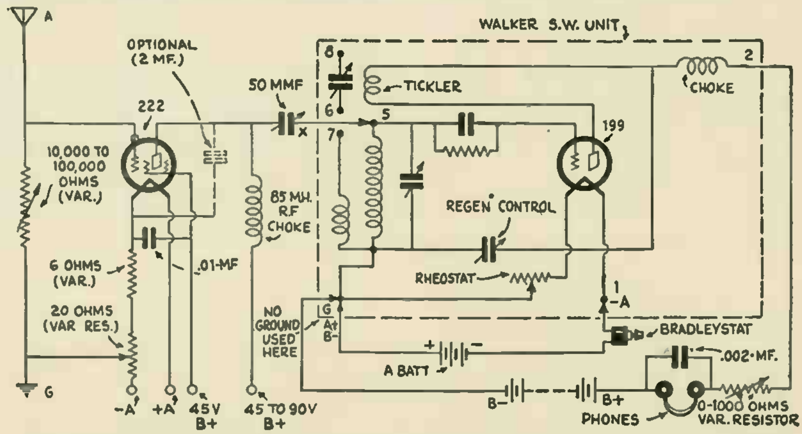


Diagram above shows how to add an untuned, screen grid, radio frequency stage to the "Walker Flexi-Unit", resulting in much stronger signals and pick-up range. This circuit was tried out with gratifying success.

The SUPERIOR SHORT WAVE RECEIVER USED AT G2DT

By E. T. SOMERSET,
Owner and Operator

This article gives the S-W "ham" an idea of what is being used in England for the reception of long distance signals.

THE receiver, seen in the photograph of experimental station G2DT, is designed for amateur code and broadcast phone reception. From the diagram, it will be seen that it employs a screen-grid T.R.F. stage, followed by a screen-grid detector. Out of fairness, I must state that the screen-grid tubes used here are "Mazda SG-215" which are identical in micromhos with the American '24; but their grid-to-plate capacity is five times less

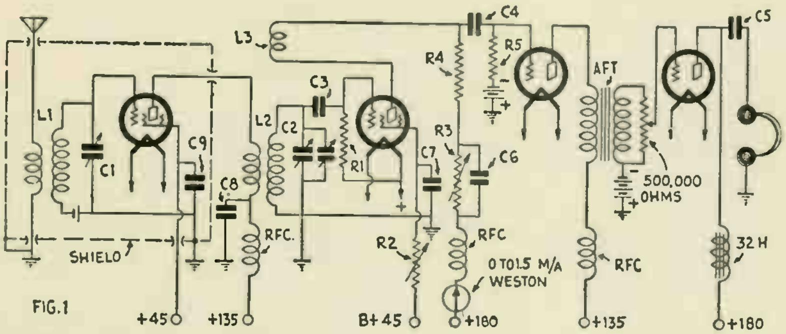


FIG. 1

All values and coil-winding data are appended to the diagram.

C1 = 100 mmf.
C2 = Tank 94 mmf.
Vernier 18 mmf.
C3 = 150 mmf.
C4 = 0.01 mf. Mica
C5 = 4.0 mf.
C6 = 4.0 mf.
C7 = 0.1 mf.
C8 = 2.0 mf.
C9 = 0.1 mf.
R1 = 4 Mr.
R2 = 25,000 r.
R3 = 50,000 r.
R4 = 100,000 r.
Wire Wound.
R5 = 0.5 Mr.

Wiring diagram of G2DT short wave receiver, employing one shield grid R.F. stage ahead of regenerative detector, feeding into a resistance-coupled A.F. stage and then into a second transformer-coupled stage.

One way of explaining this difference between the screen-grid tube and the ordinary "triode" is to say that, in the circuit of the latter, where the load impedance is usually higher than the plate resistance, the current through the load is determined more by the load impedance than by the plate resistance. In the screen-grid circuit, the plate resistance is almost invariably higher than the load impedance; and the current is determined mostly by the plate resistance instead of the load impedance.

The maximum output from the screen-grid tube, used as a detector, is obtained when the load resistance is equal to the plate resistance of the tube. This, however, is impracticable; as it would mean a plate resistor of the order of one megohm and would cause an appalling drop in the voltage applied to the plate of the tube. It is necessary, therefore, to strike a balance and, if 300 volts "B" is available, it is usual to use a plate resistor of the value of 250,000 ohms. If the available voltage is only 180, then it behooves us to use a resistor of 100,000 ohms, to obtain efficiency. This value is shown in the diagram at R4.

It will be observed that a variable resistor is shown at R2, and with good reason. The screen-grid tube is, in reality, extremely critical as to the screen-grid voltage, when functioning as a detector; and this control, when properly regulated, will show a reading of the order 0.8= to 1.0= milliampere upon the meter in the plate circuit. Such a reading will be indicative of correct functioning.

The coil forms used are "R.E.L.," whose average diameter is 1¾ inches; they are of truly skeleton construction and, if wound with 27/42 D.S.C. Litzendraht wire, will be found to be extremely efficient. For C1 and the tank capacity C2, the Hammarlund "MC/23" condensers can be used as very little surplus metal appears in their construction. The vernier, which is wired in parallel with C2, is an "R.E.L." adjustable, but Cardwell's new type will serve just as well.

When the set is used as an amateur-band receiver, the tank C2 is set by means of a wavemeter in the desired band; and the stator of the vernier is adjusted at such a distance from the rotor that full dial-spread is obtained. When it is desired to listen to short-wave broadcasting, then the tuning is done on C2 and the vernier is used for an accurate setting of resonance.

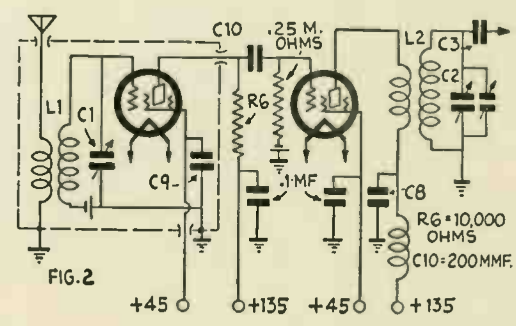


FIG. 2

This diagram shows method of adding another R.F. untuned stage to G2DT's receiver.

INDUCTANCE DATA TURNS

	L1		L2		L3
8,500-Kc.	Prim: 9	Secy: 15	Prim: 9	Secy: 15	6
7,000-Kc.	Prim: 4½	Secy: 7	Prim: 4½	Secy: 7	6
14,000-Kc.	Prim: 2¾	Secy: 3½	Prim: 2¾	Secy: 3½	5
28,000-Kc.	Prim: 1	Secy: 1¾	Prim: 1	Secy: 1¾	5

SPACING BETWEEN TURNS

	L1		L2		L3
3,500-Kc.	Prim: 1/32"	Secy: 1/32"	Prim: 1/32"	Secy: 1/32"	1/32"
7,000-Kc.	Prim: 1/16"	Secy: 3/16"	Prim: 1/16"	Secy: 3/16"	1/32"
14,000-Kc.	Prim: 1/4"	Secy: 1/4"	Prim: 1/4"	Secy: 1/4"	1/32"
28,000-Kc.	Prim: 1/3"	Secy: 1/16"	Prim: 1/3"	Secy: 1/16"	1/8"

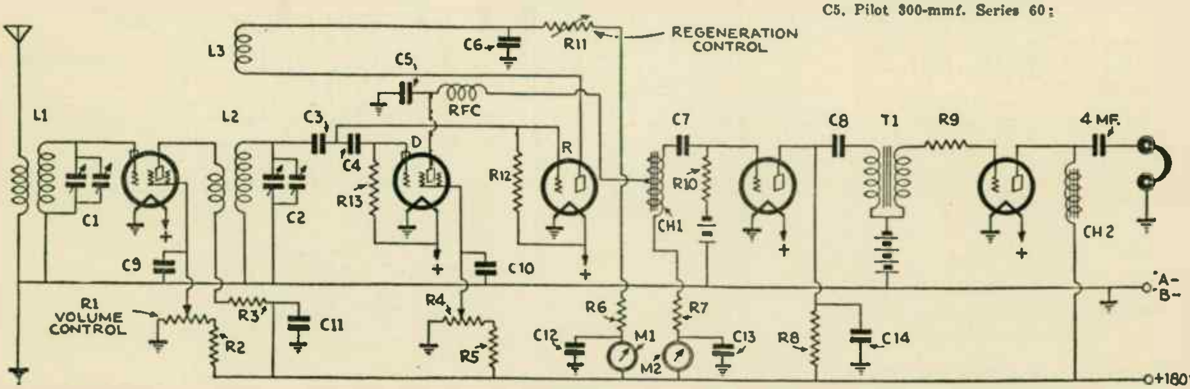
¼" gap allowed between WINDINGS

A SEPARATE REGENERATION TUBE

By E. T. SOMERSET
G2DT, Assoc. Member I. R. E.

Probably no one thing has caused as much trouble as the regeneration control in the average set. Mr. Somerset here explains how he uses a separate "reactor" tube, which at last provides a smooth and reliable regeneration control.

IT is common knowledge that the ordinary autodyne (regenerative) detector used in all short wave receivers is hard put to it, to efficiently carry out the dual functions of *rectification* and *regeneration;* and it is the purpose of this article briefly to describe a tuned radio-frequency receiver, in which the function of regeneration is allotted to a separate tube, called the "reactor." This tube need not be chosen with an eye to its ability to rectify, but rather to oscillate smoothly and easily; and here is advantage number one. The mean grid voltage of the reactor will not be affected by the change in the steady grid voltage of the rectifier (detector), so that the fall of grid voltage due to the rectification of the carrier does not have to be arranged for—and this is advantage number two. Lastly, we have the greatest advantage in being able to make our detector, whether it be a triode or a screen-grid, operate at optimum and thus achieve maximum efficiency in rectification.



Complete hook-up of the Somerset short wave receiver, with separate reactor tube "R," used solely to provide smooth and reliable regeneration control. The regeneration is regulated by the variable resistance R11. Detector tube "D," is impedance-coupled to the first audio stage.

Simple to Construct

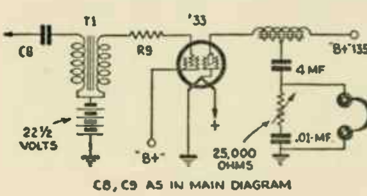
From the circuit diagram it will be apparent that no difficulties in construction will be encountered by the beginner —in fact, a Pilot Super-Wasp can readily be altered to take the "separate reactor" tube. The question of coupling between the detector and the first audio tubes arises and, while the author has found resistance-capacity coupling to be preferable in the case of the autodyne detector, it is possible here to use choke-coil coupling (which gives greater amplification) without fear of encountering "threshold howl."

The only shielding used is a cylindrical cover for the R.F. tube, and an electrostatic shield of 14 gauge aluminum between C1 and C2—and the receiver is perfectly stable; this being due, in no small measure, to the adoption of the Ferranti plate-feed scheme, as shown by the liberal use of resistors, which serve the dual purpose of decoupling and voltage dropping and save the necessity of battery tapping points for varying potentials required.

Ease of Operation

In operation the receiver is very much the same as the customary autodyne; except that the familiar hiss of the detector has vanished and the trials and tribulations of getting the correct ratio of screen-grid volts to plate volts for an autodyne S.G. detector becomes quite a simple job..

As a guide to efficient operation it may be well to mention that readings on the oscillator and detector meters of 0.4 to 0.5 ma. and 0.8 to 1.1 ma., respectively, should be aimed at.



Mr. Somerset's improved regenerative short wave receiver, may have a Pentode power tube added to the output stage, as shown in the diagram above.

Constants

C1-C2. Tank-Vernier 100-mmf.;
C3, Pilot 100-mmf. Series 60;
C4, Pilot 200-mmf. Series 60;
C5, Pilot 300-mmf. Series 60;
C6, Pilot .001-mf.
C7, Pilot 0.25-mf. No. 800;
C8, Pilot 0.5-mf. No. 800;
C9-C10, Pilot 0.1-mf. No. 808;
C11-C12-C-13-C14, Pilot 2.0-mf. No. 9302;
R1-R4, Pilot 50,000-ohm No 940;
(N. B.: R1 is the Volume control.)
R3, Pilot 1,000-ohm No. 962;
R2-R5 30,000-ohm;
R6 20,000-ohm;
R7 40,000-ohm;
R8 3,000-ohm Pilot No. 964;
R9 100,000-ohm Vacuum;
R10 500,000-ohm Vacuum;
R11 200,000-ohm Pilot No. 942;
R12 7.0-megohm Pilot No. 864;
R13 4.0-megohm Pilot No. 859;
L-1, L-2, L-3, "R.E.L." skeleton coil form-wound as below;
Ch1, Thordarson "Autoformer";
Ch2, Ferranti B2 (or Thordarson) Choke;
T1, Ferranti AS5 Audio Transformer;
M1-M2, Weston 301 0-1.5 milliammeters.

COIL WINDING DATA

	Turns L 1 Prim.	Turns L 1 Sec.	Turns L 2 Prim.	Turns L 2 Sec.	Turns L 3 Reactor
7,000-Kc.	..4	7	4	7	5
14,000-Kc.	..3	4	3	4	3½
28,000-Kc.	..1½	2	1	2	4

Primary and secondary windings are spaced ¼-inch and the space between turns is 1/16-inch except for the 28-M. band when spacing between turns is ¼". All windings are made with 27/42 D.S.C. Litzendraht wire.

How to Build Really Efficient

Short Wave Converters

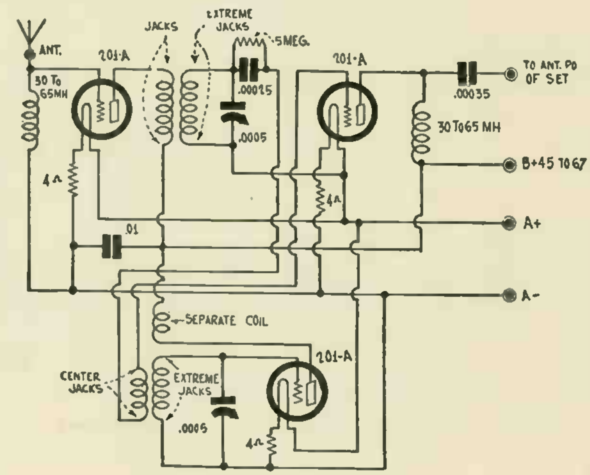
By HENRY B. HERMAN

Mr. Herman describes in detail how to build highly efficient short-wave converters in contra-distinction to the ordinary short-wave adapters, which do not utilize the radio frequency stages of your broadcast receiver.

A SHORT-wave adapter is a device for plugging into the detector socket of a receiver, thus substituting short-wave input for broadcast input, while utilizing none of the radio-frequency amplifying properties of the receiver itself, although the receiver's audio channel and speaker are used to give suitable volume to the reproduction.

A short-wave converter is a device for receiving short waves, converting them to a lower frequency by the mixing process, and delivering this lower or intermediate frequency to the antenna winding of the receiver, so that the receiver is used *in toto*, with all its R.F. and A.F. amplification. The receiver is simply tuned to some frequency clear of broadcast reception (so that one a little above 1,500 kilocycles is desirable) and all tuning is done thereafter with the converter.

The diagram at the right shows connections of a battery operated, short-wave converter utilizing '01A type tubes. The plate voltages for the converter tubes may be supplied by the "B" source which now furnishes the plate current for your broadcast receiver, or a separate "B" battery may be used to supply the converter plate current. The same "A" battery or "A" eliminator which supplies your broadcast set may also supply the converter "A" current.



Advantages of the Converter

The advantages of the converter are so many and so great that there can be little doubt about its superiority. Everybody interested in short-wave reception has already a good broadcast receiver, one capable of high quality, sensitivity, and selectivity. It is provided with a good loud speaker and a good power supply. When the converter is used, all this equipment is effective. Nothing is left idle while the short waves are being received; nothing is cut out of the circuit; all is retained.

Now, if the selectivity of the broadcast receiver is good, that virtue is transferred to the short-wave combination. If the sensitivity of the broadcast receiver is high, the short-wave end will be correspondingly sensitive. If the quality is good, the quality of the short-wave reproduction will also be faithful. If the power supply is ample, it will also be ample when the converter is added. If the loud speaker in the broadcast receiver is high-class, it will be equally good when it is used on short waves.

Just as the broadcast superheterodyne is superior to the straight radio-frequency amplifier, so the converter is superior to the straight short-wave receiver. The superheterodyne is superior in selectivity, and for short-wave reception a high order of selectivity is essential; it is also superior in respect to sensitivity and, to receive distant short-wave stations, a high order of sensitivity is essential.

List of Parts for "Battery" Type Converter

Two sets of Screen Grid Coil Co., De Luxe short-wave coils, wound on air dielectric, two coils to a set;

Two .0005 mfd. Hammarlund de luxe straight-line frequency tuning condensers;

Two radio-frequency choke coils 50-millihenry, shielded type;

One .00035-mfd. fixed condenser;

One .00025-mfd. fixed grid condenser with clips;

One 5 to 7 meg. grid leak, with mounting;

Three 4-ohm filament resistors with mountings;

One .01-mfd. fixed condenser;

One 7 x 14-inch drilled bakelite panel, with three UX tube sockets. (4-spring) and coil sockets built in;

One cabinet to fit;

Five binding posts;

Two National Type B "Velvet" vernier dials, with two pilot lamps (use of pilots optional; connect in series across 5 or 6 volts).

List of Parts for "A. C. Type" Converter

Two sets of Screen Grid Coil Co. "De Luxe" short-wave coils;

Two .0005 mfd. Hammarlund straight-line frequency tuning condensers;

Two radio-frequency choke coils, 50-mh. shielded type;

One .00035-mfd. fixed condenser;

One .00025-mfd. fixed grid condenser with clips;

One 5 to 7 meg. grid leak;

Two Electrad wire-wound, flexible type, biasing resistors; 300 ohms each;

Three .01-mfd. fixed condensers;

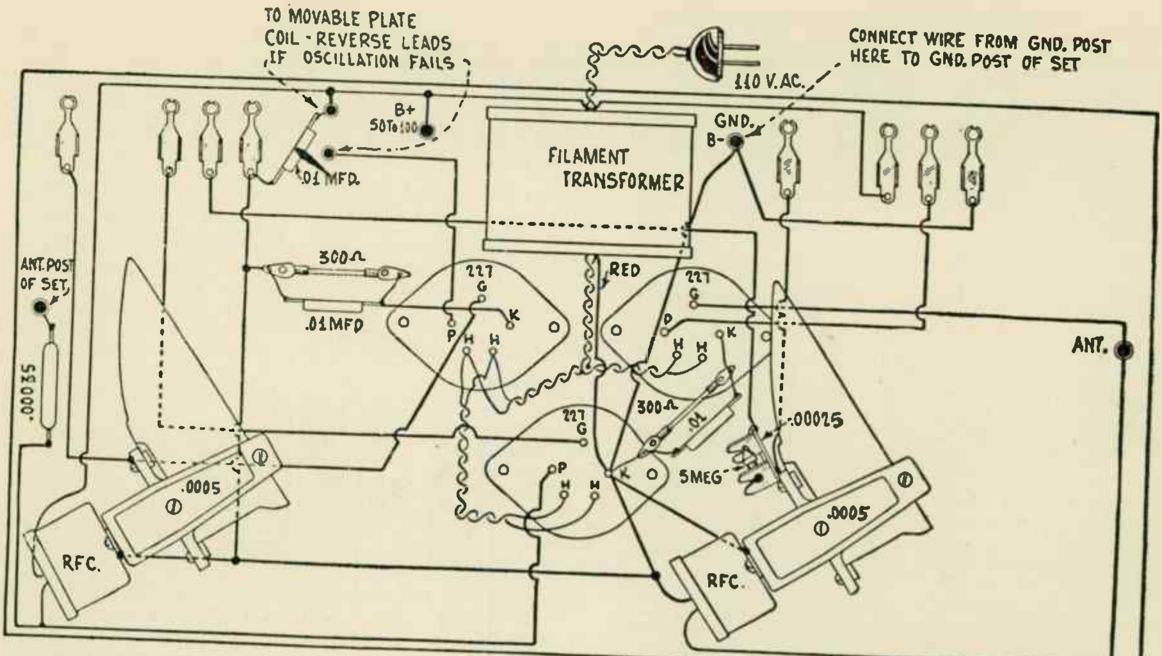
One 7 x 14-inch drilled bakelite panel, with three UY tube sockets (5-spring) and coil sockets built in;

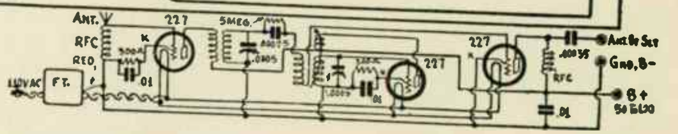
One cabinet to fit;

Four binding posts;

One Polo 2.5-volt center-tapped filament transformer, 6-ampere rating;

Two National Type VB-D "Velvet" vernier dials, with 2.5-volt pilot lights and lamp brackets.





Picture diagram of the Universal Short-Wave Converter, with accompanying schematic diagram. The picture diagram is a trifle less than one-half actual size.

Construction of a Converter

The parts for such a converter may be disposed on a 7x14-inch bakelite panel which is fitted to a cabinet 3 inches high, so that the panel is on top.

The tubes may be arranged from front to back, or left to right; or triangularly as the diagram reveals them. At the left is the first tuned circuit, which receives the short waves from the antenna; at the right is the oscillator. Their coupling effects a beating of two frequencies and produces a difference-frequency, equal to the intermediate-frequency established in the receiver proper.

The converter may be built to use A.C. tubes or battery type tubes. A converter of either type will work on any set, A C. or battery-operated; but both types rely on the receiver for "B" voltage. The A.C. converter needs a filament transformer, to take care of the 5.25-ampere heater current of three 227 tubes.

The data for winding the coils will be predicated on the assumption that bakelite or hard-rubber tubing is used; even though the commercial coils recommended are wound on ribbed forms, to afford 93% of air dielectric.

It is not practical to duplicate the commercial coils, as the ribbed forms are made by machinery and, unfortunately, are not independently available. Nevertheless, the same waveband coverage will be assured, even though the radio-frequency losses will not be so low when the standard bakelite or hard rubber forms are used.

Preparation of Coils

Get two pieces of bakelite, 2⅝ x ½ inch and, on the central longitudinal line of each, drill four 6/32 machine-screw holes (No. 29 drill), separated from one another as follows: first hole, 3/16-inch from the end; next hole ½-inch from the first; third hole, also ½-inch from its predecessor; fourth hole, 1¼ inches away from the third. Both pieces of bakelite are drilled exactly alike, and will serve as the coil bases. In each of the four holes will be placed a prong like those used on the base of a tube or as phone tips.

Now get six round bakelite forms, 2¾ inches in diameter and 2⅝ inches axial length, and drill two holes 2¼ inches apart, lengthwise, to correspond to the outside holes on the bakelite mounting strips already drilled. Considering hardware, there will be a clearance of about ¼-inch between the tops of two pair of prongs, for winding the primary, which has three turns of No. 24 single-silk-covered wire. Use the space between second and third prongs and put on this winding before the prongs are attached to the strip, or the strip to the circular bakelite form.

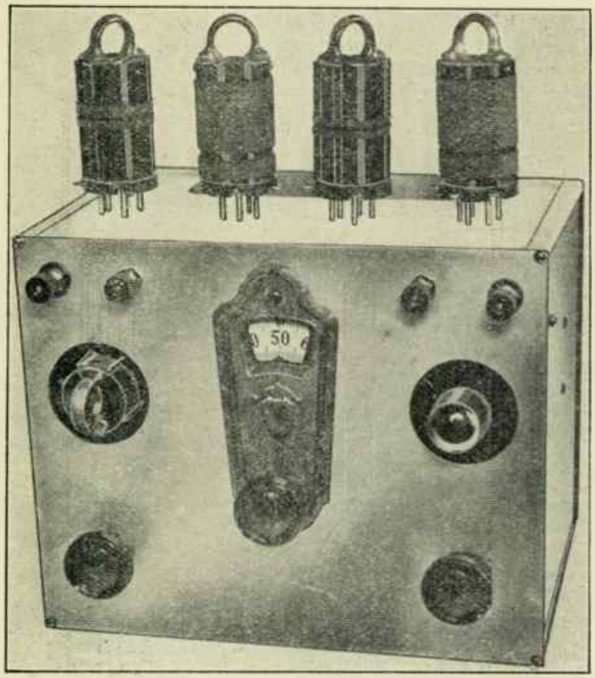
Between the prongs, 1¼ inches apart (or about 1 inch apart, considering the hardware at top) wind on the form three secondary turns of No. 18 enamelled wire, spacing the turns about the thickness of the wire. Anchor the beginnings and ends of wiring through two small parallel holes, which you drill in the circular form. Then attach the circular form to the mounting strip, by passing the hardware through the coinciding holes, and tightening down. It is preferable to put lugs at the top of the strip, and bakelite spaces between the strip and the circular form. Solder the terminals of the coils as follows: One secondary terminal to one outer prong; the other secondary terminal to the other outer prong; the primary to the two inside prongs. Make two such coils.

The same procedure is followed in making and winding the higher-wave coil, except, of course that the number of turns is different. Put on four primary turns of No. 24 S.S.C., and 17 turns, space-wound as previously, for the secondary, using No. 18 enamelled wire here. Make two such coils.

These two coils will cover the short-wave band from 15 to 200 meters with a .0005-mfd. tuning condenser. The range of the first coil is 15 to 80 meters; the second, 78 to 200 meters.

The oscillator plate winding, if it is to be an adjustable coil, consists of 10 turns

(Continued on page 56)

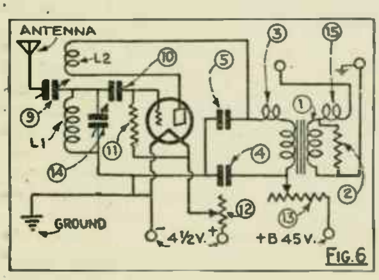


A SHORT

This receiver can be used with a pair of 'phones to listen in on short-wave stations; it can also be used as a short-wave adapter for your broadcast set. The "Fun Box" has its own batteries and uses a '99 type tube; one of the new 2-volt tubes could be used.

Front view of "Fun Box" short - wave receiver, which can also be used as an adapter for your broadcast set, enabling you to obtain loud speaker reception of short-wave stations.

ANYONE can assemble this simple self-contained short-wave receiver and enjoy the thrills of tuning in United States and foreign stations throughout the world. It is a one-tube set employing the battery type '99 tube, complete with batteries installed in the 10 x 8 x 6 inch aluminum radio shield can. You can pack it into a grip or carrying case and carry it wherever you go. After having acquired skill in the manipulation of the set with earphones, you can attach it with one wire



Above: Schematic diagram of short-wave receiver and adapter.

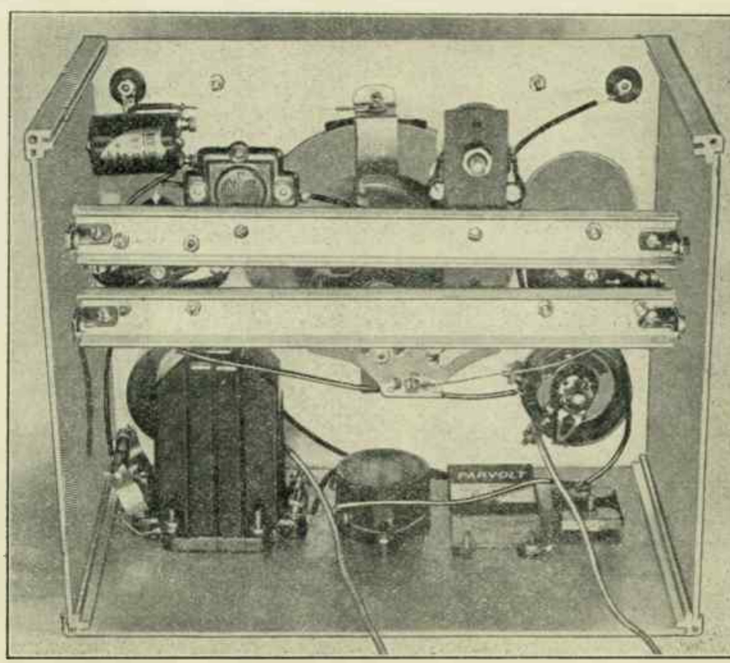
to the amplifier of your present broadcast receiver and enjoy loud speaker reception. Broadcast, as well as short-wave stations, can be received with the use of the plug-in coils. It makes an ideal set for the beginner who wishes to become familiar with amateur reception as well as for the broadcast listener who desires to explore the short-wave regions.

Perhaps the first thing to secure is the aluminum shield can. The type specified comprises four grooved corner posts with tapped holes in the ends. The top, bottom and sides slide in the grooves and the front and back are attached to the corner posts with screws, holding the entire box in shape. The stock is 1/16-inch thick.

Fig. 1 shows the front drilling plan. The size and location of all holes are not given, as these depend upon the particular parts employed

In the set illustrated a Pilot condenser and dial was used. Since the box is of metal, the rheostat 12 and the variable resistance 13 should be mounted on small bakelite pieces which are in turn fastened to the box, thus insulating them from the box. The antenna binding post and one of the output binding posts are likewise insulated from the metal box with bakelite washers. The other two posts are connected directly to the box.

The audio transformer 1, and R. F. choke coil 3, and the condensers 4 and 5 are mounted on the bottom as shown at Fig. 2. These parts can be connected as illustrated with No. 18 copper wire covered with spaghetti insulation, before assembling the box. In many cases connection is made to the box as indicated, by the ground symbols in the illustrations. The resistance 2 is mounted on clips attached to the transformer ter-



WAVE "FUN BOX"

By
CLYDE FITCH

minals. This resistance is only required when the set is used as an adapter.

Fig. 4 shows how the tube socket 6 and coil socket 7 are mounted on the aluminum channels. The grid condenser 10 and antenna coupling condenser 9 are also mounted on these channels as shown. The wiring is clearly indicated in the illustration. The grid leak 11 is mounted on clips attached to the tube socket. Note that the connections to the coil socket are for Pilot coils; if other coils are used these connections may be different.

The wiring for the instruments on the front is shown in Fig. 5. The other R. F. choke coil 15 is mounted on the left end piece of the box, looking from the back. The box may now be assembled, all but the back and top, and the remaining connections made. These are all shown by the letters in the various illustrations.

Fig. 3 shows a rear view with the batteries and coil shelf in place. Note that the top of the box has a section cut out so that the four spare coils, shown standing on top of the set in one of the reproduced photographs, can be slipped into the paper tubes on the shelf. The battery connections are shown in Fig. 7. Two leads go into the set for the A+ and B+ connections. The A— is connected to the metal box. Of course, a "C" battery is used for the "A" battery in this case. The schematic diagram is shown at Fig. 6.

LIST OF PARTS

The parts are numbered to correspond with the numbers in the illustrations:

(1) Audio frequency transformer.
(2) 100,000-ohm grid leak resistance.
(3) Short-wave radio frequency choke coil.
(4) 1-mf. by-pass condenser.
(5) .00025-mf. fixed condenser.
(6) 4-prong UY type socket.
(7) 5-prong UY type socket.
(8) Bakelite strip 1" x 3" x 1/16"
(9) 15-mmf. midget variable condenser.
(10) .0001 grid condenser.
(11) 3-megohm grid leak.
(12) Filament rheostat, 20 ohms.
(13) Variable resistance, 50,000 ohms.
(14) Tuning condenser, 150-mmf.
(15) Short-wave radio frequency choke coil.
(16) Aluminum channels, 3/8" x 3/8" x 9 5/8".
(17) Bakelite shelf 9 5/8" x 2" x 3/16".
(18) Blan radio shield can 10" x 8" x 6".

In addition there will be required one set of five Pilot short-wave coils; two small 22½-volt "B" batteries; one 4½-volt "C" battery; 4 binding posts; 1 type '99 tube; one pair telephone receivers; 8 small brass angles; wire, solder, screws, terminals, insulating washers, etc.

Operation

The set may be tested by connecting the antenna and ground wires to their respective posts, and a headset to the output posts. A coil and tube must be placed in their sockets also. The rheostat acts as a filament switch; this should be turned on. The 50,000-ohm variable resistance, mounted on the right (looking from the front) controls the regeneration; this should be adjusted, together with the tuning dial, until the set oscillates, and the heterodyne whistle

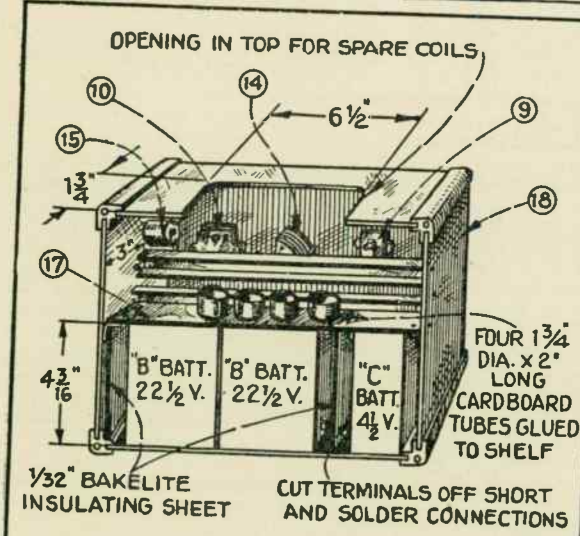


FIG. 3

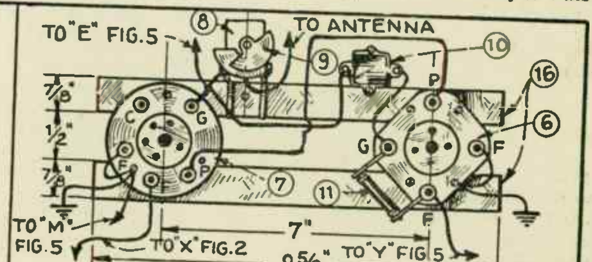


FIG. 4

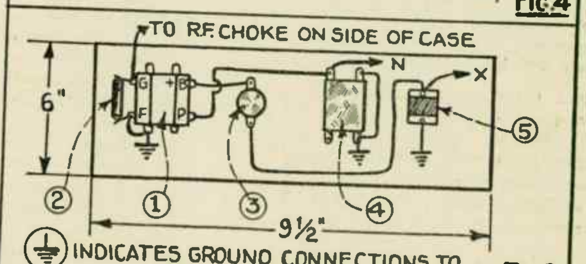


FIG. 2

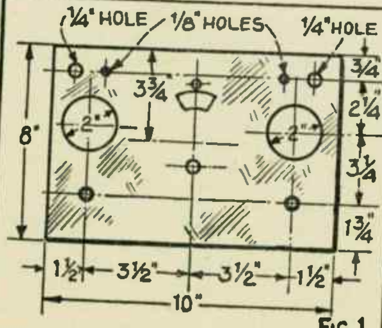


FIG. 1

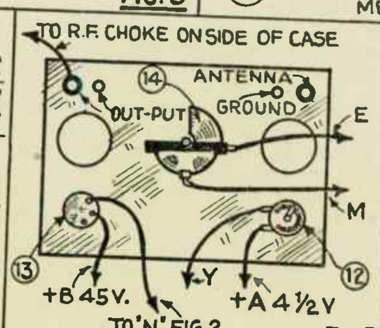


FIG. 5

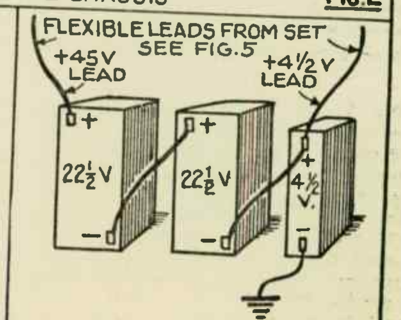


FIG. 7

of the short-wave stations is heard. A readjustment of the variable resistance to a point just below oscillation will bring in the phone stations at their best.

Using the different coils for different wavelengths may require a different adjustment of the antenna condenser 9 mounted inside. By slotting the shaft with a saw, this can be turned with a screwdriver by reaching in from the opening in the top of the box.

By connecting insulated output binding post—the one at the extreme right—to the grid of your detector in your present broadcast receiver, the detector acts as an audio amplifier, together with the other two stages of audio amplification in the set, giving three stages in all.

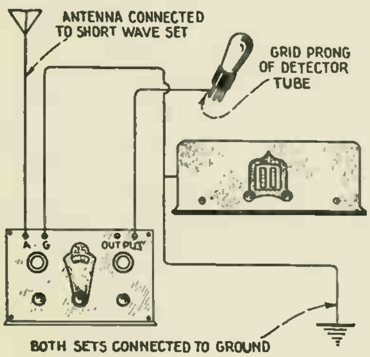


Fig. 8. How aerial and ground are connected to set and converter.

The connection to the detector grid can be made by attaching a small wire to the grid prong of the tube and let it protrude sufficiently for a connection with a spring clip terminal. This is satisfactory in sets using a grid condenser and leak. In some sets no grid condenser and leak are employed, a "C" bias voltage being used instead. In this case it will be necessary to open the grid connection to the detector socket when tuning the short-wave set as an adapter. In many sets which have a plug connection for a phonograph pick-up, the output of the short-wave set can be plugged in, in place of the phonograph pick-up. The ground wire should be connected to both sets and the aerial connected to the short-wave set only when using it as an adapter.

Fig. 8 shows a clear idea of how the set is connected for use as an adapter. The detector tube of the broadcast set is removed, the output lead from the short-wave set connected to the grid terminal as shown, and the tube is replaced in the broadcast set.

As stated above, sets employing "C" batteries or bias on the detector tube cannot be used with this connection. A good method would be to make an adapter as shown in Fig. 9. This consists of a vacuum tube socket mounted on a vacuum tube base, both, of course, for the same type of tube as is used for the detector; that is, either four-prong or five-prong. The socket connections are all soldered to the respective tube base prongs, with the exception of the grid terminal, which is left open. This is to be connected to the output lead from the short-wave set. Therefore, when the detector tube is placed in the adapter and the adapter placed in the empty detector socket in the set, all connections will be the same as usual but the grid connection, which is free and can be connected to the short-wave set as shown.

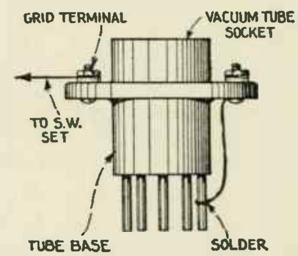


Fig. 9. How to make socket adapter providing a free grid terminal.

Short Wave Converters

By HENRY B. HERMAN

(*Continued from page 53*)

of No. 18 enamelled wire on 2¾ inches diameter, 1 inch in length. Put on the winding at one extreme of this form, to allow room for a right-angle pivot bracket. Use two pieces of bakelite tubing, about 1¼ inch high, to pass 10/32 machine screws (about ⅜-inch outside diameter), as supports for the pivot and hence for the coil form itself.

The direction of winding is not important, except in the case of the plate coil. But the easiest solution is to disregard the direction of the winding even here, and to connect the coil in circuit; if oscillation fails, then reverse the connections of the terminals of the plate coil.

To receive the coils, special sockets are provided, which may be tip jacks, if home-constructed coils are used. Commercial panels have all sockets built in.

R. F. Choke Tests

The R. F. choke coils are shown mounted on the frames of the tuning condensers; this is accomplished by widening the hole on either side of the base strip of the R. F. choke (using either a drill or a penknife) to pass a 10/32 screw. As only one mounting hole is needed for each choke, two such screws are required. The tapped holes to receive these 10/32 screws, which should be no more than ½-inch long are in the condensers already.

Sometimes shielded R. F. chokes are so constructed that one terminal of the winding is connected to the shield inside. If this is true, no special precaution need be taken as to the choke used in the antenna-ground circuit, except to have the shield-connected terminal represent ground.

The test for this is to use a small dry-cell battery and a suitable indicating device; for instance, a 1.5-volt dry cell and a 0-6 voltmeter. Connect one terminal of the meter to one side of the battery, and have two free leads; one running from the other battery post; the other lead to the other side of the meter. To test for correct meter polarity, see that the deflection is positive; that is, gives the desired reading of 1.5 volts without regard to the coil. Connect one side of the battery to the frame of the shielded choke, the other free lead, from the meter, to one side of the coil. Then remove this connection from the coil and put it to the other terminal of the coil.

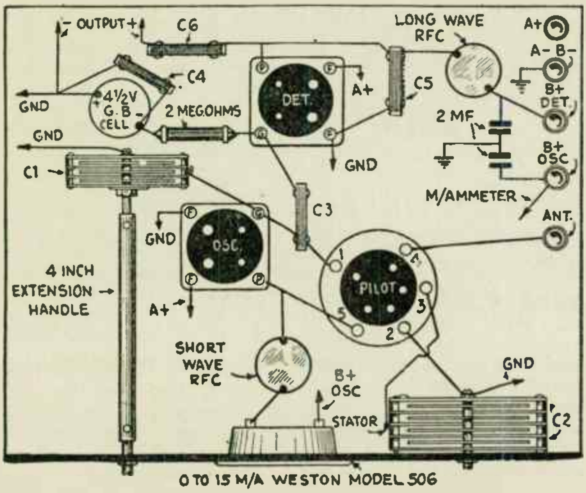
If the deflection is 1.5 volts from one side of the choke to the coil frame that side is the grounded one and should go to ground; the other choke lead going to antenna. Under these circumstances the other side of the choke, because of the resistance of the winding included in the tested circuit, will give only a small deflection, instead of full 1.5 volts.

It is well to test both chokes, one after the other, and put markers on the terminals. If both terminals show only a slight deflection, instead of full 1.5 volts, then the coil is not connected inside to the shield at either terminal; and it should be selected for use in the plate circuit of the modulator, as this carries a high direct potential. The object is to avoid shorting due to the coil shield being connected to the condenser frame, or ground, and again to "B+" through internal conduction.

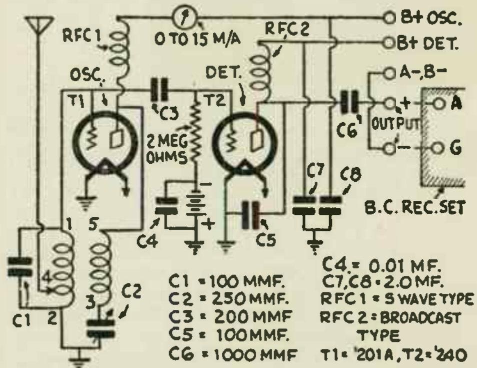
If both coil terminals, connected one after another in series with the test circuit to the coil shield, show full 1.5 volts, the entire choke is short circuited.

In point of cost the converter is in a class by itself. A device that will convert an existing broadcast receiver into a first-class short-wave receiver costs so little that no one will hesitate to get one, as soon as he is convinced that really worth-while results can be obtained with it. Perhaps the broadcast receiver cost $100. A three-tube converter may cost $25, if of the best type of construction; thus, for $25, a short-wave receiver costing $125 may be enjoyed.

ONE-COIL SUPER-HET CONVERTER



Top view of One-Coil Super-Het S-W Converter.



Wiring diagram of One-Coil Converter. Windings 3 and 4 are wound on one tube.

THE converter about to be described is essentially for those who still believe that the triode (3 electrode tube), when properly used, makes the best detector; in that careful regulation of screen-grid voltage for maximum efficiency does not enter into the question, and a lot of experimenting is saved. It will be seen from the theoretical diagram that two tubes are used. In a previous issue of SHORT WAVE CRAFT was described a Tropadyne in which only one tube was used. The writer has no wish to belittle this idea; but experiments have shown that, at the high frequencies dealt with here, considerable difficulty is likely to be experienced in obtaining uniformity of operation, owing to small differences in characteristics between one tube and another—and it is presumed that not everyone has a stack of tubes with which to experiment!

The oscillator is quite straightforward, and best results are to be obtained with a tube whose impedance is of the order of 10,000 ohms (an '01A, '27 or '30). Capacity feed is utilized, and a radio-frequency choke used to deflect the oscillations through the regeneration circuit.

It is assumed that this converter will be used with a broadcast receiver having its "A—" and "B—" common to ground; but, should it be ascertained that the said receiver has "B—" joined to "A+," it will be necessary to insert a large-capacity (1 microfarad) condenser between the negative output binding post of the converter and the "Gnd" binding post on the broadcast receiver. The ground lead should then be connected to the ground binding post on the converter, and not to the broadcast receiver as well.

Should "A—" and "B—" be common, then all is well to connect up the converter's positive output lead to the aerial terminal of the receiver, and the converter's negative lead to the ground post of the receiver.

The detector receives radio-frequency as usual but, unlike a broadcast receiver's detector, passes on R.F. oscillations also; thus demanding in its plate circuit a component that will put up a high impedance at radio frequency. To achieve this, the R.F. choke has been introduced as if we had decided upon a tuned circuit; but in that case an extra tuning control would have been required. A standard broadcast choke will do, since long-wave signals are being dealt with.

For the detector tube, it is recommended that a tube whose impedance is of the order 20,000 to 30,000 ohms to be used. (This corresponds to the '00A; but ordinary American single-grid tubes have lower impedances. *—Editor.*)

Referring to the diagram it will be seen that a condenser C5 is connected between the detector plate and "A—"; this is to combat an anti-regenerative effect that sometimes occurs and so damps the circuit that the oscillator ceases to function. From the plan layout, it will be observed that the tuning condenser C1 is set well back; and this is really worth while to completely avoid hand-capacity effects. Grid-bias detection is used, because it is more economical, should "B" batteries be used; and nothing is to be gained by the "leaky-grid" method, since small inputs are not being dealt with.

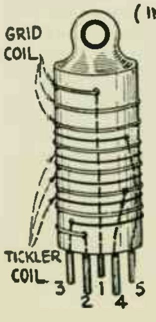
The reader is very strongly urged not to consider beauty of layout too much, but rather to aim at efficiency; and, if this is decided upon, then only low-voltage wiring will go below the sub-panel. The inductances are wound on "Pilot" forms; the grid winding may be of No. 18 gauge enamelled, and the regeneration or tickler winding of No. 26 D.S.C. It should be noted that the turns of this winding are placed between the turns of the grid winding.

For "B" supply, 90 to 135 volts upon the detector and 45 volts on the oscillator works admirably.

Increasing capacity of C2 the needle of the meter should kick upwards; this indicating that the oscillator is generating local oscillations and that "all is well".

The best operating conditions will be when the plate current of the oscillator is about 1 to 3 M.A., more than that shown when the tube is not oscillating.

-E. T. SOMERSET.



(INDUCTANCE CONSTANTS FOR PILOT FORMS)

COIL No 1 15λ TO 23λ	COIL No 2 21λ TO 34λ	COIL No 3 30λ TO 50λ
GRID TURNS 4¾ SPACED ¼"	GRID TURNS 9 SPACED 3/16"	GRID TURNS 14 SPACED ⅛"
TICKLER TURNS - 4	TICKLER TURNS - 7	TICKLER TURNS - 6
AERIAL TAPPING ⅛ TURN FROM BOTTOM	AERIAL TAPPING ¼ TURN FROM BOTTOM	AERIAL TAPPING ½ TURN FROM BOTTOM

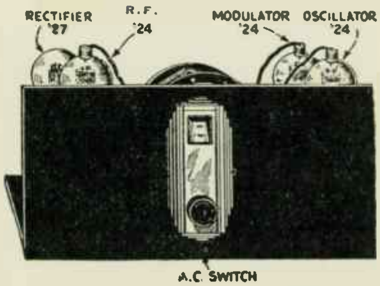


Fig. 2—Front view of a short-wave converter, showing single tuning dial; the dial on your broadcast receiver is set once and forgotten.

SHORT WAVE CONVERTER

with "B" Supply Built-in

By Jacob P. Lieberman

This 10-600-meter converter has its "B" supply incorporated as a part of the converter itself. With this low-priced instrument you can listen to short waves on your regular broadcast receiver.

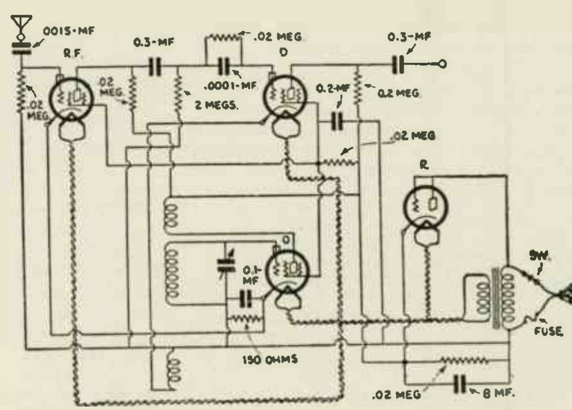
THE interest in short-wave converters, which bring in short waves when worked in conjunction with any broadcast receiver, has been running very high for several months; but one consideration has impeded what otherwise would have been an utterly tremendous demand for these devices. It is known that they work superlatively well; that they afford full utility of all the amplification obtained from the broadcast receiver (each tube of which is worked to its full duty); and that proper design and constants ensure the achievement of as much sensitivity and selectivity as with the best of short-wave receivers. However, it is nearly always necessary, except with prohibitively expensive models, to search around for some method of obtaining the "B" voltage. It is easy enough to include a filament transformer, so that the heaters will be supplied; but, with commercial broadcast receivers, where voltage taps are inaccessible, designers have faced a difficult problem in attempting to assure availability of the "B" voltage.

Methods of Tapping the Set

One method suggested is to take this voltage off the screen-grid of a radio-frequency amplifier tube. This could be done by baring the end of the "B+" lead from the converter and looping that end; removing from the receiver the radio-frequency tube ahead of the detector; tightening the looped end of the wire around the "G" prong; and reinserting the tube in the receiver. This method is all right, provided no resistor is in series with the screen of the tube selected, and provided (of course) that the set comprises screen-grid radio-frequency amplification. But, since in many receivers there is such a series resistor, and many others use no screen-grid tubes, the application of this method is not universal.

Another makeshift is to use a "wafer" adapter to pick up the filament connections of the power tube or, if there are two such tubes in parallel or in push-pull, the connections to the filament of one of them. Then, when the power tube is removed from the receiver, inserted in the socket wafer, and placed back in the set, with the wafer between tube base and socket, the positive potential of the filament is available. However, to take this potential off one side of the filament would introduce hum; so a center-tapped resistor of 100 ohms value, or higher, is used, the lead from the center tap being the positive voltage. The value of this voltage is equal but opposite to the grid-bias voltage on the power tube. However, the set may have no power tube, or may have only a 112 or 112A; in which instance the potential thus obtained would be 9 volts or less—certainly nothing to consider seriously.

Fig. 1—Simple wiring diagram of the short-wave converter with "B" supply built in. This converter has a radio frequency booster stage, with shield grid tube, placed ahead of the detector. This converter transforms your broadcast receiver into a Super-Heterodyne, by means of the oscillator tube (O); (R) is the plate supply rectifier tube. The converter was designed by J. E. Anderson and Herman Bernard.



So the advisability of including a "B" supply in the converter is obvious. The usual method employed in receivers (where a power transformer, with a type '80 rectifier, a filter choke and filter condensers are used) is an excellent solution; but the assembly becomes bulky and the cost rises considerably. In fact, the "B" supply may cost as much as all the rest of the parts in the converter.

A Simple "B" Supply for the Converter

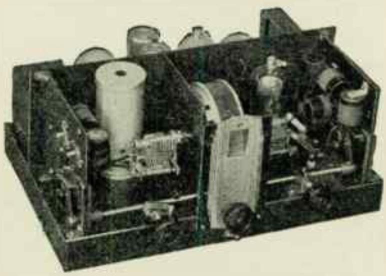
How to satisfy both requirements—that is, the inclusion of a built-in "B" supply at very little extra cost—has been solved by two well-known radio engineers, J. E. Anderson, former Western Electric engineer, and Herman Bernard, specialist in short-wave converters. The method embodied in the invention of these two members of the Institute of Radio Engineers dispenses with the use of a so-called power transformer.

The A.C. voltage is taken from the supply line, and introduced across the united grid-plate elements of a '27 tube, in series with a voltage divider that goes to the cathode of this tube. Hence the alternating current is rectified by the tube, which has enough capacity to take care of the relatively small current drain of the converter. The method, of course, may be applied to all receivers, converters, adapters and the like that require only small plate current, say, not more than 16 milliamperes; although even more current could be taken from the rectifier by working it beyond the conservative limits, and shortening the life of that tube a little.

It can be seen from the diagram (Fig.

Reliable Short-Wave RECEPTION

To Use with your present Set, attached in 10 minutes NATIONAL NC-5»most powerful converter made.



NATIONAL NC-5 Short-Wave Converter for use with any radio set

No trouble to connect this powerful NC-5 to any radio set. Simply move the antenna wire from the set to the proper binding post on the converter;—connect the converter wire to antenna post on the set and plug the electrical connection into baseboard alongside the one that goes to your set. No need to disconnect when receiving ordinary broadcasts.

WORKS WITH ANY SET

Owing to the super-power of the NATIONAL NC-5 Converter (there are two extra stages of amplification), it will bring in broadcasts and code on short-waves from all over the world on any radio set.

SINGLE CONTROL TUNING

Specially designed to make circuits "track" each other accurately. No interlocking or "dead spots." Operation is stable over the range.

NO PLUG-IN COILS

The NC-5 Converter has a new coil-switching system with practically perfect results for converter use, but without the inconvenience of plug-in coils. The new design helps, but R-39, the remarkable low-loss dielectric, really makes it possible. No ordinary insulating material works as well. There is no intercoupling between coils.

A Change in Color of Dial-Light Indicates Which Coils Are in Circuit

ATTRACTIVE — COMPACT

Size, 8" x 17½" x 12". Standard Model. In beautifully finished metal cabinet.

DE LUXE MODEL

In hand-rubbed solid mahogany case with genuine inlay in front panel. Harmonizes with the most beautiful radio sets.

NATIONAL
NC-5 SHORT WAVE CONVERTER

For Serious Short-Wave work, this outstanding instrument, the NATIONAL SW-5 THRILL BOX.

For those who wish to go into a serious short wave reception or broadcasts of code, or for experimental purposes, the NATIONAL SW-5 THRILL-BOX is recommended.

READ WHAT USERS SAY:

"Truly a masterpiece in the SW field." . . . "No comparison possible with other receivers." . . . "Works perfectly and surely brings in the DX." . . . "Have had years of experience and I have never seen a receiver that nearly approaches the NATIONAL SW-5 THRILL-BOX in performance." . . . "5 continents and 23 countries received." . . . "They don't make SW Receivers better than the NATIONAL SW-5." (Names on request.)

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Range 9-2000 meters. Extremely high signal to noise ratio. True single-knob tuning. Set and forget the antenna trimmer. Easy to log with NATIONAL projector Dial, type H, no parallax. Special 270° Type S.E. Tuning Condenser with insulated main-bearing and constant-impedance pigtail makes gang-tuning possible on the short waves. Equipped with standard set of 4 pairs of R.F. Transformers covering range of 15 to 115 meters wound on forms of genuine NATIONAL R-39. Uses the new UX-235 Variable-Mu Tubes, giving improved sensitivity and less critical operation. Humless A.C. Power Supply with special filter section. R.F. Filter on Rectifier Tube, and Electrostatic shield. R.C.A. Licensed. Made also in low drain battery model.

The NATIONAL SW-5 THRILL-BOX in its distinctive cabinet

NATIONAL
SW-5 A.C. & D.C. THRILL BOX

Write for full particulars and prices on the NATIONAL NC-5 and SW-5

NATIONAL CO. INC., « 61 Sherman St. » Malden, Mass.

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1) that the primary of the filament transformer is connected to the convenience outlet or lamp socket in the usual fashion; but that it is also connected across the combined grid-plate element and one side of the voltage divider. The latter need be but an .02-meg. (20,000-ohm) resistor of the grid-leak type; since only "bleeder current" flows through it, and special wattage precautions need not be taken. It is practical to omit the cathode-"B"-resistor entirely.

The filter consists exclusively of a condenser, so the capacity should be large. This requirement is met by a dry-electrolytic 8-mf. condenser, with the cap (anode) connected to the rectifier's cathode and the lug on the can (negative), connected to the other side of the voltage divider, which is B minus.

It should be remembered that the cathode is positive; hence the other side of the voltage divider is negative. The negative of the rectifier will serve as the grid-return point for the converter's tube circuits; and no ground connection should be introduced from the receiver, as there is effective grounding through the capacity in the filament transformer.

Because the circuit is alive, as a source of both D.C. and A.C. voltages, it is desirable to isolate the aerial from any conductive coupling; which is done by placing a condenser in series with the aerial.

Since the cathode is positive, the "B+" voltage is taken from this point; and it will be more than 100 volts, if the A.C. supply is 110-volts. The extra voltage is dropped in the rectifier tube.

Automatic Regulation Is Obtained

Screen-grid tubes being used, a lower voltage is required for the screens than for the plates; so the three screens are tied together, and a resistor, also .02-meg., is connected from the common screen lead to "B+". Therefore the effective voltage on the screens will be less than the applied voltage, by the voltage drop across the .02-meg resistor, which is caused by screen current flow. Moreover, the screen voltage will be beneficially inconstant. When the signal is strong, and the plate current is lower than the steady no-signal value, the screen current also is lower. The screen voltage therefore rises (since less current causes less voltage drop in the series screen resistor), and a new measure of stability is achieved in the functioning of the screen-grid tubes. The amplification is held steadier, and fading effects are lessened.

There are four tubes in the converter: (1), radio frequency amplifier; (2), modulator; (3) oscillator, and (4), rectifier. The converter is triple-screen grid, the rectifier being, as stated, a 227.

The economical aspects of the circuit are apparent, since no extra windings are needed to constitute a power transformer of the more usual sort, while adequate filtration results from the use of only a condenser for this purpose. This is due to the low plate-screen current. If the current were high, the capacity would have to be higher than 8 mf. As it is, the circuit operates without any more hum than the usual well-filtered A.C. receiver of the finest console types. If a small "B" choke is provided, cathode to "B+," two 1 mfd, condensers at either end of the choke would provide sufficient filtration.

"This method of achieving the highly-desired result of a short-wave converter with 'B' supply built in, at hardly any extra cost above what a converter would cost without 'B' supply, is one that should prove of striking benefit to the radio industry and radio consumers," said Mr. Bernard.

Interesting Circuit of the Converter

The utter omission of any and all radio-frequency chokes will be noted. The couplets should be spaced ¼-wave-resistor of .02 meg., while the load on the plate circuit of the modulator is also such a resistor. By that method all trapping effects, due to large distributed capacity (which might be present in high-inductance radio-frequency choke coils) are avoided; and not only is response obtained all over the dial, but high sensitivity as well. Chokes of small inductance could also prevent dead spots, but might not afford as much sensitivity.

Even the grid leak has very low resistance, compared with values used for broadcast frequencies, while the grid condenser is a Hammarlund equalizer, 20-100 mmf., set at full capacity. This combination of grid-condenser capacity and leak resistance gives a time constant of 2 micro-seconds; hence it takes only two one-millionths of a second for the condenser to discharge to a little less than half its original charge. With a small time constant, the amplification is good on high frequencies.

As for operation, you yourself must select the most suitable intermediate frequency; this will be gleaned from experience. Most receivers now in use are more sensitive at the higher frequencies. Of late sets, particularly those in the 1930-31 production class, the opposite is true. If your receiver is so sensitive that you pick up broadcasting at almost all dial points in the broadcast band, select either extreme (the highest or the lowest set dial position), whichever is the more sensitive, and stick to that.

Once your intermediate frequency is established to your satisfaction, you should adhere to it; for then logging of the converter will hold.

The coils used in the DX-4 All-Wave Converter are of the air-wound precision type. The form consists of two circular bakelite cutouts, held together by bakelite ribs, 1/16-inch thick, running the length of the form. Thus, as the wire is put on, it touches bakelite ribs over only 3 per cent. of the entire winding circumference.

The diameter is an odd one, almost 3 inches, however; and those who desire to wind coils for the converter may use a 3-inch diameter and make provision for plugging into a five-prong tube socket used as a coil socket.

The winding data are:

Smallest coil (AKP-1): three turns of No. 18 enamelled wire, space-wound, and tapped at the second turn; the beginning of the winding goes to the oscillator's grid, the tap to ground and the end to the modulator's cathode. Hence the pickup winding (cathode to ground) consists of one turn, and the tuned winding (grid to ground) consists of two turns. The tickler is spaced ½-inch away and consists of six turns of No. 18 enamelled wire, wound in the same direction as the other; whereupon the beginning of the tickler (adjoining end of the other winding) goes to "B+", and the end of tickler to plate.

Second Coil (AKP-2): 12 turns of No. 18 enamelled wire, space-wound, tapped at the 10th turn. Separation, ⅛-inch. Tickler, 8 turns of No. 24 silk-cov. wire.

Third Coil (AKP-3): 25 turns of No. 18 enamelled wire, tapped at the 20th turn. Separation, ⅛-inch. Tickler, 10 turns of No. 24 silk-covered wire.

The relative connections and winding directions of all three coils are the same.

List of Parts for DX-4 Converter

Three plug-in coils for 10 to 600 meters or two for 30 to 600 meters);
One filament transformer, 2.5 volts;
Two .00035-mf. fixed condensers;
Two Hammarlund .0002-mf. "Midline, Jr." tuning condensers;
Four blocks, each of three 0.1-mf. condensers in one case;
One Hammarlund 100-mmf. equalizer for grid condenser;
One .0015-mf. fixed condenser;
One 8.0-mf. electrolytic condenser;
Five .02-meg. resistors (20,000 ohms);
One 50-meg. resistor; and mounting clips;
One 150-ohm flexible biasing resistor;
One National dial, type VGE (modernistic), with pilot lamp and knob;
One front panel, 7 x 10 inches;
One subpanel, with five UY sockets;
Two binding posts, one for aerial and one for output;
One A.C. cable and plug;
One A.C. switch and bracket;
One 1-ampere fuse and holder.

"The idea of resorting to a simple circuit to obtain a positive 'B' voltage economically has been in the minds of many for a long time. The problem presented itself to Mr. Anderson and myself principally in connection with a midget broadcast receiver, so small in size that it virtually fits in one's overcoat pocket—and yet there the receiver is.

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NEW 2V TUBES

230—General Purpose $ .75
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TRANSMITTING TUBES—UX210's—15 watt rating—$1.50

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UV211—75 watt General Purpose 16.00
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UV203A—50 watter, Oscillator 16.00
872—Power Mercury Vapor 12.00
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All Tubes unconditionally guaranteed ninety days against mechanical and electrical defects.

Meters—black flange, Flush Panel Mounting, 2¾" diameter. Milliameters, 0-10, 0-15, 0-25, 0-30, 0-50, 0-75, 0-100, 0-200, 0-300, 0-400, each $1.00
A.C. Voltmeters, 0-3, 0-5, 0-7½, 0-10, 0-15, 0-150. Each $2.50
D.C. Voltmeters, 0-300, 0-600 $3.00 0-750 $5.00
100 watt bleeders, mounted and center tapped, 9⅛" long 5,000, 10,000, 20,000 ohm, each $1.40
50,000 or 100,000 ohm, each $2.00
75,000 or 100,000 ohm with six taps $2.25
Closing out stock fo Navy 5 watters, type CG1162, ea. $ .39
Radiobuilders 80 meter crystals. Cut from finest Brazilian Quartz, 1" square cut. Accuracy guaranteed 1/10 of 1% in 3500 to 4000 KC band. Each $4.40
Dust-proof plug-in crystal holders, each $1.50
1/16" aluminum for panels 6/10c per square inch
Filament Transformers, 18 watts, 7.5v CT, each $1.00
For 866's, 2.5v CT, 10 amps, 15,000v insulation $2.75
For all 50 watt tubes, 11 volts CT, 10 amperes $5.50
For all 250 watters, 12.5 volts CT, 10 amperes $6.00
Stand-off insulators, similar to GR $.09 ea., Doz. $ .90
Genuine Mershon 8 Mfd. 400 volt condensers $ .95
85 watt grid leaks, 10,000, 15,000 ohms, each $ .65
Latest Amateur Call books $ .82
Enameled aerial wire No. 12, 100 ft. solid $ .75
Enameled aerial wire No. 12, 1 length 200 ft. $1.40
20 ohm Kurz Kasch rheostats with knob. Each $ .20
UX or UY sockets, heavy spring contacts $ .10
Special 1000v Dubilier mica condensers, .002 $ .15
20,000, 50,000, 1000,000 ohm potentiometers $ .50
250,000 ohm Centralab gain controls $ .79
Pilot plug-in coil forms. Complete $ .39
Air King short wave Coils. Set of four $1.75
.0001 Pilot midget condensers for above $ .55
RCA audio transformers, 3 to 1 ratio $ .75
Copper coil 3" diameter ¼" tubing, per turn $.08½
¼" soft drawn Virgin copper tubing, per foot $ .08
5" dials for transmitter, each $ .20
.01, .25, .5, 400v by-pass condensers $ .25
GE ½ or 1 watt G10 neon lamps $ .55
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RADIOBUILDERS CONDENSERS

Mfd.	800v.	1000v.	1500v.	2000v.	3000v.
1	$1.10	$2.00	$2.95	$ 4.75	$ 6.95
2	1.55	3.00	3.95	8.00	22.50
4	2.75	4.00	5.50	14.00	19.95

Above condensers tested at 40% overload. All sealed in heavy metal containers with large terminal insulators. Above ratings are actual DC working voltages. All are guaranteed.

1000 volt oil impregnated condensers, uncased. Make up your own condenser units ½ mfd. $.20; 1 mfd. $.30; 2 mfd. $.40; 3 mfd. $.50; 4 mfd. $.60. All condensers guaranteed as rated.

Thermostats for crystal temperature control. Keeps temperature within ¼ of 1°. Special price, each $1.25
Complete instructions furnished for building constant temperature control boxes.
7 mfd. 1500v flash test Dubilier condensers. Each $1.75
1000v Dubilier mica condensers, capacities .0001 (100 mmfd.) to .0035, each $ .20
1500v Dubilier moulded micadon condensers, capacities .0001 (100 mmfd.) to .02. List price up to $2.00. Our price $ .25
800v fixed mica condensers. All capacities $ .15
Subpanel wafer sockets, UX or UY $ .05
CT resistors 10, 25, 50, 75 ohm $ .15
85 milhenry RF chokes $ .15
Hard rubber panels 7x10 or 7x12 $.55 7x14 $ .60
Pilot midget condensers. All capacities to 100 mmfd. $ .55
2000 ohm head phones, extra sensitive. Pair $1.20
Electric soldering irons $1.00
Odd lot .00025, .00025, .0005 lo-loss var. condensers $ .50
.00014 variable condensers $ .75
9 plate midget condensers (48 mmfd. Max. Capacity) $0.35
Tested seconds UX210, 281, or 250's $ .85
Tested seconds types 227, 224, 226, 201A, each $ .25
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HOW TO BUILD A Good *Television* Receiver

By R. WILLIAM TANNER, W8AD

A short-wave receiver suitable for the perfect reception of Television image signals is not the easiest apparatus to design. Mr. Tanner, who is well-known for his research and practical achievements in short-wave work, here presents full details for building a first-class television receiver and he discusses both the radio and audio frequency amplifiers clearly and accurately. If you intend to build a television S-W receiver, don't fail to study Mr. Tanner's valuable suggestions.

THIS season has the promise of being a big one for television. Many stations are now on the air, transmitting motion-picture films and direct-pickup subjects, as well as silhouette movies in black and white. The films are not lacking in interest, but are filled with plenty of action to compensate for lack of detail. The direct-pickup subjects are of famous persons, vaudeville acts, etc., and some of them have sound accompaniment.

It will be remembered that, about two years ago, television received a great amount of publicity; its lack of progress was due to the fact that poorly-designed reproducing equipment, and ordinary short-wave receivers, were sold to the experimentally-inclined public. At that time only silhouette movies were transmitted. Is it any wonder that television was looked upon as something yet very far away?

With the high-grade reproducing apparatus now available, there is no reason why television should not be more popular.

For some time the writer has been experimenting with television. It has been found that most of the problems lie directly in the receiver and the audio amplifier. Contrary to general opinion, the usual form of short-wave receiver is entirely unsuitable for even fair pictures. The use of a regenerative detector results in excessive selectivity, which cuts off the sidebands and thereby the pictorial values of the picture. The audio amplifier, employed in such receivers, not only gives insufficient gain but is incapable of amplifying the required range of frequencies.

A special receiver is an absolute necessity; but there are a number of major problems involved in the design of such a receiver, to which the average experimenter assigns little or no importance.

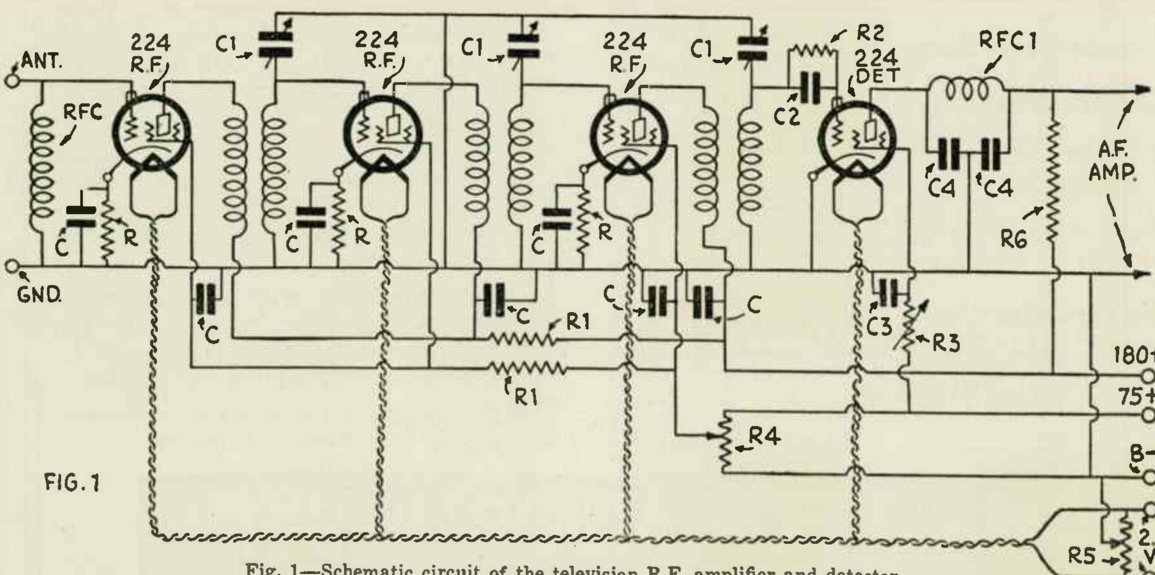
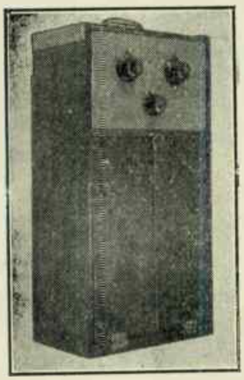
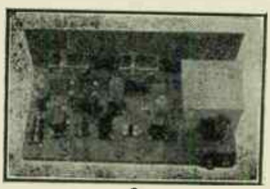
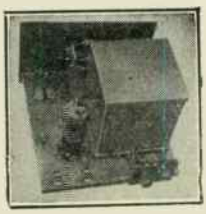


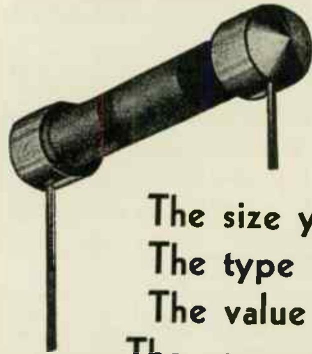
Fig. 1—Schematic circuit of the television R.F. amplifier and detector.

RFC... Short-wave R.F. choke
RFC1.. Short-wave R.F. choke
C...... .006 mf. by-pass condensers
C 1.... .00014 mf. 3 section condenser
C 2.... .00015 mf. grid condenser
C 3.... .1 mf. by-pass condenser
C 4.... .00015 mf. by-pass condensers
R...... 500 ohm bias resistors
R 1.... 10,000 ohm decoupling resistors
R 2.... 1 to 2 megohm grid leak
R 3.... 0 to 100,000 ohm variable resistor
R 4.... 0 to 50,000 ohm variable resistor
R 5.... 30 ohm center-tapped filament resistor
R 6.... 250,000 ohm plate resistor









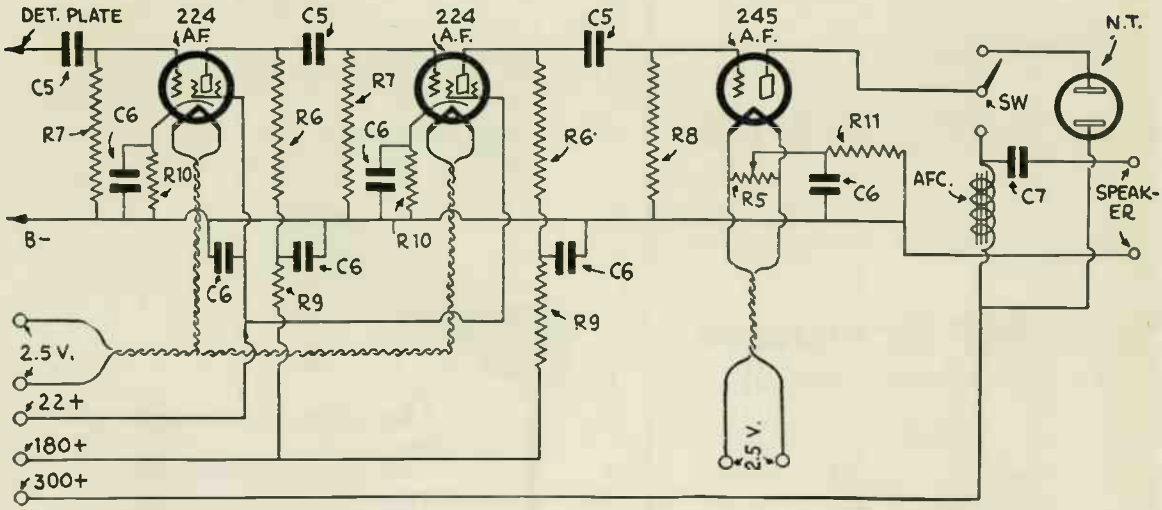


Fig. 2—Circuit of television audio amplifier with filters to prevent motor-boating, and switch to change from pictures to voice.

R 6... 250,000 ohm plate resistors
R 7... 500,000 ohm grid resistors
R 8... 250,000 ohm grid resistor
R 9... 20,000 ohm filter resistors
R 10... 1,000 ohm bias resistors
R 11... 16,000 ohm bias resistor
C 5... .01 mf. audio coupling condensers
C 6... 1 mf. 250 volt by-pass condensers
C 7... 2 mf. 600 volt speaker condenser
AFC... 30 Henry A.F. choke
NT..... Television or neon tube

Requirements In a Successful Television Receiver

It is the purpose of this article to point out these problems and to offer suggestions as to their cure, as well as to give the reader constructional plans.

These major problems are:

(1) Sufficient gain, in both radio- and audio-frequency amplifiers, to provide good clear pictures at reasonable distances from the transmitting stations.

(2) The radio-frequency amplifier must pass a band sufficiently wide to include all frequencies encountered in television. As these frequencies are from (approximately) 15 to 25,000 cycles, the tuned R.F. circuits will have to pass a band 50,000 cycles or 50 k.c. wide.

(3) The R.F. and detector circuits must be free from regenerative effects, in order not to cut off any of the higher frequencies.

(4) The audio amplifier must consist of the correct number of stages to provide a "positive" picture.

(5) Motorboating or audio howling (feedback) must be entirely eliminated.

(6) In order to obtain a picture of good visibility, the last or power audio stage will require a tube drawing a relatively high plate current. The larger the tube, the better the picture—up to certain limits.

The use of one untuned, and one tuned R.F. stage, ahead of a grid-leak type detector will generally prove quite satisfactory over a distance of a hundred miles or so; however, results might be inconsistent. Therefore, at least two tuned stages should be included wherever possible.

An untuned or ballast stage ahead of the two tuned stages is almost a necessity when single control is employed. Construction of the R.F. transformers is then simplified, since all are wound alike; and antenna effects are entirely absent. The additional gain obtained from this stage is not great, but sensitivity is not its purpose.

Screen-grid tubes will, of course, be needed in the R.F. amplifier; as the gain per stage, below 200 meters with three-electrode tubes, is too low to be of much use.

Necessity of Proper Shielding

The use of multi-stage R.F. amplifiers on short waves brings up the question of feedback. Complete shielding of all coils, tubes, variable condensers, and leads carrying high-frequency currents is a requirement which has previously been met in a half-hearted way by designers of short-wave receivers. The writer has yet to operate a manufactured, tuned-R.F., short-wave receiver in which feedback was low enough to bring in the details of halftone television signals.

Placing the components of each stage within a separate shield box is almost as bad as no shielding at all; since feedback from the plate to the grid circuits, resulting in considerable regeneration if not oscillation, is altogether possible.

If television is to become popular with the general public, single control of the tuned circuits will be necessary. As the waveband now in use for this service (Commercial and Amateur) lies between 100 and 175 meters, plug-in coils are not needed; this greatly simplifies construction. Trimmer condensers, in parallel with the main tuning condensers, can be employed to bring the various stages into resonance; exactly as in broadcast receivers.

In order to gang two or more tuned circuits successfully, the stray capacities should be reduced to the lowest possible value and be made as nearly equal (in each circuit) as practical. In addition, the operation of the controls should not change any capacity except that of the tuning condensers. Even with a well-made ganged condenser, the percentage of difference in capacities is generally greater at the low end of the scale than at the high. Because of this, it is well not to work at too low a value of tuning capacity; therefore the trimmers may be as high as 25 mmf. (.000025-mf.). Minor variations are thus decreased in importance.

While the use of a band-pass filter is, undoubtedly, the best means of obtaining the required 50- to 60-kc. width, nevertheless plain, broadly-tuned coupled circuits will give practically as good results and offer greater ease in construction.

The mention of broadly-tuned coupling transformers brings us to the problem of regeneration. In the detector circuit this is easily eliminated by not providing a tickler, but in the R.F. stages the matter is entirely different. Even though the elements within the screen-grid tubes are shielded, it is possible that external couplings, either magnetic or capacitive, may be so great that regeneration is present. This will sometimes (unfortu-

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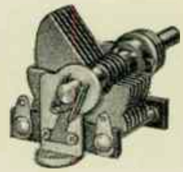

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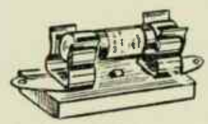

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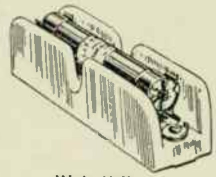

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nately, quite frequently) cause the amplifier to oscillate. Broadly-tuned transformers accentuate the already existing feedbacks. Therefore, these feedbacks must be eliminated to the highest possible degree.

All circuits (such as screen-grid, plate and cathode) should be properly bypassed. The use of "decoupling" resistors is far more effective in reducing feedback than the usual type of R.F. choke in the individual leads. If the tube sockets and transformers are separated any distance, the plate and grid leads MUST be run in metal tubing; preferably copper or brass.

A peculiar condition exists in a television audio amplifier. If a grid-leak type of detector is employed, an *odd* number of A.F. stages must be used; with a biased detector, an *even* number is needed. The reason for this is that, when a signal is passed through a vacuum tube, it shifts in phase 180 degrees; this means a complete reversal of the picture in each stage. In grid-leak detection, rectification takes place in the grid circuit and a 180° shifting of phase occurs ahead of the audio amplifier.

Therefore, in the practical receiver, three audio stages will be needed when the detector is of the grid-leak type; and four stages for the biased detector.

Resistance coupling becomes a requirement when the wide band of frequencies is considered; but even then the lower frequencies will not be passed efficiently unless the coupling condensers are of relatively high capacity. The resistors should be of the finest quality obtainable; preferably those having pigtail connections and soldered into circuit permanently, rather than of the kind that plug into clips.

Audio feedback or motorboating is easily eliminated by the use of audio filters, connected in the "B+" leads to the detector and intermediate A.F. stages. Such filters are simple, consisting merely of fixed resistors and high-capacity bypass condensers.

To provide proper illumination of the television or neon tube, the power tube should be one drawing at least 20 milliamps. While '71A tubes can be employed with some success, one or two '45s will give much better pictures. One is generally sufficient for the average receiver.

Now that we have an understanding of the problems of the television receiver, together with an idea of how these are solved, let us advance to the constructional details.

Fig. 1 is the schematic circuit of a three-stage R.F. amplifier (the first stage being untuned) and a non-regenerative grid-leak detector. This makes a comparatively inexpensive arrangement and will give good results at a distance of five hundred miles or more from the transmitting station.

Values of Required Components

The ballast stage employs a radio-frequency choke in place of the usual resistor for coupling to the antenna. This permits greater freedom from interference by nearby stations. This antenna coupler may be a standard choke or a coil consisting of 50 turns of No. 30 wire on a bakelite form, one inch in diameter.

Bias for the R.F. amplifiers is obtained in the usual manner; by means of 500-ohm resistors (R) connected in the cathode leads. These are shunted by .006-mf. bypass condensers.

The decoupling resistors R1 have a value of 10,000 ohms each, and are connected in the 180- and 75-volt leads between the third and second R.F. stages. This method is employed in many commercial short-wave receivers, and has proven far superior to the usual R.F. chokes. The "postage-stamp" type of bypass condensers, .006-mf. capacity, will give as good results as larger ones and have the advantage of small dimensions and extremely low inductive effect.

The ganged, three-section tuning condenser C1 may be a regular .00035-mf. broadcast type with all rotor plates, except three per section, removed. A unit having extra-heavy plates and of solid construction should be selected. A three-compartment shield will be needed for this. There are a number of parts manufacturers now making three-gang .00015-mf. shielded condenser; and one of these should be given preference over a modified .00035-mf.

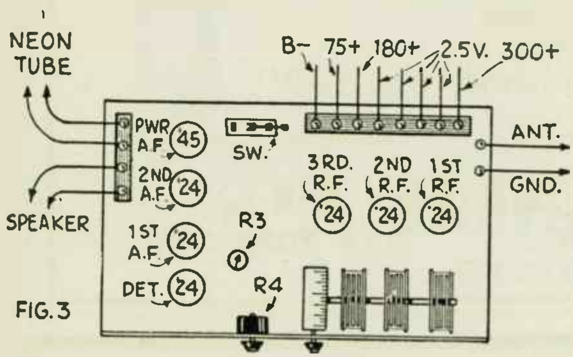

Fig. 3 — Layout of parts on a Silver-Marshall type 721 metal chassis.

When R.F. transformers are enclosed within metal shield "cans," the diameter of the winding forms should be rather small, in order to reduce losses to a minimum. A diameter of 1¼ inches is a very good size. Threaded bakelite tubing of this diameter can be procured from all radio supply stores, and is sold in 2-inch lengths. These forms are threaded for 64 turns per inch and are best suited for No. 30 enamelled wire. One length will make two transformers.

Assuming that this type of form will be used, cut one in half and drill four holes in each form, along one edge, for soldering lugs. Wind the secondary with 41 turns of No. 30 wire, and solder the leads to two of the lugs. (The lugs are attached to the form by means of 8/32 machine-screws, ¼-inch long.) The primary is then wound, starting at the end near the lugs. Wind 40 turns of No. 34 S. C. C. wire in between the secondary turns, and solder the leads to the two remaining lugs. All transformers are wound alike, and all coils in the same direction.

The top lead (farthest from the lugs) of the secondary goes to the grid and the top lead of the primary goes to the plate. All three transformers must be connected into the circuit in the same manner; otherwise ganging will be impossible.

The metal tubing for the plate and grid leads should be of ¼ inch stock, and grounded to "B —." The exact length of each will depend upon the separation of the tube sockets and R. F. transformers.

Overloading of the detector and audio amplifier is prevented by the volume control R4, which has a value of 50,000 ohms. This is connected to vary the screen-grid voltage, on the R. F. tubes, from zero to 75 volts.

The variable resistor R3 in the screen-grid lead to the detector is employed to provide the highest degree of sensitivity possible. This has a maximum resistance of 100,000 ohms.

The circuit for the audio amplifier is shown in Fig. 2. Two screen-grid intermediate stages precede the power stage; all stages are resistance-coupled to pass all frequencies from 15 to 50,000 cycles. Connections for the audio filter resistors R9 are clearly shown.

A switch (SW) in the plate circuit of the '45 power stage is provided to allow either a speaker or neon tube to be used at will. The speaker filter (AFC-C7) is the usual choke-condenser combination.

It will be noticed that a voltage of 300 is specified for the plate of the '45 tube; this is not excessive since 50 volts is required for grid bias. Any type of "A and B" eliminator can be used, providing the voltage and current ratings are high enough.

His experimental television receiver was only a breadboard model, and far from being a good looking job; therefore specifications are given herewith for a

permanent, modern layout. A "721" S. M. pierced metal chassis should be purchased, together with six UY five-prong and one UX tube sockets, sub-panel type. These are mounted as shown in the layout (Fig. 3).

If the builder does not care to go to the trouble of constructing the R. F. transformers and shield cans, Silver-Marshall "Type 123" broadcast transformers may be used, by removing turns from both the primaries and secondaries. A total of 50 turns should be left on the secondaries and 40 on the primaries.

These transformers may be readily mounted, in the holes provided, directly under the gang condenser. All fixed resistors, bypass condensers and R. F. chokes should be mounted underneath the metal chassis.

No. 14 insulated tinned wire must be used for the filament circuits; though No. 18 is large enough for the R. F. and other circuits.

After the set is completed, connect it to a good power pack and insert the tubes. Assuming that the set is ready to operate, tune in, say, W2XCR (in Jersey City, N. J.) on approximately 105 meters. This is done by listening in on the speaker. Then switch over to the neon tube and start the scanning-disc motor.

A Jenkins "Model 100" radiovisor was used by the writer; so the operation of this will be described. Turn the motor rheostat up so that the disc passes through and beyond synchronous speed; and then retard its speed slightly by cutting down on the rheostat. Reduce the speed still further by braking the motor shaft with the thumb and forefinger; until the picture appears. If the picture tends to progress to the right, the speed of the motor is too high, and the rheostat should be cut down still more. If the progress is to the left, either the speed of the motor is too slow or the braking was not done correctly.

After synchronization has been reached, the picture may "hunt" slightly but, in time, will steady down of its own accord. The effect may be hastened by braking the motor shaft each time the picture swings to the right.

Framing the picture, either horizontally or vertically, is accomplished by means of the hood covering the neon tube; this is supplied with the radiovisor kit.

The standard scanning disc used at most transmitting stations is the 48-hole type, so this should be specified when purchasing the radiovisor.

Very little has been written on the subject of television, especially in regard to the R. F. end; therefore this article should be helpful to those interested in the most fascinating branch of short waves.

The writer will be glad to advise anyone on other details upon receipt of a stamped envelope.

Octocoil Winding Data

To cover the short wave bands from 16 to 225 meters, 4 plug-in coils are used, each coil being 1½ inches in diameter and the turns or coil form being octo or 8-sided and not round as in most coils, with the turns supported only from the 8 respective ribs. These coils "L1" are designed for operation with a .00015-mf. variable condenser; the tickler is represented by "L2."

Color	Meter Range	No. of Turns, L1	No. of Turns, L2
Green	16- 30	6	6
Brown	29- 58	13	13
Blue	54-110	21	15
Red	103-225	54	27

Data on National "Short Wave" Coils for Their Battery Type Short Wave Receiver

The secondary winding of the coils being shunted by 90 mmf. (.0009 mf.) variable condensers. Diameter of coil forms 1½ inches:

No. 10 coils, covering from 9 to 15 meters:
Secondary 2 5/6 turns of No. 16 Enamel
Primary 1 5/6 turns of No. 34 Enamel
Tickler 3 turns of No. 32 Double Silk.

Coil Data

No. 11 coils, covering from 14.5 to 25 meters:
Secondary 6¼ turns of No. 16 Enamel
Primary 3 5/6 turns of No. 34 Enamel
Tickler 3 turns of No. 32 Double Silk.

No. 12 coils, covering from 23 to 41 meters:
Secondary 11 5/6 turns of No. 18 Enamel
Primary 7 5/6 turns of No. 34 Enamel
Tickler 3 turns of No. 32 Double Silk.

No. 13 coils, covering from 40 to 70 meters:
Secondary 19 5/6 turns of No. 18 Enamel
Primary 12 5/6 turns of No. 34 Double Silk
Tickler 4 turns of No. 32 Double Silk.

No. 14 coils, covering from 65 to 115 meters:
Secondary 34 5/6 turns of No. 24 Enamel
Primary 21 5/6 turns of No. 34 Double Cotton
Tickler 4 turns of No. 32 Double Silk.

No. 15 coils, covering from 115 to 200 meters:
Secondary 62 5/6 turns of No. 28 Enamel
Primary 38 5/6 turns of No. 32 Double Silk
Tickler 5 turns of No. 32 Double Silk.

DESIGN OF COILS USED IN SHORT-WAVE RECEIVERS:

Pilot "Super-Wasp": tuning capacities 160-mmf (max.) in series with .01-mf., regeneration capacity 250 mmf.

Diameter of form, 1⅜ inches.

Meters Covered (Approx.)	Antenna Coupler Turns	Detector Coupler Grid (Spaced ⅛ in.)	Detector Coupler Tickler
14.5-27.0	4½No.24DSC	3½No.24DSC	4No.24DSC
26.0-50.0	9½No.24DSC	7½No.24DSC	6No.24DSC
48-100	20½No.24DSC	17¾No.24DSC	7No.24DSC
100-200	46¼No.24DSC	45¾No.24DSC	15No.24DSC

Hammarlund: for tuning capacities 125-mmf.; regeneration 100 mmf.

Diameter of form, 2 inches. Windings separated 1 turn.

Meters	Grid Coil Turns	Plate Coil Turns
14- 24	3 No. 16 DSC	3 No. 16 DSC
22- 40	7 No. 16 DSC	5 No. 16 DSC
35- 65	15 No. 16 DSC	6 No. 16 DSC
60-110	24 No. 18 DSC	12 No. 18 DSC

No. 16 wire spaced 11 turns to inch; No. 18, 17 turns.

Variable primary of 6 two-inch turns, used with all coils, is 1 13/16 inches in diameter, hinged.

Silver-Marshall "Midget": for 140-mmf. tuning capacities.

Diameter of form 1 inch; primary (tickler) wound in slot. Forms threaded 39 turns to inch.

Meters:	Tuned Secondary Turns	Primary Turns
16-31	6½	5 2/3
30-57	13½	7 2/3
55-104	25½	12 1/3
103-195	46½	25 2/3

"Craft-Box" tube-base coils, home-made. Forms 1⅛-inch. Tuning capacity 32-mmf. Regeneration capacity, same. Windings separated ⅛-inch.

Meters	Tuned Secondary Turns	Tickler Turns
18-25	7 No. 28 DCC	7 No. 28 DCC
25-35	10 No. 28 DCC	10 No. 28 DCC
35-45	15 No. 28 DCC	14 No. 28 DCC
45-65	20 No. 28 DCC	18 No. 28 DCC
63-100	50 No. 28 DCC	50 No. 28 DCC

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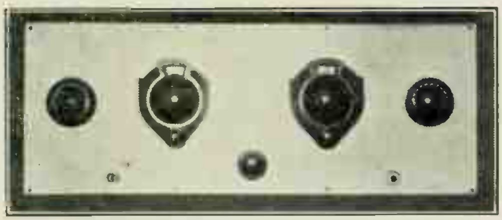
2-Volt Tube Receiver

By JOHN CARTER

(*Continued from page* 8)



The 2-volt tube S-W receiver fitted with vernier dials.

The mechanical assembly of the parts, together with the shielding, is not difficult and anyone handy with tools should be able to build this set in a few evenings.

A sneet of aluminum is mounted on top of a wooden baseboard and fastened by four screws, one in each corner. The two shield cans are very durable, with ample space for the coils and tubes. The heavy aluminum sides slide into grooved aluminum posts, which have iarge overlaps and are held firmly in position by four screws. A hinge is easily affixed to each shield, by drilling four small holes, and is bolted to the box; this is very handy when changing coils. The three plates that shield the condenser C1 and C2 are very efficient.

Only one wire connects to each of the condensers C^1, C^2 and C^4. The rotors of these condensers and the "F—" terminals of the tube socket are bolted to the chassis and the chassis is grounded; which makes a common return and saves time in wiring. Shielded wire is used throughout and is point-to-point; all connections being soldered. (Care should be exercised not to use too much flux as this will cause leakages.) It is very important that all holes drilled in the aluminum shield boxes for the wiring connections should be made as small as possible, so that the shield on the wire fits the hole snugly. This grounds the shields around the wire and helps stray radio-frequency currents from entering the boxes.

All terminal connections are brought to the rear of the set and mounted on a strip of bakelite. The aerial condenser C4 and the phone jack are insulated from the aluminum panel with mica or bakelite washers. Two round aluminum cans, of the type used for coils, serve to shield condensers C^3 and C^4.

An aerial sixty to seventy feet long, using single-stranded copper wire, was found very satisfactory, and the selectivity of the set was also very good; this is made possible by the use of condenser C3. The setting of this condenser depends upon the length of aerial used but, generally, it must be lowered as the desired wavelength is lowered. Use a good ground connection, preferably direct to the ground; if this is not available, a water pipe should be used. Care must be taken that all paint and corrosion is removed and the pipe scraped until the clean metal shows. More short-wave circuits fail to oscillate from the lack of a good ground connection than any other known cause.

The two main tuning dials are C1 and C2; the oscillation is controlled by C4. To simplify tuning, and to make possible accurate logging, small calibrated dials instead of knobs are used to rotate C3 and C4.

The attractiveness of the panel and the symmetrical layout of the parts put this receiver on a par with any set. In New York City this set has brought in England, Holland and numerous American stations.

List of Parts

C1, C2	Two Hammarlund 125-mmf., Midline condensers;
L1, L2	Two sets of Hammarlund plug-in coils;
C3	One Hammarlund 65-mmf. variable condenser;
C4	One Hammarlund 100-mmf. variable condenser;
C5	One .0001-mf. Aerovox fixed condenser;
C6, C7, C8, C9	Four .01-mf. Aerovox fixed condensers;
C10	One .002-mf. Aerovox fixed condenser;
R1	One Electrad. 4-megohm grid leak and mount;
R2	One Electrad 100,000-ohm rheostat;
R3	One 10,000-ohm Aerovox resistor;
R4	One 400-ohm potentiometer;
Z, Z, Z	Three Hammarlund 250 chokes;
T	Three UX tube sockets;
J	One Aluminum panel, 7"x16";
	One Sub-panel, 8½"x14";
	One Audio transformer
	Two Blan "A-1" aluminum shield boxes;
	Three Alcoa aluminum shield plates;
	Two Aluminum coil shields;
	One phone jack;
	One filament switch.

The Short-Wave S-G Craft Box

By BERYL BRYANT

(*Continued from page* 14)

A metal tab is soldered directly to the clip of the grid leak as shown in Fig. C. A similar piece is made and drilled with a hole in the tab to pass a 6-32 brass machine screw. A hole is drilled ¾-inch from the screw fastening the clip to the bakelite mounting strip of the grid-leak mounting. The second strip is now arranged in such manner as to be variable in the surface exposed to the fixed strip, being pivoted by the same screw used for the mounting of the binding post as shown (Fig. 2). The binding post (*B*1), used to connect the antenna directly to the grid of the R. F. tube, is fastened to a screw soldered to the one which fastens the clip to the bakelite strip. The ground binding post (*B*3) is mounted on the bakelite strip in the same manner as the series-condenser binding post (*B*2) and its screw is soldered to the lower clip of the mounting. On the rear of the baseboard should be left a space 1¼ inches wide by 9 inches long for the "A" and "B" batteries, which are held in position by a strap of fibre or "fish" paper. This strap should be an inch wide and strong enough to prevent tearing.

Adjustment and Operation

To operate the receiver the batteries are first placed on the rear of the baseboard but not fastened down until connected; all are connected in series, to provide 135 volts. Two 4½-volt "C" batteries connected in parallel are used for the "A" battery, or, if longer life is desired, three dry cells connected in series may be used. "A—" and "B—" are connected together and to the lead from the filament switch. The "A+" is connected to the "A" battery, "B+ Det." and the R. F. screen-grid lead to 45 volts positive. It was found by experiment that a slight increase (not over 67½ volts) on this grid improved signal strength to a noticeable figure. The "B+90" and "B+135" are also connected to the proper battery terminals.

Caution: do not connect the batteries, especially the "B" batteries, until the constructor is positive that all connections have been properly made in the receiver.—*Radiocraft.*