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The Hammarlund Short Wave Manual

1935 EDITION

IN this manual will be found the constructional details on what is, probably, the most carefully selected and comprehensive group of inexpensive short-wave receiver designs ever published in a single volume.

The selections were made by the editors of five of the leading radio publications of the United States, from among the most popular and efficient designs described in their publications during the past year or so. Then models of the receivers were constructed and put through their paces in the laboratory and "on the air" with the result that the twelve designs presented here represent the cream of the hundreds offered to the home constructor during past months.

Inasmuch as the most popular designs are the more simple ones that combine low cost with efficiency, the receivers described here naturally fall in that class. The requirements of the constructor who is looking for more advanced design are not overlooked however. Then, too, while the demand is greatest for short-wave broadcast receivers, the special requirements of receivers for operation on the amateur bands have not by any means been neglected as is indicated by the fact that band-spread designs, and even a 5-meter receiver have been included in this group.

Having arrived at the final selection of receivers, the next step was to turn the models over to the experimental laboratory for careful study to determine whether any of them could in any way be improved. The fact that several of them came out of this laboratory with improvements should not be taken as a reflection on the original designers or the publications in which the original descriptions appeared. The changes made mainly took the form of substitution of more modern tubes or more efficient coils, with some changes in associated parts to adapt them to these new units. In a few other instances changes which brought about a considerable improvement in efficiency at a slight increase in parts cost were considered justified and were therefore made.

In some respects reception of short-wave signals differs considerably from reception of signals on the broadcast band above 200 meters. Perhaps the most prominent difference is found in the astonishing distances that can be covered with even the most simple one or two-tube receivers. It is no particular feat, for instance, to hear the European stations and others from remote parts of the globe quite regularly with such receivers.

Such distance reception is not limited to the hours of darkness, as is DX reception on the broadcast band. In fact some of the most phenomenal reception is obtained in the daytime.

Generally speaking the larger the wavelength, the later in the day will best reception occur. The 16 meter broadcast stations, for instance, are best during the morning hours. Those operating on 19 meters come in well during the late morning and early afternoon hours. The 25 and 31-meter stations usually are heard with maximum volume during the late afternoon and early evening hours and those on 50 meters are best received after darkness has fallen.

The foregoing holds true with few exceptions in North America. One of these exceptions is reception from Australasian stations. These operate around 31 meters, yet are heard best by Americans in the early morning before breakfast (at which time it is evening in Australia and New Zealand).

There are explanations for the conditions mentioned, some of them being rather involved. However, the important thing, from the standpoint of the short-wave listener, is that these conditions do exist. They mean that the old practice of sitting up all night for good DX reception is a thing of the past, and that practically any waking hour is a good one for foreign DX reception, on one wavelength or another in the short-wave range.



Tuning a short-wave receiver is a far more critical business than is the same operation on the broadcast band. This is not due to any electrical peculiarities inherent in the short waves, and is best explained by an arithmetical example.

Assume that a receiver is capable of separating stations which are broadcasting at frequencies 10 kilocycles apart. In the broadcast band of 1500 to 550 kc. there would be room for 96 such station channels. If the tuning dial were properly marked off in 96 divisions, therefore, a station would be heard at every division on this dial.

Now, going down to the short-waves, the tuning range of a single coil may be from 20 meters to 50 meters which means, in terms of frequencies, from 15,000 kc. to 6,000 kc. Instead of providing for 96 channels there would be 900 such 10-kilocycle channels and with the same dial marking as mentioned above, there would be 10 channels to every division of the dial instead of only one. It therefore follows that in tuning the short-wave stations the adjustment of the dial has to be exact to a small fraction of a division. A high radio tuning dial is one way of accomplishing this.

Undoubtedly the most practical method is found in the use of some sort of band-spreading system. The most common of these is the one in which a small variable condenser is connected directly across the regular tuning condenser, the small condenser being employed for the exact tuning. Take as a

(Continued on next page)

THE HAMMARLUND MANUFACTURING CO., Inc.

424-438 West 33rd Street, New York, N. Y.

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specific example a short-wave receiver with a coil plugged in, which covers the range of 20 to 50 meters mentioned above, and employing a tuning condenser of 140 mmfd. maximum capacity. Rotating this condenser through its entire capacity range tunes the receiver through a frequency range of 15,000 to 6000 kc., a span of 9000 kc. or 900 10-kc. channels. Now, suppose a shunt variable condenser of much smaller capacity is placed across this 140 mmfd. condenser. Swinging this small condenser through its entire range will result in a relatively small capacity variation and therefore a relatively small frequency range. With the selection of the proper small capacity, for instance, the frequency range with the smaller condenser may be only 1/10th as great as with the larger condenser and in such a case there would be only 90 channels within the range of this condenser, tuning would become as non-critical as that in the average broadcast-band receiver.

When this system is employed no additional coils are required and the only extra cost is that of the small condenser. The large condenser is employed to tune the receiver into the particular band desired, say the 25 meter broadcast band, for instance, then the small condenser is employed to tune in the stations within that band. These stations will then be spread out over perhaps 15 or 20 degrees on the band-spread dial whereas they would fall within 1 or 2 degrees if tuned on the dial of the larger condenser alone.

Variable condensers, such as the Hammarlund Type MC-120B, are available which are especially intended for parallel band-spread use. These are made with the 2 condenser sections combined in a single unit but with separate shafts. The larger section at the rear is provided with a slotted shaft for screw-driver adjustment and a lock nut for locking it in a permanent position once it has been adjusted to the desired band. The smaller front section has a standard shaft for control by a front panel tuning dial. These condensers are principally used in "ham" receivers.

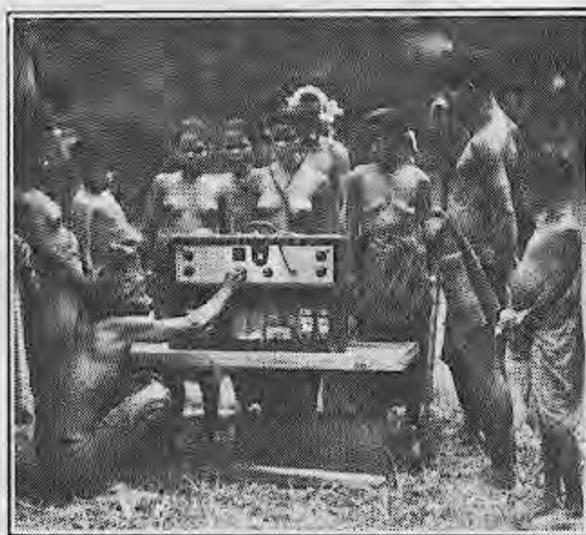
For those who are interested in a more detailed study than that presented here, an interesting discussion of band-spreading methods, analyzing the various methods in considerable detail, will be found in the October, 1934 issue of "Radio News."

There is a considerable difference in opinion as to what constitutes the most desirable type of receiver for short-wave work. There are many who prefer the



POPULAR JAPANESE SHORT WAVE TRANSMITTER

The station which is heard the world over and is the goal of listeners.



SHORT WAVE FANS IN JUNGLES OF MALACCA

A group of Jungle Dwarfs (the Sakai) tuning in on a short wave regenerative receiver brought to them by Frank Buck. The variable condensers, sockets, coils, etc. are all HAMMARLUND.

modern superheterodyne and a host that swear by the regenerative receiver.

There is much to be said for both types of receivers. Where a single receiver is required to cover both the short-wave and broadcast bands, the superheterodyne receiver undoubtedly has the edge because of its superior selectivity on the broadcast band. For purely short-wave work it can safely be said that either of these general types of receivers, if well designed and constructed, is capable of excellent service.

Among those who "build their own" the regenerative type of receiver is by far the most popular. It is less costly, easier to build, more easily understood by the novice and more economical in current consumption. Its selectivity may not equal that of a good superheterodyne, but it is selective enough for most purposes. Its sensitivity is as great as can be used in many locations—enabling it to bring in any signals that are above the local noise level of the average location.

No mention has been made of either straight tuned r. f. receivers, or those employing super regeneration, because neither one of these rates serious consideration for general short-wave work between 15 meters and 200 meters.

Super-regeneration is without a rival for use in inexpensive receivers to operate on wavelengths below 10 meters because at these extreme frequencies neither tuned radio-frequency amplification or normal regeneration are useful. For the regular short-wave ranges, however, super-regeneration is generally considered too critical and too noisy to be practical.

If the signal voltage of a distant station is only in the neighborhood of a few millionths of a volt (as is very often the case) at the antenna it is obvious that losses or inefficiency of any kind may make it quite impossible to hear that signal. Whether one's personal preference is for a superheterodyne or a regenerative receiver, therefore, the most important single factor in the success of the receiver, outside of the choice of a good design to follow, will be the care exercised in selecting the parts. Not only is it essential to provide a high degree of amplification, but it is equally important that losses be studiously avoided throughout the r. f. circuits.

Some points of inefficiency are generally recognized. In the matter of insulation, for instance, the average short-wave enthusiast has learned that nothing short of the best is good enough. This explains the almost universal preference for Isolantite insulated tuning condensers and coil sockets. There are, however, other factors which are less often considered. Perhaps the most important of these is the plug-in coil.

A recent study of the low and medium-priced plug-in coils available on the open market showed them to have an average "Q" of approximately 100 (at 15 megacycles) whereas the "Q" of a perfect coil should approximate 200. Inasmuch as "Q" represents the efficiency of a coil in a tuned circuit, the implication of these figures is obvious. In actual practice, a "Q" of 200 is not obtainable in practical plug-in coils because of certain inherent losses introduced by the metal prongs of the coil form, metal near the coil when in position in the receiver, etc.

Hammarlund has made high-grade plug-in coils for years, but these have been beyond the purse of the average set builder. However, after a careful investigation, the conclusion was reached that plug-in coils of excellent characteristics could be produced to sell at a low price, especially as much of the research and development work involved in such an effort had already been accomplished in producing the coils employed in the Hammarlund "Pro" receivers. The design work was therefore started and the new coils are now on the market at the same price as ordinary coils. The forms employed in these new coils are moulded of XP-53, an exclusive Hammarlund product developed for this purpose. In this new insulating material the losses have been reduced to a point where it closely approaches the low-loss characteristics of the most expensive dielectric materials. Even the use of artificial coloring has been avoided, leaving the material a natural light tan. In production, these characteristics are scrupulously maintained and even improved by moulding the XP-53 in a groove ribbed shape to reduce the contact area between winding and form to a minimum.

As matters of utility and convenience, the coil forms are moulded with an inside shoulder which permits mounting the new Hammarlund type APC trimming condensers within the form, where they are required for special band-spread or "fixed tune" purposes. A generous rim is provided at the top edge of the form, making it easy to grasp, and a removable wavelength index card is provided at the top of the form, on which the range of the coil is printed. Where forms alone are purchased, for winding coils at home, these index cards are left blank so that



POLICE ON SHORT WAVES

The elaborate short wave arrangement of the Police Department of New York City.



REMOTE SHORT WAVE WORK

Sports and other remote broadcasts are sent to the main transmitter by portable short wave equipment as shown. Note the antenna—a loop of tubular copper—

the builder can write in the range of the finished coil.

The development of the coil form was, of course, only one step in the process of design. The design of the windings for the various frequency ranges represents the real achievement of the engineers. The first step in this work was to determine the most practical frequency ranges for each coil—not in an effort to cover as much of the short-wave band as possible with each coil but to determine the required range for each coil in its relationship to the important short-wave stations. It is a well established fact that the greatest short-wave tuning efficiency is obtained when the coil inductance is such that relatively little tuning capacity is required to tune the coil to the desired frequency. The problem, therefore, was to allocate the ranges so that as many as possible of the important frequency bands could be tuned at relatively low capacity values. The bands aimed at primarily were the 19, 25, 31 and 49 meter broadcast bands and the 20, 40, 80 and 160 meter amateur bands. In the final coils all of these are tuned with highly favorable capacity ratios. At the same time ample overlap is provided between ranges. The entire band from 17.5 meters up to, and including approximately, one third of the regular broadcast band is covered with a set of four coils, using a 140 mmf. Hammarlund condenser, as follows:

- Coil 1—17,100 kc. to 7,300 kc. (17.5 to 41 meters).
- Coil 2—9,200 kc. to 4,000 kc. (32.6 to 75 meters).
- Coil 3—4,500 kc. to 2,000 kc. (66.6 to 150 meters).
- Coil 4—2,200 kc. to 1,100 kc. (136 to 270 meters).

In addition to the above coils, a separate coil is available to cover the balance of the broadcast band. This coil has a range of 1,200 to 535 kc. or 250 to 560 meters.

It is well to point out here that the above frequency ranges were measured under actual operating conditions, with the coil plugged into a typical band-spread (parallel condenser) receiver and the antenna connected. If anything these ranges are conservative because the test receiver was completely shielded and the proximity of the shield walls would tend to reduce the coil ranges at the high-frequency ends. This is important because it means that the builder of a re-

ceiver can depend on these coils covering the ranges specified.

Having determined the approximate ranges for the coils, there were left the numerous other factors for study, such as the best form factor, the best wire sizes and spacing, the best positions for the coils on the forms and the spacing between windings. Most of these vary with frequency and therefore each individual coil represented a separate problem in itself.

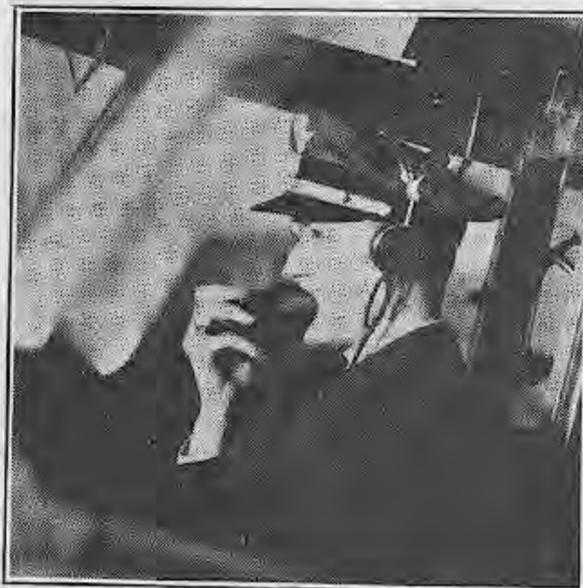
Space does not permit going into more detail here but the final proof of the excellence of these coils is found in the fact that the "Q" (at 15 megacycles) was found to exceed 150. This is believed to be the highest value of efficiency obtainable in plug-in coils of conventional type.

Finally, the prong connection arrangement is worthy of mention. There have in the past been no standards as to which prong should be the control-grid connection, which the plate, etc., in any but 4-prong coils; and even in these the standard was not definite. Now, through the efforts of some of the manufacturers and of the magazine "Radio News" an attempt is being made to standardize these connections. The standards proposed to date have been adopted in these Hammarlund coils.

Proper attention and forethought in planning the layout and wiring is essential if a short-wave receiver is to prove efficient. This is particularly true of the parts involved in the tuned circuit of the detector (and the r. f. tube if one is used). The coil should be placed a distance at least equal to its radius from other parts such as the tuning condenser, tube shields, metal panels, metal chassis, etc. Otherwise such metal masses will seriously reduce the efficiency of the coil. The coil, the tube and the tuning condenser should, except for this limitation, be placed as close together as practical in order that all wiring of the grid and tuned circuits will be as short as possible. Then this wiring should be run in straight lines—avoiding right-angle bends, as one would the plague.

A metal panel or chassis should not be depended upon as a conductor for r. f. circuits. All r. f. connections should be made by means of wires, and these wires all connected together at one point of the metal chassis or panel.

One part of the average short-wave re-



SHORT WAVING FROM AEROPLANES

A radio operator talking to his home office by way of short waves.



HAMMARLUND SHORT WAVE RADIO ON THE MORRISSEY

Oscar Hammarlund (left) at the controls of a Hammarlund "Pro" with Capt. Bob Bartlett looking on, on board the *Morrissey*, the North Pole schooner.

ceiver that receives too little attention is the r. f. filter in the plate circuit of the detector. Unless a really good filter is used here the r. f. currents get into the headphones or into the audio amplifier where they tend to increase body capacity effects, cause instability and may even make it difficult to obtain proper regeneration. A filter consisting of two chokes connected in series and with .00025 mfd. by-pass condensers, one connected from the junction of the two chokes to filament or ground, and the other from the B-plus end of the second choke to ground, will provide good results. The chokes required for such use may be of 1 or 2 millihenries inductance. The Hammarlund type (CH-X) are suitable, are easy to wire, and inexpensive.

There are several factors which contribute to smooth and effective regeneration. The antenna series condenser employed in most short-wave receivers has a material influence because it determines the degree of antenna coupling and therefore the amount of energy absorbed from the regenerative circuit by the antenna. The voltages (plate and screen) applied to the tube also influence regeneration, as does the plate by-pass capacity.

Where "fringe howl"—a terrific audio disturbance which occurs as the tube goes into or out of oscillation is experienced, the condition may sometimes be improved by the adjustments of the antenna or plate by-pass condensers. A more likely remedy, however, is to shunt the headphones or audio transformer primary (whichever is connected in the detector plate circuit) with a fixed resistor of 100,000 ohms or higher.

For simple regenerative receivers the antenna which will provide the best general results is the ordinary "L" type with a single lead-in wire. This antenna should be as high and long as practical, the lead-in should be kept clear of walls or other objects, the insulation should be good, and the antenna and lead-in should be one continuous length of wire without joints. If joints are necessary, they should be carefully soldered.

Special antenna systems have their advantages in many cases—but for the most part are not entirely practical for use with any type of receiver in which the antenna is capacity coupled direct to the grid circuit of the first tube as is the case in the great majority of regenerative receivers.

A Boy Scout's S. W. Receiver

THIS set was described in detail in the September, 1934, issue of "Radio News."

This receiver was built by Scout Robert Crockett of Pelham, New York, and is a good example of a design which aims at a happy combination of efficiency and economy. It is assembled on a wood base and panel to avoid the expense of a metal chassis. Also, the dials used, cost but a few cents whereas dials of the vernier or drum types would add considerably to the overall cost. It will be noted, however, that the all-important parts involved in the tuned circuits were selected with an eye for efficiency, as typified by the Hammarlund Isolantite insulated condensers.

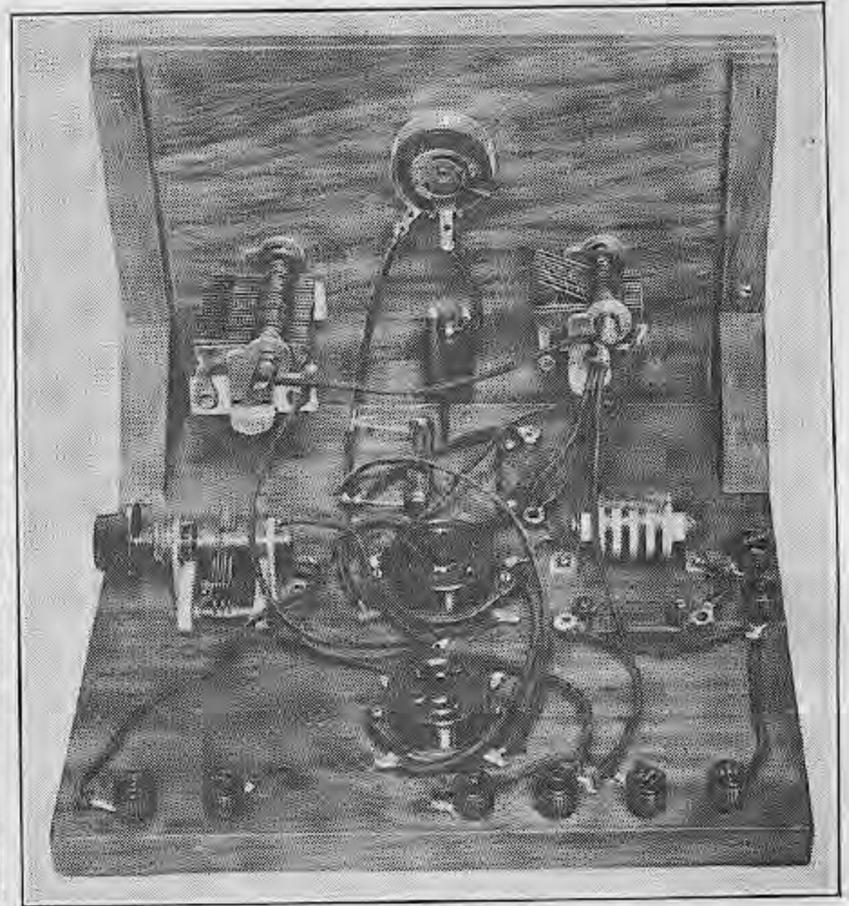
The receiver employs relatively few parts and is a simple one to construct—easily within the ability of the novice who contemplates the construction of his first short-wave receiver. Further, it is one which, when completed, will give plenty of enjoyable reception. Scout Crockett has succeeded in tuning in some 300 short-wave stations with it.

No radical claims are made for the set—such as loudspeaker operation, etc., but it will bring in the short-wave broadcast, amateur, police, aviation, television and commercial 'phone and telegraph stations with comfortable audibility. European short-wave broadcast stations are heard with plenty of volume for clear headphone reception.

Operation is also extremely simple, the left-hand dial providing the station selection and the right-hand dial the control of regeneration. The upper knob controls the rheostat. This is not used as a sensitivity control but simply to compensate for the normal drop as the two 1½ volt dry cells used for the filament supply become aged.

One feature of this receiver which is out of the ordinary is the use of a midget air dielectric variable condenser (C1) in series with the antenna circuit. It has been a common practice to employ a "trimmer" condenser of the compression type for this purpose but, through the use of a variable air dielectric condenser here, readjustment is greatly simplified inasmuch as a screw driver is not required, and the variation in capacity is far smoother than is the case with the compression type condenser.

There is frequently a distinct advantage in being able to adjust the antenna series condenser readily. This condenser varies the degree of antenna coupling. Now, if the antenna is closely coupled to the detector circuit it tends to absorb energy and thus prevent oscillation, even when the regeneration control is well advanced. On the other hand, close antenna coupling results in more



List of Parts

HAMMARLUND PRODUCTS

- C1—Midget variable condenser, type MC-358
- C2—Midget variable condenser, type MC-140M
- C3—Midget variable condenser, type MC-250M
- L1, L2, L3—Set of 6-prong plug-in coils, type SWK-6
- RFC—R.F. choke, type CH-3, 8 millihenries

MISCELLANEOUS

- C4—Aerovox mica condenser, type 1460, .0001 mfd.
- C5—Aerovox mica condenser, type 1460, .001 mfd.
- R1—I.R.C. metalized resistor, 3 megohms
- R2—Yaxley 30-ohm rheostat
- SW—Cutler-Hammer, s.p.s.t. toggle switch
- 1 Type -30 triode vacuum tube
- 1 Eby 4-prong socket, type 12 or Hammarlund Code S-4 Isolantite socket
- 1 Eby 6-prong socket, type 12 or Hammarlund Code S-6 Isolantite socket
- 8 Binding posts, suitably marked for connections as shown in Figure 1.

of the signal energy reaching the grid of the detector with correspondingly greater volume at the headphones. Against this is the fact that selectivity decreases as the coupling is increased.

The usual practice is to adjust the series condenser (the coupling) so that the detector can be made to oscillate readily throughout all ranges. The antenna absorption varies with frequency, however, so that when coupling is loosened to the degree required at frequencies where absorption is highest, it is likely to be found unnecessarily loose at other frequencies where antenna absorption is less.

From this discussion it is seen that the adjustment of this condenser represents a compromise in most receivers where a permanent adjustment is maintained. However, with the type of condenser used in this "Scout" receiver, this can be readjusted to meet the variations in absorption at different frequencies. It can also be adjusted to provide loose coupling and therefore higher selectivity if interference is encountered, or to provide closer coupling when tuning in extremely weak signals. In other words by varying this condenser as needed, the selectivity and sensitivity of the receiver are under more complete control of the operator and better reception is the result.

The front panel of the receiver is of 5/16 inch plywood with ¼ inch plywood cleats screwed along the ends at the back for greater rigidity. The baseboard is of 5/8 inch hard wood. The front panel is attached to the baseboard by means of wood screws, or with wood plugs and glue; and is reinforced with two-inch triangular wood corner brackets, glued to panel and base at each end of the receiver.

Before mounting the front panel on the base it is well to drill the four holes required for mounting the panel controls, otherwise the drilling operation is likely

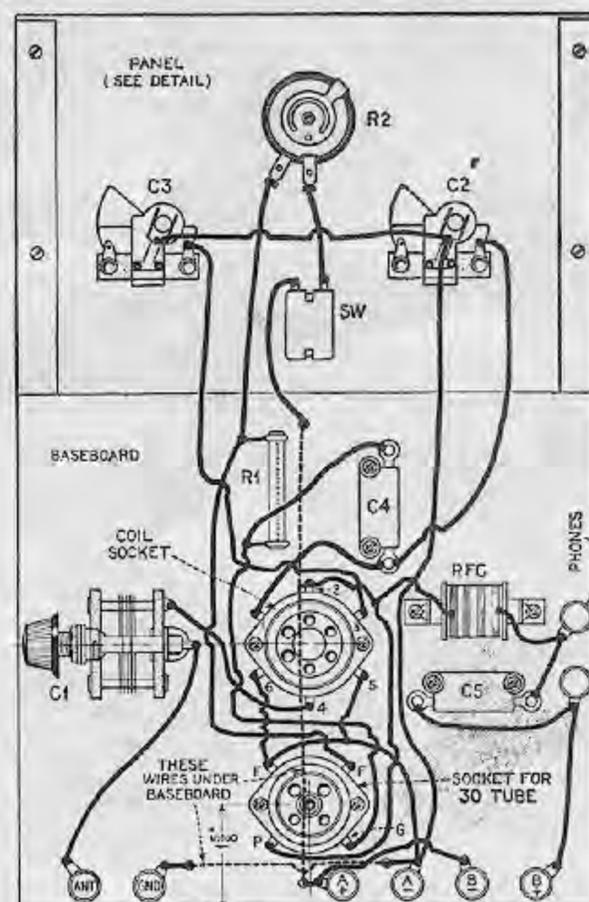


Fig. 1

to impose a strain on the panel. After the panel is drilled and is mounted on the baseboard, then all of the parts can be mounted in the positions indicated on the picture wiring diagram, Figure 1.

For the novice constructor it will be more instructive if the circuit diagram of Figure 2 is studied in conjunction with the picture wiring diagram of Figure 1. One can readily learn more by attempting to wire the receiver from the schematic diagram. This involves a little study but makes for a more complete understanding of the receiver and its circuits. If wired up in this way, the wiring can then be checked against the picture wiring diagram to avoid any possibility of error.

As will be noted from Figure 2, the plug-in coils employed with this receiver

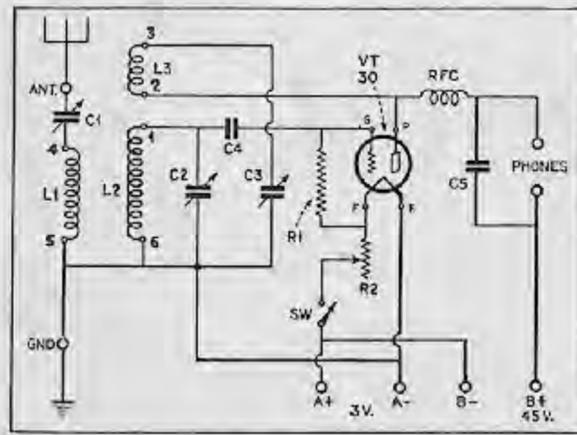


Fig. 2

are of the 3-circuit type. Coils having a separate primary winding for the antenna circuit, as do these, provide somewhat looser coupling than is obtained when the antenna is connected directly to the grid of the tube through the series condenser

as it is a common practice in one-tube receivers. This puts less dependence on the antenna series condenser as the sole coupling means and therefore involves less readjustment of this condenser. The balance of this circuit is so usual as to eliminate any need for further discussion, especially as the values of all parts are given in the accompanying list of parts.

The batteries required consist of two No. 6 dry cells for the filament supply and one 45 volt battery of the type used in portable receivers, or two 22½ volt C batteries. Large size B batteries are not required because the current drain of the single -30 tube is very small.

This receiver can also be used on the regular broadcast band by adding a suitable larger coil to the short-wave coil set.

The Sporting Twin

THIS two-tube regenerative receiver was described in detail in the May, 1934, issue of "Short Wave Radio" by Robert Hertzberg.

This little receiver does not in any sense represent a new development in the short-wave construction field. Instead, it is one in which the designer combined well-known and accepted principles to produce a set that is simple and inexpensive to build, but which the builder can depend upon for really worthwhile short-wave reception of all sorts of signals.

The circuit, as per Figure 2, employs 2 tubes. One type -30 tube is used as a regenerative detector with a condenser, C2, to control regeneration. A -33 type pentode provides one stage of audio amplification, this tube being coupled to the detector tube by means of a transformer.

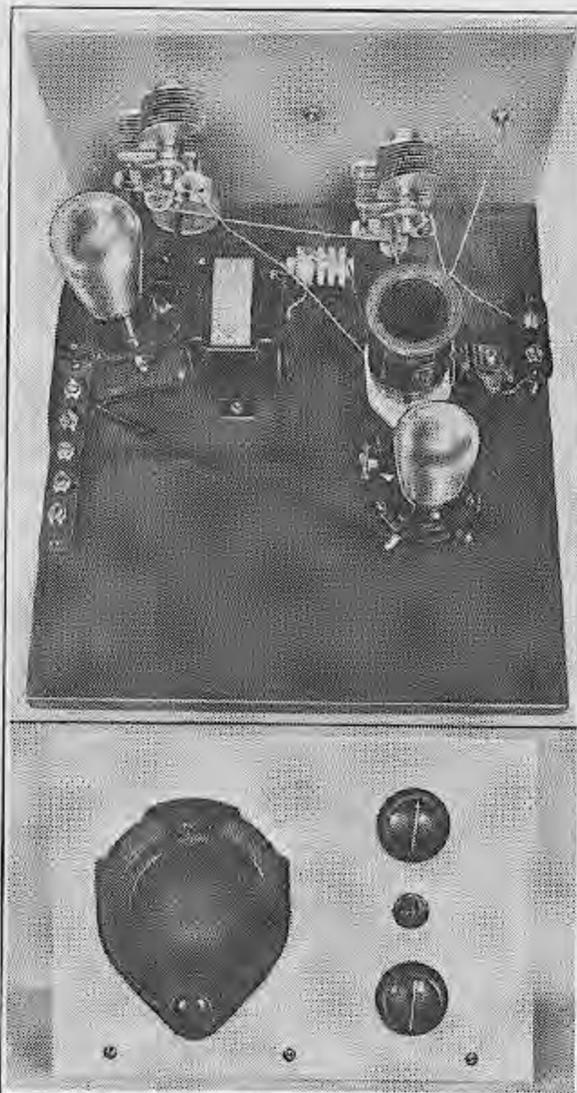


plate supply either 90 volts or 135 volts of B battery may be employed, but the higher value is recommended if maximum audio amplification is desired.

The model uses a wood baseboard 10 inches wide by 10½ inches deep. The aluminum front panel is 10 inches by 7 inches. The baseboard depth can be reduced to 8 inches if space is not to be provided for the batteries.

In assembling the receiver, at which time Figure 1 should be studied, the tuning condenser (C1) and regeneration condenser (C2) are mounted directly on the aluminum panel, as are also the on-off switch and the rheostat (SW and R1).

The Hammarlund short-wave plug-in coils will permit this little set to tune throughout the entire short-wave range from approximately 240 meters down and whether the owner's interest lies in short-wave broadcast, amateur, police, aviation or commercial reception—or all of these—he will be gratified by the results produced by this receiver.

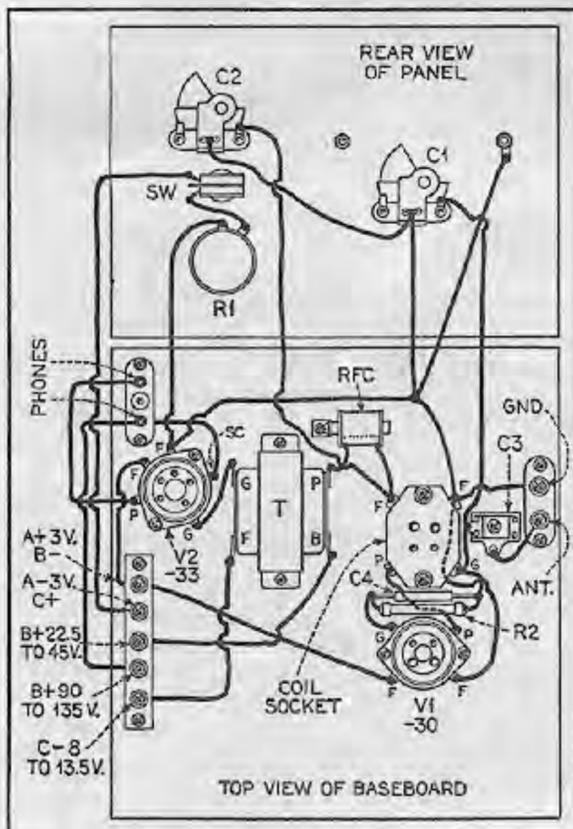


Fig. 1

Both of these tubes are of the 2-volt filament type. Two ordinary No. 6 dry cells may therefore be used to supply the necessary filament current. For the

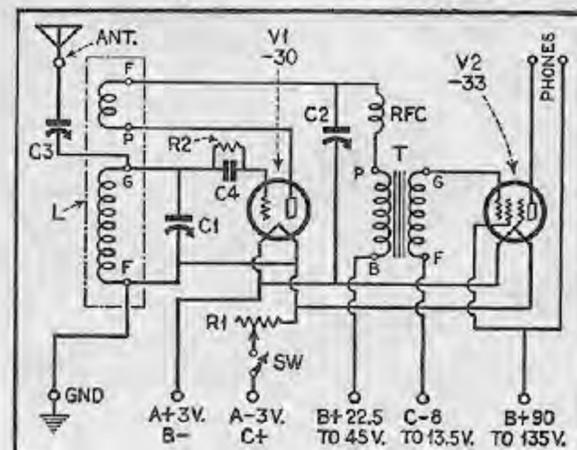


Fig. 2

List of Parts

HAMMARLUND PRODUCTS

- C1, C2—Midget variable condensers, type MC-140M
- C3—Equalizer condenser, type EC-35
- RFC—R. F. choke, type CH-8
- L—Set of 4-prong, 2-circuit plug-in coils, type SWK-4
- S—Isolantite 4-prong socket, type S-4

MISCELLANEOUS PARTS

- C4—Aerovox type 1460 fixed condenser, .0001 mfd.
- R1—Electrad 10-ohm. rheostat
- R2—I.R.C. metalized resistor, 3 megohms
- SW—Toggle switch, s.p.s.t.
- T—Thordarson audio transformer, type R-260
- V1—Eby 4-prong tube socket, type 12, or Hammarlund Code S-4 Isolantite socket
- V2—Eby 5-prong tube socket, type 12, or Hammarlund Code S-5 Isolantite socket
- 1 Eby 5-gang strip (screw terminals)
- 1 Eby 2-gang strip (screw terminals)
- 1 Eby 2-gang strip (tip jack terminals)
- 1 Kurz-Kasch vernier dial (large)
- 1 Aluminum panel 10 inches by 7 inches (cut and drilled—Blas the Radio Man)
- 1 Wood baseboard, 10 inches by 10½ inches, ¾ inch thick
- 3 Metal bushings for elevating terminal strips, etc.

The Dragnet

(2 Tube S. W. Set)

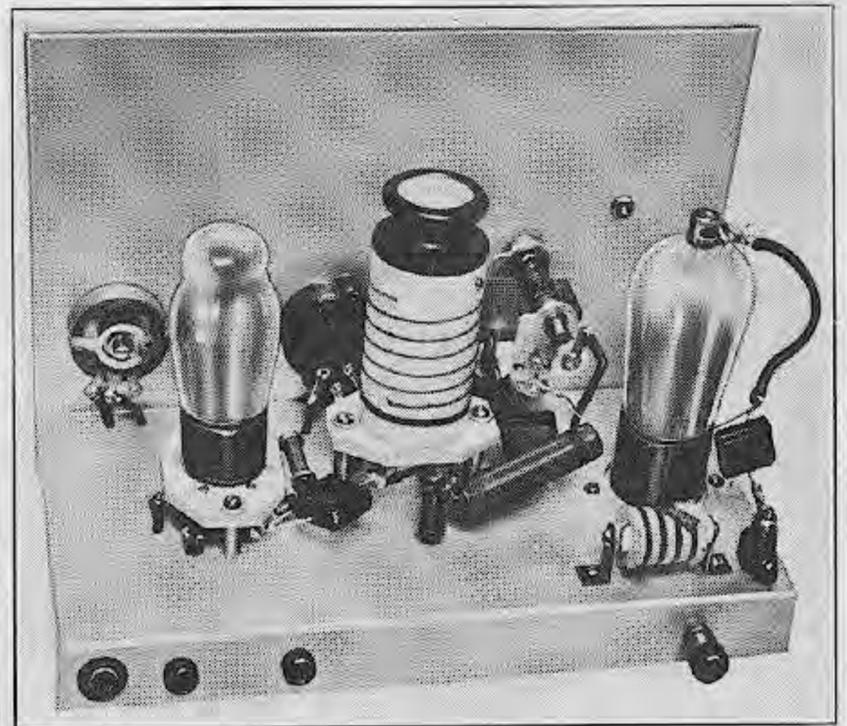
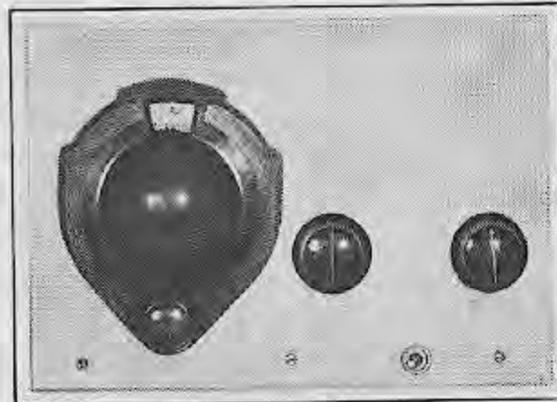
DESIGNED by the technical staff of "Radio News," this receiver was originally described in the August, 1934, issue of that publication.

The "Dragnet" employs two of the latest types of 2-volt tubes and is designed to take full advantage of their superior features. Although only 2 tubes are employed, 3-tube results are obtained because the type -19 tube is a dual purpose type having two triode sections enclosed within one bulb. One of these triodes is used as a regenerative detector while the other provides one stage of audio-frequency amplification which aids materially in building weak signals up to good headphone volume. The other tube, a type -34 variable-mu pentode, is used in an untuned stage of radio-frequency amplification.

This r.f. stage serves a three-fold purpose. First, it provides an appreciable amount of r.f. amplification. It is a known fact that for maximum amplification from tubes of this type they must work into a high impedance load. The load which best satisfies this condition is a tuned circuit. It is this type of circuit, consisting of the coil L1 and condenser C2 that is employed in the "Dragnet". Also, under actual measurement it was found that the common practise of using a resistor input did not produce nearly as good results as the choke, RFC, nor did chokes of lower inductance (millihenries) equal the one employed.

The second advantage of the r.f. stage is that it serves to completely isolate the antenna from the regenerative detector circuit and therefore eliminates absorption of regenerative energy by the antenna, thus making regeneration much more constant and easier to regulate.

The third advantage is that with this r.f. tube acting as a barrier, the r.f. energy generated by feedback in the detector tube when in an oscillating con-



List of Parts HAMMARLUND PRODUCTS

- C2—Midget variable condenser, type MC-140M
- RFC—R.F. choke, type CH-8
- 2 Isolantite 4-prong sockets, type S-4
- 1 Isolantite 6-prong socket, type S-6
- 5 Isolantite plug-in coil forms, 4-prong, type CE-4

MISCELLANEOUS

- C1, C7—Aerovox type 1467 .00025 mfd.
- C3, C6—Aerovox type 1467 .0001 mfd.
- C4, C5, C9—Aerovox pigtail by-pass condensers, .1 mfd., 200 volts
- C8—Aerovox pigtail by-pass condenser, .5 mfd., 200 volts
- R1—I.R.C. metalized resistor, 5 megohm, 1/2 watt
- R2—Centralab potentiometer, 100,000 ohms
- R3—I.R.C. metalized resistor, 1000,000 ohm, 1/2 watt
- R4—I.R.C. metalized resistor, 1 megohm, 1/2 watt
- R5—I.R.C. metalized resistor, 1500 ohms, 1/2 watt
- R6—I.R.C. metalized resistor, 15,000 ohms, 1/2 watt
- R7—Yaxley "Junior" rheostat, 10 ohms
- SW—Toggle switch, d.p.s.t.
- 1 Kurz-Kaseh vernier dial, 2 3/4 inches
- 1 Midget porcelain stand-off insulator
- 2 Insulated 'phone tip jacks
- 1 Binding post (for ground terminal)
- 1 5-wire battery cable, length optional
- 1 Rubber grommet (for protecting battery cable where it passes through chassis)
- 2 1 1/2 inch bakelite knobs (for R2 and R7)
- 1 Aluminum panel, 10 inches by 7 inches, and 1 aluminum chassis, 10 inches by 5 inches by 1 inch high (Blame the Radio Man).

dition or when on the edge of oscillation, cannot be radiated and cause interference in neighboring receivers. In other words, this receiver is strictly a "non-blooper".

The complete circuit is shown in Figure 2. It will be of interest to follow this through from antenna to headphones.

The resistor R3, condenser C5 and resistor R4 are the elements of the resistance coupling system through which the audio-frequency output of the detector is applied to the grid of the audio section of the -19 tube.

The parts used throughout were selected for their high efficiency, a feature of the greatest importance, especially in the r.f. and detector circuits. Thus the coil and tube sockets are of Isolantite, as are also the forms upon which the plug-in coils are wound, the insulation of the tuning condenser and the insulating form of the r.f. choke. Even the antenna connection terminal takes the form of a tiny porcelain stand-off insulator to insure against losses. To reduce coil losses to a minimum, the coil socket is mounted on bushings which elevate it approximately 1 inch from the chassis. Half-inch bushings are supplied with each Hammarlund socket. Inasmuch as they are not required for the socket of the -34 tube, two sets are used for mounting the coil socket. The socket for the type -19 tube is elevated on the bushings sup-

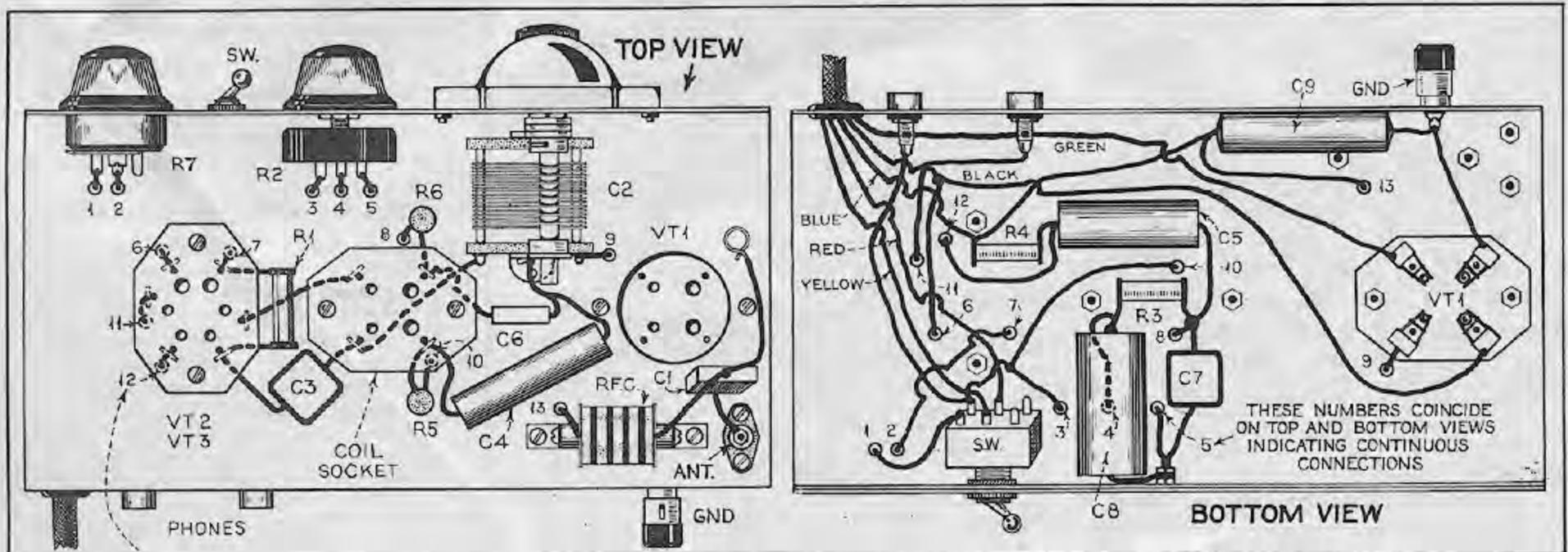


Fig. 1

plied with it.

The coils for this receiver are home-wound and the complete winding data will be found herewith. The Hammarlund Isolantite coil forms employed offer numerous advantages, in addition to that of high efficiency. They are supplied with plenty of holes through which to carry the ends of the windings to the

prongs and therefore no drilling is required. Also, they are equipped with knobs which have cardboard inserts, under transparent windows, on which the wavelength range of each of the coils may be marked. The correct internal connections to the four prongs of each coils are shown in Figure 3.

COIL DATA

Range	L1	L2	Frequency	Wavelength
No. 1-6	6	18300-10710	15-8-28.0	
No. 2-10	7	13040-6670	23-45	
No. 3-18	9	7140-3850	42-78	
No. 4-30	12	4170-2260	72-133	
No. 5-50	20	2380-1220	126-245	

No. 22 d.s.c. wire used for L1, ranges 2, 3, 4 and 5; No. 28 d.s.c. for range 1.

No. 28 d.s.c. for all ticklers (L2).

L1 and L2 separated 1/8 inch, all ranges.

L1 windings spaced to occupy 1 1/2 inches for coils 1, 2 and 3. Close wound for coils 4 and 5. All ticklers close wound.

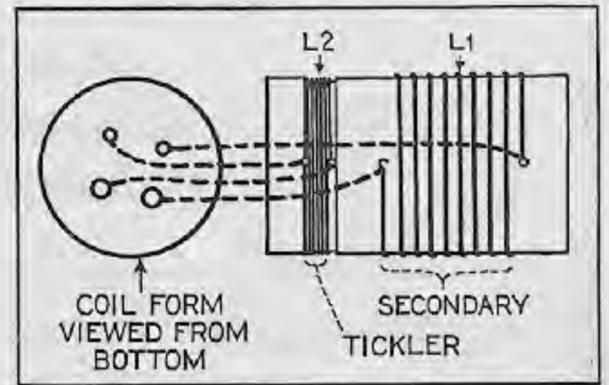


Fig. 3

The switch SW is of the double-pole-single-throw type and cuts off both the A and B batteries, the latter to prevent slow B battery leakage across R3 when the receiver is not in use.

The panel and chassis each consist of 7 inch by 10 inch aluminum sheets. The chassis is bent at right angles, 1 inch from the front and 1 inch from the rear edges, making it 10 inches by 5 inches by 1 inch high.

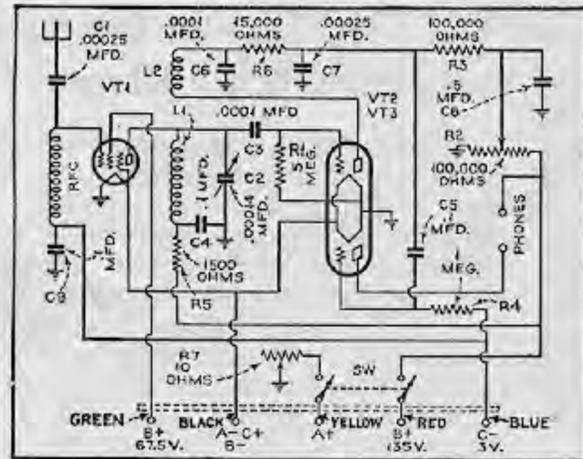


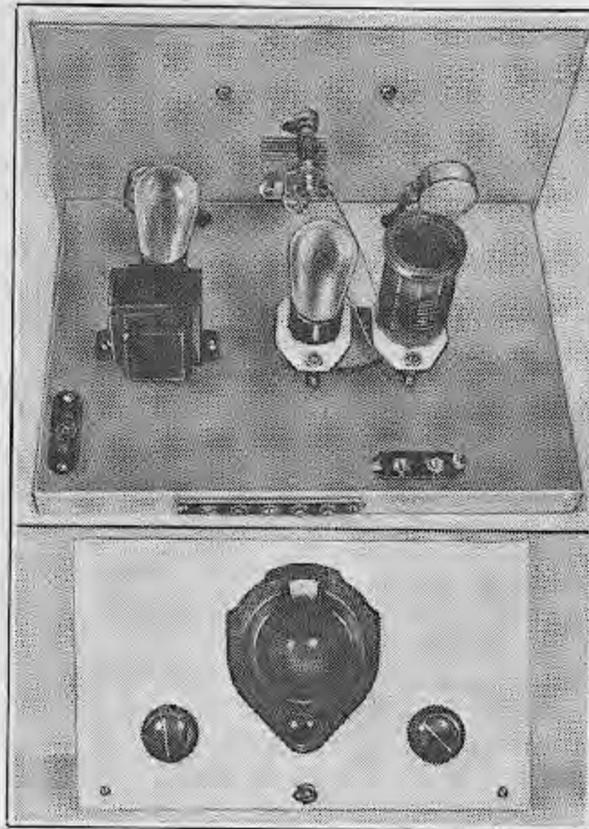
Fig. 2

The Argonaut

THIS 2-tube, dry-cell operated receiver was described in the August, 1933, issue of "Short Wave Craft." At that time it received an enthusiastic welcome from short-wave constructors, one reason being its relatively widespread layout which simplifies wiring and makes it an especially good receiver for the beginner.

It employs a type -30 tube as a regenerative detector, with regeneration controlled by varying the plate voltage through the medium of the potentiometer R2. The audio stage also employs a type -30 tube which is transformer coupled to the detector. This tube combination will provide good headphone volume even on weak signals.

The antenna series condenser, C3, as shown in Figures 1 and 2, is quite novel in its construction. Instead of using the usual equalizer type, adjustable condenser here the designer made his own condenser by winding 14 turns of insulated hook-up wire tightly around a 1 1/2 inch length of bus bar, the hook-up wire and the bus bar each forming one plate of the condenser. The capacity of this condenser is varied either by slipping the coil partly off the bus bar, or by unwinding turns. The sole advantage



offered by this kink is the fact that it costs nothing. Actually it is cumbersome to adjust and it is suggested that the constructor will save time and trouble by substituting a Hammarlund type EC-35 equalizer condenser here, its cost being only a few cents and easily justified by the greater convenience and permanency of adjustment.

It will be noted that there are two antenna posts. Number one is intended for use with an antenna of only a few feet in length, or where an external antenna series condenser is employed. Terminal number two is used where an antenna of normal proportions is employed.

The Hammarlund four prong short wave coil kit will provide excellent coverage, and if broadcast stations are wanted, an extra coil will afford equivalent results.

List of Parts

HAMMARLUND PRODUCTS

- C1—Variable condenser, type MC-140M
- RFC—R.F. choke, type CH-X
- 2 Isolantite sockets, 4 prong, type S-4
- L—Set of 4-prong 2-circuit plug-in coils, type SWK-4

MISCELLANEOUS

- C2—Cornell-Dubilier condenser, .0001 mfd.
- C3—See text
- C4—Cornell-Dubilier condenser .00025 mfd.
- C5—Cornell-Dubilier pigtail by-pass condenser, .1 mfd.
- R1—I.R.C. metalized resistor, 5 megohms
- R2—Electrad potentiometer, type R1-242, 100,000 ohms
- R3—Electrad potentiometer, type R1-269, 20 ohms
- T—Thordarson transformer, type T-5736
- 1 Kurz-Kasch vernier dial (large)
- 1 Aluminum panel, 7 inches by 12 inches, 16 gauge, and 1 aluminum chassis, 11 3/8 inches by 8 inches by 1 inch high (Blair the Radio Man)
- 1 Eby 2-gang terminal strip (screw terminals)
- 1 Eby 2-gang terminal strip (tip jack terminals)
- 1 Eby 5-gang terminal strip (screw terminals)
- 1 Eby wafer type 4-prong socket or Hammarlund Code S-4 Isolantite socket
- 1 D.P.S.T. toggle switch.

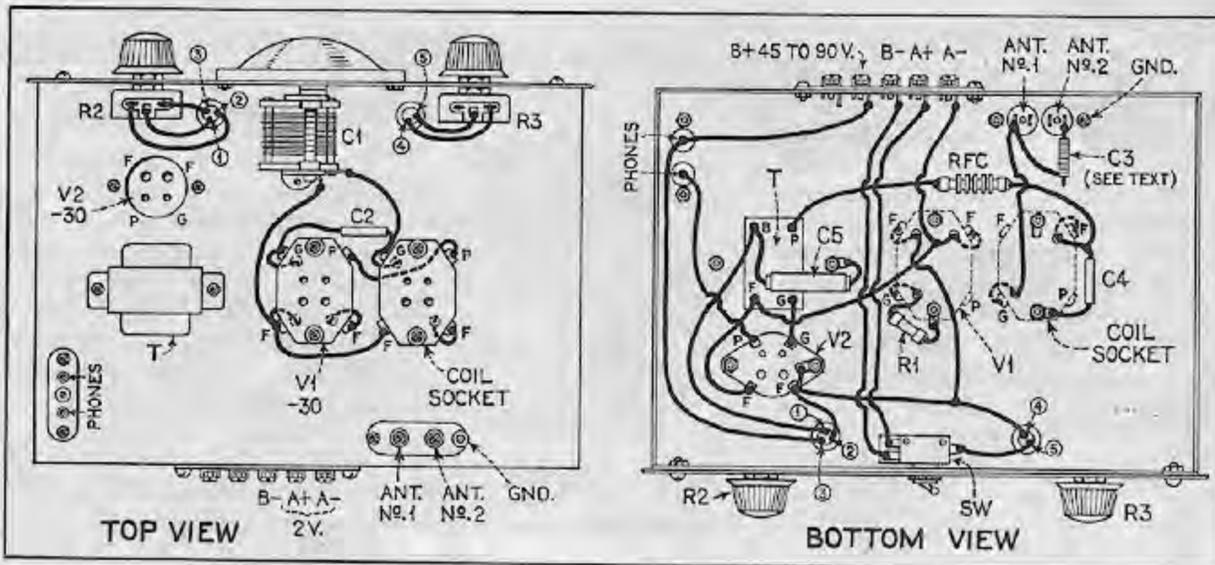


Fig. 1

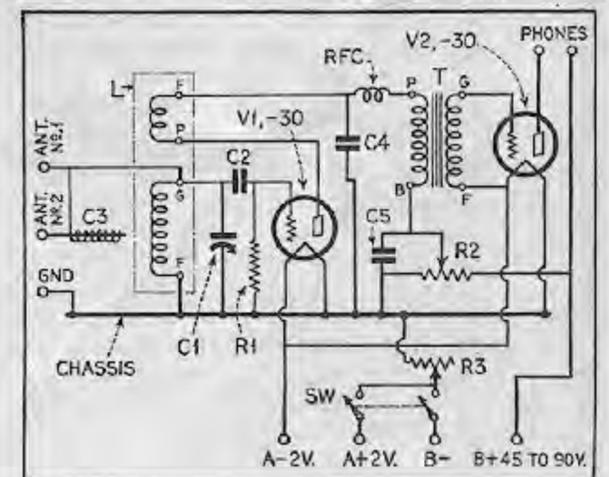


Fig. 2

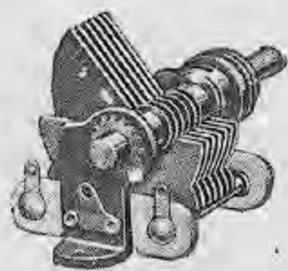
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For B
Hammarlund
PA
PRO

Manufactured by HAMMARLUND MANUFACTURING CO.

Improved HAMMARLUND Midget Condensers



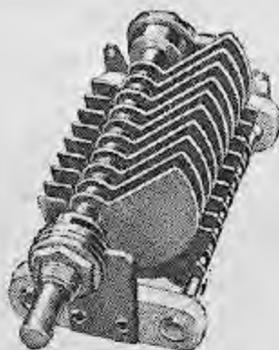
Type MC

The marked efficiency of Hammarlund condensers at ultra high frequencies has been attained by extensive research in materials and design, constant experimentation and careful workmanship, plus years of experience.

Isolantite insulation reduces dielectric losses to a minimum, assuring maximum and uniform efficiency under all conditions of temperature and humidity. Wide bearings, front and rear afford extra good contact without objectionable inductive reactance. Non-corrosive, soldered brass plates eliminate vibration and effect lowest series resistance. Shafts 1/4" in diameter, extending 5/16" beyond rear frame to facilitate ganging. Individually tested for breakdown on 500 volts A.C. 1 1/2" bakelite knob. Available from 20 mmf. to 325 mmf.

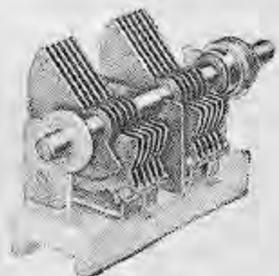
Code MC-140M	\$2.50
Code MC-100M	2.25
Code MC-35S	1.50

These Double Spaced Midgets have wide spacing, special bearings, and Isolantite, making them particularly suitable for ultra short wave receivers and transmitters. Midline or semi-circular plates in 20, 35 and 50 mmf. sizes.



Double Spaced

HAMMARLUND Dual and Band Spread Midgets



Dual Midget

Like Hammarlund Single Midget Condensers, these duals incorporate in their design every requirement of a high quality small size two gang condenser. Their rigidity, low losses and careful construction affords greatest electrical and mechanical efficiency in all types of short wave receivers, using two gang tuning condensers. The entire condenser is built on a strong Isolantite base, including a shield plate between the stators. Other specifications are the same as for the singles. Made for single hole panel mounting. Overall length behind the panel—3 1/4".

There are double spaced duals for ultra high frequencies for transmitting and receiving.

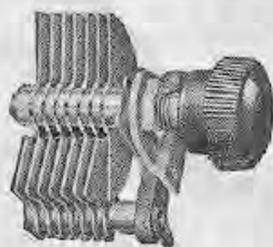
The Band Spread Midget Condensers are designed for use as band spread tuning condensers for short wave receivers or amateur band frequency meters, and are extremely effective. The tank section may be set and locked at any desired capacity, permitting the tuning section to spread narrow frequency ranges over the entire dial, regardless of the range of the band, or the coils used.

Code MC-120 B	\$3.00
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Band Spread

HAMMARLUND Star Midget Condensers



Star Midget

A very popular low priced midget for set builders, experimenters and laboratories. There are types for receiving, and transmitting, for short wave tuning, regeneration, antenna coupling, verniers, etc. Light in weight, strong and compact in construction, smooth as velvet in operation. Low minimum capacity, low loss natural Bakelite insulation, non-corrosive aluminum plates. Easy single hole mounting, 1/4" shaft, 5/16" bushing, 1" bakelite knob. Size 1-9/16" wide by 1 3/4" high. Depth behind the

panel from 11/16" to 1 1/2" depending on capacity. Available in sizes from 15 mmf. to 140 mmf.

Code SM-25 (25 mmf.)	\$.35
Code SM-100 (100 mmf.)	1.00
Code SM-140 (140 mmf.)	1.25

New HAMMARLUND Low Loss Coil Forms and Short Wave Plug-in-Coils



Type SWF

These attractively priced coil forms are made of XP-53 dielectric, a remarkable new loss insulating material. Rugged, durable and most important, extremely effective, for XP-53 losses are extremely low. Its amber color is natural . . . no artificial coloring to cause losses. The coil proportions provide most practical form factor. The forms are groove-ribbed for air spacing of windings. There are also flange grips, and neat meter index inserts, for wavelength indications. Another clever feature of the form is a threaded shelf, molded inside, to permit the mounting of a trimming or padding condenser for tuning the coil to a fixed frequency or for band spread arrangement.

Code SWF-4 (4 prong)	\$.35
Code SWF-5 (5 prong)	.35
Code SWF-6 (6 prong)	.40

Hammarlund Short Wave Plug In Coils provide maximum signal strength, and greatest selectivity on all bands. Extensive laboratory work results in practically perfect design of primary, secondary and tickler, coupling and overlap.

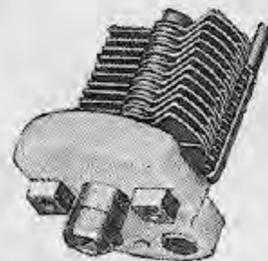
Wound on low loss XP-53 dielectric Hammarlund Plug In forms. Four coils cover the entire range of 17 to 270 meters, and only one additional coil is required to cover the broadcast band. Secondaries of the 17 to 41 meter and 33 to 75 meter coils are of heavy silver plated wire to reduce skin resistance losses to a minimum. The secondaries of the other coils are of silk covered copper wire. The 270 to 560 meter coil is of bank-wound litz.



SWK Set of Coils

Code SWK-4 (Kit of four, 4 prong, 2 winding coils, range 17 to 270 meters)	\$ 3.00
Code SWK-6 (Kit of four, 6 prong, 3 winding coils, range 17 to 270 meters)	3.75
Code BCC-4 (4 prong, 2 winding coil for broadcast band, range 250 to 560 meters)	1.25
Code BCC-6 (6 prong, 3 winding coil for broadcast band, range 250 to 560 meters)	1.50

New HAMMARLUND Air Padding Condensers



Air Padding Condenser

These are high quality air dielectric condensers for use wherever space is at a premium. They will maintain constant capacity under any conditions of temperature, humidity or vibration. Highest order of efficiency adapts them particularly to short wave and ultra short wave work.

Overall dimension of 10 mmf. size only 1-7/32" high. 15/16" by 1 1/2" high. Isolantite base. Soldered brass rotors and stators. Sizes range from 25 mmf. to 100 mmf.

Better Radio
Hammarlund
PRECISION
PRODUCTS

HAMMARLUND CO., Inc., 424-438 West 33rd Street, New York



All prices shown here are
list prices of parts used in
sets described in this manual.

HAMMARLUND Isolantite Coil Forms and Sockets

These Coil Forms are of extruded Isolantite. Their low losses and effective stability guarantees efficient high frequency results under all conditions.

Equipped with convenient black enameled wooden handle with a flat top, in which is a removable paper disc for writing in frequencies. A celluloid disc protects the paper, a spring ring holding the disc in place. Surface is "non-skid," eliminating troubles encountered in winding on slippery surfaces. The numerous holes provided in the form, make drilling unnecessary. The form is 1 1/2" in diameter and 2 1/2" long exclusive of knob and prongs. Made in 4, 5 and 6 prong types to fit standard sockets.



Type CF

Code CF-4 (4 prong)	\$1.00
Code CF-5 (5 prong)	1.00
Code CF-6 (6 prong)	1.00

Low loss sockets are just as important as low loss coils or condensers. In the Hammarlund Isolantite sockets, low loss is combined with low cost. Constant resistivity and perfect contact eliminates noise.



Type S

The sockets have glazed tops and sides. The side gripping contacts are rust proof. They can be used for sub panel or base mounting. Made in four, five, six and seven prong styles. They all are 2 1/4" long, and 1 5/8" wide, with standard mounting centers of 1-27/32".

Code S-4 (4 prong)	\$.60
Code S-5 (5 prong)60
Code S-6 (6 prong)60
Code S-7 (7 prong)60

HAMMARLUND Flexible Couplings

This coupling permits tandem operation of any number of independent units without requiring exact shaft alignment—a great convenience and time saver. The condensers are insulated from each other, allowing instruments in gang to be operated as independent units. Bakelized canvas, with brass bushings for 1/4" shafts. Four rust proofed and hardened steel screws provide against any shaft slipping. The overall diameter is 1 1/2".



Type FC

Code FC	\$.60
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New HAMMARLUND MEX and Standard Midget Equalizing Condensers

The type MEX condenser is an extremely small adjustable low loss condenser expressly designed for trimming RF coils, but useful for many other purposes. So light in weight, as to permit its being self supported in wiring. The base is Isolantite. Dielectric is Mica, and spring plates of phosphor bronze. The size of the base is 5/8" by 3/4".



MEX

MEX (range 3 to 30 mmf.)	\$.30
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The standard Equalizing Condenser is a little larger than the MEX, and is also for neutralizing, balancing and trimming purposes. It is also useful for adjusting multiple tuned circuits or gang condenser units. Adjustment of the center screw provides gradual capacity change over a wide range. May be attached directly to binding post of socket or condenser. Mica dielectric, phosphor bronze flexible plate and bakelite base. Size of base—1 1/4" by 11/16".

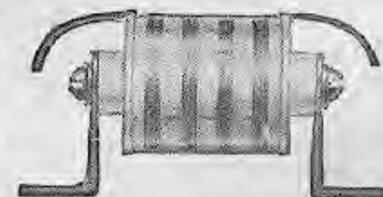


Type EC

EC-35 (range 3 to 35 mmf.)	\$.40
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HAMMARLUND Standard and Midget Isolantite R. F. Chokes

The Standard Choke is particularly designed for short wave, and ultra short wave receivers and transmitters, but is equally effective within broadcast band. Compactness permits mounting in isolated positions well removed from stray RF fields. Four windings, moisture proofed, and carried on Isolantite spool. Protected by radio frequency lacquer and cellophane covering. Inductance—8 mh; DC resistance—70 ohms; distributed capacity—3 mmf; 125 milliamperes. Choke is 1 3/8" by 7/8".



Type CH-B

Code CH-B	\$1.10
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The Midget Choke is invaluable for use where space is at a premium. Its tiny size, and lightness permits it to be supported by its own leads. Five universal wound pies mounted on a 3/4" Isolantite core, with coils impregnated to insure ruggedness and minimize atmospheric effects. Tinned copper wire leads, secured to Isolantite core with metal end caps. Length across caps—1 1/2". Diameter—1/2". Inductance—2.1 mh; DC resistance—35 ohms; capacity—1 mmf., 125 milliamperes.



Type CHX

CHX	\$.75
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HAMMARLUND Triple Grid Tube Shields

The complete isolation afforded by this shield permits full use of the enormous amplification possibilities of the new tubes.

A special drawn in neck completes the shielding between the control grid and the plate, and a removable top is used to entirely shield the control grid cap. The body, cap and base are all made of heavy aluminum and designed for maximum cooling. Measures 4 5/8" high by 1 5/8" diameter. Mounting center is standard—1-27/32".



Type TS-50

Code TS-50	\$.40
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A Power Pack for S. W. Receivers

THE power pack illustrated in the accompanying photographs and diagram, is one which is to be described in detail in one of the forthcoming issues of "Radio News." Special permission was obtained from this publication to publish this advance information because it is felt that this particular design fills a long felt need for a really good power supply unit designed especially for use with short-wave receivers.

Many present day power packs prove entirely suitable for use with non-regenerative receivers, or with receivers designed for the broadcast band only. But when used with short-wave regenerative receivers these units' hum is so troublesome in many instances as to seriously mar reception. This is particularly true if the receiver is maintained in an oscillation condition for reception of c. w. signals.

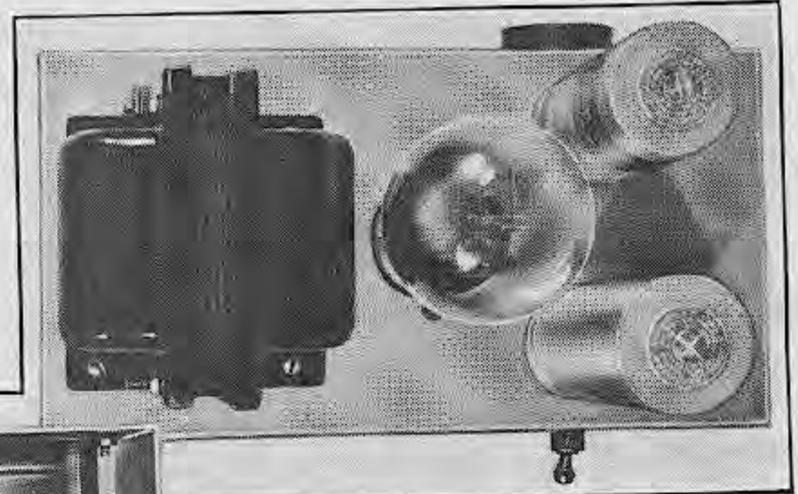
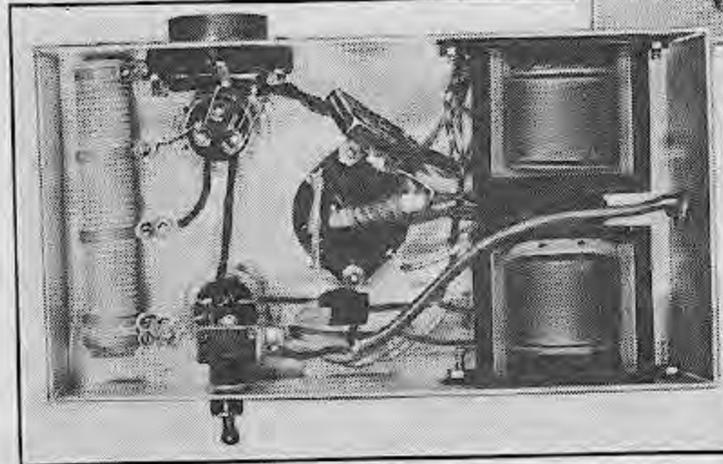
Such trouble is usually traceable to the inclusion of an inadequate filter in the power supply unit. It may be due to skimping on capacity, or to the use of only one choke, or perhaps 2 chokes having insufficient inductance.

Another common source of trouble is found in unstable operation of the receiver, particularly if it is one employing a tuned r.f. stage ahead of the regenerative detector. Such instability is often due directly to inadequate by-pass capacities across the various voltage taps in the power pack.

Both of these types of troubles are effectively eliminated in the unit described here. Two sizable chokes are included in the filter, and a total of 16 mfd. for the filter capacity. In addition, a capacity of 4 mfd. is provided across each of the output voltage taps. The high voltage to the filter is obtained through a center-tapped resistor connected across the rectifier filament to further aid in hum reduction.

The filter circuit employed makes use of the choke input method. This arrangement has several distinct advantages over the capacity input type of filter. Most important is the better voltage regulation obtained. This is especially important in short-wave receivers which employ an r.f. stage and control the sensitivity by varying the cathode or grid bias. Such control varies the plate current of the r.f. tube and as a result, unless good power supply regulation is obtained, the plate voltage applied to the other tubes will vary. This is one reason why in such receivers reducing the sensitivity of the r.f. stage may cause the detector to spill over into an oscillating state.

Another advantage of the choke input filter is that the likelihood of one of the filter condensers "going west" is greatly diminished. The surges which cause condensers to break down are much less



the d.c. output voltage obtained with choke input is considerably lower than that obtainable with capacity input. This is really an advantage because while few short-wave receivers employ more than 200 volts on the plates it is difficult to obtain power transformers which will provide such low voltage. The normal and least expensive power transformers provide an a.c. voltage of 300-350 each side of the center. When a condenser input filter is used with these, at normal drains, the d.c. voltage output is usually in excess of 300 volts—a value quite excessive for most short-wave receivers. Thus the use of choke input permits employment of the least expensive type of standard power transformer.

The power pack described here provides 220 volts d.c. at a current drain of 25 milliamperes. In addition it includes a 6-volt filament winding rated at 1.5 amperes which will supply the filaments of up to 5 tubes of the 6-volt type. In the particular model shown here the voltage divider is provided with 3 adjustable taps, thus supplying the high voltage and two intermediate values, all variable.

Another feature of this power pack which should not be overlooked is the r.f. filter consisting of the r.f. choke RFC, and the mica condenser C6 which has a capacity of .006 mfd. The purpose of this filter is to avoid the tunable hum sometimes so troublesome in short-wave sets.

Alterations may readily be made in this power pack to meet the requirements of any particular receiver. For instance, if it is built for use solely with a certain receiver which contains its own voltage divider then a voltage divider need not be included in this power pack. Or if the receiver is one which requires only two plate voltages, then only two taps need be provided on the power pack voltage divider and only two by-pass condensers will be needed.

The construction of this power pack is simple. The power transformer has all terminals brought out the bottom in the form of color coded leads. A large cut-out in the chassis is not required to accommodate these leads as they can be readily passed through two 1/2 inch holes. Suitable holes will be required for mounting the two condenser cans and one for the 4-prong tube socket; all on the top of the chassis. A similar hole should be cut for the cable plug socket in one side wall and smaller holes for the a.c. cord, in one end, and for the off-

- List of Parts*
- C1, C2—Aerovox type GG electrolytic condenser, 2-section, 8-8 mfd., 450 volt-d.c.
 - C3, C4, C5—Aerovox type GGG electrolytic condensers, 3-section, 4-4-4 mfd., 450 volts, d.c.
 - C6—Aerovox mica condenser, .006 mfd.
 - CH1, CH2—Thordarson chokes, type T-1402
 - RFC—Hammarlund type CH-X r.f. choke
 - R—Electrad 30 ohm center-tapped filament resistor
 - R2—Electrad Truvolt voltage divider, type C-200, 20,000 ohms, 50 watts, with 3 adjustable intermediate taps
 - 1 Eby 4-prong tube socket, type 12
 - 1 Eby 6-prong tube socket, type 12
 - 1 Eby 6-prong cable plug, male
 - 1 Six-conductor cable (of required length)
 - SW—Toggle switch, s.p.s.t.
 - T—Thordarson power transformer, type T-5172
 - 1 Type -80 rectifier tube
 - 1 Six foot line cord with plug
 - 1 Rubber grommet, 1/2 inch (for power cord hole in chassis)
 - 1 Aluminum or steel chassis (shaped and drilled—Blas the Radio Man)

prominent after the first choke whereas a condenser connected ahead of this choke is subjected to abnormal loads. By eliminating the input condenser, therefore, the strain on the condensers is effectively eliminated.

A third, and perhaps somewhat left-handed advantage of this system is that

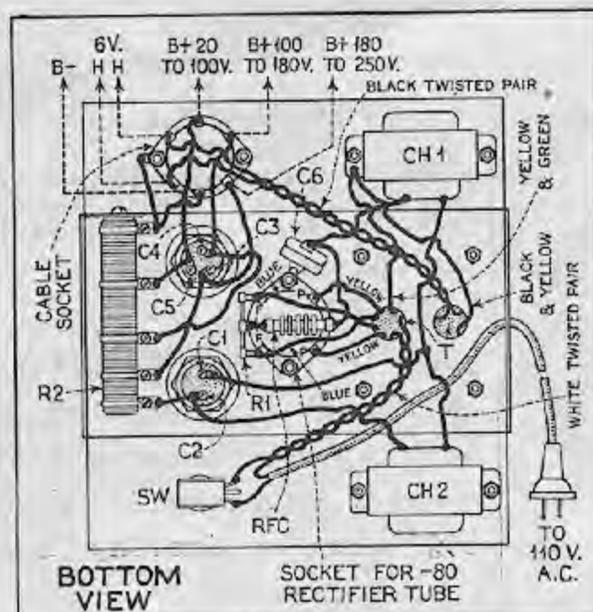
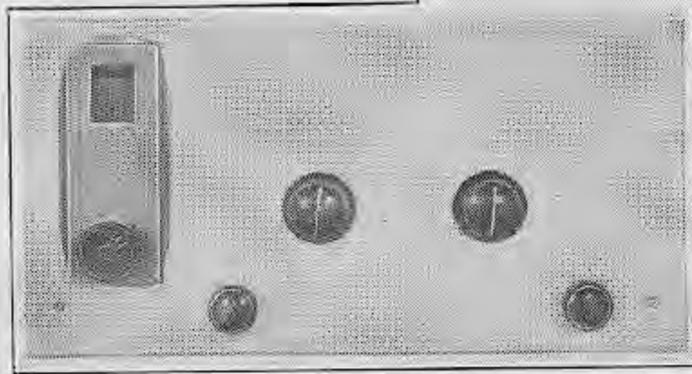
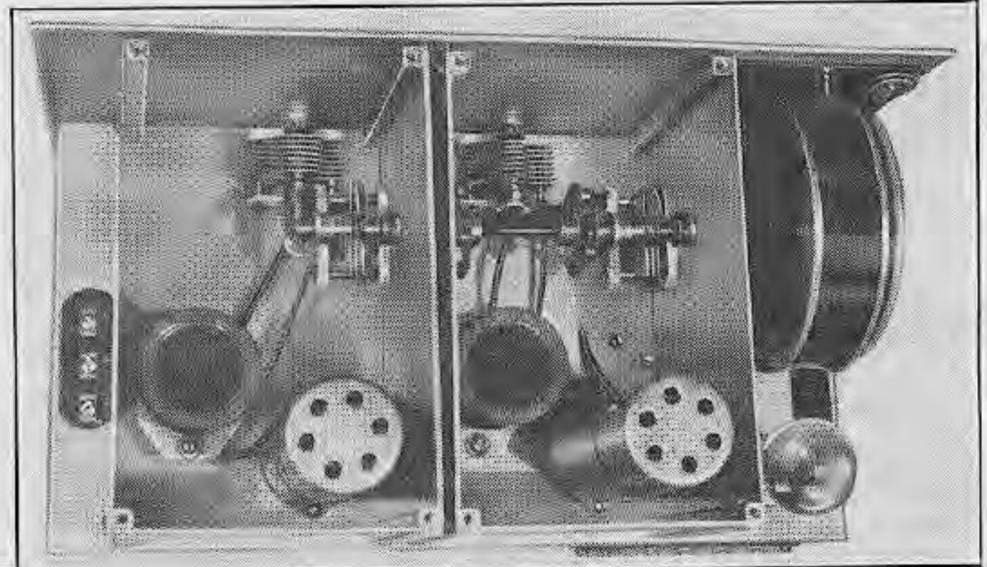


Fig. 1

The Radio Amateur's Handbook 3-Tube Band Spread A C Set



SOONER or later most owners of regenerative receivers feel the urge to try the use of radio-frequency amplification ahead of the regenerative detector. In the days when only triode tubes were available the complications in this were severe and at best very little amplification was obtained in the r.f. stage. With the introduction and popularization of screen-grid tubes and r.f. pentodes, however, the picture has changed completely with the result that a well designed r.f. stage adds tremendously to the sensitivity and general behavior of the regenerative receiver.

The receiver illustrated here represents a good example of such a set. It is a model constructed after the description which appeared in "The Radio Amateur's Handbook," tenth edition.

In the construction of this model there was some variation from the original, mainly in the method of obtaining regeneration. The original had the tickler in the cathode circuit and standard plug-in coils are not well suited to this arrangement. In the model described here, therefore, the circuit was changed to include the tickler in the plate circuit. No change was made in the method of controlling regeneration—a potentiometer to vary the voltage applied to the screen grid.

Referring to the schematic circuit of Figure 2, it will be seen that the r.f. stage is quite conventional in every respect. It uses a -58 r.f. pentode, self biased.

The single audio stage is impedance coupled to the detector circuit. It employs a type -56 tube which is also self biased.

It is important that means for controlling the gain of the r.f. stage be provided on the front panel of such a receiver as this. Otherwise even moderately strong signals will overload the detector. If the regeneration control alone were depended upon for this purpose the results would be highly unsatisfactory because in addition to detector overloading, there would be a distinct loss of selectivity when regeneration is retarded to reduce the volume. On the other hand, by controlling the gain of the r.f. stage, the input to the detector can be held down to a low level, full regeneration employed and thus maximum selectivity obtained.

The band-spread system employed provides continuous band-spreading by means of a small condenser shunted across the tank tuning condenser of each stage. These tank condensers are controlled by individual knobs. These may

- List of Parts*
- HAMMARLUND PRODUCTS**
- C1, C2—Midget variable condensers, type MC-20-S
 - C3, C4—Midget variable condensers, type MC140-M
 - L1, L2—Kit of 4-prong plug-in coils, type SWK-4
 - L3, L4, L5—Kit of 6-prong plug-in coils, type SWK-6
 - RFC—R.F. choke, type CH-X
 - 1 Isolantite socket, 4-prong, type S-4
 - 1 Isolantite socket, 6-prong, type S-6
 - 2 Tube shields, type TS-50
 - 2 Flexible couplings, type FC
- MISCELLANEOUS**
- C5, C6, C8—Cornell Dubilier .01 mfd., 200v.
 - C7—Cornell Dubilier .1 mfd., 400 v.
 - C9, C10—Cornell Dubilier type HC-227 1.0 mfd., 160 v.
 - C11, C12—Cornell Dubilier .00025 mfd.
 - CH—Thoradson audio choke, type T-2927
 - R1—*I.R.C. resistor, 5 megohms
 - R2—I.R.C. resistor, 250 ohms, 1 watt
 - R3—Electrad potentiometer, 10,000 ohms
 - R4—I.R.C. resistor, 50,000 ohms, 1 watt
 - R5—Electrad wire wound resistor, 15,000 ohms, 5 watts
 - R6—Electrad wire wound resistor, 5000 ohms, 5 watts
 - R7—I.R.C. resistor, 100,000 ohms, 1/2 watt
 - R8—I.R.C. resistor, 5 megohms 1/2 watt
 - R9—I.R.C. resistor, 2000 ohms, 1 watt
 - R10—Yaxley potentiometer, 50,000 ohms
 - 1 National illuminated drum dial, type H
 - 2 Eby laminated wafer sockets, 6-prong
 - 1 Eby laminated wafer socket, 5-prong
 - 1 Eby strip, 5-gang (screw terminals)
 - 1 Eby strip, 3-gang (screw terminals)
 - 1 Eby strip, 2-gang (tip jack terminals)
 - 1 Aluminum chassis and 2 aluminum shield cans (see text); drilled and shaped—Blan the Radio Man
- *All metalized type.

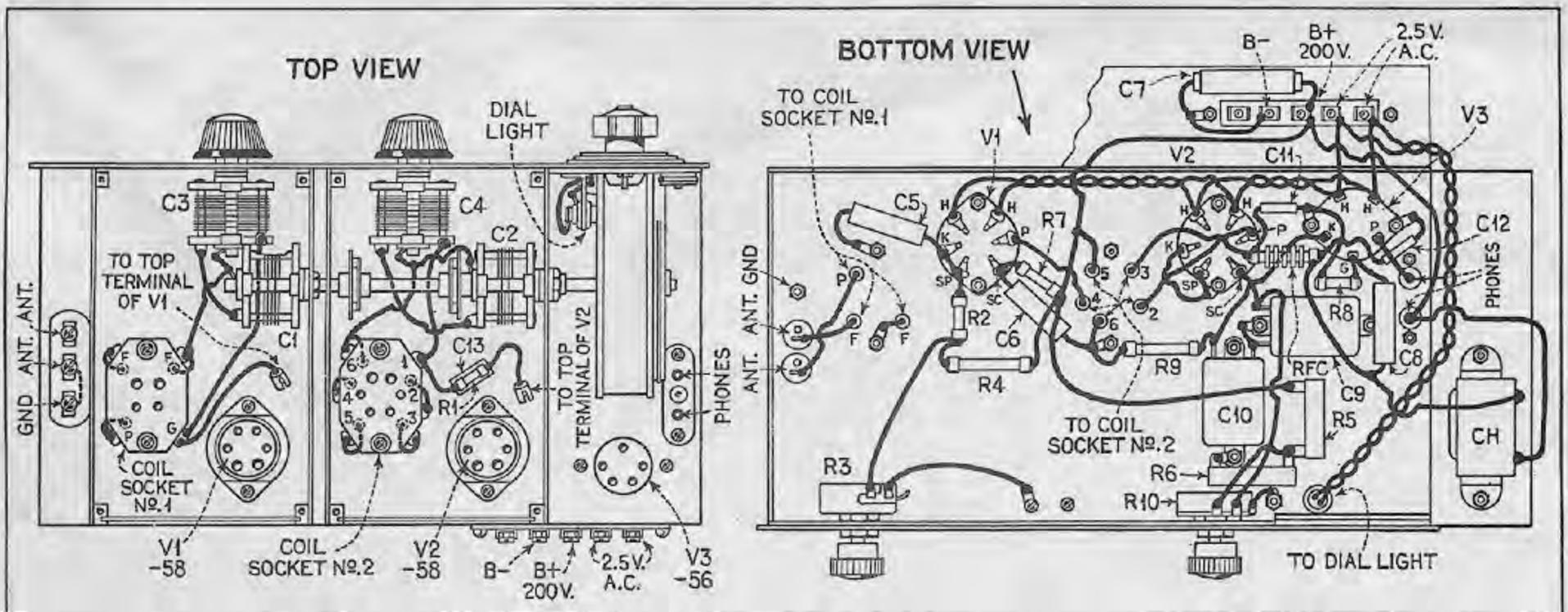


Fig. 1

be seen as the two top control knobs in one of the accompanying photographs. The small band-spread condensers, however, are ganged for control by the single main tuning control at the left end of the receiver.

Not only does this system provide a very helpful degree of band spreading at any and all points throughout the range of the receiver, but it also provides single dial control within any band which has been selected by means of the tank condensers. Thus when the broadcast listener has tuned the tanks to resonance in the 25-meter broadcast band, for instance, he proceeds to tune in the individual stations in that band with the single main control, much in the same manner as he would tune in broadcast band stations on a modern broadcast receiver. The circuits will be found to track fairly well throughout the full rotation of the band spread dial, although some readjustment of the r.f. tank condenser will be required.

The model receiver shown here was

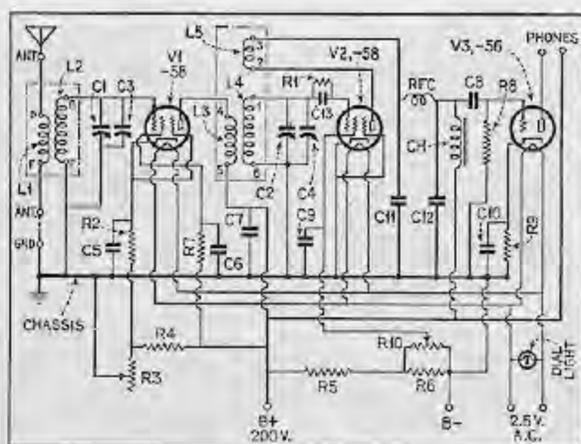


Fig. 2

built for use with Hammarlund standard plug-in coils and with the tuning capacities used, will cover the short-wave range from 19 to well over 200 meters, with adequate overlap, using 4 pairs of these coils.

The secret of using a tuned r.f. stage successfully, ahead of a regenerative detector, lies in providing through shielding. If shielding is inadequate there will

be interaction between the two circuits to the extent that the tuning of one will react on the other and regeneration will be difficult to control.

This receiver is intended for operation from an a.c. power supply unit which will supply approximately 200 volts d.c. for the plates and 2½ volts for the heaters. Should it be desired to employ B batteries, the voltage divider consisting of R5 and R6 may be eliminated and the "high" end of the potentiometer brought out to the 45-volt tap on the B battery.

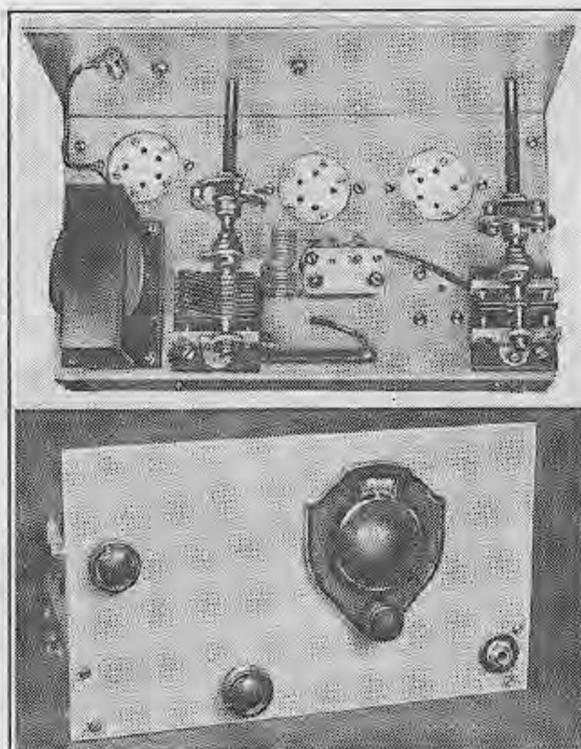
The chassis is made from a sheet of 16-gauge aluminum, 17 inches by 11 inches. The edges are bent down 2 inches all around, making the deck dimensions 13 inches by 7 inches. The front panel is 13½ inches long by 7 inches high. The shield cans each measure 7 inches long, 4¾ inches wide and 4¾ inches high. They are assembled on corner posts which are drilled and tapped so that the sides and ends of the shields may be securely attached by means of machine screws.

The Ray Five-Meter Set

THIS three-tube super-regenerative receiver was originally described in detail in the December, 1933, issue of "Radio News." It was designed by Garo W. Ray, chief operator of Station WICC, Bridgeport, Connecticut, and owner and operator of an amateur station where he has carried on extensive experimental work in the 5-meter band. This receiver is the outgrowth of his experiments.

The receiver is constructed on an aluminum chassis and panel for the sake of the shielding they provide. These aid in the elimination of hand capacity, and to further reduce this trouble, the variable condensers are mounted at the rear of the chassis with long insulating shafts and flexible couplings.

Coils L1 and L2 consist of 6 or 7 turns each of bare round bus bar shaped on a pencil. After the receiver is completed a little experimentation will determine whether 6 turns or 7 turns are required for each. The spacing between turns also plays an important part in determining the frequency band covered and a considerable amount of variation may be obtained by spreading the turns. This adjustment will be facilitated if one can obtain the assistance of a friend who has a 5-meter receiver in operation,



which can be used as an oscillator or monitor, in adjusting the coils to the proper frequency range.

The oscillator transformer L3-L4 is not particularly critical as to the number of turns required. The specifications are shown in Figure 2. The choke coil, L5, consists of 25 or 30 turns of No. 36 silk-covered wire, spaced to occupy 3 inches on a piece of ¼-inch diameter bakelite or hard rubber rod.

The circuit diagram is shown in Figure 1. C8 is the tuning condenser while the mica compression condenser, C9, is a stabilizing capacity which in effect also functions as a band setting condenser. After the coils L1 and L2 have been approximately adjusted, the final location of the band can be accurately made by means of C9. The antenna series condenser, C7, while not primarily a tuning condenser nevertheless plays an important part in tuning.

In assembling the receiver, it should be noted that all of the variable condensers are above ground potential and must therefore be thoroughly insulated from the chassis by mounting them on insulating pillars about 1 inch long. The coils L1 and L2 are soldered directly to the condensers thus keeping their leads as short as possible.

In operating the receiver a rather strong hissing sound will be very much in evidence until a station is tuned in. As a station is tuned in the hissing sound will be greatly decreased, or will disappear entirely in receiving strong stations.

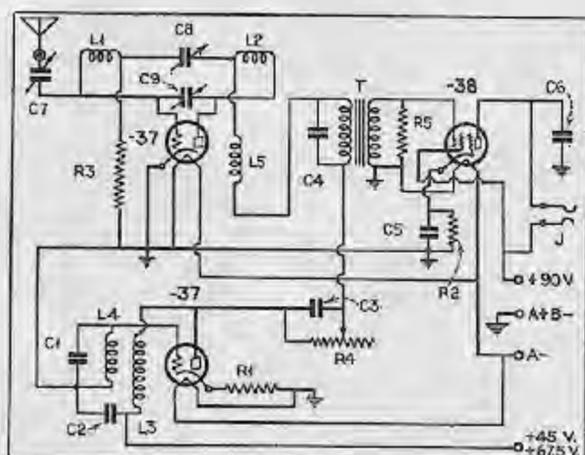


Fig. 1

List of Parts

HAMMARLUND PRODUCTS

- C7—Midget variable condenser, type MC-20S
- C8—Midget variable condenser, type MC-140M
- C9—Adjustable condenser, Isolantite insulated, type MICS-140
- 3 Isolantite sockets, 5-prong, type S-5
- 2 Insulated flexible shaft couplings, type FC

MISCELLANEOUS PARTS

- C1—Aerovox condenser, .002 mfd.
- C2, C3, C5—Aerovox type 260 by-pass condensers, .1 mfd.
- C4—Aerovox condenser, .005 mfd.
- C6—Aerovox condenser, .001 mfd.
- J—Single circuit (open) phone jack
- L1, L2, L3, L4, L5—(See text)
- R1, R2—I. R. C. metalized 2000 ohms, 1 watt resistor
- R3—I. R. C. metalized 3-megohm, 1-watt resistor
- R4—Electrad type R1-205 potentiometer, 50,000 ohms
- R5—I. R. C. metalized 200,000 ohm, 1 watt resistor
- T—Thordarson audio transformer, type R-260
- 12 inch length, ¼ inch diameter, bakelite rod (for extension shafts)
- 1 Grid clip
- 2 Type -37 tubes
- 1 Type -33 tube
- Aluminum for chassis and panel, 1/16 inch
- 1 5-wire battery cable
- 1 Kurz-Kasch vernier dial

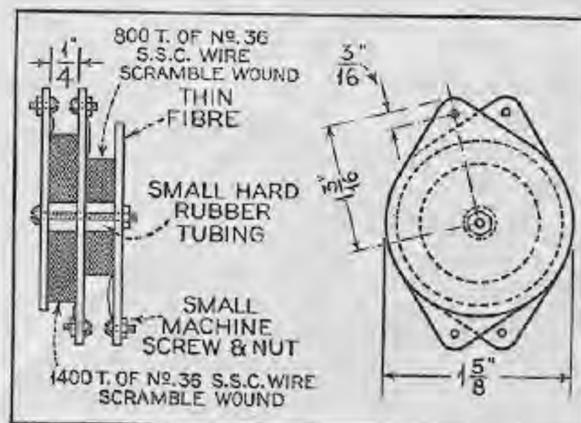
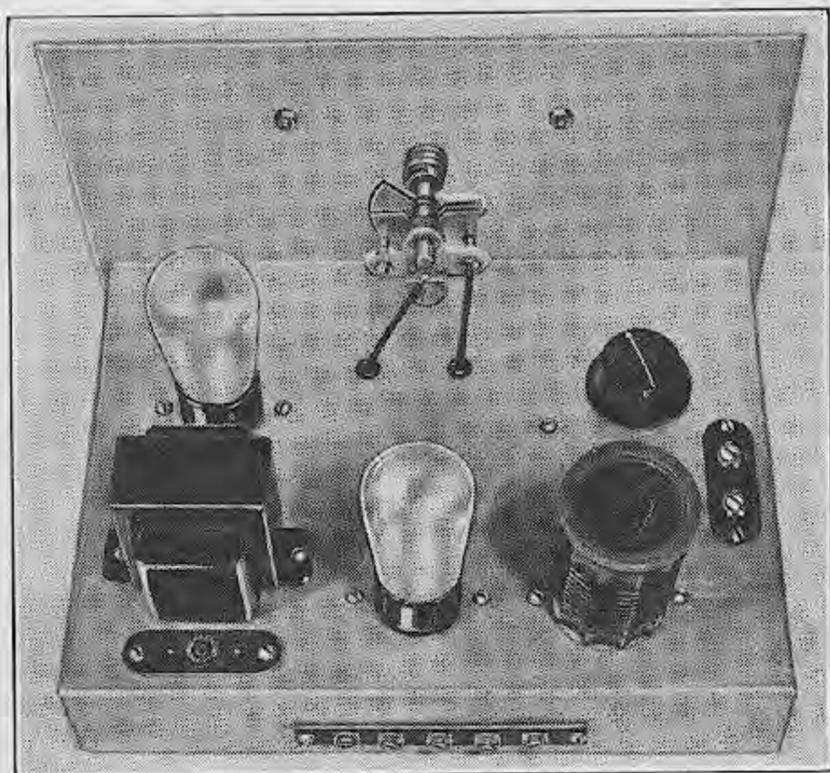
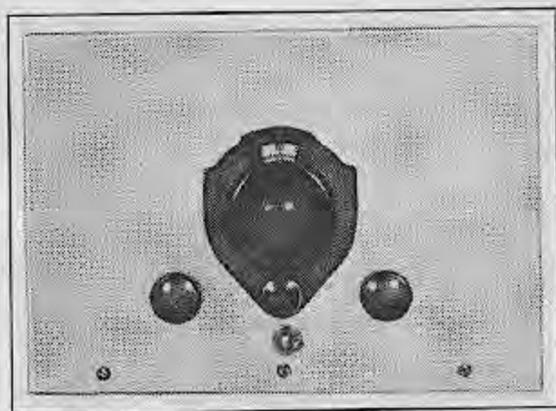


Fig. 2

The Doerle 2 Tube Receiver

MR. WALTER C. DOERLE is well-known for his various short-wave receiver designs and the receiver described here has been justly popular with short-wave enthusiasts. Basically it is not unusual in the circuit employed. However, careful consideration of design details has resulted in this particular Doerle receiver being especially popular since it was first described in the magazine "Radio."



Analysis of the schematic circuit diagram in Figure 2 shows the standard tickler method of obtaining regeneration, and a capacity-coupled antenna circuit. Band-spread tuning is provided by means of a small variable condenser, C2, shunted across the larger tuning capacity, C1.

The condenser C1 is used for tuning to the desired range, then the smaller condenser will spread the stations in this range over a wide area on the main tuning dial. Inasmuch as the smaller condenser is utilized for all exact tuning, it is controlled by the large dial in the center. The "rough tuning" condenser, C1, requires less critical adjustment, and may therefore be controlled by a small knob, as shown at the lower right corner of the front panel. Some builders prefer to have the large condenser controlled by the main dial and to use the smaller condenser more in the nature of a trimmer. Where this system is preferred it is only necessary to transpose the positions of the 2 condensers on the panel, the wiring of the receiver remaining the same as shown in the picture wiring diagram.

Regeneration is controlled by means of the potentiometer, R2. A .25 mfd. by-pass condenser, C5, is connected across this potentiometer to ground—its pur-

pose being partly to by-pass any noise that may develop in the potentiometer. The condenser C4 is the normal plate by-pass condenser completing the r.f.

plate circuit to ground, thus by-passing the primary of the audio frequency transformer.

A type -30 tube is employed for the regenerative detector and another for the single audio stage. Two 1½ volt dry cells are used for the filament supply and are controlled by a rheostat which is mounted back on the chassis, as it requires only occasional adjustment.

Hammarlund plug-in coils of the 4-prong, 2-circuit type are used.

The chassis consists of a piece of 16-gauge aluminum, 13½ inches long by 11 inches wide with the four corners cut out and the four sides bent down to form walls 2 inches high, leaving a deck space 9½ inches long by 7 inches deep. The front panel, also of 16-gauge aluminum, is 10 inches long by 7 inches high.

It will be noted in Figure 1 and in the photograph that there are five terminals shown on the battery terminal strip. Only four of these are used and a 4-gang strip will therefore be satisfactory.

To tune, first find proper adjustment for the antenna condenser, C6, by advancing the regeneration control until the circuit breaks into oscillation, then tuning throughout the range with condenser C1. If it cannot be made to oscillate throughout this range, decrease the capacity of the condenser, C6, until it is found possible to maintain oscillation throughout the entire tuning range. If, on the other hand, too much regeneration is obtained, then increase the capacity of C6.

List of Parts HAMMARLUND PRODUCTS

- C1—Midget variable condenser, type MC-140M
- C2—Midget variable condenser, type MC-35S
- C3—Equalizer condenser, type EC-35
- RFC—R.F. choke, type CH-X
- 1 Set of 4-prong plug-in coils, type SWK-1
- 1 4-prong Isolantite socket type S4

MISCELLANEOUS

- C3, C4—Cornell Dubilier mica condenser, .00025 mfd.
- C5—Cornell Dubilier pigtail by-pass condenser, .25 mfd.
- R1—I.R.C. resistor, 1-5 megohms
- R2—Electrad, type R1-205 potentiometer, 50,000 ohms
- R3—Electrad, type R1-204, 10 ohms rheostat
- SW—Toggle switch, s.p.s.t.
- T—Thordarson type T5736 a.f. transformer
- 2 Ely 4-prong sockets, wafer type, or Hammarlund Code S-4 Isolantite sockets
- 1 Kurz-Kaseh vernier dial (large)
- 1 Aluminum Doerle panel and chassis (Blau the Radio Man)
- 1 Eby 2-gang terminal strip (tip jack terminals)
- 1 Eby 2-gang terminal strip (screw terminals)
- 1 Eby 4-gang terminal strip (screw terminals)

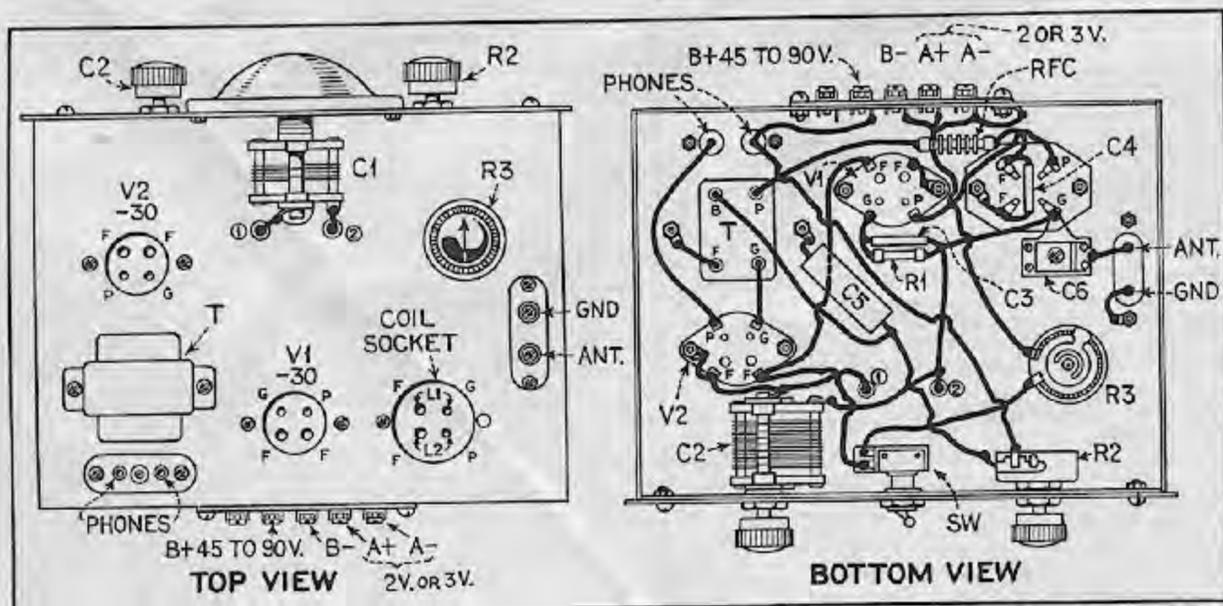


Fig. 1

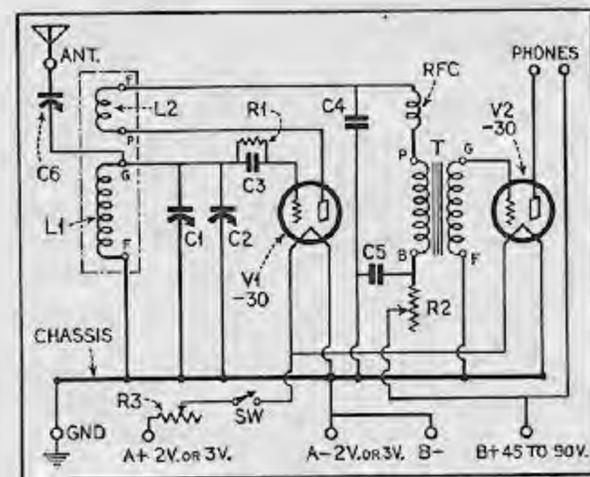


Fig. 2

The Pentaflex

IN spite of its tiny size, this receiver, which was originally described in the September, 1932, issue of "Short Wave Craft," provides real 2-tube results.

The method of employing a pentagrid converter tube such as the 6A7 to serve as both a detector and an audio amplifier stage is made clear in Figure 1. Here the screen-grid section of the tube is connected like any other screen-grid tube employed as a regenerative detector. G4 is the control grid, G3 and G5 together constitute the screen, and P the plate. The triode section, used as the audio amplifier, employs G1 as its grid and G2 as its plate. The cathode K is common to both sections. The resistance coupling

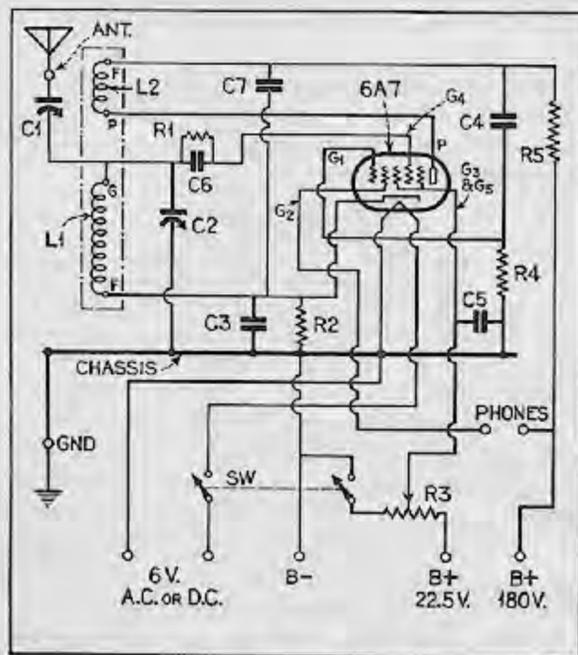
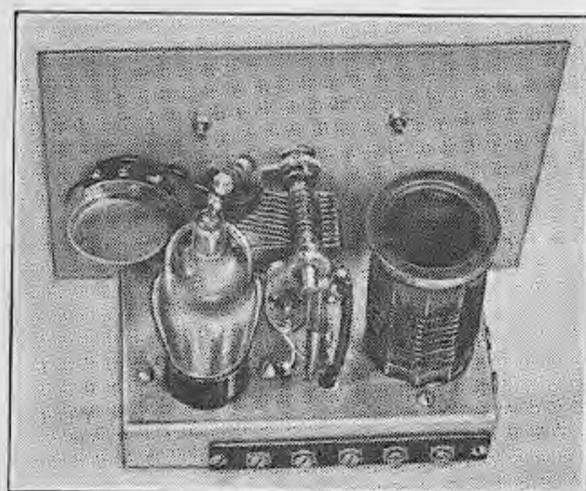
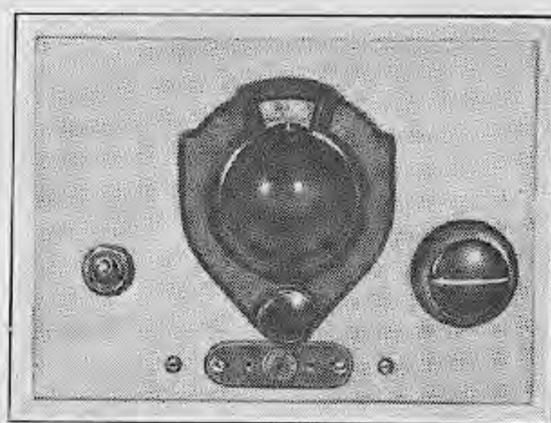


Fig. 1



Rear View

between the sections consists of R5 as the plate coupling resistor, C4 as the coupling condenser and R4 as the grid leak. The headphones are connected in



Panel View

the circuit of G2 (the triode plate). This application of the 6A7 tube obviously lends itself to compact receiver

design and the Pentaflex takes full advantage of this. The overall size is only 7 inches long, 5 inches high and 3 inches deep. The chassis is formed from a 7 inch by 5 inch sheet of 16-gauge aluminum bent down 1 inch all around. This provides deck space of 3 inches by 5 inches after the chassis has been attached to the back of the 7 inch by 5 inch panel by means of 2 screws.

The plug-in coils employed are the standard Hammarlund 4-prong type, four of which are employed to cover the entire short-wave range down to 19 meters.

List of Parts

HAMMARLUND PRODUCTS

- C1—Equalizer condenser, type EC-35
- C2—Midget variable condenser, type MC-140M
- L1, L2—Standard set 4-prong plug-in coils, type SWK-1
- 1 Isolantite coil socket, type S-4, 4 prong

MISCELLANEOUS

- C3, C5—Cornell Dubilier by-pass condensers, .1 mfd.
- C4—Cornell Dubilier by-pass condenser, .01 mfd.
- C6—Aerovox pigtail mica condenser, .0001 mfd.
- C7—Aerovox pigtail mica condenser, .0005 mfd.
- R1—I.R.C. metalized resistor, 3 megohms, 1/2 watt
- R2—I.R.C. metalized resistor, 400 ohms, 1/2 watt
- R3—Electrad potentiometer, 50,000 ohms
- R4, R5—I.R.C. metalized resistors, .25 megohms, 1/2 watt
- 1 Kurz-Kasch vernier dial, small size
- 1 Grid clip
- 1 Toggle switch, d.p.s.t.
- 1 Eby 7-prong wafer type tube socket for 6A7 tube, or Hammarlund Code S-7B Isolantite socket
- 1 Pentaflex panel and chassis—see text (Blan the Radio Man)
- 1 Eby 5-gang strip (screw terminals)
- 1 Eby 2-gang strip (screw terminals)
- 1 Eby 2-gang strip (tip jack terminals)

A Dual Regenerative Receiver

THIS 2-tube receiver, which was described in detail in the June, 1933, issue of "Short Wave Craft," provides an unusually flexible system of regeneration control by combining both the condenser and potentiometer methods. Thus the screen-grid voltage can be adjusted to the value that provides the smoothest regenerative action, then the condenser is employed for the variation required in tuning. Or this method may be reversed if desired, fixing the adjustment of the

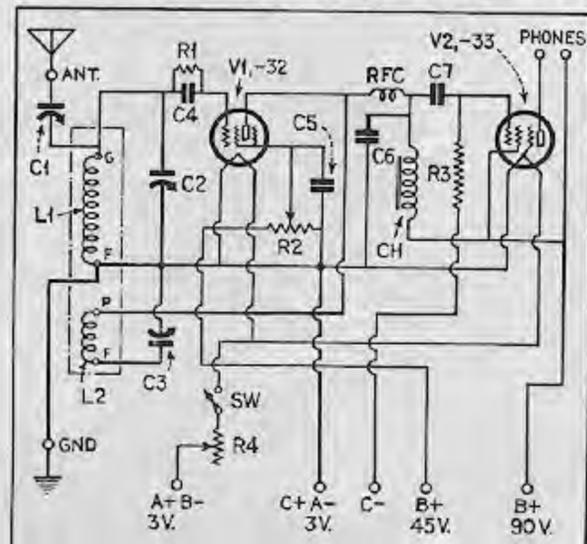
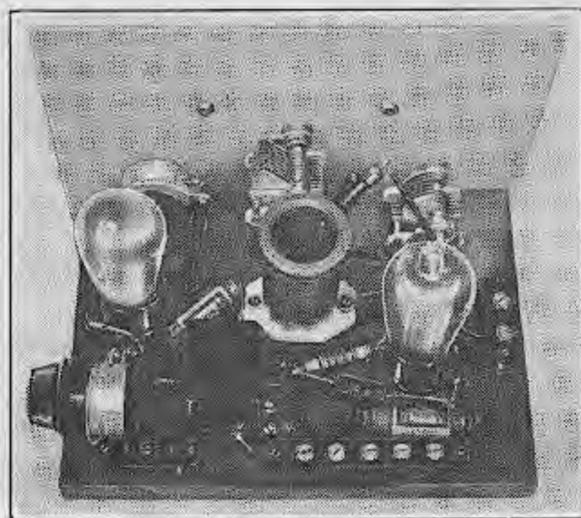


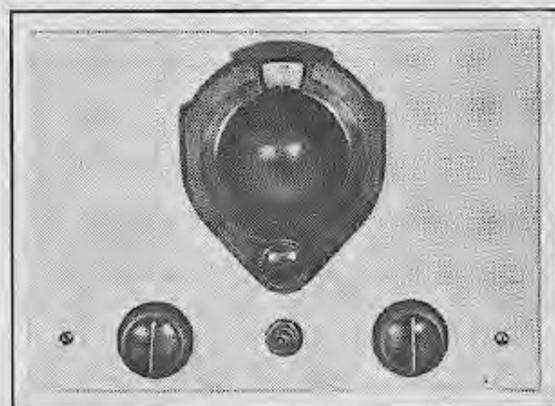
Fig. 1



Rear View

condenser and using the potentiometer as the operating control

The receiver is constructed on a wood baseboard 9 1/2 inches long and 7 inches



Panel View

deep. The front panel is of aluminum, 10 inches long by 7 inches high. On this panel are mounted the tuning condenser C2, the potentiometer R2 (with on-off switch SW operated by same shaft) and regeneration control condenser C3.

List of Parts

HAMMARLUND PRODUCTS

- C1—Equalizer condenser, type EC-35
- C2—Midget variable condenser, type MC-140-M
- C3—Midget variable condenser, type MC-100M
- L1, L2—Standard 4-prong, type SWK-1, plug-in coils
- RFC—R.F. choke, type CH-X
- 1 Isolantite coil socket, 4 prong, type S-4

MISCELLANEOUS

- C4, C6—Cornell Dubilier mica condensers, .00025 mfd.
- C5—Cornell Dubilier by-pass condenser, .1 mfd.
- C7—Cornell Dubilier by-pass condenser, .01 mfd.
- CH—Thordarson audio choke, type T-2927
- R1—I.R.C. metalized resistor, 5 megohms, 1/2 watt
- R2—Electrad potentiometer, type R1-205, 50,000 ohms
- R3—I.R.C. metalized type resistor, .5 megohms
- R4—Electrad 10 ohm rheostat, type R1-204
- 2 Eby moulded tube sockets, one 4-prong, one 5-prong, or Hammarlund Code S-4 and S-5 Isolantite sockets
- 1 Eby 2-gang strip (screw terminals)
- 1 Eby 5-gang strip (screw terminals)
- 1 Eby 2-gang strip (tip jack terminals)
- 1 Wood baseboard, 9 1/2 inches by 7 inches by 3/4 inch
- 1 Aluminum panel 7 inches by 10 inches (Blan the Radio Man)
- 1 Kurz-Kasch vernier dial, large size
- 1 Grid clip

The A. R. R. L. "Ham" Receiver

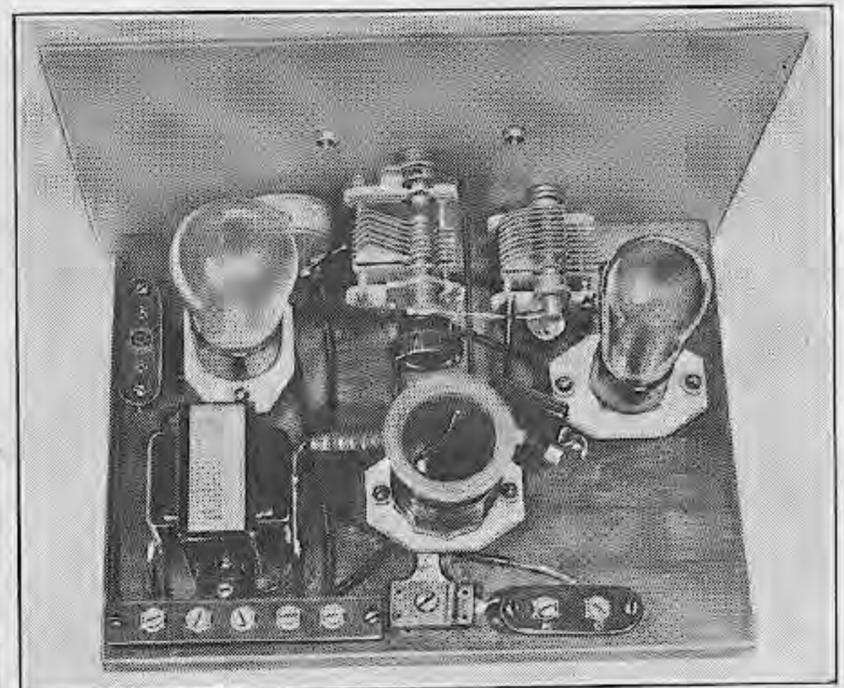
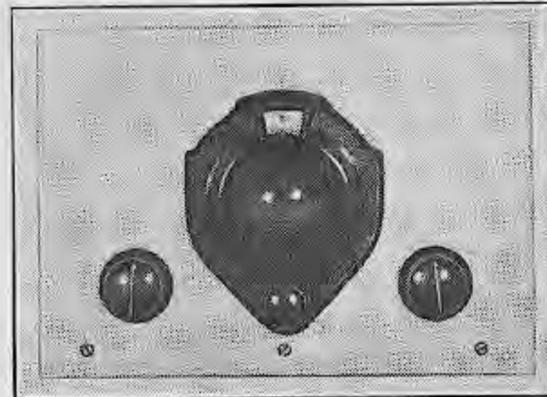
THE receiver described here is one which is featured by the American Radio Relay League and the magazine QST as an ideal job for a budding "ham". This receiver was described in detail in the A.R.R.L. booklet "How to Become a Radio Amateur," 3rd edition.

To quote from the descriptive article in this book: "The receiving set we describe is of simple design and construction. It is easy and straight-forward to assemble and operate, and yet will readily bring in amateur signals from distant stations with a suitable antenna and ground."

"Some of our readers may notice that the circuit is similar to the old familiar 'three-circuit' tuner so commonly built by broadcast listeners in the early days of broadcasting. Do not think, for this reason, that it is not a particularly good amateur receiver. It may surprise you to know that this tuner, with occasional modifications, is used in the majority of the amateur stations in this country. Much of the international amateur work, expedition communication, etc., is done with receivers using this circuit."

While this little set was designed primarily for the reception of C.W. and 'phone signals from "ham" transmitters, the very features which make it a good "ham" receiver will make it a good receiver for any type of short-wave work.

The tuning condenser really consists of two condensers assembled in a single frame. The 100 mmfd. section is used for coarse tuning or band setting. The smaller section provides a capacity of 20 mmfd. and it is with this portion that the fine tuning and band spreading is accomplished. Its shaft is brought through the front panel to the main tuning control. The knob for adjusting the larger section is at the rear of the condenser, behind the panel. The band spreading permitted by this arrangement is an invaluable feature of the receiver when operated on the 20, 40, 80 or 160-meter "ham" bands and is a decidedly useful feature on other ranges as well because



List of Parts HAMMARLUND PRODUCTS

- C1—Midget variable condenser, type MC-120B, 2 sections of 100 mmfd. and 20 mmfd.
- C2—Midget variable condenser, type MC-140M
- C4—Equalizer condenser, type EC-35
- L1, L2, L3—Standard 3-current, 6-prong, plug-in coil kit, type SWK-6, or four 6-prong coil forms, type CF-6
- RFC—R.F. choke, type CH-X
- 1 4-prong Isolantite socket, type S-4
- 1 5-prong Isolantite socket, type S-5
- 1 6-prong Isolantite socket, type S-6 (for coil)

MISCELLANEOUS

- C3—Aerovox type 1460 fixed condenser, .0001 mfd.
- R1—Electrad type R1-204 rheostat, 10 ohms
- R2—I.R.C. metalized resistor, 2 megohms
- T—Thordarson type R-260 audio transformer
- 1 Eby 2-gang strip (tip jack terminals)
- 1 Eby 2-gang strip (screw terminals)
- 1 Eby 5-gang strip (screw terminals)
- 1 Kurz-Kasch vernier dial (small)
- 1 7 inch by 10 inch aluminum panel, 16-gauge (cut to size and drilled—Blair the Radio Man)
- 1 Wood baseboard, 9 1/2 inches by 7 inches by 3/4 inch thick
- 1 Toggle switch, s.p.s.t

it spreads the station out on the dial so that instead of two or three stations falling within one degree, as they do on so many receivers which do not include this feature, they are spread out over a dial range of perhaps five or ten degrees and thus tuning is much simplified.

Regeneration in the detector circuit is accomplished by means of the usual tickler and is controlled by means of the variable by-pass condenser, C2.

An aluminum front panel is used to minimize body capacity while tuning the receiver. This panel is screwed to the front edge of the wood baseboard. The three Hammarlund Isolantite sockets—this type of socket is recommended because of their low r.f. losses—are elevated approximately 5/8 inch above the baseboard by means of bushings which are supplied with them. Similar bushings provide a convenient means for mounting the 3 terminal strips.

The receiver as described here provides excellent results when Hammarlund standard 6-prong plug-in coils are used. However, some constructors may

prefer to wind their own coils and the necessary data is therefore given here, based on the use of Hammarlund Isolantite coil forms.

Coil Data

	L1	L2	L3	Frequency Range
No. 1	70	20	10	1000 to 2200 kc.
No. 2	30	10	10	2250 to 4200 kc.
No. 3	11	7	5	4200 to 9000 kc.
No. 4	5	5	5	9000 to 18000 kc.

All coils are wound in the same direction using No. 30 double silk-covered wire, close wound. Approximately 1/16 inch spacing is provided between coils. In each case the grid coil (L1) is the top winding, the tickler (L2) is in the middle and the antenna coil (L3) at the bottom. The top end of the grid winding corresponds with the coil terminal marked No. 1 on the schematic diagram, the lower end to No. 6; the top end of the tickler to No. 3, the lower end of the tickler to No. 2; the top end of the antenna coil to No. 4 and the bottom end of the antenna coil to No. 5. The numbers marked on the coil socket in the picture wiring diagram, Figure 2, correspond to the coil terminal numbers on the schematic diagram, Figure 1, and the ends of the three windings should connect with the coil form prongs indicated by the numbers on the coil socket.

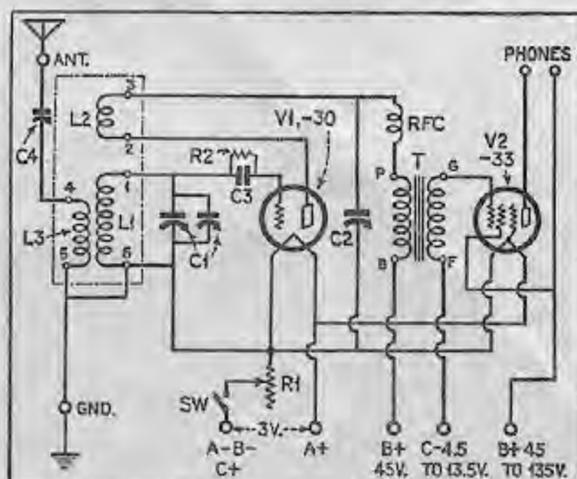


Fig. 1

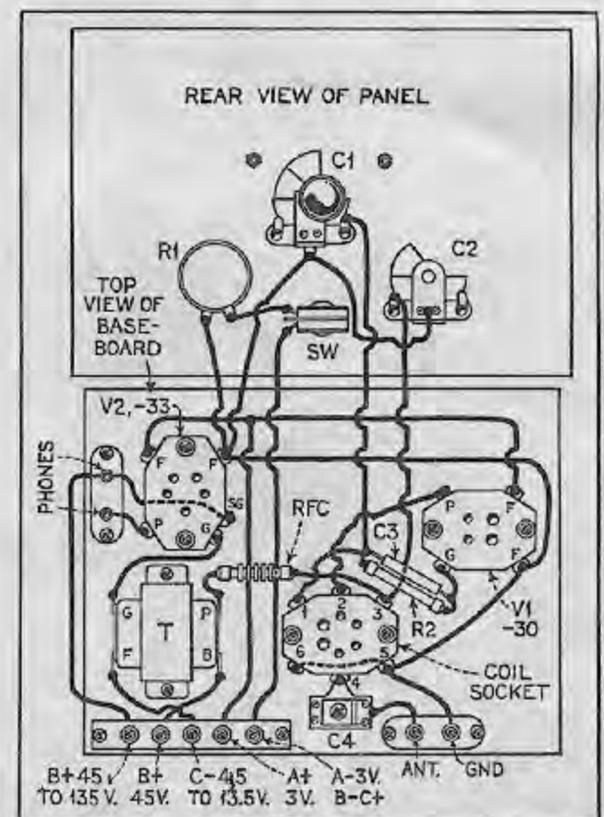


Fig. 2