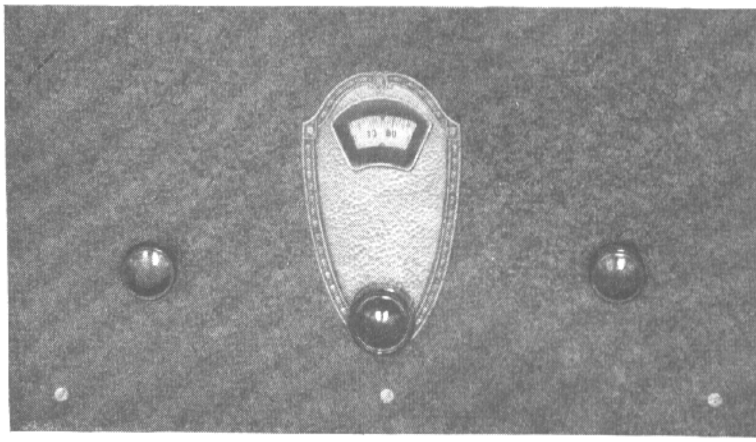
A Non-Radiating Short-Wave Tuner

By JAMES MILLEN

RADIO BROADCAST has described in past months a number of interesting short-wave receiver units of various designs. The unit described here, a product of the National Company, contains no audio system—which makes it applicable to any audio system whether a part of a standard receiver or not. The set is non-radiating, and due to the isolation of the radio-frequency stage from the detector circuits, the tuning points as noted on the dial do not vary with antennas of varying lengths. The antenna circuit is choke-coupled to the screen-grid tube. A "picture diagram" of the set and most of the constructional data have not been included in this article because a blueprint of the hook-up and layout and constructional data are available through RADIO BROADCAST *or direct from the National Company.* —THE EDITOR.



SYMMETRY AND SIMPLICITY IN THE FRONT PANEL

NOW that short-wave broadcasting has passed through its early experimental stages and reached the state where reliable reception of good quality programs is readily obtained by means of easily constructed and inexpensive receivers, a great many readers who in the past have confined their efforts to the construction of radio receivers for use on the regular broadcast band, desire to build a good short-wave receiver.

Aside from the mere fun of building a "different" type of radio set, there is that thrill of receiving understandable programs from distant and foreign stations. With a short-wave receiver, distance takes on an entirely new meaning.

It is not uncommon to receive broadcasting from ANE at Java, 3LO at Melbourne, Australia, 5SW at London, PCJJ in Holland, and many others; and static and fading are frequently entirely absent when reception on the regular broadcast band is exceedingly poor.

THE DESIGN OF THE RECEIVER

THE National Screen-Grid Short-Wave receiver comprises several interesting features. One is the single tuning control. Another is the foundation unit design which permits an efficient layout of parts, with but a few connections to be made by the assembler. As a result of the 222 type tube in the first stage, the sensitivity of the receiver in general is materially better than that of the plain regenerative detector type formerly so much in use. Furthermore, the use of the 222 tube ahead of the essential regenerative detector prevents radiation—a problem which would soon become quite serious if all the short-wave receivers were of the radiating variety. Still another important advantage secured by the use of the 222 tube as in this receiver is the elimination of tuning "holes," or dead spots commonly encountered with plain regenerative receivers. Although heretofore rather carefully placed shielding has been considered essential to a receiver using the 222 tube, the use of the untuned antenna circuit employed in this screen-grid short-wave receiver makes shielding unnecessary. The elimination of the shielding not only reduces the cost of parts and simplifies the work of construction, but also makes it a simple matter to change coils when going from one band to another. To cover the band of from 15 to 115 meters (20 to 2.65 megacycles) four interchangeable transformers are used. These transformers differ in a number of respects from the conventional "short-wave coils" with which everyone is familiar.

In the past it has been the general practice to employ coils of fairly large diameter—usually about 3 inches or so. As a result, all but perhaps the 100-meter coil would have a diameter much greater than its length. It is a well known fact that the most efficient coil is one having what is known technically as "unity form factor," or in other words a length of winding equal to the diameter. By using a coil diameter smaller than customary and at the same time varying the spacing between turns and size of wire, a coil of high efficiency for each band has been developed. In addition, in order to secure a high mutual inductance between the primary and secondary of the r.f. transformer without unnecessarily high capacity coupling, the primary or plate coil is wound of very fine wire located between the turns of the secondary or grid coil. The tickler winding in each instance is located in a slot at the low potential end of the transformer.

One of the most essential and most neglected features of a good short-wave inductance is rigidity. Without rigidity any slight vibration or jar in the room where the receiver is being operated will result in unsteady signals. Also, such coils will not stand up under continual handling, with the result that stations are seldom received from time to time at the same dial setting. In the case of these coils, such difficulties are entirely overcome by winding the transformers on threaded micarta tubing, and soldering the ends of each coil directly to the special one-piece contacts located around the bottom of the tube.

While some readers may think that the use of such a micarta tube would increase the losses in the coils by a noticeable amount, such has been found not to be the case, as the dielectric is located in the weakest part of the magnetic field of the coil.

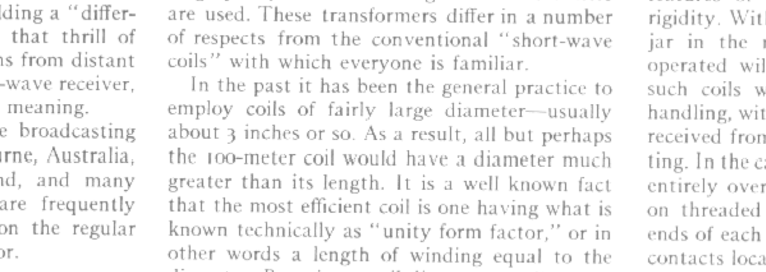


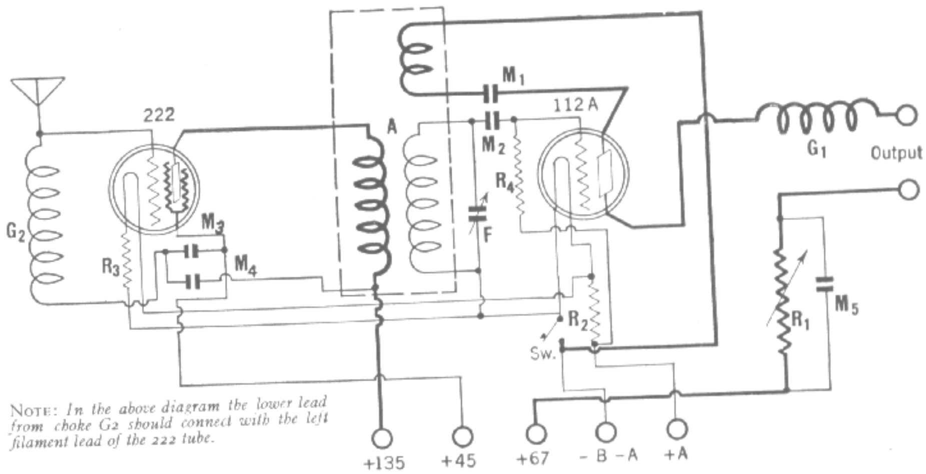
FIG. 1. UNDERNEATH THE SUB-PANEL

Another interesting feature is the special tuning condenser employed. This condenser, while resembling in general appearance the standard National Girder Frame condenser, is one designed especially for use in short-wave receivers. In the first place, it has a straight frequency line characteristic, so as to make tuning equally easy at both ends of the dial. A further arrangement for facilitating tuning is the 270 degree rotation, which spreads the stations over 50 per cent. greater dial range than if the standard 180-degree rotation had been employed. The double plate spacing that will be noted from the illustrations, is employed to "smooth out" any slight irregularities in the characteristic curve of the condenser, which, while not ordinarily detectable at broadcast frequencies with standard condensers, is quite noticeable at the short wavelengths.

A final innovation in the condenser design is a constant impedance pig-tail which eliminates variations in dial settings due to pig-tail inductance variations when the old style of "clock spring" contact is used.

The r.f. choke coil, G_1 in Fig. 2, used in the detector plate lead, is of the multi-section slot-wound variety having very low distributed capacity over a wide band of frequencies. The other r.f. choke, or grid circuit impedance, G_2, is one especially designed for the purpose and has an inductance of approximately 2 millihenries.

Perhaps it would be well to caution at this time against the use of the wrong size filament resistor, R_3, for the UX-222 tube. This resistor should be of the 15-ohm size and not 22 ohms. Due to the type number of the tube, UX-222, and the practice of some resistor manufacturers of marking their 22-ohm units as type 22, many experimenters have assumed that a "type 22" resistor is the proper one to use with a UX-222 tube under any conditions.



NOTE: *In the above diagram the lower lead from choke G2 should connect with the left filament lead of the 222 tube.*

FIG. 2. THE CIRCUIT DIAGRAM

COIL DATA

THE four coils used in this set have wave-length ranges as follows:

Type A—15.5 to 26.5 meters. Secondary, 4 turns of No. 14 enameled wire; tickler, 2 turns of No. 30 d.s.c. wire; primary, 3 turns of No. 28 enameled wire.

Type B—23.5 to 41 meters. Secondary, 7 turns of No. 14 enameled wire; tickler, 2 turns of No. 30 d.s.c. wire; primary, 6 turns of No. 28 enameled wire.

Type C—37.5 to 65 meters. Secondary, 14 turns of No. 14 enameled wire; tickler, 3 turns No. 30 d.s.c. wire; primary, 14 turns No. 28 enameled wire.

Type D—64 to 115 meters. Secondary, 25 turns of No. 18 enameled wire; tickler, 4 turns No. 30 d.s.c. wire; primary, 25 turns No. 28 enameled wire.

All of the coils are wound on 2 inch tubing. The secondaries of the first three types are spaced 8 turns to the inch; the secondary of D coil is spaced 14 turns to the inch. The tickler is wound in a slot ⅜" below the filament end of the secondary and the primary is wound in the spaces between the secondary turns.

CONSTRUCTIONAL NOTES

BY CAREFULLY studying the illustrations, one will readily see how to mount all of the parts on the foundation unit. All holes are drilled and the work is very easy. As soon as the assembly is completed the wiring may be done. If the wiring diagram is carefully followed it is quite simple for anyone to obtain a very neat job. Needless to say, all connections should be carefully soldered. The two moulded mica condensers located under the sub-panel, are fastened in place by soldering their terminals directly to the socket and coil clips between which they are connected.

In order to make contact to the cap or control grid of the 222 tube, use a short length of small, flexible, rubber-covered wire, or very fine single silk-covered wire, running in a piece of small spaghetti and ending in a fuse clip or similar home-made clip, to snap on at the top of the cap.

AUDIO AMPLIFIERS

FOR headphone reception, it is recommended that a single stage of transformer-coupled audio amplification be added to the output of the receiver as just described. While such an additional amplifier is not at all necessary, it will be found of considerable aid in receiving distant and weak signals.

When loud speaker operation from such short-wave broadcasting stations as KDKA, WABC, etc., is desired, then the use is recommended of a high grade two-stage transformer-coupled audio amplifier of either the straight or push-pull variety.

LIST OF PARTS

THE complete parts, together with the foundation unit, may be obtained in kit form. However, all the parts, with the exception of the coils, are of standard des gn, and other equivalent parts may be substituted. The coil data is given in the text.

A—4 National short-wave transformer coils covering the range of 15 to 115 meters
E—1 National dial, type E, with type 28 illuminator
F—1 National condenser, short-wave type, 125 mmfd.
G_1—1 National r.f. choke, No. 90
G_2—1 National h.f. impedance, No. 10
M_1—1 Aerovox molded mica condenser, 0.001 mfd.
M_2—1 Aerovox molded mica condenser, 0.00025 mfd.
M_3, M_4—2 Aerovox bypass condensers, 0.5 mfd.
M_5—1 Aerovox bypass condenser, 1.0 mfd.
R_1—1 Electrad Royalty resistor, type L, 0–500,000 ohms
R_2—1 Filament resistor, 2 ohms
R_3—1 Filament resistor, 15 ohms
R_4—1 grid leak, 6 megohms
S—1 Yaxley filament switch
8 Eby binding posts
1 Foundation Unit, including Westinghouse Micarta panels, sockets, gridleak and r.f. choke mounts, completely drilled, ready to assemble
UX-222 and UX-201A tubes

OPERATION OF THE RECEIVER

AT THIS time, the writer feels that socket-power units are not suitable for use with a short-wave receiver. It is necessary for satisfactory results, therefore, to employ 135 volts of dry or storage B battery, in addition to the usual 6-volt storage A battery. If an audio amplifier of some kind is not to be employed, then a pair of phones should be connected to the "output" posts on the right-hand side of the sub-panel.

A good ground may be connected to minus A. In some instances, however, better results are obtained without the use of a ground.

For an antenna it is recommended to use a single wire of from 35 to 100 feet in length and as high and free from surrounding objects as possible.

By means of the variable resistance regeneration control (right-hand knob) the detector tube may be made to oscillate, and then the carrier of the station received. A slight readjustment of both controls should then bring in the station. The tuning of a short-wave receiver is a much more critical process than that of a standard broadcast receiver, and unless care is used, the novice is likely to pass right by a station.

Station 5SW at Chelmsford, England, can generally be heard between 5 and 6 P.M. in Boston when using transformer B and with the dial set at about 31.

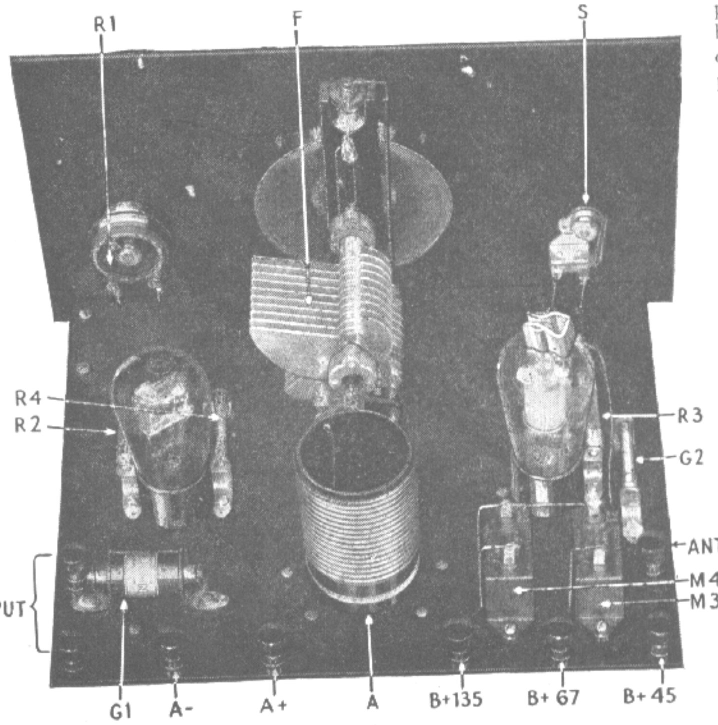


FIG. 3. ABOVE THE SUB-PANEL