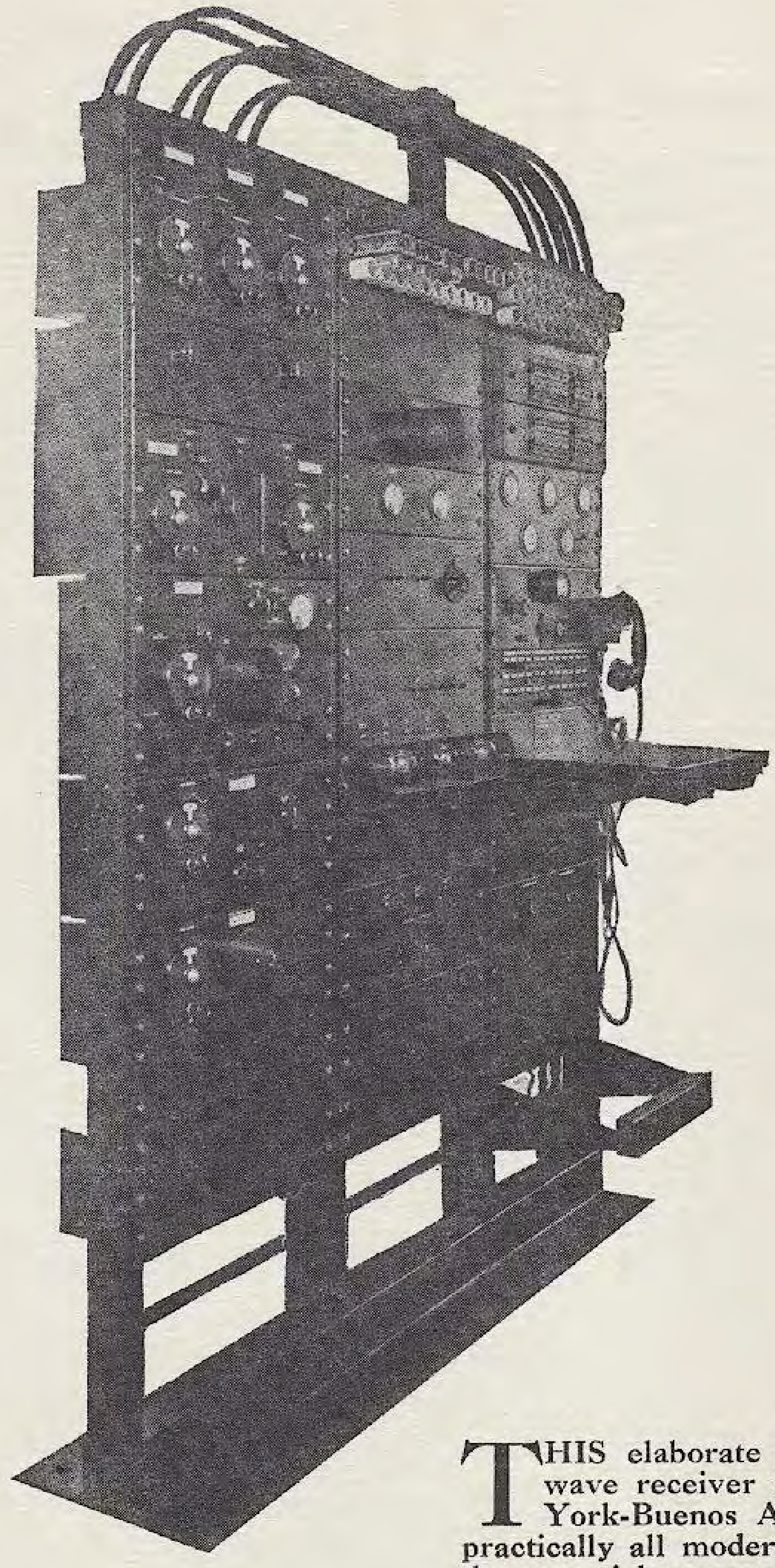
# 1931-32
# Short-Wave Receivers

PRICE 10 CENTS



THIS elaborate International Tel. & Tel. short wave receiver is employed as part of the New York-Buenos Aires telephone circuit. As with practically all modern short wave receivers, many of the essential components are of NATIONAL COMPANY design and manufacture.

Other important commercial users of National short wave apparatus include: General Electric Co.; Westinghouse Electric & Mfg Co.; R.C.A.; Tropical Radio (United Fruit Co.); Federal Tel. & Tel. Co.; American Tel. & Tel. Co.; Canadian Marconi; U. S. Naval Research Laboratories; U. S. Navy; Signal Corp, U. S. Army; U. S. Dept. of Commerce (Lighthouse Service); Jenkins Television Corp.; Press Wireless, Inc.; DeForest Radio Co.; Wired Wireless, Inc.; Pan-American Airways; Curtiss-Wright; Boeing Airplane Co.; Western Air Express; Roosevelt Field, Inc., and Southern Air Transport.

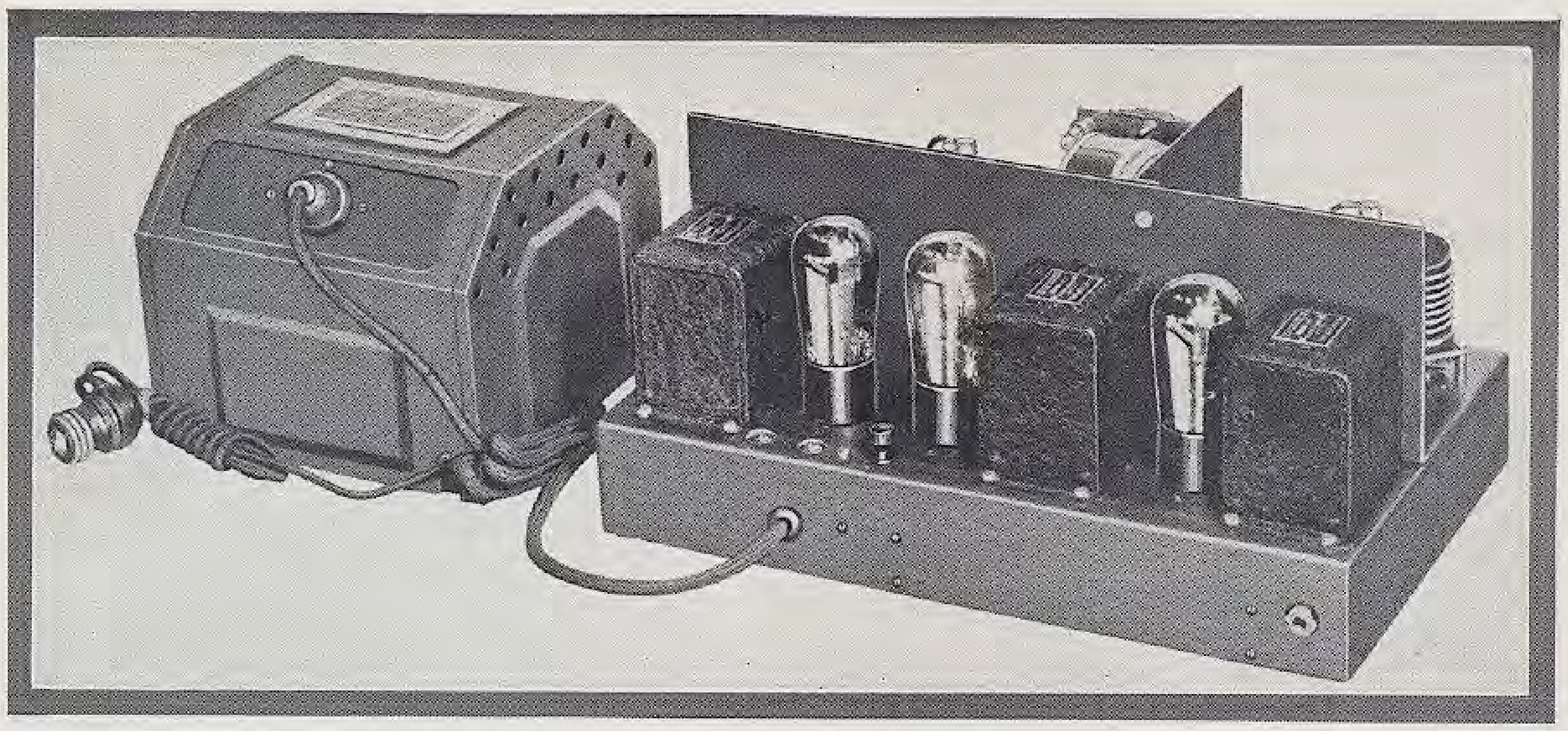
*"It is the purpose of this booklet to describe a series of high frequency radio receivers designed to meet the requirements of everyone interested in short-wave reception, whether it be from a broadcast, amateur communication, commercial communication, or experimental point of view.*

*"Within its pages will be found a description of a number of different short-wave receivers, all of standard NATIONAL quality, but differing in scope. Each is exceptionally fitted to give unusually fine performance in its particular field, and it is felt that anyone interested in high-frequency work will find a receiver suited to his purpose in this comprehensive line.*

*"Although primarily a description of NATIONAL equipment, it is hoped that the sound, though ingenious, design and the minute attention to detail in the receivers described will contribute to make this booklet of value to amateurs and professionals alike."*

James Millen

Malden, Mass
June 1, 1931.



# An *Analysis of* A. C. Operated *Short-Wave* Receiver Design

*The famous NATIONAL SW5 Thrill Box, pioneer single dial control a.c. operated short wave receiver, is now still further improved by the use of the new -35 variable mu tubes in the r.f. and detector sockets. For broadcast reception, a model using the -45 power output tubes in push-pull is also available. Special coils cover the range of from 9 to 750 meters*

REALIZING that before short-wave receivers could come into popular use they must be made to operate with very nearly the same ease and convenience as a modern broadcast receiver, we made a study of their weak points. A receiver was needed that would not only hold its own against any of the older type battery operated jobs for general amateur and experimental reception, but would also meet every requirement of the non-technical owner who, when he felt so inclined, wanted to hear 5SW in London, 2ME in Melbourne, Australia, or any one of a dozen other foreign broadcasting stations without the necessity of waiting for possible re-broadcasts of these stations.

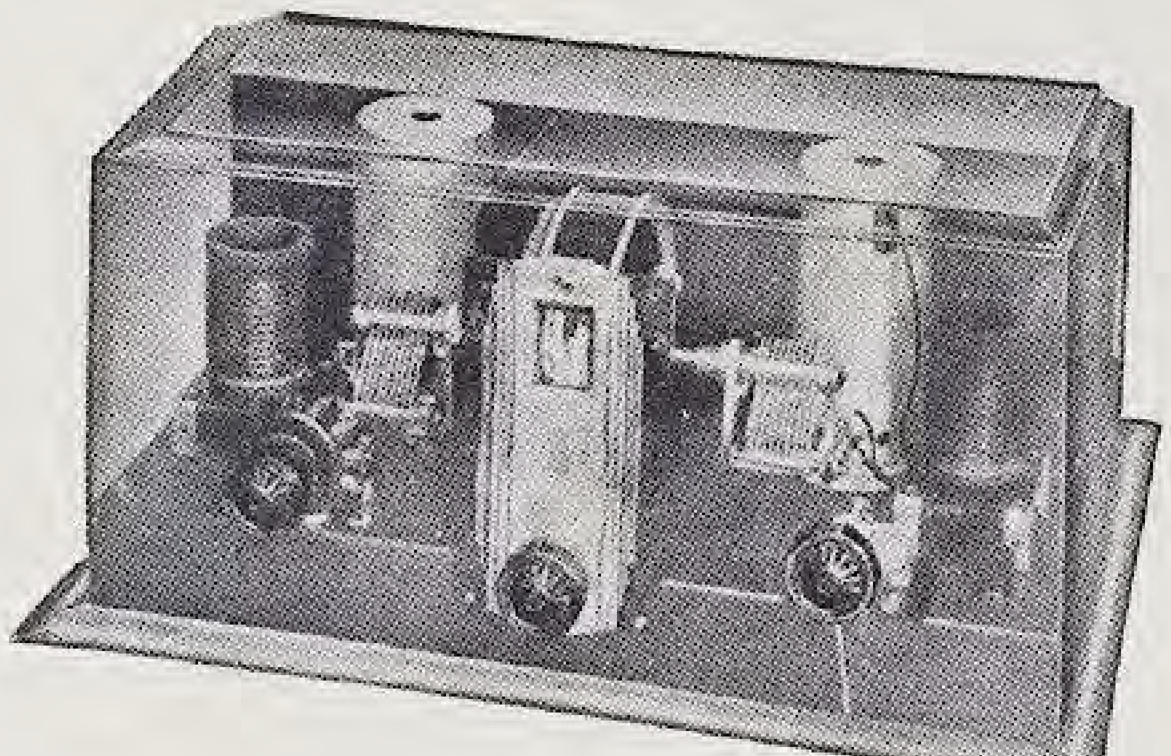
As a result of this survey, the following essentials of a good short-wave receiver were brought to light:

1—Absolutely humless a.c. operation, 2—Single dial control, 3—Loud speaker reception from foreign broadcast stations, 4—Good tone quality, 5—Non-critical tuning, 6—Neat appearance.

Most of these problems have heretofore been unsurmountable in receiver design.

Now, after nearly a year of work on the development of such a receiver in the laboratories of the National Company, in collaboration with a number of well-known short-wave authorities (including, in particular, Robert S. Kruse, who spent a great deal of time both in the National Company's laboratory and in his own laboratory at Hartford, in making investigations into the causes of the various types of hum encountered in such receivers), a new a.c. short-wave receiver was developed.

Now after almost a year of commercial experience in the manufacture of this particular model, the wisdom of the early design has been so thoroughly proven that the only changes to be announced for the coming season are the replacement of the -24 screen grid tubes in the detector and r.f. sockets with the newer -35's, which result in smoother control and quieter operation without any sacrifice in sensitivity.



A front view of National's new a.c. operated short-wave receiver. Special constructional features, as outlined in the text, are incorporated in the design of this receiver to make it exceptionally satisfactory for a.c. operation

As short wave receivers are more and more coming into general use for entertainment purposes in the reception of short wave broadcasts, an alternate model is also available now which employs the -45's in push-pull in the last audio stage, in place of the -27's. For general experimental and amateur communication use, however, the standard model with the 227's, as herein described, is still to be recommended as the more preferable. The only difference in the two receivers is in the last audio stage sockets and bias resistors. The two power packs, however, are radically different.

When dealing with short waves, the manner in which the circuit is used is important.

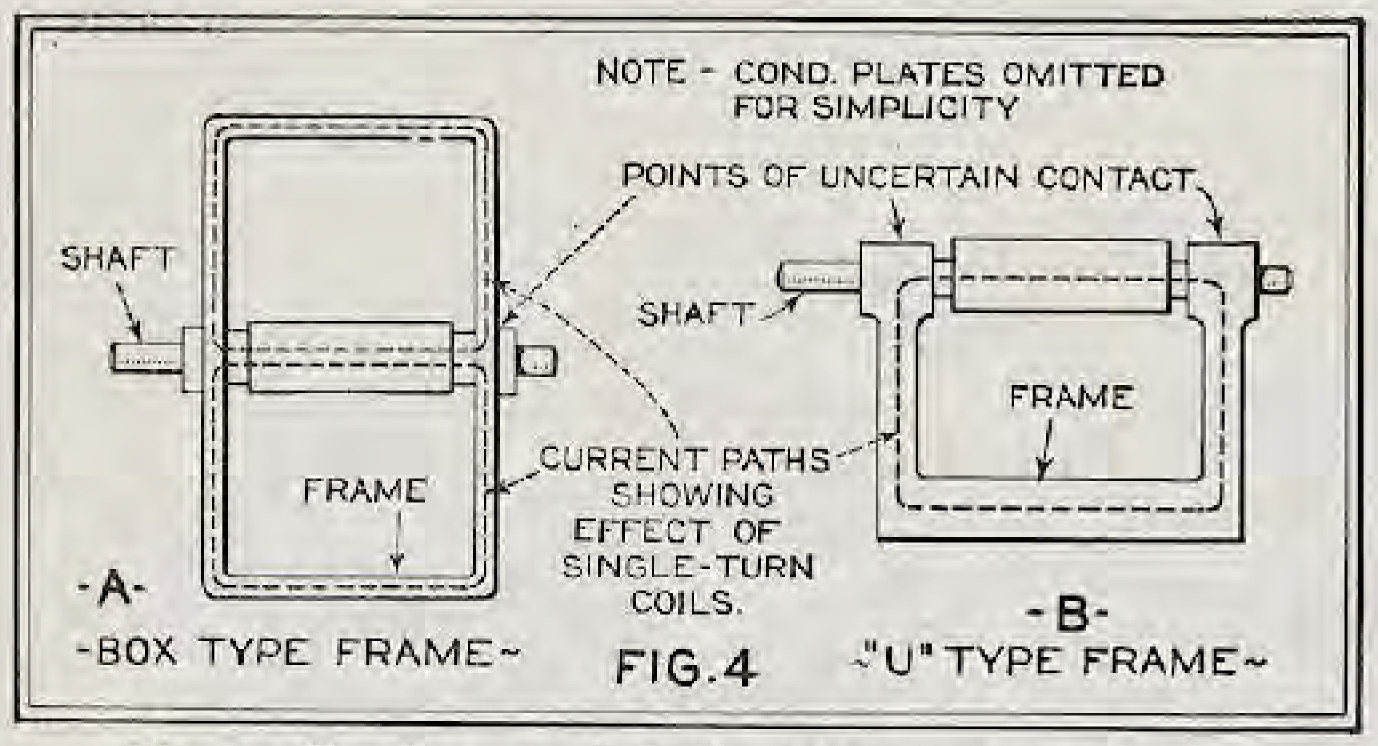
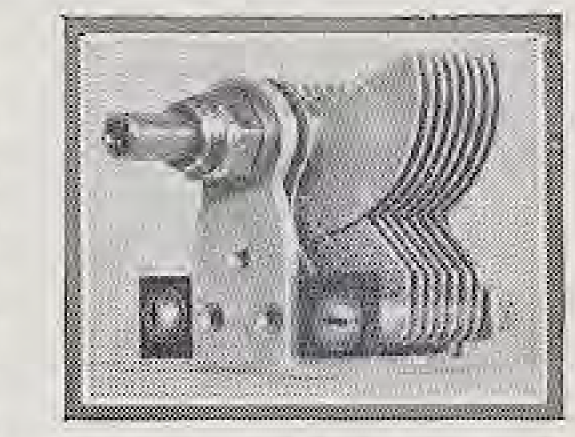



**Fig. 4. The frame and shaft of the condenser form a single-turn coil. As the shaft is turned the bearing contacts change and the single turn is partly opened and closed, tending to produce noises in nearby tubes or those coupled to the condenser**

**This specially designed short-wave receiver (at the right) is unlike other small tuning condensers, in that its frame is part metal and part insulation, thus preventing production of a shorted turn, a feature to be avoided in short-wave receiver construction**


**Below, a general view of the revamped tuning condenser especially adapted to short-wave use**



The circuit itself comprises a tuned screen-grid radio-frequency stage, in which provision has been made, if desired for the use of the heater type pentode tube, where slight additional gain at the expense of selectivity is wanted; a screen-grid regenerative detector; a two-stage transformer-coupled audio amplifier, employing push-pull in the second stage and with provision for plugging 'phones into the output of the first stage when desired; and a separate power pack especially designed for short-wave work.

Occasionally good hum-free a.c. operation on short waves may be obtained by the mere substitution of the heater type a.c. tubes for the more conventional d.c. types in a standard battery operated short-wave circuit. Such instances, however, are few and far between, as they seem to be the result of an unusually good a.c. line condition, plus a "better than average" set of heater tubes. In most cases the mere use of conventional heater type a.c. tubes results in a quite pronounced and annoying hum that tends to vary somewhat.

Thus, in our work on the development of an a.c. short-wave receiver, we soon found that while we would seem to be securing excellent results on one power line, it was essential that we take the entire outfit to another part of town or to a town in another state which was known to have a particularly poor and troublesome power system, in order to "check and double-check" all results.

After considerable experimentation of the so-called "cut and try" variety, it was found that there were some dozen or so very definite sources of hum trouble to be encountered in the short-wave receiver that would not cause the slightest trouble in a broadcast receiver. It was the identification and the elimination of these concealed sources of hum that finally made possible an a.c. short-wave receiver in which the hum is as low as in a battery powered set.

First, the tubes themselves must not only be of the heater type, but also, for complete freedom from hum, must be carefully selected. This is especially true of the detector tube which may be found to be quite noisy when just on the edge of oscillation, unless it is selected with care.

The cause of hum when using some types of heater tubes is apparently due to two things; one being direct leakage across the ceramic insulating column between one side of the heater and the cathode, and the other to an unneutralized 60 cycle field around the heater.

In general, the -27's when operated on the verge of oscillation, are less troublesome than the -24's. At first thought this quieter performance of the -27 would tend to recommend its use as the detector. It was soon found, however, that, though more noisy when approaching oscillation, the -24 screen-grid detector was, under practical operating conditions, actually quieter due to its improved sensitivity, eliminating the necessity for full regeneration for the same signal output as obtained with the -27. Improved tone quality was a further by-product obtained from this decreased amount of regeneration.

The new -35's are even an improvement in this respect over the -24's.

The second point that must be given careful consideration if successful a.c. operation is to be had, is the power supply unit. This unit should be entirely separate from the receiver itself, completely shielded and located at least three feet from the receiver proper.

It should have exceedingly low inherent hum in its output; (i.e., at least a double section filter using good quality chokes and plenty of condenser capacity must be employed). The power transformer should have an electrostatic shield between the primary and the other windings in order to prevent line disturbances from getting into the power unit and into the set. The rectifier tube must also have an r.f. filter comprising a radio-frequency choke and by-pass condenser in its output, directly preceding the hum filter. It is this r.f. filter system in the power unit which provides one of the two things necessary to eliminate the so-called "tunable" hum; that is, a hum that shows up only on certain wave-lengths but which nevertheless is quite pronounced. Apparently such hum results from disturbances set up in the rectifier tube itself.

Strange as it may seem, separate heater windings on the power transformer seem to give no improvement over the use of a single winding.

The set proper should be completely enclosed in a steel cabinet in order to exclude stray low-frequency magnetic fields. Incidentally, these stray fields seem to be the cause of the "a.c." hum frequently encountered with some battery operated short-wave receivers. In order to make the shielding all the more effective, the power supply potentiometer with its associated by-pass condensers should be located inside the set in order to eliminate any external leads which might contain r.f. currents.

It has been found that almost every .5 mfd. condenser of the conventional

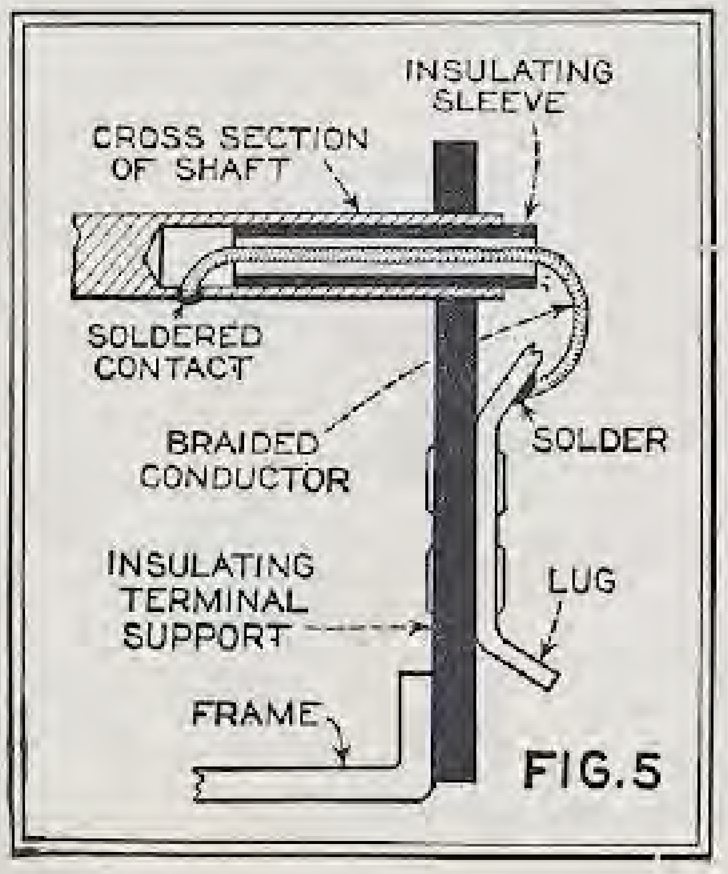



**Fig. 5. The new condenser uses one insulated bearing. The connection from the tuned circuit to the rotor is made through a pigtail of the constant impedance type**

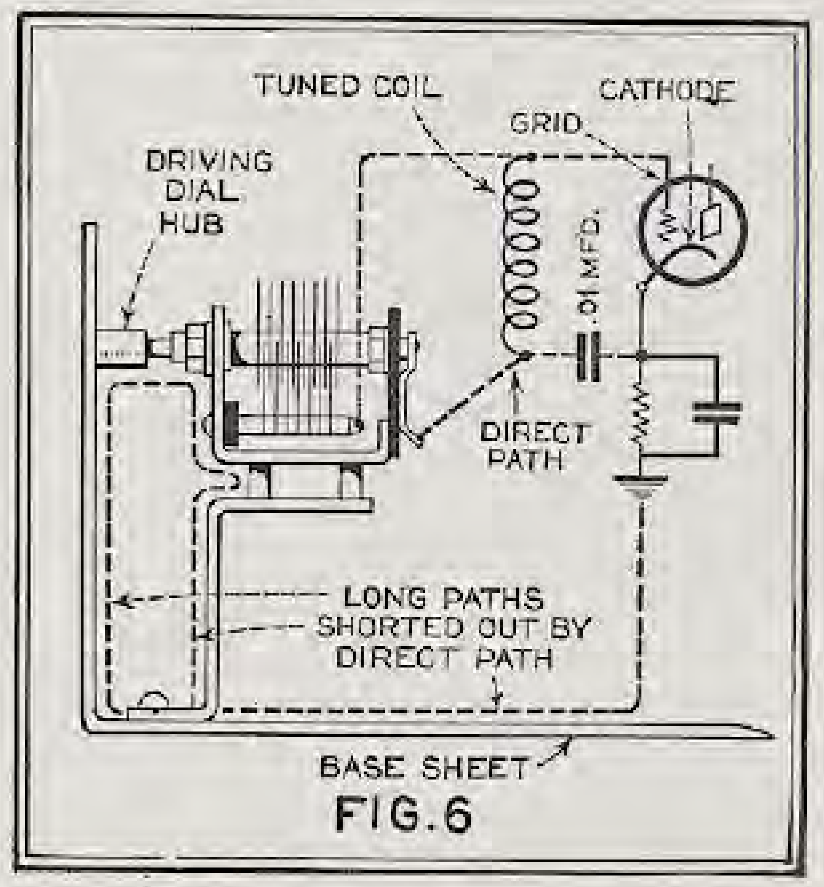
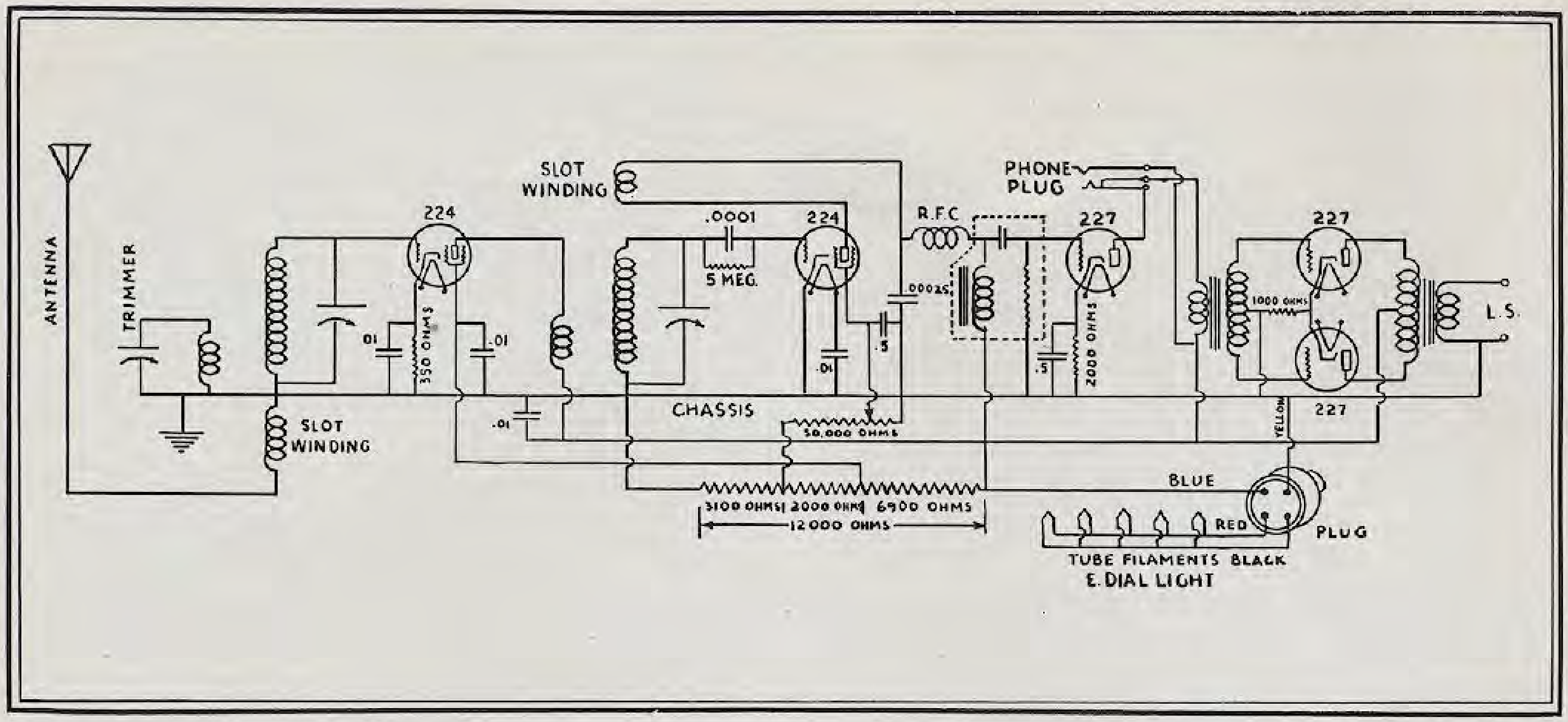
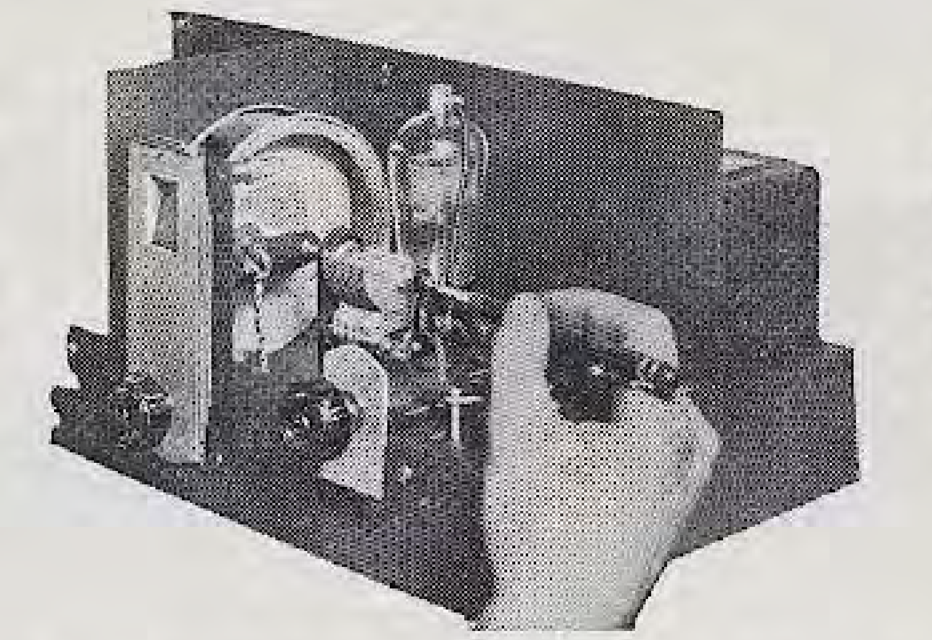



**Fig. 6. Note that by means of the connection providing a direct path from rotor to coil, the longer loop circuits constituting short-circuited turns are removed from the immediate vicinity of the tuned circuits thereby nullifying the detrimental effects**




The circuit comprises a tuned screen-grid radio-frequency stage, with provision for using a heater type Pentode tube; a screen-grid regenerative detector; a two-stage transformer-coupled audio amplifier employing push-pull in the second stage when desired; a separate specially designed power pack supplies A and B voltages



A side view of the receiver showing the method of mounting the specially designed tuning condensers. Shielding is employed not only to isolate the tuned circuit from each other but also to shield the audio channel from the tuner section

paper variety now on the market has a materially higher r.f. impedance at the lower wavelengths than a good .01 mica condenser. It is evident, therefore, that even though the cost be slightly more, the use of the smaller mica by-pass condenser will prove more effective and in many instances will completely eliminate a hum that is quite pronounced when using the paper condenser (hum resulting from common coupling through impedance of condenser).

Along with low impedance by-pass condensers, should also be mentioned center-tap resistors of low ohmic value. That is, they should be of not over 20 ohms, rather than the conventional 60 ohm type employed in broadcast receivers. Furthermore, it will be generally found that a noticeable improvement can be obtained, when operating on a poor power line, if this resistor is of the flat type rather than the round type, which apparently has considerable radio-frequency impedance at the extreme high frequency on which we are working. One side of the center-tap resistor had best be by-passed by one of the small mica condensers previously mentioned.

While the jack for head-phone reception is located so as to cut out the final or push-pull stage, there is bound to be a time, especially when listening to some of the foreign stations, when it may be desirable to connect the 'phones in place of the loudspeaker and use all of the obtainable amplification. But this possible use of the headphones in the output of the complete receiver is not the reason for the employment of push-pull in the final audio stage. Should a single output tube have been employed in place of the push-pull, an unbalanced drain of considerable magnitude would have been imposed upon the power pack, which, in turn, would have produced an infinitesimal fluctuation in some of the bias resistors, resulting in the introduction of hum in the detector and first audio-frequency circuits, which then would be amplified and passed on to the listener, even though the 'phones were plugged into the first stage jack, and the final stage not in use.

And now comes a method of hum control that will perhaps seem more logical than those already described; that is the location and arrangement of the wiring. As will be seen from the photographs, the receiver is constructed on a metal sub-panel to which is also added a metal bottom

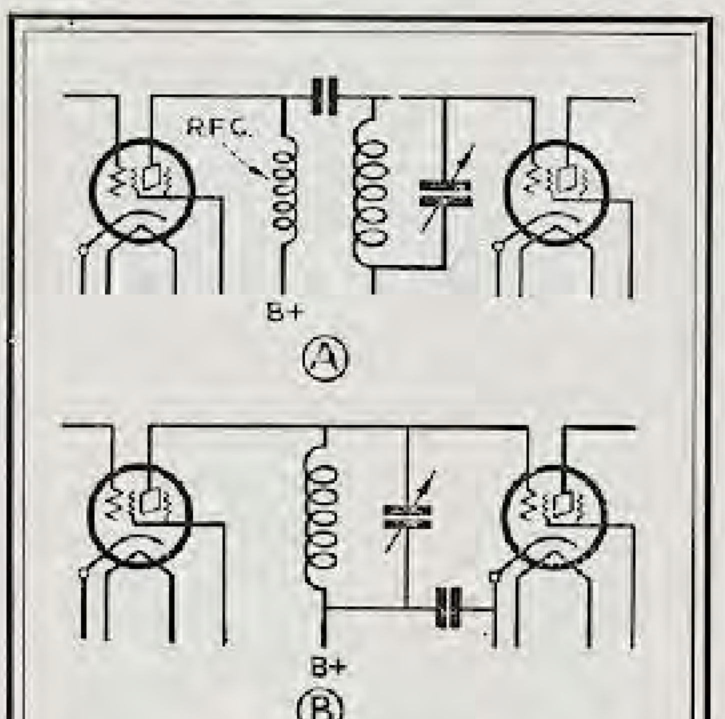



FIG.7

Fig. 7. After using a tuned impedance as the interstage coupling device, as shown at left—first as in "A", then "B"—the hum that was developed was found to be objectionable. It was eliminated by the use of a radio-frequency transformer as a coupling medium, as shown in "C"

Fig. 8. To make a short-wave receiver operate satisfactorily from a socket powered B supply, it is necessary that extra special precautions be taken in the design and construction of the power unit to incorporate r.f. chokes and bypass condensers so as to make the receiver stable in operation

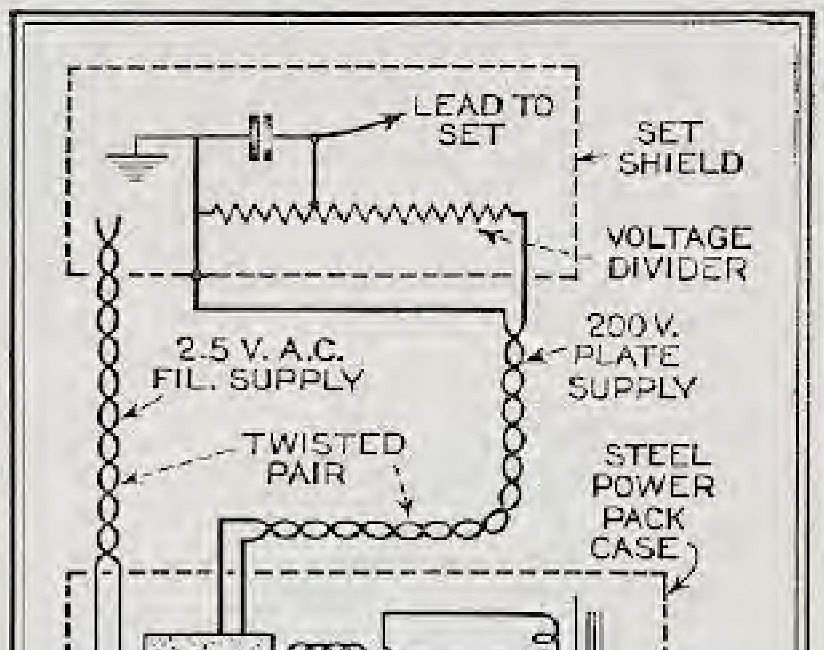



FIG.8

shield. By being careful to see that practically all of the radio-frequency leads are located above the sub-panel, while all of the power supply leads are located in the enclosed compartment beneath the sub-panel, much is done to eliminate troubles from so-called modulation hum.

And now for the final and perhaps least expected of all sources of hum trouble—the interstage r.f. transformer. In order to simplify construction, an attempt was at first made to use a tuned impedance as the interstage coupling device, first as shown in Fig. 7-A and then as in Fig. 7-B, where the stopping condenser is located in the grid return circuit of the detector rather than in the plate circuit of the screen-grid amplifier. In both of these instances the receiver not only lacked the sensitivity obtainable when using a transformer but also suddenly developed a new hum.

### *Interstage R. F. Transformer*

Apparently both of these r. f. coupling devices were capable of passing on to the grid of the detector tube some of the hum frequencies developed in the r. f. circuit. The loss of sensitivity was due seemingly to the fact that there is no such thing as an r. f. choke of infinite impedance at all frequencies, which spoiled the effectiveness from a "gain" point of the circuit. The stopping condenser in the grid return circuit at "B" apparently had considerable impedance at some frequencies which also prevented that circuit from performing at par.

The solution is obviously a radio-frequency transformer as shown at "C", Fig. 7, in which not only is the sensitivity of the receiver kept up where it belongs, due to the complete omission of shunt radio frequency chokes and series blocking condensers, but also all low-frequency coupling between any part of the r. f. amplifier circuit and the detector tube grid is completely eliminated.

## Coil Tuning Ranges

*"Brown" (No. 10) Range* 9 *to* 15 *meters or* 33.3 *to* 20.0 *Megacycles*
*"Black" (No. 11) Range* 14 *to* 25 *meters or* 21.2 *to* 12.0 *Megacycles*
*"Red" (No. 12) Range* 23 *to* 41 *meters or* 13.0 *to* 7.33 *Megacycles*
*"White" (No. 13) Range* 38 *to* 70 *meters or* 7.9 *to* 4.30 *Megacycles*
*"Green" (No. 14) Range* 65 *to* 115 *meters or* 4.7 *to* 2.61 *Megacycles*
*"Blue" (No. 15) Range* 110 *to* 200 *meters or* 2.73 *to* 1.5 *Megacycles*
*"Orange" (No. 16) Range* 200 *to* 360 *meters or* 1.5 *to* .83 *Megacycles*
*"Yellow" (No. 17) Range* 350 *to* 550 *meters or* 860 *to* 550 *Kilocycles*
*"Purple" (No. 18) Range* 540 *to* 750 *meters or* 555 *to* 430 *Kilocycles*

## Dial Readings

| STATION | COUNTRY | COILS | WAVE | DIAL |
|---|---|---|---|---|
| *PHI* | *Holland* | *Black* | 16.88 | 85 |
| *PCL* | *Holland* | *Black* | 18.07 | 112 |
| *W6XN* | *U. S. A.* | *Red* | 23.35 | 03 |
| *G5SW* | *England* | *Red* | 25.53 | 55 |
| *VK2ME* | *Australia* | *Red* | 28.5 | 85 |
| *PCL* | *Holland* | *Red* | 31.4 | 100 |
| *W2XE* | *New York City* | *White* | 49.02 | 90 |
| *W3XAU* | *Philadelphia* | *White* | 49.5 | 92 |
| *W8XK* | *Pittsburgh* | *White* | 62.5 | 140 |

There are quite a number of regeneration control systems, each of which seems to have some particular short-wave band in which it operates to best advantage. Where the plug-in coils are used, as in this case, to cover an extremely wide frequency range, it is necessary to find some means of regeneration control that will be smooth at all times, and not result in uncontrollable fringe howl, bad hand capacity effects and interlocking.

Of the four most generally used methods, namely, variable plate by-pass condenser, series plate resistor, tickler shunt resistor, and screen-grid voltage control, the screen-grid voltage control method, when accompanied by other circuit details results in uniformly satisfactory performance at all wavelengths.

### *Tuned Circuits*

Good tuned circuits are at the bottom of a good receiver of any sort. Since a tuned circuit comprises a coil and condenser, let us consider both of these units in turn.

Until recently there have been no proper high-frequency tuning condensers, designed for that purpose. The practice has been rather to use some sort of a broadcast-range condenser with a few lonesome plates providing the small capacity actually needed. Some improved designs have appeared quite lately, also some of the more recent "vernier" condensers have by good fortune been well adapted to some high-frequency needs and have been much used for such purposes.

One of the early steps taken in the development of the new receiver, therefore, was the design of the special short-wave condenser. Unlike other small tuning condensers it may be mounted in all of the regulation manners—screwed to a panel, screwed to the base or secured to a panel by the hexagon nut on the front bearing in conventional "single hole mounting" style. At high frequencies any condenser with two bearings tends to be noisy, either at once or else after it has had some use. This tendency can be decreased by the use of a good jumper from rotor to frame and by the use of spring tension to secure good bearing contact. Both devices have in the past been used with varying success. Single-bearing condensers of the "vernier" type, however, are noticeably quieter than 2-bearing types and the difference grows with frequency until at about 60,000 kc. (5 meters) the 2-bearing type has become nearly useless. There are several possible reasons for this trouble. Prominent among them is the effect shown in Fig. 4. The frame and shaft of the condenser form a single-turn coil. As the shaft is turned the bearing contacts change and the single turn is partly opened and closed, tending to produce noises in nearby tubes or those coupled to the condenser. At ordinary frequencies the effect is not serious and therefore need not be worried about, but at high frequencies it is well worth avoiding. The new condenser accordingly uses but one bearing and that bearing is insulated. The connection from the tuned circuit to the rotor is made through a pigtail of the patented constant impedance type. (See Fig. 5.) The pigtail does not go to the frame, but to a terminal lug on an insulating support at the rear end of the condenser. The stator terminals are close to this terminal, permitting very short leads if desired.

The dial appearance alone was not the only reason for the selection. The projection feature eliminates paralax. This dial has two inherent characteristics that make its use particularly valuable in short-wave work. The first is that the projection feature eliminates parallex in the scale reading which prevents accurate logging at the various dial settings without being extremely careful at just what angle the dial is being viewed. The other is the electrically silent vernier drive which is obtained by the use of a non-metallic cord. The silent drive feature, as in the case of the insulated condenser bearing, is very important when tuning in on wavelengths below 20 meters.

The new battery type Radiotrons UX230, UX231 and UX232, are ideally suited for use in place of the UY224s and 227s in this new NATIONAL SW5 "Thrill Box" where A. C. supply is not available. The accompanying blueprints give all necessary data on circuit changes.

### *Operating Notes*

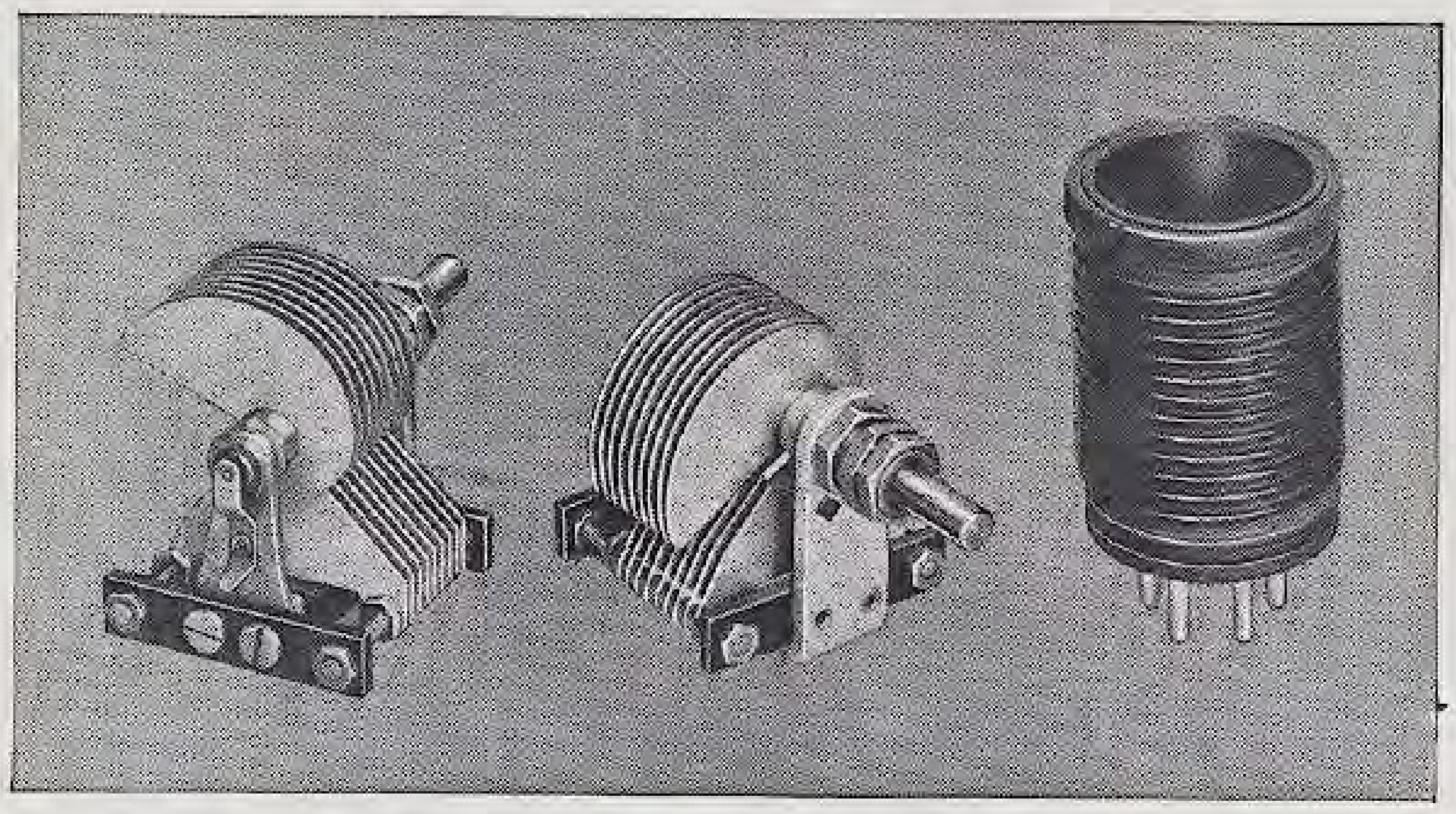
There's little more to bringing in those elusive foreign short-wave broadcasters than merely sitting down to your receiver, flipping the filament switch and carelessly twiddling the dials. Yet, many a broadcast listener has been led to believe that it's just as easy as listening to a local program. Not only must the operator of a short-wave receiver exercise greater care in tuning in to a distant station, but he must use his judgment as to when to listen. All the tuning on earth won't bring in a station if it doesn't happen to be on the air. Matters become more complicated in this respect because of the difference of time between the location of the receiver and the transmitter. There's no doubt about it, a fellow's got to use his head when tuning in on the short waves. The list of short-wave broadcasters on the following pages is the most authoritative and latest which it has been possible to compile.

Although the reception of foreign short-wave broadcasting stations is no longer an unusual experience for thousands of radio fans, there are still many owners of short-wave receivers who have never heard anything outside of the United States or Canada. Their disappointing failures can be explained usually by either or both of two reasons: they do not exercise enough patience in tuning their sets, or they do not know when and where to listen.

### *Advent of Short-Wave Broadcasting*

From his contacts with several thousand purchasers of a popular short-wave receiver kit, the writer would say that nontechnical people have been somewhat oversold on the idea that foreign reception is merely a matter of flipping a switch. It isn't at all. Troublesome hand-capacity effects have been pretty well eliminated but you still have to hang a bit tensely over the dials and wait for signals to fade in to an understandable level. The advent of short-wave broadcasting (as distinctly distinguished from "ham" radio telegraphy) has revived the fine art of dial twisting, and unless the set owner masters it he will never know the thrill of hearing VK2ME in Sydney, or RA97 in Siberia, or that German jawbreaker at Koenigswusterhausen.

The most important dial or knob is the one that controls the regenerative action of the detector. This is true for all types and makes of short-wave receivers, as they all use a regenerative detector, with and without tuned or untuned r. f. amplification and with one, two or three stages of variously coupled a. f. amplification. Simply keep the detector in a continual state of oscillation by rocking the regeneration dial back and forth as you turn the tuning dial a fraction of a degree at a time. When you encounter a carrier wave you will hear a tell-tale whistle. If the signal is fairly strong you can back down the regeneration until the whistle disappears; if the signal is rather weak, it is best to "zero-beat" it. This is the process of keeping the circuit in oscillation, but tuning it so that the frequency of the local oscillation is exactly the same as that of the incoming carrier wave. Under this condition no whistle is generated, there being no heterodyne action, and the voice of music can be distinguished. The signals will sound rather "mushy" if they are zero-beated, but at least they will be recognizable. Sometimes, after a station is brought in by the zero-beat method, its strength may increase so much that the detector can be thrown out of oscillation; the signals will then clear up considerably.



**Special condensers and coils have been designed for this receiver, and contribute to its high efficiency**

Unless a very short antenna is used, the tuned r. f. stage is rather broad. The trimmer condenser serves to compensate for various lengths of antenna that may be used, and need be set but once, when the receiver is first put in operation. As it affects the operation of the detector stage, it should be adjusted and then forgotten, in order that the stations may be logged accurately.

The aligning procedure is simple; the detector is put just under the edge of oscillation and the trimmer condenser turned until a point is found where oscillation is maximum. Of course, the detector may still be made to stop oscillating by simply retarding the regeneration control. This method of alignment is much more accurate than the usual custom of tuning in a station for maximum volume.

Having a good receiver in good operating condition is only half the battle. You have to know when to listen, and at what points on the dials. The accompanying list of stations, with their hours of operation in Eastern Standard time, should be of great assistance to you in this respect.

One thing many people cannot seem to get into their heads is that time is different in different places in the world. Many short-wave set owners finish their suppers at 7:00 or 7:30 in the evening and then sit down to their receivers with the innocent expectations that there will be short-wave stations to hear all evening. This is not always so. Seven o'clock New York time is midnight in London, and G5SW, the famous British Broadcasting Company's short-waver, is just signing off for the night. The writer has read hundreds of letters from people who complain of their inability to bring in London for their bridge guests—at nine o'clock. This is an age of scientific achievement, but even a dozen short-wave sets won't bring in a station that isn't transmitting.

Right now the best times to hear foreign stations are early in the morning and about the middle of the afternoon. Between four and about eight a. m. the stations in Australia, Siam, Siberia, the Dutch East Indies and Holland are quite active, and they deliver astoundingly strong signals. VK2ME, in Sydney, is testing pretty regularly with Schenectady and with the British Post Office stations in England.

Those Dutch stations are by far the best ones. PLE and PLF, in Java, working with PHI, PCO and PCK in Holland, operate powerful transmitters, and if you tune way down low on your smallest coil you can get them loud enough to wake up the family next door.

If you have always confined your listening hours to the early evening, you won't know your set in the early morning. The air is comparatively clear and quiet and the very low-wave stations skip in without much coaxing.

During the afternoon the German stations get busy, and come through just a little under WGY. In England G5SW starts at 2 p. m. E. S. T., and is an old stand-by.

As you know, skip distance effects vary with wavelength time of day, and the condition of the atmosphere. Therefore, divide your listening schedule something like this: 14 to about 20 meters, best from daybreak to about 2:00 p. m., and then fades out as darkness approaches; it is useless to listen below 20 meters after dark. 20 to 35 meters Europeans from 1:00 p. m. to about ten in the evening (if they happen to be putting on late programs). 35 to 75 meters, best between twilight and daybreak.

### *Locating the Foreigners*

You can locate many of the foreigners by spotting some of the American stations. For instance, you can get W2XAF (WGY) pretty easily on 31.48 meters; crawl just under him and look for PCJ, NRH, and the German station at Koenigswusterhausen. Little NRH, in Costa Rica, is about two degrees below these. You can spot this group of stations because they are about ten degrees below a very powerful code station on about 33 meters. This is XDA, in Mexico City, which also occasionally uses voice. When it does it sounds just about as WJZ does to a receiver located in Bound Brook. The usual broadcast antenna can, of course, be used, and if connected to the short wave receiver through a small condenser, such as .000005 mfd. capacity, both receivers may be left connected permanently to the common antenna. However, a good ground is rather essential to the stable, quiet operation of the high frequency set. Tubes of known reliability are to be preferred.

# *Solving the* Band-Spread Problem *of Short Wave Reception*

*A new and simple coil unit for short-wave receivers which allows stations in a given band to be "spread out", so to speak, over more than a mere few dial divisions. This new band-spread principle permits more accurate tuning and greatly improves opportunity for real DX work. Band-spread coils are particularly suited for amateur communication use.*

IT was in an effort to develop some ready means for wide band spread at any frequency without impairing the general purpose qualities of the SW5 that the special band-spread coils were designed. These new coils are merely plugged in, in the same manner as the standard coils, without making any changes in the receiver itself.

The result, in the case of the 20-, 40- and 80-meter amateur bands, is a 50-division spread, located right in the center of the dial. Special band-spread coils are also available for a number of different commercial bands, such as used by police departments, aviation transport companies and certain groups of foreign broadcast stations.

In general appearances, as will be seen from the accompanying photographs, the new band-spread coil differs from the conventional s.w. coil only in that a lead comes out of the top for clipping directly to the cap of the screen-grid tube in place of the lead and clip built into the receiver. Inside the detector coil form, however, will be found a small grid leak and grid condenser as well as an adjustable low-capacity trimmer condenser. The coil form itself is made of R39, the low-loss short-wave coil material developed for the NATIONAL COMPANY by the Radio Frequency Laboratories of Boonton, New Jersey. The material in this coil form differs from regulation bakelite in that no coloring material, filler, or wood flour, the latter the ingredient that introduces the high-frequency losses, are used. Instead, the pure bakelite resin is mixed with finely ground mica.

**Figure 1. The new band-spread coil, showing the trimmer condenser underneath which are the grid-condenser and grid-leak**

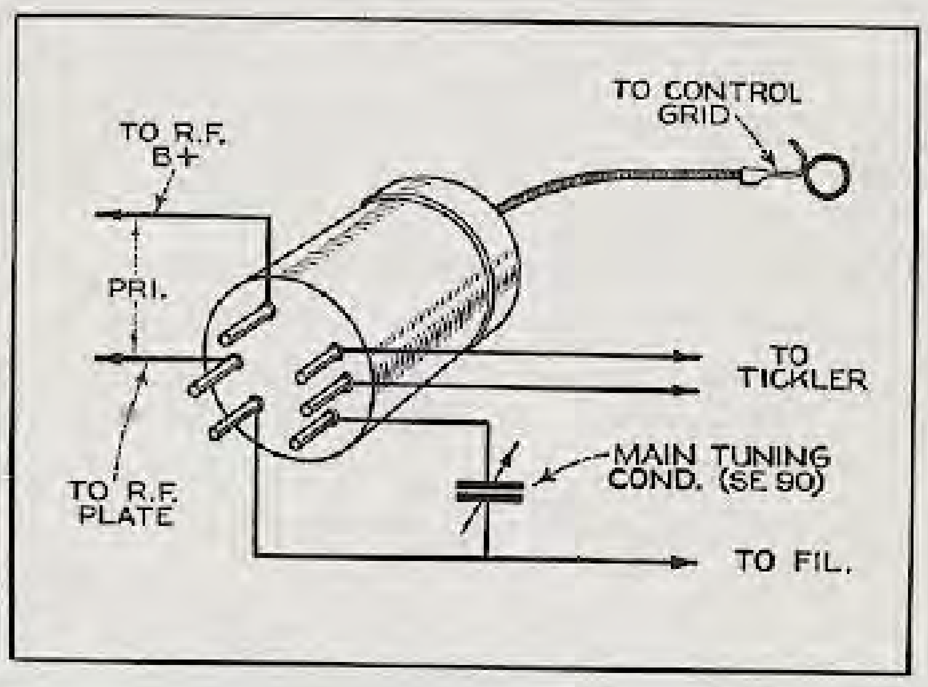



**Figure 3 (at right). Bottom of coil form, showing proper connections for use in SW-5 Thrill Box**

### *New Band Spread Arrangement*

Figure 2 shows the new band-spread arrangement. It will be seen that C1, the regular variable tuning condenser, now shunts only a portion of the total inductance, while the grid leak R1 and the condenser C3 connect directly to the top of the coil. Finally, the trimmer condenser C2 shunts this whole arrangement and is in parallel with the tube capacity, connecting directly from the grid to the filament.

Figure 3 shows a sketch of the coil and indicates how the prongs of the coil are connected, together with the disposition of the screen-grid lead which comes out of the top of the coil.

The particular L/C ratio arrived at in this arrangement results in a circuit of a high order of sensitivity. This, with the other advantageous features outlined here, make these new band spread coils a happy addition to the short-wave receiver art.

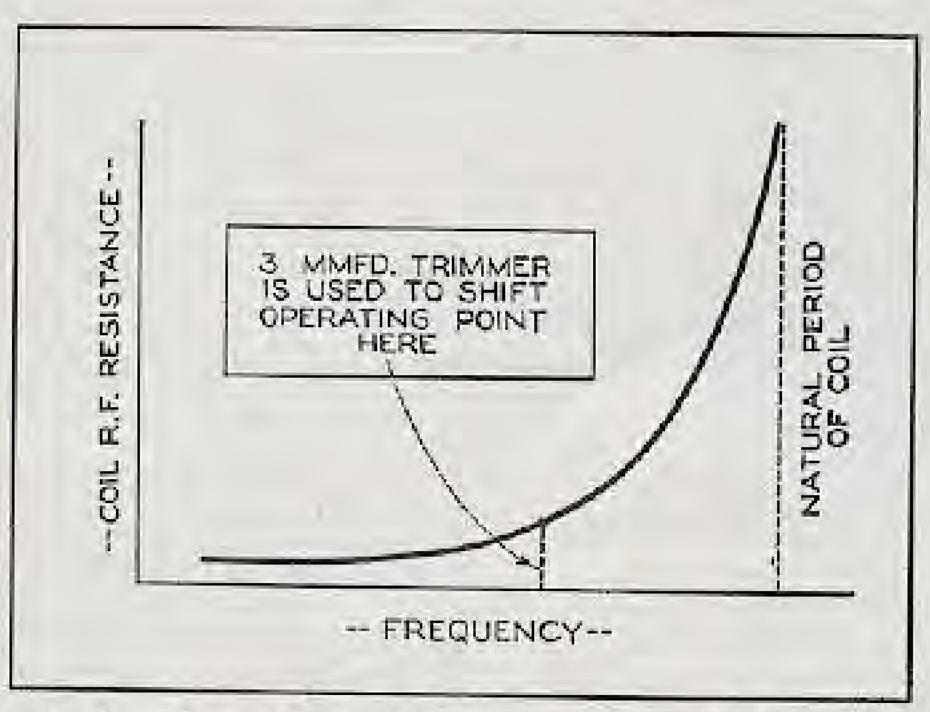



Figure 4. An r.f. resistance curve, indicating the rise in resistance as the natural period of the coil is approached and how the operating point is shifted to a low resistance value by the use of the 3 mmfd. trimmer

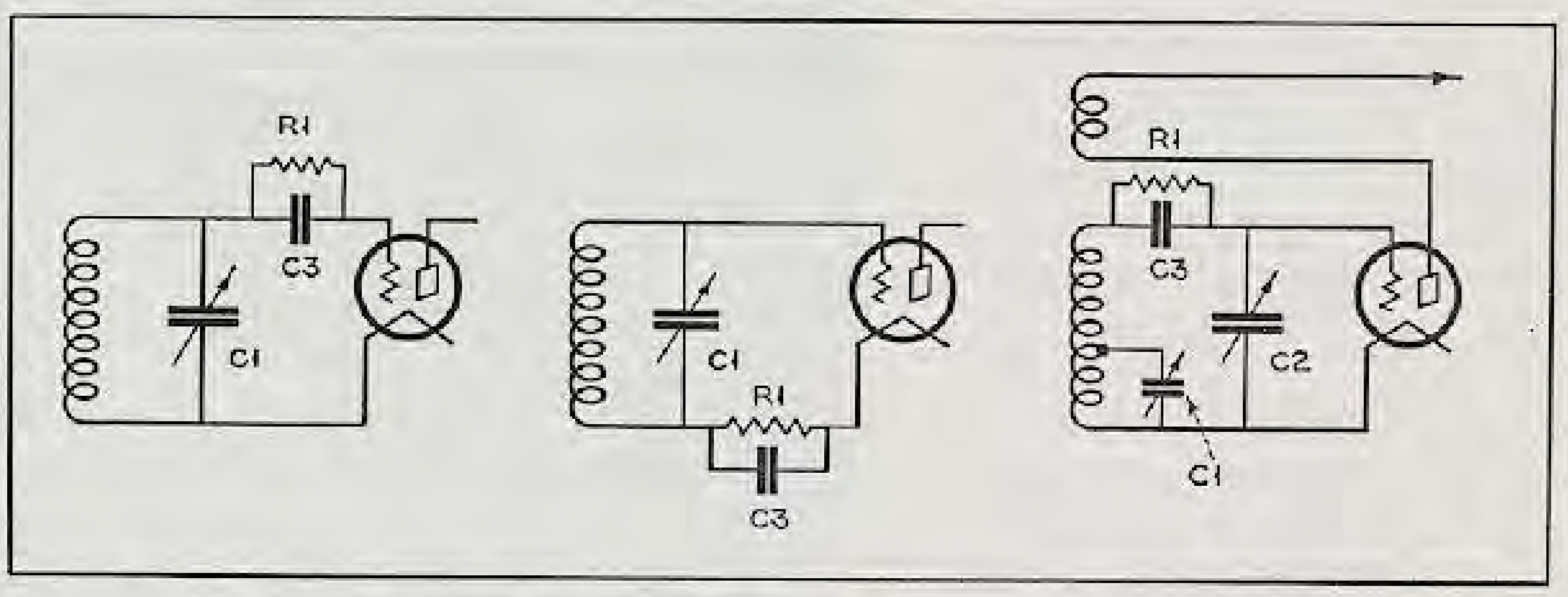
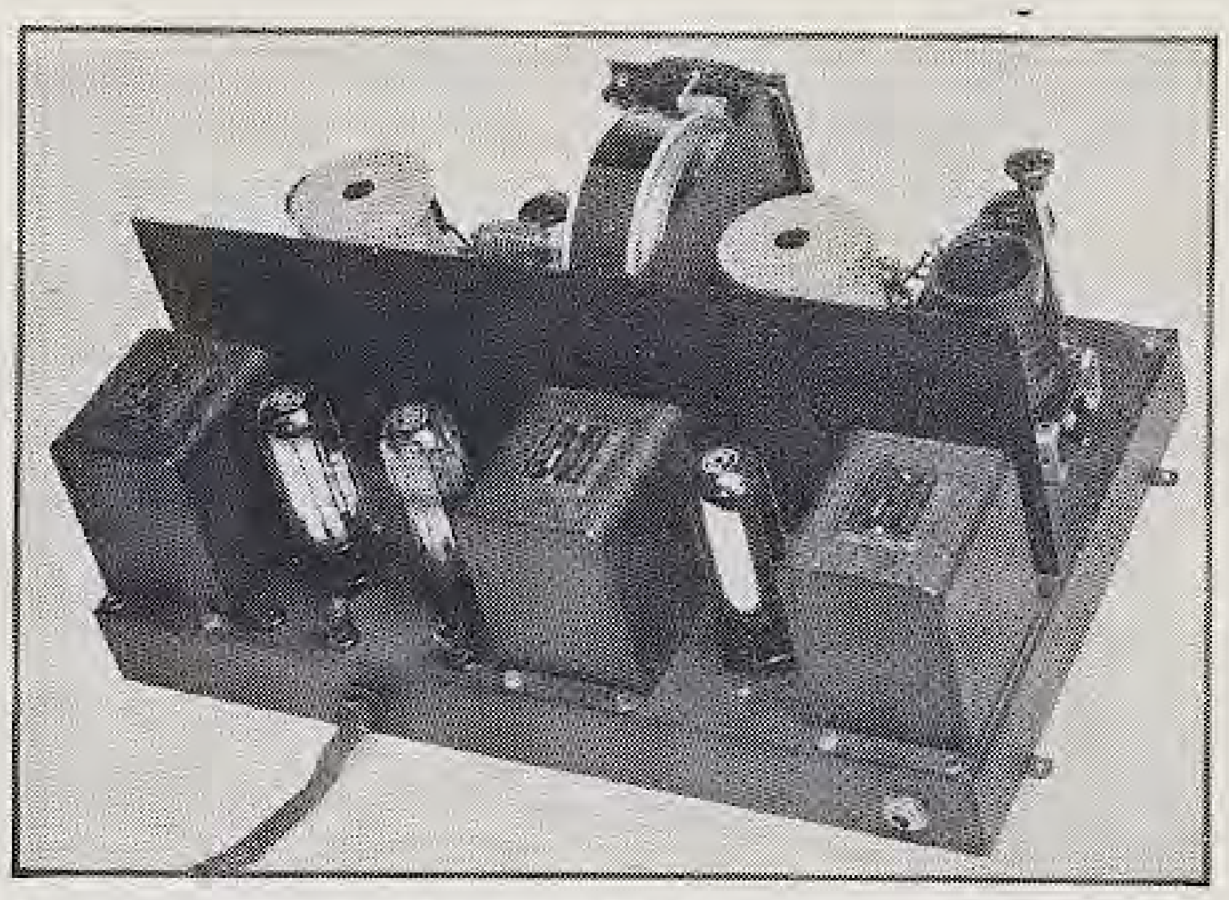



Figure 2 (Left). The conventional detector circuit with grid-leak and condenser at the top of the coil between it and the grid of the tube. (Center) Here the grid-leak is located in the grid return to filament, providing same results as Figure 1. (Right) The band-spread circuit showing the grid-leak and condenser in a new position. C1 is a 100 mmfd. tuning condenser; C2, adjustable mica condenser in parallel with tube capacity (about 3 mmfds.); C3-R1, grid-leak and condenser located inside coil form

# *The Air Cell* and the *Two Volt Tubes* as applied to the SW5 Short-Wave Receiver



Looking down on the top of the receiver. Metal shield walls separate the tuning elements from the audio channel located along rear edge

*All advantages of the A.C. SW5 Thrill Box are now available in the new battery model designed around new low-current 2-volt tubes and the 2-volt Air Cell battery*

THE new standard of performance set by the SW5 A.C. Thrill Box, described in the preceding pages, soon created a considerable demand for a battery model of equivalent capabilities.

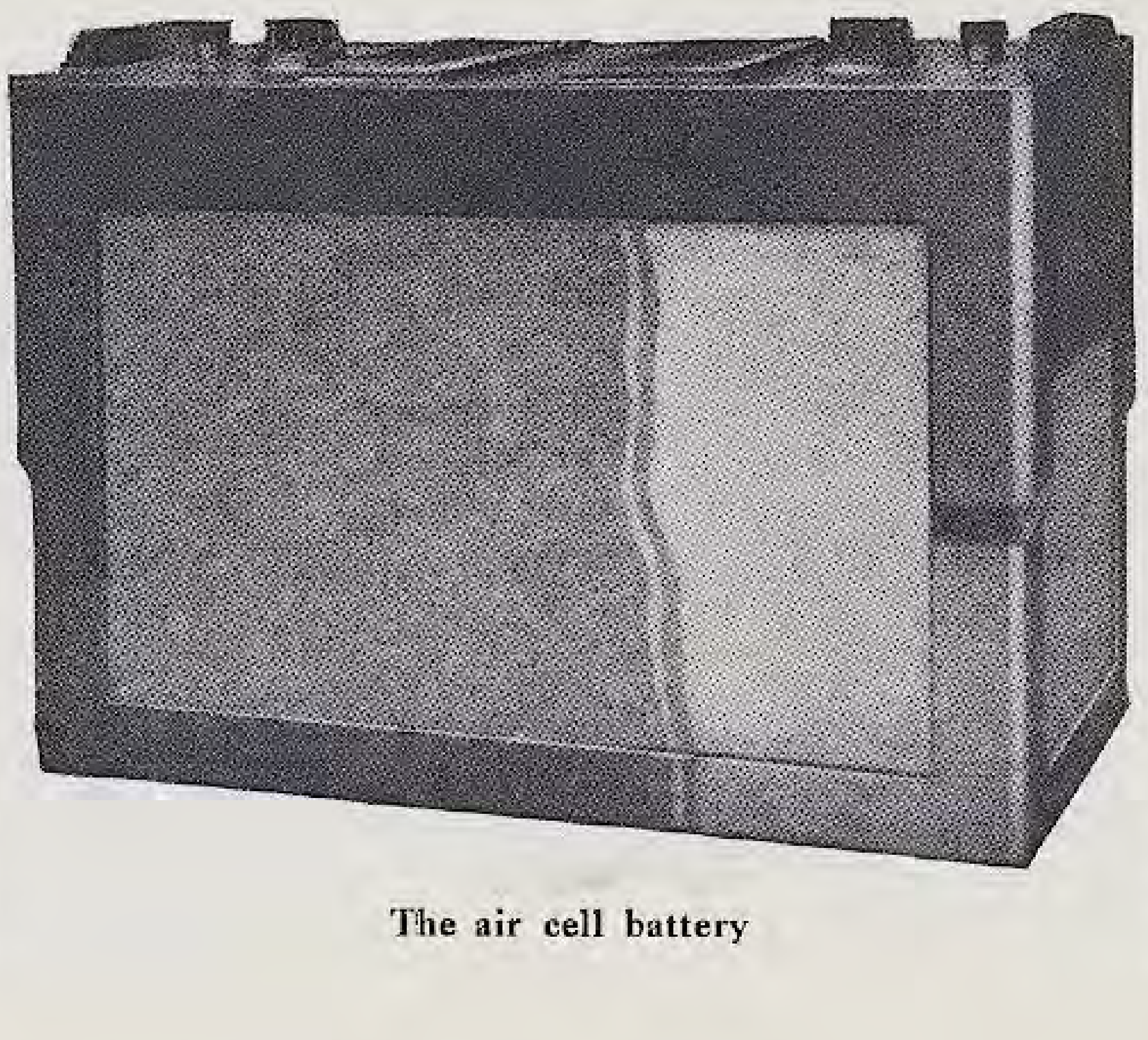
### *New Tubes and Battery*

About the same time there appeared on the market a series of new tubes designed to have extremely low filament current consumption and for use with a new type of "A" battery known as the "Air Cell". In co-operation with the tube and battery engineers at the Cleveland laboratories of the National Carbon Company, Robert S. Kruse and Dana Bacon collaborating with other engineers of the National Company have evolved the battery model of the SW5 Thrill Box, which, at the time of this writing, is still the only short wave receiver to bear the endorsement and approval of the National Carbon Company, manufacturers of the new Eveready "Air Cell".

This new model is equal in general overall performance to its A.C. predecessor and, in addition, has the advantage of higher power output than the original A.C. model which used the 227 tubes in push-pull amplification. This higher audio output is obtained as a result of the use of two of the UX-231 power tubes in a push-pull audio circuit. Consequently, very fine tone quality is obtained on short wave broadcast reception without in any way impairing the performance of the receiver for communication and experimental purposes.

### *Battery Model*

It is this battery model that has proven so popular with many of the exploration parties and expeditions to far lands during the past year, the majority of them using this receiver for all their communication work. These sets are also well suited for use on shipboard, in summer camps, and in foreign countries where the standard 110 volt 60 cycle A.C. current supply is not available.



The air cell battery

As the design of this receiver parallels that of the A.C. model very closely, the following account of some of the problems encountered in the des.gn of both receivers and not fully covered in the preceding pages, may be fittingly told at this time.

### *"Selectivity Before Gain"*

It is practically self-evident that good sensitivity and good selectivity cannot be combined unless one uses tuning ahead of the first tube in the set—that is to say, "selectivity before gain." Should anyone be in doubt it is only necessary to recall that a few years since we had broadcast receivers with such "untuned inputs," "coupler tubes" and the like, but that now we have gone to the opposite extreme and invariably put one, two, and even three tuned circuits ahead of the first tube. The only reason broadcast receivers ever tolerated the coupling tube was that it was considered "impossible to produce alignment of the first circuit with the rest becaue of the association of the first circuit with the antenna." As soon as this was discovered to be a mere superstition all manufacturers dropped the coupling tube in a moment. Why not? Has it any advantages whatever?

Similarly the short-wave receiver has stuck to the "coupling tube" idea because it is "impossible to—" and so on. Some consideration of this belief suggested that it was not altogether sound; indeed, the suspicion arose that it was probably not more than 2 or 2½ times as difficult as in the usual broadcast receiver. The ganging problem was accordingly attacked as the heart of the matter. Experiments soon confirmed the suspicion that satisfactory ganging could not be expected from cut-down broadcast condensers. A smaller, more rigid tuning condenser was devised, with due attention to avoidance of all wiping contacts. Some details of the construction were discussed in the June paper referred to above.

Having found the new tuning gang to maintain alignment it was necessary next to assure the permanence of the coils. This is a thing not quite as simple as it sounds. From the standpoint of mechanical solidity it was desirable to wind the wire in threads, cut in a molded bakelite form. A very few tests confirmed the previous experience that such a coil is very bad at short waves. There remained the choice of using some sort of a skeletonized or ribbed coil-spool or else going to a better high-frequency material for a threaded spool. It was known from previous work that a good low-loss ribbed spool can be made of black bakelite, but in the present set such a spool would not answer because the wire is supported at the ribs only and can therefore shift slightly during the handling of the coils. This shifting produces alterations of inductance and "raises hob" in a single-control set—though quite harmless in a multi-control one. The coils were therefore wound in cut (not moulded) threads in spools made of a special bakelite called "R-29". This is a product of Radio Frequency Laboratories and has in several instances been found to hold the solution to a knotty problem.

The use of a 4-prong coil form to fit the standard UX socket, or a 5-prong socket like the UY standard, was very attractive but was abandoned in favor of a special 6-prong socket which permitted complete independence of the three windings which appear on each coil form. This independence permits two major advantages. One is avoidance of detector grid-blocking and the other is the ganging trick first described in detail in an earlier part of this article.

## *Method of Ganging*

The method of ganging with these coils depends on their winding arrangement. The heavy-wire winding is spaced to occupy a length about equal to its diameter. This is not quite the best theoretical form but is one which is conveniently maintained for all the coils of the series, while at the same time it is not far from the ideal. This heavy-wire winding is used as the secondary, regardless of the position in which the coil is used. Putting it differently, the heavy-wire winding is always the tuned winding which feeds the next grid—whether that be the r.f. tube or the detector. "Inter-wound" with heavy-wire winding is a primary winding of fine wire. This winding has 66% as many turns as the secondary. This ratio gives almost all of the r.f. gain which would be obtained with a primary having as many turns as the secondary. At the same time it does not transfer as much capacity from the plate circuit into the next tuned circuit (grid circuit), where it is not wanted. There are several reasons why it is desirable to keep this capacity-transferring action down. One is that the capacity is not exactly the same for all tubes and will therefore change slightly when the tubes are changed, thus tending to disturb the calibration or "logging" of the set. Another reason is that the plate-circuit capacity is—for one particular tube—a fixed capacity, and if this capacity is "transformed over" into the secondary one has the effect of a small fixed condenser shunted across the tuning condenser. This is bad, because one must then increase the size of the tuning condenser quite coniderably to preserve the same tuning range. Incidentally, also, the power factor and selectivity of the tuned circuit suffer if the primary has more turns than the 2-to-3 proportion just mentioned.

The third winding on the form is close-wound of small silk-covered wire in a narrow groove at the lower end of the spool. It is normally used as the detector tickler. Because of the high gain of the type of detector employed this tickler has fewer turns than is usually specified for short-wave circuits.

## *Circuit Alignment*

It has been customary in short-wave receivers to use two types of coils, the antenna-coupler or r.f. input coils being without ticklers and having provision for coupling in the antenna through an antenna winding or a small condenser. It was decided in this case to avoid the condenser-coupling method for the double reason that it tends to cause severe mistuning and that noises, especially power-line noises, appear to be somewhat more severe with such an input than with an antenna coil. A variable condenser in series with the antenna does not provide proper compensation when the antenna is inductively coupled, the series condenser having to be reset with almost every change in tuning. It therefore amounts to another tuning control and spoils the single control feature entirely. A "vernier" condenser connected across tuning condenser will give fairly good compensation but will *not quite* maintain alignment across the tuning scale. The reason for this may be stated as follows: At one particular dial setting it is possible to produce exactly the same effect with a secondary-shunt capacity as with a primary-shunt capacity, but this statement does not hold exactly if the tuning is changed, unless the coupling is made exceedingly tight. Since it was stated above that the primary-secondary coupling was intentionally not made too tight, one may see that complete compensation must be done in the *same* circuit of the r.f. and detector coils.

This leads to the arrangement shown in the finally accepted circuit, Fig. 1.

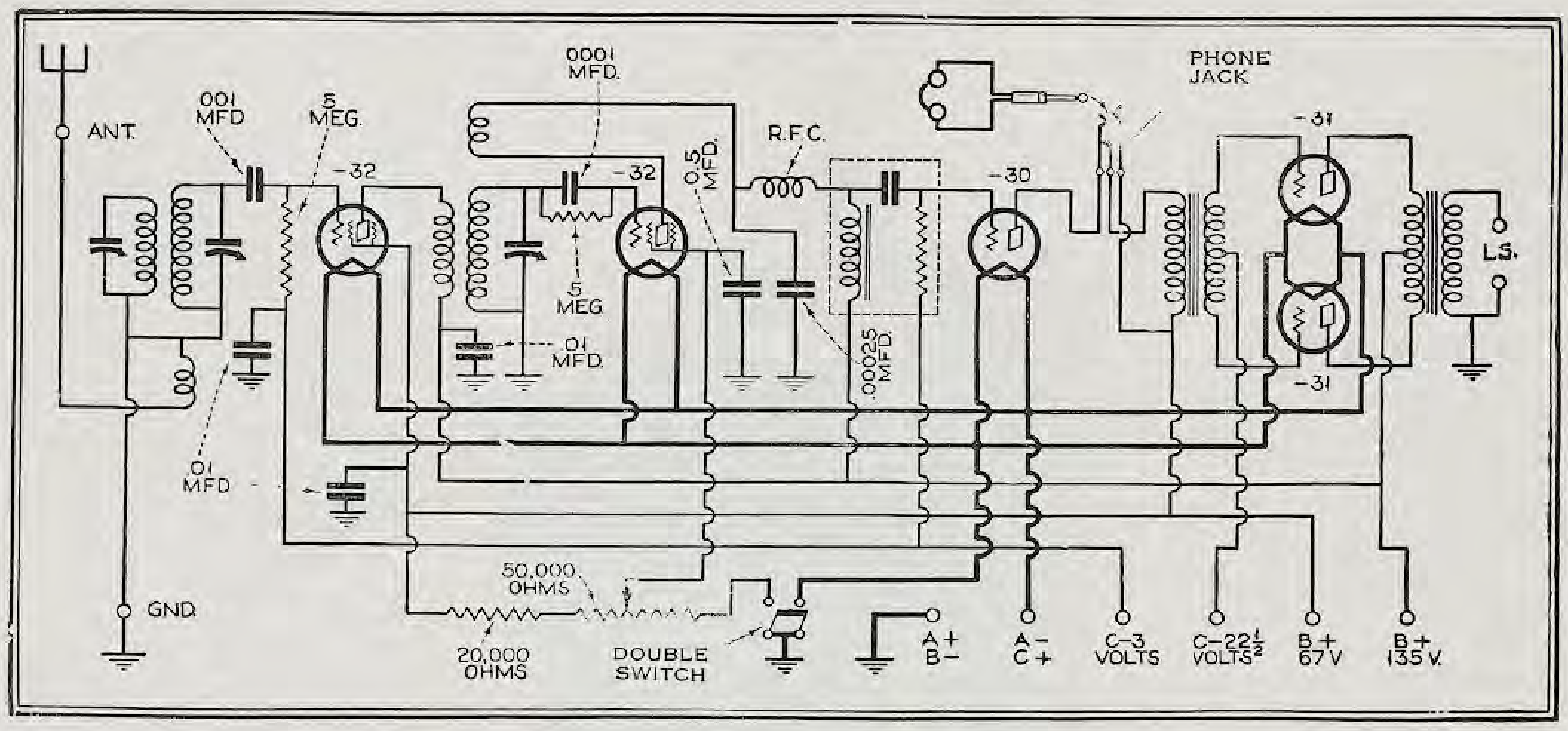
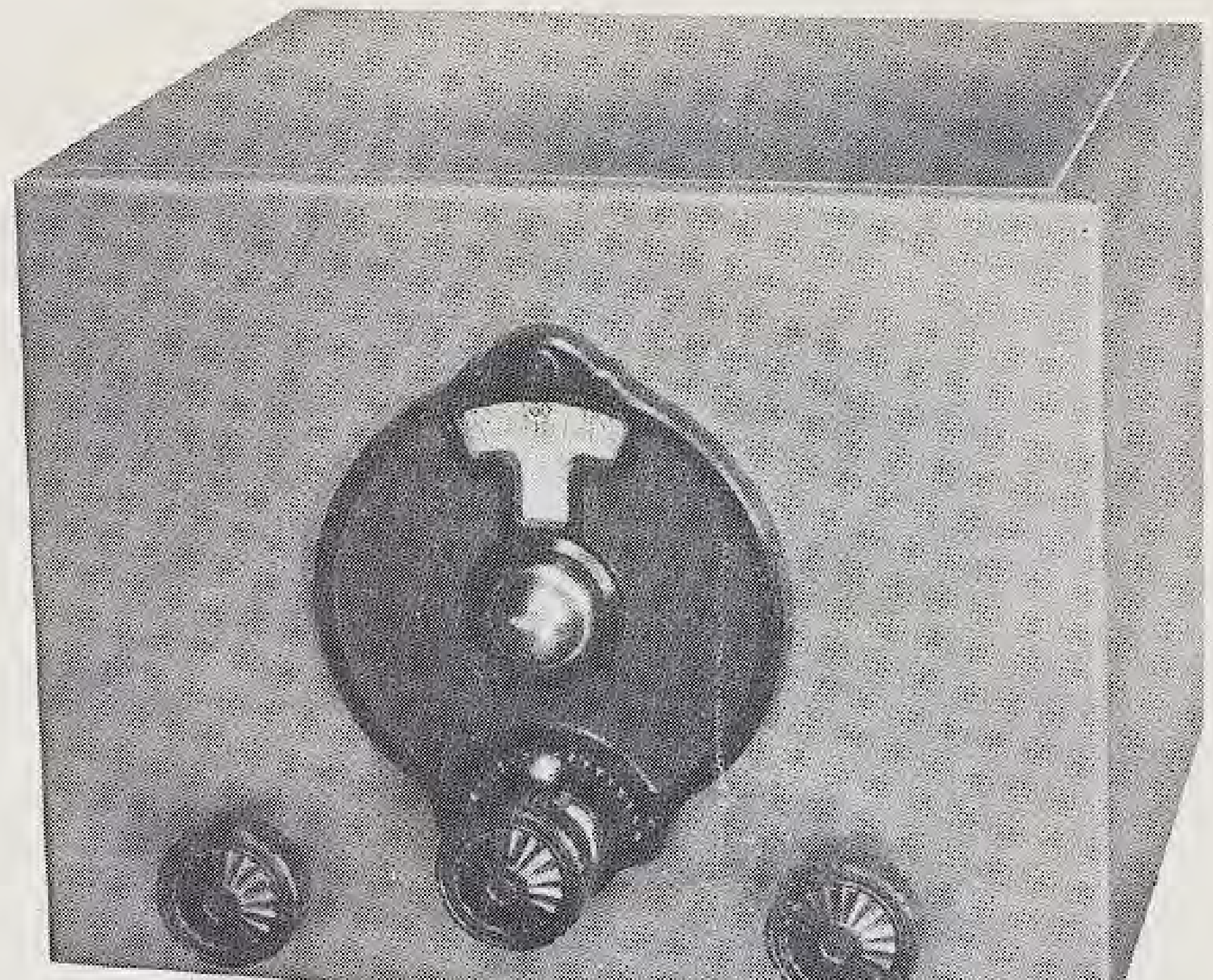



**Fig. 1, the complete circuit. In the antenna circuit we have the r.f. transformer with both primary and secondary shunted by variable condensers. That across the secondary S1 may be termed C1. In the detector circuit the variable condenser termed C2 is shunting the secondary, which we will term S2. Explanation of these two circuits and how they are ganged is contained in the text**

# *Special Tubes Contribute* to the Efficiency of the



# Latest Thrill Box—*the* SW3

## A.C. and 6-Volt D.C. Models

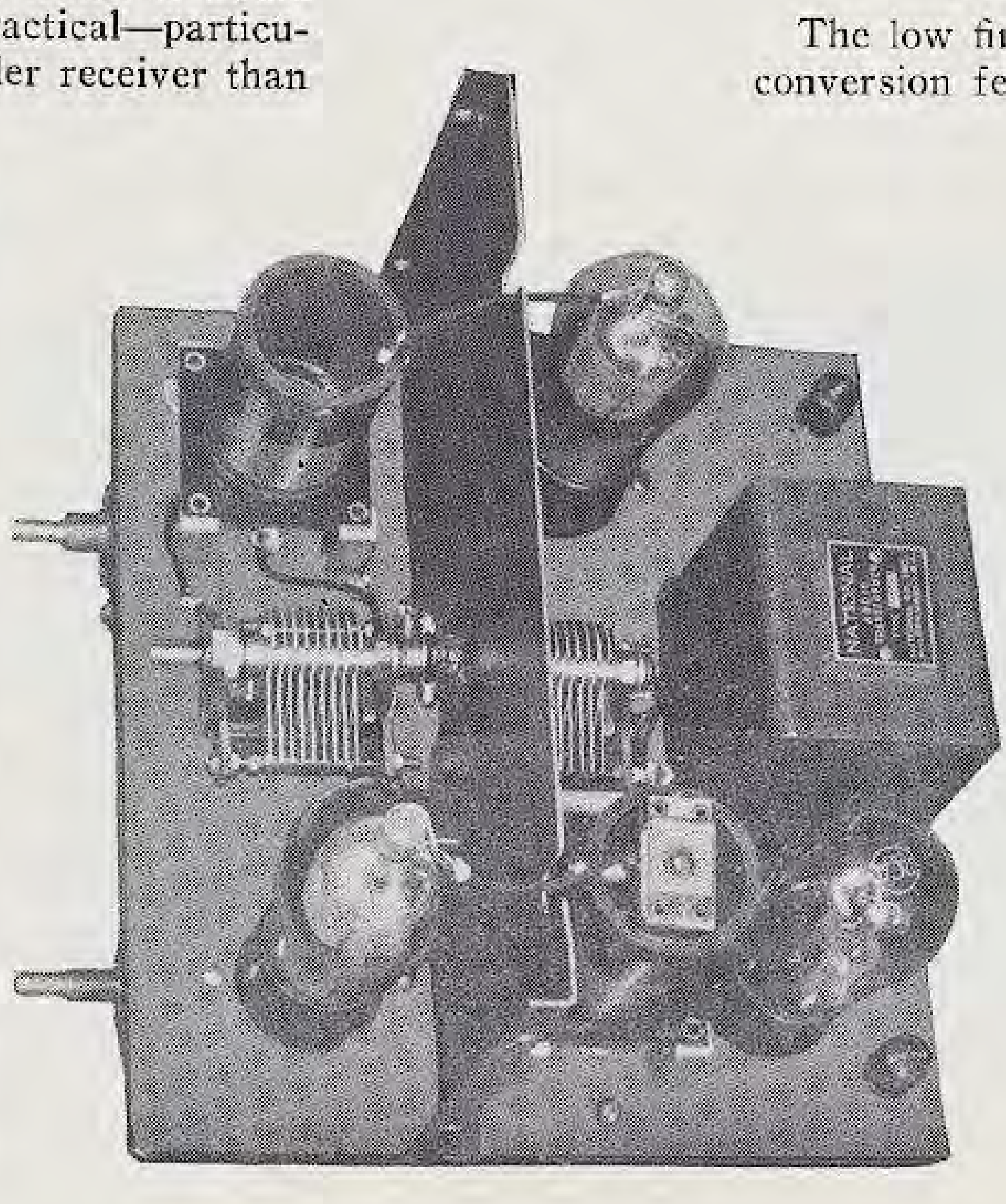
*The SW3 Thrill Box employs the same circuit, and all other essential features, as the famous SW5, except for a more compact layout and the elimination of the last or push-pull audio stage. It is designed especially for aircraft, portable, and amateur communication use*

THE sensitivity of the SW5 is so great that the push-pull stage is seldom, if ever, used when the receiver is being employed in amateur communication work or by expeditions for maintaining contact with their base stations.

There are also many places in which it would be much more convenient and practical—particularly in aircraft—to have a smaller receiver than the SW5 Thrill Box without any sacrifice in operating efficiency, and for these purposes the SW3 fills a long felt want.

### *A Universal Model*

By taking advantage of the new 6-volt battery type tubes, primarily for automobile radio use, it has been possible to so design the new receiver as to have a universal model that will work from either batteries or the NATIONAL No. 5880 Power Pack. All that is necessary is to use the special battery tubes when running on batteries and the standard A.C. tubes, plugged into the same sockets, when running on A.C. with the Power Pack. This feature makes it readily possible to operate the same receiver from batteries when used on a boat, in an airplane, or wherever A.C. is not available, and from A.C. when more convenient.



### *Ideal Amateur Receiver*

The low first cost, as well as the D.C. to A.C. conversion feature, makes this new receiver particularly well suited for amateur use, the first investment covering the receiver alone and a later investment the power pack equipment for converting it from batter to A.C. operation.

When being used for amateur work, it is only necessary to secure the three sets of special band-spread coils (the SW3 uses the same coils as the SW5) in order to secure advantageous operation over all of the standard amateur wavelengths.

The NATIONAL Type "C" Velvet Vernier Dial is employed in order to permit logging directly on the dial itself, a feature highly prized by many commercial as well as amateur operators.

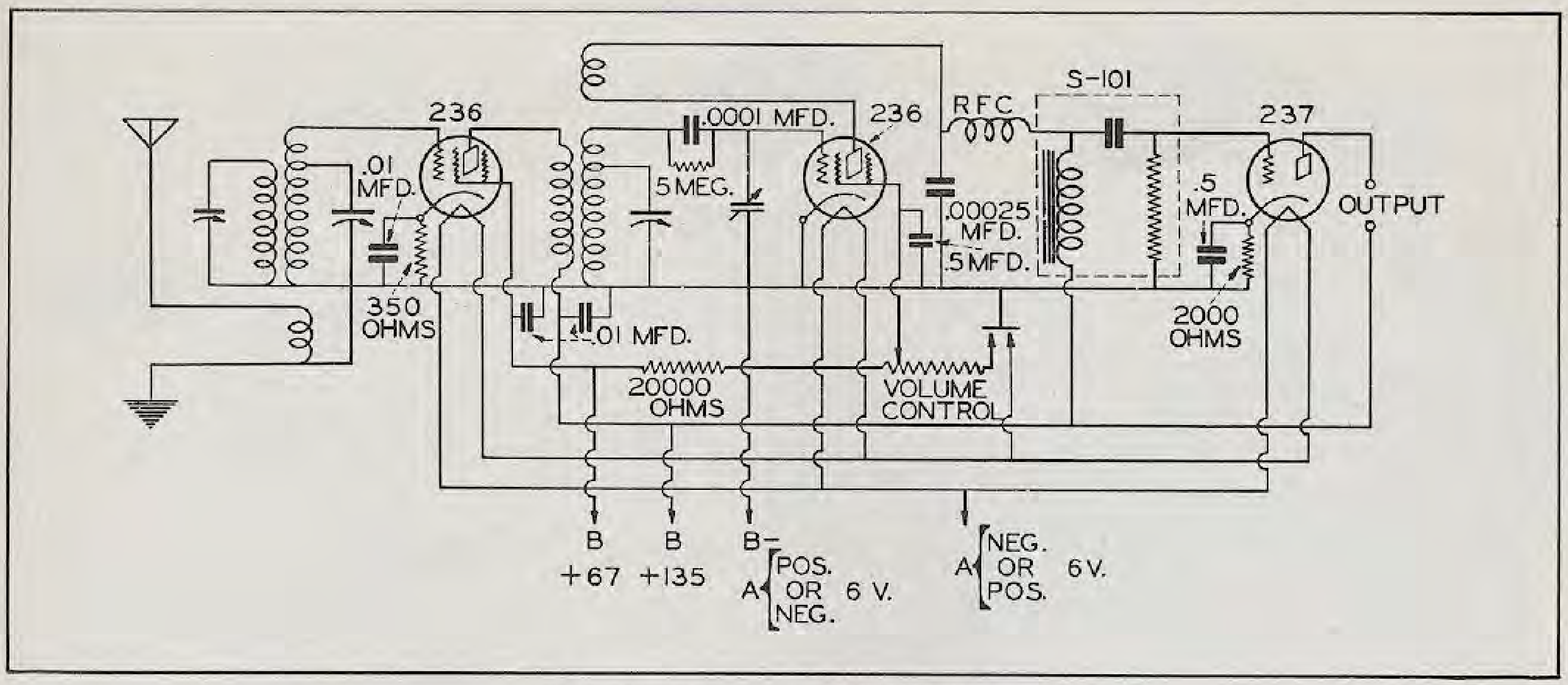



Fig. 1. Circuit diagram of SW3 Thrill Box

The 90 mmf. Straight Frequency Line 270° short wave tuning condensers are mounted in tandem directly behind the Type "C" Velvet Vernier dial and connected together by means of an insulated flexible coupling. Between these two condensers is located the shield partition. This shielding is of extreme importance and unless it makes good contact with both the sub-panel and the side of the cabinet will not be serving its proper purpose. There will be no doubt in the mind of the operator on this point, since unless this shield is properly grounded the R.F. tube will oscillate.

### *Tube Shields*

Due to the arrangement of the various components, it has been possible to eliminate any necessity for tube shields as the shield partition effectively accomplishes the same purpose. It will be noticed from the photographs how this shield runs between the two screen-grid tubes and their associated electrical circuits.

The circuit employed in the compact SW3 Thrill Box is, as will be seen from Fig. 1, identical with that of the SW5 except for the last audio stage and the type of tubes employed.

### *Battery Model*

The battery model uses the UY- tubes in the R.F. and detector sockets and UY- in the first audio socket. These new tubes have the standard 5-prong UY base and are of the indirectly heated cathode type.

In physical size the tubes are considerably smaller than the regular A.C. tubes but in the design of the SW3 this feature was not utilized to further decrease the physical dimensions of the receiver, the size being retained to make possible the inclusion of A.C. tubes for A.C. operation of this same unit.

# *Radio Time The World Over*

**TIME AND DAY CONVERSION TABLE**

| Longitude | Place | TODAY | | | | | | | | | | | | | | TOMORROW | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EAST 180 | Fiji Islands | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 165 | New Zealand (*) | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 150 | Australia, east | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 135 | Japan | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 120 | China, Philippines | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 105 | Indo China, Straits Settlements | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| 90 | Calcutta (**) | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 0 | 1 | 2 | 3 | 4 | 5 |
| 75 | | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 0 | 1 | 2 | 3 | 4 |
| 60 | Mauritus, Seychelles | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 0 | 1 | 2 | 3 |
| 45 | Aden, Somaliland, Madagascar | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 0 | 1 | 2 |
| 30 | South Africa | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 0 | 1 |
| 15 | Germany, Italy, Norway, Sweden | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 0 |
| 0 | England, France, G.M.T. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 |
| 15 | | 23 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 |
| 30 | | 22 | 23 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
| 45 | Brazil, east | 21 | 22 | 23 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| 60 | Agentina, Porto Rico | 20 | 21 | 22 | 23 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| 75 | Washington, D. C., E.S.T. | 19 | 20 | 21 | 22 | 23 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| 90 | Chicago, C.S.T. | 18 | 19 | 20 | 21 | 22 | 23 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
| 105 | Denver, M.S.T. | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| 120 | San Francisco, P.S.T. | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 18 | 14 | 15 |
| 135 | | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 150 | Alaska | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| 165 | Samoa, Hawaii (***) | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| WEST 180 | | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| | | YESTERDAY | | | | | | | | | | | | | | | | | TODAY | | | | | | |

NOTES:—(*) Add one-half hour for New Zealand Time.
(**) Calcutta local time. Subtract one-half hour for India Standard Time.
(***) Subtract one-half hour for Hawaiian Standard Time.

NOTES:—0 is midnight, 1 is 1.00 A.M., etc. 12 is noon, 13 is 1.00 P.M., 15 is 3.00 P.M., etc.
Read the figure columns vertically, thus:—when it is 12, noon on Monday in New York E.S.T., it is 3.00 A.M. on Tuesday in Melbourne, Australia.
Or again; 11.00 P.M. on Sunday in San Francisco is 6.30 P.M. on Monday in New Zealand and 5.00 P.M. in Australia.
The hours of darkness—6 P.M. to 6 A.M. are shaded

# *Television* and Short Waves

*Very little apparatus is required in addition to a good short-wave receiver for viewing television programs which are now being transmitted daily by a number of stations*

THERE are some half dozen or more powerful short wave stations transmitting television signals on a regular daily schedule. All of these stations at present are operating in the general band of from 100 to 150 meters and may readily be picked up in almost any part of the country with a standard short wave receiver.

The operators of these different television stations, with few exceptions, have now gotten together and standardized on a method of transmission; namely, a 60 x 72 line picture transmitted at the rate of twenty pictures per second.

It therefore becomes practical for any experimenter, possessing a short wave receiver capable of picking up television signals, to obtain a scanning disc, motor, neon lamp, and associated paraphernalia, and secure visual reception. While the images received with such a layout will undoubtedly be lacking in entertainment value, they will, nevertheless, be quite recognizable and due to the number of different stations from which images may be obtained, considerable fun will be had by the experimenter who gets an early start in this new field.

The standard NATIONAL SW5 Thrill Box makes an excellent receiver for picking up television signals, particularly when the transmitter is some distance away, which permits the full value of the high sensitivity of this receiver to be utilized. Instead of connecting the output to a loudspeaker in the usual manner, it should be connected to the special amplifier-neon tube arrangement, the circuit diagram of which is given in Fig. 2. This is merely a combination power supply—power amplifier, capable of illuminating and modulating the standard neon lamp made for television use.

The NATIONAL COMPANY'S 60 x 72 element disc is a precision device developed primarily for laboratory work but ideally suited for the home experimenter. It is of aluminum, 24" in diameter by .062" in thickness, accurately machined and mounted on a large hub for installation on a ½" motor shaft. The light apertures are all of the NATIONAL square construction and counterbored to reduce angular distortion.

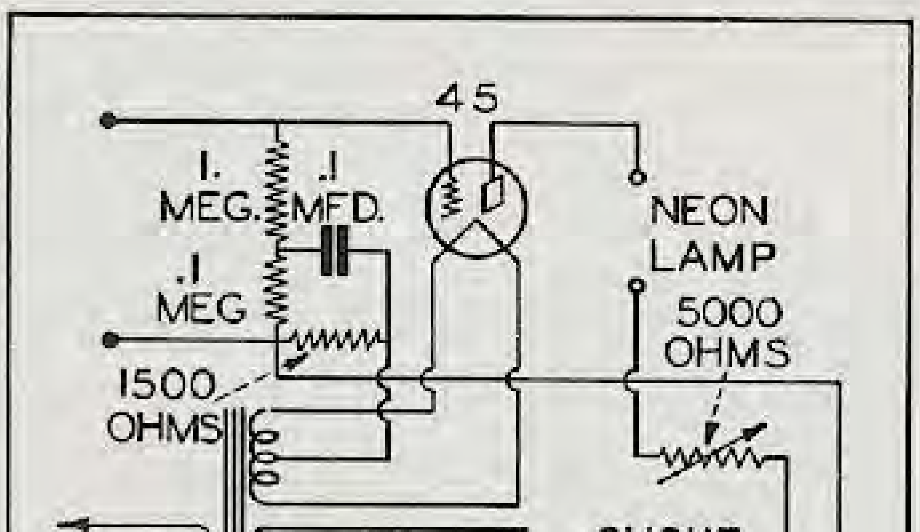



**Fig. 2. The circuit diagram of the special amplifier — neon lamp arrangement for viewing television transmissions picked up with the standard National SW5 Thrill Box**

Where the receiver is located within the same "power" district as the transmitter, then a 1/6 h.p. 1200 r.p.m. synchronous motor is recommended for driving the disc. Where the receiver is fed from a different power source than the transmitter, then a variable speed motor, such as the Baldor, should be employed. After a little practice in adjusting the speed controls, the picture can be held in synchronism for rather long periods without great difficulty.

While the use of any good short wave receiver capable of picking up the signal from a television transmitter will give fairly good results, it is to be recommended where best possible results are desired and the receiver is to be located from one to fifteen miles or so of the transmitter, that a receiver especially designed for the purpose be employed.

Such a receiver should employ no regeneration, a broadly tuned low-gain R.F., a detector capable of wide frequency band-pass, and an audio amplifier of the high-gain resistance coupled type with an output of at least two watts and a frequency range of from about 50 to 20,000 or even more if possible. Using such a receiver within one mile of the 800 watt N.B.C. television station WZXBS at Times Square, New York City, half-tones comparable in detail to those on this page were obtained, and friends appearing before the transmitter were instantly recognized.

When attempting to use a strictly "television" receiver at some distance from the transmitter, however, the results will generally not be as good as obtainable from the conventional sharply tuned regenerative short wave outfit due to lack of sufficient selectivity to cut out interference, lack of sensitivity and, even more impor-

| | | | |
|---|---|---|---|
| | | **2000-2100 Kilocycles** | |
| W3XK | 5,000 watts | Jenkins Laboratories | Wheaton, Md. |
| W2XCR | 5,000 " | Jenkins Television Corp. | New York, N. Y. (1) |
| W2XAP | 250 " | Jenkins Television Corp. | Portable |
| W2XCD | 5,000 " | DeForest Radio Company | Passaic, N. J. |
| W9XAO | 500 " | Western Television Corp. | Chicago, Ill. |
| W2XBU | 100 " | !Harold E. Smith | N. Beacon, N. Y. (*2) |
| | | **2100-2200 Kilocycles** | |
| W3XAK | 5,000 watts | National Broadcasting Co. | Portable |
| W3XAD | 500 " | R.C.A.-Victor Company | Camden, N. J. |
| W2XZS | 5,000 " | National Broadcasting Co. | New York, N. Y. |
| W2XCW | 20,000 " | General Elec. Co. | S. Schenectady, N. Y. |
| W8XAV | 20,000 " | Westinghouse Elec. & Mfg. | E. Pittsburgh, Pa. |
| W9XAP | 1,000 " | Chicago Daily News | Chicago, Ill. (3) |
| W2XR | 500 " | *Radio Pictures, Inc. | Long Island City, N. Y. |
| | | **2750-2850 Kilocycles** | |
| †W2XBO | 500 watts | United Research Corp. | Long Island City, N. Y. |
| W9XAA | 1,000 " | Chicago Federation of Labor | Chicago, Ill. |
| †W9XG | 1,500 " | Purdue University | W. Lafayette, Ind. |
| †W2XAB | 500 " | Atlantic Broadcasting Co. | New York, N. Y. (4) |
| | | **2850-2950 Kilocycles** | |
| W1XAV | 500 watts | Short Wave & Telev. Labs. | Boston, Mass. |
| W2XR | 500 " | Radio Pictures, Inc. | Long Island City, N. Y. |
| W9XR | 5,000 " | Great Lakes Broadcast'g Co. | Downers Grove, Ill. (5 |

(1) Operated in conjunction with WGBS.
(2) C.P. to move transmitter to Albany, N. Y., pending.
(3) Operated in conjunction with WMAQ, Chicago.
(4) To be operated by Columbia Broadcasting System in conjunction with WABC, New York City.
(5) Operated in conjunction with WENR; application pending for transfer to National Broadcasting Company.
! One hour daily (1 to 2 P.M.)
* Subject to operation between 5 and 7 P.M.; subject to shared operation after 10 P.M. and before 2 P.M. by agreement with other licensees within 150 miles of W2XR.
† Means construction permit; all others hold licenses.

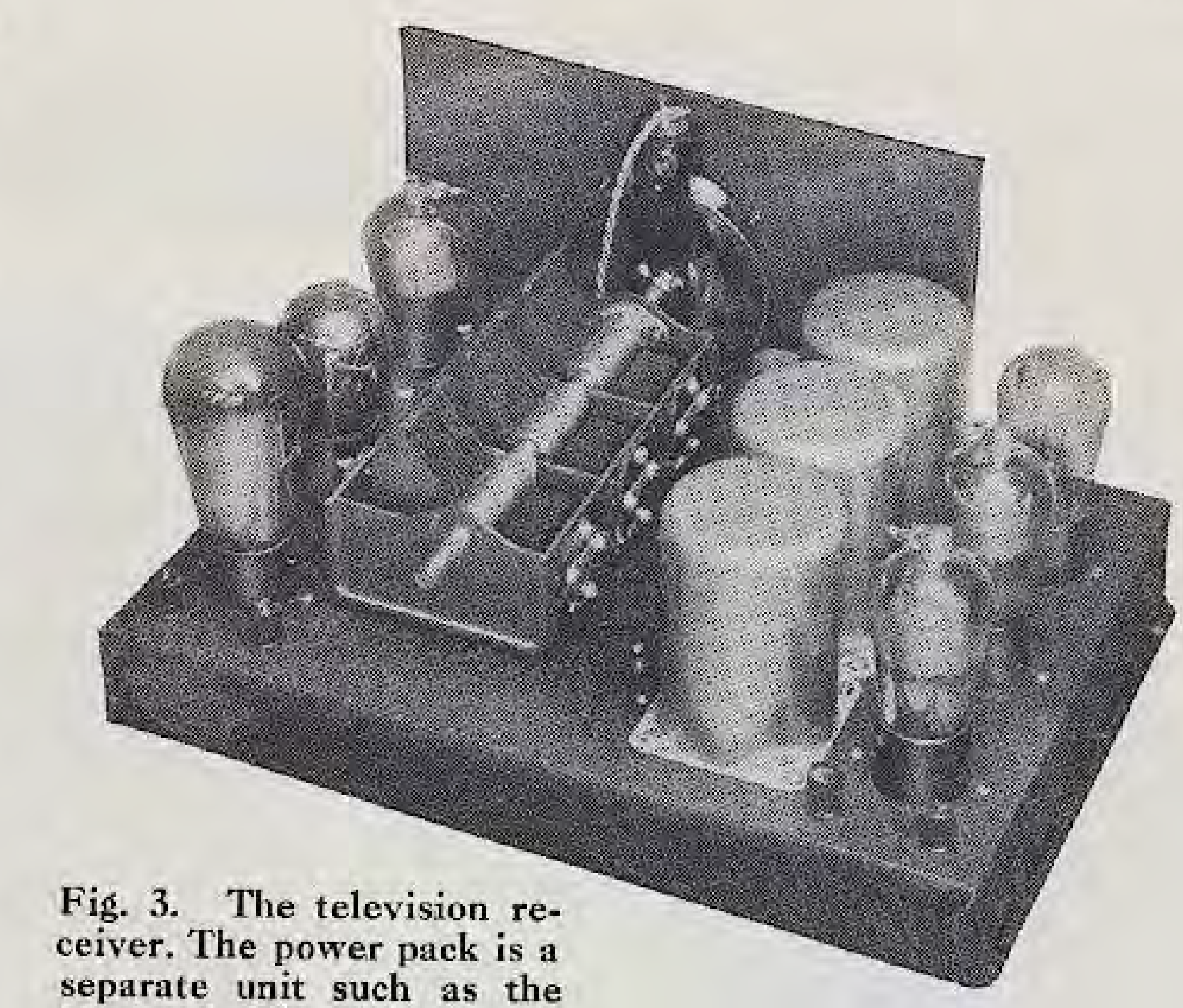


**Fig. 3. The television receiver. The power pack is a separate unit such as the National No. 4590 which also contains biasing resistors for -45 power tube**

tant, a high noise to signal ratio as a result of the wide frequency passing characteristic of the audio system. This noise is far more injurious to good picture detail than the exclusion of the higher audio frequencies resulting from the use of a transformer coupled audio system.

On this page is given the circuit diagram and a pictorial view of the type of "television" receiver outlined above and considered by the engineers of the different television stations now regularly on the air as best suited for "nearby" reception of their transmission.

By following the circuit data of Fig. 4 closely, no difficulty will be had by the average experimenter in constructing the complete receiver. All of the parts are standard except the R.F. coils and the sub-panel, which can be made by the constructor (study details in Figs. 3 and 4) or are obtained in special order from the National Company.

There are two good reasons for using a separate power unit. The first is performance—for in all short wave apparatus, and particularly television receivers, it is necessary to keep AC "hum" down to a minimum. This is most readily accomplished by locating the power transformer a few feet from the R.F. tuner. The second reason is cost:—Many experimenters (and television is, at this stage of the game for experimenters) already possess power supply units ample for the purpose. The only special requirements being an R.F. filter on the 280 rectifier, a good double section hum filter and the inclusion of the heater circuit centre tap resistor and the 1,500 ohm '45 biasing resistor directly in the power supply.

There are two controls on the panel, other than the tuning dial; one is the sensitivity or "volume" control, and the other, the plate voltage on the '45 control. By controlling the voltage on the '45 plate the brilliance of the neon lamp can be adjusted to give the best pictures.

### *List of Parts*

Metal chassis containing 6 sockets, binding posts and necessary mounting brackets; National type E Velvet Vernier Dial; National-Scovil 3 gong Variable Condenser (C1); National shielded R.F. transformers, set of 3 (T1 T2 T3) for television range; Lynch Fixed Resistors; 350 ohms 2 watt R1, 3, 8; 2,000 ohms 2 watts R14; 50,000 ohms 2 watt R11, 7, 13, 5, 9, 12; 5 megohms 1 watt R4; ¼ megohm 1 watt R6, 10, 15; .5 mfd.—C2, 5, 9, 11, 12; .01 mica—C8, 10, 13; .0002 mica—C6, 7; Aerovox Fixed Condensers; Variable Resistors—R2—50,000 ohms, R14—10,000 ohms (wire); National Voltage Divider; National R.F. Choke; Cable, plug, grid grips, wire, etc.; National Power Pack.

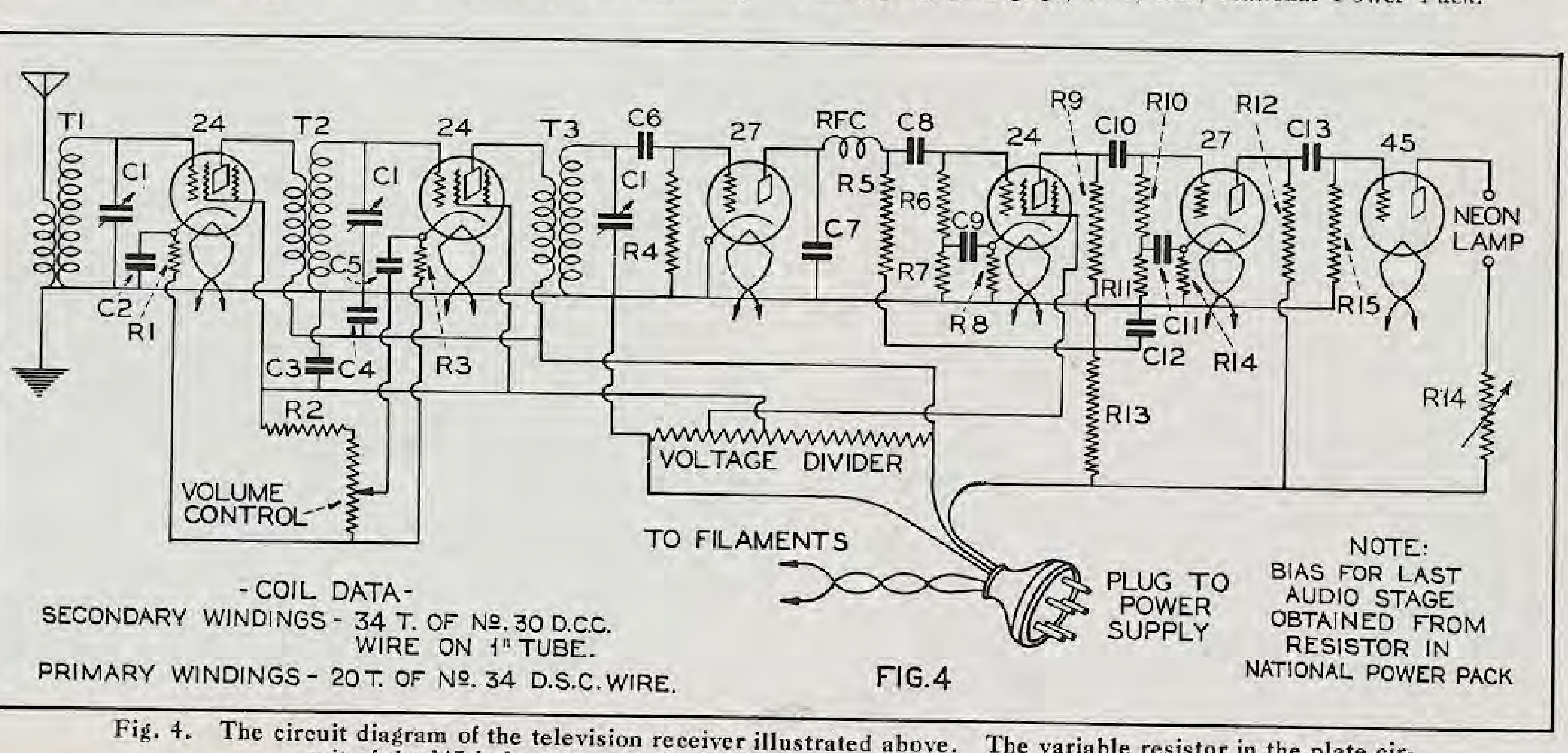
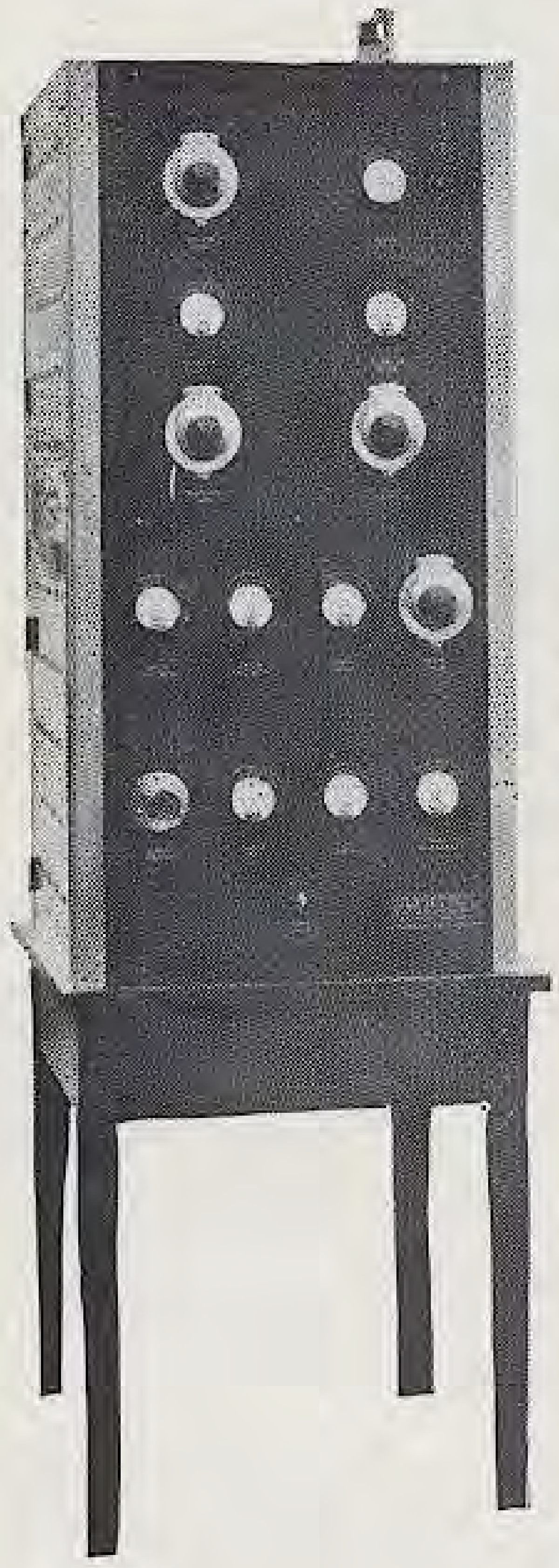
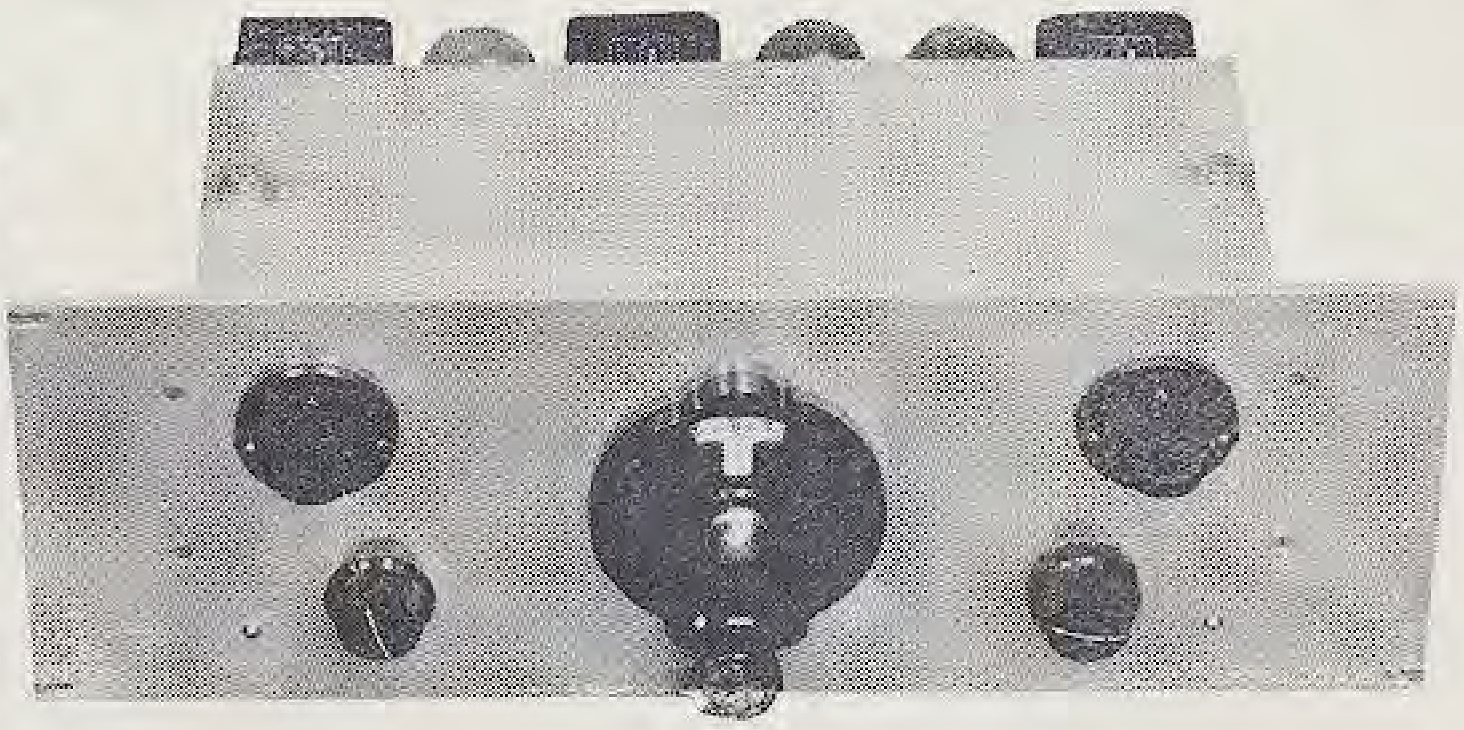



**Fig. 4. The circuit diagram of the television receiver illustrated above. The variable resistor in the plate circuit of the '45 is for adjusting the D.C. biasing current thru the neon glow lamp**

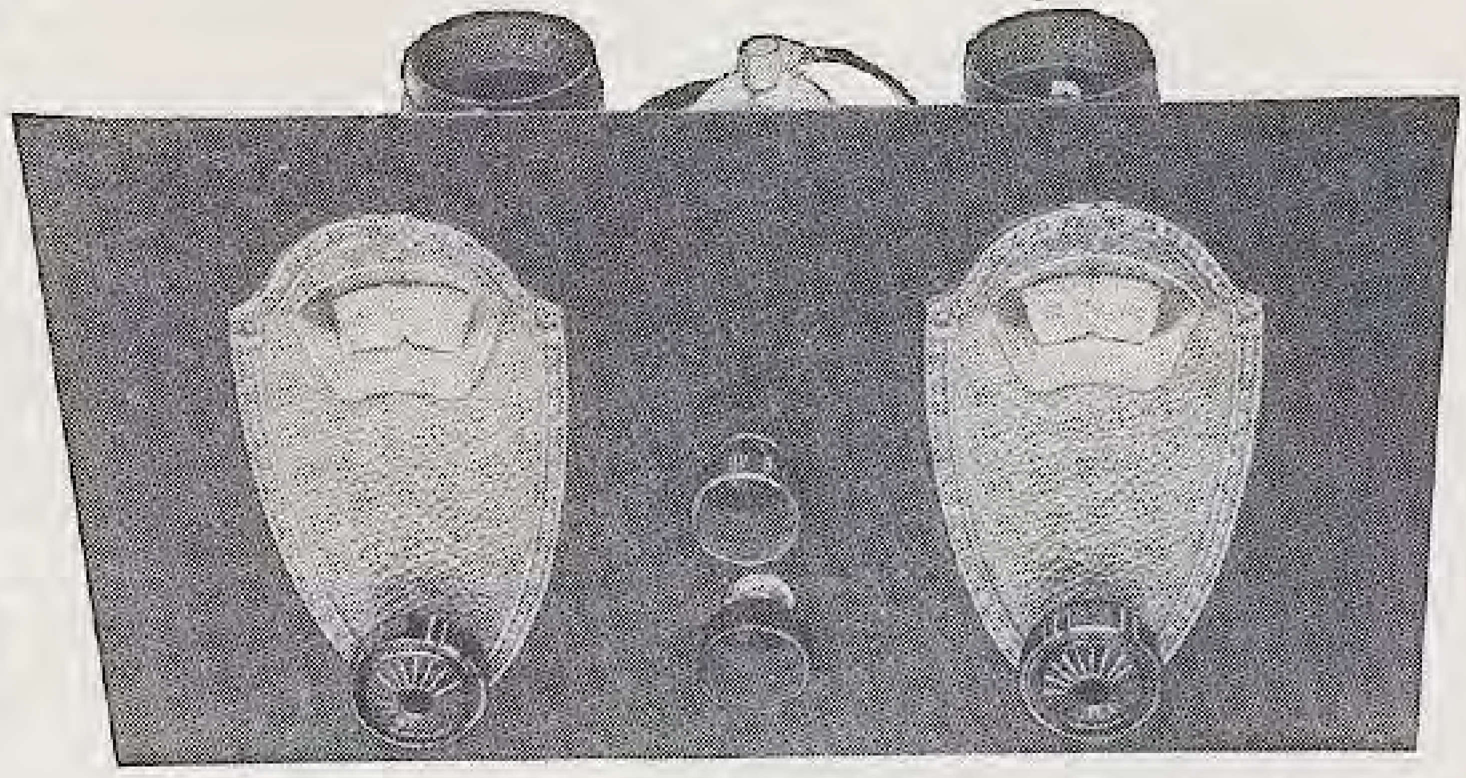
# *Famous Equipment*



At the right is a receiver employed by the Airways Division of the Department of Commerce



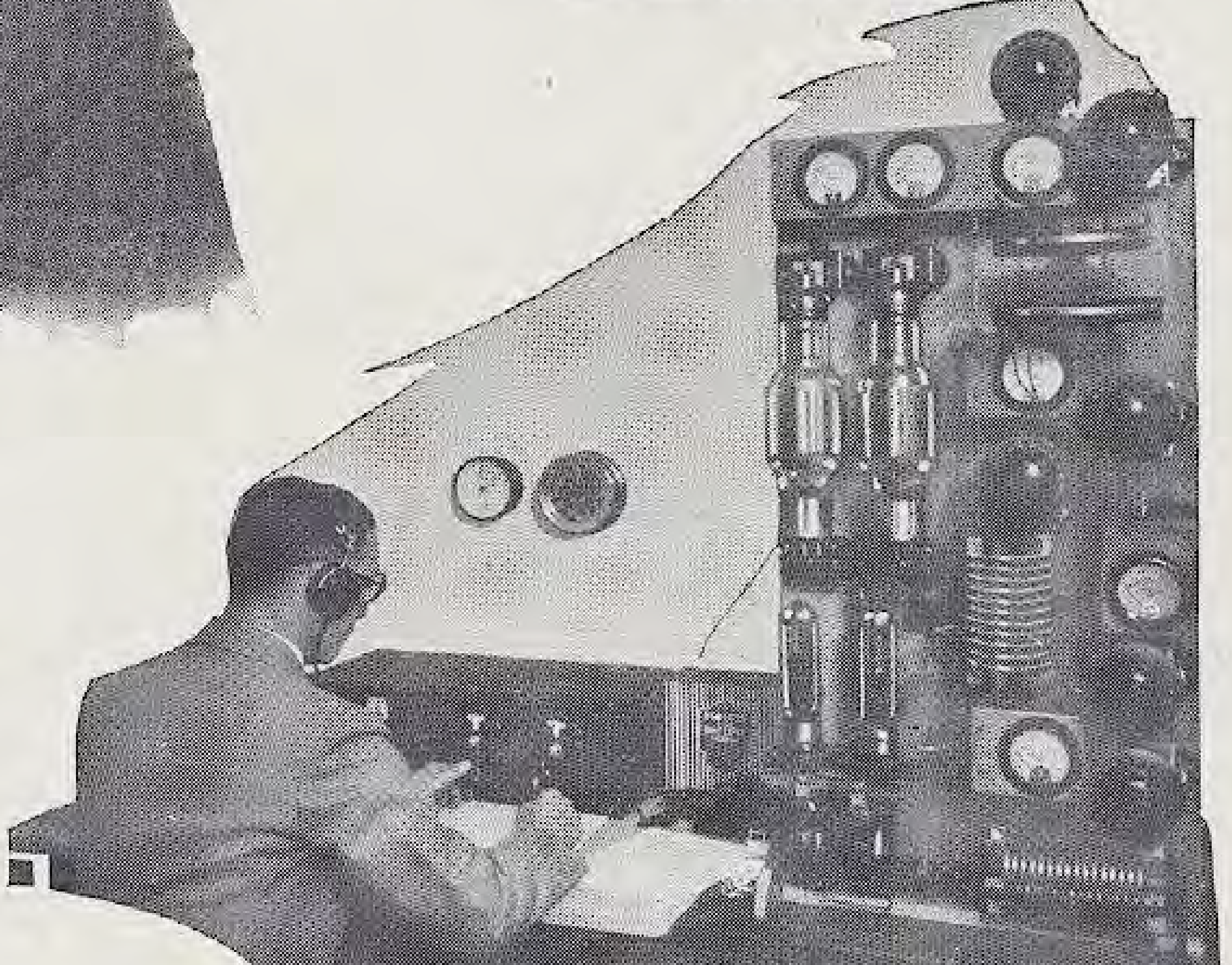
At the left is the front view of the 250 watt transmitter of the master control station NDS, Chicago, Illinois, of the Navy Volunteer Communication Reserve



The front view of the short-wave adapter illustrates its neat and compact assembly

Below is Thomas A. Marshall at the controls of his push-pull receiver. Mr. Marshall is Chief Radio Electrician of the U. S. Navy

Fred H. Schnell, famous radio amateur, is shown below at the controls of the Radio News "Short-Wave Super" in the operating room of his "ham" station W9UZ

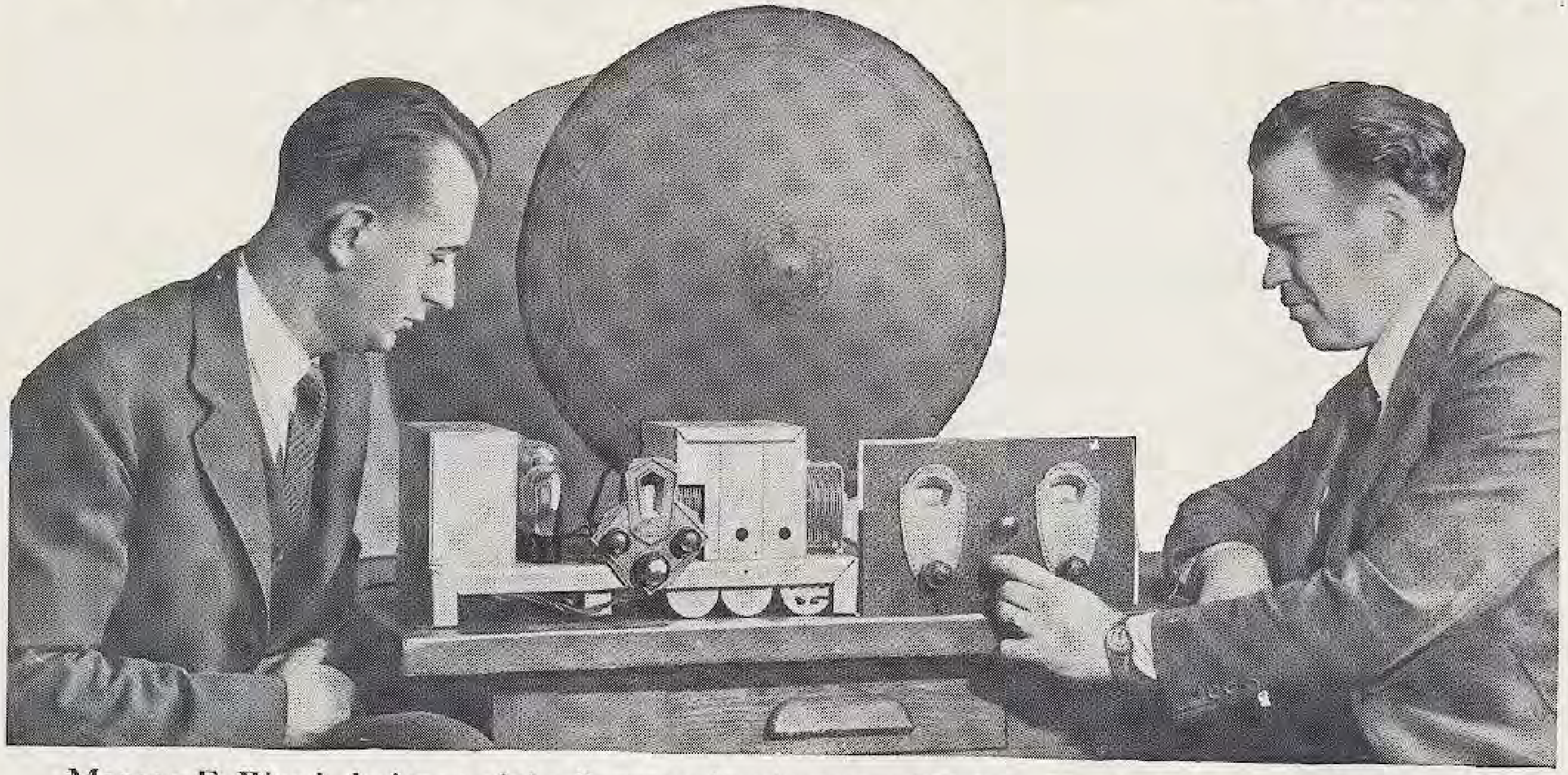


## Standard Model TM Transmitting Condensers

The NATIONAL Transmitting Condensers are widely used by the U. S. Government, broadcasting stations, communication companies and amateur transmitters, and are mechanically and electrically correct.

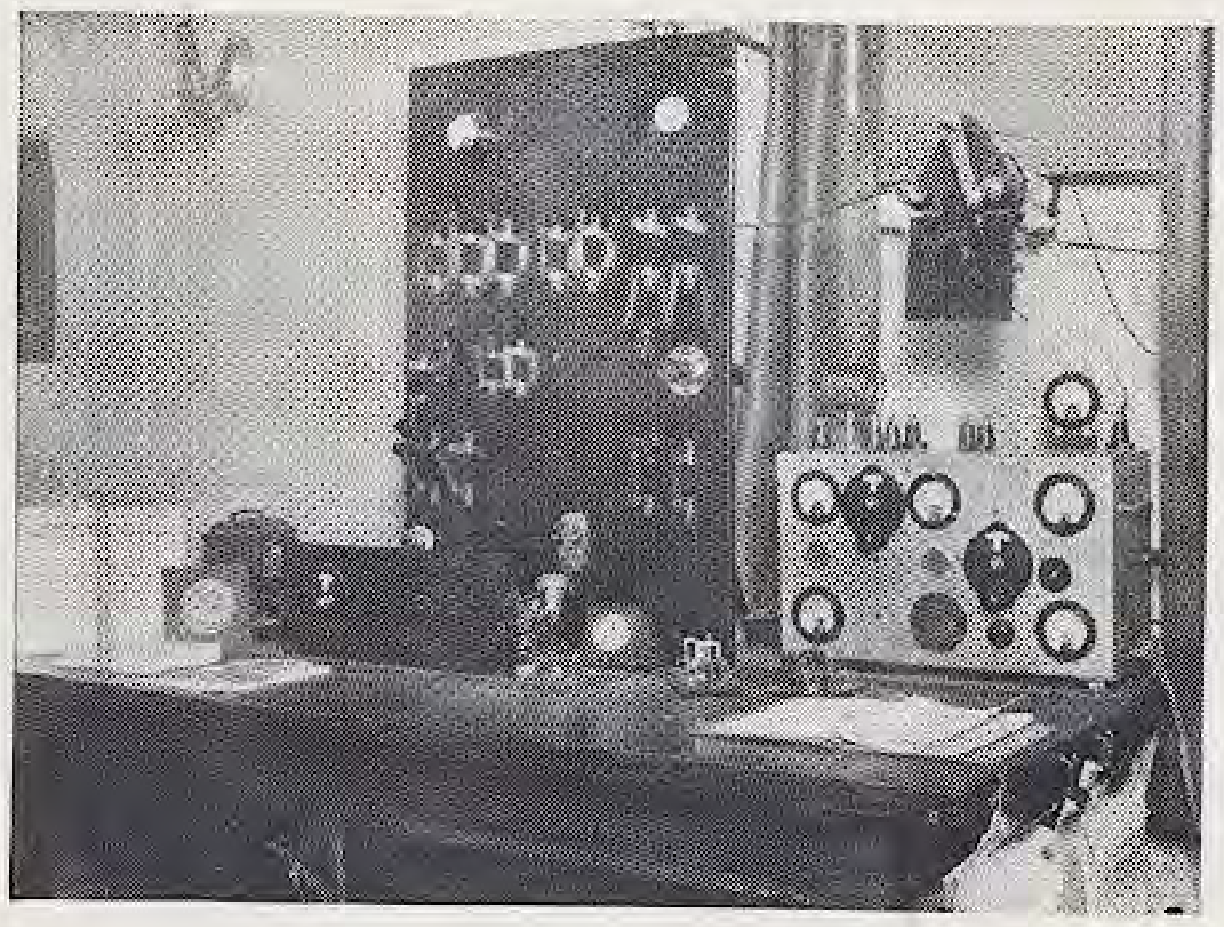
The condensers are supplied with either 3/16" or 3/8" spacing for high voltage work. Standard insulation for all the TM type condensers is crolite.

# *Using "National" Parts*



Manson E. Wood, designer of the Supersonic adapter, and Volney Hurd, shown operating the unit in conjunction with a standard broadcast receiver

At the right is shown the operating table of station W3CXL—the Army amateur net control station at Washington, D. C.



H. C. Leuteritz, Communications Engineer, with one of the Pan-American receivers

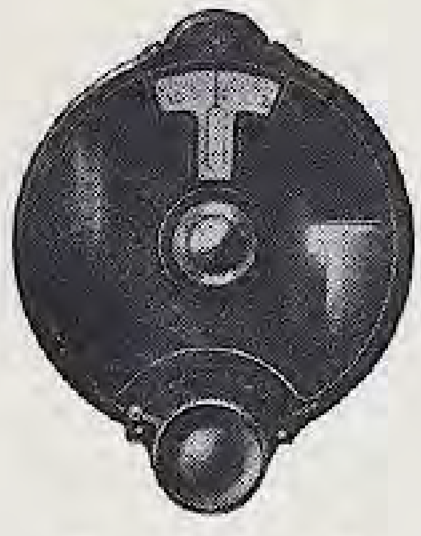
A prominent short-wave station, WHB, — owned and operated by the New York "Times"—is shown at the right

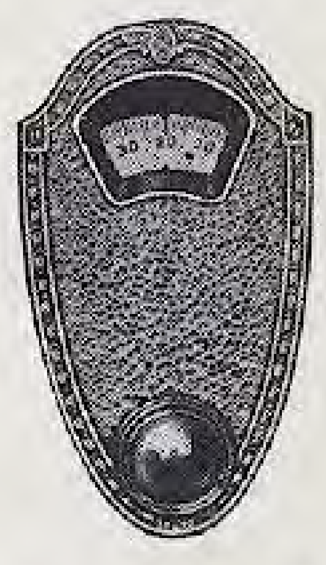
# Just a Few of the Standard

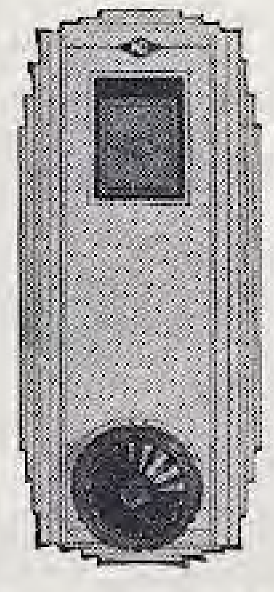
# NATIONAL Parts

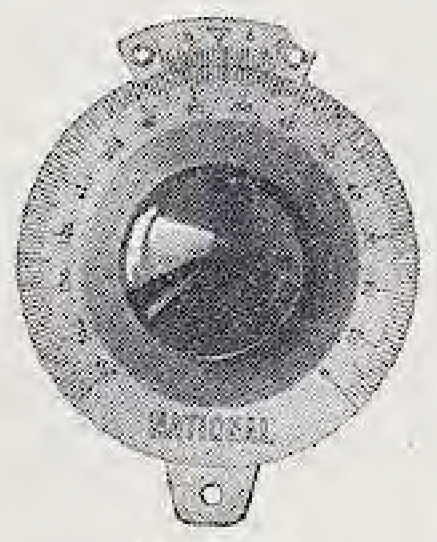
## *Developed Especially for S-W Use*

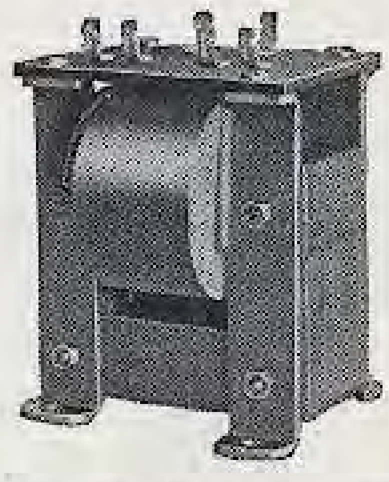

Type A


Types B and C

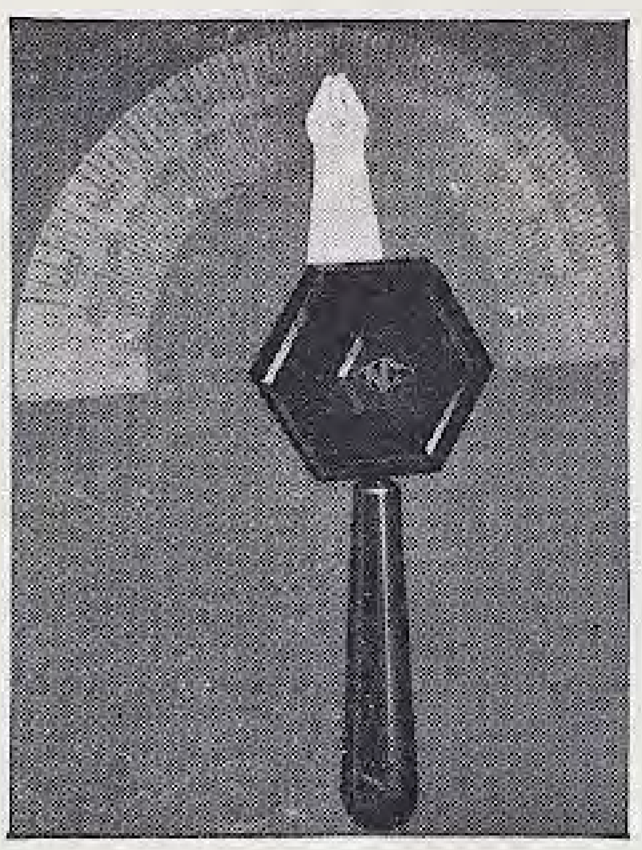

Types E and F


Types G and H

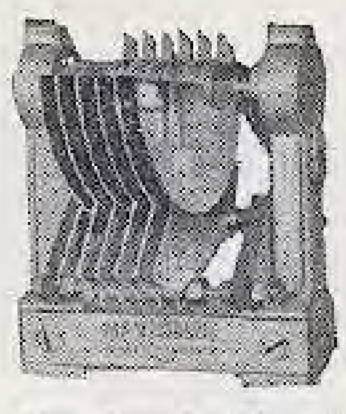

Type N

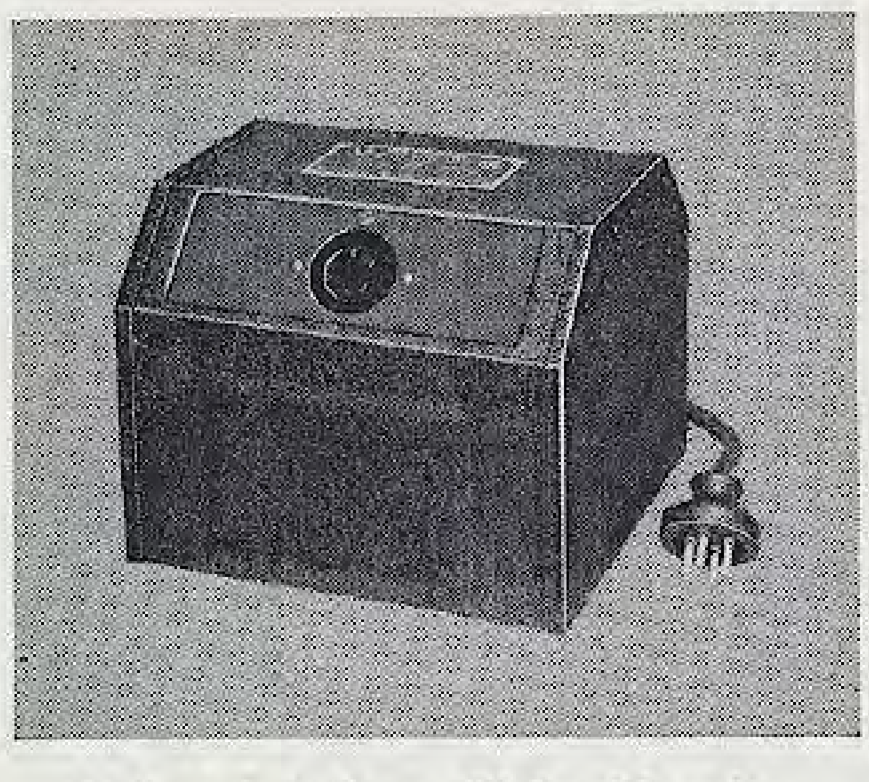

Power Transformer Type U

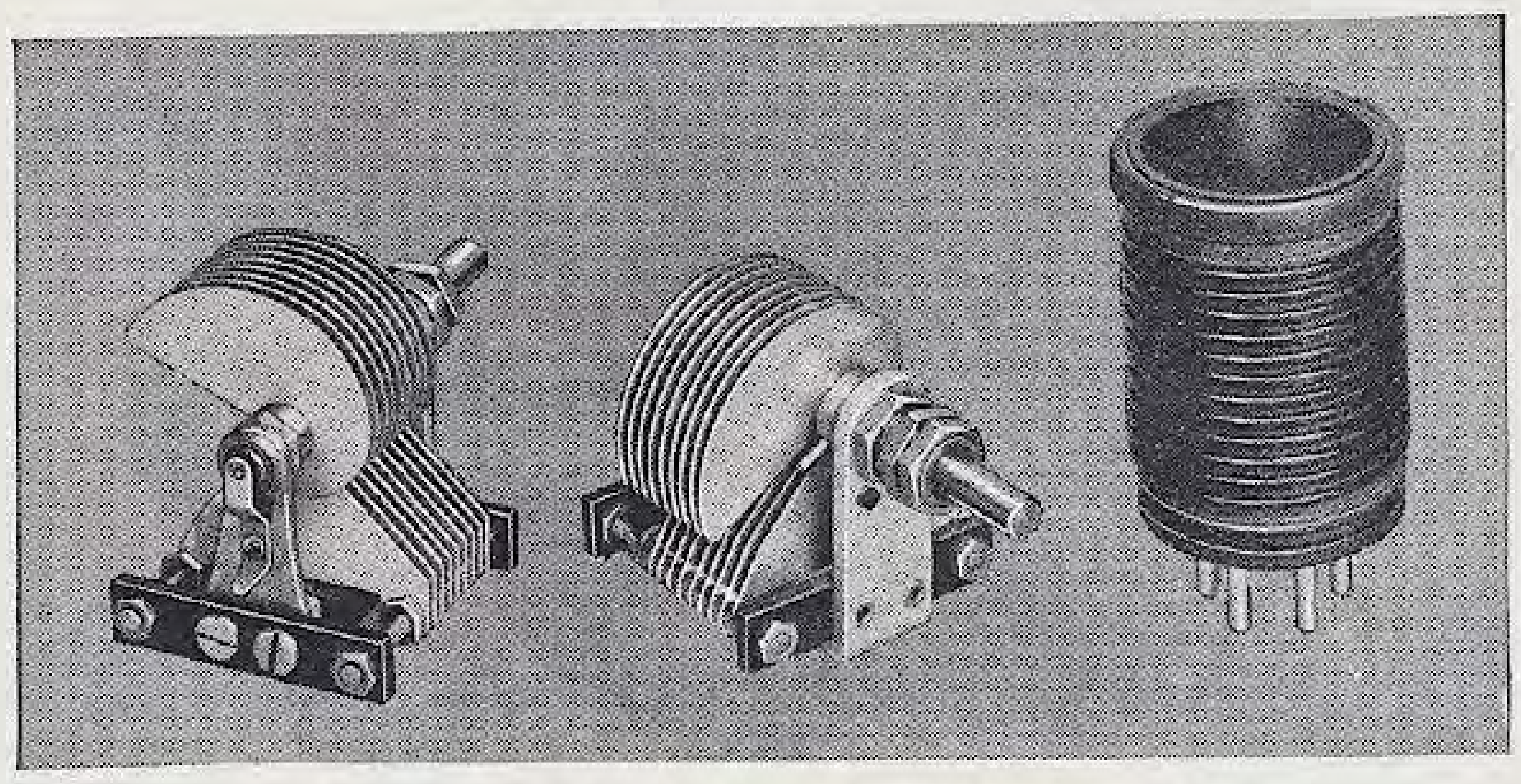

Velvetone Audio Transformer


No. J Indicator


Girder Frame Tuning Condenser


Equicycle Short Wave Condenser


Velvet A-B Power Units, Manufactured Under R.C.A. License


Precision Parts for Efficient Short Wave Receivers

SEND FOR COMPLETE CATALOGUE

# Short-Wave Broadcast Stations

## *Wave-Length, Frequency, Call Letters and Location*

| Wave-Length | Frequency | Call Letters | Location |
|---|---|---|---|
| 9.68 | 31,000 | W8XI | East Pittsburgh, Pa. |
| 13.05 | 23,000 | W2XAW | Schenectady, N. Y. |
| 14.01 | 21,400 | WLO | Ocean Township, N. J. |
| | | | Lawrence, N. J. |
| 14.15 | 21,130 | LSN | Monte Grande, Arg. |
| 14.50 | 20,680 | FSR | Paris, France |
| 14.62 | 20,500 | W9XF | Chicago, Ill. |
| 15.14 | 19,780 | WNI | Deal, N. J. |
| 15.50 | 19,400 | .... | Nancy, France |
| 15.55 | 19,300 | FTM | St. Assise, France |
| 15.57 | 19,250 | PPU | Rio de Janeiro, Brazil |
| 16.30 | 18,400 | PCK | Kootwijk, Holland |
| 16.35 | 18,350 | WMD | Deal Beach, N. J. |
| 16.38 | 18,310 | FZS | Saigon, Indo-China |
| 16.44 | 18,240 | FRO FRE | St. Assise, France |
| 16.52 | 18,150 | PMC | Bandoeng, Java |
| 16.80 | 17,850 | PLF | Bandoeng, Java |
| 16.87 | 17,780 | W8XK | East Pittsburgh, Pa. |
| 16.90 | 17,750 | HSITJ | Bangkok, Siam |
| 17.34 | 17,300 | W2XK | Schenectady, N. Y. |
| 17.52 | 17,110 | WOO | Deal, N. J. |
| 18.10 | 16,550 | G2AA | London, England |
| 18.37 | 16,320 | VLK | Sydney, Australia |
| 18.40 | 16,300 | PCL | Kootwijk, Holland |
| 18.50 | 16,200 | FZR | Saigon, Indo-China |
| 18.80 | 15,950 | PLG | Bandeong, Java |
| 19.50 | 15,375 | F8BZ | Paris, France |
| 19.56 | 15,340 | W2XAD | Schenectady, N. Y. |
| 19.72 | 15,210 | W8XK | Pittsburgh, Pa. |
| 19.83 | 15,120 | .... | Vatican City (Rome) |
| 19.99 | 15,000 | CM6XJ | Central Tuinucu, Cuba |
| 20.50 | 14,620 | XDA | Mexico City, Mexico |
| 20.70 | 14,480 | WAXK | East Pittsburgh, Pa. |
| 20.80 | 14,420 | VPD | Suva, Fiji Islands |
| 20.90 | 14,340 | G2MM | Sonning on Thames, England |
| 21.50 | 13,940 | .... | Bucharest, Roumania |
| 22.14 | 13,620 | F8BZ | Paris, France |
| 22.38 | 13,400 | WND | Deal Beach, N. J. |
| 23.00 | 13,043 | .... | Rabat, Morocco |
| 23.35 | 12,830 | .... | Buenos Aires, Argentina |
| 23.35 | 12,850 | W2XO | Schenectady, N. Y. |
| 23.86 | 12,630 | .... | Rabat, Morocco |
| 24.46 | 12,250 | FTN | St. Assise, France |
| 24.46 | 12,250 | KIXR | Manila, Philippine Is. |
| 24.68 | 12,150 | GBS | Rugby, England |
| 24.80 | 12,090 | .... | Tokio, Japan |
| 24.89 | 12,045 | NAA | Arlington, Va. |
| 24.98 | 12,000 | FZR | Saigon, Indo-China |
| 24.98 | 12,000 | .... | Oporto, Portugal |
| 25.5 | 11,750 | PK6KZ | Makassar, Celebes |
| 25.24 | 11,880 | W8XK | Pittsburgh, Pa. (KDKA) |
| 25.24 | 11,880 | VUC | Calcutta, India |
| 25.42 | 11,800 | UDR2 | Vienna, Austria |
| 25.53 | 11,750 | G5SW | Chelmsford, England |
| 26.20 | 11,440 | KIXR | Manila, P. I. |
| 26.22 | 11,435 | DHC& DHA | Nauen, Germany |

| Wave-Length | Frequency | Call Letters | Location |
|---|---|---|---|
| 26.70 | 11,230 | IBDI | SS "Elettra" |
| 27.00 | 11,100 | OUITH | Vienna, Austria |
| 27.27 | 11,000 | .... | Pozan, Poland |
| 28.00 | 10,700 | VAS | Glace Bay, N. S. |
| 28.20 | 10,630 | PLR | Bandoeng, Java |
| 28.50 | 10,510 | VLK | Sydney, Australia |
| 29.00 | 10,340 | .... | Paris, France |
| 29.98 | 10,000 | .... | Belgrade, Jugo Slavia |
| 30.30 | 9,890 | LSN | Buenos Aires, Arg. |
| 30.50 | 9,830 | NRH | Herdia, Costa Rica |
| 30.75 | 9,750 | .... | Agen, France |
| 31.10 | 9,640 | .... | Monte Grande, Arg. |
| 31.26 | 9,600 | PCJ | Hiverson, Holland |
| 31.28 | 9,580 | W3XAU | Byberry, Pa. |
| 31.35 | 9,570 | WIXAZ | Springfield, Mass. (WBZ) |
| 31.36 | 9,560 | NAA | Arlington, Va. |
| 31.56 | 9,500 | OZ7RL | Copenhagen, Denmark |
| 31.60 | 9,490 | OXY | Lyngby, Denmark |
| 31.80 | 9,430 | .... | Poesen, Poland |
| 32.00 | 9,375 | EH9OC | Berne, Switz. |
| 32.06 | 9,350 | CM2MK | Havana, Cuba |
| 32.50 | 9,230 | FL | Paris, France |
| 32.85 | 9,130 | HB9OC | Berne, Switz. |
| 33.00 | 9,090 | VK3ME | Melbourne, Aus. |
| 33.70 | 8,900 | .... | Poznan, Poland |
| 33.81 | 8,872 | NPO | Cavite, P. I. |
| 34.00 | 8,820 | VK3UZ | Melbourne, Aus. |
| 34.50 | 8,690 | HKF | Bogota, Columbia |
| 34.68 | 8,650 | W3XE | Baltimore, Md. |
| 33.54 | 8,440 | G2AA | London, England |
| 35.70 | 8,400 | VBS | Khabarovsk, Siberia |
| 36.74 | 8,160 | .... | Leningrad, Russia |
| 37.02 | 8,100 | Eath | Bandoeng, Java |
| 37.02 | 8,100 | JIAA | Vienna, Austria |
| 37.36 | 8,030 | NAA | Bangkok, Siam |
| 37.43 | 8,015 | .... | Arlington, Va. |
| 38.00 | 7,890 | VPD | Doeveritz, Germany |
| 38.56 | 7,775 | FSBZ | Paris, France |
| 38.60 | 7,770 | FTF | Kootwijk, Holland |
| 39.15 | 7,660 | FTL | Kootwijk, Holland |
| 39.70 | 7,550 | HJF | Bogota, Columbia |
| 40.00 | 7,500 | .... | Radio Touraine, Fr. |
| 40.20 | 7,460 | FYR | Lyons, France |
| 40.50 | 7,400 | .... | Eberswalde, Germany |
| 41.00 | 7,310 | .... | Moscow, U. S. S. R. |
| 41.70 | 7,190 | VK6AG | Perth, Aus. |
| 41.50 | 7,220 | HB9D | Zurich, Switz. |
| 42.70 | 7,020 | EAR125 | Madrid, Spain |
| 43.00 | 6,980 | EAR110 | Madrid, Spain |
| 43.00 | 6,980 | CT1AA | Santos, Port. |
| 43.50 | 6,900 | IMA | Rome, Italy |
| 43.60 | 6,875 | F8MC | Casablanca, Morocco |
| 43.60 | 6,875 | D4AFF | Coethen, Germany |
| 43.70 | 6,860 | KEL | Bolinas, Calif. |
| 43.84 | 6,840 | VRY | Georgetown, British Guiana |
| 46.06 | 6,430 | PCM | The Hague, Holland |
| 47.00 | 6,380 | CT3AG | Funchal, Madeira Is. |
| 47.00 | 6,380 | HC1BR | Quito, Equador |
| 48.30 | 6,205 | HKC | Bergoda, Columbia |

| Wave-Length | Frequency | Call Letters | Location |
|---|---|---|---|
| 48.62 | 6,170 | HRB | Tegucigalpa, Hond. |
| 48.74 | 6,155 | W9XAL | Chicago, Ill. (WMAC) |
| 48.83 | 6,140 | KA1XR | Manila, P.I. |
| 48.83 | 6,150 | W8XK | East Pittsburgh, Pa. |
| 48.91 | 6,125 | 7LO | Nairobi, Kenya Africa |
| 49.99 | 6,120 | .... | Motala, Sweden "Rundradio" |
| 48.99 | 6,120 | .... | Chi-Hoa (Saigon) Indo-China |
| 48.99 | 6,120 | .... | Tolouse, France |
| 48.99 | 6,120 | MTH | Rio de Janeiro, Brazil |
| 48.99 | 6,120 | EAR25 | Barcelona, Spain |
| 49.07 | 6,110 | VVB | Bombay, India |
| 49.15 | 6,100 | W3XAL | Bound Brook, N. J. |
| 49.17 | 6,095 | VE9GW | Bowmanville, Ont., Can. |
| 49.17 | 6,100 | VQ7LO | Nairobi, Kenya, Af. |
| 49.31 | 6,080 | W9XAA | Chicago, Ill. |
| 49.31 | 6,080 | W6XAL | Westminister, Calif. |
| 49.31 | 6,080 | HS2PJ | Bangkok, Siam |
| 49.34 | 6,075 | W9XAA | Chicago, Illinois |
| 40.54 | 6,075 | W2XCK | Kearney, N.J. |
| 49.05 | 6,050 | KEVE9CL | Winnipeg, Man., Can. |
| 49.40 | 6,070 | UOR2 | Vienna, Austria |
| 49.46 | 6,065 | SAJ | Motala, Sweden |
| 49.50 | 6,060 | W8XAL | Cincinnati, Ohio |
| 49.67 | 6,040 | W9XAQ | Chicago, Illinois |
| 49.67 | 6,040 | PK3AN | Sourabaya, Java |
| 49.97 | 6,000 | ZL3ZC | Christchurch, N.Z. |
| 49.97 | 6,000 | HRD | Tegucigalpa, Hond. |
| 49.97 | 6,000 | EAR25 | Barcelona, Spain |
| 49.97 | 6,000 | RFN | Moscow, U. S. S. R. |
| 50.00 | 6,000 | PK2AF | Djocjacarta, Java. |
| 51.00 | 5,875 | CN8MC | Casablanca, Morocco |
| 51.40 | 5,833 | HK | Barranquilla, Colu. |
| 55.00 | 5,450 | F8BP | Ruggles, France |
| 58.00 | 5,170 | OK-MPT | Prague, Czecho-slovakia |
| 67.65 | 4,430 | DOA | Doeberitz, Germany |
| 70.00 | 4,280 | AHK2 | Vienna, Aus. |
| 72.90 | 4,110 | WGBN | Deal, N. J. |
| 80.00 | 3,750 | F8KR | Arlington, Va. |
| 72.70 | 4,120 | GFWV | Constantine, Tunis, Africa |
| 80.00 | 3,750 | 13RO | Rome, Italy (Prato Smeraldo) |
| 82.90 | 3,620 | DUO | Doeberitz, Germany |
| 84.24 | 3,660 | OZ7RL | Copenhagen, Den. |
| 98.95 | 3,030 | .... | Motala, Sweden |
| 105.3 | 2,850 | W2XR | New York, N. Y. |
| 104.4 | 2,870 | .... | Chicago, Illinois |
| 142.9 | 2,100 | W2XCR | Jersey City, N. J. |
| 142.9 | 2,100 | W3XR | Wheaton, Md. |
| 142.9 | 2,100 | W2XBU | North Beacon, N. Y. |
| 142.9 | 2,100 | W2XCD | Passaic, N. J. |
| 175.2 | 1,712 | WMP | Framingham, Mass. |
| 175.2 | 1,712 | F8FY | Cannes, France |
| 186.6 | 1,608 | W9XAL | Chicago, Illinois |
| 187.0 | 1,604 | W3XCD | Passaic, N. J. |