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RADIO NEWS

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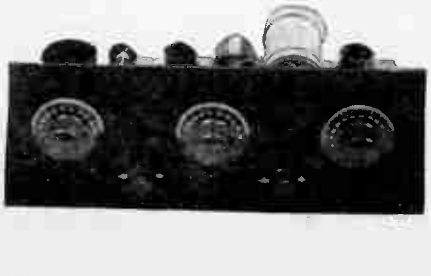

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Edited by H. M. BAYER

Technical Editor, "Radio News"

Volume No. 5

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Table of Contents

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The "Peridyne" Principle

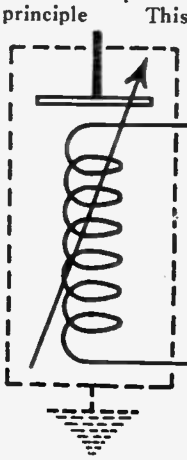
A New System of Variable-Shield Tuning

By Hugo Gernsback

Member, American Physical Society; Member, American Association for the Advancement of Science

THE "Peridyne" receiver described here, is rather revolutionary because it embodies an entirely new principle in what we have named the "Peridyne" method of shield-tuning.

A new radio symbol, the "peridyne" character, had to be created by the author, as no symbol for this arrangement is provided in the present radio practice.



We predict great commercial possibilities for this invention; which for the first time, it is believed, makes it possible to bring a single dial set into perfect inter-stage resonance and consequently, to operate it at the maximum possible efficiency.

This article explains theoretically, the distinctive features of the "Peridyne." The following article includes the constructional data of the "Peridyne 5," a five-tube set, by means of which the author in New York receives Pacific Coast stations several times during the week, even during the summer.

The "Peridyne 5" we believe, is the greatest 5-tube DX set that has ever been described, anywhere.—EDITOR.

WHEN reviewing the trend of progress of radio receiving sets during the past few years, the careful observer is most impressed by the fact that receivers are being simplified, so far as the controls are concerned.

Time was, when as many as twenty controls were on the panel. This we consider in these latter days, a monstrosity. I believe I was the first to point out, as early as 1922, that the single-control set would prevail in the future. This has indeed proved to be the case, and wherever possible today the preference of all constructors is for the single-control idea.

Several years ago, when the three-dial sets first came into vogue, it had already been realized that the three manually-controlled condensers could very well be placed on one shaft, using but one hand to tune instantaneously the three circuits with their three respective condensers. Theoretically, it should be possible to do this with ease but, practically, it is more difficult. It will be found that, with most good 3-dial sets, the settings of all three dials for different stations (particularly DX stations) never are the same. Thus, for instance, on a certain station the setting of dial 1 might be 50; of dial 2, 51; and of dial 3, 51¾, etc. Several years ago, it was found advantageous to place balancing condensers in parallel with the main tuning condensers, in order to compensate the small differences of capacity; but at best this gave us only an approximation which was more theoretical than practical.

The reason is that no two circuits tune exactly alike over the entire broadcast scale between 200 and 545 meters; even the best precision condensers do not do the trick. The reason is that the difference is found, *not only in the condensers, but in the inductors as well.* It is almost impossible to make two inductors exactly alike. The slightest difference in diameter, winding, spacing of the wire, etc., makes changes which multiply discrepancies quickly when the coil becomes part of a radio-frequency amplifier. Consequently, even the best single-tuning-control sets of today invariably include compensators of some kind, usually midget variable condensers, in parallel with the main tuning condensers.

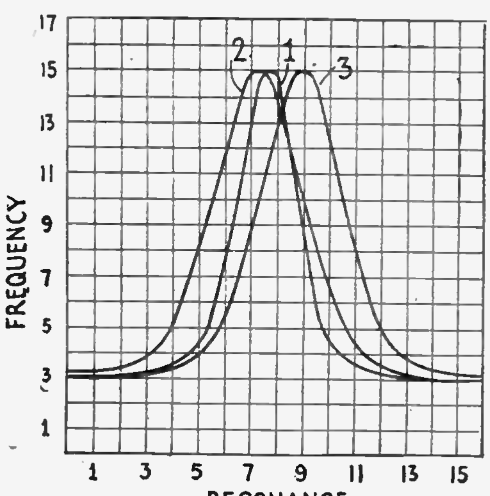


FIG.5

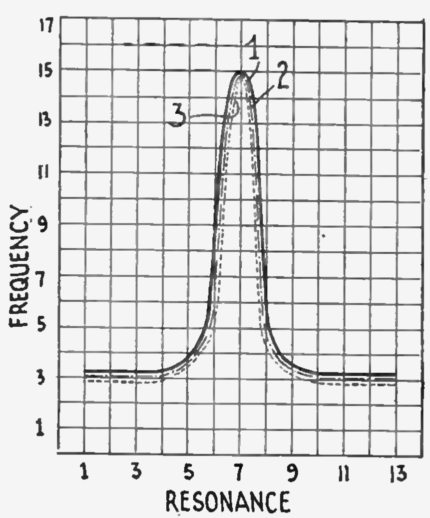


FIG.6

The curves in Fig. 5 represent the operation of three R.F. transformers at a given frequency; in Fig. 6 is shown the mean of the three curves. It will be noticed that they are practically coincident, after each has been adjusted by means of the Peridyne shield, regulating the inductance.

HARMONIZING THE R.F. STAGES

Fig. 1 shows this graphically; here we have at A the diagram of a three-dial tuned-radio-frequency set. The same set is shown at B, stripped of its unessentials. B, in other words, is an electrical skeleton of the circuit A. The same letters are used throughout for the same symbols. Thus, in A, we have the letter R, which is the internal resistance of the vacuum tube. This is shown in B, as a simple resistance. R1 stands for the resistance of inductance L2; while this resistance is slight, still it exists.

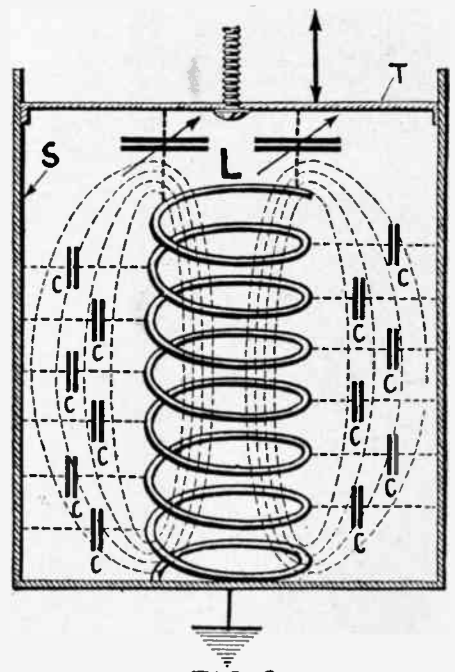


FIG. 2

If the sides and particularly the ends of a shield are too near the enclosed coil there results a capacity effect (indicated by the small condensers) reducing the efficiency of the shielding enormously. If the top of the shield can be slid up and down, this effect, however, can be turned to good account.

The three condensers on one shaft, C1, C2, and C3, tune the inductors L2, L4, and L6. In order to compensate for the differences of readings between the condensers, when used with their inductors, the small condensers Ca, Cb, and Cd, are used.

Some condensers have these small compensators affixed in such a way that they need, supposedly, to be balanced but once, and then left in this condition. This, however, is not found satisfactory, because the setting does not remain the same for all wavelengths. For that reason, most sets have extra controls on these small balancing condensers, so that they may be adjusted, particularly for DX tuning. It is admitted that on local tuning this is not necessary, because usually the tuning of the local stations is broad anyhow, so that exact correspondence is not required here. But, for the man who lives out in the country, anywhere from 500 to 300 miles away from the nearest broadcast station, it is a matter of prime importance; and for him, as well, it becomes a matter of manual dexterity to tune the set to bring in the distant stations.

If we now refer back to Fig. 1, illustration C, we find a graph, or plotted curve of the results of the tuning, which is not strictly orthodox, but is given simply to show the results graphically. It will be seen that the resonance curves, providing the small compensating condensers are not used, will be something like 1, 2, and 3. Each curve has a different resonance peak; and in order to make all three peak at exactly the same frequency, let us say value 14, each of the peaks would have to coincide at this point. If they do not, it simply means that the three transformers would not be in resonance with each other, and would therefore tune only *approximately;* thus we would obtain only average results, which may be satisfactory for local stations where powerful signals are received, but are not for distant stations. In order to rectify this we

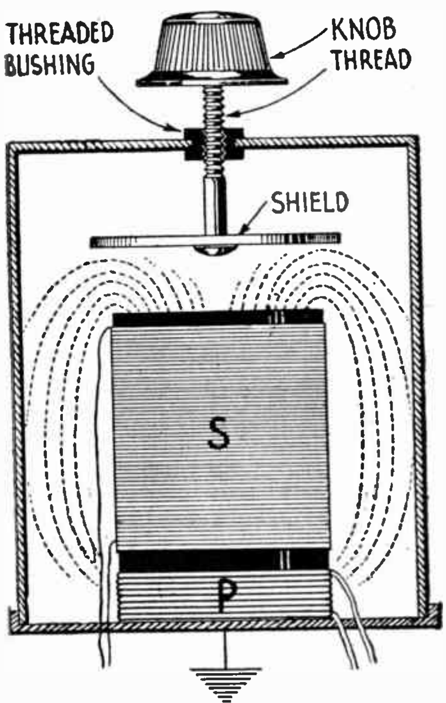


FIG. 4

The "Peridyne" tuning shield; its distance from the coil's high-voltage (grid) end is varied by the knob which is attached to a screw having a fine pitch, capable of producing very fine variations in this critical distance.

might use the compensating condensers Ca, Cb, and Cd, which then would bring the circuits into resonance with each other. In this way, the receiver would be brought to its highest efficiency, and the distant station could be received; always providing, of course, that the signal was actually in the aerial.

CHANGE OF INDUCTANCE BY SHIELDING

I have always been struck by the fact that the use of these balancing condensers in

Two beneficial effects can be combined by varying the shield's top; it becomes a compensating condenser and it matches the inductance of the enclosed coil to that of the others in the receiver.

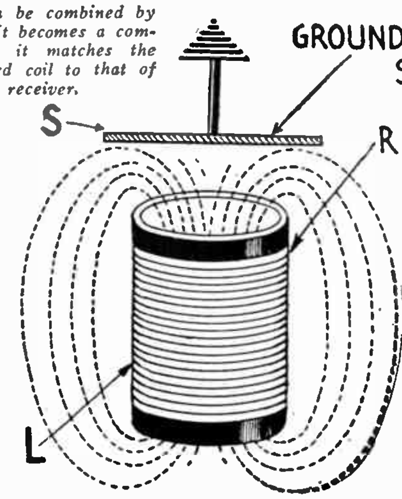


FIG. 3

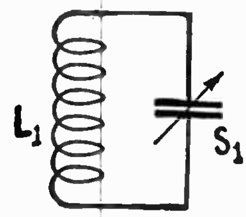


FIG. 3-A

parallel with the main tuning condenser is, at best, only a makeshift—a crutch, so to speak—something that would not be used if we had something better. So far, we have had nothing better, so the makeshifts were used.

During the past year or so, however, a new wrinkle came along. I refer to shielding in general. It was found that, to protect most effectively the stability of a receiving set, not only from certain electro-magnetic as well as capacity effects, arising from components within the receiver, but from various disturbances from outside the set—it was good practice to shield certain parts of the receiver. By shielding completely the inductors, for instance, many advantages are immediately obtained in the set, which may be summed up as follows: the set can be made to tune sharper, the parts may be brought closer together, stray leaks may be eliminated. Most important of all, however, a tuned-radio-frequency transformer, or, for that matter, any inductor in any receiving set must always be thought of as a pick-up coil. If we disconnect the aerial and ground from a set which is not shielded, it is still possible to receive signals from nearby stations, simply because the coils themselves, acting as loop antennas, pick up enough energy. Shielded inductors show no such sensitivity and no signals can be received with a well-shielded receiver

In referring to Fig. 2, we have, first, an inductor L, and a shield S, surrounding the inductance. It has been found in actual practice that if the sides, and particularly the top, of the shield come too close to the inductor, we lose more than we gain; for the simple reason that the inductor does not work efficiently unless it is sufficiently distant from the shield. The inductor has its field of magnetic flux and, if a shield cuts this flux to any considerable extent, losses are immediately incurred, and the over-all efficiency of the receiver is cut down. It has been realized for a long time that, if shields are used at all, they should be proportioned

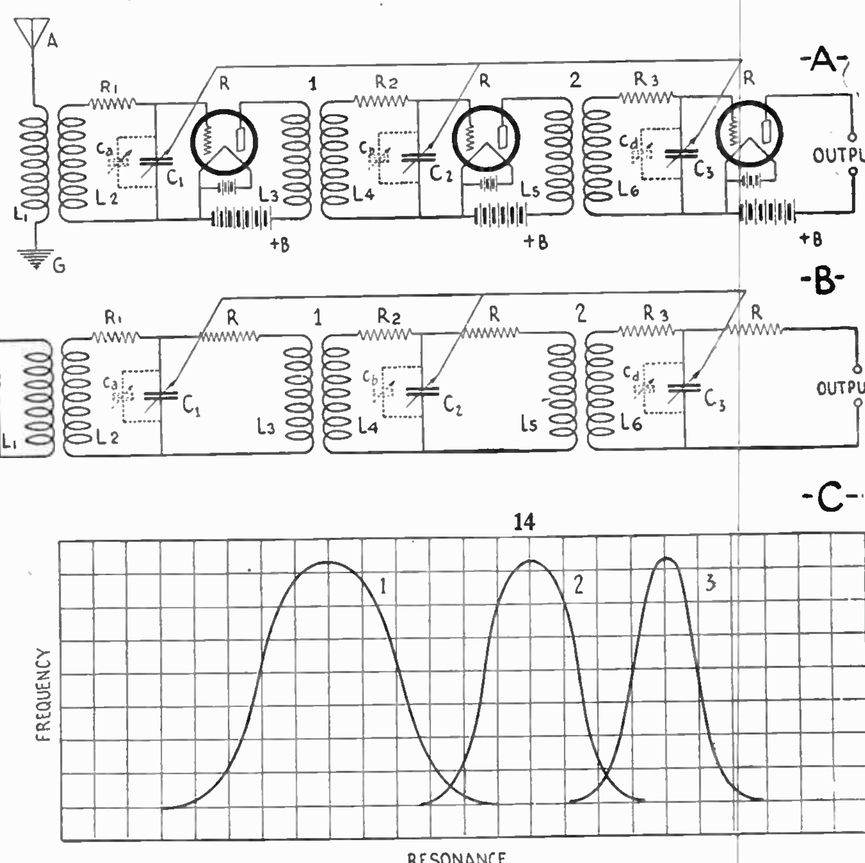


FIG. 1

Above, 1A, the diagram of a three-dial tuned radio-frequency set. 1B shows this circuit stripped of its unessentials. The three curves of 1C are the resonance curves of the above set whose transformers are untuned.

in such a manner that the walls and top are far enough away from the inductor so that they do not influence the magnetic field seriously.

If the shield is brought too close, the condition indicated by the dotted lines of the equivalent condensers occurs; because the turns of the coil may be considered as a series of small condenser plates, each in capacitative relation to the shield. This effect can be nullified to a great degree, as just explained, if the shield is kept far enough away from the inductor. This effect, it should be pointed out at once, is not so important at the sides of a radio-frequency transformer as at the high-potential end of the inductor, which is usually located at the top. Here the effect of the shield becomes tremendously important; so important, as a matter of fact, that if the shields are not correctly proportioned much more is lost than gained.

To use a homely analogy, it is as if you were trying to use a live spring, and then loaded it down with such heavy weights that there would be no elasticity left to uncoil the spring.

THE "PERIDYNE" ACTION

I noted, about a year ago, when working with shields—and the same thing must have been observed by many others—that when I moved a can up and down above an inductor in a set that was actually working, at certain positions the set would bring in stations at a tremendous volume; while, in other positions of the shield, the reception of certain signals was practically impossible. The explanation is simple; the shield, if not placed right, will displace the resonance points of the radio-frequency transformer, tremendously. The logical idea, therefore, was to make the shields variable in such a way that the various radio-frequency stages could be matched to a very fine degree by bringing the respective inductors into absolute resonance with each other.

Referring back again to Fig. 2, T (the top of the shield) is made movable, so it can be slid up and down. It was found immediately that this solved most of the difficult problems that has been hitherto encountered. The effect is also diagrammatically shown under Fig. 3. Here we have an inductor L and a movable grounded shield S. It will be seen that, as it is moved towards the radio-frequency transformer, the shield cuts the magnetic lines of force. Electrically, we have the system analyzed in Fig. 3A, where L1 is the inductor and S1 the shield; which, it should be noted, now becomes a variable condenser and thereby can be made to affect the period of response of the radio-frequency transformer L1. It will be seen, therefore, that *the movable shield performs two functions:* first, the shield is a variable condenser, a compensating condenser, in effect; secondly, it is used to match its accompanying coil with the other coils in the receiver. It has been found in actual practice that the variable shield, from an electrical standpoint, is far more effective than an external compensating condenser; because the variable shield, once set in its most advantageous adjustment, can be left in this position, and the inductor will then work with the same efficiency over the entire broadcast range. This it actually does, strange as the fact may seem.

While I have experimented with ungrounded shields, I soon discarded them because they become entirely too critical and too easily affected by hand capacity and temperature changes; so the grounded tuning sheild actually works out better in practice. Even here very slight changes of the tuning shield will bring in stations that otherwise could not be received at all. Thus, for instance, when using a 5-tube set and employing the principles explained here, I could not bring in station KFI (Los Angeles) over 3,000 miles distant, unless the tuned shields were adjusted carefully. But it was easy to bring the station in several times during the week, after the system had been once brought to the highest peak of efficiency.

FINENESS OF ADJUSTMENT

A motion of less than 1/64 of an inch, toward or from one of the radio-frequency transformers, is sufficient to throw out the distant station. In practice I have used a shielded inductor termed a "Peridyne," as shown under Fig. 4. The word "Peridyne" is derived from the Greek *peri*, meaning "on all sides," and *dynamis* "force"—alluding to the complete enclosure of the coil by its tuning shield.

In Fig. 4 we have an inductor, and a round metallic can in two parts. We have an adjustable shield which is moved up and down by turning the central knob. The thread may be either 6/32 or 8/32. Even a single turn of this fine thread, as explained before, will throw a distant station in or out.

It should be noted, by referring to Fig. 4, that the radio-frequency transformer has its highest-potential side nearest to the shield, and it should also be noted that the "Peridyne" tuning shield does not act as a "losser." It would become such only if the shield came very close to the inductor, which, in practice, it never does. As a matter of fact, the best results are obtained when the shield is at least one inch away from the inductance. It then becomes a corrective device to bring the entire system to the exact resonance.

Graphically this is shown under Figures 5 and 6. In Fig. 5, the three curves represent the operation of three radio-frequency transformers in an average set that may be termed fairly sensitive. We have also, it will be noticed, in Fig. 6, the mean for the three curves. In even the best of sets heretofore constructed, these three curves rarely coincided exactly. One of the transformers might work at its best peak, but the other two would not. You could, therefore, get only an approximation of the best results supposedly inherent in the set; which, however, in practice could never be realized unless corrective measures, such as compensating condensers, were used. In a "peridyned" set, however, after the shields have corrected the entire system to perfect interstage resonance, you will have the result shown in Fig. 6, where all three curves fall into practically one exact curve. In other words, all three radio-frequency transformers, with their condensers, automatically come up to the same resonance peak, and the set therefore works at its highest possible efficiency over the entire broadcast range, without manual setting of correcting instrumentalities.

With the "Peridyne" system, therefore, it is possible to get from a set the last fraction of efficiency which would not be available otherwise.

OTHER ADAPTATIONS

I once more wish to emphasize the point, because it is quite important, that in a correctly designed "Peridyne" shield practically no losses whatsoever are observed; because in no case does the shield come close enough to the inductor. The "Peridyne" shield, in fact, is not used as a true losser, but only as a compensating device. For reasonably-matched radio-frequency transformers, it is never necessary to bring the "Peridyne" shield closer than one inch, at the nearest, to the top of the inductance. Frequently the distance is much greater than this, the average being from 1½ to 2 inches; although, when the set oscillates violently, this distance may sometimes, but rarely, be reduced to three-quarters of an inch. When the shield is so close, it does absorb a little energy.

It should be noticed that the utility of the "Peridyne" idea is not restricted to matching independent radio-frequency transformers in a tuned-radio-frequency circuit; but it can be used for many other purposes,

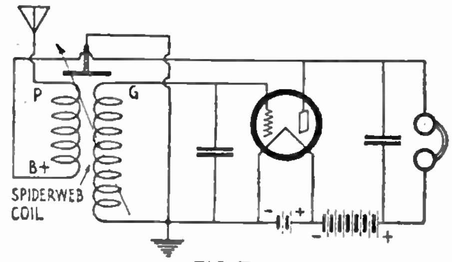


FIG. 7

The Peridyne principle applied to control of regeneration. The shield, as shown, can be employed to regulate the amount of feed-back and keep it below the point of oscillation. The shield can also be used to actually tune over a narrow wave band.

which will immediately become apparent to the radio technician. It even becomes possible to do away entirely with the usual tuning condenser and tune solely by moving the "Peridyne" shield to or fro; although this can be accomplished only within a rather narrow range.

I have even found it possible to use the "Peridyne" shield as a regeneration control in connection with a regenerative tuner. Fig. 7 shows the arrangement.

Then too the "Peridyne" shield can be used admirably for matching the intermediate transformers of a superheterodyne, to peak them and bring all of them to their highest point of efficiency. In some circuits, notably the Tropadyne, it will be remembered that the intermediate transformers are shunted by a small variable capacity in order to bring the intermediate transformers into resonance with each other. By means of the "Peridyne" shield the intermediate transformers can now be matched quite easily and far more efficiently; because, when they are once set, the setting will not have to be changed.

I, personally, would advocate the use of the "Peridyne" shield only in connection with air-core intermediate transformers. Another use for the "Peridyne" shield is in wave traps, doing away entirely with the tuning condenser. I have found, for instance, when using a spiderweb or honeycomb coil, that an almost micrometric adjustment of the shield will easily throw the wave trap in or out of tune.

Summing up, therefore, the "Peridyne" idea of tuning by shielding opens a new era in extraordinarily fine electro-mechanical balancing systems, not possible heretofore. By means of the "Peridyne" shields, a number of radio-frequency transformers in a set can be brought into perfect resonance with each other and, once adjusted, the set will remain at its highest efficiency over the entire broadcast range (200 to 545 meters).

The "Peridyne" Five*

Construction of a Highly-Sensitive Receiver Using the New System of Variable-Shield Tuning

By Hugo Gernsback

Member, American Physical Society; Member, American Association for the Advancement of Science.

THE "PERIDYNE" FIVE set described here has been designed by the author for the special purpose of "DX" work. It may be termed the DX set par excellence. The author, in New York, has brought in Pacific Coast stations at a distance of over 2,400 miles, airline, even in the summer time. The electrical system used is the popular Interflex circuit described by the author in his articles on Interflex receivers, two years ago. In addition to this, full use is made of the new "Peridyne" variable-shield tuning system, whereby the set can be balanced to a degree of accuracy which has been impossible, heretofore, in tuned-radio-frequency circuits. At the same time, the set is fully shielded.

The "Peridyne" Five has only two controls; only one of them a tuning control. An important consideration in this set is also the fact that, though this set can be made to oscillate violently, it does not radiate in the least. The author demonstrated this by placing another receiver a few feet away from it; although the "Peridyne" could be made to squeal and oscillate violently, the effect could not be picked up on the nearby set. The set is very simple in its construction, and we know that our readers will want to try this excellent circuit immediately.—EDITOR.

IN my previous article, I sketched briefly the theoretical considerations of the "Peridyne" action of shield-tuning and its tremendous advantages. Also, at this point it might be well to set at ease those persons who wrote me before the publication of these articles at which time they heard of my experiments with the "Peridyne" shields. A good many of them claimed that the idea of variable-shield tuning is an old story.

This was to be expected; because nothing new is ever brought out without some one's coming along and claiming credit for it. The trouble with those people who have written to me is that they came to a hasty conclusion. One of the letters pointed out that there is such a thing as "spade tuning," whereby a movable piece of metal is slid across a honeycomb or spiderweb coil. Another letter pointed out that a neutralizing scheme, using a metal vane inside of a coil, had been used for many years.

All these things, of course, were previously well known to me. For this reason I went to great pains in my first article to point out that at no time should a "Peridyne" shield be called a losser; because, in a carefully-balanced "Peridyne" shielded set, the shield is never near enough to the coil to act as a losser, as this term is usually understood.

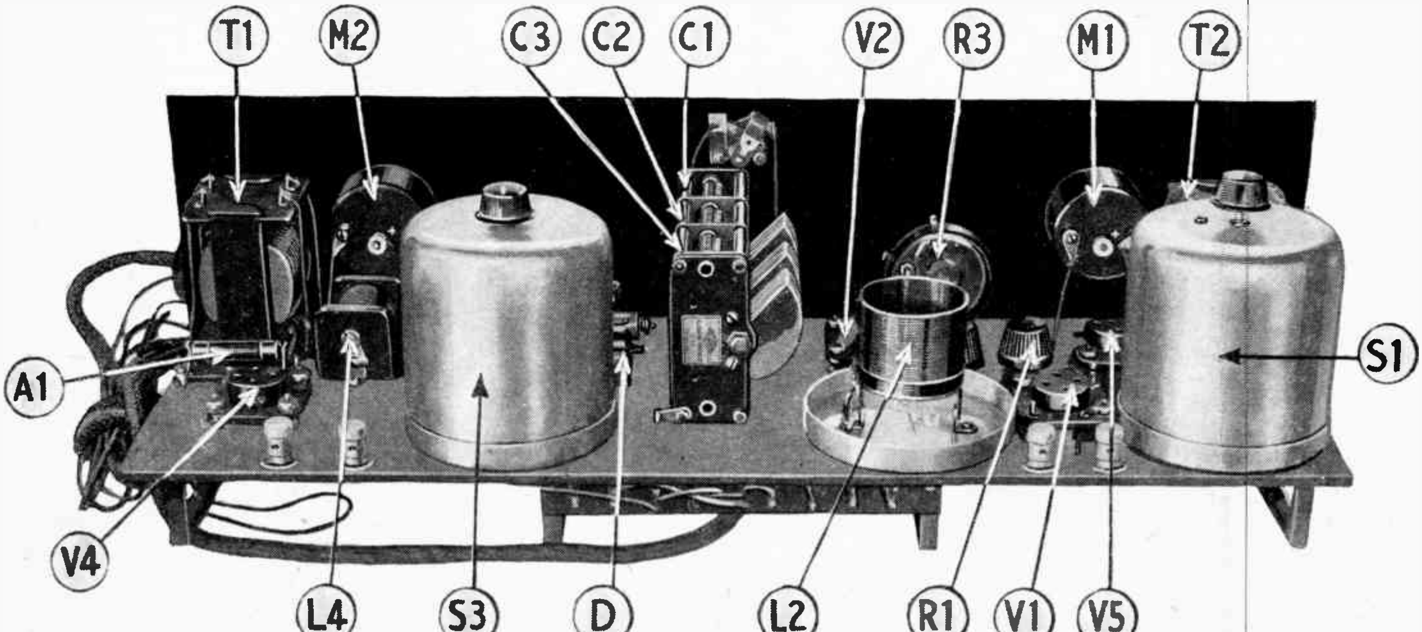
When tuned radio-frequency amplification first came into general use for broadcast reception many metallic lossers were used; notably in certain Freshman sets, where the coil was as near as an eighth of an inch to the metallic frame of the variable condenser which turned it. Here we had a real losser. In the "Peridyne" system, it is an exceptional condition when the shield must be brought nearer to the coil than an inch. There is a tremendous difference between these arrangements; the fact that mounting the coil on the end-plate causes eddy-current effects in the metal, due to its close proximity, whereas the "Peridyne" shield is too far away for this action.

This difference is really very great, and becomes apparent only after you have built and operated a set using the "Peridyne" principle of variable-shield tuning. I took pains to point this out in Figures 3 and 3A, in my first article and I pointed out also that the inductances of the coils are altered not by losing energy, but because the shield changes both the self-inductance and self-capacitance of the coil. Once you get familiar with the difference, interesting possibilities from the use of the "Peridyne" principle immediately open up.

RECEPTION WITH THE "PERIDYNE"

The "Peridyne" Five set described in this article is, frankly, a highly-developed DX receiver. I started out with the idea of showing that a 5-tube receiver, plus crystal detector, could accomplish anything and everything within the powers of an 8- or 10-tube set, no matter what circuit was used; and I am ready to prove that this circuit, using but five tubes, will eclipse many an excellent superheterodyne loop receiver, for the following reasons.

I must point out again that, in the circuit I am about to describe, there are practically none of the losses that are usually encountered in most sets. Quite the contrary; the

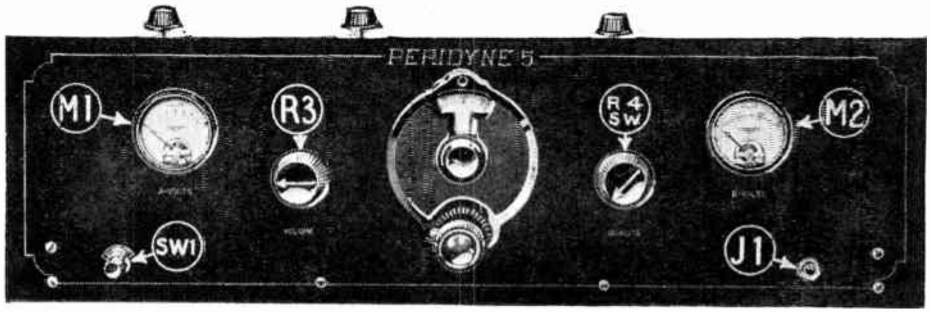


The rear view of the "Peridyne" Five shows C1, C2, C3, the three-ganged variable condensers; S1 and S3, R.F. coil shields; L2, an R.F. transformer; M1, filament voltmeter; M2, plate voltmeter; R1, R.F. rheostat; R3, volume control; D, detector; L4, R.F. choke; A1, amperite; and T1 and T2, A.F. transformers.

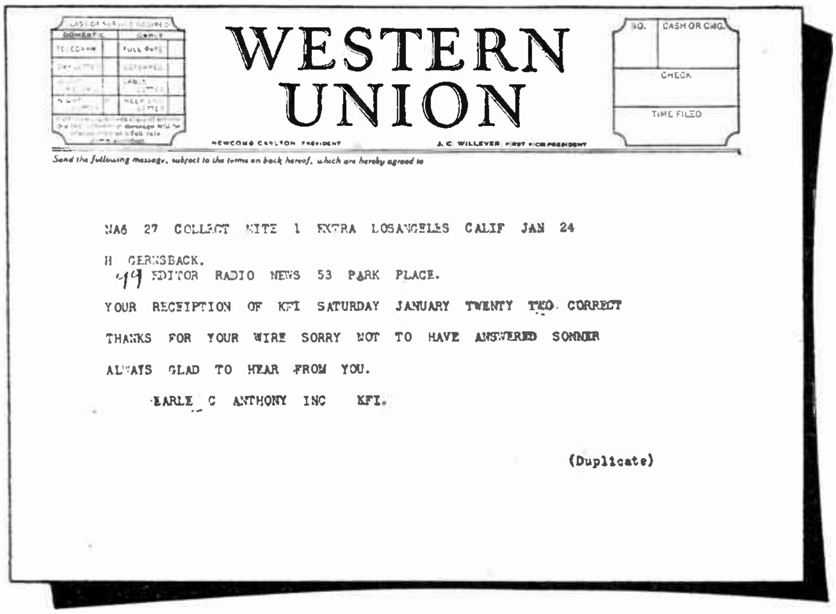
* RADIO NEWS *Blueprint Article No. 37.* (*See page* 104).

last fraction of possible efficiency is obtained from this set, because of the extremely fine balancing possible with the "Peridyne" shields. Instead of suppressing oscillations, instead of having the usual lossers, we keep the "Peridyne" Five usually just below the oscillation point by means of a simple oscillation control; and hence the highest possible efficiency is created and maintained.

May I say that this set has been in use by me a considerable time, and has been tried out under all circumstances? Though, of course, winter reception is better, still extraordinary results have been achieved thoughout the summer in the city of New York, where conditions are not too good at any time; while in the winter time, with this 5-tube set, I have been able to receive KFI, Los Angeles (the distance of which is 2,430 miles, air-line) almost nightly when that station was on the air. I have been able, even in the summer time, with plenty of static, to receive the California station at least once a week when conditions were fair.



On the "Peridyne's" front panel are the filament and plate voltmeters, M1 and M2, and the switch, SW1, that controls them; R3, volume control; R4-SW, combination switch and rheostat; J1, output jack; and the single control for the three condensers.



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Send the following message, subject to the terms on back hereof, which are hereby agreed to

NA6 27 COLLECT NITE 1 EXTRA LOSANGELES CALIF JAN 24

H GERNSBACK.

49 EDITOR RADIO NEWS 53 PARK PLACE.

YOUR RECEIPTION OF KFI SATURDAY JANUARY TWENTY TWO CORRECT

THANKS FOR YOUR WIRE SORRY NOT TO HAVE ANSWERED SONNER

ALWAYS GLAD TO HEAR FROM YOU.

EARLE C ANTHONY INC KFI.

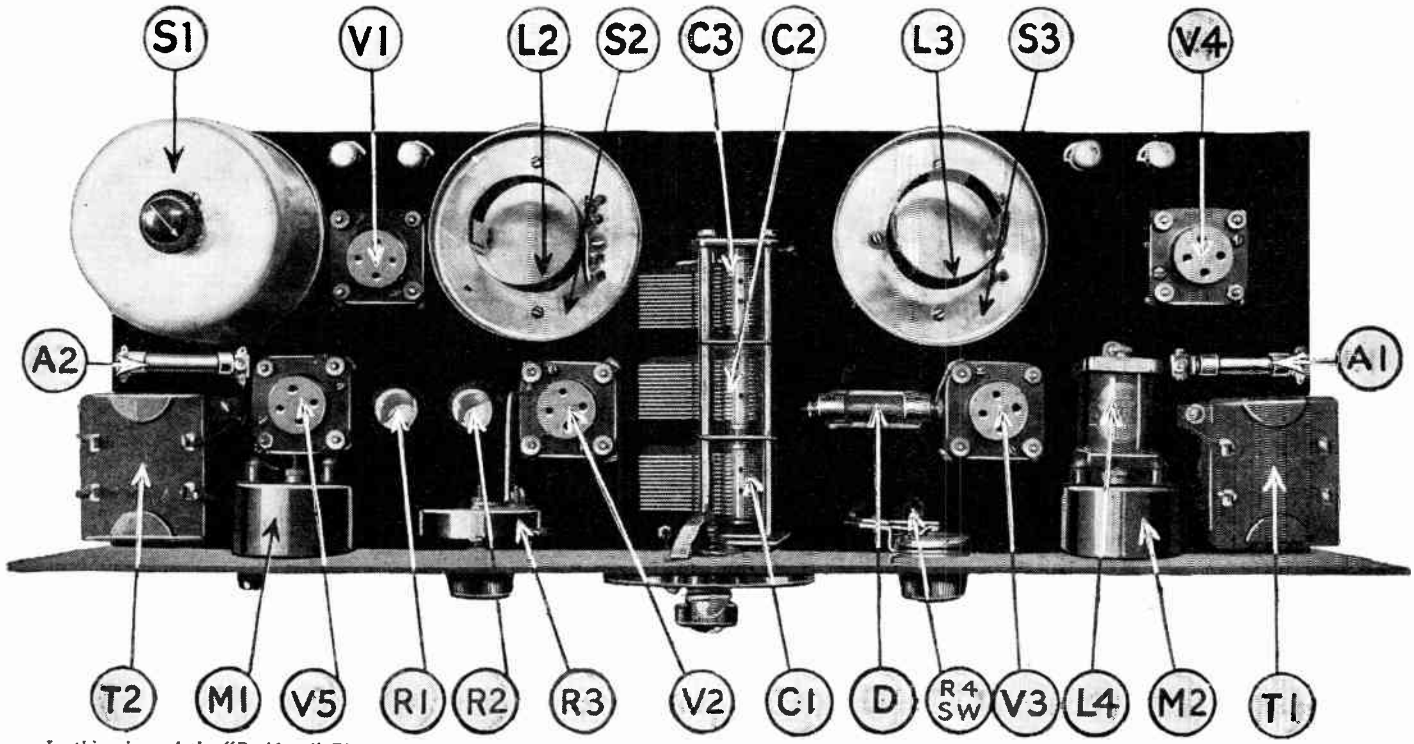
(Duplicate)

During the past summer there has been hardly a night when stations within a radius of 1,000 miles could not be brought in on the loud speaker. I therefore claim that this set is most unusual when it comes to distance; in fact, for city use the set really is too sensitive and often entirely too loud. For that reason, when I wish to receive local stations with this set I use an indoor antenna 30 feet in length; but, even with such an antenna, stations as far away as Cleveland (425 miles distant by air-line) could be brought in on the loud speaker without undue fussing. Most of some twenty-odd local stations were still uncomfortably loud, when using but 90 volts "B" battery.

I wish to point out here that the set gives an unusual amount of power; for, comparing this 5-tube set with many 9- and 10-tube sets in the RADIO NEWS LABORATORIES, we have not found one, with the exception of the Strobodyne, that delivered more power on 90 volts than the Peridyne. I know that these are strong claims, and I do not wish to be over-enthusiastic concerning this circuit, simply because I originated it; I would much rather let the builders of this set speak for the circuit after they have constructed "Peridyne" Fives themselves. I believe I have rather underestimated the results than overestimated them.

NEED OF SHIELDING

While I have pointed out in my theoretical article that the Peridyne system of shield



In this view of the "Peridyne" Five are clearly shown two R.F. transformers, L2 and L3, on their shield bases, S2 and S3; R1 and R2, rheostats; V1 and V2, R.F. amplifier sockets; V3 and V4, A.F. amplifier sockets; V5, power-tube socket; A1 and A2, amperites; and L4, R.F. choke. The other components bear the same symbols as those in the opposite illustration.

tuning can be used without enclosing the shield itself in a can, it is necessary, in my estimation, for best results, that the system be used exactly as specified in this article. In the first place, particularly when it is used in cities where there are several broadcast stations, an unshielded set today is practically useless. If the inductors are not totally shielded, the windings themselves become pick-up coils and act like an antenna. This is quite easily proven. If, after constructing the set, aerial and ground are disconnected, you will find that it will be practically impossible to receive any signals at all, even from a nearby station. But the moment the cans are lifted from their inductors, stations will come in quite loud; and it will also be found immediately that there is considerable interference, not only from waves coming from various stations, but from strays within the set. Total shielding of the inductors, I therefore consider absolutely necessary.

I seek to emphasize that, if a constructor wishes to build the entire set, making all the parts himself as far as possible, none of the dimensions, particularly those of the inductors and cans, should be changed in the least. It will interest the builder to know that I tried some eighty different kinds of inductors, small and large, short and long, heavy and thin wire, with all sorts of insulation, before I finally decided upon the construction which I now use.

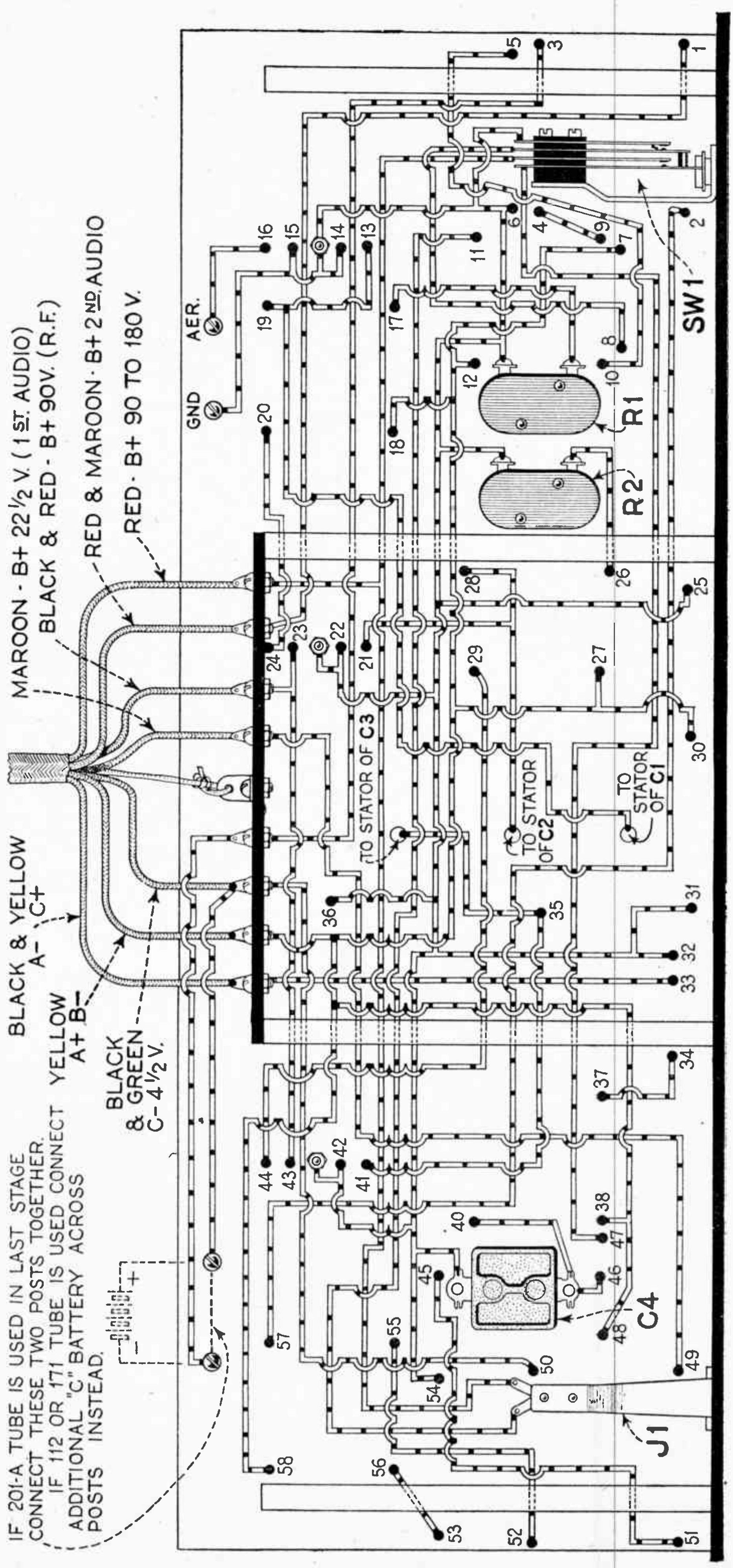
There is no hocus pocus about this set at all; rather, it is very simple in construction. I believe that it is a set far easier to construct than many more pretentious ones. There is a minimum of wiring and no instruments and components that are not absolutely essential are used in this set. I have tried to eliminate anything not of vital importance to the receiver. Any number of refinements, that could have been placed in the set, have been left out; because, after using them, I have convinced myself that, in most cases, the set will work practically as well without them.

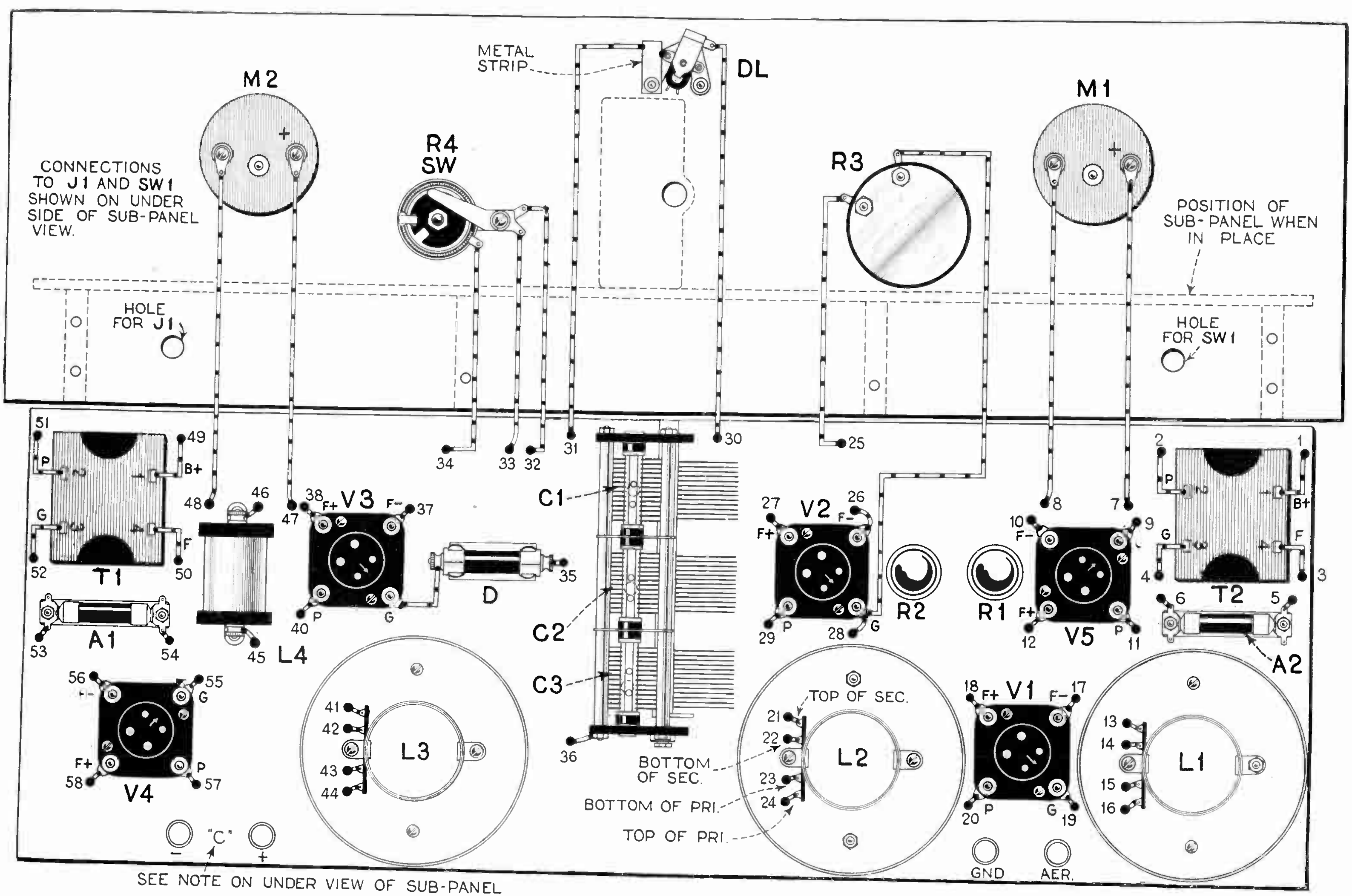
INTERFLEX PRINCIPLE INCORPORATED

The circuit used contains nothing revolutionary; the only novelty lies really in the "Peridyne" system of shield tuning. Those who have used or constructed any one of my Interflex circuits, such as the Balanced Interflex, the Regenerative Interflex, know that the insertion of the crystal detector immediately in the grid lead of the first audio amplifier tube will do wonders. For those who have not read my former articles on the Interflex action, let me repeat that the Interflex system does a number of important things.

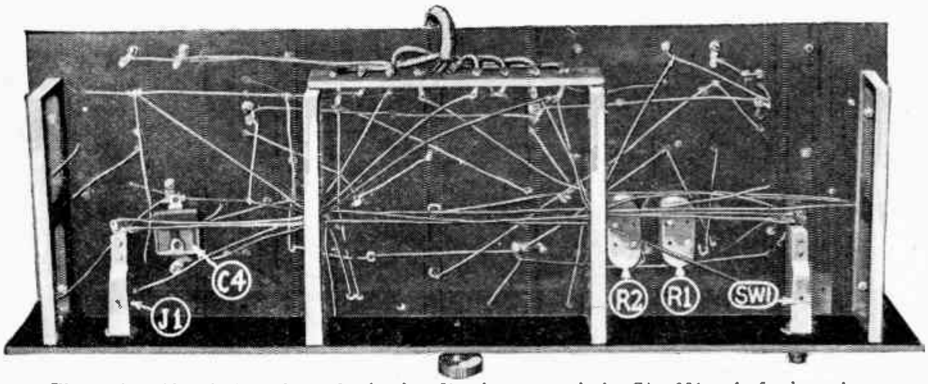
First of all, the crystal detector entirely replaces one tube; the "Peridyne" Five, which uses five vacuum tubes, is therefore in reality a 6-tube set and must be considered as such. The detector is a half-wave rectifier and passes practically no radio-frequency currents. Inserted in the grid lead it does away with the condenser and grid leak, and the usual lossers. It should be noted that the tube to which the crystal detector is connected becomes the first audio amplifier. There are, therefore, three stages of A.F. amplification in this set, which accounts for its tremendous volume.

The circuit itself, as I have said, presents no great novelties, except that, although a three-gang condenser is used, no compensating condensers are required. All compensation is accomplished by means of the "Peridyne" shields, a point that should be remembered.





The rear view of the front panel and the top of the sub-panel are shown on this page, with the wires that go to the different instruments. Notice that the holes going through the sub-panel are numbered, corresponding to those in the under view of the sub-panel shown on the opposite page. As the set is wired, the connections should be crossed off on the diagram.



The under side of the sub-panel, showing J1, the output jack; C4, .001 mf. fixed condenser; R1 and R2, rheostats; and the voltmeter switch, SW1.

CONSTRUCTION AND ASSEMBLY

As to the constructional details, I need not go to any length, because the illustrations which I present are pretty thorough and complete. Use only the best of materials throughout. Use good insulation, and when running your wire connections, see that no radio-frequency wires run parallel to each other. One of the illustrations shows the extreme simplicity of the wiring on the bottom of the panel.

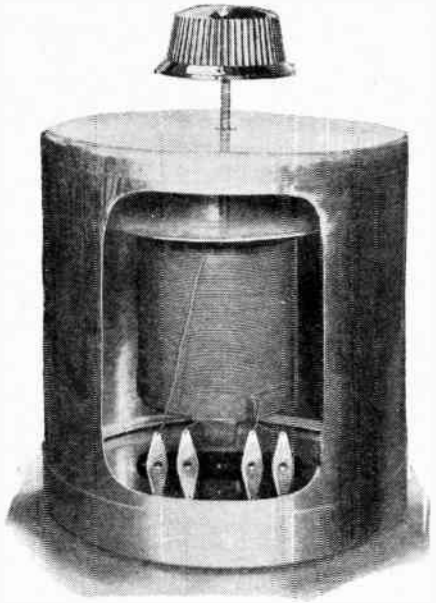
In building the set, for simplicity's sake, I have used flexible Celatsite wire, which comes in different colors, and makes the wiring of the set rather simple. This wire is quite thin and has stranded wires, with good insulation. In this set I have used four colors as follows:

Red for plate and "B" battery;
Green for grid, grid returns to "A—" and "C—";
Yellow for "A+" battery leads;
Black for "A—" battery and other leads at ground potential.

All connections made must be soldered. I do not believe the same results can be had from this particular set with screw-connections, as they very often give rise to losses; for in this set such losses must be reduced to the irreducible minimum.

IMPORTANCE OF METERS

I found it quite necessary (as a matter of fact I don't consider it possible to use this set without them for DX work) that the specified voltmeters be used. The reason is, that the set is exceedingly sensitive to the operating temperature of the radio-frequency tubes, and these must always be kept at their exact voltage. Only by using a voltmeter



A cut-away view of a "Peridyne" transformer and shield. The tuning shield is shown here much closer to the coil than it will be used.

(M1) across the "A" battery can you tell at all times that the voltage is exactly the same. If it is not, then the two radio-frequency rheostats must be hand-adjusted; which should never be necessary if the supplied voltage is that to which the set has been originally balanced.

And here I wish once more to tell those who work with sets of this kind, of the importance of knowing at all times that the voltage in their sets is correct. This is the case with, not only the "Peridyne" Five, but many other sets. Radio constructors have found that at certain times their sets are really excellent, but, little by little, they lose their sensitivity. The reason usually is drop in voltage, as a result of which the set no longer operates at its highest efficiency. For this reason, I continue to wonder that so many sets are made without a good voltmeter. Without this instrument, you operate your set blindly; it is like driving your car without a speed indicator, which no sane person will do.

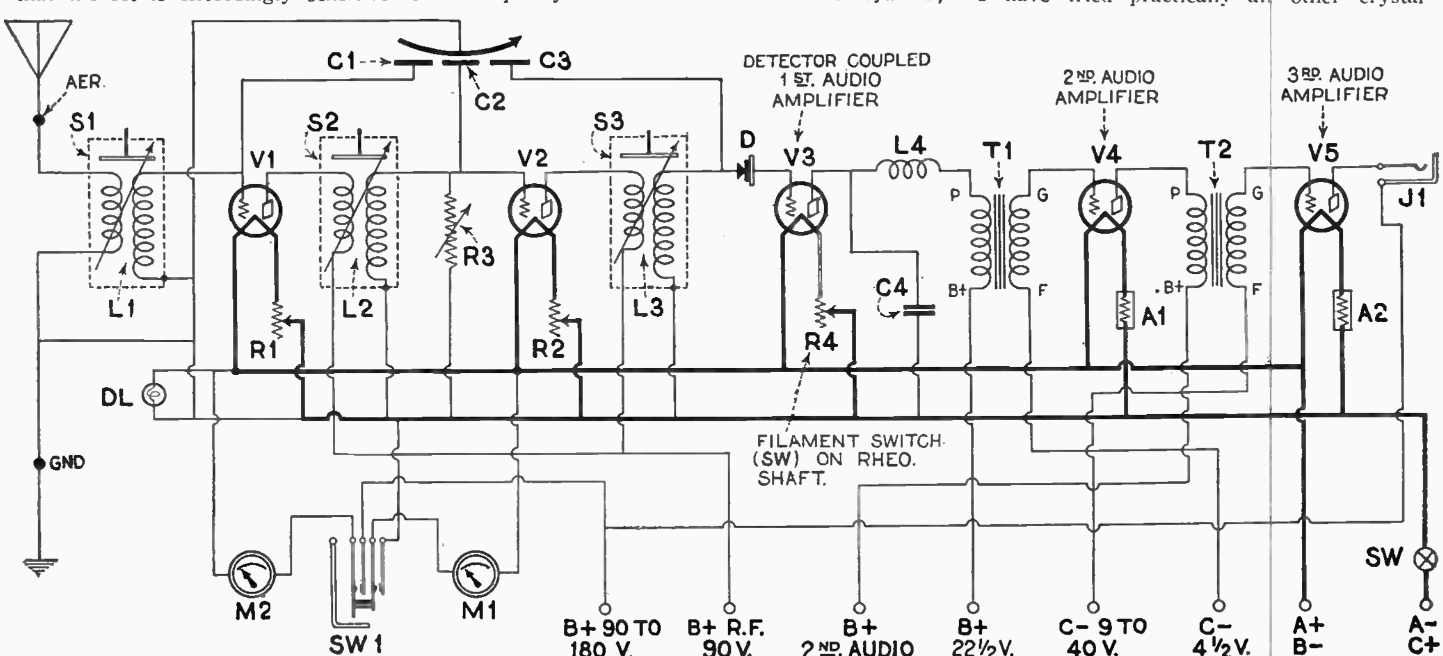
Oh yes! I have forgotten to mention that in the "Peridyne" Five I use just one by-pass condenser, whereas most sets of this kind incorporate any number of them. I do not find it necessary to use more than one. This, of course, simplifies the set a great deal.

The oscillation control in this set is a 100,000-ohm smooth-action variable resistor (R3), used in the first radio-frequency stage. It is possible, as will be explained further on, to do without it for city use, when the "Peridyne" shields are used as lossers; but for DX work it is highly important, as a matter of fact, one of the most important adjuncts to the entire set.

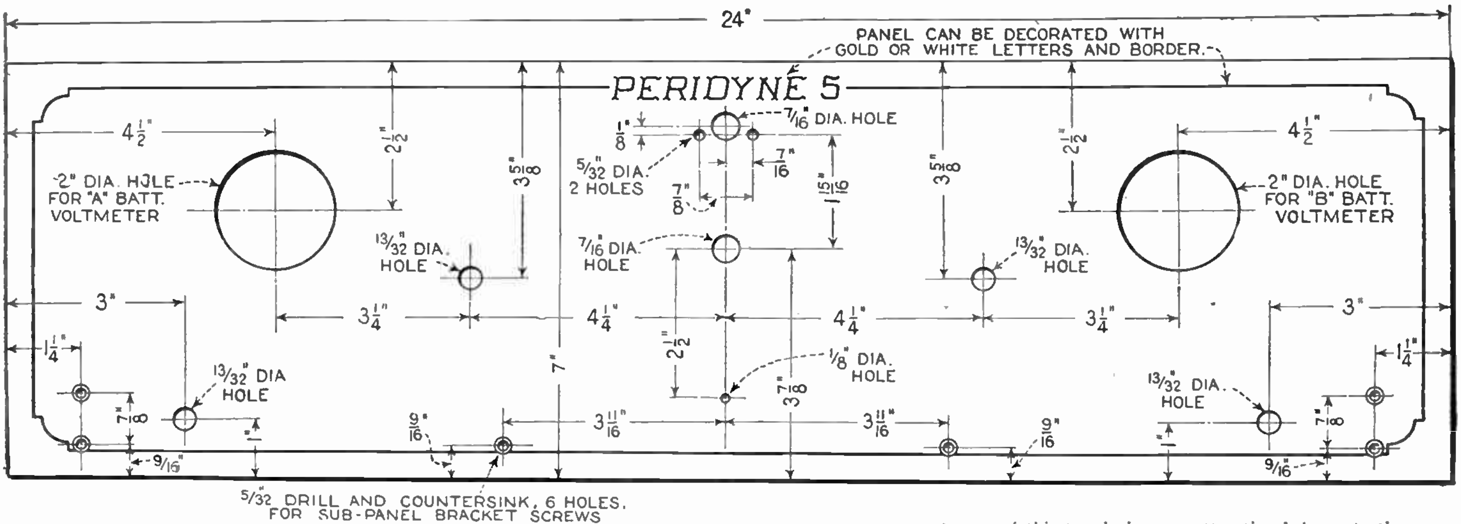
I maintain, as do many others, that no radio circuit which suppresses regeneration entirely can ever be as sensitive as a set that regenerates strongly. Practically all neutralizing methods consume some energy and thereby reduce the distance-getting ability of the set; whereas, the regenerating set, nine times out of ten, is better for distance reception. As this is frankly a DX set, I use a suitable regeneration control, by means of which the set can be brought to the highest efficiency for its particular wavelength reception without the usual lossers.

TESTING THE DETECTOR

A word about the detector. I have found, so far, that only the carborundum detector works well in the grid circuit of a tube; I have tried practically all other crystal



The parts indicated in this schematic diagram of the "Peridyne" Five are numbered and lettered to correspond with those in the other diagrams and illustrations. Note that DL is the miniature lamp illuminating the tuning dial.



Comparatively few holes have to be drilled in the front panel of the "Peridyne" Five. The layout of this panel gives an attractive balance to the receiver, as may be seen in the illustrations.

detectors with mediocre results. It seems that the carboroundum crystal gives an entirely different action; the reason being probably that, of all crystal detectors, the carborundum type usually operates best with a slight biasing potential. That slight potential exists in this circuit, and hence the carborundum detector actually replaces a tube. This statement can easily be proven by short-circuiting the detector, when the volume of the set will be observed to drop considerably. On the other hand, not all carborundum detector crystals work alike; some are more sensitive than others. I would recommend to all who build the set to have at least three such detectors on hand, and find out which works the best.

And let no one think for a minute that a crystal detector in a set is a "fussy" article. As to the 6,000 Interflex sets that have been built in this country, I have on file hundreds of letters from owners who have worked their sets right through the summer, when static and actual sparks came crashing through the set, without the crystal being impaired. In the carborundum detector we have a crystal held against a steel block under several pounds of pressure. In this detector nothing is likely to be burnt out. because this crystal can be subjected to a tremendous amount of heat without changing its efficiency.

During the summer time, while using the "Peridyne" Five, I never disconnected the aerial, and at times I have drawn out from the crystal detector itself sparks half an inch long at the approach of a thunderstorm. Yet, strange to say, it did not impair the set at all. In one of my Interflex sets, which is now over three years old, I still use the same old carborundum crystal, having never replaced it; while in the same period I have replaced some tubes three and four times. Thus, the carborundum crystal has outlasted the vacuum tubes. So, if you have any idea in mind that a crystal detector is a perishable article, in a DX set, this lengthy statement should disabuse your mind; because, once a good crystal has been found, you need pay no more further attention to it than if it were a binding post.

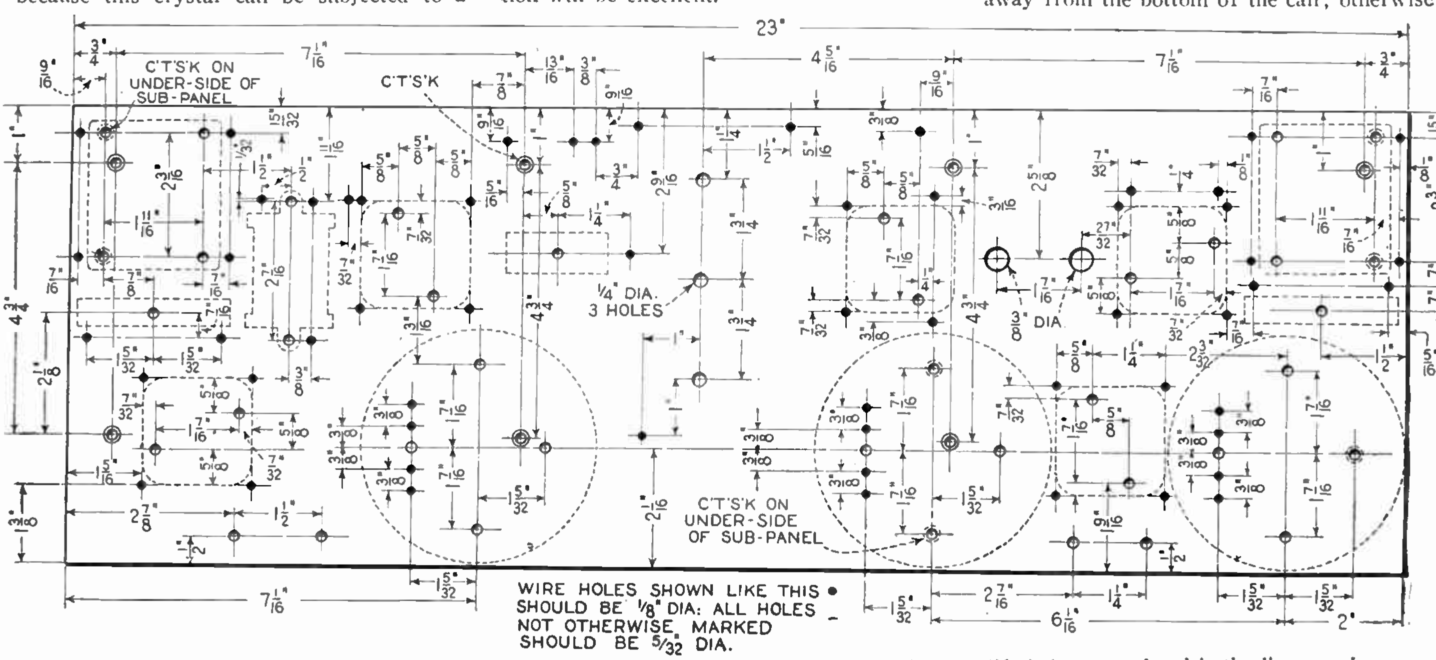
The important part of the carborundum detector is that it works best only one way which has to be found by experiment. On local stations not much difference, if any, can be detected. It becomes important only when you are listening to a DX station; then you will find that a reversal of the carborundum detector will practically kill all reception, while in the correct position reception will be excellent.

Furthermore, I insist, and many critics have found the assertion true, that a crystal detector inserted in the grid lead, providing all other conditions are right, makes for purity of sound, that is usually not found in other sets. The nasal, twanging sound of so many sets is practically absent when the crystal is used in the Interflex way. All those who have used it thus will never again use another method. This quality becomes particularly apparent when you are listening to talk; comparatively few sets reproduce speech in a natural tone. Scientists are all agreed that there is no clearer-sounding detector than the crystal. In this respect it is more efficient than the vacuum tube. Hence the great purity of sound obtained by the Interflex method.

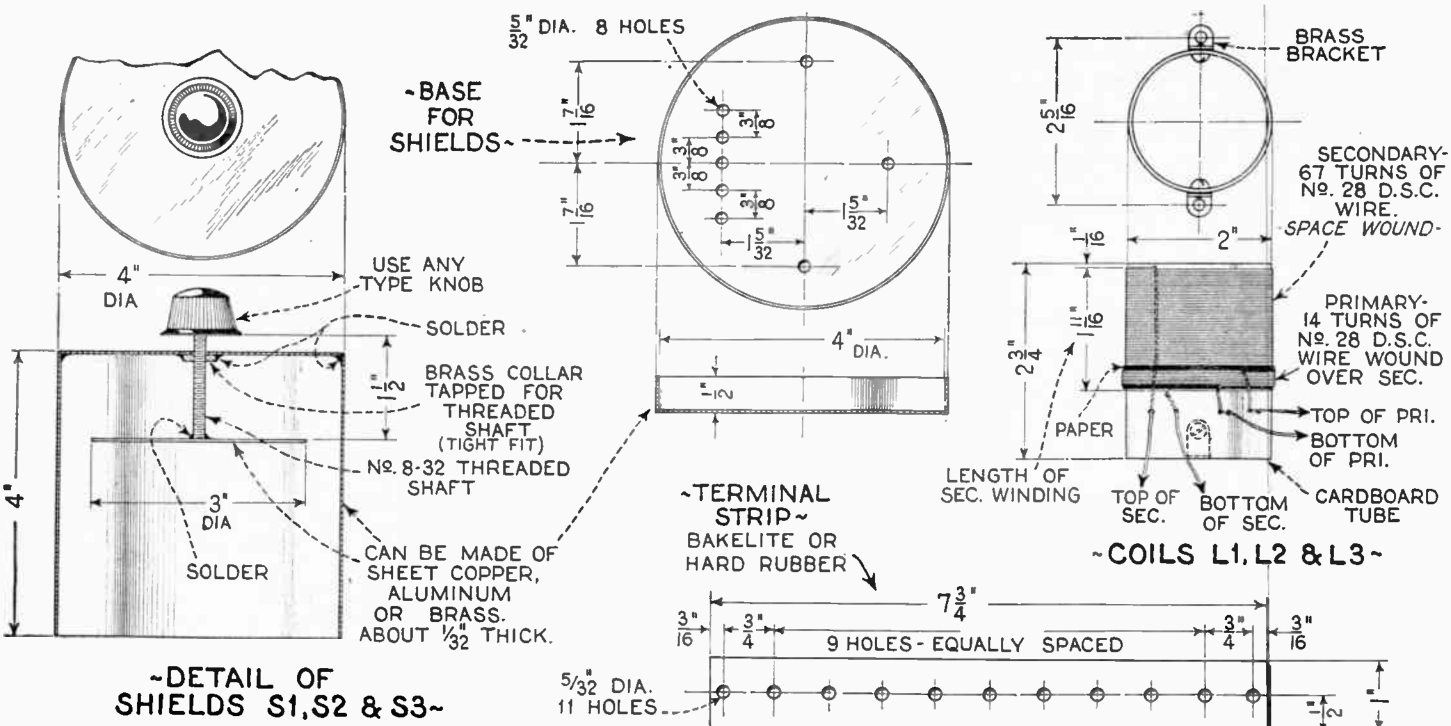
MAKING COILS AND SHIELDS

In the "Peridyne" Five I use a factory-made inductor, which is self-supporting, the coil being held together by a thin film of celluloid. As this construction requires special forms, I have substituted, for those who wish to build their own coils, a simple method whereby the secondary and primary of the inductor are wound on a cardboard tube.

It is absolutely essential that the lower part of the winding be exactly 1 1/16 inches away from the bottom of the can; otherwise



The drilling instructions are given for the holes necessary in the sub-panel. The holes indicated by a solid circle are numbered in the diagrams shown on other pages of this article.



The constructional details for the "Peridyne" shields, R.F. transformers, and terminal strip. Great care should be exercised in the construction of these parts; as the first two mentioned are extremely important.

the constants will all change from those given. The secondary is first wound with 67 turns of No. 28 double-silk-covered wire, space-wound, which can be effected by using a silk thread between the windings. This silk thread can be taken away afterwards. The primary is wound beginning at the exact bottom of the secondary; there are 14 turns of No. 28 D.S.C. wire. The primary is wound on top of the secondary by interposing a piece of stiff bond paper.

If you are enterprising enough to build your own cans, the dimensions are given in the illustration. They can be made of sheet copper, zinc, aluminum or brass; if you make these yourself, you will probably use copper or brass, on account of the soldering. The brass collar should be tight enough so that the 8/32 threaded shaft will work without play. This is most important, as will be seen afterward. The bottom of the can may be made similarly out of two pieces of brass or sheet copper. Dimensions are given for the movable shield, and little else need be said about this.

A most important consideration, however, is that the top part of the can must fit the bottom part tightly. If the fit is loose, a rattling noise will be heard in the loud speaker; for the reason that *the shield is a condenser* and, if there is play between the can and the bottom part, this will amount to a loose contact, and your set will be noisy. If, therefore, the shields do not fit tightly, this can be remedied by inserting pieces of tin foil between the tops and the lower parts, to make a good mechanical connection. You will then experience little trouble.

Of importance are rheostats R1, R2, and R4. R1 and R2 are Bradleystats, which are mounted on the sub-panel, and are never touched after the set is balanced. R4 should be a 30-ohm wire-wound rheostat, because the first audio amplifier tube is very often critical and works best only with the exact voltage. Choke L4 should be of 85 millihenries and is quite necessary for the operation of the set, to choke back any incidental radio-frequency currents which might be passed through the first audio amplifier tube and through the crystal detector in case the set is overloaded. The second and third audio amplifier tubes require no rheostats, but use amperites.

SYMBOL	Quantity	NAME OF PART	REMARKS	MANUFACTURER ★	
C1,C2,C3	1	Triple Var. Cond.	.0005 mf. each section	1	2
L1,L2,L3	3	R. F. Transformers	Special } special Peridyne units	2	
S1,S2,S3	3	Coil Shields	Special } special Peridyne units	3	
T1, T2	2	A. F. Transformers	3:1 ratio	3	9,20,21,22,23,24
R1, R2	2	Rheostats	Carbon type	4	
R3	1	Variable Resistor	0-100,000 ohms	5	6,12,26,36
R4, SW	1	Switch-Rheostat	30 ohms; combination instrument	6	12,26,35
A1	1	Amperite	5 volts, 1/4 ampere type	7	
A2	1	Amperite	5 volts, 1/2 ampere "	7	
D	1	Detector	Carborundum type	8	
L4	1	R. F. Choke	85 millihenries	9	2,3,23
C4	1	Fixed Condenser	.001 mf.	10	6,22,25,26,27,28,29,33,42
M1	1	Voltmeter	0-8 volts	11	30,31,23
M2	1	Voltmeter	0-150 volts	11	30,31,23
J1	1	Jack	Single circuit type	12	6,26,27,28,32,36,37
SW1	1	Jack-Switch	Two circuit type (D.P.S.T.)	12	6,26,27,28,32,36,37
	1	Vernier Dial		13	8,23,27,32,35
	5	Sockets	UX type	14	1,3,23,27,28,32,33,34
	4	Binding Posts		15	12,15,23,27,34
	1	Panel	7 X 24 X 3/16 inches	17	16,40
	1	Sub-Panel	8 X 23 X 3/16 inches	17	16,40
	4	Brackets	6 3/4 X 2 inches, hard rubber	17	27
	1	Battery Cable	With fuse, 7 wires	18	6,12
V1, V4	4	Vacuum Tube	201-A type	37	38,39
V5	1	Vacuum Tube	112 type	37	38,39
	1	Terminal Strip	7 3/4 X 1 X 3/16 inches	17	16,40
	4	Rolls Hook-up wire	Black, Yellow, Red, and Green	19	18,41

NUMBERS IN LAST COLUMN REFER TO CODE NUMBERS BELOW.

1 Amsco Products, Inc.	2 Hammarlund Mfg. Company	3 Silver Marshall, Inc.
4 Allen Bradley, Inc.	5 Central Radio Laboratories	6 Carter Radio Company
7 Radiall Company	8 Carborundum Company	9 Samson Manufacturing Company
10 Aerovox Wireless Company	11 Jewell Electric Instrument Co.	12 Yaxley Mfg. Company
13 National Company, Inc.	14 Benjamin Elec. Mfg. Company	15 X-L Radio Labs.
16 Micarta Fabricators	17 American Hard Rubber Co.	18 Belden Manufacturing Co.
19 Acme Wire Company	20 Thordarson Elec. Mfg. Company	21 American Transformer Co.
22 Sangamo Electric Company	23 General Radio Company	24 All-American Radio Corp.
25 Dubilier Condenser Corp.	26 Electrad, Inc.	27 Pilot Electric Co., Inc.
28 De Jur Products Company	29 Tobe Deutschmann, Inc.	30 Weston Elec. Instrument Co.
31 Roller Smith Company	32 Pacent Electric Company	33 Electrical Research Lab. (ERLA)
34 H. H. Eby Mfg. Co., Inc.	35 Brooklyn Metal Stamping Company	36 Herbert Frost, Inc.
37 E. T. Cunningham, Inc.	38 Radio Corporation of America	39 C. E. Manufacturing Co. (CeCo)
40 Formica Insulation Company	41 Cornish Wire Company	42 Polymet Manufacturing Co.
43	44	45

★ THE FIGURES IN THE FIRST COLUMN OF MANUFACTURERS INDICATE THE MAKERS OF THE PARTS USED IN THE ORIGINAL EQUIPMENT DESCRIBED HERE.

If you use alternate parts instead of those listed in the first column of manufacturers, be careful to allow for any possible difference in size from those originally used in laying out and drilling the panel and sub-base.

ADJUSTMENTS

After the set has been completely wired, you can begin to test. Remember first that the inductors must be connected right. If the set has been wired correctly, and no results are obtained, the chances are that either the secondary connections or the primary connections of the coils have been reversed. If they are connected as shown in the illustration, the arrangement is correct and no trouble should be experienced. Remember that the (detector-coupled) first audio amplifier tube requires only *22½* volts when using good tubes. It is a rarity that 45 volts are used here; and I, personally, never recommend such a high voltage, because it is not necessary and tends only to distort the signals.

ABOUT TUBES

A word about tubes. This set, as I have mentioned several times, is first of all a DX set; as such it must have good tubes. Use only the best; insist upon having a set of matched tubes from your dealer, tubes that do not vary more than 10 per cent in their characteristics. Even then you may find that "switching around" the tubes will give you the best results.

If everything is connected up, you will find little difficulty in bringing in local signals. The important point now becomes the adjustment of rheostats R1 and R2 located behind the panel and mounted on the subpanel these are extremely sensitive. When using the set normally, you do not require more than 90 volts; that is, if no power tubes are used. Be sure that your voltmeter on the "B" side (M2) reads 90 volts exactly; and that on the "A" side (M1) 6 volts exactly. Then balance your set.

At first the chances are that it will howl its head off. Tune in a weak station and adjust rheostats R1 and R2. Keep R4 turned on practically full. Tune to a midway frequency, let us say around 300 meters, such as KDKA, WRNY, etc. If the set howls, that is, oscillates too loud, adjust R1 and R2 carefully. Now the oscillation control R3 comes into use. *This oscillation control, by the way, is most important.* It is intimately related to R1 and R2. This oscillation control, that is, its high resistance of 100,000 ohms, controls not only oscillations, but volume as well. When it is turned all the way towards the right, stations, even the most powerful, becomes practically inaudible. Turning it to the left makes the set oscillate freely.

The trick of the set is to balance the three controls in such a way that the set will oscillate slightly, but not too loudly, on the highest wavelength. Then by tuning in the station at the lowest wavelength, around 200 meters, where the set oscillates most freely, it becomes a matter of carefully adjusting rheostats R1 and R2. No exact directions can be given on this, but five minutes' playing with the set will easily show you where the best point is. If the oscillations are too wild on all frequencies try reducing the R.F. voltage from 90 to 67½, or even 45.

THE "PERIDYNE" COMBINATION

But before all this is settled, we come to the most important part, and that is the "Peridyne" action. First, turn the movable shields all the way up, with the knobs extending as high as they can go. You will find, as a general rule (and I have tried this hundreds of times) that the following will be the best procedure.

Sitting in front of the set, we have the three cans with their knobs from left to right. The first is the antenna coil, the second the second radio-frequency coil, the third, the third radio-frequency coil. It will be found that, in most cases, the first knob is turned down lowest, the second higher, and the third one still higher. You will find that the middle coil is the most sensitive to the "Peridyne" shield tuning. This shield tuning should be attempted only when listening in to a DX station. On local stations it is difficult to balance the set. Inasmuch as all inductors and all shields vary, it is quite impossible to give exact directions as to how far down or up the tuning shield should be turned. But you will master this quickly by tuning for a weak station or a DX station. Then you will find that even a single turn makes a tremendous difference. Be *absolutely sure* that the screw which holds the shield is not loose in its bushing; otherwise there will be a rattle in the loud speaker. As I stated before, when you start compensating, turn all three knobs up as far as they go. Then manipulate the middle knob until the signal comes in loudest. Further compensation is then had by turning the knob until the signal comes in loudest. Further away the station, the more important the "Peridyne" action becomes.

It should be noted that, once the set has been balanced to its highest efficiency the "Peridyne" shields are never touched again. The set as described here must oscillate (though weakly) on the highest wavelength. It will do this when the oscillation control R3 is turned down all the way to the left. In this position the lower wavelengths will oscillate violently, in which case R3 is turned up more to the right. Remember, rheostats R1 and R2 are important in this, because they are intimately related to the oscillation control R3. *The "Peridyne" shields are really used only to bring the three-gang condensers, with their respective inductors connected to them, into resonance at exactly the same wavelength.* That is the reason why no compensating condensers are connected with the gang condensers.

When you have tuned in a DX station and you have balanced your set where the signal comes in loudest, you will find that you can leave all adjustments in this position and the stations will roll in, one after another, faithfully and with tremendous volume. In actual operation, rheostat R4 is set to its best position; with most sets this position will be with the rheostat practically turned on full. The quality of the signals can be bettered by very slight adjustments; even 1/16 of an inch makes a very big difference as the detector-coupled first audio amplifier is quite critical as to the filament voltage.

TUNING

If everything has been exactly compensated, you will now be able to tune the set with the two controls; namely, the knobs of the gang condenser and the oscillation control R3. You tune in any whistle of any station, then adjust carefully R3 until the whistle is cleared and the station comes in. As a rule, turning the knob towards the left will increase the loudness of the signal. If it is turned to the left, beyond a certain point, the set will oscillate and howl. On DX stations, even the most minute difference will result in a great change of volume. *If by any chance the action of R3 is reversed (that is, the loudest signals are when the knob is turned to the right rather than to the left) this immediately proves that the "Peridyne" shields are set wrong.* It means simply that the gang condensers and their respective inductances are out of resonance. You will quickly find that, by manipulating the knobs of the "Peridyne" shields, this condition is remedied, and will familiarize yourself with the correct action of the set. Once you get the hang of it you will never forget it.

You will find that this set tunes with an unheard-of sharpness and that even nearby stations can be easily cut out without background and overlapping of signals. As the set is extremely delicate, I recommend the use of only spring-type sockets. The tubes should be weighted down with separate antihowl tube weights, to keep them from howling, as otherwise they surely will do this, on account of mechanical feed-back from the loud speaker, particularly when the set is not placed in a cabinet. I therefore do not recommend use of the set except in a cabinet, to do away with audio feed-back from the loud speaker.

For city use, where DX reception is not desired, the oscillation control R3 can be practically eliminated. In that case the "Peridyne" shields can be used as lossers, by turning them down so that the shields come within a quarter of an inch of the coils or less. It will be found that, in this position, an effective balance of the set can be made very nicely; but it will tune somewhat broadly because it no longer oscillates, the shields now being used as actual lossers. But for city reception, where only a single, solitary tuning knob and no other controls are desirable, this method can be used; although in some locations there will now be some "cross-talk," particularly from nearby stations. They will seem to overlap because the set no longer tunes sharply. If it should tune too broadly, manipulation of rheostats R1 and R2 will bring the receiver nearer to the point of oscillation.

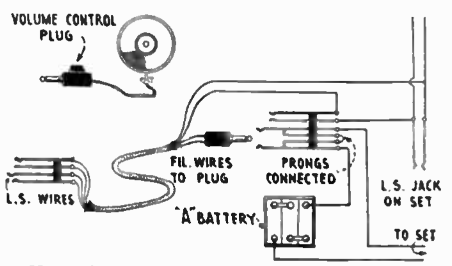
Of course, I personally, do not advocate the use of this set in this manner; that is, by using the "Peridyne" shields as lossers, because that is not the way they are intended to be used. But I have mentioned it for only the one reason; and that is, if the losser method is used, the set becomes really a very capable *single-control* receiver, with all that that words implies. But, of course, in that adjustment, the set is practically valueless when it comes to DX reception. DX reception and broad tuning do not go together.

I have found it desirable to use cable leads instead of binding posts in this set. The particular cable that I have used is most desirable and economical in the long run, because it is fused and will prevent blowout of the tubes.

I should be very glad to hear from those who have built the "Peridyne" Five and shall be glad to give technical advice to those seeking it.

REMOTE SET CONTROL

It is often convenient to be able to listen to radio programs by means of an extension cord to the bedside or other part of the house; but its disadvantage is that one has to go down to the set to turn it off. This trouble can be overcome by means of a four-wire extension cord, having one end connected to a double-circuit filament-control jack, which may be screwed to the side of the cabinet or radio table, and at the other end a single-circuit filament control jack



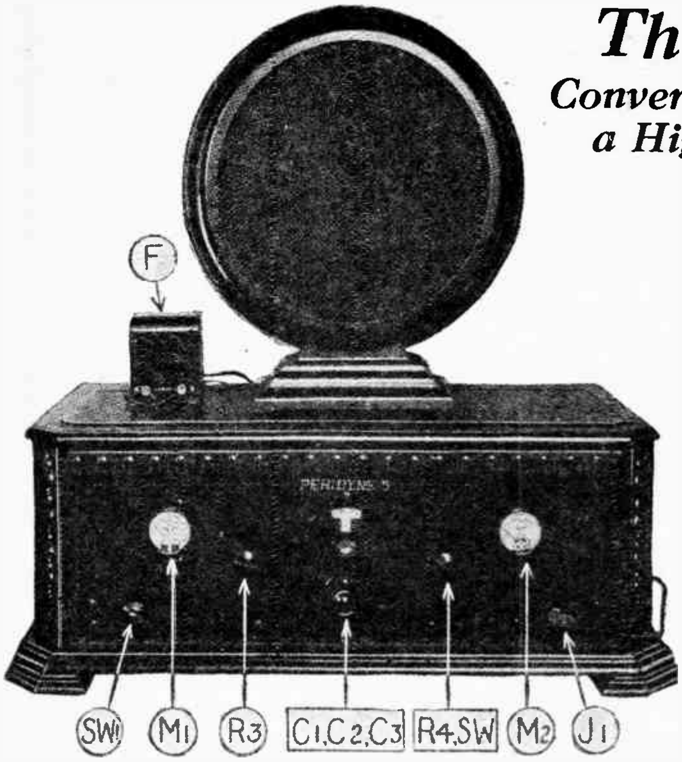
How the filament circuit can be controlled from a distant point.

with connections as shown in the diagram. pulling out the loud-speaker plug.

The Electrified Peridyne*

Converting the Battery-Operated Model into a Highly-Sensitive Receiver, Using the New A. C. Tubes

By Hugo Gernsback



The front of the Electrified Peridyne receiver; C1, C2, C3, the control for the condensers; R3, volume control; R4-Sw, combination switch and filament control; M1, A.C. voltmeter; M2, D.C. voltmeter; J1, single-circuit jack, and F, output filter. The components used in this receiver are designated alike in the illustrations and in the list of parts which gives their values.

IN designing the electrified Peridyne, the thought naturally was uppermost in my mind to make the conversion in such a manner that the original set will not have to be torn apart, or re-constructed, in order to convert it into an electric receiver. There are a number of alternating-current tubes available in the market now, all of which have their good qualities and their good points; but some of them have drawbacks when it comes to the electrification of a battery-operated set. For instance, the five-prong or Y-type tubes can, of course, be used; but this means ripping out at least one of the old sockets and putting in new ones, besides rewiring. Then there is another variety of alternating-current tubes, working on 3 volts, which also are satisfactory in their operation, but require an overhead "harness," which is run along the tops of the tubes.

I finally selected a four-prong heater-type tube, because experience showed that this type required the least constructional changes in the set and, after the experimental work had been concluded, it was found that a remarkably efficient electric set had been obtained. The power of the completed set is astonishing and, when using only 90 volts on the R.F. stages and full "B" power on the last audio stage, there is enough volume to operate a number of loud speakers and fill a large auditorium, from practically all nearby and local stations.

On comparing the wiring diagram of the electrified set with the wiring diagram of the battery set, it will be found that very few changes have been made. The only important one is the rewiring of the filament connections. A word of advice must be said here; and it is that, as those experimenters who have built alternating-current operating sets know by this time, the filament leads must be twisted, as indicated in the diagram and all the pictures. If the filament leads are not twisted, an objectionable hum will result.

REWIRING OPERATIONS

The particular alternating-current tube used in this set is a four-prong "heated-cathode" tube, operating on 15 volts; it consumes 0.35 ampere. This makes it possible to use a small toy transformer as an "A" power supply. It should also be noted that the filaments are no longer grounded. This means simply a little change, taking but a few minutes.

It is best, when rewiring the filament leads, to see to it that *two different colors are used*, never the same colors; because you are apt to get the wrong connection when both wires are of the same color. Please bear this in mind.

The other changes are all small: First, one of the voltmeters (M1) must be changed from 6-volt D.C. (which was the scale used in the D.C.-operated set) to a 25-volt A.C. instrument, for indicating the filament voltage.

Another minor change is the addition of a small fixed resistor of 60 ohms, indicated as R5 in the diagram, in series with the pilot light. This is necessary, otherwise DL (the 6-volt bulb usually supplied with a dial) will burn out.

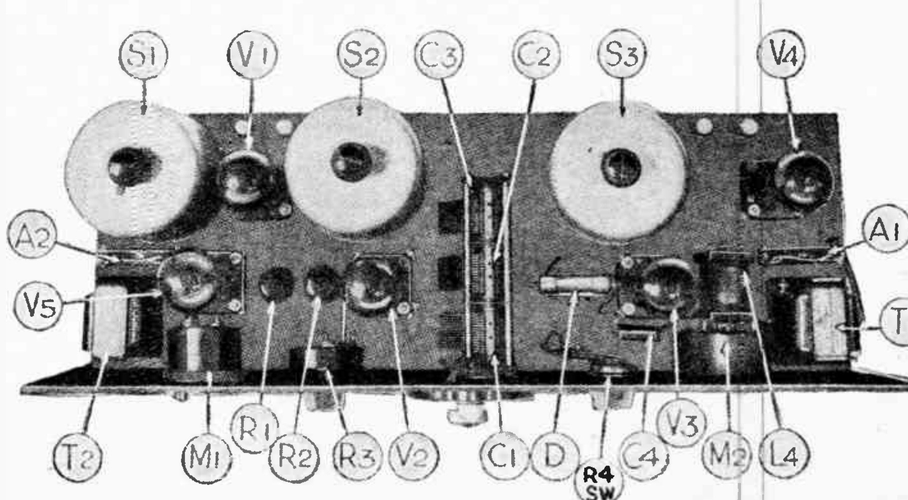
Another change is in the rheostat, R4, which now becomes a power switch. The new type listed in the specification sheet must be substituted. This is a 75-ohm rheostat with filament switch, and is structurally different from the one used in the battery set; as the latter cannot be used.

The only other change is condenser C4, which, in the battery set, was connected to the plate of the detector-coupled first audio-amplifier tube V3 and to "A—." It is now connected to the grid of that tube and to one of the filament leads, as shown.

TUBE CONNECTIONS

Right here, it becomes necessary to state that alternating-current tubes operate entirely different from direct-current tubes. If all the connections have been made, it may be found that there is a hum. This may be occasioned, particularly, by the filament leads being connected wrongly to the detector-coupled first audio amplifier. By reversing the leads, on this tube, the hum is usually done away with. On the rest of the tubes, always remember, that "B—" and "C+" leads must be connected to the *plus posts* of all tube sockets. The reason for this is that the cathode of the tube is connected to the plus post of the socket. This is the most important point and should not be overlooked, as no results will be obtained if these instructions are not followed.

In this set, the old cable (X) specified with the battery set is retained. In addition, we have two extra cables, each of two wires, termed "Y" cable and "Z" cable. Both of these cables are between six and



S1, S2, S3, Peridyne Shields; V1-V4, A.C. tubes; V5, A.C. power amplifier; T1, T2, A.F. transformers; D, detector; L4, R.F. choke coil; R1, R2, filament rheostats; A1, A2, resistor mountings.

* RADIO NEWS *Blueprint Constructional Article No. 45. (See page 104).*

eight feet long and are used to connect the set to the power plant. The "X" cable shown in the illustration is the same one used in the battery set, but the fuses at H should be removed and the clips short-circuited.

THE POWER UNIT

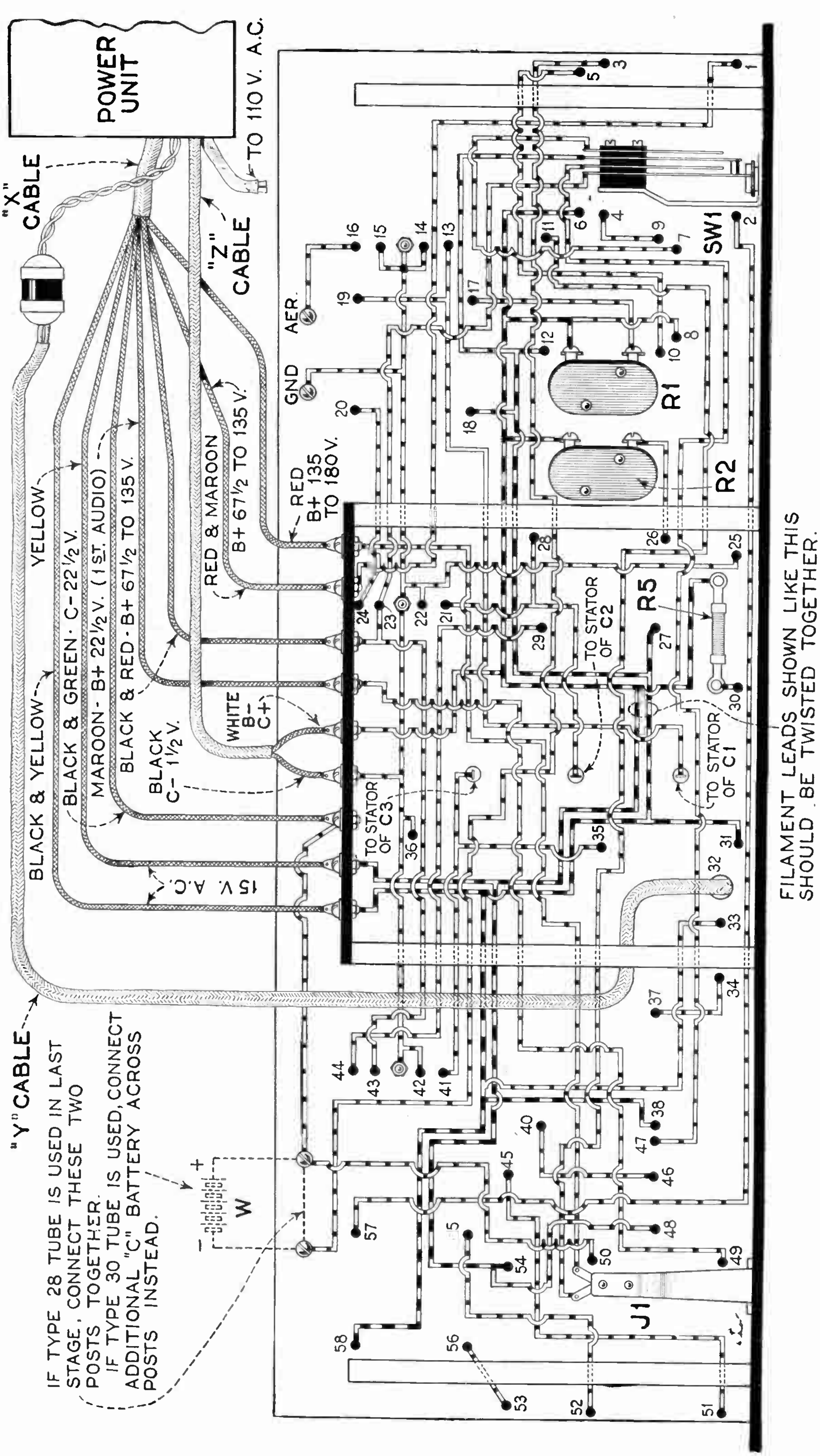
The power unit is remarkable for its simplicity and the small amount of space it takes up. It is one of the smallest power-supply devices, I believe, that has ever been described. It measures only 10½ inches long by 6 inches wide and 6 inches high; this is about the size of an ordinary storage battery. This unit is designed to be placed underneath the table, or in a cabinet console and should be at least four or five feet away from the set itself. The case may easily be constructed of ordinary sheet metal and painted to suit. Your tinsmith can make it for a small amount.

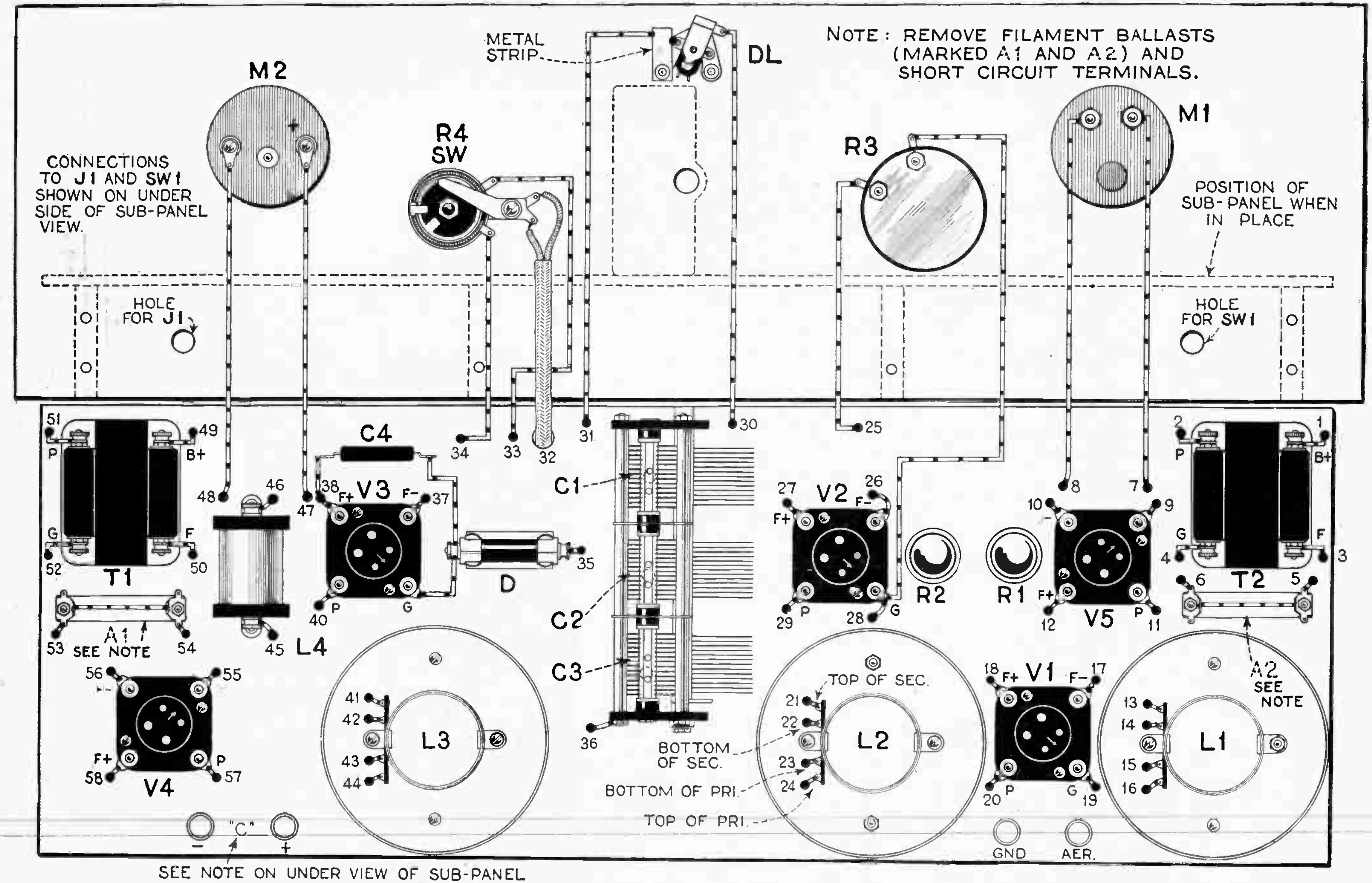
The switch Sw2, which controls the power, as well as rheostat D, are mounted on a small piece of bakelite, of the dimensions given in one of the illustrations.

The "B" supply is a standard "B" power unit, including a Raytheon tube. The type specified is the one which is best suited for the operation of these particular tubes, and will not give rise to "motor-boating" and other feed-backs. Moreover, it was selected on account of its very small size and compactness. The filament-heating transformer is a toy transformer, with a tapped switch, set for the correct voltage; *i.e.*, set for its correct voltage, which will be found on the name plate of the transformer.

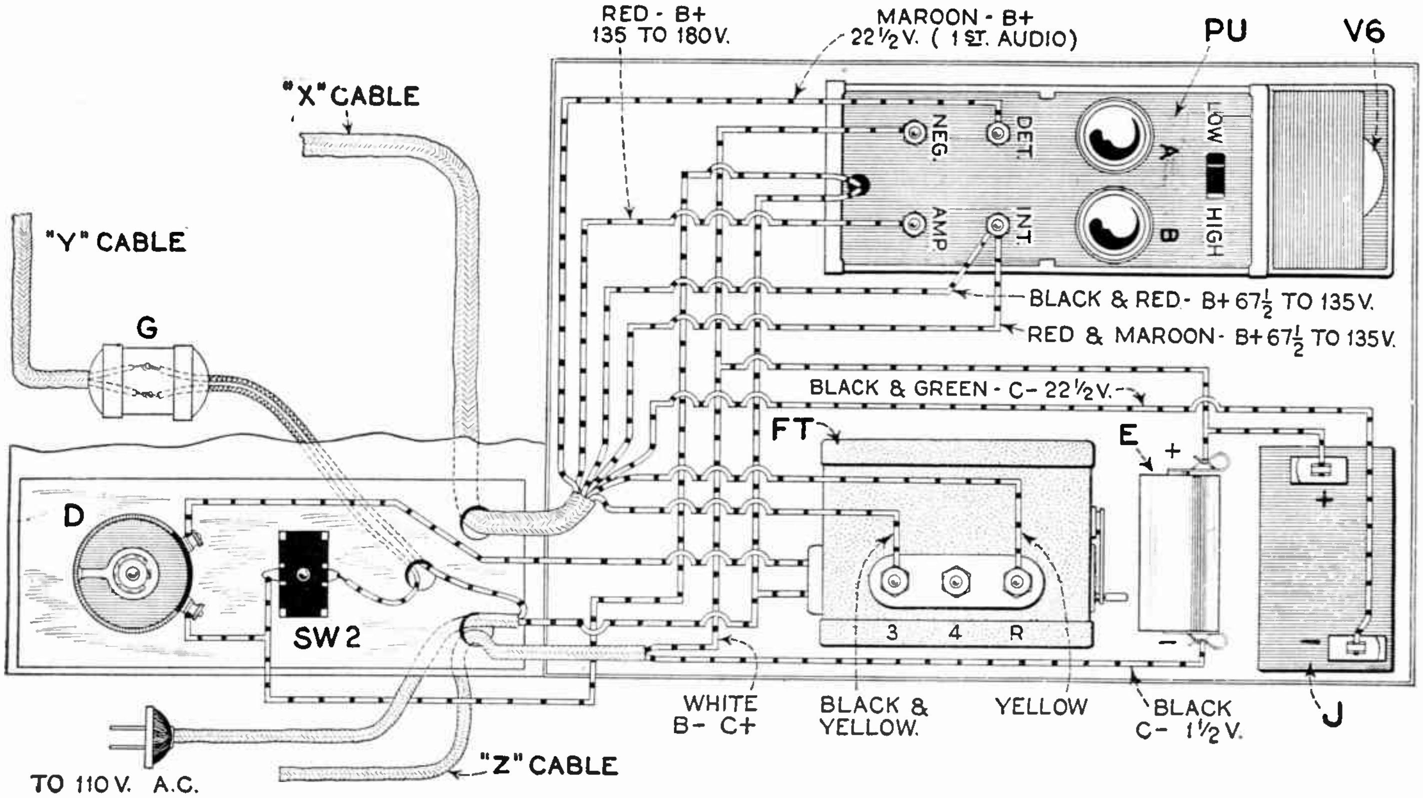
The entire assembly of the power plant is made as shown in one of the illustrations. There is just enough room left for the two "C" batteries, quite necessary for the successful operation of the set. Corrugated paper or asbestos can be used to house the two batteries, so that no short circuits can occur.

Once the "A" power unit has been assembled, it reuires no further attention. The "C" batteries will last for many months.





On the preceding page is shown the wiring beneath the sub-panel of the Electrified Peridyne 5. Above on this page are shown the connections from the components on the front panel and the top of the sub-panel. These parts bear the same symbols as those in the list of parts and the holes for leads through the panel are numbered alike in top and bottom views.



Wiring diagram of the power unit for operating the Electrified Peridyne. The schematic diagram of this unit will be found on another page of this article.

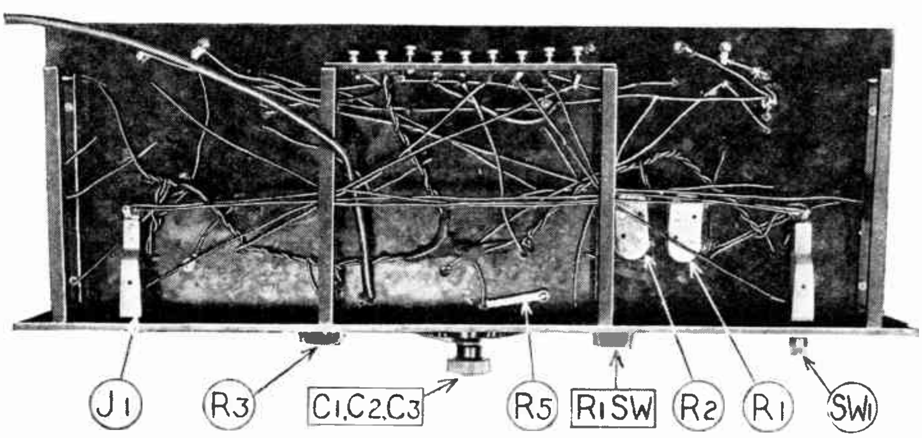
Extending from the power plant are the two knobs of the "B" power unit (A and B), used to adjust the "B" voltage; D is a filament control rheostat. It will be noted that there is used a connector G, in connection with the "Y" cable, which is necessary in case the power plant is to be disconnected from the set; while the leads of the cable can be soldered to the terminal board on the set. I would advise using binding posts of the spring-operated type; for the reason that, when the power plant is to be removed, the binding posts can be quickly disconnected, instead of unsoldering the connections—always a troublesome proceeding. It would be extremely difficult to transport the set and the power plant if they were connected together by means of all the cables, and it would then require two persons to carry the two units; whereas, if the cables are made with a connector, it becomes easy to disconnect. The leads to the 110-volt A.C. supply are connected to the usual plug, which goes to the socket.

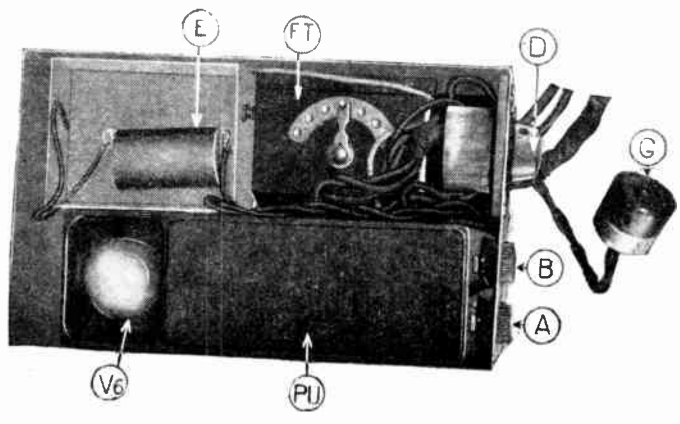
OPERATION

If all the connections have been made properly, and if the power plant has been built, we are now ready to operate the set. But before doing so, it should be remembered that the amperites in the filament circuit of the second and third audio amplifiers cannot be used with the 15-volt tubes; they are therefore removed and wire connections made across the two clips (A1 and A2). No filament resistor of any type is required with these two amplifier tubes.

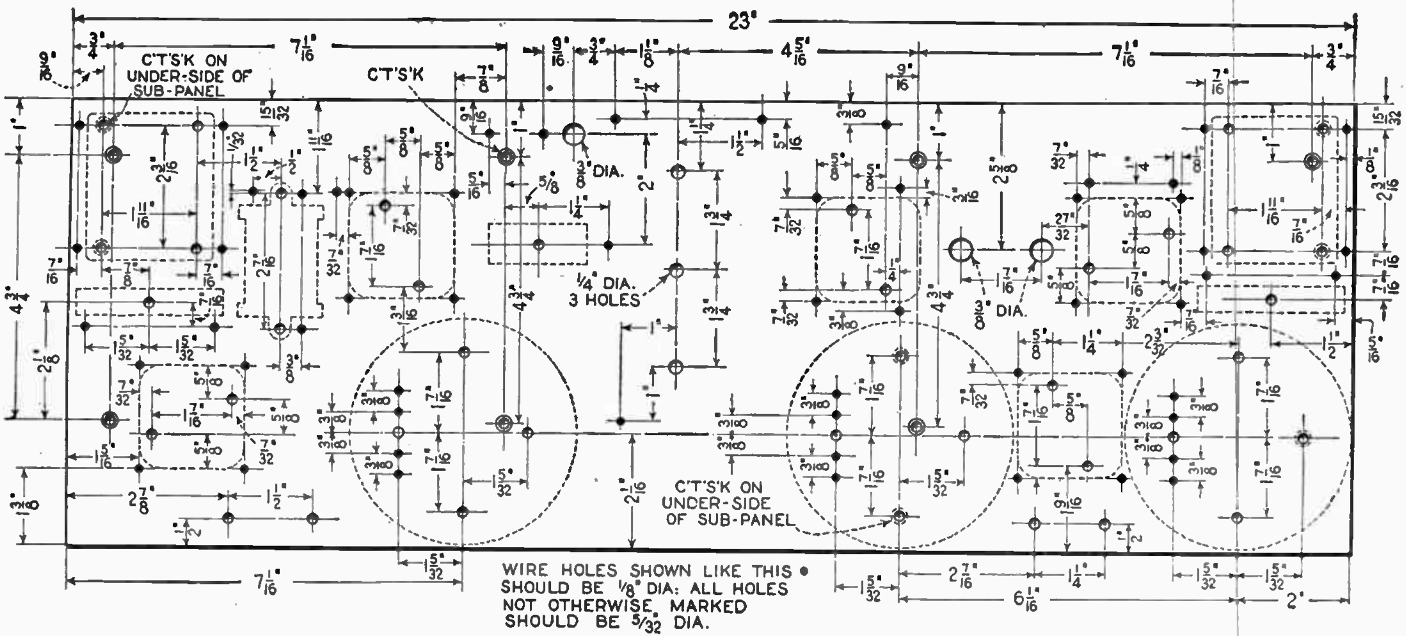
We are now ready to test the set, and if all connections have been made, the current is turned on. Of course, before you do so, you will have made sure, that connections have been checked carefully. For safety's sake, only a single tube should be operated in a socket, to make sure that everything is in ship-shape order. If the one tube lights satisfactorily, all the others are put in.

A peculiarity of these alternating current tubes is that it takes about thirty to forty seconds for the heater to heat up before the set begins to operate. A hum may be heard during that period, but it should not be loud. If everything is connected right and the "C" voltages are correct, the set will work with tremendous volume, and there should be no hum. If there is a hum, it should be so slight, that it is never noticable when a station is tuned in.





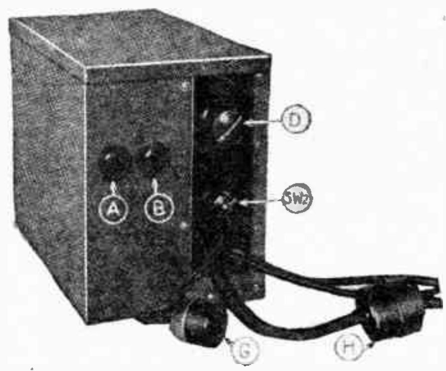
The under side of the Electrified Peridyne is shown above. The various parts are numbered in correspondence with the diagrams on the preceding pages. On the right is the top view of the power unit. E, a 1½ volt "C" battery; FT, filament transformer; D, filament rheostat; PU, "B" power unit; G, stage connector; V6, full-wave rectifier tube.



Drilling layout for the sub-panel of the Electrified Peridyne. The parts are indicated by the dotted outlines.

A most important point to remember with these A.C. tubes is that the "C" voltage is extremely critical. If any hum develops at all, it can usually be eliminated entirely by varying the "C" voltage. Usually, one and one-half volts (that of a single flashlight cell) is all that is necessary for the bias of the radio-frequency tubes; but on the second and third audio amplifiers, a "C" bias of from 4½ to 22½ volts is required.

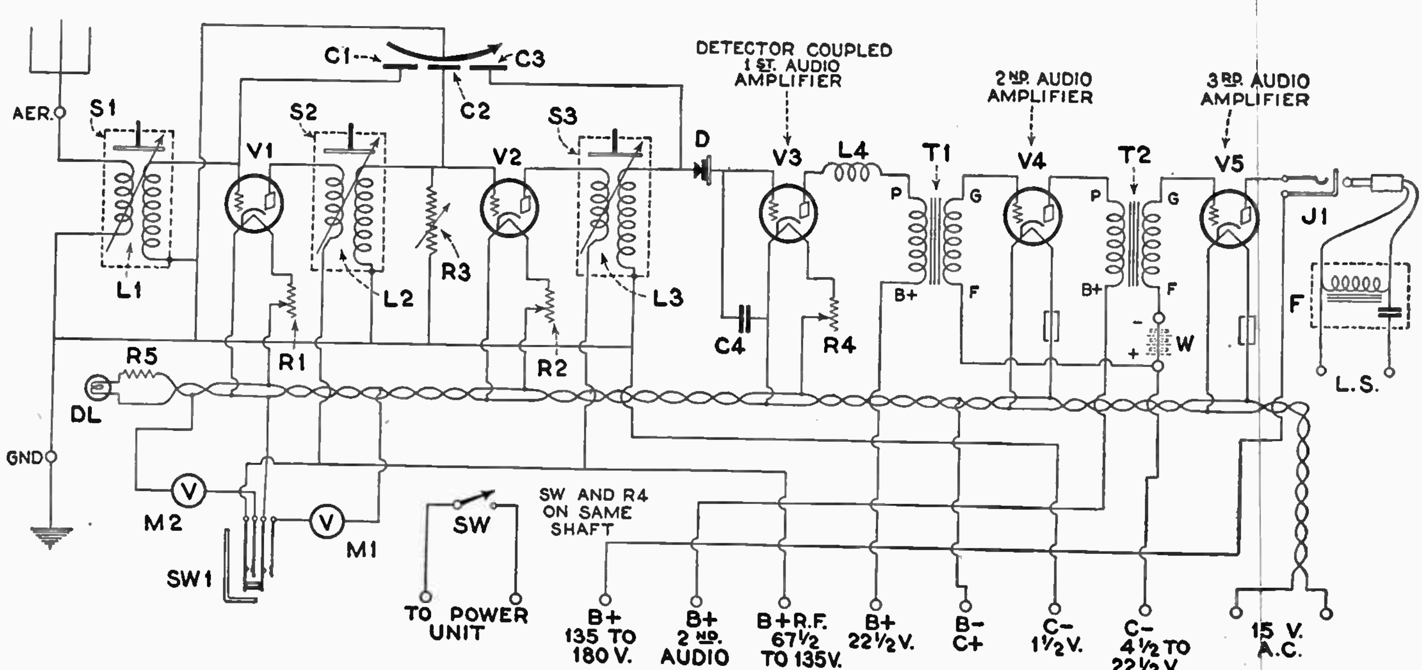
As tubes vary, as well as the circuit and transformer characteristics, no exact rule can be laid down here. You will have to try which voltage gives the best results. This can be ascertained in a few minutes' time. You will find that, when the correct "C" voltage is ascertained, the set will give an exceedingly sweet and pure tone, and there must positively be no distortion. The tone will be full and round, and there must be no hum.



Front view of power unit: SW2, 110-volt snap switch; H, fuse-block housing; A and B, plate-voltage rheostats.

Remember also, what I have said before, that the filament leads of the detector-coupled first audio amplifier may have to be reversed if a hum persists. It may also be necessary to change the capacity of condenser C4. The capacity of that condenser is shown as .001-mf.; this capacity may be either too large or too small under some circumstances, and many have to be changed, but it is not at all critical.

If the set operates well, but howls, that is, oscillates, this can be overcome by carefully balancing rheostats R1 and R2. Careful adjustment is necessary. Rheostat R4 is set only once for best quality and left that way. It is never used in tuning. Resistor R3 is used to stop oscillation and to bring in a station clear, once a signal has



The schematic diagram of the Electrified Peridyne. The similar diagram of the power unit for use with this set will be found on another page of this article.

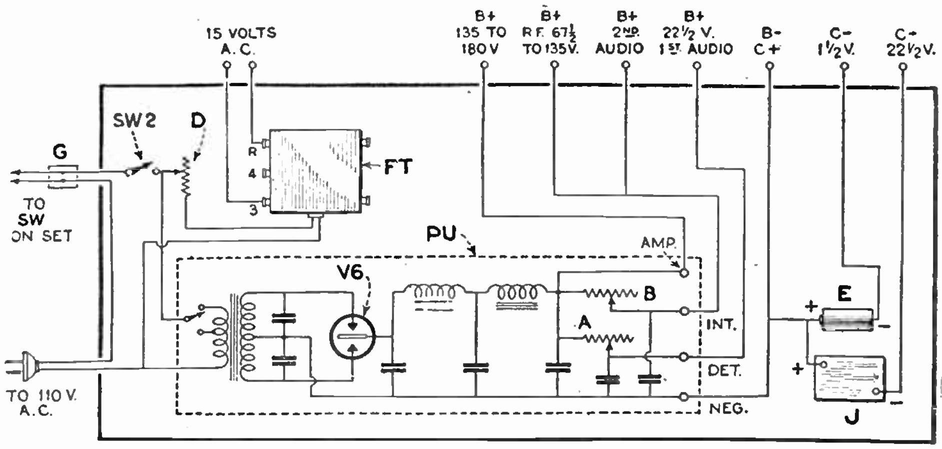
been tuned in. In this respect, the set works exactly like the battery set, and there is no difference here.

As the last audio stage in the receiver is a power tube equal to the 171-type, use of an output filter to protect the loud-speaker winding against the heavy plate current is advisable. This filter, which is indicated as F in the accompanying illustration of the front of the completed receiver, may be placed behind the set cabinet or inside a console, where it will be out of sight. It requires no adjustment of any kind, and once installed, may be disregarded.

The particular filter illustrated consists of an audio choke coil and a high-capacity fixed condenser in one case; there are a number of such filters on the market. An 1:1 ratio output transformer will serve the purpose just as satisfactorily.

Nothing need be said about the Peridyne action, which remains the same as in the battery set. I went to great pains to explain the action in my former articles and nothing need be added here; because the Peridyne action is not influeced at all by the electrification of the set itself.

I was particularly well pleased with the results obtained, and I have been able to duplicate all of the excellent results obtained with the battery set. In a single evening, I have tuned in over thirty DX stations, as far West as Denver, with the local stations in operation. I am quite certain that the Electrified Peridyne set will give the exact results of the battery set, as far as distance and selectivity is concerned. The set remains unusually sharp, the same as it was before, and there is no reason for doubt that this set will be every bit as popular as the battery set; which so far, has enjoyed an astounding popularity in, not only this country, but a great many foreign countries as well.



The schematic diagram of the power unit specially designed for use with the Electrified Peridyne.

SYMBOL	Quantity	NAME OF PART	REMARKS	MANUFACTURER ★	
C1,C2,C3	1	Triple Var. Cond.	.0005 mf. each section	1	2
L1,L2,L3	3	R. F. transformers	Special Peridyne units	2	
S1,S2,S3	3	Coil shields	Special Peridyne units	3	
T1,T2	2	A. F. Transformers	3:1 ratio	4	3,10,15,17,20,31,32,34,35,56
R1,R2	2	Rheostats.	Carbon type	5	
R3	1	Variable resistor	0-100,000 ohms	6	7,13,44
R4,Sw	1	Switch-rheostat	75 ohms (new type with insulated switch)	7	
R5	1	Fixed resistor	60 ohms, wire wound type	7	13,40,43,44
D	1	Crystal detector	Carborundum type	9	
L4	1	R. F. choke coil	85 millihenries	10	2,3,17
C4	1	Fixed condenser	.001 mf., mica type	11	7,13,30,31,32,39,40,41,42,38
M1	1	A.C. voltmeter	0 - 25 volts (special)	12	29,30
M2	1	D.C. voltmeter	0 - 150 volts	12	17,29,30
J1	1	Jack	Single circuit type	13	7,40,44,45
Sw1	1	Jack-switch	Two circuit type (D.P.D.T.)	13	7,44,45
V 1-4	4	A.C. tubes	4-terminal heated cathode - type 28	14	
V5	1	A.C. power tube	4-terminal heated cathode - type 30	14	
Sw2	1	Snap switch	110 volt type	7	13,20,44,45,55
FT	1	Filament transformer	Jr. toy type, 15 volts output	15	54
PU	1	"B" power unit	180 volts maximum output	4	
E	1	"C" battery	1-1/2 volts	16	52,53
J	1	"C" battery	22½ volts, 4-1/16 x 2-9/16 x 2-3/4 inches	16	52,53
D	1	Rheostat	30 ohms	17	1,6,7,13,20,31,40,43,44,45,51
X	1	Battery cable	7-wire	18	13,33,50
Y,Z	2	Battery cables	2-wire (lamp cord may be used)		
G	1	Stage connector			
F	1	Output filter	Audio choke-fixed condenser unit	20	1,31,56
V6	1	Rectifier tube	Full-wave, gaseous, 85 milliampere type	19	36,37
	1	Vernier dial		22	3,10,31,47,49
	5	Tube sockets	UX type	23	1,3,4,8,17,31,43,44,45,46,48.
	4	Binding posts		21	1,8,17,31,45
	1	Front panel	24 x 7 x 3/16 inches	24	26,27,28
	1	Sub-base panel	23 x 8 x 3/16 inches	24	26,27,28
	1	Terminal strip	7¼ x 1 x 3/16 inches	24	26,27,28
	1	Panel strip	7 x 2¾ x 3/16 inches (for power unit)	24	26,27,28
	1	Baseboard	10 x 6 x ½ inches (for power unit)		
#1, #2	2	Amperite mountings	(Not needed in A.C. operated set)	57	
	4	Rolls hook-up wire	Black, yellow, red and green	25	18,33
	4	Brackets	6¾ x 2 inches	24	
	1	Resistor mounting	For crystal detector	1	
	1	Sheet iron	22 x 26 inches, galvanized (for power box)		
	1	Sheet iron	7 x 11 inches, galvanized (for power box)		

NUMBERS IN LAST COLUMN REFER TO CODE NUMBERS BELOW.

1 Amsco Products, Incorporated	2 Hammarlund Manufacturing Company	3 Silver-Marshall, Incorporated
4 All-American Radio Corporation	5 Allen-Bradley, Incorporated	6 Central Radio Laboratories
7 Carter Radio Company	8 H.H. Eby Manufacturing Company	9 Carborundum Company
10 Samson Electric Company	11 Aerovox Wireless Corporation	12 Jewell Electrical Instrument Co.
13 Yaxley Manufacturing Company	14 Arcturus Radio Company, Inc.	15 Jefferson Electric Mfg. Co.
16 National Carbon Company	17 General Radio Company	18 Belden Manufacturing Company
19 Raytheon Manufacturing Company	20 Leslie F. Muter Company	21 X-L Radio Laboratories
22 The National Company	23 Benjamin Electric Mfg. Company	24 American Hard Rubber Company
25 Acme Wire Company	26 Micarta Fabricators, Incorporated	27 Formica Insulation Company
28 Diamond State Fiber Company	29 Weston Electric Instrument Co.	30 Roller Smith Company
31 Electrical Research Labs. (ERLA)	32 Sangamo Electric Company	33 Cornish Wire Company
34 Thordarson Electric Mfg. Company	35 American Transformer Company	36 C.E. Manufacturing Co. (CeCo)
37 ORS Music Company	38 Dubilier Condenser Corporation	39 Tobe Deutschmann Company
40 Electrad, Incorporated	41 Polymet Manufacturing Company	42 Micamold Radio Corporation
43 De Jur Products Company	44 Herbert H. Frost, Incorporated	45 Hart & Hegeman Manufacturing Co.
46 Alden Manufacturing Company	47 Brooklyn Metal Stamping Co. (BMS)	48 Air Gap Products Company
49 Kurz Kasch Company	50 Howard B. Jones	51 Federal Radio Corporation
52 Burgess Battery Company	53 Diamond Elec. Specialties Corp.	54 Lionel Corporation
55 Cutler Hammer Manufacturing Co.	56 Karas Electric Company	57 Radiall Company

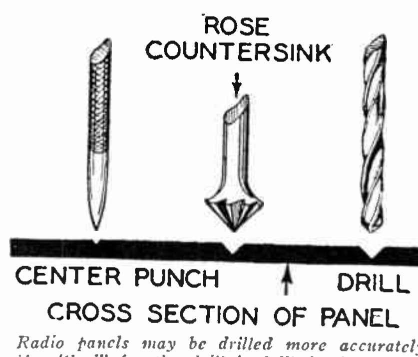
★ THE FIGURES IN THE FIRST COLUMN OF MANUFACTURERS INDICATE THE MAKERS OF THE PARTS USED IN THE ORIGINAL EQUIPMENT DESCRIBED HERE.

If you use alternate parts instead of those listed in the first column of manufacturers, be careful to allow for any possible difference in size from those originally used in laying out and drilling the panel and sub-base.

HOW TO DRILL HOLES EXACTLY AS LAID OUT ON THE PANEL

By Lester P. Young

No one knows better than the amateur radio constructor the difficulty of drilling a panel so that it comes out perfectly true. A panel may be laid out correctly and the center punch used for locating the start of the drill; and yet, due to the travel of the drill point, the drill holes will be off center.



Radio panels may be drilled more accurately if a "bed" for the drill is drilled with a rose countersink, after the spot has been center-punched.

A simple method for overcoming this trouble follows: the panel is laid out in the usual way with the center punch. Then with a rose countersink drill out a "bed" which will just take the slope of the drill point, as shown in the illustration. This scheme is a sure way of starting the drill point on true center and never fails of getting a hole drilled where it is wanted.

The Strobodyne Circuit

A New Frequency Changer

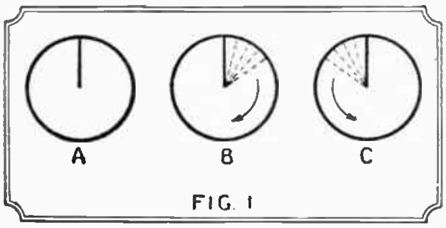
By Lucien Chrétien (Paris, France)

HERE is another circuit with a "dyne" ending! True, there are many "dynes" already, but the only way to distinguish something new from something already existing is to christen it. The name "Strobodyne" was coined because the system employed is somewhat similar in operation to the Stroboscopic phenomenon, which is explained in this article, and to distinguish it from other circuits derived from the superheterodyne.

The main characteristic of the superheterodyne, tropadyne, second-harmonic "super" and the like is the interference of the incoming signal with local oscillations, the intermediate frequency being produced after the resulting beat note is detected. The detection may be obtained by any standard method, such as grid condenser and leak, operation on the bend in the tube's grid voltage-plate current characteristic, crystal, etc. In the ultradyne there is no detection as generally understood; there is *modulation*. Modulation is accomplished also with the double-grid tube, but the actual functioning is different.

THE STROBOSCOPIC PHENOMENON

If a black line is painted on a white disc mounted on the shaft of a motor (Fig. 1A),



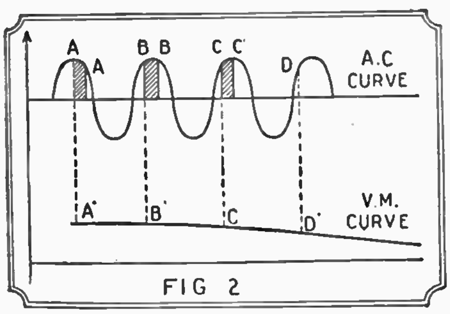


Fig. 1 illustrates the apparent slow rotation of the line, known as the stroboscopic phenomenon. Fig. 2 shows the electrical variations measured by the ondograph.

when the motor turns at a speed of say 1,500 revolutions per minute, the line becomes invisible. Now suppose that the electric light in the room is turned on and off 1,499 times a minute. You will then see the black line turn slowly around the disc at the speed of one turn a minute, like the second hand on a clock (Fig. 1B). This effect may be accomplished either by using as the source of light, a neon tube supplied with alternating current of the proper frequency, or by placing between the observer and the disc a rotary shutter revolving at the proper speed.

The "frequency" of rotation of the disc in this case is 1,500 r.p.m., that of the light 1,499, and the resulting frequency 1,500 minus 1,499, or 1. This explanation should make the stroboscopic (from the Greek "twisting of vision") phenomenon clear.

If the black line on the disc is as shown at A (Fig. 1), when the motor starts one may see it. The light goes out during 1/1499 of a minute, then goes on again; during this time the disc will have revolved one turn plus 1/1500 of a turn. When the light goes on again the observer will see the line a little further towards the right (supposing that the motor turns in clockwise direction). As this action takes place rapidly, it seems that the black line is moving around the white disc like the hand of a clock. If the light were turned on and off 1,500 times a minutes, the black line would appear to be motionless (as in Fig. 1A) although the disc would actually be revolving at 1,500 r.p.m. If the light is turned on and off at a slightly greater speed, the black line will appear to turn backward (Fig. 1C).

This same effect is obtained in numerous cases wherever there is a periodic motion. For instance, one may observe the action of an automobile engine running at 3,000 r.p.m. by means of a light turned on and off 2,999 times a minutes. The engine would appear to turn at 1 r.p.m. and the action of the pistons, valves, etc., could be observed as if seen in a slow-motion picture.

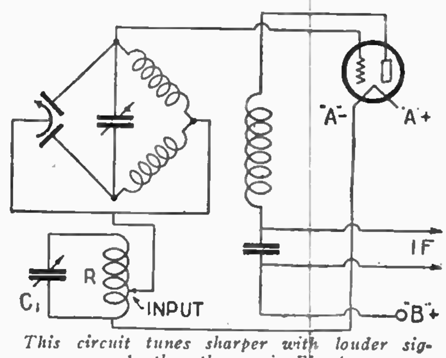
AN ELECTRICAL ANALOGY

The Strobodyne circuit, which is now presented here for the first time, is based upon the same principle, except that electric actions take place instead of optical ones. A similar system is used in the "Ondograph," a French instrument designed to register the waveform of alternating power currents. The explanation of its operation will greatly help the reader to understand the operation of the Strobodyne, so we shall review it here briefly.

For instance, to determine if a 50-cycle A.C. generator produces harmonics, the Ondograph is connected to it. It is composed of a small synchronous motor (whose speed is regulated by the frequency of the current) operating a commutator through a train of gears designed to rotate it 49 times while the motor revolves 50 times. This commutator connects in the circuit a condenser, the voltage across which is measured by a registering voltmeter. The operation may be better understood by referring to Fig. 2. If the commutator closes the circuit at the point A on the A.C. curve, the condenser becomes charged and discharges through the voltmeter, which indicates the voltage A^1 (V.M. curve). During the next cycle the commutator again closes the circuit but 1/50 of a turn later, on account of its rotating more slowly than the motor. At B the condenser is charged again, and the voltmeter registers as shown at B^1, indicating a slightly lower voltage. Since the voltmeter is highly damped and does not fluctuate between successive readings it indicates the various values of voltage every 1/49 of a second; and one may see the variations of a 50-cycle alternating current registered at the speed of 1 cycle a second. This apparatus, in other words, is a true frequency changer.

THE STROBODYNE PRINCIPLE

Now suppose that, instead of low-frequency alternating current, radio frequencies are used. We replace the condenser-voltmeter system by a circuit containing inductance and capacity, forming an oscillating circuit, and if it is tuned to the intermediate frequency a current will flow through it every time a beat note is produced. At any given instant the oscillations through the circuit will have an amplitude which is in direct ratio to that of the applied ones. This means that if the applied oscillations are modulated, the intermediate frequency will also be modulated. When there is resonance between the oscillating circuit and the successive impulses passing through the commutator, each impulse is applied in phase with those already flowing through the circuit. This is the principle used in the Strobodyne. The only thing to find is the commutator to operate at radio frequencies. In the Ondograph, alternating currents of 50 cycles or so are used, but now high-frequency currents of the order of 1,000,000 cycles and more are to be handled.



This circuit tunes sharper with louder signals, than the one in Fig. 4.

One may readily understand that it would be impossible to build a mechanical commutator to operate at these frequencies. However, thanks to modern physicists, the smallest known particles of matter, electrons, are now domesticated and the vacuum tube supplies the commutator which we shall use.

THE TUBE COMMUTATOR

When a vacuum tube oscillates at a wavelength of 300 meters, corresponding to 1,000,000 cycles per second, the grid becomes alternately negative and positive 1,000,000 times a second. When it goes positive a current flows through the grid-filament circuit and the grid-filament space-resistance decreases. It decreases so much, in fact, that as far as radio frequencies are concerned, a circuit connected to the grid is practically short-circuited. On the contrary, when the grid goes negative, the grid-filament resistance becomes practically infinite. It can therefore be seen that a circuit connected between the grid and filament may be considered as being shirt-circuited 1,000,000 times a second. This action provides the automatic commutation required.

THE STROBODYNE CIRCUIT

Using the foregoing explanations, we may now show in detail the functioning of the Strobodyne. See Fig. 3. R is the tuning circuit through which the received oscilla-

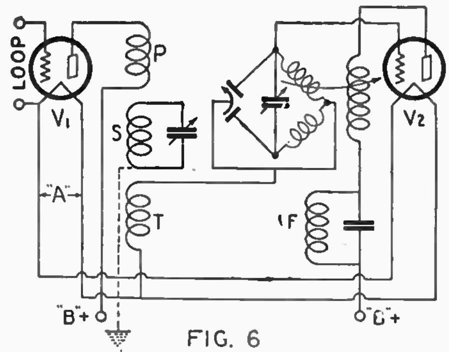


FIG. 6

A further improvement on the circuit shown in Fig. 5, having the R.F. transformer in three sections.

tions, the frequency of which is to be lowered, are applied to the tube. This circuit is coupled either inductively (or capacitively as shown by the dotted lines) to the circuit, IF, tuned to the intermediate frequency. G is a circuit tuned to the frequency of the local oscillation to be generated by means of the feed-back coil, P. This simple diagram will allow us to show, among other things, that there is in this case neither modulation nor detection.

One of the main advantages of the system is that the tube is used not only as an oscillator-controlling bulb, but also as an amplifier. This is probably why, for a given number of tubes, the Strobodyne is generally more sensitive than other "supers."

The diagram shown in Fig. 3 is practicable, but its operation is not quite as explained in the description of the Ondograph (Fig. 2). In the case of the latter, the commutator acts during a very short time, this being even reduced in the diagram to mere points (A, B, C, D, etc.). But it is easy to show that the same phenomenon occurs if the time of operation is longer, so long as it does not extend over exactly a full cycle or one of its harmonics.

If one assembled the circuit shown in Fig. 3, several difficulties would appear at once. The oscillations through circuit G would stop for some settings of the tuning condenser, C1, because the local oscillations would be close in frequency to the received ones. It is, therefore, necessary to use some form of circuit in which the tuning of one circuit does not affect the other; in other words a system similar to that used in the tropadyne. However, note that in the Strobodyne no instrument such as a grid condenser or grid leak for detecting is employed.

AN IMPROVEMENT

After a great many tests the circuit shown in Fig. 4 was developed. The diagram shows the typical Wheatstone-Bridge arrangement. The tuning and oscillating circuits, R and G, have been transposed, but this does not change the operation of the circuit. In this hook-up the center of the coil, M, is connected to the center of the capacity, C2; but, since it is not possible to get to the center of the dielectric (unless a double condenser is used), a tap is made between two small capacities (C3 and C4), which may consist of a compensating condenser having one rotor and two stators. Since this capacity is in parallel with that of the variable condenser, it should be as small as possible, in order not to reduce the tuning range of C2.

This arrangement has the advantage that, if the point, M, is not exactly in the center of the coil, the circuit may be balanced by adjusting the compensating capacities, C3 and C4.

CONDITIONS REQUIRED FOR STABLE OPERATION

How should the Strobodyne tube work? During the half-cycles when the grid is positive the signal should be suppressed. Circuit R should be short-circuited by the low-grid-filament resistance. This takes place with a fairly high potential on the grid; from which it follows that oscillations produced through the oscillating circuit, G, should be fairly strong. During the half cycles when the grid is negative the tube should amplify. This amplifying effect would be suppressed if the grid were made too negative (in which case the plate current would fall to zero) or even if the operating point were brought below the lower bend of the characteristic curve of the tube. It is therefore necessary that the amplitude of the local oscillations should be not too great.

These two conditions limit the amplitude of the oscillations, which control the sensitiveness of the system. To adjust the amplitude of the generated oscillations we may, for instance, vary the plate voltage or the coupling between the plate and grid coils of the oscillating circuit. In practice we have used both of these methods, as will be explained later.

OBTAINING SELECTIVITY

The main feature of all novelties is that there are always some surprises which spring up when least expected. This new circuit did not fail to conform to the rule and we found that, although the sensitiveness was great, the selectivity was practically non-existent.

Condenser C2 would have barely any effect on the tuning. This was, of course, an unwelcome fact, but it tended to show how different the system is from the standard circuits. However, after looking it over, one may see that this lack of selectivity may be easily explained: the tuning circuit is practically short-circuited half the time and this damping effect is the cause of the very broad tuning.

To overcome these defects various methods could be used. For instance, a part only of the tuning circuit could be inserted in the common grid circuit (Fig. 5). The damping effect in this case varies with the autocoupling between the two circuits. However, if the tuning circuit were so connected, one might think that only part of the signal voltage would be applied to the grid of the tube; this, naturally, would be a waste of precious energy.

This would be true if there was a certain fixed amount, but since the voltage developed across the circuit depends upon its damping, it is evident that the less the damping produced by the local oscillations, the greater the signal voltage received. This is proved experimentally, because the circuit of Fig. 5 tunes sharper and the signals are louder than with that of Fig. 4. Before proceeding further, we may say that the arrangement of Fig. 5 is that used in the complete receiver. It allows the writer, who is located in Paris (France), to hear most of the European stations after four o'clock in the afternoon, using a loop only one foot square.

REMARKABLE SENSITIVITY

The secret of the great sensitiveness obtainable with this circuit lies, we believe, in the fact that the tube amplifies, while in standard superheterodynes the tube used as a frequency changer is also a detector. Since a detector produces in the plate circuit a variation equal to the *square of the applied grid voltage,* it follows that a very weak signal produces barely any variation in the plate circuit. On the other hand, an amplifying tube produces in the plate circuit a response which is proportional to the amplifying characteristic of the tube and to the voltage applied to the grid. The difference in sensitiveness between the two systems is readily apparent when weak signals from distant stations are being received.

On a very weak signal the amplification obtainable with the Strobodyne is equivalent to that of a standard superheterodyne with a stage of radio - frequency amplification ahead of it. The Strobodyne with one stage of T.R.F. is tremendously sensitive, the addition also improving the selectivity considerably. This, however, introduces a third control. The main problem is the connection of the R.F. stage.

This may be done as shown in Fig. 5 by taking a tap on the secondary of the transformer; but we have found that the following arrangement is better. The circuit is drawn in Fig. 6. The R.F. transformer has three windings; the primary, connected in the plate circuit; the secondary, which is tuned; and the coupling-winding T, which reduces the damping effect upon the tuning circuit.

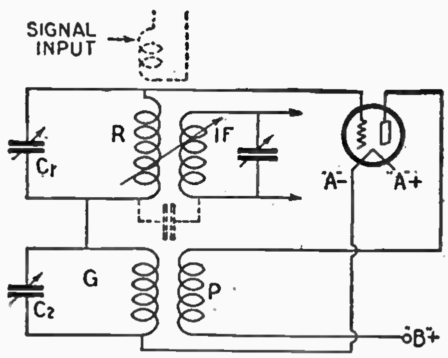


FIG. 3

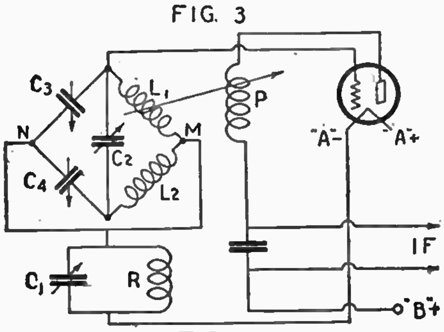


FIG. 4

By the circuit in Fig. 3 it can be shown there is neither modulation nor rectification in the tube. Fig. 4 shows a Wheatstone Bridge circuit incorporated in the hook-up.

The Screen-Grid Strobodyne Receiver*

A Supersensitive Set Utilizing an R.F. and Two Intermediate Stages of High Amplification and Push-Pull Audio Output

By R. E. Lacault

IT has been stated that the new screen-grid tubes may be used only in special circuits. Because of this fact, it was considered inadvisable to attempt to adapt the original model of the Strobodyne to these tubes. It would be possible to make elaborate changes in the set which might permit the incorporation of screen-grid tubes; but the circuit would not be highly efficient, and therefore little or no advantage would be gained by the change. On the other hand, these additions and alterations to the original Strobodyne would complicate the receiver to such an extent that, probably, it would not be as satisfactory as with 201A-type tubes.

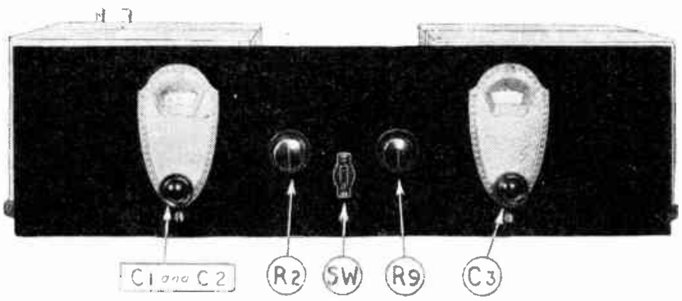


Fig. D. The two illuminated vernier dials are the only wavelength tuning controls of the receiver. R2 is a filament rheostat and R9 the volume knob. The battery switch (SW) is the only other control mounted on the front panel.

REDESIGNING THE RECEIVER

However, experimenters may avail themselves of the combined advantages of the Strobodyne circuit and of screen-grid tubes by another method. The writer has developed a new model of the Strobodyne, which has been designed especially to take full advantage of the high amplification factor of screen-grid tubes; this new receiver, which is fully described in this article, is known as the "Screen-Grid Strobodyne," and is believed by the writer the most sensitive receiver of its kind in existence.

When designing the Screen-Grid Strobodyne, the writer's chief desire was to build a receiver possessing maximum selectivity. Secondly, he endeavored to make the construction as simple as possible. Thirdly, selectivity, tone quality and ease of operation were considered. The design which is presented herewith measures up to expectations in every way. It is believed that the receiver has been built in the simplest manner possible, and that it is no more difficult to operate than the average superheterodyne; in fact, much simpler than most. The sensitivity is sufficient to reach the noise level at all times, and therefore, nothing more can be expected or desired in this direction. By virtue of the screen-grid tubes the intermediate-frequency amplifier provides enormous amplification, the selectivity is more than enough to satisfy all conditions, and excellent quality of reproduction is obtained by using push-pull audio amplification with power tubes in a transformer-coupled circuit.

IMPORTANCE OF DETAILS

A glance at the diagrams on these pages may cause the reader to think that the construction of the set is unnecessarily complicated. However, it must be remembered that, because of their great amplification, in circuits using screen-grid tubes special precautions must be taken which are not necessary in the average set. Each circuit and each screen-grid tube must be shielded very carefully. R.F. choke coils and by-pass condensers are needed in many positions in the circuit, and the arrangement of apparatus must be considered very carefully in order to prevent undesired coupling. Therefore, it will be necessary for the set builder to endeavor to duplicate in every particular the receiver illustrated here, if he is desirous of taking full advantage of the high amplification obtainable from screen-grid circuits.

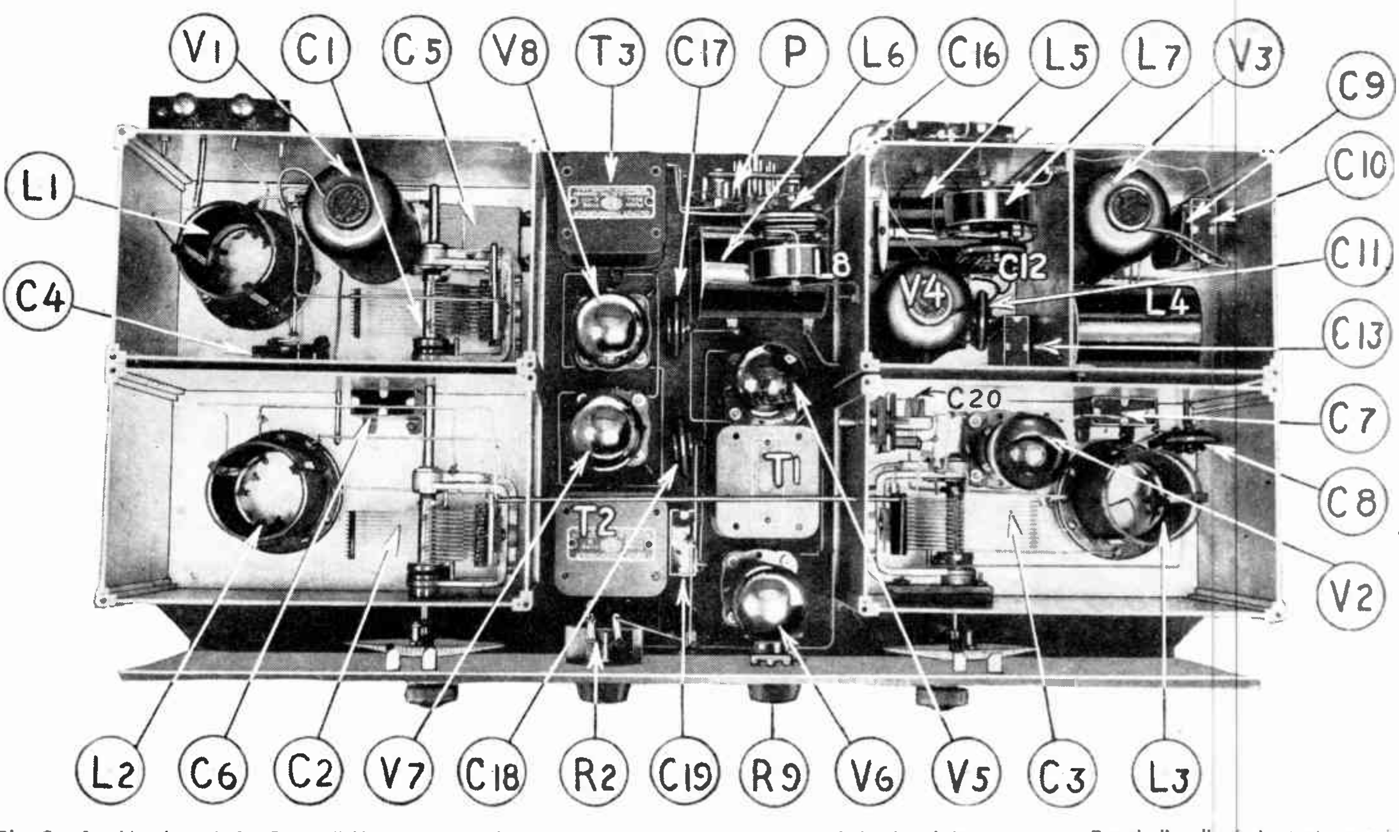


Fig. C. In this view of the Screen-Grid Strobodyne, the set, with the shield covers removed, is viewed from the top. Practically all of the parts may be located in this picture; the symbols used correspond to those employed in the other illustrations, text and list of parts.

* RADIO NEWS *Blueprint Constructional Article No. 63.* (*See page 104.*)

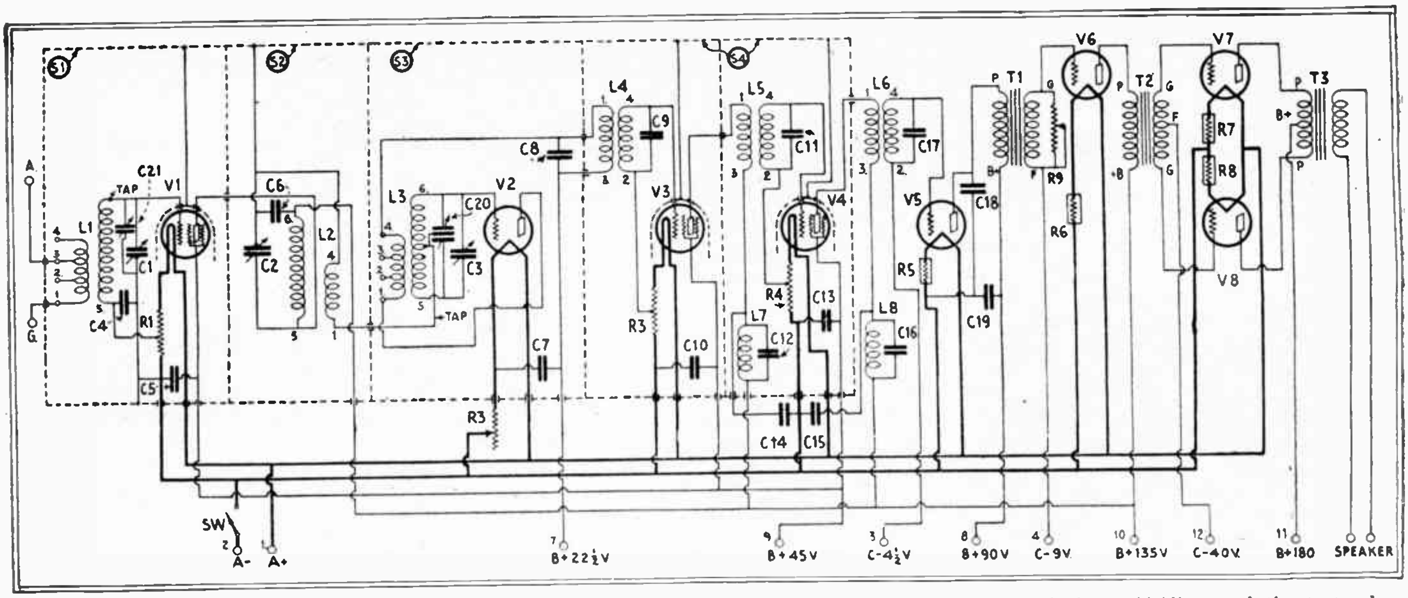


Fig. 1. The complete schematic circuit diagram of the Screen-Grid Strobodyne is given above. The dotted lines indicate shielding, and the parts shown within the dotted lines are located in the shield compartments.

In order to perfect the design of the Screen-Grid Strobodyne as much as humanly possible, two receivers of the new model were constructed. The two have been tested in various locations in New York City and in several laboratories. In this way the author was able to assure himself that the Screen-Grid Strobodyne will perform satisfactorily under various operating conditions, and also that it can be duplicated easily. While it is not possible to state what any set will do in any particular location, because local conditions even over a small area affect results, it has been proved by these tests that, as far as sensitivity is concerned, this receiver far outperforms many eight- and nine-tube receivers which previously were considered of the highest sensitivity.

In test at one location in New York City, it was found that, with the shielding securely in place and the aerial and ground wires disconnected, it was impossible to pick up any trace of signals. However, with a piece of wire *less than one foot long* connected to the aerial binding post, it was possible to receive all New York City stations with good volume. When using a wire four feet long as an aerial, and without a ground connection, Philadelphia stations were received at noon with good volume.

With the Screen-Grid Strobodyne, the word "Sensitivity" takes a new meaning and a new radio realm is opened to the owner of one of these new sets; provided it has been constructed carefully and as described in this article. To tell the truth, the writer was himself astonished at the results obtained with the set, although he had worked on the design for several months in order to make every detail perfect and to secure the maximum efficiency from each circuit Therefore, he. feels sure that the results from the receiver will surprise agreeably any experimenter who builds it.

COMPONENTS NEEDED

The following is a complete list of the parts required for the construction of the Screen-Grid Strobodyne receiver:

Three variable condensers, .0005-mf., removable-shaft-type (C1, C2 and C3);
Three R.F. transformers, screen-grid-type (L1, L2 and L3);

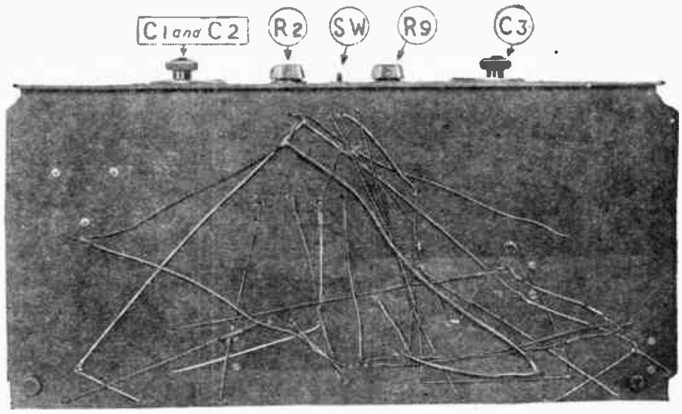


Fig. E. A large part of the wiring is located under the baseboard of the receiver, as shown in this picture. A majority of these wires are battery connections direct from the cable plug.

One A.F. transformer, standard-type (T1);
One A.F. transformer, push-pull input-type (T2);
One A.F. transformer, push-pull output-type (T3);
One volume-control resistor, 0-100,000-ohm (R9);
One filament rheostat, 0-20-ohm (R2);
One battery switch, toggle-type (SW);
Four aluminum shields, 5 x 6¼ x 9 inches (S1, S2, S3 and S4);
Two filament-ballast resistors, 201A-type (R5 and R6);
Two filament-ballast resistors, 112-type (R7 and R8);
Three tapped fixed resistors, 10-25-ohm (R1, R3 and R4);
Two R.F. choke coils (L7 and L8);
One intermediate-frequency transformer (L4);
Two intermediate-frequency transformers, screen-grid type (L5 and L6);
Six fixed condensers, matched, .00025-mf. (C8, C9, C11, C12, C16 and C17);
One fixed condenser, .002-mf. (C18);
Nine by-pass condensers, 0.5-mf. (C4, C5, C6, C7, C10, C13, C14, C15 and C19);
One double-stator balancing condenser, maximum capacity 50 mmf. per stator (C20);
One equalizing condenser, 2-20-mmf. (C21);
Eight vacuum-tube sockets, UX type;
Two tuning controls, vernier illuminated type;

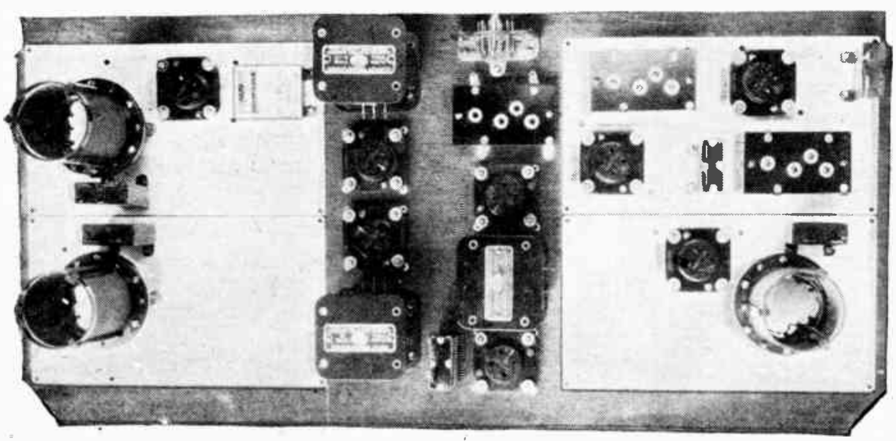


Fig. A. This picture shows the completion of the first step in constructing the receiver. The apparatus illustrated is mounted on the baseboard and then the wiring is started in the A.F. amplifier and from the cable plug to various points in the set.

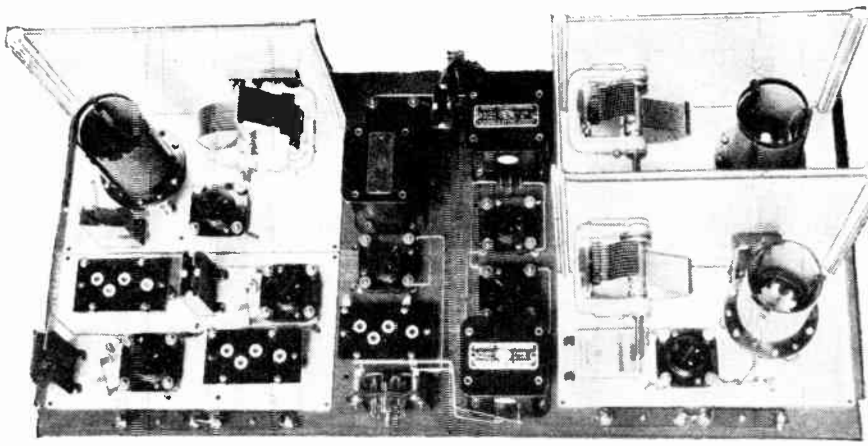


Fig. B. The second step in the assembly of the receiver is shown above; the front sections of three of the shield compartments are erected and the variable condensers are mounted in their proper positions. With the set in this condition it is possible to practically complete the wiring.

Three copper tube-shields, screen-grid type;
Three adapter rings for tube-shields;
One battery cable and plug, 12-wire type (P);
One extension condenser shaft 10¼ inches long, ¼-inch diameter;
One wooden baseboard, ½ x 12 x 25¼ inches;
One Cortland panel, 3/16 x 7 x 24 inches;
Two insulating mounting plates for variable condensers, 2¼ x 1½ x 3/16 inches;
One binding-post strip, 3 x ¾ x 3/16 inches;
One binding-post strip, 3½ x 1 x 3/16 inches;
One ¼-inch bakelite rod, 4 inches long;
Forty feet of flexible insulated hook-up wire;
Twenty feet of No. 16 gauge bus bar;
Three clips for screen-grid tubes;
Three screen-grid tubes (222-type) (V1, V3 and V4);
Two standard amplifier tubes (201A-type) (V2 and V5);
One semi-power tube (112A-type) (V6);
Two power tubes (171-type) V7 and V8).

In addition to the radio parts described above, the following hardware is needed in building the receiver:

Eighteen 6/32 round-head brass machine-screws ¾-inch long;
Twenty-two 6/32 round-head brass machine-screws ½-inch long;
Three No. 8 flat-head brass wood-screws, 1 inch long;
Nine No. 6 round-head brass wood-screws, 1¾ inches long;
Thirty-three No. 5 round-head brass wood-screws, ½-inch long;
Six No. 6 flat-head brass machine-screws, 1¼ inches long;
Ten No. 5 round-head brass wood-screws, 1 inch long;
Six No. 5 round-head brass wood-screws, 1¼ inches long;
Nine spacers, 1 inch high;
Four dozen 6/32 nuts;
Two pieces of angle brass, ½ x ½ x 6 inches, to support partition in shield S4;
One aluminum sheet, 4-21/32 x 6 x 1/16 inches for shield partition;
Two brackets to support coils L7 and L8.

HOME WORK REQUIRED

The Screen-Grid Strobodyne is *not* a kit receiver and its construction cannot be described in the same manner. Fans building the usual kit receiver will find that drilled panels, shields and chassis are available to facilitate the construction, and the directions for the assembly of such set are, therefore, very simple. However, with the Strobodyne, the builder has to drill his own panels, shields and baseboard; and he will find that parts of the mechanical construction require some skill with tools. In this article, therefore, the writer will attempt only to suggest ways of assembling the various parts of the set, but, without doubt, in many cases the builder will find it necessary to work differently.

The first problem which confronts a prospective owner of a Screen-Grid Strobodyne is obtaining the various coils. All of the coils used in the original model are factory-made products; but it is possible to make such coils at home, and complete details are given in Fig. 5.

Coils L1, L2 and L3, as shown in the drawing, are of skeleton construction. This design makes possible the highest electrical efficiency, but often taxes the ability of the home constructor. If it is found too difficult to employ this method of construction, a standard bakelite tube may be used as a coil form. This change may make necessary a reduction of one or two turns on the windings of each coil, but this is best determined after the receiver has been constructed.

Coils L4, L5 and L6 are the intermediate-frequency transformers. These are wound on wooden bobbins of the dimensions shown in the diagram. The primary and secondary windings are of exactly the same size, and should be wound simultaneously. After the coils have been completed, they *must* be matched carefully with a laboratory oscillator. (The method to be followed is described fully in the RADIO NEWS Superheterodyne Book in an article by Prof. Grover Ira Mitchel, entitled "Matching Intermediate Transformers." *The experimenter who does not possess the facilities of matching these coils is advised not to attempt their construction.* Also, if home-made coils are used, the condenser C9, which is connected across the secondary of the first intermediate-frequency transformer (L4), is not required and should be omitted from the circuit when building this set.

ORDER OF ASSEMBLY

The illustrations which accompany this article clearly show the construction of all parts of the receiver. In building the set, the parts mounted on the baseboard are fastened in place before starting wiring, as shown in Fig. A. Next the wiring is completed as far as possible, and then the parts shown in Fig. B are mounted. After the set has reached this stage of completion, the remainder of the wiring is put in. The front panel is then fastened in place and the receiver is practically completed. Fig. C gives the appearance of the completed receiver, with shield covers removed, when viewed from the top; Fig. D shows the arrangement of controls on the front panel of the set; Fig. E, the method of concealing battery wires under the baseboard, and Fig. F, the completed receiver with shields in place.

Those who wish to build the set from the schematic diagram, will refer to the complete circuit in Fig. 1. However, those who prefer to work from pictorial drawings, will find the wiring layout in Figs. 2 and 3. In addition to these illustrations, Fig. 4 shows the exact location of all parts on the sub-base, and Fig. 6 is the drilling layout for the controls on the front panel. More detailed information on building the set follows.

After all of the required parts have been purchased or made, the first step to take in

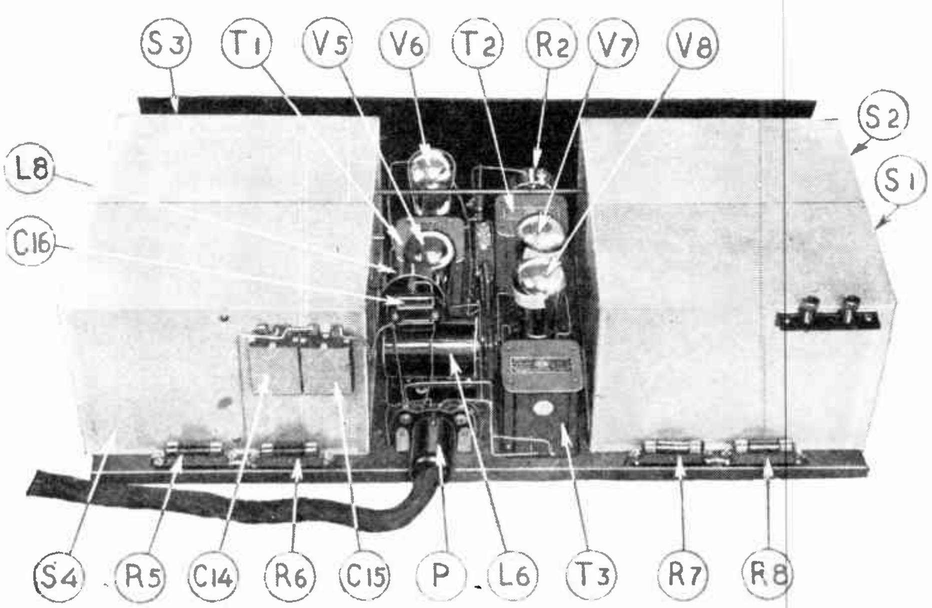


Fig. F. This rear view of the Screen-Grid Strobodyne shows the appearance of the set after the construction has been completed.

building the receiver is to lay out the wooden baseboard, which is ½ x 25¼ x 12 inches. It is important that the baseboard be exactly this size; as a smaller base would cramp the apparatus, and a larger base would not fit into the standard radio cabinet. Before mounting parts on the baseboard, draw a line through the center, running from front to back of the board. Then draw two more lines; one on each side of the center, parallel to the center line and 3½ inches away. Now draw a line 1¼ inches from the front edge of the baseboard and parallel to it from one end to the other. These lines should be drawn accurately with a ruler.

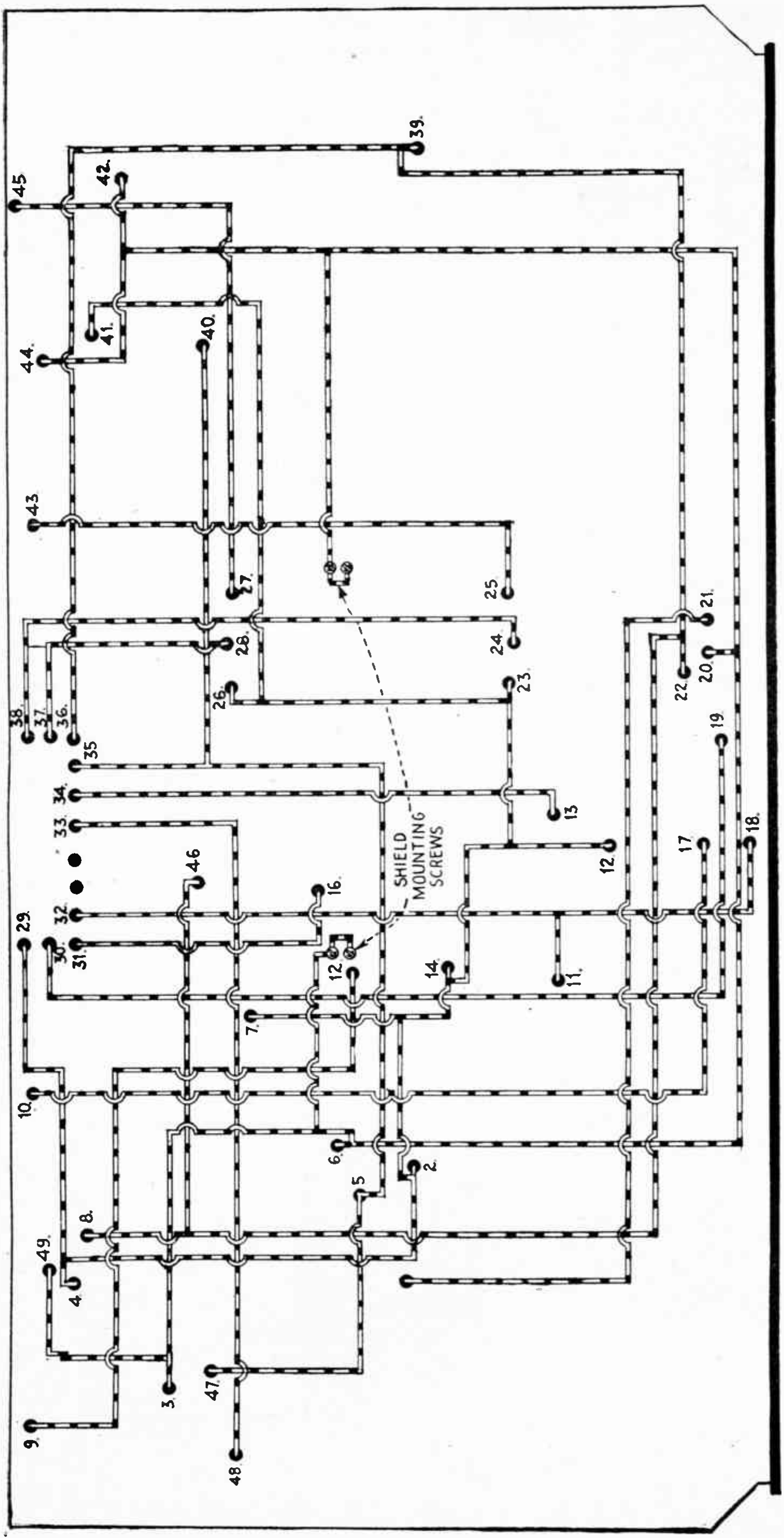


Fig. 3
Pictorial diagram of wiring under the baseboard of the Screen-Grid Strobodyne.

The first parts to be mounted on the baseboard are the bases of the four shield sections. However, before the shields are mounted, they should be accurately drilled for the apparatus which is to be mounted on them. The two front shields (S2 and S3) are mounted first, and so placed that their front edges fall upon the line which was drawn 1¼ inches from the front of the baseboard, and their inner edges upon the lines which are drawn 3½ inches from the center line. With the shields in this position there is between them in the center of the baseboard a space of 7 inches which is available for mounting the amplifier apparatus. In mounting the front shields it is highly important that they be placed accurately; because they support the variable condensers and, if the shields are not straight, the condenser shafts will be at the wrong angle. The bases of the shields are temporarily fastened in place by mounting the tube sockets or some other pieces of apparatus.

TUBE-SHIELD BASES

Before mounting the rear-shield bases (S1 and S4) on the baseboard it will be well to adjust the insulating rings of the shields for the screen-grid tubes, on the three sockets (V1, V3 and V4) which are mounted at the back. To do this, remove the screws and nuts which hold the springs of the sockets, and use instead of these screws the threaded pins which are fastened in the bakelite ring used to support the tube shield. (See Fig. 7.) This is accomplished easily and should be done now in order to fasten the sockets on the rear shield and hold them in place. However, before fastening the rings on the base of the sockets, the two mounting holes in the socket-base proper should be countersunk; so that flat-head machine screws may be used to fasten the sockets down on the baseboard.

The proper order is, therefore, to countersink the holes in the socket-base, introduce the two machine-screws in the holes of each socket and, after the screws and nuts are removed from the four corners of the socket-base, the ring is placed in their stead and the four blades of the socket are held in place by the nuts which fasten on the threaded pins of the bakelite ring.

Next, line up the rear shields (S1 and S4) so that they will be exactly straight with the front one, as shown in the parts layout, Fig. 4. Again, it will be of advantage to use a square and ruler in order to have the shields lined up exactly parallel to the front of the baseboard. These may be held in place by the three sockets upon which the bakelite rings have been mounted.

Once the sockets are holding the bottom of the shields tight, you may drill all the holes through which the wiring is to pass, as well as the four holes in the corners of each shield for passing the long screws which hold the corner posts of these shields.

Next mount the audio amplifier apparatus on the baseboard and all the othe parts on the bottom of the shield.

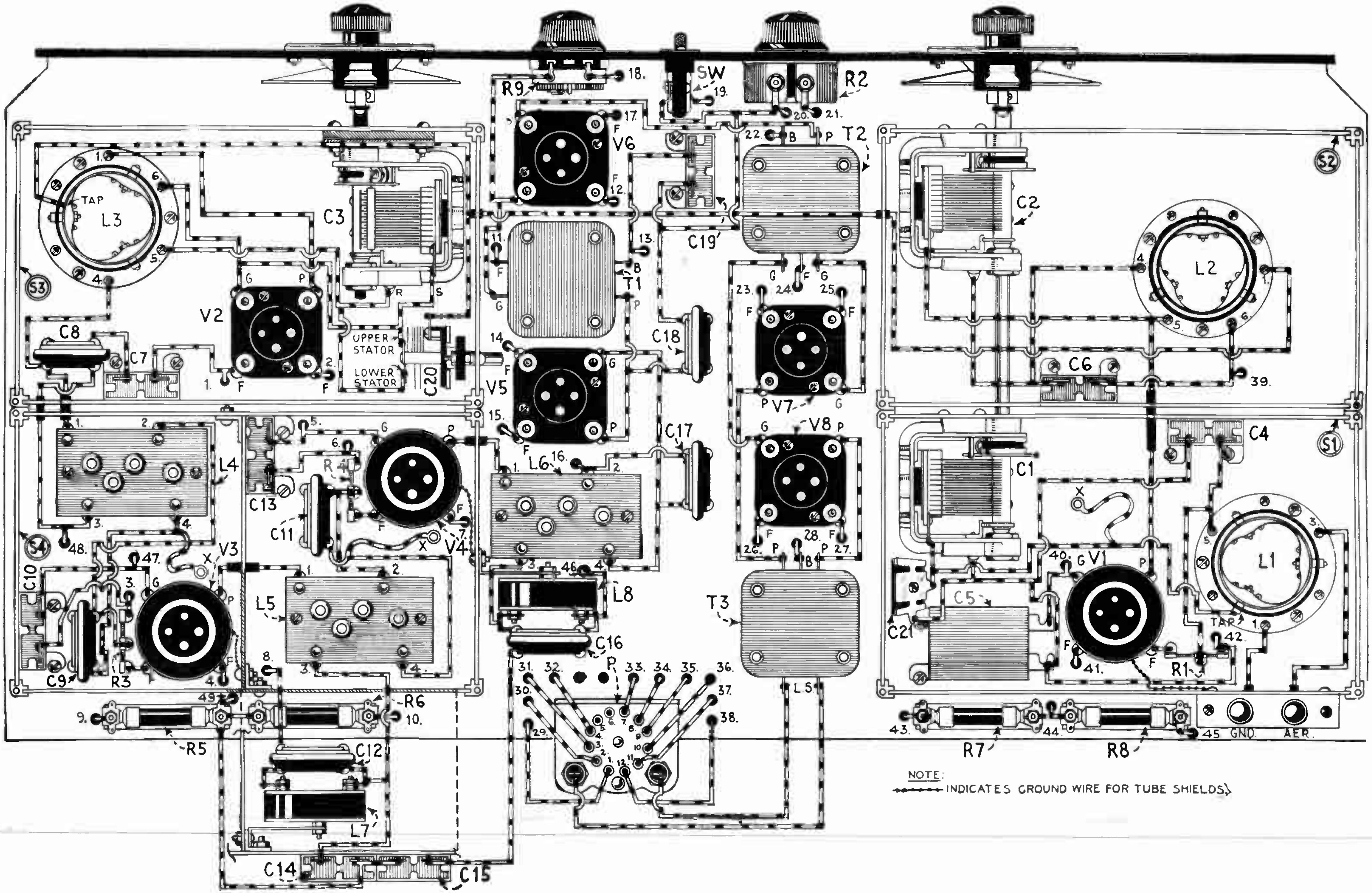


Fig. 2. This pictorial diagram of wiring above the baseboard, together with Fig. 3, the diagram of wiring under the baseboard, give complete details of all electrical connections in the Screen-Grid Strobodyne and indicate the relative position of all parts. In these two diagrams, wherever a wire passes through a hole in the baseboard, it is identified by a number, and these numbers correspond in the two diagrams, thus making it easy to follow the wiring.

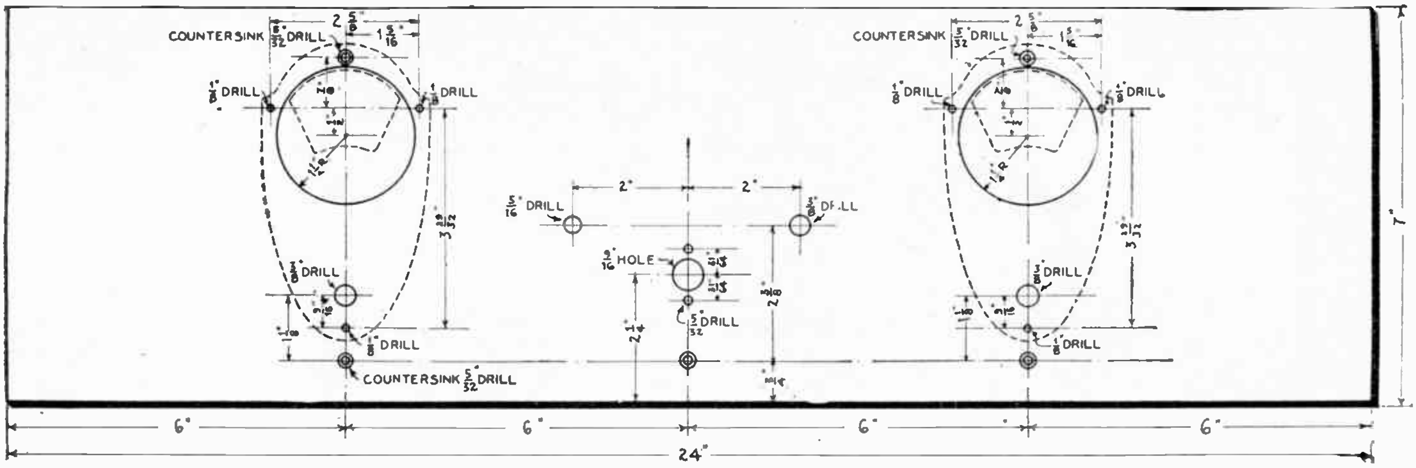


Fig. 6. This drilling layout shows the exact position of all holes in the front panel required for mounting the tuning controls of the set with the apparatus originally used.

Holes are provided in the panel of the plug for mounting such jacks; but they are not of the correct diameter, and it is necessary to enlarge them to mount the phone-tip jacks which will be used in the set. The jacks should not, however, be mounted at this time; for it is necessary to leave free access to the pins behind the small panel of the plug base, in order to solder the various leads to the pins.

The wiring may then be done; this is started by running wires from each one of the pins on the plug (P) to the various points where they should connect, and this is kept under the baseboard as much as possible. The wiring above the baseboard may also be started in the audio amplifier as well as inside the shields, where several connections may be put in at this time. Such connections are easily found by looking over the schematic and pictorial diagrams (Figs. 1, 2 and 3) which clearly show all the wires of the receiver. Also, at this time it should be explained that the various fixed condensers are held in position by the wiring, and that bus-bar wire is used for this purpose.

The three tapped filament resistors (R1, R3 and R4) should be connected so that the shortest (10-ohm) section is connected to the socket in each case.

The leads which are to be connected to apparatus on the panel may be left long enough to reach to these controls; so that, once the panel is fastened against the baseboard, they can be soldered easily to the lugs where they should be connected.

It is advisable to place a piece of spaghetti tubing over the wires wherever they pass through the shields, in order to prevent any possibility of the insulation being cut off by the edge of the metal. This is a precautionary measure which is worth while; as if the wire is pulled accidentally against the edge of the aluminum shield it may cause short circuits.

The next step is to drill the sides of the shields and to mount the variable condensers on the partitions where they belong. Full-sized drilling layouts are included among the free blueprints, and may be used for this purpose if the constructor feels the necessity of doing so. It is necesasry to cut a piece of aluminum and two pieces of angle brass in order to form an extra partition in the rear right shield (S4) to provide two compartments of equal size for the two stages of intermediate amplification.

When preparing the aluminum shields, it is important to drill the holes accurately; especially those for the mounting of the variable condensers, so that they will accurately match the dials which are fastened on the front panel. A very small variation in the drilling of one will, of course, affect the others; and it may happen, if the holes have not been drilled carefully, that the shaft of the condenser will not fall exactly in front of the bushing of the dial. Therefore, we urge the builder of this receiver to be very careful when drilling the aluminum shields, to trace them with a square and ruler and drill each partition *separately*. The last is to avoid the drill's biting sideways and traveling obliquely through the aluminum; the results of which would be that the holes would not center in the right places, where they had been indicated. It is not recommended that two or more partitions be placed on top of each other to drill at one time, for this reason. Be sure to use sharp drills.

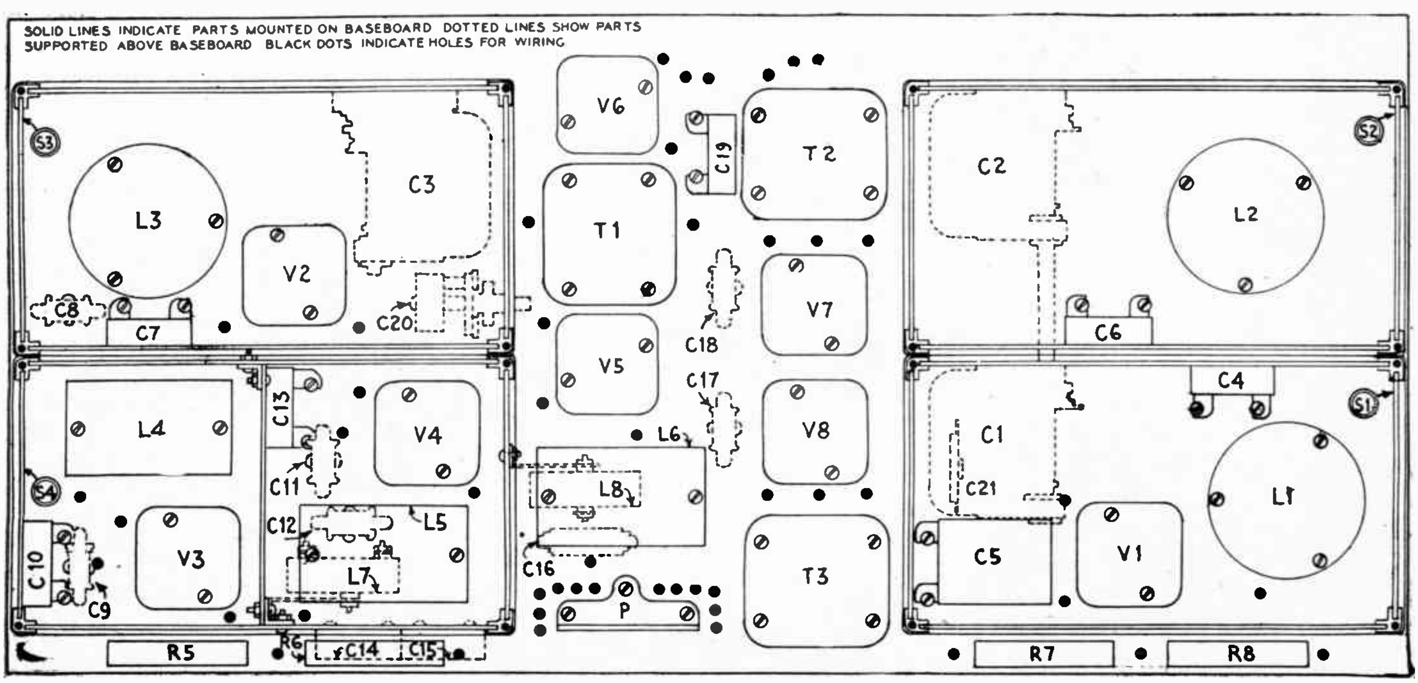


Fig. 4. In the above parts-layout each piece of apparatus is shown on the baseboard in exactly the correct position; and the sizes of the parts are in proportion to the size of the baseboard. Parts shown in dotted lines are supported above the baseboard.

MOUNTING THE CONDENSERS

It will be seen that, in shield S3, the variable condenser C3 is not mounted directly on the shield, but on a piece of bakelite which is itself fastened on the aluminum shield. This is done to insulate the frame of the condenser from the shield, because both sides of the condenser are at high potential and the whole instrument must be insulated from the shield which is itself connected to the "A—." The size and drilling layout of the bakelite plate which insulates the condenser from the shield is given in one of the blueprints.

The two other variable condensers, C1 and C2, which are mounted on shields S1 and S2, should be attached to the shields without their shafts, which are removed by loosening the two set screws on the rotor. In place of these, a 10¼-inch shaft is introduced through both rotors, in order to turn the two condensers at the same time, with a single dial.

The next step is to put in place the partitions supporting the variable condensers C1 and C2, in order to connect them to the rest of the circuit. These partitions are supported by the corner post, made also of aluminum, which should be fastened with 6/32 machine-screws, ¾-inch long. These screws pass through the wooden baseboard and hold the whole shield flat on the baseboard, as well as support the corner posts.

After all the condensers have been placed in their proper locations the insides of the shields may be wired; that is, all the wires connected to the condensers and other accessories inside of the shields may be put in place before the partitions are set up, in order to have better access to all the various pieces of apparatus. Also, the condenser C21 is mounted on the stator C1 by fastening the brass lug of C21 under the terminal screw of C1.

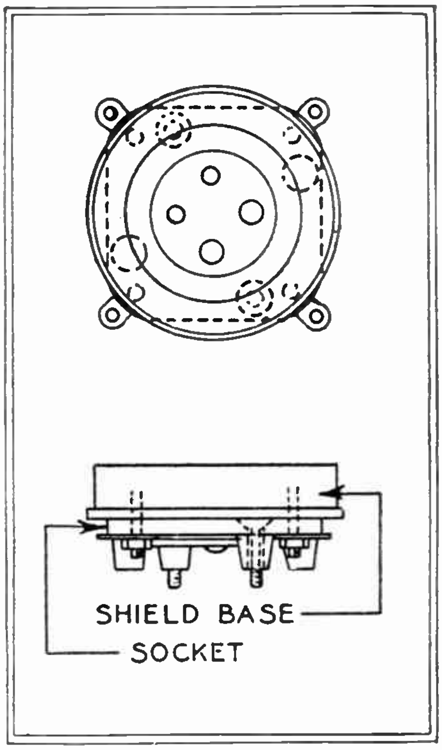


Fig. 7. Shields are required in connection with the screen-grid tubes (V1, V3 and V4) of the receiver; and the bases which support the shields must be attached to the sockets as shown.

The two R.F. choke coils, L7 and L8, are mounted on the shield, S4; L7 is located on the inside of the shield and held in place by a bracket which is fastened to the assembly bolt which holds the central partition of the shield. This bolt is 1¼ inches below the top of the shield. L8 is located outside the shield, directly over the coil L6; it is mounted in place by a bracket fastened to the left side of the shield with a bolt passing through the shield.

The aerial-and-ground binding-post strip is fastened on the back of the shield S1 by means of 6/32 screws and nuts, and angle brass, as shown in the back view of the set (Fig. 5). The two by-pass condensers (C14 and C15) are also mounted on the back of the shield S4 with screws and nuts as shown in the picture.

If the shield partitions do not slide easily down the grooves of the corner posts, unscrew the fastening screws under the baseboard until the posts are loose, and then the partition should slip down easily. After the set has been completed, the corner posts may again be screwed tightly in place; this will hold the partition securely in the proper position.

THE TUBE SHIELDS

The 222-type tubes are so sensitive that it is necessary, in order to avoid direct pick-up of energy by the elements of the tube, to shield the tube itself, although it is already enclosed in the shielding compartment.

If the metallic shields used to cover the tubes are too long, they may be cut at the bottom; so that, when the tube shields are placed in position inside the aluminum shields, they permit the covers of the boxes to be screwed down. After they are cut to the proper size, a wire should be soldered at the bottom of each tube shield; the other end of this wire being fastened to one of the screws on the aluminum box, thus connecting the tube shield to the "A—" battery.

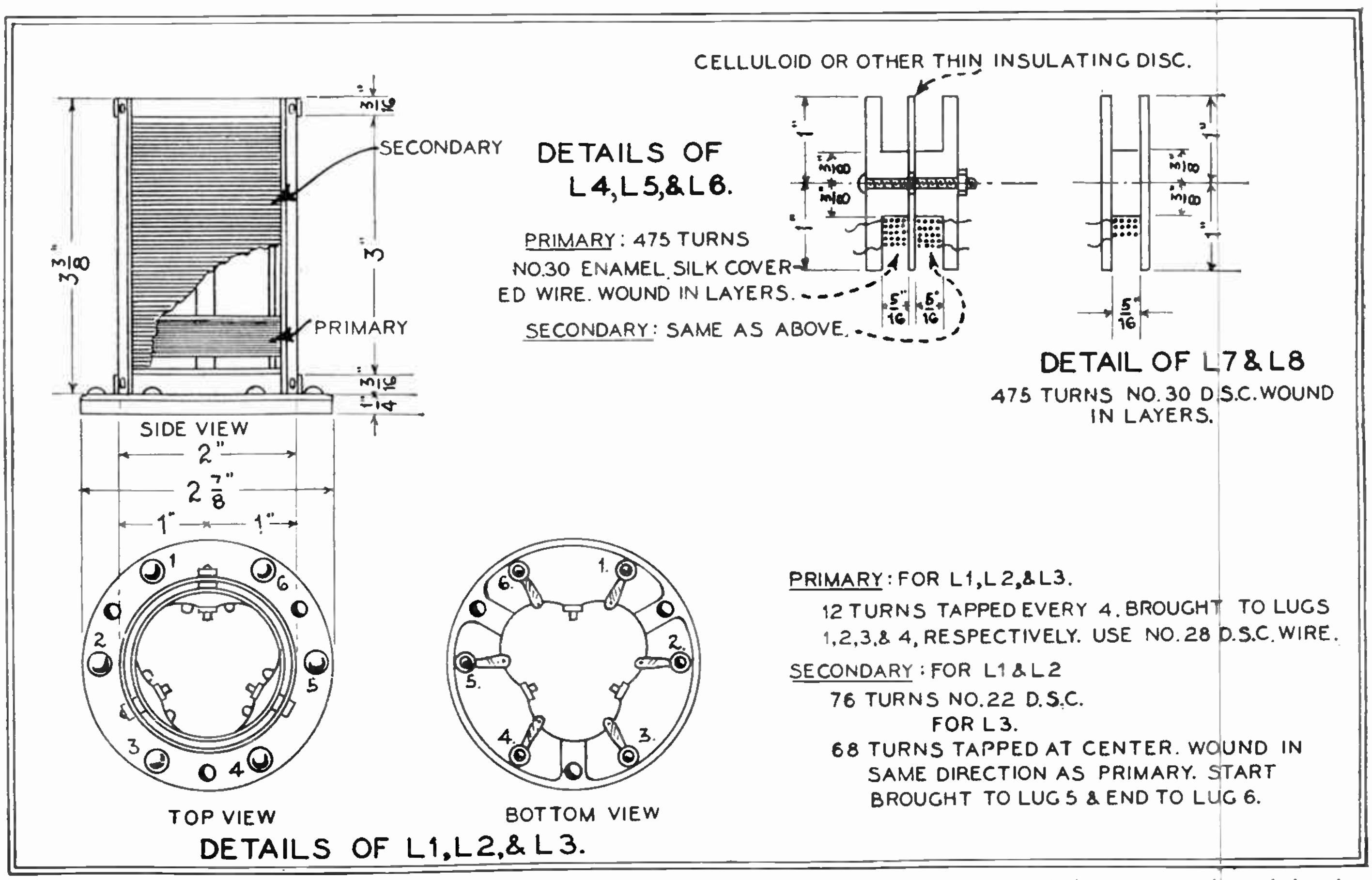


Fig. 5. These drawings give complete details of winding the various coils of the receiver. Coils L1, L2 and L3 are of air-core construction and the others are wound on wooden bobbins. If best results are desired, the coils must be wound accurately and the intermediate-frequency transformers must be carefully matched.

SYMBOL	Quantity	NAME OF PART	REMARKS	List Price Each	MANUFACTURER ★	
C1,C2,C3	3	Variable condensers	Removable-shaft-type, .0005-mf.	$ 5.50	1	
L1,L2,L3	3	R.F. transformers	(See drawings for description)	4.00	2	
T1	1	A.F. transformer	Standard-type	10.00	3	
T2	1	A.F. transformer	Push-pull, input-type	12.00	3	
T3	1	A.F. transformer	Push-pull, output-type	12.00	3	
R9	1	Variable resistor	0-100,000-ohm, volume-control-type	1.50	4	
R2	1	Rheostat	20-ohm	.75	5	
SW	1	Battery switch	Toggle-type	.45	6	
S1-S4	4	Stage shields	5 x 6 x 9-inch, aluminum	3.50	7	
R5,6,7,8	4	Fil.-ballast resis.	5-volt, 1/4-ampere type (201A type)	1.10	8	
R1,R3,R4	3	Tapped fixed resis.	25-ohm, tapped at 10 ohms	.25	9	
L7,L8	2	R.F. choke coils	(See drawings for description)	2.00	10	
C4-7,C10	5	By-pass condensers	0.5-mf., paper-type	1.00	11	
C13,15,19	4	By-pass condensers	0.5-mf., paper-type	1.00	11	
C8,9,11,12	4	Fixed condensers	Matched, .00025-mf.	.40	10	
C16,C17	2	Fixed condensers	Matched, .00025-mf.	.40	10	
L4	1	Intermediate trans.	(See drawings for description)	4.50	10	
L5,L6	2	Intermediate trans.	(See drawings for description)	5.00	10	
C18	1	Fixed condenser	.002-mf., mica-type	.50	8	
C20	1	Balancing condenser	Double-stator-type, 50 mmf. per stator	2.00	12	
C21	1	Adjustable condenser	Neutralizing type, 2-20 mmf.	.50	1	
V1,V3,V4	3	Vacuum tubes	Screen-grid-type (222 type)	5.50	13	
V2,V5	2	Vacuum tubes	General-purpose-amplifier (201A type)	1.50	13	
V6	1	Vacuum tube	Semi-power-type (112A type)	3.00	13	
V7,V8	2	Vacuum tubes	Power-amplifier-type (171A type)	3.00	13	
	8	Tube sockets	UX-type	.75	14	
	2	Tuning controls	Illuminated vernier-type	3.25	15	
	3	Tube shields	Screen-grid type	1.50	9	
	3	Adapter rings	Insulating-type (for tube shields)	.35	9	
P	1	Battery-cable-plug	12-wire-type	5.00	16	
	1	Extension shaft	Brass, 10½ x ¼-inch (for C1 and C2)	.25	1	
	1	Wooden baseboard	25½ x 12 x ½-inch			
	1	Front panel	24 x 7 x 3/16-inch Prices	Vary	17	18*
	1	Binding-post strip	3 x ½ x 3/16-inch *	*	17	18*
	1	Binding-post strip	8½ x 1 x 3/16-inch *	*	17	18*
	1	Mounting plate	2½ x 1½ x 3/16-inch (For C3) *	*	17	18*
	1	Insulating shaft	4 x ½-inch (For C3) *	*	17	18
	50 ft.	Hook-up wire	Flexible-insulation-type	1.50	11	
	20 ft.	Bus-bar wire	No.16-gauge			
	18	Machine screws	6/32, ⅜-inch long, round-head, brass			
	32	Machine screws	6/32, ½-inch, round-head, brass			
	6	Machine screws	6/32, 1¼-inch, flat-head, brass			
	3	Wood screws	No.6, 1-inch, flat-head, brass			
	9	Wood screws	No.6, 1¼-inch, round-head, brass			
	22	Wood screws	No.5, ⅝-inch, flat-head, brass			
	10	Wood screws	No.5, 1-inch, round-head, brass			
	6	Wood screws	No.5, 1¼-inch, round-head, brass			
	9	Spacers	1 inch high, brass (For L1, L2 and L3)			
	4 doz.	Nuts	6/32, brass			
	2	Brass angles	½ x ½ x 6-inch (Partition supports)			
	1	Aluminum sheet	4-21/32 x 6 x 1/16-inch (Shield Partition)			
	2	Angle brackets	(For supporting L7 and L8) ½ x 1½-inch			
	3	Terminal clips	For screen-grid tube			

* This manufacturer supplies the panels for this set in completely drilled form.

NUMBERS IN LAST COLUMN REFER TO CODE NUMBERS BELOW.

1 Hammarlund Manufacturing Company, 424 W. 33rd St., New York City	10 Radio Electric Labs. (R.E.L.), 116 West 65th St., New York City	19
2 Aero Products, Incorporated, 1772 Wilson Avenue, Chicago, Ill.	11 Acme Wire Company (Parvolt), New Haven, Connecticut	20
3 Sangamo Electric Company, Springfield, Illinois	12 Allan D. Cardwell, Incorporated, 81 Prospect Street, Brooklyn, N.Y.	21
4 Electrad, Inc. (Royalty), 175 Varick Street, New York City	13 C. E. Manufacturing Co. (CeCo), 702 Eddy Street, Providence, R.I.	22
5 Herbert H. Frost, Incorporated, Elkhart, Indiana	14 Benjamin Electric Mfg. Company, Chicago, Illinois	23
6 Pilot Electric Mfg. Company, 323 Berry Street, Brooklyn, N.Y.	15 National Company, 61 Sherman Street, Malden, Mass.	24
7 Aluminum Co. of America (Alcoa), 120 Broadway, New York City	16 Yaxley Manufacturing Company, 9 So. Clinton St., Chicago, Ill.	25
8 Radiall Company (Amperite), 50 Franklin Street, New York City	17 Micarta Fabricators, Inc., 309 Canal Street, New York City	26
9 Carter Radio Company, 300 S. Racine Street, Chicago, Ill.	18 Cortlandt Panel Engraving Company, 165 Greenwich St., New York City	27

★ THE FIGURES IN THE FIRST COLUMN OF MANUFACTURERS INDICATE THE MAKERS OF THE PARTS USED IN THE ORIGINAL EQUIPMENT DESCRIBED HERE.

If you use alternate parts instead of those listed in the first column of manufacturers, be careful to allow for any possible difference in size from those originally used in laying out and drilling the panel and sub-base.

No. 63

This is to ground the shield to the rest of the circuit. Connection to the control-grid terminal on top of each 222-type tube is made easily by using some flexible wire, which may be twisted around the top of the tube to form a loop which may be slipped on the tip after the tube shield has been placed over the tube.

After all the front and back partitions of the shields have been put in place, the side partitions may be placed in the slides and the wiring may be completed; that is, the wires passing through the side partitions are put in place and connected as shown in the pictorial wiring diagram.

FRONT-PANEL WORK

The drilling of the front panel does not present any difficulty. It is required only to have it traced very accurately and drilled. If there is a slight variation in one or both shafts, the distances on the panel may be corrected; so that the dials will fit exactly over the shafts once they are fastened on the panel.

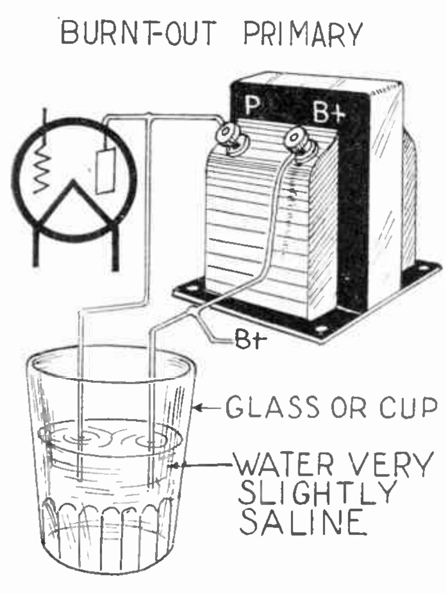
In order to cut the holes for the dial windows, it may be necessary to drill several small holes around the circle which is shown in the dial template, and knock out the center; unless you have handy one of the small circular saws which may be fastened in a drill. However, the circular saw is much simpler; as it will cut a circle in bakelite in short time and with little effort. These small circular saws are available in various diameters, and may be obtained in any hardware store. Any set builder may be recommended to use one, in preference to making holes with the old-style panel-cutter.

After all the wiring has been completed, the panel supporting the dials, the rheostat (R2), the volume-control resistor (R9), and switch (SW), may be placed against the baseboard after the shaft of the condenser has been introduced in the bushing of each one of the dials. This locates the panel exactly and the supporting screws, which hold the panel to the baseboard, may be located accurately after the condenser shafts have been fastened to the dials and the dials have been found to turn true and easily. Connections may then be made to the volume control, rheostat and switch, which are the only apparatus mounted on the panel.

When Transformers Burn Out

When this system is used, the burning out of an audio transformer does not mean complete cessation of radio entertainment until the instrument is replaced. In the absence of the necessary apparatus temporary reception can be often obtained by the use of very ordinary articles.

If the primary winding is burnt out two wires from the primary binding posts should be placed in a glass or cup containing water, and the distance between the two wires should be adjusted until best reception is obtained.



If an audio transformer burns out, the receiver may sometimes be operated temporarily by making use of the system illustrated above.

"Seeing" Music with a Television Receiver

Here is an Easily Constructed Scanning Apparatus which Affords Ample Opportunity for Elementary Experiments in Television

TELEVISION has arrived, but as yet only a few scattered stations are transmitting television images. While preparing for regular television programs, however, the radio fan can perform some highly interesting experiments with a simple television apparatus that he can construct himself at little cost. This machine has all the parts of what is now generally considered the standard television receiver; namely, a scanning disc pierced by a spiral of holes, a motor to drive it, a neon glow tube, and a means of controlling the speed of the motor. By assembling it, the experimenter will obtain a good introduction to the theory and practice of television without having to spend a great deal of money on complex apparatus. After acquainting himself with some of the fundamental theoretical principles and practical operating difficulties, he will be better able to make and use a real television receiver when regular television service is available.

The parts composing the crude machine illustrated in these pages were picked up at random in the RADIO NEWS Laboratories. An electric fan, which was about to be packed away, was instead dusted off and the blades and wire guard removed from it. As the fan was of the "oscillating" type, the worm mechanism which makes it swing back and forth was unhooked, so that the motor would remain stationary while in operation. (These operations did not ruin the fan, as the blades, guard and worm mechanism can be reattached in a few minutes.) It was decided to use a fan instead of a special television motor because fans are very widely used, and because the summer will be well over by the time the constructor builds this machine. Few people would care to spend $25 or $30 for a special motor just for an experiment, but they can easily make use of an idle electric fan.

The general appearance of the complete machine, as assembled in the RADIO NEWS laboratories in about two hours, is shown in the pictures accompanying this article, but this design need not be adhered to. It was built, not for the purpose of receiving television images, but merely to show how ordinary voice and music "looks" in a television receiver. The geometric patterns and formations built up by the apparatus are extremely interesting to behold. More will be said about the operation later.

Fig. A. The experimental television receiver in the RADIO NEWS Laboratories. The only adjustment is the knob regulating the motor's speed. The patterns created by the music are observed through the square hole cut in the cloth, opposite the neon lamp.

A CHEAP, USABLE DISC

After taking the fan apart, lay it aside for a while and make the scanning disc. All the discs which are now being sold commercially for television purposes are made of aluminum and are accurately drilled with round or square holes, not more than one-sixteenth of an inch across. For this home-made contraption, an ordinary flat piece of cardboard is perfectly satisfactory. It should not be less than a sixteenth of an inch thick, and cut into a disc 12 inches in diameter.

With the aid of a pencil, a ruler and a compass (which you can borrow from your son's or little brother's school bag), now mark off 24 *radii* (lines running from the center of the disc out to the edge). These should be 15 degrees apart. As a circle has 360 degrees, the lines will radiate outward evenly. If you have forgotten how to subdivide angles with a compass, simply draw one diameter first through the center of the disc. Then draw another one exactly at right angles to it. These gives you four lines. Now spot the middle of each of the four sections as closely as you can, and draw four more lines from the center. If you now subdivide each of the resulting sections into three equal parts, you will have the twenty-four lines.

Take the ruler and measure a distance of 5¼ inches along the vertical center line. Make a mark at this point. Proceeding on the next line to the left, measure a distance of 5 3/16 inches. Proceed along, measuring off the distances as indicated in Fig. 1; you will have a total of 24 points. Through each one, drill a hole slightly less than ⅛-inch in diameter; then, with a piece of stiff wire or a narrow strip of brass, ream out the holes so that they will be square in shape. Their edges are bound to be a little fuzzy, but do not worry about this.

For those who want to save themselves the trouble of marking out the individual lines, RADIO NEWS has prepared full-size blueprints which can be used as drilling templates. To use one of these blueprints, you simply lay it over the piece of cardboard and punch through the center points marked on it. (*These templates are free;* simply write to RADIO NEWS, 230 Fifth Avenue, New York, N. Y., and ask for the Television Disc Blueprint.)

If you haven't a piece of cardboard of the right size at home, go to the nearest stationery or draftsmen's supplies store and ask for a piece of heavy bristol board. This will cost only a few cents.

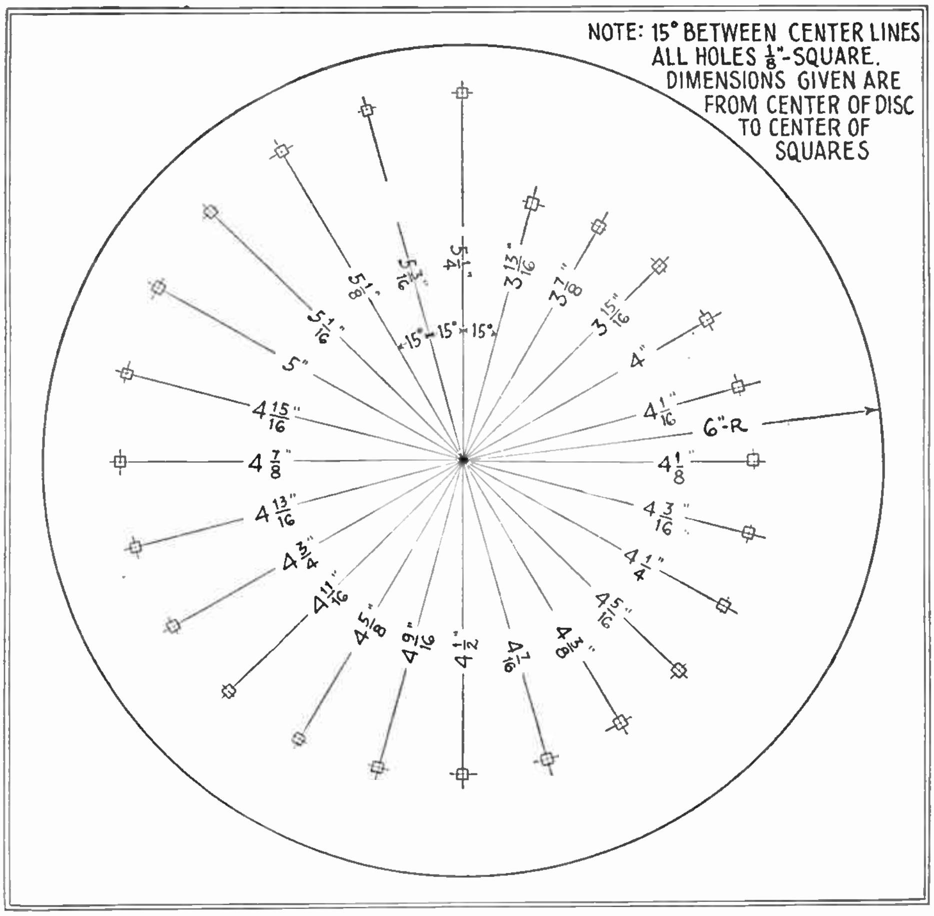


Fig. 1. Details of the scanning disc used in the set-up. The holes overlap; but very interesting images are obtained.

After drilling the scanning disc, the next problem is to mount it to the shaft of the fan motor. Obtain from a hardware store a pulley that will fit the shaft of your particular motor. This will have a set screw which allows it to be tightened against the shaft. To fasten the cardboard disc to the face of the pulley, first drill and tap the latter for four 8-32 screws, then clamp the disc between two 5-cent phonograph records and pass the screws through into the pulley, as shown in Fig. 2. This was the arrangement used in the original model of the machine; but any other that suggests itself may be employed. The important thing is to make the disc run as smoothly and as evenly as possible. After mounting it, give it a coat of black paint. Liquid shoe polish will serve just as well; the idea is merely to darken the cardboard.

THE FLASH LAMP

The main item of expense involved in this "television" receiver is the neon glow tube. This costs about $12, but is a good investment because you will be able to use it later in any real television instrument you build. This tube is about six inches long and two and a half inches in diameter, and is fitted with a standard UX-type base, which fits in a standard tube socket. It contains two flat metal plates, placed about a sixteenth of an inch apart and parallel to each other. When an electric current of the proper value is passed through it, the entire surface of one of the plates lights up with a pinkish-red glow, characteristic of the gas *neon*. The eye-catching red signs now being used so extensively for advertising purposes contain this same gas.

The neon glow tube responds to changes in electrical current just as a loud speaker does but, instead of producing sound, it reproduces the changes as variations of light. When a regular television receiver is being operated with television impulses, a picture is built up on the plates of the tube with the aid of the scanning disc.

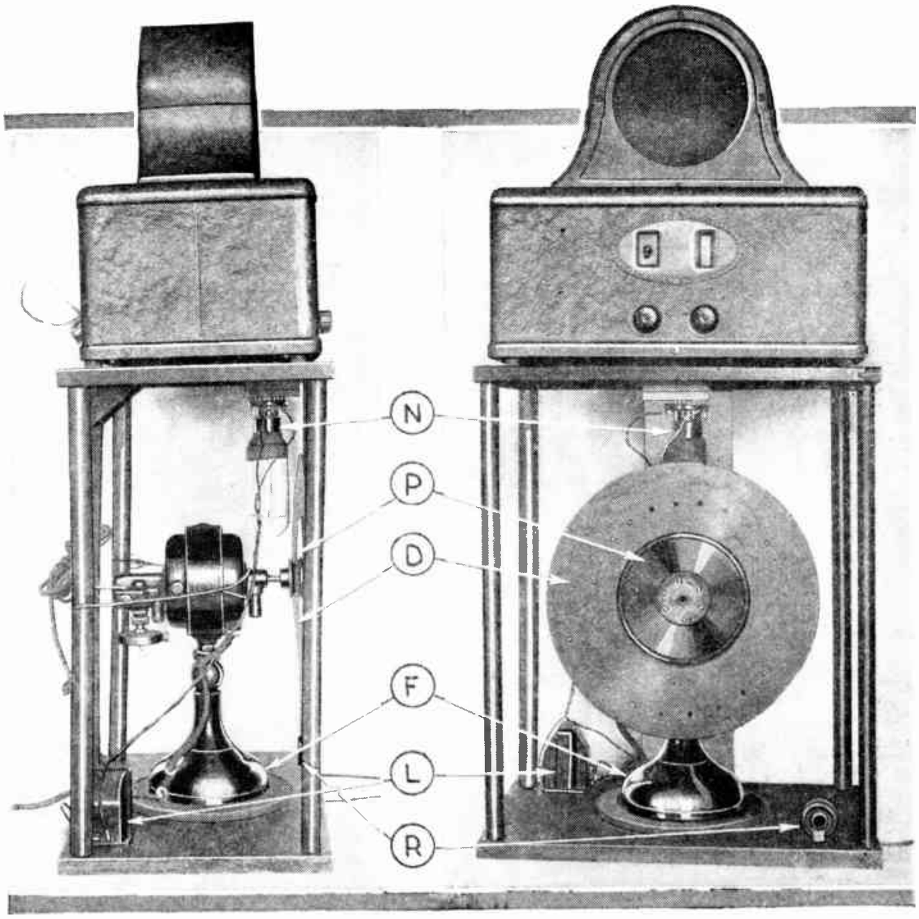
On the other hand, *if voice or music impulses are led to the tube while the disc is rotating*, endless varieties of patterns will be observed. After watching them for a while you will be able to distinguish a low note from a high one by merely watching the picture it makes; and you will be able to tell the difference between voice and music.

The neon tube is suspended just behind the scanning disc. It may be either fastened to the underside of the bread board that holds the radio receiver as shown in the pictures (Figs. B and C) or supported on an arm extending over the disc. In the laboratory machine, four corner pieces (old broom sticks) were used to allow a cloth cover to be tacked around the fan. A hole was cut in the front of the cloth, so that the upper section of the disc between the farthermost and innermost holes could be observed. The neon tube should be so placed that the hole which is 5¼ inches from the center of the disc passes just across the top of the plate, and the hole which is 3 13/16 inches from the center just across the bottom edge.

THE CIRCUIT

A double-impedance unit, such as are used in audio amplifiers, is mounted anywhere along the breadboard on which the motor rests. A 60-ohm rheostat for controlling the speed of the motor is mounted on the front edge, so that it can be adjusted easily.

(*Continued on page* 101)



Figs. B and C. The apparatus with the cloth cover removed; N, neon lamp; D, scanning disc; P, phonograph records used for clamp (see Fig. 2); F, fan base; R, motor rheostat; L, double-impedance unit (see Fig. 3.)

How to Build the Fan Motor Television Receiver

A slight adjustment of the rheostats and the picture comes in clearly. This photo shows a complete television receiver connected to an ordinary radio set. The picture is seen in the cone.

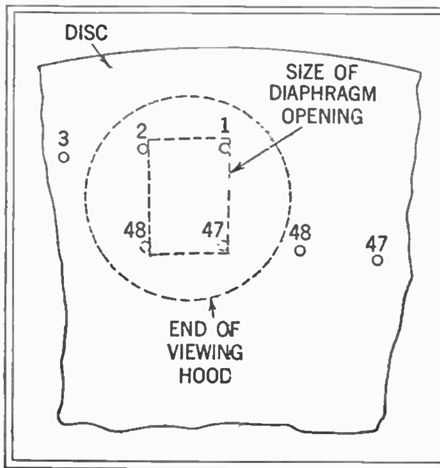
A Television Receiver of Simple Design, Built Around an Ordinary 16-inch Electric Fan Motor.

THE accompanying photographs and drawings show the appearance and the construction details of the television receiver, the apparatus pictured having, of course, to be connected to the output of a suitable radio receiving set. The ideal set for receiving television images from WRNY or other stations, is, for the broadcast wavelength of 297 meters, one comprising two or three stages of tuned radio frequency, a detector and at least three stages of resistance-coupled amplification. When a resistance-coupled amplifier is used, it will be found best to use about 250 volts at least on the last stage from either storage or dry "B" batteries. A good "B" eliminator may be used, but a special filter is usually necessary, to prevent "motor-boating" with a resistance-coupled amplifier.

PROPER MOTOR FIRST ESSENTIAL

The first requisite for building this television receiver is a good 16-inch fan motor. If the television disc to be used (it should have 48 holes for reception from WRNY and 3XK; also 1XAY and WLEX of Boston; and 24 holes for reception from WGY, W2XAD, and W2XAF, G. E. Co., Schenectady), is quite light, a 12-inch fan motor may do the work. If you have direct current in your laboratory or other location where the apparatus is to be operated, then you will have no trouble in controlling the speed of the motor down to the 450 r.p.m. required for WRNY reception or the 900 r.p.m. required for reception from the other stations broadcasting television.

If you have to select or use an alternating current fan motor, then you will have to find out whether the motor can be slowed down to a steady speed of 450 r.p.m. If the A.C. motor happens to be of the type that has throw-out contact brushes, which open the starting winding after the motor has attained fairly high speed, you will probably find this sort of motor unfit for television purposes. If the motor is of the universal A.C.-D.C. type, with commutator and brushes, the armature being connected in series with the field, then you will find that this motor can be regulated as to speed very nicely by means of the series resistances shown in the accompanying diagram. We strongly recommend a universal type motor if you are going to purchase one, as these have been found to regulate well with regard to the speed.



The method of laying out the diaphragm opening is shown clearly by the above drawing.

MOUNTING THE DISC

The disc used in the television receiver here illustrated was a 48-hole 16-inch diameter bakelite disc of standard manufacture. This disc may be mounted and secured on a regular bushing provided with lock nuts supplied by the people who make the disc. In the present case, however, the perforated disc was mounted on the brass spider and hub which had originally carried the fan blades. The blades were removed from the legs of the spider and these were then flattened out in a vise and checked up on a lathe for alignment. A light cut may be taken across the face of the spider legs in the lathe, if one is handy. By drilling holes through the bakelite disc, it is readily secured to the spider by machine screws and nuts, or the holes in the spider legs may be tapped if the builder so desires. Care must be taken to see that the disc rotates as perfectly as possible in both planes of rotation, that is, flatwise and edgewise; in other words, it must not wobble and care must be taken to see that the spiral is rotated in a true manner. These two requisites are easily checked up by means of a machinist's surface gauge, or else by making up a gauge from a nail driven in a block of wood and holding this near the disc as it is slowly rotated by hand.

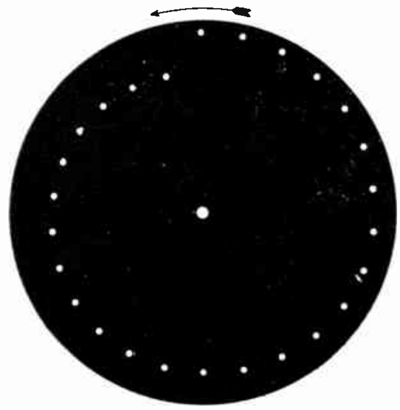
NEON TUBE MOUNTING

The frame for supporting the neon tube behind the revolving television disc is simply constructed from light brass bar, measuring about 1/16-inch by ⅝-inch. Strap iron may be used if the builder happens to have this stock on hand. No dimensions are given for the height of the frame as many builders will want to use a different size disc than the one we used, and so the height of the frame and the dimensions of the metal composing it will depend upon the diameter of the disc, of course.

Examination of the drawings herewith will show that the neon lamp may be rotated, so that the front plate inside the tube may be placed exactly parallel with the perforated television disc. This is easily accomplished by the simple expedient of using a standard vacuum tube socket having a hole in the center, or what is known as the one-hole mount. By passing a machine screw through the center of the socket and putting a nut on top of the bakelite shelf, the socket and neon tube can be rotated as required. Two sub-base brackets or supports, available at any radio supply store, are used in building the top of the superstructure which carries the neon tube. Two well insulated wires lead from the vacuum tube socket down to the base of the machine. The connections to the socket for the average neon tube is to the plate terminal and to the diagonally opposite filament terminal. This can be determined by experiment after the machine is built, or else beforehand by testing the neon tube on your receiving set. The plate that faces the television disc is the one that has to be illuminated. In some neon tubes there is a large and small plate; the large square plate is the one that is to face the television disc.

VIEWING HOOD AND LENS

The viewing hood or visor shown on the machine herewith was built by cutting down a standard megaphone which can be purchased in any sporting goods store. The heavy metal ring at the mouth of the megaphone enabled the designers to secure it by means of three spring brass clips, soldered to the brass front plate shown in the drawings. It can be snapped off whenever desired. One of the accompanying drawings shows how the size of the diaphragm plate is determined, the rule here being that only one disc hole or perforation must be exposed at a time. A thin piece of leaf copper was used in the present case, from which to cut the diaphragm opening, and this was sweated to the brass front plate of the instrument. A fairly strong lens, about 2 inches in diameter, with a focal length of appproximately 3 ½ inches, was procured for the purpose of helping to enlarge the image. This lens was secured inside the megaphone viewing hood by placing three machine screws through the megaphone shell and putting nuts on these, inside the shell.



This indicates the arrangement of the holes and the direction in which the disc should rotate to receive television from station WRNY.

HINTS ON RECEPTION

WITH regard to the style of motor to use this is best of the series type; that is, with the armature and field winding connected in series. Small induction motors can be used, but do not regulate well in speed much below one-half their normal speed of 1750 r.p.m. If the picture image is observed and drifts toward the right, the motor is going too slow; if the picture drifts to the left, it is going too fast. The editor has found it advisable to regulate the motor speed to a point considerably above the desired value, and then to apply a piece of cardboard or a blotter against the surface of the disc to slow down the speed to the desired point. D.C. motors will regulate very well with the electrical rheostat arrangements shown in the circuit accompanying this article.

This is probably one of the best ways to build the viewing visor for any size television receiver, as the visor can always be snapped off the machine when it is to be moved to some other location.

STROBOSCOPE INDICATES CORRECT SPEED

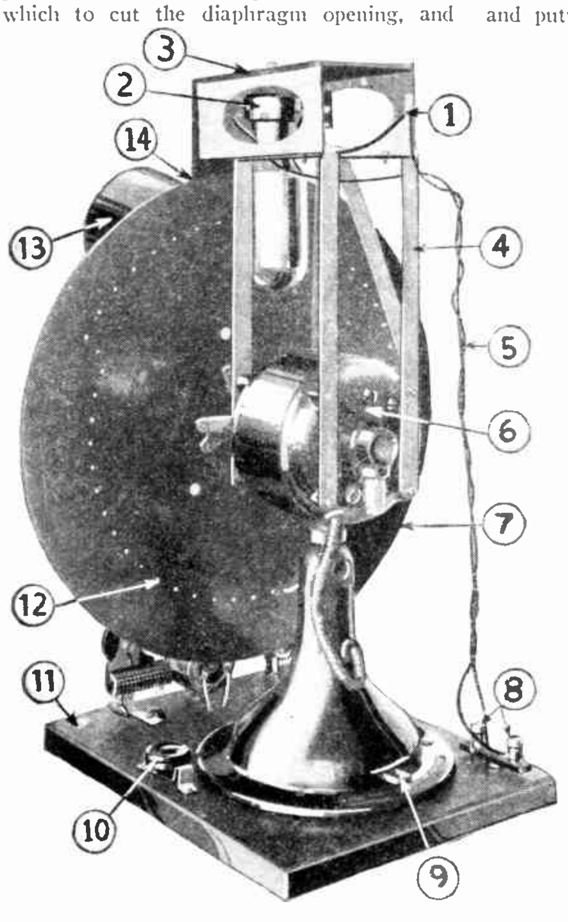
One of the greatest problems the beginner in television reception will encounter is that of checking the correct speed. Of course the average machinist or electrician will not mind checking the speed frequently with an ordinary speed counter, or possibly he may be so fortunate as to own a tachometer for the purpose. However, the average tachometer cannot be used with a small motor, as it takes too much power from the motor, and therefore slows the disc down and you do not know where you are at.

The method of using the *stroboscope* principle, with the black line disc noted in the present photographs, together with a tuning fork of the proper pitch, was suggested by the Editor, Mr. H. Gernsback, and details were worked out by members of the staff.

For the benefit of those who are desirous of using the stroboscope principle for checking other speeds than those here given, the following table and formulae will be found useful.

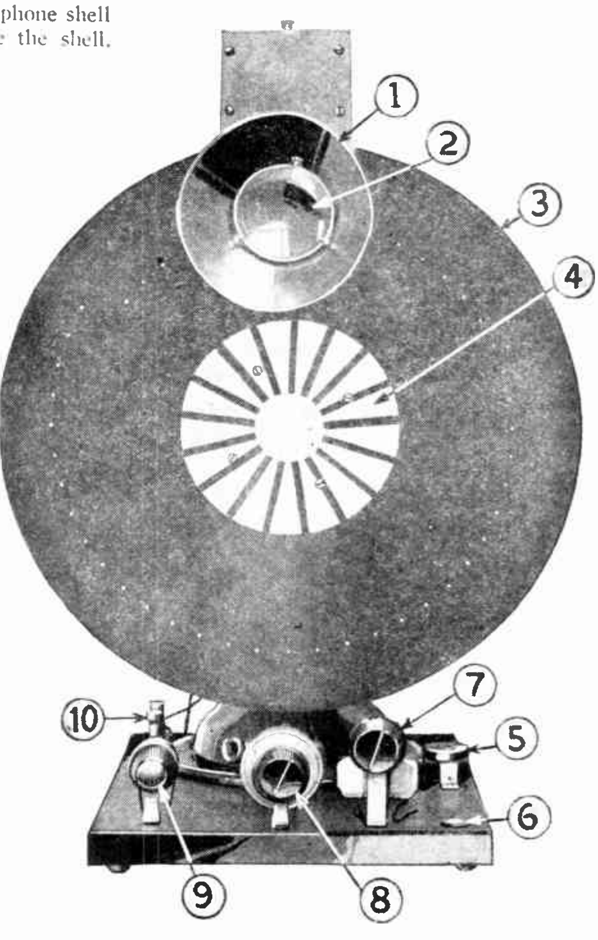
STROBOSCOPE TABLE

R.P.M. of Shaft	*R.P. Sec.*	*Tuning fork freq.*	*No. of marks on chart*
60	1	128	128
120	2	128	64
180	3	128	42.6
240	4	128	32
450	7.5	128	17
480	8	128	16
900	15	256	17
1080	18	128(72)	7.1 (4)
1260	21	128	6

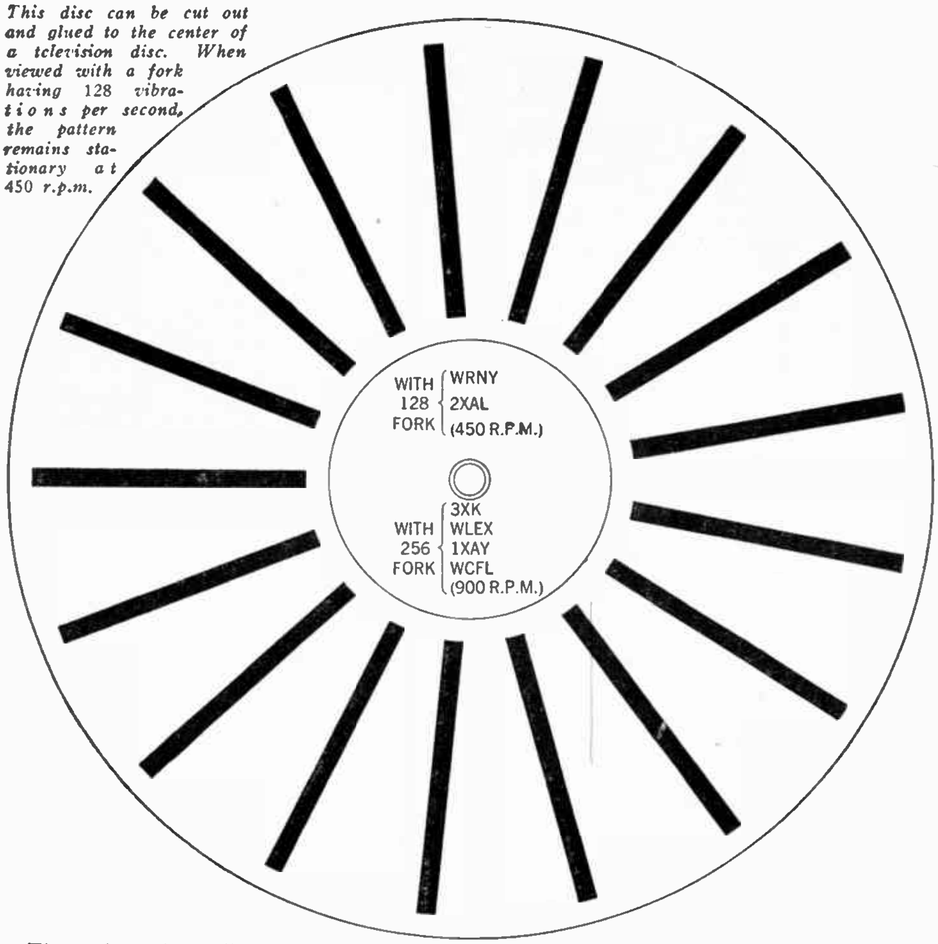


In the diagram at the left, 1 indicates a separation of the wires leading to the socket 2, affixed to top plate 3, which in turn is mounted on the uprights 4, screwed fast to the motor by the screws which hold the case in place. The wires 5, lead down to binding posts 8, which connect with the ordinary receiving set. 9 is the standard switch on the fan motor which receives its current through plug 10. 11 is a control button, 12 the holes in the television disc, and 13, the core.

Right—1 indicates the cone; 2, the lens; 3, the disc; and 4, the stroboscopic pattern; 5, attachment plug; 6, control button; 7, vernier rheostat; 8, main motor control; 9, neon lamp control; and 10, leads to the receiving set.



This disc can be cut out and glued to the center of a television disc. When viewed with a fork having 128 vibrations per second, the pattern remains stationary at 450 r.p.m.



These formulae will help to solve your problems: here N = Rev. per second of disc; F = freq. of fork per sec.; and M = number marks on disc. Then $N = F \div M$; $M = F \div N$; and $F = M \times N$.

The following pitch forks are available: 426.6, 256, 128, 288, 320, 341.3, 384, 480, 512.

For the benefit of the constructor we have provided herewith a good size reproduction of the stroboscope discs which can be cut out or else copied on to a piece of Bristol-board or drawing paper, and either glued or attached to the front of the television receiver. A tuning fork of the proper pitch may be obtained from music stores or from college laboratory supply houses.

For checking the speed of the motor at 450 r.p.m., a tuning fork giving 256 vibrations per second is necessary. This is used with a disc containing 17 black marks for the 450 r.p.m. specified. For other speeds, either a different fork has to be used, or else the number of lines on the stroboscope disc will have to be changed. All this data is contained on the drawings of the discs reproduced herewith.

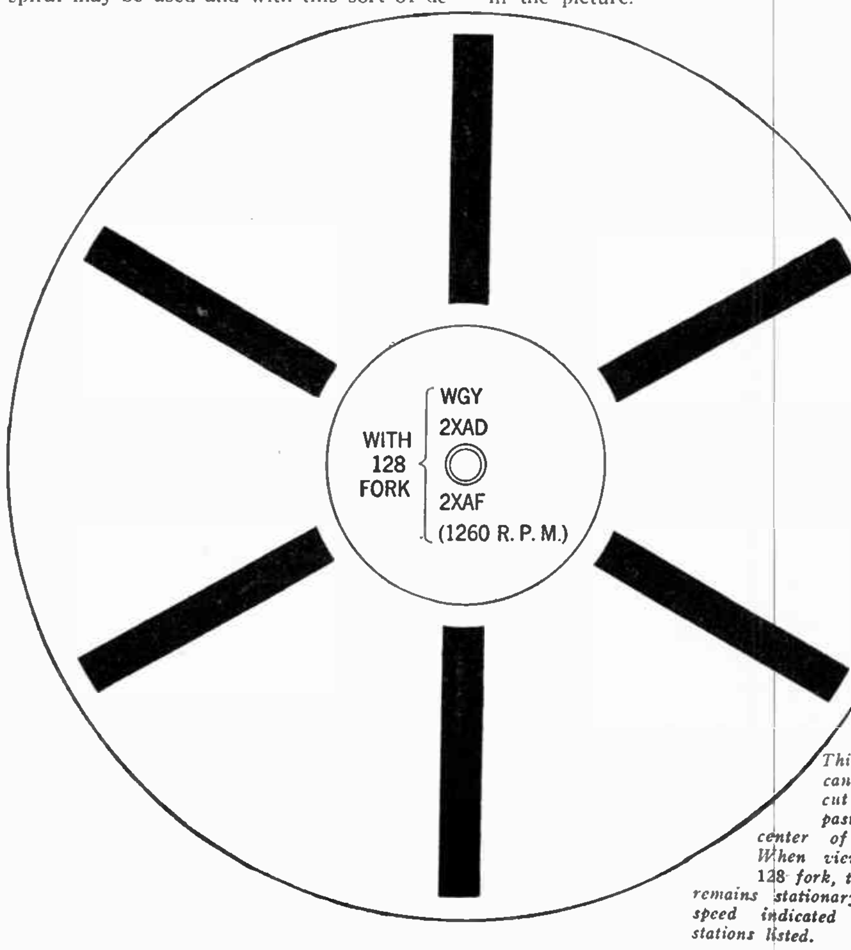
All one has to do in using the stroboscope check for the proper speed, is to regulate the rheostats in series with the motor, and then repeatedly take a sight on the revolving black line disc through the legs of the vibrating tuning fork. The tuning fork is struck on the edge of the table or across the knee, and while vibrating, it is held a few inches from the eyes and twisted, so that the revolving disc is observed in a diagonal line passing under the corner of the upper fork leg and over the corner of the lower fork leg. This line of sight is shown in one of the accompanying diagrams.

While in most cases it will probably be found that the number of marks on the disc or else the vibrations of the tuning fork to be used will come out to an even figure, or at least that a suitable combination can be worked out for the speed desired, the calculation may show that an uneven number of marks will be required with any standard fork. Here, instead of using a number of radial black marks on the rotating disc, a spiral may be used and with this sort of design, any uneven number of convolutions such as 7½, 7-1/3, etc., may be employed.

HOOK-UP OF APPARATUS

One of the accompanying diagrams shows how the power clarostat (about 150 ohms maximum resistance) and the small 10 to 15 ohm variable resistance is connected in series with the motor. Across the small variable resistance a push-button is connected, and by pushing this button periodically, it becomes possible to keep the motor speed quite constant. In setting the speed of the motor in the first place, the rheostats are adjusted until the speed is a little below the 450 r.p.m. (if you happen to be "looking in" at WRNY's television signal), this factor being indicated when checking the speed with the stroboscope fork, by the fact that the black lines on the disc are seen to rotate slowly backward. If these lines rotate slowly forward or left-handed, then the speed of the motor and disc is above 450.

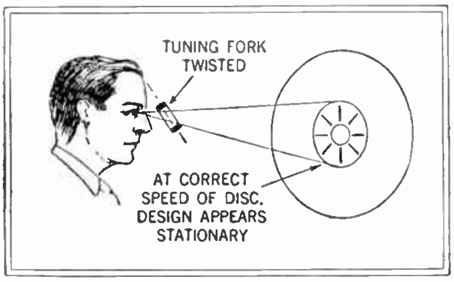
Rubber-covered wire or lamp cord may be used to connect the rheostats and the motor. The small clarostat at the extreme left of the motor baseboard is connected in series with the wires supplying the energy to the neon tube. The terminal posts to the neon tube circuit are mounted on a piece of bakelite, secured to the rear left corner of the baseboard. A rubber foot should be placed under each corner of the baseboard; this will allow the wiring to be simply placed against the wood and held in place with a few staples, if necessary. The clarostats are mounted on small right-angle brackets made from brass or iron. The push-button is placed in a tight-fitting hole, bored through one corner of the baseboard. The 110-volt supply for the motor circuit is brought into the apparatus, through an approved socket or receptacle, mounted on the righthand side of the baseboard, as shown in the picture.



This pattern can also be cut out and pasted to the center of a disc. When viewed with 128 fork, the design remains stationary at the speed indicated for the stations listed.

OPERATING THE APPARATUS

When the television signal is being received and the neon tube is connected to the output of the radio receiving set (and providing there is sufficient voltage used in the last stage—not less than 180) pulsations of pinkish light will be seen in the neon tube. If a sufficiently high voltage is used and the radio apparatus is properly adjusted with regard to the "C" bias, etc., then a pulsating pinkish light should be seen covering the whole neon tube plate which



The tuning fork must be so twisted that either the upper or lower leg is closer to the eye. The aperture between the legs should be very small. The entire pattern can be viewed if the fork is held close to the eyes.

faces the rear of the television disc. If the pulsating glow is seen on the rear plate, then the wires leading to the neon tube must be reversed.

If you are "looking in" with the television receiver, and, having checked the time of the television broadcast with the newspaper program, you should first check the motor speed and make certain that it is revolving at the prescribed speed. As you look into the viewing visor, preferably in a darkened corner of the room, you will see successive lines of orange-colored light as the spiral of holes repeatedly scans the illuminated plate in the neon tube. If you see these bands of light, but they only form irregular splotches, then the chances are that your motor speed is either too high or too low, and a slight change in the rheostat should be made. It is well to recheck the speed of the revolving disc with the stroboscope fork after doing this, as you may change the speed too much.

Several things may happen if you are successful in building up a picture image with the machine; the image may be upside down or it may slowly drift across the viewing lens repeatedly. If the picture slowly drifts across the lens, then the motor speed should be momentarily accelerated by pushing the button connected across the smaller resistance. This presupposes that the motor is running slightly below the correct television speed for the station to which you are "looking in." You may have to change the small variable resistance or even adjust the larger one slowly in order to make the picture stationary on the lens.

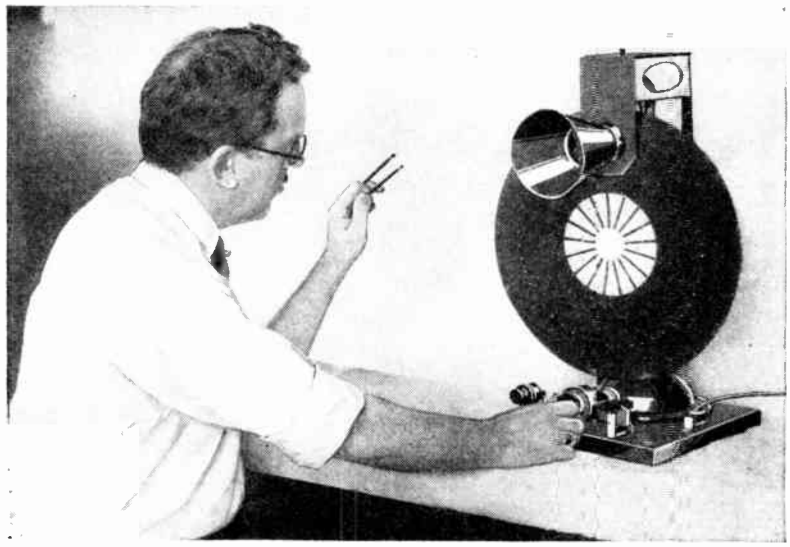
If the picture is upside down, then you are scanning the neon tube plate in reverse order; that is, from bottom to top, instead of top to bottom, and the disc must be taken off and turned around. In some cases it will be necessary to turn the disc around and also reverse the motor, or in still other instances, in order to rectify the picture image, the direction of the motor rotation will have to be reversed.

If the motor happens to be of the universal type, which means that it is usually a series-wound motor, then the direction of rotation can be changed by simply reversing the connections to the field or to the armature brushes. If the motor is an A.C. induction type, with a separate starting winding, then the direction of rotation is reversed by simply transposing the terminals from the starting winding. If the motor happens to be one of those types using copper shading plates, mounted on the tips of the iron stator poles, then the direction of rotation can be effected by remounting the shading plates on the opposite pole tips; or simpler still, the whole stator frame may be removed from the car-case or motor housing, and reversed in its position with respect to the same.

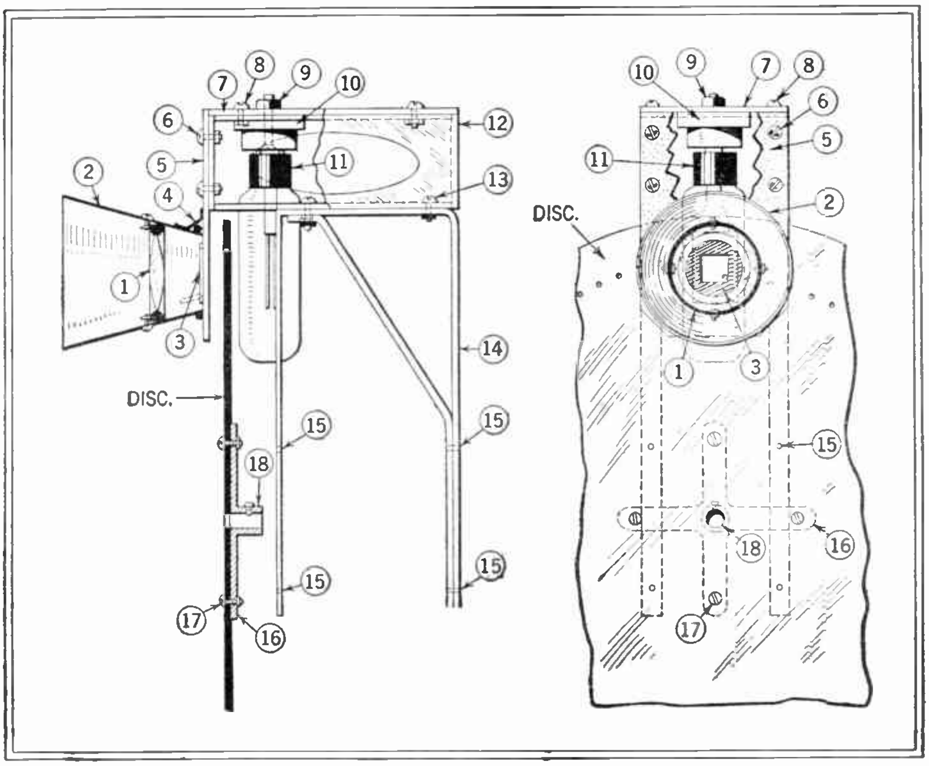
In some cases directon of rotation of the motor may be effected by sliding the shaft out of the rear bearing and then turning the motor around. This is rarely the case, but with some induction motors it is possible to do this, the rotor being secured to the shaft by a set screw.

The television set builder who is interested in the connections of the resistance-coupled amplifier, and other details connected with the radio receiving set, should read all about this matter, where complete diagrams are given with explanatory remarks, in the *Television* magazine, Volume I, No. 2. Various methods of connecting the neon television lamp are supplied by some of the manufacturers putting out these tubes. The common connection for the neon lamp, however, is in series with the plate and "B+" supply wire; in other words, it is connected in the same relative position as your loud speaker. Some of the neon lamps, however, are supposed to be checked carefully with a milliammeter, so that no more than a certain current in milliamperes is passed through them, in order to conserve their life. When using one of these more sensitive type neon lamps, it will be found necessary to connect a clarostat, or other fairly high variable resistance, in series with the "B" supply, before it reaches the neon tube. This series variable resistance in the neon tube circuit may have a range of 0 to 10,000 ohms.

(*Continued on page 109*)



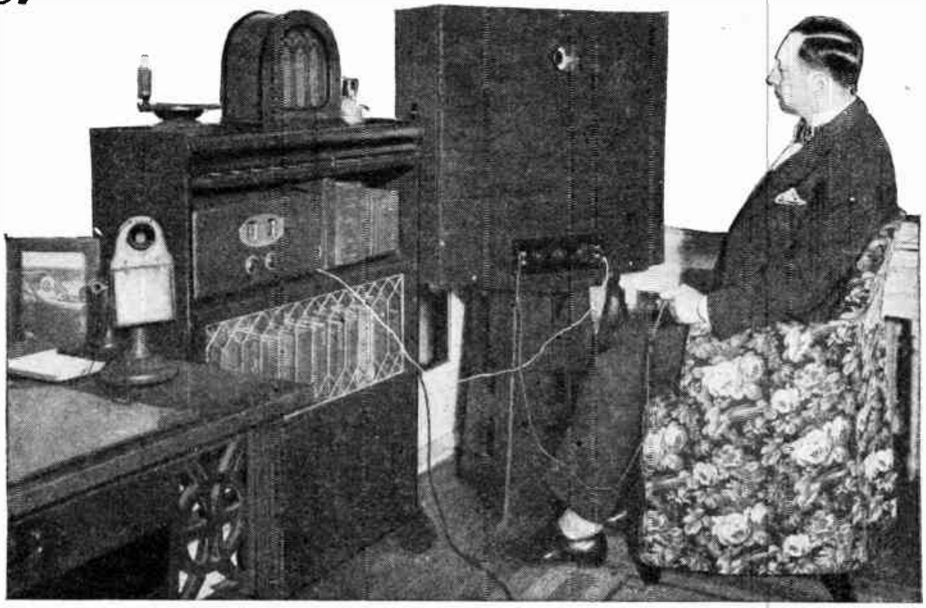
The photograph shows operator checking the speed of the television receiver by means of a tuning fork and a patterned disc. When viewed through the tines of a vibrating fork, the pattern remains stationary, exactly as you see it here.



Further details of the television receiver. 1, double convex lens; 2, cone; 3, aperture; 4, clips for holding cone; 5, face plate; 6, screws for holding same; 7, top; 8, screws for bolting to plates 12; 9, single hole mounting of socket 10; 11, neon lamp; 13, bolts for holding plate 12 to upright 14; 15, holes for mounting uprights to motors; 16, mounting for disc held in place by screws 17; 18, shaft mounting.

How to Make Your Own Television Receiver*

By Robert Hertzberg



H. Gernsback, Editor of RADIO NEWS, *receiving the television broadcasts from WRNY at his home in New York City, with the simple apparatus described in this article. For purposes of the test, the neon tubes and loud speaker were connected in series temporarily, with successful operation simultaneously.*

IN order to pick up and reproduce the television images now being broadcast by WRNY and W2XAL, you need only a modest assembly of instruments, some of which you probably already have on hand, and some of which you will have to buy.

First, since the television images are transmitted simultaneously on 297 and 30.91 meters, by WRNY and W2XAL, respectively, you need either a regular broadcast tuner or a short-wave tuner. If you live in or near New York, and obtain satisfactory loud-speaker results from the regular WRNY transmissions, all you require is a separate audio-amplifier of the resistance-coupled type, and the scanning mechanism, to be described later. If you are already using a resistance-coupled amplifier, as many radio fans are, you will need only the scanning apparatus.

If you cannot hear WRNY's 297-meter wave very well, the best thing to do is to install a short-wave set, in order to pick up the 30.91-meter wave of W2XAL. You will require the audio amplifier also, however. Happily, short-wave receivers are very inexpensive and can be built very easily, so you should assemble one without delay. It will enable you to pick up, not only W2XAL's television signals, but also the "radio-movies" of station W3XK (using the Jenkins system), and musical programs from short-wave broadcast stations in many parts of the world. We can particularly recommend the set described in the RADIO NEWS Blueprint No. 62. This uses an R.F. amplifying stage, has only one tuning control, and costs very little to assemble. If you do not already own a short-wave receiver, just drop us a card and we will send you Blueprint No. 62 free of charge.

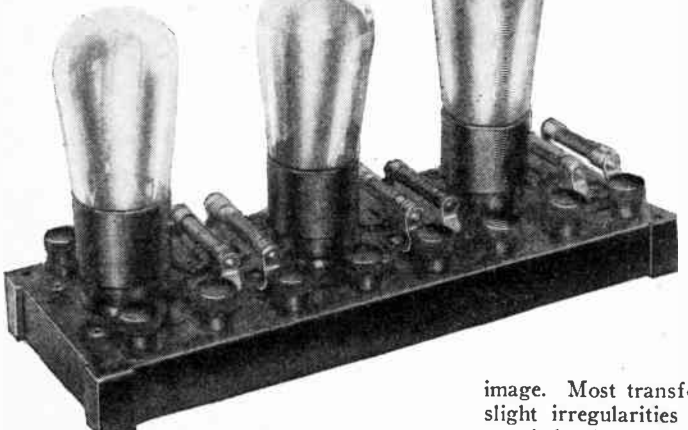
In making this receiver, do not install the single stage of audio amplification. Leave out the audio transformer and the third tube, and simply provide two binding posts for the wires that are shown connected to the primary posts of this transformer. The detector is then easily connected to an external resistance-coupled audio amplifier.

If you are able to use your regular broadcast receiver for WRNY, you will not use for television reception the present audio amplifier if it is of the transformer type. Simply run a wire from the plate (P) post of the detector tube to the top input post of the resistance-coupled amplifier shown in Figs. 1 and 3, unhook the "B+Det" wire running to the power unit or "B" batteries, and bring this same wire to the other input post of the audio amplifier instead. With this arrangement, the detector will be feeding directly into the resistance-coupled amplifier.

RANGE OF FREQUENCIES

"Why can't a regular transformer amplifier be used? Why is a resistance amplifier necessary?" you may ask.

The answer is that resistance-coupled amplifiers amplify audio-frequency impulses ranging from 50 to 5,000 cycles *more uniformly* than do most transformer-coupled amplifiers. The television impulses broadcast by WRNY-W2XAL and others cover this frequency range, and they must be reproduced faithfully at the receiving end, without emphasis on any particular register, in order to create a recognizable image. Most transformer amplifiers possess slight irregularities in their response characteristics but, when voice or music is being reproduced, these are not very noticeable to the ear. When television images are being reproduced, even the slightest irregularity will cause the already crude images to break up and assume peculiar shapes. The general experience of television experimenters has been that resistance-coupled amplifiers are more satisfactory for both television transmitters and receivers, at least in this stage of the art.



A commercial three-stage amplifier which may be purchased already assembled is convenient and compact. The 171-type tube in the output is best suited to the characteristics of the neon tube.

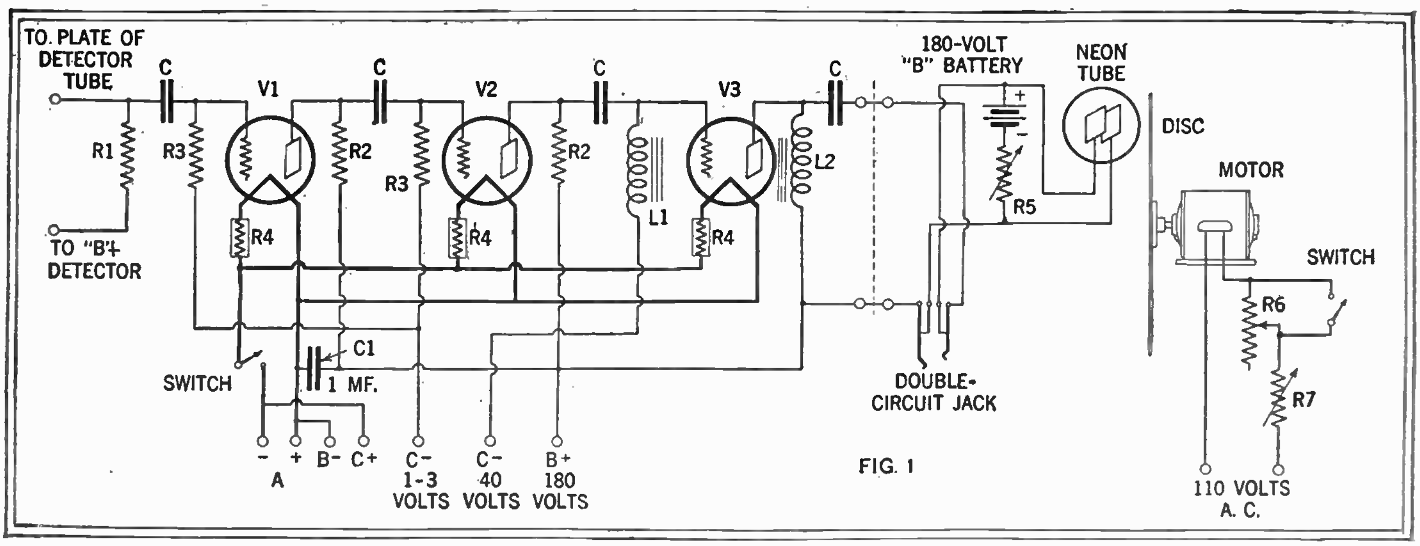
The above statements should not be interpreted as a condemnation of the transformer amplifier. There has long been raging in technical circles a controversy over the respective merits of the transformer and resistance systems for the amplification of voice and musical signals, with the radio experts evenly divided between the two camps. At the present time, however, it is easier to get good pictures from the latter system, so we recommend resistance coupling. However, it is entirely possible to obtain satisfactory results from a *high-quality* transformer arrangement; witness the work being done by James Millen, of Malden, Mass.

A good three-stage resistance-coupled amplifier can easily be assembled on a wooden board, about five inches wide and twelve inches long. A completely-assembled one can be bought for about ten dollars, but a home-made one will not cost so much. After you finish it, you will have a fine amplifier, not only for television impulses, but for regular broadcast programs as well.

DESIGN OF AN AMPLIFIER

You will need the following parts, arranged and connected as shown in Figs. 1 and 3: a wooden baseboard; three UX-type tube sockets, V1, V2, V3; three ¼-ampere filament ballast resistors, R4; two double-resistor mountings; four 0.5-mf. fixed condensers of the by-pass type, C; one 1.0-mf. condenser, C1; a special high-value grid

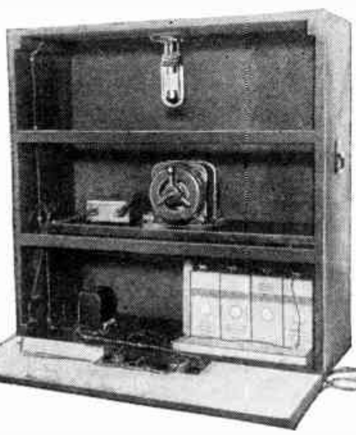
*RADIO NEWS *Blueprint Constructional Article No. 67.* (*See page* 104).



With this arrangement, sufficient amplification for good signals is obtained by the use of two "high-mu" tubes and a 171-type in the last stage. When the speaker is plugged into the jack, the neon-lamp tube is disconnected automatically from the amplifier.

impedance, L1; an output choke of 30 henries, L2; a filament switch; eleven binding posts; fixed resistors of the following values: one 100,000-ohm, R1; four 250,000-ohm, R2 and R3.

The grid impedance unit L1 is used instead of a grid leak in the last stage, as shown in Fig. 1. In this position it overcomes the tendency of the amplifier to "motorboat" when used with a "B" socket-power device. The tubes V1 and V2 are of the 240 ("hi-mu") type, while V3 is a 171A.



The cabinet of the reproducer with the front removed, showing the lamp and the motor with its regulating condenser. The "B" blocks are conveniently located beneath.

The wiring of the amplifier is simple, and should give no trouble. The hook-up is that of a perfectly straight-forward resistance-coupled system, with an output filter consisting of a choke coil (L2) and a fixed condenser (the last of those marked C).

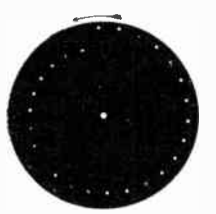
BUILDING THE TELEVISOR

With the amplifier finished, the next step is construction of the scanning mechanism. for this you will need the following parts: a neon-gas glow-lamp, which fits in a standard UX-type socket; a scanning disc 24 inches in diameter, drilled with a spiral of 48 round or square holes; a universal or a condenser-type motor, of not over ⅛-horsepower; a variable resistor, 0-10,000 ohms, R5; a rheostat, 100 ohms, R7; a rheostat, 0-10 ohms, R6, and a pear-shaped hand switch.

The neon-gas glow-lamp has been described time and time again so nothing more need be said about it here.

The scanning disc is merely a flat disc of aluminum drilled with a spiral of holes about 3/64-inch in diameter, as shown in Fig. 4. Now please accept a word of kind advice: *don't try to make your own scanning disc* unless you have available a lathe and a power drill-press, and have had some years of experience as a mechanic on precision work. We are showing the details of the disc as a matter of interest, and not with the expectation of having our readers make it themselves. Buy a disc—there are a number of inexpensive ones now on the market—and you can then expect to see good images.

For a motor to turn the disc, you can get either a condenser-type machine designed especially for television work, or a universal motor such as are used by the thousands for electric fans, vacuum cleaners, coffee grinders, etc. The speed of the motor must be capable of adjustment by an external rheostat; for it must be slowed down to 450 revolutions per minute for WRNY-W2XAL, or 900 for the Jenkins radio-Movies from 3XK. A synchronous motor, revolving at 1,800 r.p.m., can be used only if it is geared to the disc by 1:4 or 1:2 reduction gears, for WRNY and 3XK, respectively. The ⅛-horsepower size of motor is widely available, and is just right. A special condenser-type motor was used in the particular television receiver shown in the accompanying illustrations, and proved exceedingly satisfactory because its speed can be controlled very smoothly by a hand rheostat. This motor has a half-inch shaft, on which the mounting flange of the disc fitted snugly. If you happen to pick up a motor with a shaft smaller than ½-inch, you can buy for a few cents a bushing to adapt the disc to it.



The scanning disc, to show the image in correct arrangement, must revolve in the direction opposite to those of the hands of a clock.

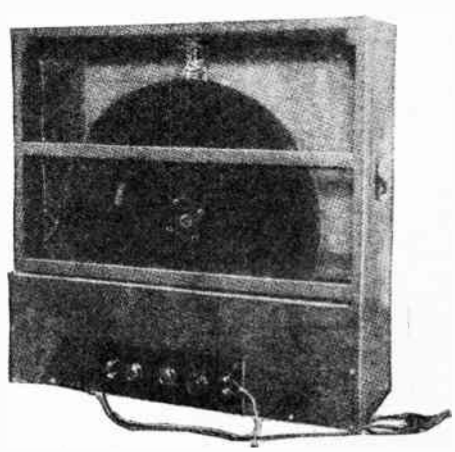
THE TELEVISOR BOX

The idea is now to assemble the scanning apparatus so that the neon tube is mounted directly behind the disc and above the motor, with its flat plates parallel and as close as possible to the back surface of the disc. The tube should be placed along the vertical center line of the disc, at such a height that the outermost hole of the spiral sweeps just under the top edge of the plates, and the innermost hole just above the bottom edge. Any strong, rigid framework that satisfies these conditions will serve the purpose.

The drawings (Figs. 5 and 6) show an arrangement of excellent design. A simple box 31 inches square and 12 inches deep is made up of ¾-inch boards, securely fastened together with wood-screws. The corners are strengthened by additional ¾-inch strips about 1½ inches wide. A shelf to hold the motor is made of another piece of ¾-inch stock about eight inches wide, and supported by two side and one center supports. No dimensions are given for the latter pieces because they naturally will depend on the size of the particuler motor on hand. They should be cut so that the center of the scanning disc coincides with the center point of the box.

The neon tube is suspended upside down from the top of the box; its socket can be spaced away from the board with thin strips in order to lower the tube to the proper position with relation to the holes in the disc.

The back of the box may be covered, or left open. A piece of beaver board, or



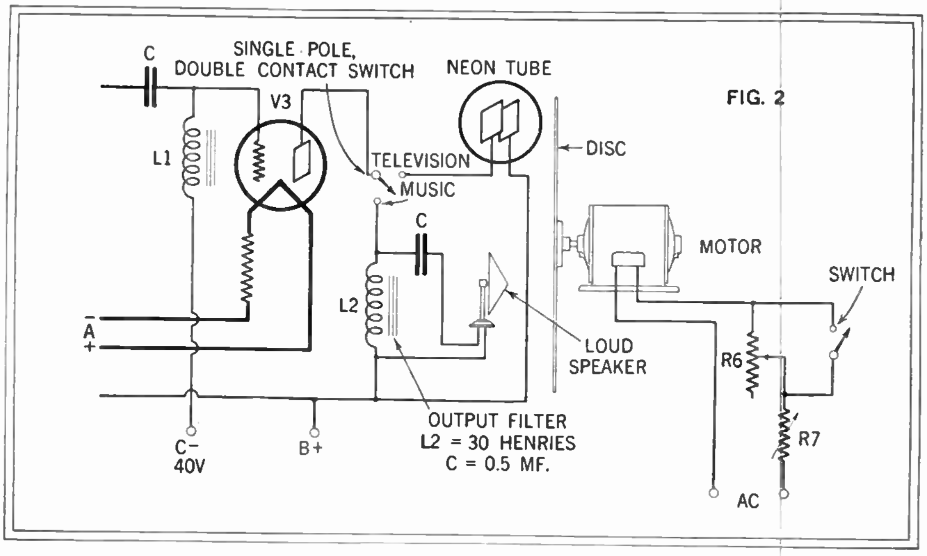
The lower panel of the cabinet—which was solidly built—in place showing the controls, (R 5, 6, 7), switch, and lead from the amplifier.

similar ¼-inch board used for partitions, will be most suitable for the purpose.

The front of the box should be covered with two pieces of this board, one 21 inches high and the other 10 inches. From the larger piece cut out a hole 1⅝ inches square, directly in front of the square plates of the neon tube. On the small board mount the three variable resistors R5, R6 and R7, and two pairs of binding posts, as shown in Fig. 6. A telephone jack may also be mounted on this panel: this device is optional and its uses will be discussed later.

To facilitate experimentation with the disc, motor and the neon tube, do not permanently screw down these front panels at first; but merely turn one or two screws into each, to hold them in position.

It is well worth while to construct a box like this, as it will afford absolute protection against the rotating disc. The latter is far less dangerous than any ordinary "B" power device but, as a matter of safety, revolving machinery of any kind should be enclosed. If you do not want to make anything as elaborate as this heavy box, use lighter material for the sides, or make upright supports of broomsticks and cover the sides with cloth. At any event, be sure that the motor is securely fastened, and that the neon tube is not shaken by its vibration.



An alternate arrangement for the output of the amplifier shown in Fig. 1.

CONNECTING THE TELEVISOR

With all the mechanical work done, you can now start with the electrical end. As explained by many articles in RADIO NEWS, the neon-gas glow-lamp has the same function in a television receiver that the loud speaker has in a music receiver. It translates back into light-impulses the modulated electrical impulses created at the transmitter by the photoelectric cells. It is connected in exactly the same place in the audio circuit that the loud speaker ordinarily occupies.

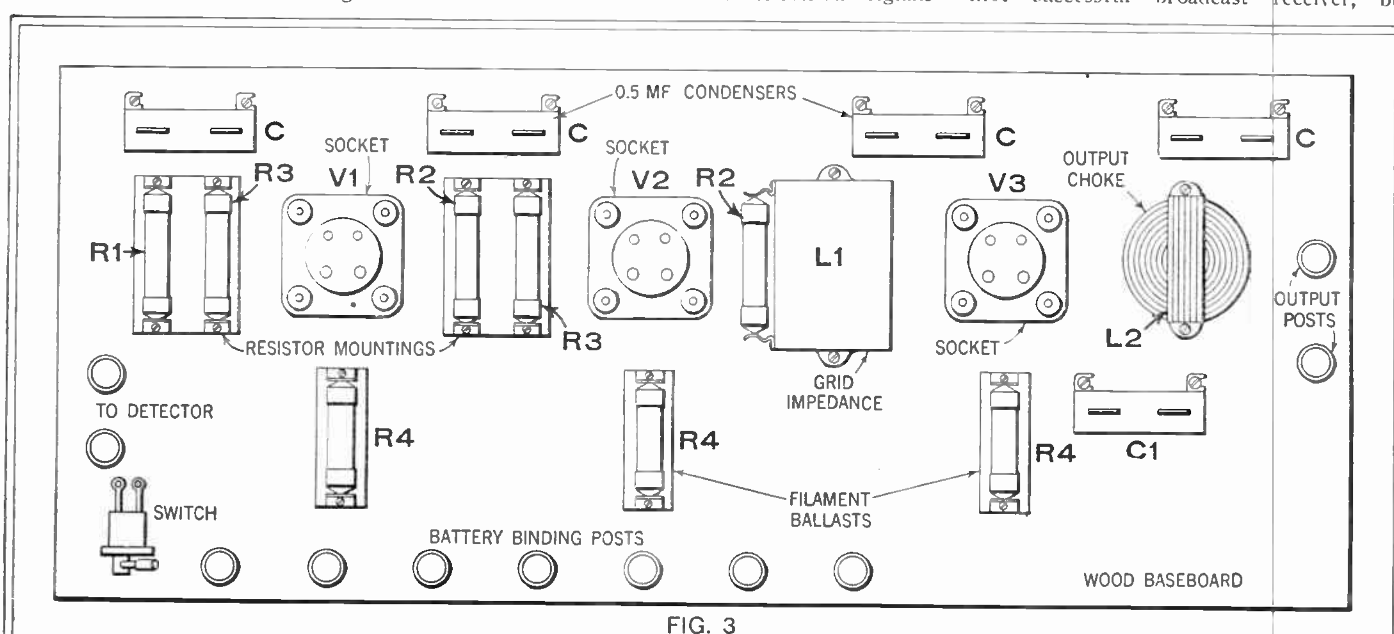
The best arrangement is shown in Fig. 1. The two output posts of the resistance-coupled amplifier are led to a double-circuit telephone jack, which may be mounted on the lower panel of the box holding the scanning apparatus. The inner springs run to the connection posts of the neon tube, across which are connected also the resistor R5 and a *separate* 180-volt "B" battery. Resistors R6 and R7 are in series with each other in the 110-volt A.C. circuit. A six-foot length of flexible cord is run from the pear switch (which is nothing more than a push button in a small wood case which can be held comfortably in the hand) to the resistor R6.

Now turn on your receiver, tune in WRNY or W2XAL with the loud speaker plugged into the double-circuit jack, and adjust the set to give a clear, loud signal. Turn up the resistor R5 until the neon tube breaks out into a bright pink glow. The glow should take place on the plate facing the disc. If it appears on the opposite plate, reverse the battery connections to it.

Turn on the alternating current to the motor, and adjust R7 so that the latter turns at about half its normal speed. Turn off all the lights in the room. The instant the buzz-saw note of television signals comes through the loud speaker, pull out the speaker plug and start playing with the motor rheostat, R7.

OPERATING IS SIMPLE

If you have no tachometer (speed indicator), the only thing to do is to run the motor up and down the scale. When you hit 450 r.p.m., the crazy criss-cross lines that are shooting back and forth and up and down the surface of the disc in front of the neon tube should melt into a rough image of a man's face, or other distinguishable object. You will notice that, with no signal being fed to the neon tube, the square of pinkish light you observe through the disc is streaked with fine dark lines. The instant the audio signal is turned on, this even glow will be modulated by the fluctuating currents. When you hit 450 r.p.m. and the image of the man's face literally uncurls itself from the hodge-podge you saw before, you will experience a thrill that will make all the effort well worth while. You probably received a big "kick" from your first successful broadcast receiver, but,



A simple layout for an amplifier such as that shown in Fig. 1. It uses straight resistance coupling in the first two stages (see preceding pages for values), a grid impedance coil, and an output choke. The output may be connected as in Fig. 2, above, for greater convenience. It is possible, also, to have the tube and speaker in series, with a slight additional "B+" voltage.

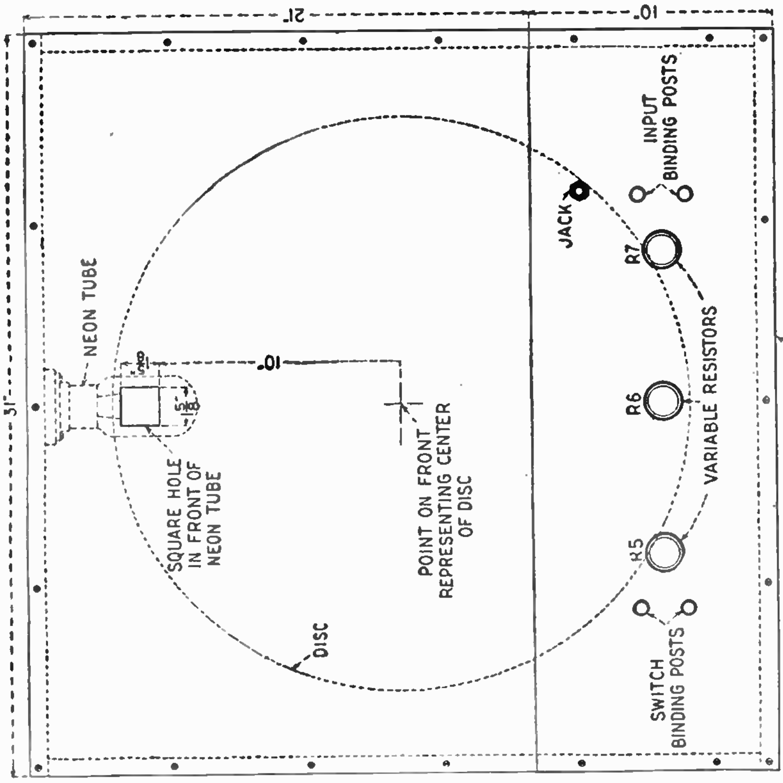


FIG. 6 *Here we have the front of the box. While the cabinet illustrated is fitted with heavy wooden panels, beaver board or similar material is quite heavy enough for the purpose. The controls are conveniently mounted, as shown.*

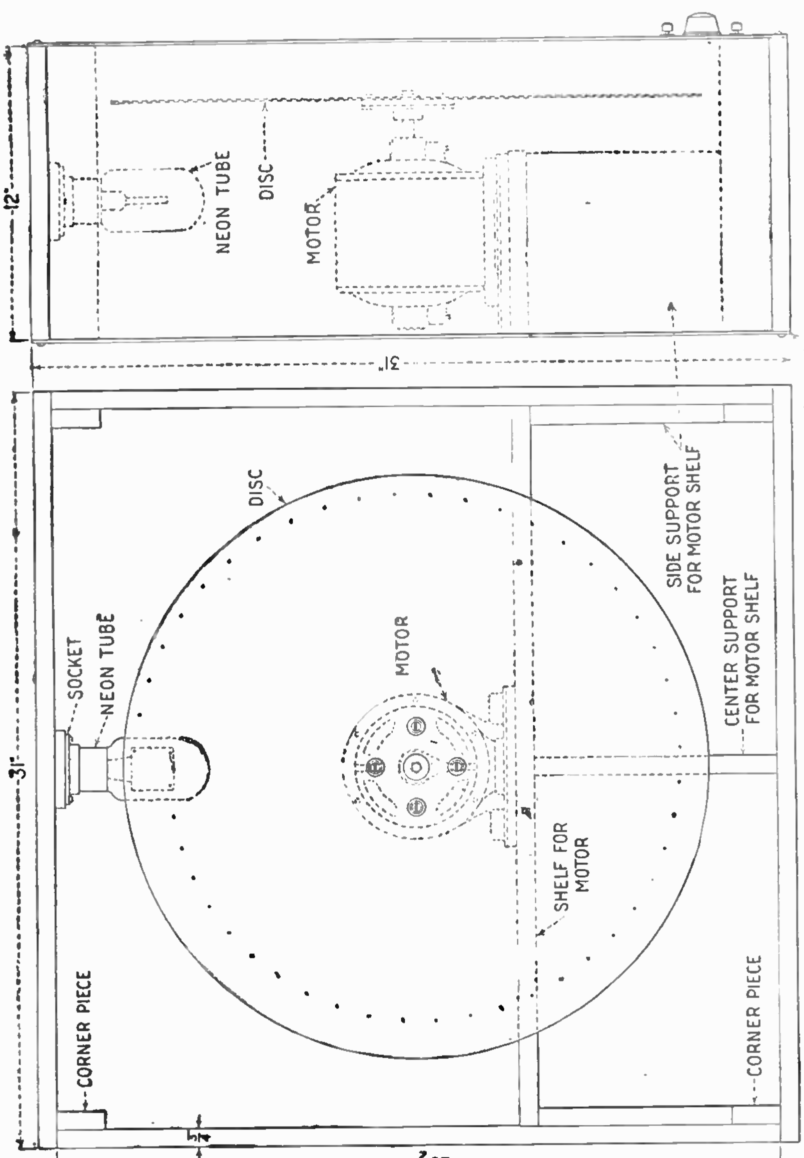


FIG. 5 *The height of the shelf is governed by the distance from the center of the motor's shaft to its base. After the latter has been mounted, the neon tube is easily adjusted to the proper place to cover the inner and outer holes of the disc with its plate. Sponge-rubber mounting may be useful to protect it from vibrations through the cabinet.*

when you see your first television image, you will know what a *real* thrill is.

In the absence of any synchronizing system, the images will tend to wander out of view but, by carefully manipulating the control rheostat R7, you can find the proper setting for 450 r.p.m. The use of the smaller rheostat R6, with its switch, is more or less incidental. Set R6 to about half its value, and just press the switch for an instant when the images start to run off. This will cause the motor to jerk and speed up for a second.

If you are using a universal motor, you can disregard R6 and its switch altogether and depend on R7 for the speed control.

The images you receive may be upside down, or the WRNY televised card may read backward. To correct these conditions, follow the operating hints given in the article on operation.

OTHER ARRANGEMENTS

An alternate circuit arrangement is shown in Fig. 2. Here the neon tube is connected directly in series with the plate circuit of the last audio tube, with a single-pole, double-contact switch to shift the output of the tube. The rest of the amplifier and motor circuit is exactly like that of Fig. 1. This is a simple hook-up; but its main disadvantage is that the voltage applied to the "B+" post must be at least 300 volts, as there is a drop of about 150 volts across the neon tube itself, and V3 is a 171A, which operates on 180 volts. As no "B" power unit designed for 171 operation will supply more than about 220 or 250 volts, it will be necessary to connect one or two 45-volt "B" battery blocks in series with the highest voltage lead from the unit you have. At least, this will be cheaper than using four 45-volt blocks for the hook-up of Fig. 1.

Several experimenters have used a "B" power unit for the neon-tube illumination with good success, but separate batteries are really the cheapest, easiest and most satisfactory source of supply.

The audio amplifier need not be limited to a 171A for the output stage. A 210-type power amplifier will work perfectly well, but in this case the shunt-feed scheme of Fig. 1 should be used. The series arrangement of Fig. 2 will strain the power pack and the neon tube is likely to be burned up by the high plate current. With the Fig. 2 hook-up, incidentally, it is a good idea to shunt the glow-lamp by a 0-10,000-ohm variable resistor; this resistor should be so set that the tube lights nicely when there is no incoming signal. The 171A draws about 20 milliamperes, which is the normal load limit of the glow-lamp; so the combination works out very happily.

TRY YOUR LUCK

Remember that television as we have it today is very crude. Do not expect perfect images, and do not forget that television on 5,000 cycles was, until only very recently, held impossible altogether. Experiment with the neon tube and the motor's speed and try different output arrangements. Try putting an ordinary reading glass in front of the images, as shown in the first illustration, and see if you can magnify them.

(*Continued on page* 104)

How to Adjust the Television Receiver for Operation

This Little Article Should Be Studied Diligently by the Television Experimenter. It Contains a Number of Helpful Hints Which May Prove to be Exceedingly Valuable to the Constructor Who is Confronted Suddenly With Any of the Television "ills" Described Here

By C. P. Mason

THE first step in the reception of a television image is the locating of the signal on the receiver dials. This is best done with the aid of headphones or a loud speaker connected in place of the neon tube. Do not fail, however, to have a fixed condenser of about 1 mf. capacity in series with the phones when connected in place of the neon tubes or across its terminals.

The television signal has a distinctive sound but, unfortunately, the short-wave band contains several signals that may easily be mistaken for television. For instance, the high-speed code transmissions of such stations as WIZ and WQO are quite like a television signal because of the "flutter," or what may be called a "group frequency." On the broadcast band, in which WRNY operates, this trouble will not be experienced.

In addition to a low "group frequency," which is the rate at which complete pictures are transmitted and which is around 18 to 20 cycles (per second), the television signal contains high-frequency notes whose character depends upon the nature and the position of the subject before the transmitter pick-up.

The experimenter will hear a signal which sounds at first like a flutter and will then note that this flutter is really the rapid repetition of a high-frequency note. The nature of this note and its loudness constantly change as the subject before the transmitter moves or is changed. For instance, a newspaper rolled up and held in a vertical position produces a distinct note which is very clean cut. A hand does not produce so clear a note, yet the signal is of the same general nature.

"CRAZY" IMAGES

The television experimenter may, upon his first attempts, be puzzled to find his received images either turned upside down, or else reversed as when looking through a photographic negative the wrong way. Both of these faults can be corrected quite easily.

It is quite obvious when an image is upside down, and the correction of this fault is equally obvious. The subjects before the transmitters at most stations broadcasting television are scanned from top to bottom during one rotation of the disc. Accordingly, if the receiving disc is so rotated that the plate of the neon tube is scanned from the bottom to top, the picture will be inverted. To reverse the manner in which the neon lamp plate is scanned vertically, it is necessary either to reverse the rotation of the disc or to remove the disc from the driving motor and turn it around. The latter operation may involve the removal of the hub and remounting on the opposite side of the disc.

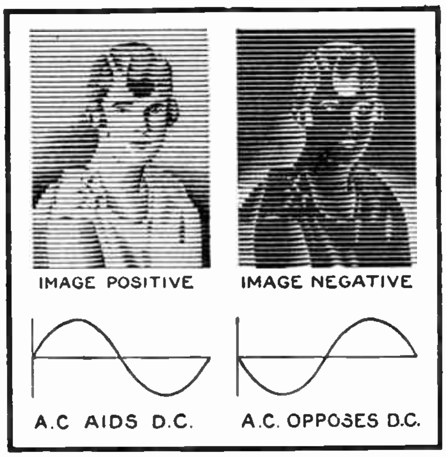


Fig. 4. When the image is negative, as shown at the right, the A.C. signal is working against the battery. Reversing the leads to the lamp is the simplest remedy.

Whether or not the received image is reversed horizontally, is impossible to tell unless one happens to know the scene being transmitted, or unless distinctive characters are held before the transmitter pick-up. For example, one of the objects often placed before the transmitter pick-up at station WLEX, in Boston, is a microphone stand with the station letters mounted on it. If the image of the microphone stand and letters is received with the object erect but reversed (so that the letters read "XELW") then the scanning disc is being so rotated that the holes pass the glowing plate of the neon tube in the wrong direction.

The correction of this fault is not so obvious. It is plain that whether the experimenter scans the plate from top to bottom or from bottom to top, makes the difference between the picture being right-side up or upside down. Similarly, whether the experimenter scans the plate from left to right or from right to left makes the difference between seeing the image correctly or reversed.

How can we make the holes pass the plate in the opposite direction and still progress from top to bottom? Reversing the rotation of the disc alone will turn the image upside down. The disc must also be turned around on the shaft of the motor. Thus if the image is right-side up but reversed, we must reverse the direction of rotation of the disc, and *also* remove the disc from the shaft and turn it around with the other side out.

In spite of the fact that these two factors make three wrong combinations and only one correct one, the wrong combinations provide perfectly recognizable images whose worse fault is to be upside down.

Should the image obtained be a *negative* instead of a positive, the trouble is due to reversed A.C. connections to the neon tube. Interchanging these connections will correct the trouble.

In the experimental work at WLEX it has been found that the television signal may be almost submerged in noise and yet provide an image. This fact will undoubtedly be of interest to those who are already trying to receive the signals from WGY and WRNY and who think that reception is hopeless, because of the noise caused by daytime electrical disturbances and the static of warm weather.

It is true that, when we are interested in listening to a signal, the noise level is an important determining factor; but in the case of television, the noise level may be high—in fact, so high as to make speech transmission hopeless—and still a fair image can be received. Of course, noise does not help matters; it provides a mottled background and tends to speckle the picture itself. Extreme noise will produce dark lines of varying width across the field of the image. But in spite of this, the picture is there, and since noise is *non-periodic unless introduced by vibration from the motor and disc*, the speckle and dark lines are continually shifting their positions while the image remains generally stationary or moves in an orderly fashion.

Therefore, if in the experimenter's attempts to receive television images, he finds the signal more or less accompanied by noise, he should not judge the noise by speech broadcast standards, but go right ahead and try the signal on the disc. It goes without saying that the minimum of noise should be introduced by the set itself. Loose connections in the microphonic tubes, noisy resistors, and other causes of noises should be avoided.

When a good television signal is being received, it sounds quite like a slowly-revolving circular saw which is slightly off center. In other words, one hears a high-pitched note which might correspond to the tooth frequency, and broken up into groups whose frequency corresponds to the rate at which the saw (the disc) rotates. The latter we have referred to as the group frequency while the high-pitched note is the modulation introduced by the scanning spot. If the disc speed is high and the signal is weak, it may easily happen that the only sound audible in a pair of phones will be the group frequency.

*A Sturdy and Dependable "B" Power Unit**

Especially Designed for Use with the "Neutroheterodyne" Receiver, and Readily Adaptable to Any Large Set

BRIEFLY, this power pack may be described as a "B and C" supply unit which operates directly from any standard 110-volt, 60-cycle source of power. It provides a maximum plate potential of 350 volts for the operation of a 210-type power tube in the last audio stage and, in addition, it gives a grid-bias potential of 25 volts for this tube. The unit also delivers various intermediate values of grid and plate potential for operating the other tubes of the receiver, as well as 8 volts A.C. at 2½ amperes for heating the filament of the power tube. The maximum total D.C. output of the unit is 60 milliamperes at 375 volts, when using a rectifier tube of the type recommended in the list of apparatus.

The illustrations on this page clearly show the constructional features of the power pack. All of the apparatus is compactly assembled on a wooden baseboard 11 by 17 inches, and the controls are mounted on a vertical bakelite panel 7 by 18 inches. It will fit easily into any console base.

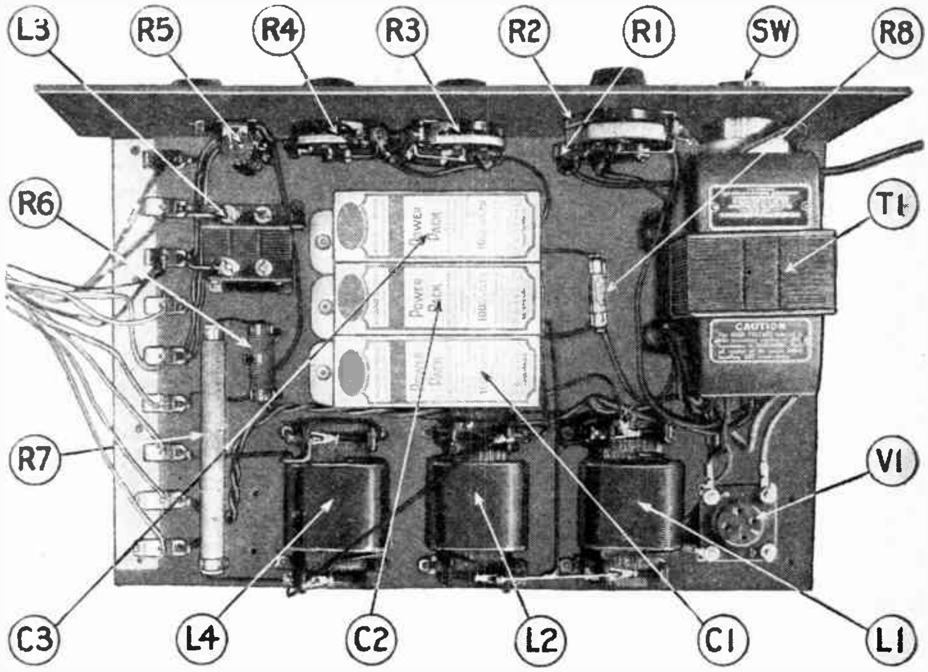


Fig. B. The exact position of all parts mounted on the baseboard is shown in this top view of the power unit. T1, power transformer; V1, tube socket; L1 and L2, filter-choke coils; L3, detector "B" choke coil; L4, output choke coil; C1, C2 and C3, filter condensers; R6, R7 and R8, fixed resistors; R1, R2, rheostats; R3, R4, grid-bias resistors; R5, "B+Det." control.

CHARACTERISTICS

In circuit design the power unit under discussion is not unusual, but several interesting features have been incorporated in the wiring. From the diagram it may be seen that the power is supplied by a single power transformer with three secondary windings. One of the latter provides the high voltage for the rectifier, and the other two windings are center-tapped and each has an output of 8 volts at 2.5 amperes; one is used for heating the filament of the power tube and the other for the rectifier.

The builder of this unit has a choice of rectifier tubes. The unit was originally designed for operation with a tube of the 216B type, but it may also be used in connection with the new 281-type rectifier. When the 216B-type tube is used the output voltages shown in the diagram are obtained; the voltages obtained from the 281-type tube are slightly higher, but the increase is not sufficient to make necessary any other changes in the unit. Both the 216B- and 281-type tubes are half-wave rectifiers and each requires the same filament current. Therefore, in most cases they may be used interchangeably. However, the latter tube has a greater current-carrying capacity and a lower resistance, with the result that it is possible to obtain a greater output under the same conditions without overloading.

The filter circuit of the power unit is standard. It employs two A.F. choke coils connected in series and three filter condensers connected at various points across the line. The two audio-choke coils of the filter circuit have a total resistance of 1,200 ohms, a maximum current-carrying capacity of 60 milliamperes and a maximum inductance of 50 henries each. The chokes have another feature which makes possible highest efficiency; namely, *an adjustable air gap in the core.* After the power unit has been connected to the receiver the air gap of each choke coil may be adjusted and in this way the A.C. hum of the output is greatly reduced.

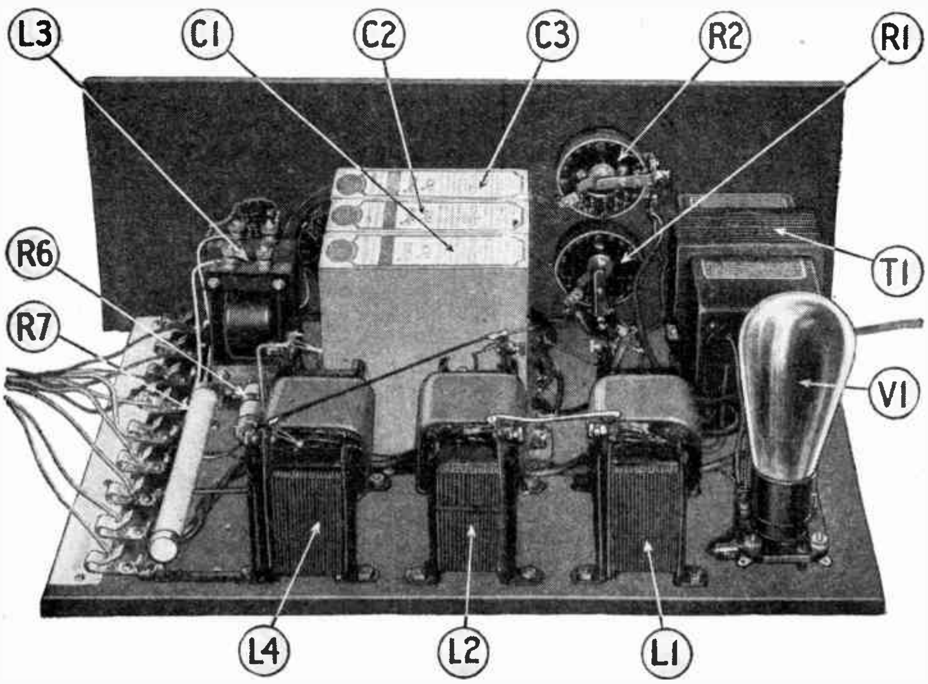


Fig. C. The appearance of the power unit when viewed from the rear. The symbols shown correspond to those used in the text, list of parts and other illustrations.

* RADIO NEWS *Blueprint Constructional Article No. 59.* (*See page* 104).

The adjustment of the air gap gives the choke the highest possible inductance under any operating conditions. The three condensers used in the filter circuit are units of 4 mf. each.

SPECIAL CHOKES INCLUDED

An interesting feature of the power unit is that the loud-speaker filter coil is mounted in the power unit rather than in the receiver. This piece of apparatus operates with equal efficiency in this position, and in this way it is possible to remove a large and heavy piece of apparatus from the receiver. The 4-mf. by-pass condenser, which together with this audio choke coil comprises the loud-speaker or output filter, is mounted in the receiver cabinet. Another piece of apparatus mounted in the power pack is the choke coil connected in the plate lead of the first-detector tube, this coil is not needed with all types of receivers, but is required for the operation of a super-heterodyne of the type this power unit was designed to supply.

VARIABLE VOLTAGES

In the resistance bank of the voltage-dividing potentiometer, both fixed and variable units are employed. Two fixed resistors connected in series are employed to reduce the potential from 330 volts to 90 volts, the value required for the operation of the amplifier tubes of the receiver. The resistor which causes the potential to drop to 45 volts for the operation of the two detector tubes is a variable unit; and two other variable resistors are employed for obtaining the two values of grid bias which are required. In addition to these two resistors, two rheostats are used to control the filament voltages of the rectifier and power-amplifier tubes.

SPECIAL FEATURES

The pack was designed originally for a seven-tube receiver (the Neutroheterodyne), but it may be used successfully with other receivers employing approximately the same number of tubes. Before describing the construction of the unit, it will be explained which features apply especially to the Neutroheterodyne; as these need not be incorporated in the power pack if it is to be used with another receiver.

In the first place, it will be noticed that the diagram calls for wires of eight different colors in the output circuit.

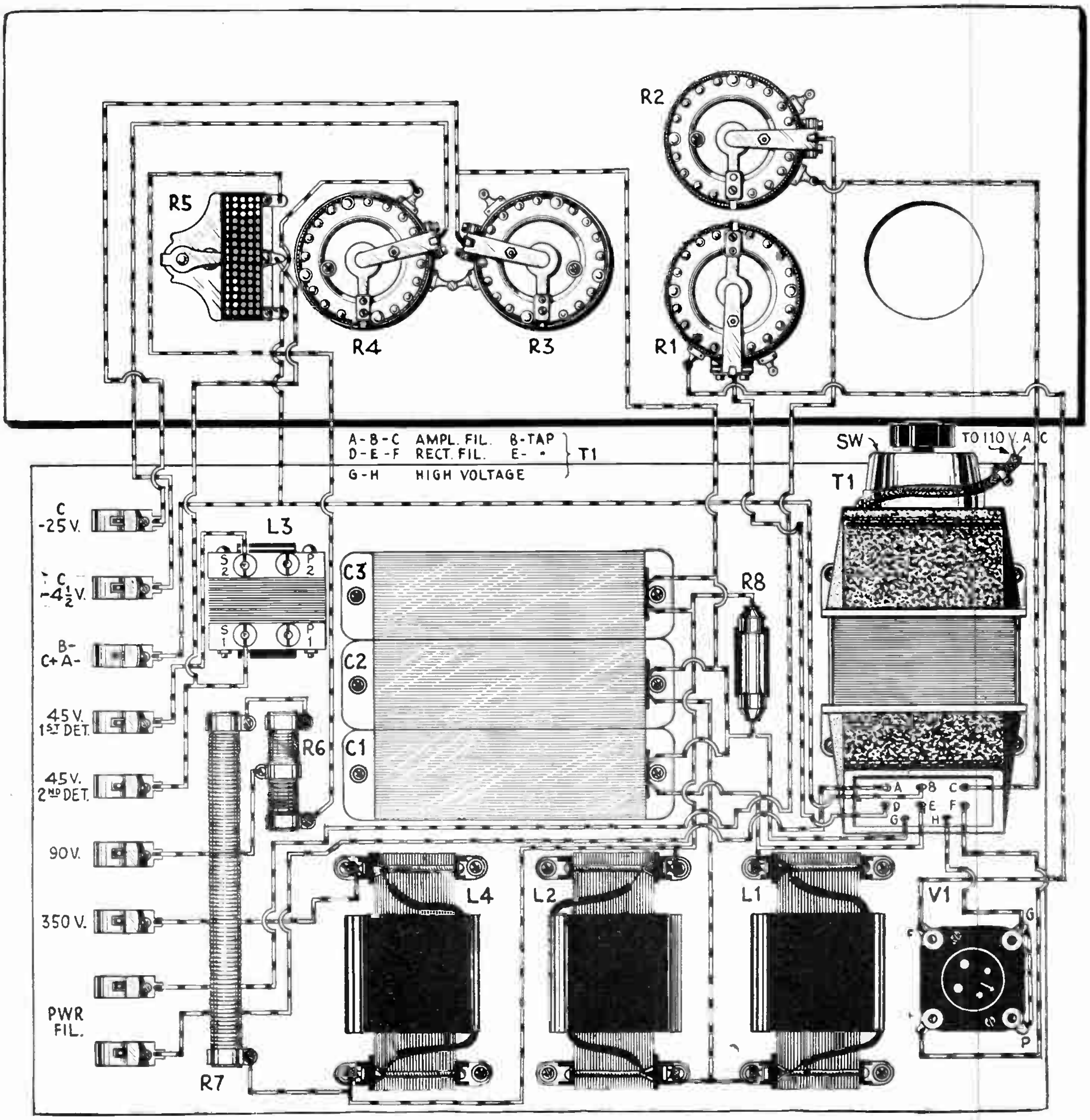


Fig. 2. When building the power unit, the constructor should mark out each wire with lead pencil on this diagram after the connection has been completed, thus insuring greater accuracy in wiring.

These colors are the same as those used for corresponding wires in the "Neutroheterodyne" receiver; but the color code should be adapted to the receiver with which it is to be used. Secondly, the audio choke in the plate-supply wire to the first detector is not needed with the average receiver; but it is essential for the operation of the "Neutroheterodyne." Thirdly, in a large number of cases, it will be unnecessary to mount the loud-speaker choke coil in the power unit; as in many receivers this piece of apparatus is mounted on the baseboard of the set. Also, in some sets, an output transformer is used in place of the loud speaker or output filter.

The illustrations on the other pages clearly show the construction of the power pack. The picture reproduced as Fig. A indicates the arrangement of controls on the front panel, and from this view of the unit it may be seen that there are six adjustment knobs. The switch for turning the power on and off, and for regulating the input to the unit, is located at the extreme left of the panel at SW. This is a standard snap switch with one "off" position and three "on" positions. It is mounted on the case of the power transformer, and it will be necessary to cut a large hole in the control panel to make possible the adjustment of the knob from the front.

The knobs R1 and R2 are arranged, one above the other, slightly to the right of the switch. These knobs control the adjustment of rheostats which regulate the filament current delivered to the 7½-volt tubes; R1 is for the rectifier circuit and R2 is for the power-amplifier tube.

Between the rheostat knobs and the right edge of the panel, three knobs are mounted, at even distances, on a line slightly below the center of the panel. The knob at the left (R3) is for regulating the grid potential applied to the power tube; the knob in the center (R4) is for regulating the bias applied to the amplifier tubes of the set, and the knob at the right (R5) is for adjusting the detector voltage.

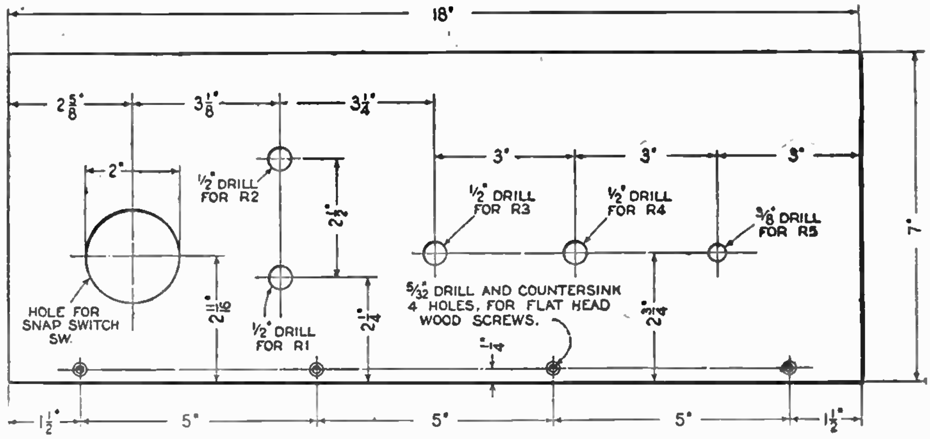


Fig. 3. This diagram shows the exact positions and dimensions of all holes required in the front panel for mounting the various parts shown in the pictures.

ASSEMBLY

The arrangement of parts mounted on the baseboard of the power unit is shown in Fig. B. When looking at the unit from the rear, the power transformer (T1) will be seen located in the front right corner of the baseboard in such a position that the key of the snap switch protrudes through the hole drilled in the front panel. At the rear edge of the baseboard, directly behind the power transformer, the tube socket (V1) for the rectifier has been mounted. This is the ideal position for this unit, as it keeps the high-voltage leads from the power transformer as short and direct as possible.

The two filter-choke coils (L1 and L2) and the loud-speaker choke coil (L4) are of identical construction, and these are mounted about one inch apart, at the rear edge of the baseboard, starting slightly to the left of the rectifier tube socket. L4 is on the left, L2 is in the center and L1 is on the right; as this arrangement makes the simplest possible wiring. The three condensers of the filter circuit are also identical. These are arranged so that their terminals face the right of the baseboard, and are mounted, one behind the other, directly in front of choke coils L2 and L4. The wiring is simplest when the condenser near the rear of the baseboard is made C1, the condenser in the middle C2 and the condenser nearest the panel C3.

Battery clips are used in place of binding posts and these are fastened directly to the wooden baseboard with wood screws. Nine clips are required and they are mounted approximately one inch apart on the left edge of the baseboard. The choke coil for the first-detector supply wire is mounted near the front edge of the baseboard, between the condenser C3 and the battery clips. The resistor (R7) of the resistance bank is a long thin unit and it is mounted on the base so that it runs from rear to front. Its position is between the battery clips and the choke coil (L4), starting at the rear edge. The resistor R6 is a comparatively short unit and is mounted between R7 and C1, parallel to and near the front end of R7. The remaining piece of apparatus, the fixed resistor R8, is mounted in a convenient position between the transformer and the condenser bank.

Fig. C shows the appearance of the power unit when viewed from the rear. The rectifier tube is in the socket and all parts are mounted and wired correctly. As the baseboard is wood all parts are fastened in place with wood screws. The arrangement which is shown makes for the shortest possible wiring and, therefore, is the most satisfactory, but if a baseboard of different shape is employed the location of the various pieces of apparatus may be shifted without materially affecting the results.

However, if the arrangement is changed it is important to separate each of the choke coils by at least one inch from all surrounding apparatus. The position of the choke coil in the plate-supply wire of the first detector is also important, and this should be placed as far as possible from the power transformer and filter choke coils. Also, this instrument should not be screwed permanently to the baseboard until after the power unit has been placed in operation; as it should be turned until it is in such a position that it causes no hum.

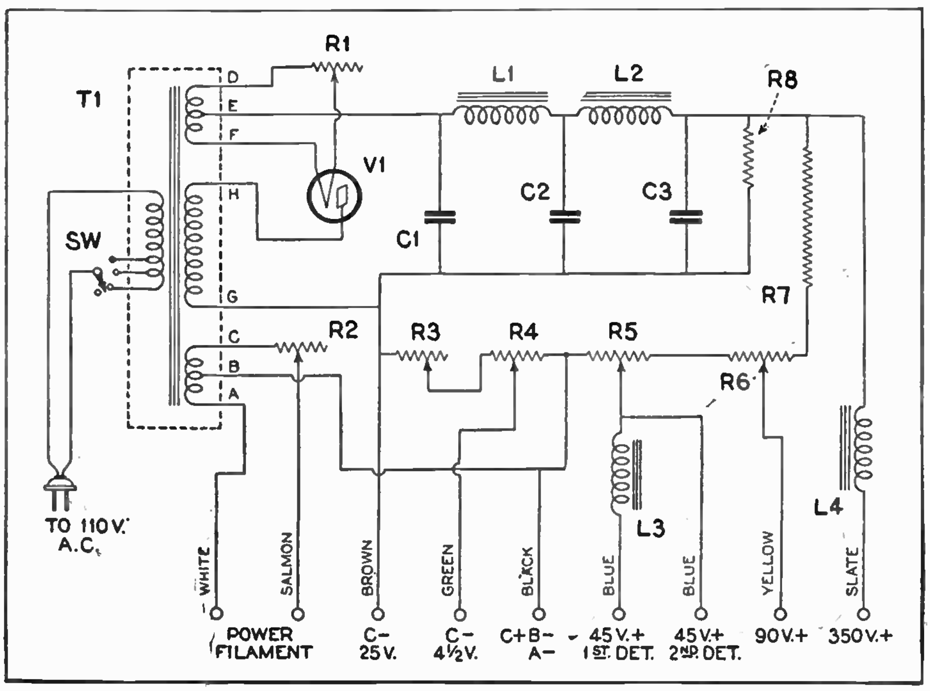


Fig. 1. Schematic wiring diagram of the Reich power pack. It will be noticed that a color code wiring system is called for; that employed here corresponds to that used in the wiring of the "Neutroheterodyne" receiver, for which this power unit was especially designed.

WIRING

After the assembly of apparatus on the baseboard and front panel of the power unit has been completed the wiring may be started. Fig. 1 shows the circuit in schematic form, and in Fig. 2 the complete wiring is given in pictorial form. It will be noticed that the system used in wiring the set is very simple and that all wires are located above the baseboard. For this purpose well-insulated flexible wire must be used.

From the circuit diagram it will be seen that the primary winding of the power transformer is the only part of the circuit which is connected to the 110-volt, 60-cycle house-supply wires. There is in the primary circuit of this transformer a three-point snap switch which makes it possible to turn off the unit, or to change the number of turns used in the winding, for the purpose of regulating the power. In the transformer selected for this power unit this switch is built into the transformer and requires no additional connections; but, if another transformer is substituted when building the set, it may be necessary to connect a switch of this type externally to the transformer. In the case of the transformer under discussion, the three points of the snap-switch adjust the power unit for operation in 60-cycle circuits of 110, 118 and 125 volts, respectively.

There are three secondary windings on the power transformer; two center-tapped filament windings and one 525-volt plate winding with a capacity of 60 milliamperes. One of the filament-heating secondary windings is connected to the filament of the power tube, with the rheostat R2 in series with one of the connecting wires. The center tap of this winding is connected to the "B—" binding post of the power unit. The second filament winding is connected to the filament of the rectifier tube with the rheostat R1 in series, and the center tap of this winding connects with one terminal of L1. One terminal of the high-voltage secondary winding is connected to the "P" terminal of the rectifier tube socket and the other terminal to the "C—25" terminal clip.

The next step is to connect the free terminal of L1 with one terminal of L2, and, then, connect the remaining terminal of L2 with one terminal of L4. The free terminal of L4 may now be connected with the clip marked "B+350". Next the filter condensers should be connected. First connect one terminal of each of the three condensers to a wire connecting with the "C—25" clip, and then connect the free terminal of C1 with that terminal of L1 which connects with the center tap of the filament winding; connect the free terminal of C2 with the wire joining choke coils L1 and L2, and connect the free terminal of C3 with the wire joining choke coils L2 and L4.

The voltage-dividing resistor bank may now be wired. The first step is to connect the resistors R3, R4, R5, R6 and R7 in series, in the order mentioned. The free terminal of R7 is then connected with the wire joining the choke coils L2 and L4. The center-tap of resistor R6 is next connected with the clip marked "B+90." Two wires are then connected to the slider terminal of resistor R5 and one of these wires is connected to the clip marked "B+45—2nd Det." and the other is connected to one terminal of the choke coil L3. The other terminal of the choke coil is connected to the clip marked "B+45 1st Det." The slider of resistor R4 is connected to the clip marked "C—4½" and, to complete the wiring of the resistor bank, a terminal of resistor R3 is connected to the clip marked "C—25." In the case of resistor R3, only two of the three terminals are used, and it is important to make sure one of the terminals to which contact is made is the slider.

The construction of the power unit is now practically complete and, after the resistor R8 has been connected, the wiring may be considered finished. One terminal of this resistor is connected to the wire joining the choke coils L2 and L4, and its other terminal connects with the wire joining the clip marked "C—25."

TESTING

After completing the construction of the power unit the wiring should be carefully checked and tested. It should be remembered that the transformer T1 develops a potential of 525 volts and that this is dangerous if not properly insulated. Therefore, it is highly important to make sure that every connection is correct and secure, and that all wires are insulated thoroughly.

In order to test the power unit it is necessary to connect it correctly with the receiver, and *all tubes* of both the receiver and power unit *must be in their sockets* when the power is turned on for the first time. This is important; for, if the power were connected and the tubes were not in their sockets, the high voltages developed would be apt to burn out the filter condensers.

As soon as possible, after the power has been turned on, the various knobs should be adjusted to their correct positions. It is particularly important that the resistor R3 be adjusted; for, if the power tube receives insufficient bias, it is apt to overheat. Before turning on the power it is a wise idea to introduce into the circuit as much resistance as possible with resistors R1, R2 and R3, and then, after the power has been applied, slowly reduce the resistance until proper operating conditions are established. If this system is followed the apparatus is protected from damage which might be caused by the high voltage.

In adjusting the various controls, meters should be used if they are available. An A.C. voltmeter with a range of 0 to 10 volts may be used for checking the filament potentials applied to the rectifier and power tubes, and a high-resistance (1,000 ohms per volt) D.C. voltmeter with a range of 0 to 150 volts may be used for adjusting the "C—25," "C—4½," B+45" and "B+90." The final adjustment of the "C—25" voltage is not made until after the receiver is operating properly, and then an 0 to 50 D.C. milliammeter is used for the purpose. This meter is connected in series with the 350-volt supply wire and a loud signal is tuned in on the receiver. When the volume of music from the loud speaker is at maximum, the knob R3 should be adjusted until the needle of the milliammeter is practically stationary. Of course, the knobs may be adjusted quite satisfactorily without the use of meters; and, if the experimenter is careful, the results will be practically as satisfactory.

SYMBOL	Quantity	NAME OF PART	REMARKS	List Price Each	MANUFACTURER ★	
T1	1	Power transformer	550-volt, 60-mla. Sec. & two 8-volt Secs.	$18.00	1	
L1,L2,L3	3	Filter choke coils	60 mla., 50 henries, 300 ohms	6.00	1	
L4	1	A.F. choke coil	80 milliamperes, 30 henries	5.00	2	
R1,R2	2	Rheostats	3 ohms, 1.5 amperes	1.35	3	
R3,R4	2	Potentiometers	400 ohms	1.75	3	
R5	1	Potentiometer	5,000 ohms (power type)	3.50	4	
R6	1	Fixed resistor	5,000 ohms (wire-wound, 25-watt type)	.85	4	
R7	1	Fixed resistor	10,000 ohms (wire-wound, 50-watt type)	1.65	4	
R8	1	Fixed resistor	100,000 ohms (grid-leak type)	.75	5	
C1,C2,C3	3	Filter condensers	4-mf., 1,000-volt rating	12.00	6	
	1	Tube socket	UX type	.75	7	
V1	1	Rectifier tube	216B or 281 type	9.50	8	
	9	Battery clips	Spring type	.05	9	
	1	Baseboard	17 x 11 x 1/2 inches			
	1	Front panel	18 x 7 x 3/16 inches		10	Prices vary
	8	Rolls of wire	Flexible, insulated, hook-up wire in white, salmon, brown, green, black, blue, yellow and slate.	1.00		
	1	Grid leak mount	(For R8)	.35	4	

NUMBERS IN LAST COLUMN REFER TO CODE NUMBERS BELOW.

1 Amer. Transformer Co. (Amertran) 178 Emmet Street, Newark, N.J.	10 Formica Insulation Company Cincinnati, Ohio	19
2 Thordarson Elec. & Mfg. Co. Huron & Kingsbury Sts., Chicago, Ill.	11	20
3 Yaxley Manufacturing Company 9 So. Clinton St., Chicago, Ill.	12	21
4 Electrad, Inc. 173 Varick St., New York City	13	22
5 International Resis. Co. (Durham) Perry Bldg., Philadelphia, Pa.	14	23
6 Acme Wire Company (Parvolt & Celatsite) New Haven, Conn.	15	24
7 Benjamin Elec. Mfg. Company 120 So. Sangamon St., Chicago, Ill.	16	25
8 C.E. Manufacturing Co. (CeCo) Providence, R.I.	17	26
9 Fahnestock Electric Company Long Island City, N.Y.	18	27

★ THE FIGURES IN THE FIRST COLUMN OF MANUFACTURERS INDICATE THE MAKERS OF THE PARTS USED IN THE ORIGINAL EQUIPMENT DESCRIBED HERE.

If you use alternate parts instead of those listed in the first column of manufacturers, be careful to allow for any possible difference in size from those originally used in laying out and drilling the panel and sub-base.

How to Construct the "Pre-Selector"*

A Receiver Accessory Which Provides Extreme Selectivity Without Loss of Sensitivity or Additional Controls

By S. Gordon Taylor

THERE has always been a strong demand for an accessory that could be connected to any standard radio receiver to improve its selectivity. In general, such devices have fallen into one of two classes. The first is the well-known wavetrap, by means of which a single interfering station may be trapped out, either partially or completely; the second class includes what amounts to an additional stage of radio-frequency amplification built as a separate unit and connected ahead of the receiver.

Both of these accessories have the disadvantage of adding one or more tuning controls and both, therefore, tend to complicate the operation of a receiver. They have also individual faults. The wavetrap, for instance, is not always capable of entirely cutting out even the single interfering station for which it is adjusted and, furthermore, it frequently reduces the intensity or volume of the desired signals. The added stage of R.F. amplificaton almost always tends to make the receiver unstable by increasing undesirable feedback. To prevent oscillation in such a combination it is usually necessary to turn back the volume control, or the sensitivity control of the receiver, with the result that the over-all sensitivity of the combination is often actually less than that of the receiver alone. Most radio experimenters have tried devices of both kinds and have recollections of these facts.

SOLVING THE PROBLEM

In spite of these faults, there are thousands upon thousands of these two classes of accessories in use today. Such being the case, it seemed well worth while to devote some attention to the development of a unit that would really provide the maximum practical degree of selectivity but which—

(1) Would not decrease volume or signal strength;

(2) Would not complicate tuning or operation;

(3) Would not tend to make the receiver unstable, and,

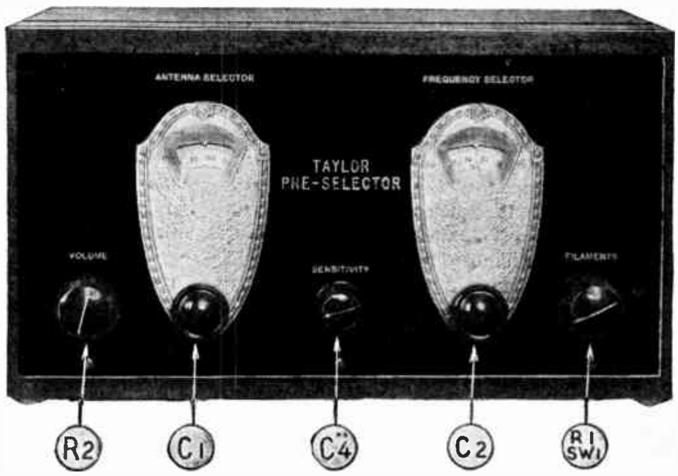


Fig. C. The "Pre-Selector" has an attractive appearance; its controls supercede entirely those of the receiving set, which may be placed elsewhere.

(4) Would be applicable to the general run of receivers in use today.

It was decided that these conditions could not be met without providing some degree of amplification in the accessory unit to make up for the losses which are bound to result from any method that might be used to increase selectivity; this meant that at least one tube would have to be included in the unit. Furthermore, either the receiver or the unit would have to be untuned if we were to avoid adding tuning controls. Finally, the tube circuit or circuits in the unit could not be tuned to the same frequency as those in the receiver because the addition of a resonant tube circuit would upset the stability of the receiver.

In the face of all these requirements, it became obvious that the only possible method of securing the desired results would be through the use of a heterodyne system. An experimental unit which included a "first detector" and oscillator was, therefore, built up. With this arrangement, the tuning controls of the receiver proper could be *set at one wavelength and left there* at all times, and the new unit would act as a frequency-converter to alter the frequency of any incoming signal to the frequency (wavelength) to which the receiver was tuned. The wavelength selected for the receiver was one just above the broadcast band, 560 meters to be exact. This scheme worked out admirably as far as selectivity is concerned. It also simplified operation, because all tuning is accomplished with the two controls of the unit instead of the three controls of the receiver proper. The combined outfit is also stable—even more stable than the receiver alone, because the receiver is now permanently tuned to such a high wavelength.

IMPROVING THE DESIGN

The only drawback found in this experimental unit was that it did not provide quite as great over-all sensitivity as with the receiver alone. Further experimental work was carried on, therefore, to overcome this objection. First, by increasing the antenna coupling in the unit, greater input-signal voltage was obtained and this has the same

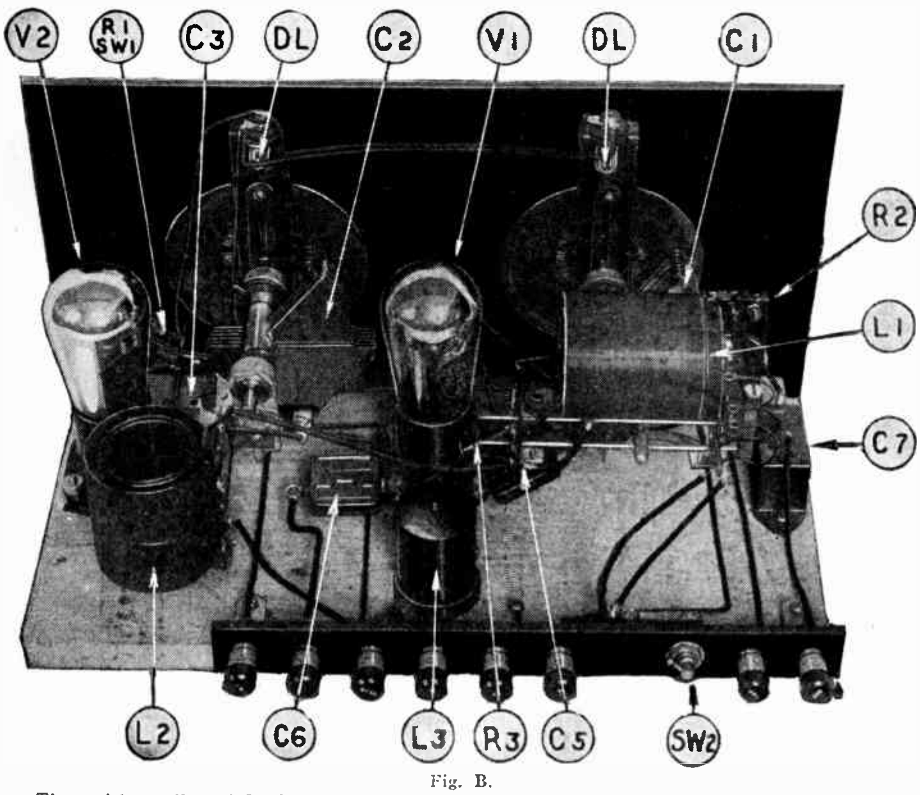


Fig. B.
The aerial coupling of L1 is automatically varied with the wavelength by the movement of C1, which tunes the first-detector input. L2 comprises the oscillator coils and coupler.

*RADIO NEWS *Blueprint Constructional Article No. 68. (See page 104).*

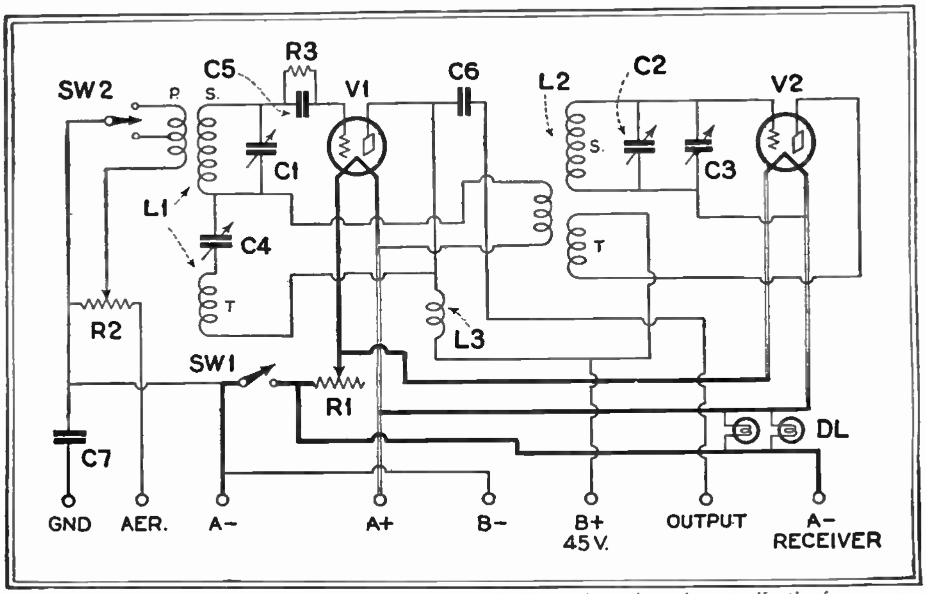


Fig. 1. The schematic diagram of the "Pre-Selector," above, shows it to be actually the frequency-changing end of a superheterodyne, for whose amplifier any tuned-R.F. set may be used. The first detector is regenerative.

effect as would increased amplification. Then regeneration was added to the circuit of the "first detector." These two changes both increased the pick-up, and increased amplification was obtained. Thus the last requirement was more than satisfied.

Next, a good deal of time and effort was spent in further refining the device. It was found, for instance, that when the input circuit of the unit was tuned to certain wavelengths the unit did not function as efficiently as at others. Also, under certain conditions, the tuning of one dial tended to alter the setting of the other. It was decided, therefore, that variable coupling between the antenna and the unit is necessary and the coupling coil was redesigned to provide automatically variable coupling. This arrangement consists of gearing the primary of the antenna coil to the shaft of the tuning condenser; so that the antenna coupling increases and decreases as the condenser is tuned for high and low waves, respectively. Careful design of the oscillator pick-up coil also helped to improve the results.

The next refinement consists of a switch which is incorporated in the unit for the purpose of turning a receiver's filaments off and on, together with the filaments of the two tubes in the unit itself. For this purpose a combination rheostat and switch is included in the unit. The former controls the filaments of the two tubes and, when it is turned off, opens the switch which controls the receiver filaments.

REMOTE-CONTROL APPLICATION

A very important possibility, and one which had not been thought of in the beginning, was that of employing this unit as a remote-control device. Inasmuch as the input frequency is changed during its progress through the unit, there should be little chance for feedback from the output to the input (aerial) lead. Therefore, there is no good reason why the unit cannot be placed some distance from the receiver. Experiment proved this theory to be correct and no difficulty was encountered in operating a receiver in the next room, approximately 20 feet away from the aerial lead and the new unit. This experiment brought up another requirement—that of controlling the volume at the unit rather than at the receiver; a special high-resistance potentiometer was therefore included in the antenna circuit. Thus, not only the tuning and all filaments, but also the volume, were entirely controlled without going near the receiver proper.

Finally, the unit was considered deserving of a name and it was informally christened the "Pre-Selector."

The Pre-Selector has been tried out with a great many receivers, both commercial and home built. Of all which were tried, the only sets with which it did not perform in the usual manner were certain superheterodynes and some receivers which employ only a regenerative detector and audio amplification. In every case where the receiver employed one or more stages of tuned R.F. amplification, the results were excellent.

With receivers which employ a regenerative detector without R.F. amplification preceding, the Pre-Selector changes the input characteristics of the regenerative circuit sufficiently to prevent proper regeneration. In some superheterodyne receivers the double-heterodyne action will result in harmonics and "birdie" whistles. This is not true of all superheterodynes; because in some cases the Pre-Selector has been found just as satisfactory with receivers of this type as with tuned R.F. outfits.

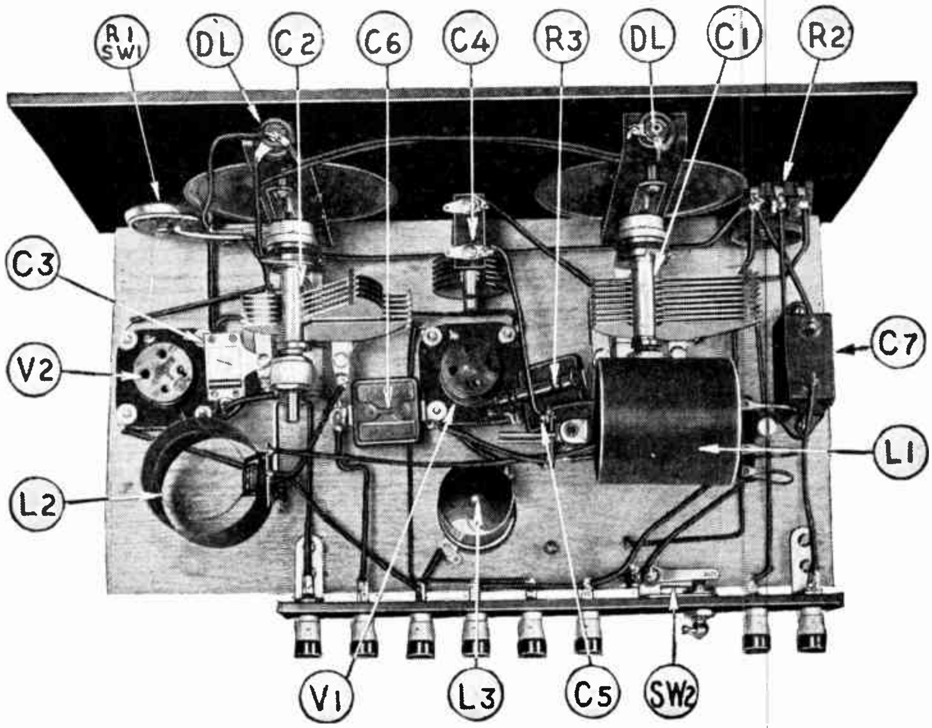
HOW THE PRE-SELECTOR FUNCTIONS

The Pre-Selector is connected between the aerial and the "Aer." binding post of the receiver with which it is to be used, and the tuning controls of the receiver are adjusted to resonance at any wavelength above the broadcast band; usually around 560 meters, for this is as high as most standard receivers will tune. The Pre-Selector may be connected to the batteries employed by the receiver or may have its own set of batteries, whichever is more convenient; more will be said about this later.

The left dial of the Pre-Selector is the wavelength or tuning adjustment; it controls the variable condenser C1 which tunes the secondary of the antenna coupler L1 in the input circuit of the first tube V1. This coupler includes a center-tapped primary winding mounted on a movable carriage which, in turn, is geared to the rear end of the shaft of condenser C1 by means of the cam-and-pin arrangement, supplied with the coupler. Thus, the primary coil is moved in and out of the secondary coil to vary the coupling according to the wavelength to which the circuit is tuned.

In series with this secondary winding of the antenna coupler is the small pick-up coil which constitutes part P of the oscillator coil, L2. By means of this pick-up coil part of the oscillator energy is impressed upon the detector grid circuit along with the incoming signal from the broadcast station that has been tuned in.

The detector combines these two frequencies to form a third, which is equal to



This view from above shows how direct are the leads employed in wiring the Pre-Selector. All wires are run above the wooden baseboard. Two methods of connecting to batteries appear in Figs. 2 and 3.

the difference between the two frequencies present in the grid circuit. By tuning the oscillator circuit this third frequency may be made equal to that, say 535 kilocycles (560 meters), to which the receiver proper has been tuned previously and the signal from the broadcast station will be amplified in the receiver and heard in the loud speaker.

From the foregoing explanation it is apparent that an installation, which includes a tuned-R.F. receiver and the Pre-Selector, really amounts to a superheterodyne receiver; in which the Pre-Selector functions as the so-called "first detector" and oscillator, while the R.F. amplifier of the receiver proper serves as the intermediate amplifier of the combination.

FEATURES OF THE CIRCUIT

The tremendous selectivity afforded by the Pre-Selector is due largely to the frequency-changing process involved. In addition, the Pre-Selector combination provides better selectivity than the average superheterodyne receiver; because the R.F. amplifier of even a very broad-tuning broadcast receiver is tuned much more sharply than are the coupling transformers ordinarily employed in the intermediate stages of a regular superheterodyne receiver.

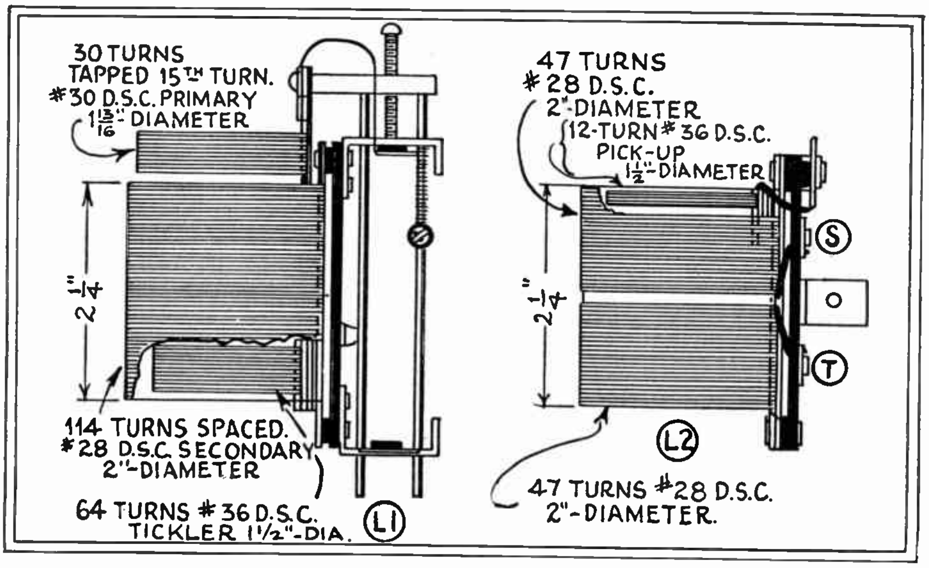


Fig. 4. Details of the coils; the primary of L1 is mounted on a slide, which is moved out of the secondary by a cam on the tuning condenser C1 as the rotor plates rise.

Regeneration in the detector circuit of the Pre-Selector is not required for the sake of selectivity, but is used solely for the amplification it provides. Ordinarily the regeneration control, C4, is left with its knob set at zero. It is only in the case of reception from very distant stations that regeneration is required and, for such reception, the knob is turned up to a point just below that at which the detector goes into oscillation. The regeneration is ob-

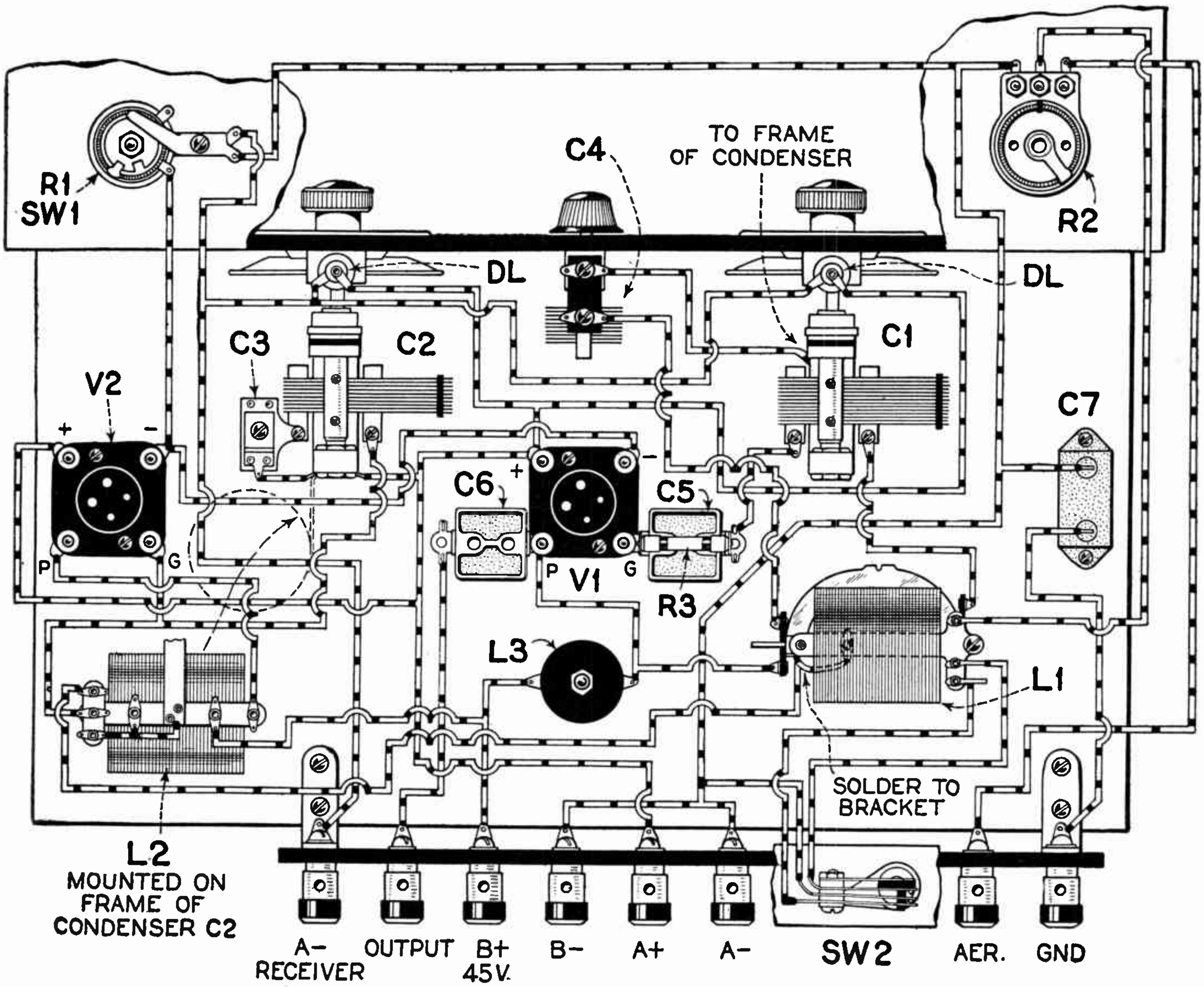


Fig. 5. Complete wiring layout of the "Pre-Selector," the apparatus is slightly spread apart in the picture to show the connections.

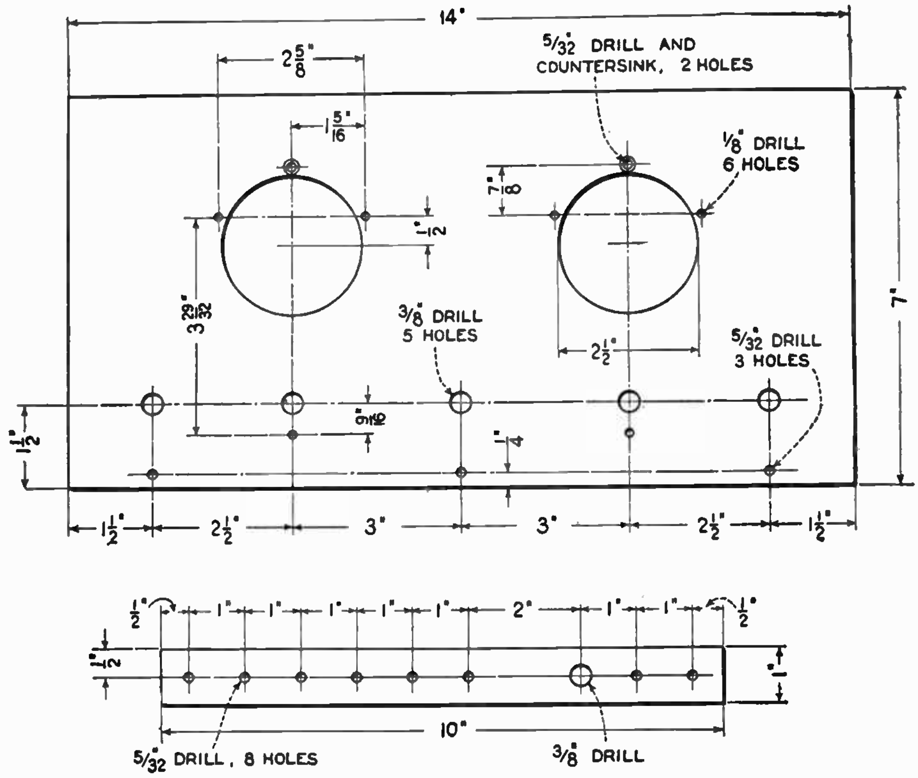


Fig. 6. Drilling details of the "Pre-Selector" panel and binding-post strip.

tained through the use of a feed-back coil mounted in a fixed position inside of the secondary of the input coupler, L1.

It will be noted from the diagram, Fig. 1, that a switch, SW2, has been included in the ground side of the antenna circuit. This switch is required, not for its effect on selectivity but rather to permit the smooth and constant control of regeneration. Where a very large antenna is employed, with the full primary winding in the circuit, the absorption effect is so great as to make regeneration ineffective. In such a case the switch is set so that only half of the winding is in the antenna circuit, thus reducing the absorption effect to overcome this difficulty.

The by-pass condenser C7 has been included in the ground circuit of the Pre-Selector, simply as a safety measure, to prevent any possibility of short-circuiting the "A" current in cases where the same device is used to provide the filament current for both the Pre-Selector and the receiver.

The only other circuit feature not covered is that which employs the small adjustable condenser, C3. The purpose of this condenser is to permit enough capacity to be added to the tuned oscillator circuit to cause the two tuning-condenser dials to read alike. When it has been adjusted so that the two tuning controls read alike for a given wavelength, their readings will remain alike throughout almost the entire waveband. This is a decided convenience, particularly when tuning for weak, distant stations.

CONSTRUCTION AND WIRING

The diagrams and photographic reproductions provide practically all the data required for the construction of the Pre-Selector; the only point that needs be touched upon is the mounting of the coils. Both L1 and L2 are mounted directly on the frames of their respective tuning condensers. L2 should be mounted in a vertical position with the small pick-up coil at the top. A tapped hole will be found in the rear of the frame of condenser C2, and a 6/32 screw passed through the hole in the brass mounting bracket of the coil and screwed into that in the condenser provides a convenient and substantial means for mounting.

The curved brass bracket which comes with L1 should be mounted on the frame of the coil by means of the two small screws provided. Its position should be that, when the coil is mounted in the position shown in the top view (Fig. A), the slotted lug on the bracket should be toward the panel and pointing down. Next, mount this coupler on the rear of condenser C1 by means of the screw provided. When in proper position, the notch in the lug of the mounting bracket should be astride the rib on the back of the condenser frame.

SUPPLY AND INSTALLATION

If it is used with a battery-operated receiver the same set of batteries may be used for the Pre-Selector. Or, if the receiver uses a "B" socket-power unit, that may also be used to provide the plate current for the Pre-Selector. If the receiver employs A.C. tubes, it will then be necessary to provide a set of three standard dry cells to supply the Pre-Selector's filament; one set of batteries will provide approximately 200 hours of actual service. The rheostat (R1) included in the filament circuit of the Pre-Selector is of resistance sufficiently high to permit these tubes to be operated safely from a six-volt source. With the supply voltage the rheostat should be turned on half-way to provide proper operating voltage for these tubes; if the supply source is 4½ volts the rheostat should be turned on three-quarters. When dry cells are used the three-quarters position is correct while the cells are new; but the rheostat must be advanced as the cell voltage drops.

In some cases as, for instance, where the "B" socket-power unit is built permanently into the receiver, it may be necessary to use a "B" battery for the Pre-Selector plate supply. In that case two of the small 22½-volt blocks ordinarily used as "C" batteries will serve the purpose and their life will be about a year, due to the extremely small plate current drain.

The proper connections for the batteries are shown in Figs. 2 and 3. In these diagrams both the Pre-Selector and receiver are shown connected to ground. In most cases it will only be necessary to ground one. The best plan is to try grounding each individually, and then both together, to determine the best arrangement.

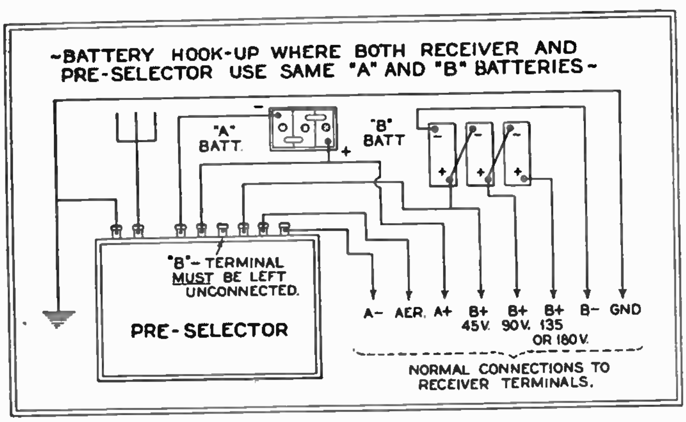


Fig. 2. Here the "B—" connection is left unused, to avoid a short across the filaments of the 199-type tubes.

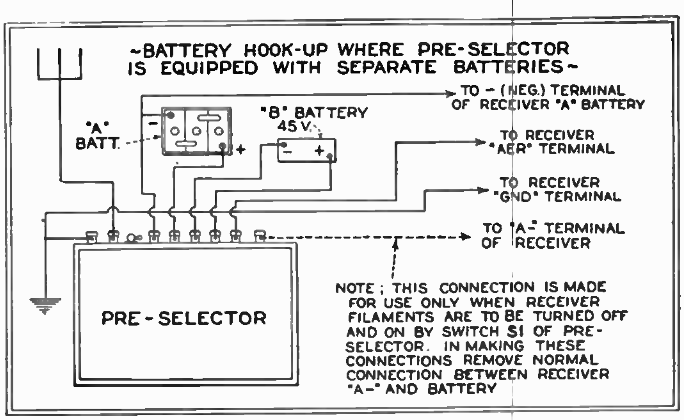


Fig. 3. Even though separate batteries are used, the connection shown makes remote control of the receiver easy.

OPERATING THE PRE-SELECTOR

After the Pre-Selector has been connected and ready for operation, the necessary preliminary adjustments of the receiver proper should be made. First, adjust the receiver dials for a wavelength somewhere above the broadcast waveband; if the exact settings of the dials of a multi-control receiver are not known, adjust the dials as closely as possible. Then turn the receiver's volume control to the position of maximum volume. Also, turn on its filament switch; unless the receiver's filaments are to be turned on and off at the Pre-Selector, when the receiver's switch should be left turned on at all times.

Next, turn on the filaments of the Pre-Selector and adjust the rheostat to provide them a voltage between 3 and 3.3. Turn the Pre-Selector's "Volume Control" all the way to the right and adjust the "Sensitivity" control so that the plates of the midget condenser C4 are all out (minimum regeneration).

With the left or "antenna selector" (wavelength) dial of the Pre-Selector at, say 40, slowly rotate the right-hand or "frequency selector" control knob until a station is heard. If none is heard, repeat the operation but with the wavelength control set at 50. It is important that the "frequency selector" control be turned slowly in hunting for stations; because the tuning with this control is so sharp that stations may be skipped over easily.

Once the first station has been heard, carefully readjust the two tuning controls of the Pre-Selector for maximum volume; then turn the "volume" knob back to reduce the volume to normal. The tuning controls of the receiver should now be readjusted to exact resonance, which is indicated by maximum volume. Also, any other adjustments provided in the receiver should be made now for maximum reception. If there are two or more antenna terminals, for instance, the Pre-Selector's output lead should be connected to the one which provides maximum energy transfer. It may be worth while to try also increasing the plate voltage on the R.F. tubes in an effort to increase the R.F. amplification. This will usually be found entirely practicable, because of the greater stability of most receivers when permanently tuned to a high wavelength.

Turning back to the Pre-Selector, it will be found advisable to experiment a little with the switch, SW2, and the regeneration control, in order to become familiar with their action and effect. Finally, adjust the small condenser C3 to bring the readings of the two tuning dials into line.

COUPLING ADJUSTMENT

A final word regarding the adjustment of the automatic coupling arrangement may be required. The cam should be slipped over the rear of the condenser shaft, with the fiber cam toward the rear and with the flat side uppermost. Now, with the condenser plates all meshed, turn the cam until its toe is just level with the bottom side of the bakelite strip upon which the coil is mounted; then tighten the set-screw in the collar on the cam. Next, loosen the set-screw in the brass pin on the lower rod of the coil carriage; let this pin slip along until it rests against the fiber cam, and then tighten the set-screw. With these adjustments made, it will be found that the primary coil moves as the condenser is rotated and, when the condenser plates are entirely unmeshed, the pin should slide just to the point of the cam. This is the correct adjustment.

In the event that there should be no reception when the Pre-Selector is first put into operation, and all connections and wiring are found to be correct, test the tube used in the oscillator socket, V2. The whole action of the Pre-Selector depends on the oscillator, and a poor or defective tube here will prevent proper reception.

APPARATUS REQUIRED

The following is a complete list:

One variable condenser, .00035-mf. (C1);
One variable condenser, .00025-mf. (C2);
One equalizer condenser, 2-20-mmf. (C3);
One midget condenser, 50-mmf. (C4);
One fixed condenser, .00025-mf., with grid-leak clips (C5);
One fixed condenser, .0001-mf. (C6);
One by-pass condenser, 0.5-mf. (C7);
One antenna coupler, with provision for automatic coupling variation (L1);
One R.F. transformer (L2);
One R.F. choke coil, 85-millihenry (L3);
One rheostat-switch, 50-ohm (R1-SW1);
One volume-control potentiometer, 25,000-ohm (R2);
One grid leak, 2-megohm (R3);
One aerial switch, single-pole double-throw (SW2);
Two vacuum tubes, 199-type (V1 and V2);
Eight binding posts, push-type;
Two vernier dials, illuminated-type;
One front panel, 7 x 14 x 3/16-inch;
One binding-post strip, 1 x 10 x 3/16-inch;
One wooden baseboard, 13¼ x 7 x ½-inch;
Two angle brackets, 1 x ½-inch;
Two tube sockets, UX-type.

THE "PRE-SELECTOR"

SYMBOL	Quantity	NAME OF PART	REMARKS	List Price Each	MANUFACTURER ★	
C1	1	Variable condenser	.00035 mf.	5.25	1	
C2	1	Variable condenser	.00025 mf.	5.00	1	
C3	1	Midget condenser	2 to 20-mmf., screw adjustment type	.80	1	
C4	1	Midget condenser	50 mmf., variable	1.75	1	
C5	1	Fixed condenser	.00025 mf., with grid-leak clips	.40	6	
C6	1	Fixed condenser	.0001 mf.	.35	6	
C7	1	By-pass condenser	0.5 mf., paper-type	.90	6	
L1	1	Antenna coupler	(See Blueprint for constructional details)			
L2	1	R.F. transformer	(See Blueprint for constructional details)	7.50	1	
L3	1	R.F. choke coil	85-millihenry	2.00	1	
R1-SW1	1	Rheostat-switch	50-ohm - switch incorporated	1.00	2	
R2	1	Volume control	25,000-ohm potentiometer	2.00	3	
R3	1	Grid leak	2-megohm	.50	3	
SW2	1	Aerial switch	Single pole - double throw	.90	2	
V1,V2	2	Tube sockets	UX-type	.75	5	
	2	Dials	Vernier; illuminated type	2.75	8	
	2	Vacuum tubes	199 type; long prongs	2.00	4	
	8	Binding posts	Push-type	.15	7	
	1	Front panel	7 x 14 x 3/16-inch			
	1	Binding post strip	1 x 10 x 3/16-inch			
	1	Baseboard	Wood - 13-1/4 x 7 x 1/2-inch			
	2	Angle brackets	Brass - 1 x 1/2-inch			

NUMBERS IN LAST COLUMN REFER TO CODE NUMBERS BELOW.

1 Hammarlund Manufacturing Company, 424 W. 33rd St., New York City
2 Carter Radio Company, 300 South Racine St., Chicago, Ill.
3 Electrad, Incorporated, 175 Varick Street, New York City
4 CeCo Manufacturing Company, 702 Eddy St., Providence, R. I.
5 Benjamin Electric Manufacturing Co., 128 S. Sangamon St., Chicago, Ill.
6 Aerovox Manufacturing Company, 70 Washington St., Brooklyn, N. Y.
7 X-L Radio Laboratories, 2424 Lincoln Ave., Chicago, Ill.
8 National Company, 61 Sherman Street, Malden, Mass.
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Nº.68

6 SHEETS
SHEET Nº.6

★ THE FIGURES IN THE FIRST COLUMN OF MANUFACTURERS INDICATE THE MAKERS OF THE PARTS USED IN THE ORIGINAL EQUIPMENT DESCRIBED HERE.

If you use alternate parts instead of those listed in the first column of manufacturers, be careful to allow for any possible difference in size from those originally used in laying out and drilling the panel and sub-base.

THE PRE-SELECTOR BLUEPRINT SET

"Ventilation" in 227 Tube Obtained by Mesh

Why the mesh-plate instead of a continuous sheet of metal in the UY-227 heated-cathode tube? Many users of this tube have wondered about the reason for this change in the design of the outer element.

During the development of this type of tube, the laboratory engineers found that emission of electrons occurred, not only from the cathods, but also from the cylindrical grid and plate unless they were relatively cool. This would be an undesirable condition in the operation of a device of this kind, as it would set up conflicting currents in a radio receiver.

To allow the plate to remain cool, and to eliminate undesirable electron emission, the use of a wire-mesh plate was adopted, thus allowing the escape of much of the heat generated by the heavy current through the filament; the wattage of the 227-type heater is 3½ times that of the 201A-type filament, and the generation of heat consequently proportional.

Screen-Grid Tubes as A.F. Amplifiers

Considerations Necessary in the Design of Circuits Employing 222-type Tubes Effectively at Low Frequencies

By William H. Fortington

THE screen-grid tube has been well exploited as an amplifier at supersonic ("intermediate") and radio frequencies, in which capacities it has met with considerable success. Articles devoted to the application of the screen-grid tube, now known in common parlance as the "222" type, have appeared in many magazines throughout this country; tubes performing similar functions have been in use for nearly two years in Europe.

The use of the screen-grid tube as an audio-frequency amplifier has been somewhat restricted, however, because of many of the inherent characteristics of the tube; the chief of which calls for an extremely high external-load impedance to produce good tonal quality.

While resistance coupling might seem to be an easy solution to the problem, it appears that, after all matters have been weighed with due consideration, the disadvantages of resistance coupling in this respect outweigh its advantages. The output impedance of the 222-type tube varies considerably, such variation being dependent upon the particular application of the tube. As a radio-frequency amplifier, in which the tube is used essentially for its screen-grid character, the output impedance is liable to run as high as 1,000,000 ohms or 1 megohm. This calls for an external load of at least 2 megohms and, when such an external load takes the form of pure resistance, it requires an enormous plate potential to compensate the drop across the resistance, in order that the tube shall operate under its normal characteristic voltages.

Under the above conditions, the amplification constant of the tube is in the region of 300—theoretically, if not practically.

SPACE-CHARGE AMPLIFIER

When it is used as an audio-frequency amplifier, the output impedance of the tube will run to a value anywhere between 150,000 ohms and 600,000 ohms, dependent upon the manner in which it is employed. The most satisfactory method with which the writer is familiar is to operate the tube as a space-charge amplifier, in which the screen-grid—that is, the external grid shielding the plate—is used as the control grid, and the control-grid is used as a "screen." The amplification constant of the tube, when used as a space-charge amplifier, is usually between 50 and 100.

In view of the above considerations, the problem of utilizing the 222-type tube as an audio amplifier would seem to be somewhat simplified; but, although this is easy, the problem as to the external load is by no means easily solved, if the experimenter is desirous of obtaining really good tonal quality together with the volume that this tube is capable of giving.

Returning to the question of load impedance, the external load in the plate circuit of the tube must be equal to at least twice the internal impedance of the tube at the lowest frequency to be amplified, in order to secure good tonal quality. This rule holds good where an inductive method of coupling is used.

Assuming the output impedance of a 222-type tube used as a space-charge amplifier to be, say, 200,000 ohms, at an amplification constant of 70, it is obvious that the load-impedance problem becomes greatly simplified. Tubes having such a high mu as this are suitable only as voltage amplifiers.

VOLTAGE, NOT CURRENT

A "voltage amplifier" is essentially a tube which handles only a small amount of power, but which is capable of producing enormous "gain" (amplification) upon weak signals. It has been the practice in the past to use a high-mu tube having an amplification constant of around 30, as a first-stage amplifier immediately following the detector. With such a tube, operating under the best conditions in an impedance-coupled circuit, it is possible to obtain a voltage amplification of around 28 or 29. With the 222-type tube, under the same conditions, it is possible to obtain an amplification factor of twice that value with equally good tonal quality. All of this is due to the inception of a newly-developed coupling device known as a 222-type audio coupler, a brief description of which would perhaps not be out of place.

The coupling device used in conjunction with the 222-type tube as a space-charge amplifier utilizes the principle commonly known as "double-impedance coupling," which makes use of inductively-loaded plate and grid circuits; coupling being accomplished by means of a suitable capacity between the plate and grids of the two successive tubes.

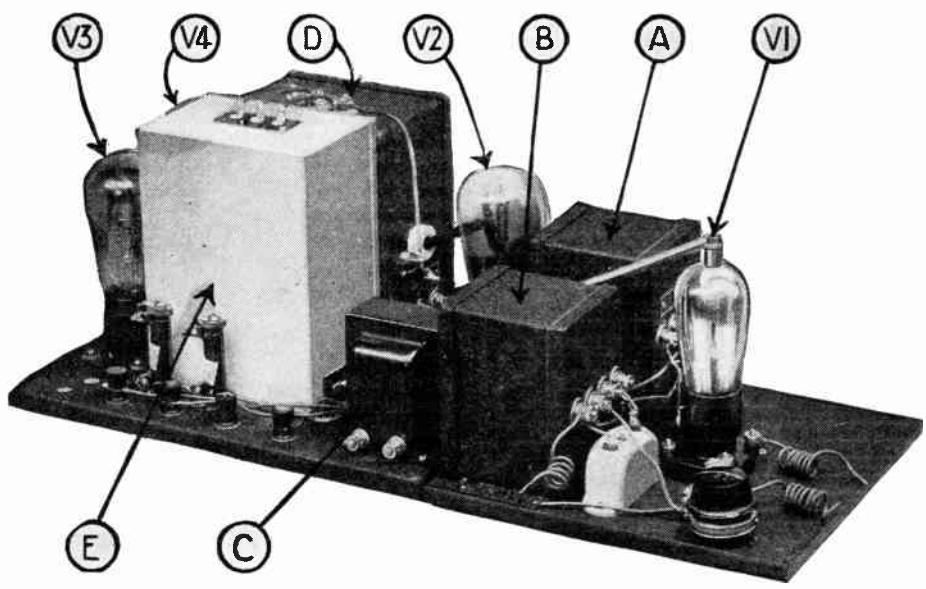
From previous consideration of the output impedance of the tube, it is obvious that the load in the plate circuit should be equal to at least twice the output impedance of the tube at the lowest frequency to be amplified.

Assuming the output impedance of the tube to be in the region of 200,000 ohms, it is necessary to secure an inductive load of at least 400,000 ohms in order that a reasonable amount of amplification may be secured at, say, 50 cycles. It is also obvious that, since the load is inductive, the external impedance will be a *function* of the frequency. In order to produce an external load of 400,000 ohms at 50 cycles, an inductance of nearly 1,500 henries is necessary. The problem of securing this amount of inductance in a confined space will immediately be realized as not so simple. The design of such an inductor entails considerable forethought and engineering skill; to satisfy the predetermined conditions, it must conform rigidly to the following requirements.

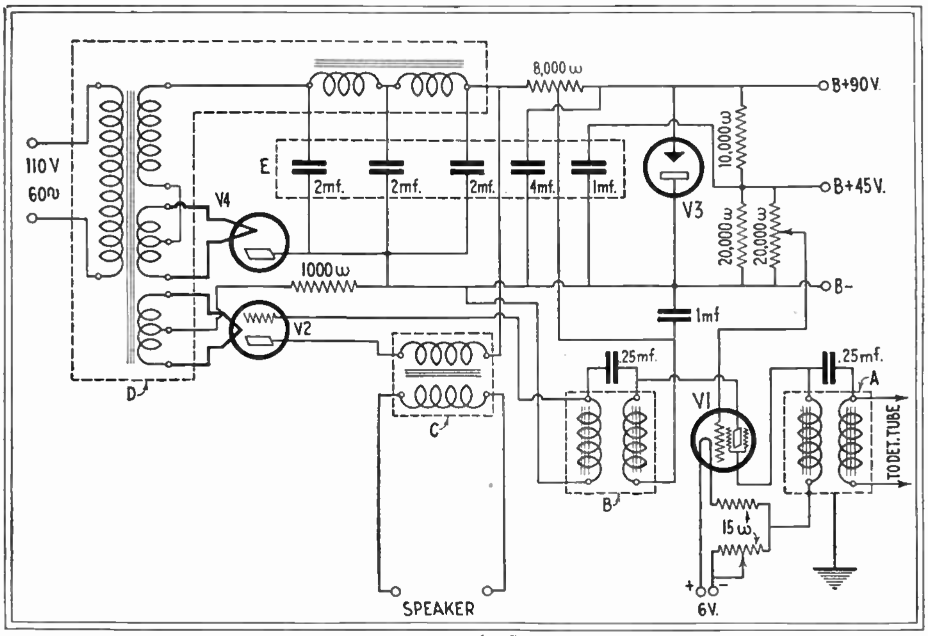
DESIGN OF COUPLER

(1) The inductance must be sufficiently high to satisfy the conditions outlined as regards to proper loading of the plate impedance.

(2) The iron content of the coil must not suffer saturation due to the steady D.C. component flowing into the plate circuit; neither may the superimposed A.C. voltages produced across the impedance have any



This power pack and amplifier, constructed by the writer, embodies the new 222-type dual impedance audio couplers which are essential to its efficient performance. Home construction of such devices, because of the enormous inductance required, is practically impossible; but they are now becoming commercially available. Blueprints of this device have not been made; but its circuit is simple, and values of the parts required are given with the circuit diagram on the following page.



Schematic diagram of the power unit and two-stage amplifier, using one 222-type (V1) and one 210-type (V2) tubes, pictured on the preceding page. V3 is an 874-type regulator, V4, a 381-type (half-wave) rectifier; A and B 222-type couplers of very high inductance, designed for screen-grid circuits; C is an output transformer of good characteristics, capable of carrying the high plate current of the 210; and D is a power unit with two 7½-volt windings for the filaments of V2 and V4, a high-voltage winding supplying an A.C. maximum of 700, and two built-in chokes for the filter circuit. Other values are given in the diagram.

considerable effect upon the normal conditions of inductance. The D.C. resistance of coil must be sufficiently low to maintain proper D.C. potential at the plate of the tube.

(3) The distributed capacity of the inductance must be kept at a minimum, in order that the shunt-capacity effect across the choke shall not cause a serious loss of amplification at the higher frequencies.

The application of such an impedance is restricted to use in circuits where the direct-current component flowing through the winding is of the order of 0.5 to 2 milliamperes. It must, however, be capable of standing at least 30 volts of A.C. across the winding without variation in inductance. The maximum permissible input voltage at the grid circuit of the 222-type tube, when used as outlined in previous paragraphs, is of the order of one volt. Assuming the mu of the tube to be around 50 when the output impedance of the tube is properly loaded, it will be seen that a voltage of at least 40 volts can be produced across the choke. The amplification factor of the tube can be considerably changed, however, to suit varying conditions, by the systematic adjustment of the voltage applied to the inner grid.

The next problem in mind is to find a suitable load for the grid circuit of the next tube. Almost all of the voltage produced across the impedance in the plate circuit of the 222-type tube will be reproduced in the grid circuit. The voltage drop at any frequency across the condenser of 0.25 mf. will be very small, at even the lowest frequency on the musical scale. For this reason the grid reactor must be capable of standing at least 50 volts of A.C. without "swinging" in inductance, as must the choke in the preceding plate circuit; it is not, however, subject to the D.C. magnetizing component encountered in the plate circuit. The D.C. resistance must be sufficiently low to maintain a constant negative potential at the grid of the next tube, and for this reason the D.C. resistance should be extremely low when compared to its reactance.

A reactor to fulfill the above conditions may be, satisfactorily, composed of several thousand turns of No. 40 wire on an interleaved core. The distributed capacity of the grid reactor must be kept extremely low, for the reasons outlined in the case of the choke in the plate circuit.

CHOICE OF POWER TUBE

Regarding the tube question, as to which is the most suitable amplifying tube to follow the 222-type tube when used in the form outlined, it is quite obvious that the grid-swing of the amplifier tube must be capable of handling at least 40 volts without encountering plate distortion. Since the maximum permissible A.C. grid voltage is approximately 70% of the effective grid bias, it is quite obvious that there are only three tubes which will comply with the conditions of satisfactory operation; these are the 171, 210 and 250 types. The 210 type, probably, is the most satisfactory, and when the arrangement depicted in the accompanying diagram was used with 22 volts positive on the inner grid, it was found that both the 210 tube and the 222-type began to distort at just about the same time. By decreasing the positive bias on the inner grid the distortion of the 222 tube was increased, which was accompanied by a decrease in amplification.

By increasing the positive bias the amplification of the 222-type tube was considerably reduced; the distortion, however, was decreased. The design of the output transformer to couple the 210-type tube into the reproducer is, of course, dependent upon the type of load into which it is to operate, and the proper transformer to suit the loud speaker should be chosen. The use of an amplifier of the type illustrated in the schematic diagram proves to be very satisfactory for the amplification of weak signals upon sets in which the detector output is fairly low. It performs the maximum of amplification with the minimum of equipment and at the same time furnishes a highly-satisfactory "B" supply device for the radio receiver itself.

The input coupling device to the grid circuit of the 222-type tube should be chosen to suit the volume obtained in the detector plate circuit. Where the detector output is extremely low and the output impedance of the detector tube is likewise low, then a transformer having a low primary inductance and a high turns-ratio might well be used for the purpose. Where the detector output is high and the output impedance is high, then impedance coupling is to be well recommended if quality is to be the prime factor. This method of coupling will, of course, keep the voltage ratios unity; bearing in mind all the time that *the maximum permissible voltage on the grid of the 222-type tube is of the order of one volt.*

The fact that the 222-type tube, when used as an audio-frequency amplifier, is overloaded if potentials greater than one volt are applied to the grid, has an important effect upon the design of receivers using a tube of this type as an A.F. amplifier. In the first place, it is absolutely necessary that the volume control be located ahead of the detector tube in the circuit, and the use of a volume control in the audio or loud-speaker circuit is entirely out of the question. If this suggestion is not observed, the music and speech from all loud local stations is apt to be distorted. Secondly, a R.F. choke coil and small by-pass condenser should be connected in the plate circuit of the detector tube to prevent R.F. currents from overloading the grid of the 222-type tube. Also, if a phonograph pick-up unit is used, a variable resistor should be connected in shunt to reduce the output.

From the above paragraph it may be seen that the 222-type tube is much more sensitive than the 201A type, and that it cannot be used to replace a 201A stage unless some means is provided for reducing the input energy. However, the fact that the input energy is low does not indicate that the output is also low; for this is not the case. In most cases the 222 stage will amplify a weak signal to a much greater volume than a 201A stage could amplify a comparatively loud signal. Because of this feature the amplifier under discussion in this article is ideal when listening in on distant stations.

CHOICE OF VOLUME CONTROL

Locating the volume control ahead of the detector may present a problem to some readers, and for this reason several suggestions will be made. A suitable volume control for a battery set may consist of: a 75-ohm rheostat connected in shunt with the primary of the R.F. transformer in the plate circuit of the second R.F. tube; a 10,000-ohm variable resistor in shunt with the aerial and ground; a 100,000-ohm resistor in series with the plate-supply wire to the R.F. tubes or a rheostat in series with the filament supply to the R.F. tubes. However, if the receiver uses A.C. tubes, only the first two methods are satisfactory.

The selection of the proper input transformer must be left to the user himself; and it is obvious that the type of transformer selected will be dependent upon the number of stages of radio-frequency amplification employed.

For the amplification of weak signals and for good reception, the 222-type tube might well be used in the screen-grid method—that is with the inner grid as the control. For broadcast reception the use of the tube as a space-charge amplifier is certainly to be recommended; otherwise a much higher load will be necessary in the output circuit of the 222-type tube.

Erecting the Right Aerial

What You Should Know About the Various Types in Common Use

By Fred H. Canfield

EVERY broadcast listener who is blessed (or cursed, as the case may be) with the slightest knowledge of radio is continually being pestered by his friends and neighbors with questions on aerials. There seems to be a countless number of queries which may be asked on this subject, and the beginner in the field usually considers each phase of the problem most vitally important.

It is said that "a little knowledge is a dangerous thing," and the newcomer in radio who asks a recruit for his opinion on the design of an aerial usually discovers the truth of this for himself; because, more often than not, if he follows the advice he receives he will waste valuable time in needless experimenting. This is because most broadcast listeners, before acquiring practical experience, are of the opinion that the results obtained from a receiver are dependent almost entirely upon the characteristics of the aerial. Therefore, while gaining experience, many fans change their aerial a dozen times or more in the effort to obtain best possible results. Also, if the receiver fails to work, they are apt to consider the aerial the cause until it is proved not guilty.

NOT THE ONLY FACTOR

On the other hand, the novice who asks advice from a person who is really familiar with radio practice receives a few simple rules to follow when erecting an aerial and is told not to worry about its efficiency after it has been erected. It is explained to him that a good set is capable of satisfactory performance, even when a comparatively poor aerial is used; but it is seldom that a poor set can be made to deliver exceptional results by using a good aerial.

From the above statement, the reader should not gain the impression that aerial design need not be considered, because this is not true. However, he should always bear in mind that the importance of much of the popularly-given instructions on the subject has been greatly exaggerated. Of course, there are a few physical laws which govern the design of aerials, and these must be taken into consideration. But the beginner should not become discouraged if it is impossible for him to follow the usual directions exactly; for the rules governing the erection of aerials are quite flexible and it is possible to make many changes in an aerial without materially affecting the results.

In this article the writer will attempt to give general directions for the erection of receiving aerials. The conditions which are considered ideal from the theoretical viewpoint are described here; but the reader must remember that it is not to be expected that he will be able to follow out all of

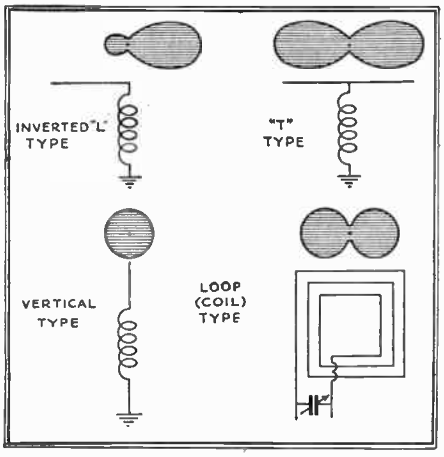


Fig. 1. The shaded areas indicate the relative sensitivity, to signals arriving from different directions, of the four principal types of aerials. The vertical-wire aerial is not directional, the loop most so; but the "T" and "inverted-L" types are most convenient for general use.

the suggestions, particularly if he resides in a city apartment. Therefore he should endeavor to construct an aerial which possesses as many desirable features as possible, and satisfy himself with this. In most instances such an aerial will give satisfaction.

WHAT IS AN "ANTENNA?"

The antenna system of the usual radio receiver (or transmitter) is made up of four parts; *viz,* the aerial proper, the aerial lead-in, the ground wire and the ground. In the transmitting station, it is the function of the *aerial* to act as the radiator of the energy produced by the power tubes of the sending apparatus. This energy is in the form of a high-frequency oscillating current, in the aerial, and by its presence produces *electromagnetic waves* in the ether. In the case of the receiver, the aerial acts as a *collector* of such electromagnetic waves. Often, in two-way communication, the same aerial is used both for receiving and for radiating radio signals.

Antenna systems used for sending and receiving radio signals are of two general types; first, those which act primarily as electrical condensers and, second, those which act primarily as electrical inductors. The first type is the more generally used, and is the basis of the discussion in this article; it consists of an aerial-and-ground connection. The second type is the *loop antenna,* and this is used only in connection with super-sensitive receivers and for direction-finding purposes. (See Fig. 2.)

THE "CONDENSER" AERIAL

A simple antenna of the condenser type would consist of two metal plates separated by air and insulated from each other except by a wire, known as a lead-in, which connects the receiving or sending apparatus between the two plates. In an antenna system of this type, the efficiency would be determined by the separation between the two plates and by the capacity formed by the two plates. However, from a practical viewpoint, an antenna of this type would not be very satisfactory. In order to make it perform with a high degree of efficiency, the size of the two plates would have to be made so large that the device would be very expensive and also cumbersome.

In actual practice such metal plates are not used as parts of an antenna system. Usually one or more wires are suspended from insulators in the air and these serve in place of one of the plates. The other plate is replaced by the ground itself. The wires suspended in air are known as the *aerial,* and the air acts as a *dielectric* between the aerial and the ground. Thus it may be seen, the usual antenna system is really a large condenser.

Aerials of different sizes and shapes have been designed to meet different requirements and, by changing the mechanical characteristics of an aerial, it is possible to make it either *"directional"* or *"non-directional."* and efficient or inefficient. Of course, different rules apply to the design of transmitting and receiving aerials; but the former will not be considered in this article.

LENGTH OF AERIALS

In the first part of this article it was stated that a few simple rules may be used to govern the erection of all types of receiving aerials; these are stated in the following paragraphs.

First, the aerial need not always be long. Many radio fans are under the erroneous impression that an aerial of great length insures excellent reception, but this is not

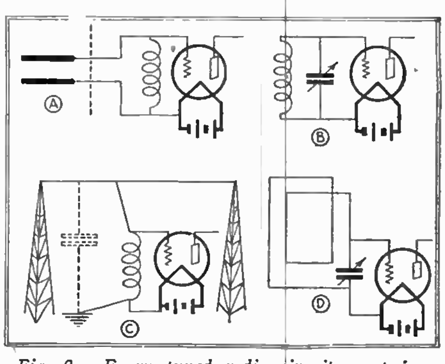


Fig. 2. Every tuned radio circuit must include both inductance and capacity; we see here how this rule applies to the antenna circuit of receivers. Figs. A and C show an aerial-and-ground system in schematic and picture form; Figs. B and D the circuit of the loop antenna.

always the case. In most instances, an aerial with an over-all length of approximately 100 feet will provide most satisfactory performance. With an aerial of this length, the average set has sufficient sensitivity to receive distant stations and ample selectivity for separating the local broadcasters. On the other hand, if the aerial were made larger, the set would probably tune broadly and local interference would be experienced; but, if the aerial were shorter, difficulty would be encountered in receiving distant stations.

There are places, however, where aerials either longer or shorter than 100 feet are required. In rural districts, where the nearest broadcast station is more than 25 miles away, interference problems are almost unknown, and, under these conditions, a long aerial, having a length as great as 150 feet, may be used. On the contrary, in congested city districts, where there are several powerful broadcast stations very nearby, it may be found necessary to use a very short aerial. Usually one 75 feet long will be found to possess ample selectivity but, in some cases, it will be necessary to reduce the length of the aerial to 40 or 50 feet in order to eliminate entirely local interference from the receiver.

In computing the length of an aerial, it is important to remember that the *lead-in wire has just as much effect upon the operation of the receiver as the aerial wire itself.* Therefore, if it is desired to erect a 100-foot aerial and the lead-in wire is 20 feet long, the aerial wire should not be more than 80 feet long. This is where a great many listeners make a mistake. Because their aerial wire is only 75 feet long they expect great selectivity; and they are very much surprised to be told that the interference they experience is caused by their long aerial, 75 feet of which is lead-in wire.

It frequently happens that a set owner wishes to use a long aerial, but is unable to do so because of lack of space. Under these conditions a multi-wire aerial of the *cage* or the *flat-top* type may be used to advantage. In the usual receiving installation, a long single wire is more satisfactory than a multi-wire aerial; but, where it is impossible to construct a suitable single-wire aerial, the use of several wires often improves results. If an aerial of the flat-top type is to be constructed, two or three wires may be used; but, if a cage-type aerial is decided upon, at least four wires must be employed, for mechanical reasons. Usually, when three or four wires are used, the aerial has an *effective* length approximately 50 per cent greater than its actual length in feet.

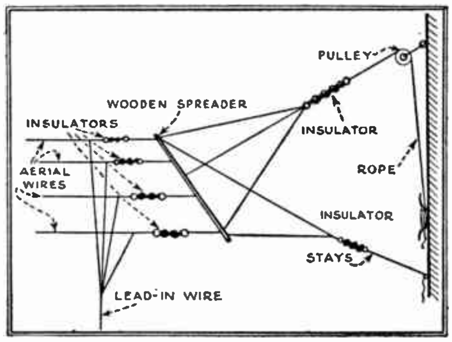


Fig. 5. Flat-top construction is probably most popular in multi-wire receiving aerials. A wooden rod is used as a spreader and the lead-in wire takes the shape of a fan; this diagram shows the usual method of construction.

LOCATION AND INTERFERENCE

The second rule to observe, when putting up an aerial, is not to run the wires near buildings, wires, trees or large metal objects. When the aerial wire runs through the branches of a tree, over the metal roof of a building, or *parallel* to telephone or lighting wires, much of the energy is absorbed before it reaches the receiving set. This has the effect of increasing the resistance of the aerial and, as a result, it reduces the sensitivity and the selectivity of the receiver.

Wherever possible, when lighting wires are a problem, the aerial should be so placed that it crosses these wires at right angles. In the case of a metal roof, the aerial should be supported as far above the building as possible; and, where branches of trees cause trouble, they should be so trimmed that they do not come in close proximity to the aerial wires. Often, when a tree is used as a support for an aerial, it is best to terminate the aerial several feet before it reaches the tree, by inserting an insulator between it and the supporting wire leading to the trunk.

After the aerial has been erected, it should be remembered that the lead-in wire requires the same care that was given the aerial. Because the lead-in must enter the house, it is more difficult to keep it away from surrounding objects; but, nevertheless, this is equally as important as in the case of the aerial. Where the wire must follow the side of a house for a distance, it is usually wise to support it on insulators, which should be spaced by brackets at least a foot and a half from the walls of the building. Also, the wire should enter the house at a point as near the radio receiver as possible.

DIRECTION OF RECEPTION

The directional characteristics of the various types of antennas is the next point which will receive consideration. In this connection it should be pointed out that the average radio listener directs too much effort toward calculating the probable direction from which most signals will be received. The fact is that, at sea or on a wide prairie, the directional characteristics of certain types of aerials may be quite noticeable; but, in most locations, the signals of all stations are reflected to such an extent, by buildings or other sources of wave interference, that the characteristics of the aerial have very little to do with the actual direction in which the receiver provides best results.

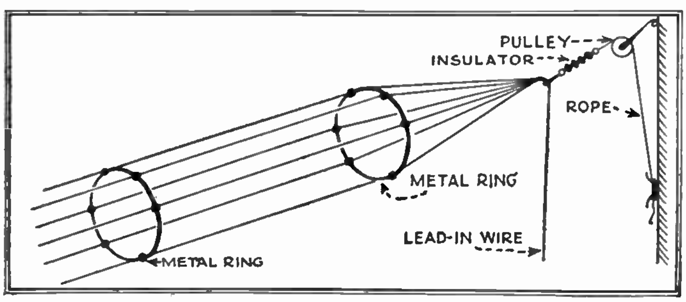


Fig. 4. The cage aerial is a popular design for a multi-wire aerial. Metal rings are used to separate the wires and each wire must be securely soldered to each ring. The rings are spaced 15 or 20 feet apart over the entire length of the aerial.

For the benefit of those who are interested in this subject of directional characteristics of aerials, Fig. 1 shows graphically the way in which the various types differ. It will be noticed that the vertical aerial provides uniform reception in all directions and, for this reason, it is the *ideal* type for all purposes. However, for mechanical reasons, this type of aerial construction is seldom used. The "T"-type aerial is the next best, but this is not very popular because it must be twice as long as the inverted-"L"-type aerial, in order to provide the same results. The inverted "L"-type aerial is theoretically the most unsatisfactory of the three, but it is a much more practical design and it actually delivers results entirely satisfatcory under most conditions.

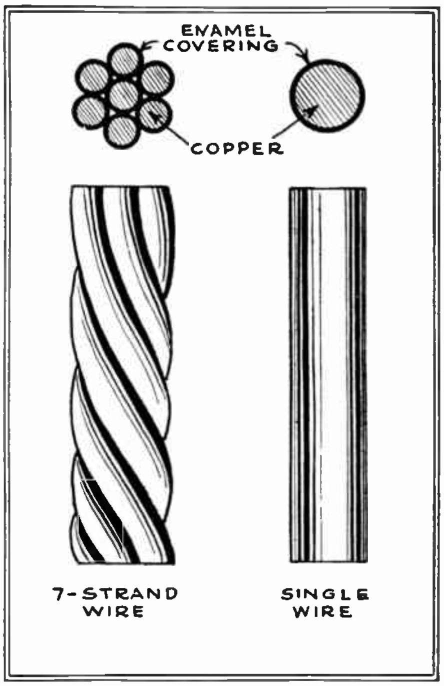


Fig. 6. Radio-frequency current flows on the surface of conductors and R.F. resistance may be decreased by increasing the surface area. With the same amount of metal, stranded wire has a greater surface than solid wire; enamel insulation also increases the surface by separating the strands.

The secret of making an aerial non-directional is to support it as high in the air as possible. It has been found that, with aerials less than 20 feet high, the directional characteristics are sometimes quite pronounced; but, as the height is increased, these effects become less noticeable. Aerials from 30 to 60 feet in height are entirely satisfactory for average reception purposes.

Of course, wherever it is possible to do so, one should plan an aerial so that it will run in the direction found most satisfactory for reception in the direction desired. However, where so many fans make their mistake is in an effort to provide the aerial with desirable directional characteristics which causes them to sacrifice other desirable features such as proper length and location, which are usually far more important.

INSULATION

Insulators are an important consideration when erecting a radio aerial, and there are many different types of insulators available for the purpose. In a receiving aerial, the energy which is picked up is very feeble, and it is essential that none of the current be wasted, if distance reception is desired. As it is the purpose of the insulators to prevent the current from leaking to the ground before it passes through the receiver, the importance of good insulation may be appreciated readily.

In a radio aerial, insulators are used at each end; they serve to connect the wire of the aerial to the rope or wire which supports it in position. Also, insulators are connected between the lead-in wire and any support which holds that wire in position. In addition, an insulating tube is required at the point where a lead-in wire enters a building, and the lead-in wire is passed through this insulator. In other words, insulators are used at all points outside the house where it is necessary to provide supports for the aerial or lead-in wires; and it is the purpose of these insulators to prevent the aerial system from coming in close electrical contact with anything which might provide a path to the ground for electricity.

On the inside of a building, it is equally important to prevent leakage of current from the aerial lead-in; but it is easier to insure against such an occurrence, for the woodwork and furnishings are dry and are fairly satisfactory as insulators. Therefore (usually at the point where the lead-in enters the house) an insulated wire is soldered to the bare wire used in the aerial and external portion of the lead-in. The insulation on this wire is all that is considered necessary to prevent leakage.

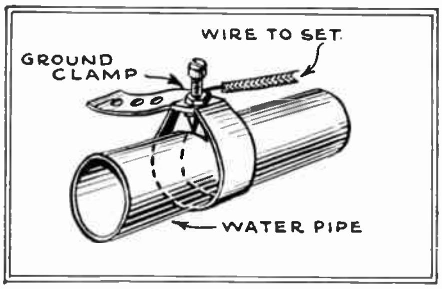


Fig. 11. A good ground connection is as important as a good aerial. A low-resistance connection to a cold-water pipe provides an excellent ground; and the best way to make this connection is with a standard ground clamp

Outdoor insulators are made in various sizes, and from various materials, in order to satisfy all requirements. The length varies from three inches for small receiving aerials to two feet or more for powerful transmitting stations. The materials used are selected because of their ability to act as an insulator under all climatic conditions; glass, porcelain, hard rubber and special-composition materials are a few of them frequently employed.

The most important thing to consider, when selecting an insulator for outdoor use, is whether it absorbs moisture. For example, a high-quality glass is excellent in this respect because it absorbs practically no moisture, it is a very good insulator, and its shape can be designed to provide ample mechanical strength for the purpose. Porcelain which has been properly glazed is another excellent material for insulation purposes, and the highest-quality insulators of this type possess the same desirable qualities as glass. However, frequently porcelain insulators are glazed only on three sides; such insulators absorb considerable moisture and are therefore unsuited for outdoor use. Usually hard-rubber insulators are not as satisfactory as the two types first referred to. When exposed to the weather hard rubber deteriorates and in time loses its strength; also, in time, the surface becomes rough and as a result holds moisture. There are several composition insulators which are very satisfactory but none have the lasting qualities of glass or a high-quality porcelain; *i.e.,* in time they are affected by the weather in one way or another.

CHOICE OF WIRE

The type of wire which will be most satisfactory is another important problem for the set owner to decide. There are as many different kinds of wire which may be used as there are insulators, and each has its particular advantages. For example, wire for use in aerials is made of bare copper, aluminum, phosphor-bronze, copper-clad iron, gold-plated copper and enameled copper. Also, it is available in several sizes, including rope with seven strands of No. 22 and even larger wire, and single strand up to No. 14 and 16 wire.

In selecting wire, the important points to consider are; first, its mechanical strength; second, its resistance to radio-frequency currents; third, its lasting qualities; and, fourth, the ease of making soldered connections to it.

The mechanical strength of aerial wire must be considered when the wire is to be stretched over a long span. Where it is planned to make the aerial 150 feet or more in length, aluminum and copper will not be satisfactory for the purpose and either phosphor-bronze or copper-clad iron should be used. However, for the usual receiving aerial which is less than 150 feet in length, copper and aluminum both have sufficient strength.

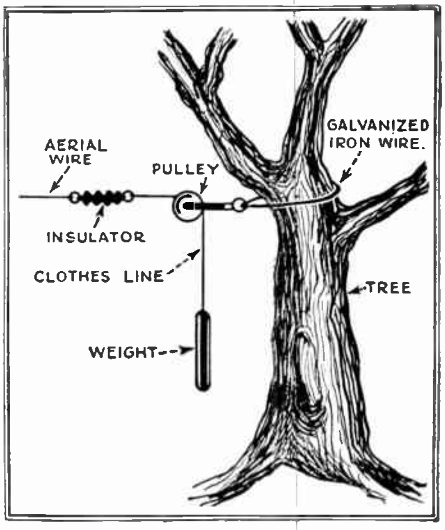


Fig. 3. This drawing shows a suitable method for attaching an aerial to a tree. The weight takes up the slack in the wire at all times, and prevents the wire from breaking when the tree sways in a heavy wind.

The *R.F.* (radio-frequency) *resistance* of the wire is important, regardless of the type of aerial which is being constructed; as it has a great effect upon the electrical efficiency of the antenna system. In this connection, it should be explained that R.F. resistance is entirely different from D.C. (direct-current) resistance, and two wires having exactly the same D.C. resistance may have entirely different R.F. resistances. The reason for this is that *R.F. currents* (such as those caused by radio waves) *flow on the surface of wire,* whereas direct currents penetrate through the entire wire. (See Fig. 6.)

In R.F. circuits the resistance may be decreased by increasing the surface area of the wire. This explains why seven-stranded No. 22 enameled copper wire is used frequently in place of a single strand of No. 14 wire which has approximately the same D.C. resistance. By using

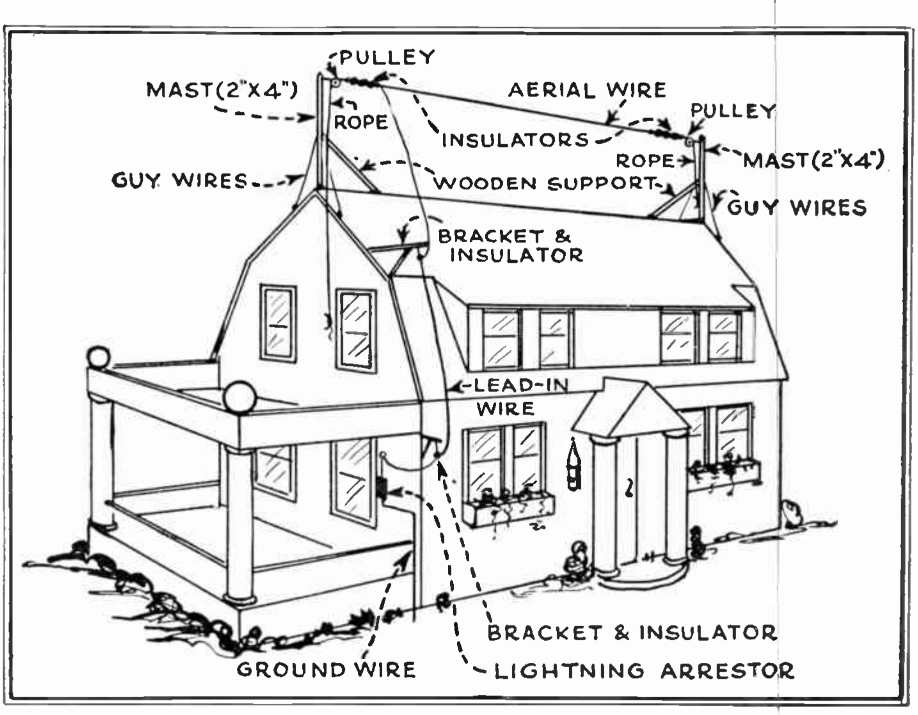


Fig. 7. This drawing gives complete details for constructing an average radio receiving aerial. Masts are used to raise the aerial wire as far from the roof as possible, and brackets keep the lead-in away from the house.

stranded wire, a greater surface area may be obtained with the same quantity of metal; and by insulating each strand with enamel, the effective surface is still further increased.

EFFECT OF CORROSION

The quality of the metal *on the surface* of the wire, also, has an effect upon the R.F. resistance. For example, the R.F. resistance of a length of clean copper wire might be originally 10 ohms; but, after it has been exposed to the weather for a few months, the corrosion on the surface might increase the resistance of the wire to 15 ohms for R.F. currents.

In the wires made and sold especially for aerials, many methods have been used to decrease the surface resistance of the wire. Probably the most popular is the use of an enamel covering, which protects the metal from the weather and, in this way, prevents corrosion. Other manufacturers gold-plate the wire, as gold is a good conductor and is not subject to corrosion. In the case of the copper-clad iron wire, the makers take advantage of the fact that R.F. currents flow on the surface of the wire, and use a less expensive but stronger metal in the core of the wire.

Single-strand, enameled copper wire of No. 14 or No. 12 gauge is probably the most popular and most satisfactory wire for receiving purposes. This wire has sufficient mechanical strength and offers a very low resistance to R.F. currents, its enamel covering prevents corrosion, and it is easily soldered. There is very little difference in efficiency between the solid wire and the stranded. The difference in resistance between solid copper wire and enameled copper wire is negligible when the wire is new; but the increase in R.F. resistance caused by corrosion after four months of exposure to the elements often causes a decrease in signal strength of as much as 25 per cent. Therefore, the enameled covering is highly desirable, and this is particularly true in large cities because of acid fumes liberated by factories and coal-burning furnaces.

Aluminum wire is not very satisfactory for radio aerials. The tensile strength of aluminum is not very great and it cannot be soldered with ordinary solder; also, it corrodes very rapidly. Phosphor-bronze wire possesses characteristics which are similar to those of copper, but has greater strength. As bronze is more expensive than copper, there is no advantage in using it, except in cases where a very long aerial is to be erected. Also, bronze wire is not sold with enamel insulation and, as it corrodes, it may not be as satisfactory as enameled copper. Copper-clad iron wire, when new, is equally as efficient as copper from the electrical viewpoint and, in addition, it is much stronger mechanically. However, it is not generally available with enamel insulation, and it must in time be replaced because the copper coating wears off, leaving ordinary iron wire, the resistance of which is very much higher.

Either gold- or silver-plated copper wire is satisfactory for use in aerials, but it is unnecessarily expensive. Both gold and silver are good conductors of electricity; however, the thin gold or silver plating is apt to wear off in a very short period of time, leaving bare copper wire.

CONNECTIONS

When putting up an aerial, joints in the wire should always be carefully made. In all cases where it is possible to do so, joints should be avoided; as they are a constant cause of trouble. For example, the aerial and lead-in may often be one length of wire; thus eliminating a joint at a place where it is difficult to make a repair and still more difficult to discover a defect.

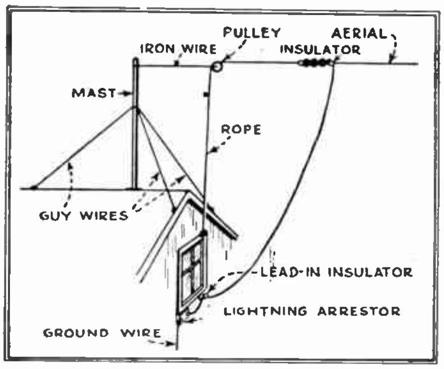


Fig. 9. This drawing shows an excellent arrangement for a receiving aerial. When this method is followed, both the aerial and lead-in wires are kept free from obstructions. The aerial wire may be fastened to either a tree or another building.

When making joints in aerial wires, both the mechanical and electrical efficiency of the connection must be considered. In the aerial wire, if a connection is not mechanically strong, a strong wind is apt to blow down the aerial. Likewise, if a good electrical connection is not made, the air will be apt to corrode the wire and increase the resistance of the aerial. Good electrical connections in the aerial are far more important than in any other part of the radio installation, because the action of the elements will quickly render a poor contact valueless Therefore, it is highly important that all joints be soldered.

Although the ground wire is not a part of the aerial, it is an essential part of every antenna system and for this reason will be considered in this article. The electrical function of the ground has been considered in the first part of this article, and, therefore, only the practical side of the ground installation need be discussed here.

It is the object of the ground wire to provide a connection to the earth of as low a resistance as possible and, usually, this may be accomplished most easily by connecting the wire with a cold-water pipe. Water-pipe grounds are approved by the Fire Underwriters, and they are far more efficient than the usual artificial or home-made ground connection. Connection is made to the cold-water pipe by a device known as a *ground clamp*. The ground clamp is a strip of sheet brass or copper, about one inch wide, which is fastened to the water pipe. However, before the clamp is applied, the outside of the pipe should be thoroughly cleaned in order to insure a low-resistance connection. In places where a city water pipe is not available, a radiator pipe may be used; but the *gas pipe must not be employed for this purpose.* Often, improved results may be obtained by using both radiator and cold-water-pipe ground connections.

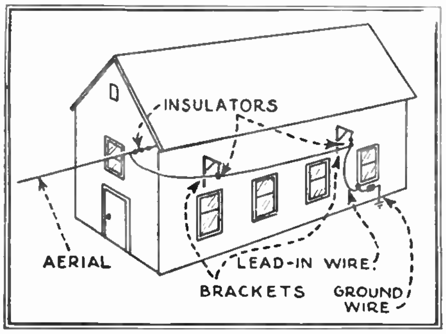


Fig. 8. In order to obtain best results, the lead-in wire should be kept free from buildings. Where necessary, brackets should be erected to support the wire at least 18 inches from the building.

On a farm in the country, where such a convenient ground is not available, it is sometimes necessary to make a special ground connection. For this purpose a metal object with a large surface, such as a clothes boiler, should be connected to the ground wire and buried about three or four feet deep in the ground. This should be located in a place where the ground is damp at all times and, before the holes is filled up, it is necessary to make sure that a good electrical connection has been made to the object which is used as the ground. The wire from the receiver to the ground may be No. 14 copper wire.

LIGHTNING ARRESTOR

The last, but one of the most important things to consider when erecting an aerial

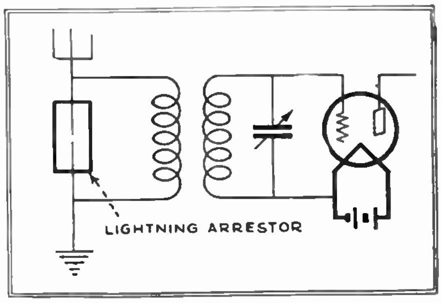


Fig. 10. A lightning arrestor is required by the insurance regulations in every case where an outside aerial is used. This device is connected across the aerial and ground wires, at the point where they enter the house, to conduct atmospheric electricity direct to ground.

is the lightning arrestor. This piece of apparatus is required by the Fire Underwriters' regulations, and it is connected between the aerial lead-in and the ground, near the point where the lead-in enters the house. It may be located on either the outside or inside of the building.

As the lightning arrestor has nothing to do with the operation of the receiver it is not necessary to discuss its electrical features in this article. The radio fan who buys a lightning arrestor should first make sure that it has been approved by the Fire Underwriters; and if so, he may feel perfectly safe in using it according to the directions given by the manufacturers for its installation.

Also, it might be added that the danger of lightning striking the average aerial is small. There have been cases where aerials have been struck by bolts; but in these cases lightning arrestors had been used and the damage caused by the bolt negligible. However, this does not mean that aerial installation may be made without including suitable means for protection against bolts. As was said previously, the arrestor is required by the Underwriters and as such, omission of this item automatically cancells one's insurance policy. By all means, it should be made part of every aerial installation.

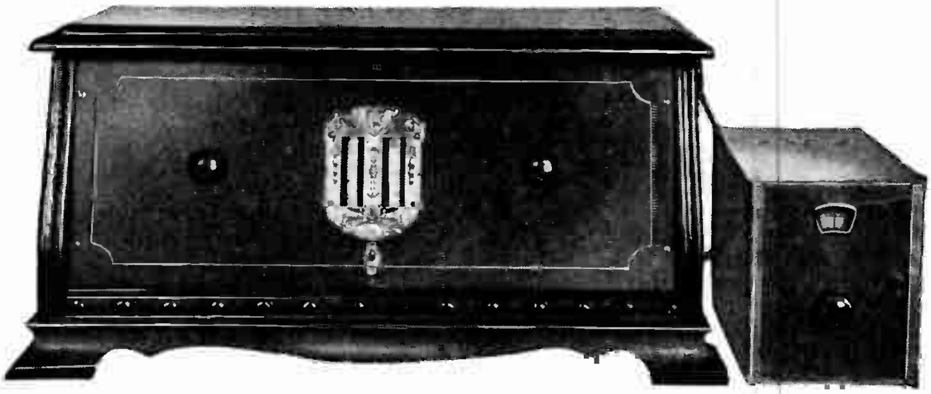
R. F. Booster Unit Improves DX Results★

Complete Details for Constructing A Simple Device Improving the Sensitivity and Selectivity of Any Receiver with No Wiring Changes

By David Grimes

THE greatest thrill of radio always has been, as it always will be, the reception of broadcast programs from remote transmitters. In the earliest days of radio broadcasting, the experimenter desired above all to have as comprehensive a log as possible, and local stations were little esteemed. Notwithstanding all the efforts to the contrary which have been made by the manufacturers and broadcasters, that desire for distance still remains with every true radio fan.

It is well known, of course, that distant reception has been made extremely difficult in the past two years, first, by the excessive number of stations which "jam" every available broadcast channel; and, secondly, by the tendency toward the production of single-control receivers, which too often involves a sacrifice of real receiving efficiency for the sake of simplicity in operation.

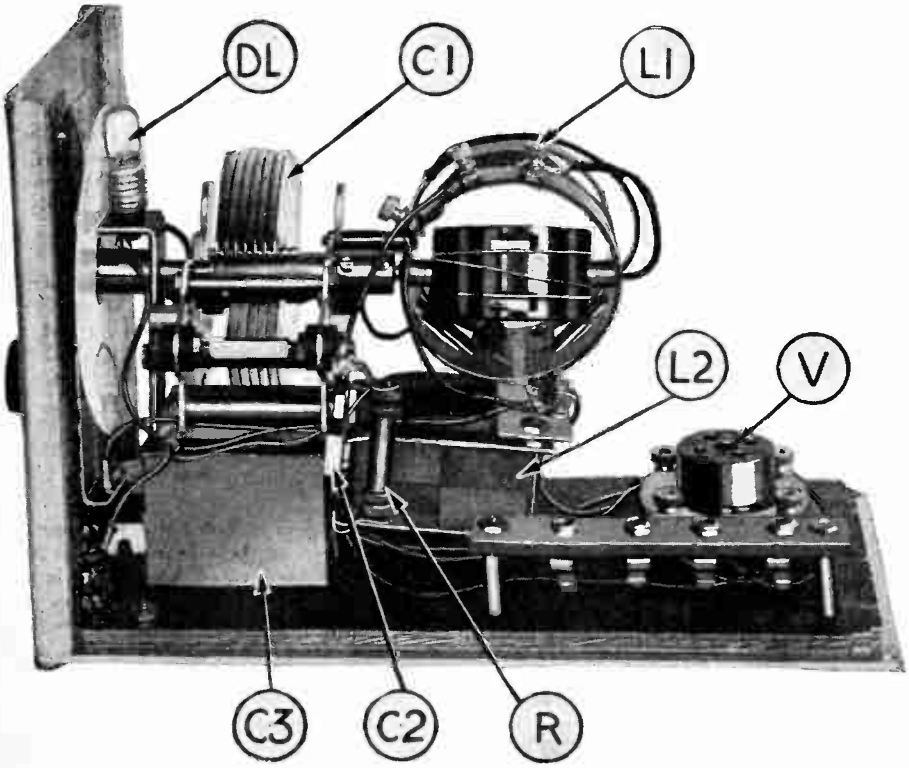


In this picture the R.F. Booster Unit is shown connected with a standard tuned R.F. receiver. In order to install the Booster Unit it is only necessary to insert a plug in the detector socket.

The owner of the old, but efficient, three-dial receiver is now seeking relief from the congested condition of the ether; while the single-dial owner has fully realized as well the inherent shortcomings of his particular instrument. It is, further, universally understood that governmental relief, because of the many technical and legal difficulties, is not to be expected in the immediate future; but the entire situation calls for some remedy at once.

Many radio laboratories have been working diligently to perfect apparatus suitable to cope with present conditions, and some devices have already been offered to the public; but these are, in most instances, limited in their application to some particular receiver or some special location. With all of these facts in mind, the writer has conducted extensive tests in the hope that some simple attachment could be designed for universal use with present sets.

An excellent solution of the problem, he is confident, has been found, and it is here presented for the first time. Its fundamental principle is a development of a new circuit whose peculiarities and unusual results have been under observation for over a year in his laboratory. Some of its interesting phases became generally known last fall; but each succeeding week of experiment has unfolded additional possibilities and, only recently, came the realization that the R.F. "Booster Unit" holds a universal answer for the problem of improving the receivers in present use.



View of R.F. Booster Unit, with sides of shield-can removed. C1, variable condenser; C2, grid condenser; C3, by-pass condenser; L1, Coupler unit; L2, audio choke coil; R, grid leak; V, tube socket; DL, dial light.

The attachment has been worked out in such a way that it is necessary merely to plug it into the detector-tube socket of a set, without making other connections of any kind. *No changes of any kind are necessary in the set itself.* In this way, the device may at any time be put instantly into service, and as quickly removed from the receiver. This permits the making of an intelligent comparison, and the marked improvement will demonstrate that the small cost of construction is more than warranted by the results. Every part of the receiver is utilized without change—the R.F., detector and A.F. circuits.

The "plug-in" unit constitutes a genuine addition to the set and is in no sense a replacement. The tuning of the receiver is not changed; it is merely made sharper. There is, therefore, no need of re-logging the set except to record the new stations which will be heard after the unit has been attached.

Reference is made here to Fig. 2 which shows the functional rearrangement of a standard five-tube tuned-radio-frequency re-

* RADIO NEWS *Blueprint Article No. 54.* (*See page* 104).

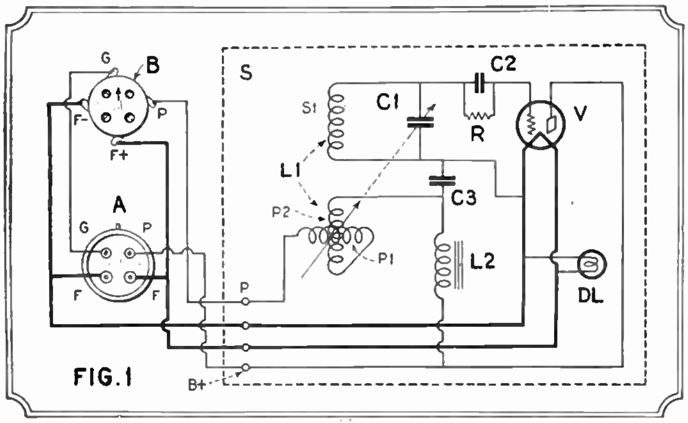
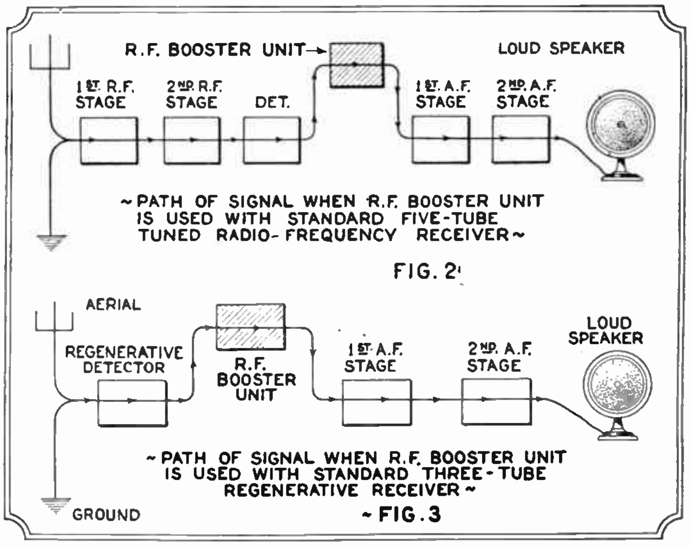


Fig. 1—Complete schematic wiring diagram of the R.F. Booster Unit described in this article. The symbols correspond to those used in the text and other illustrations. Figs. 2 and 3 indicate the location of the Unit in two types of sets.



ceiver. The unit is connected in immediately after the detector stage and immediately ahead of the first audio stage. Fig. 3 shows the comparative arrangement for a three-tube regenerative receiver. It will be noted that the "Booster Unit" is connected following the detector in the regenerative set, and the tickler coil then operates in the plate circuit of the booster stage, where it is quite as effective in its operation as it was previously. Fig. 4 is a schematic wiring diagram of the unit and the associated circuits jsut ahead and just after its position in the tuned radio frequency circuit. The unit wiring is shown within the dotted lines which indicate shielding; while the remaining wiring belongs to the associated circuits. Fig. 5 shows the schematic wiring diagram when the unit is connected into the regenerative circuit.

Now the theoretical considerations in this circuit are most interesting. At first glance, it appears that a second detector has been added to the circuit—and so it has! The detector circuit, ordinarily used in the receiver for the production of the audio frequencies, no longer serves this purpose; but the "by-products" or secondary functions of the detector, ordinarily wasted, are retained and utilized in this new circuit for the increase of selectivity and distance.

RADIO-FREQUENCY COMPONENTS

In order to appreciate fully the electrical actions taking place, one must recall that the plate circuit of a detector tube contains, not only audio-frequency currents, but also radio-frequency currents of half the wavelength ("harmonics")! These are the frequencies which are brought into play upon the installation of the R.F. booster unit. So the circuit that was formerly the detector circuit becomes a radio-frequency stage and the new unit operates as a detector.

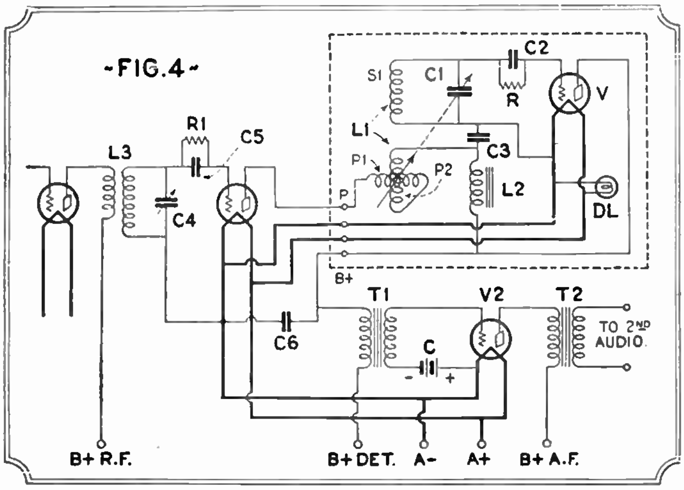
The "Booster Unit" may be used in either one of two ways: in the first, the unit operates on the original wavelength of the signal and under these conditions the detector tube functions exactly as an additional stage of tuned R.F. amplification. In the second, the Booster Unit operates on the "half-wave" or "second harmonic" of the signal, and then the detector acts as a frequency-changing circuit. Different results are obtained when the unit is used in these ways; in the first, both the sensitivity and the selectivity of the receiver are generally improved while, in the second, the selectivity is greatly improved but the sensitivity is slightly impaired. The standard unit described in these pages operates on the original wavelength of the signal; but elsewhere in this article will be found directions for making a booster unit which operates on the half-wave. Both types are satisfactory; but they accomplish different results.

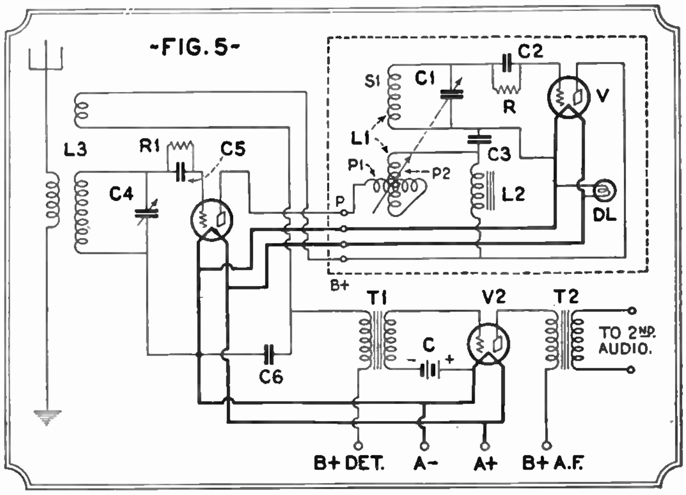
The above description will cover that application of the Booster Unit which makes the detector stage an additional stage of radio-frequency amplification. A unit of this type will considerably increase the distant pick-up of the receiver and will also

A Highly Desirable Item for the DX Fan!

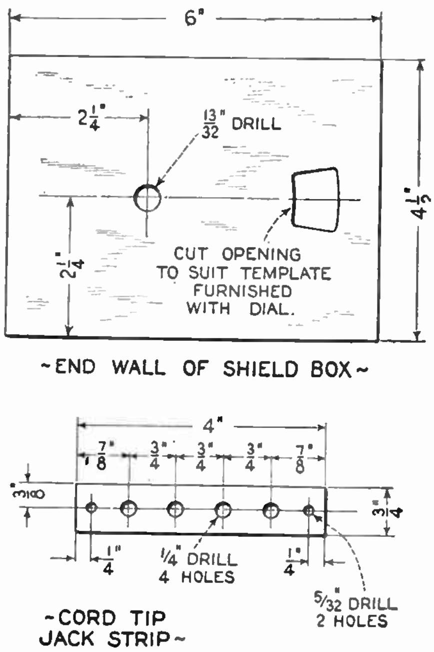
MANY listeners have long been looking for a device of some kind which might be connected to a receiver of any type to give the increased sensitivity, selectivity and volume to be expected from another R.F. stage; but of those developed for this purpose, few have been found satisfactory. While several manufacturers have produced separate R.F. units to be inserted between the antenna and the first tuned circuit of the receiver, an additional stage of this nature introduces liability to uncontrollable oscillation.

This article is a description of the theory and construction of a unit which will accomplish the long-desired end; it may be connected, by the simple insertion of a plug in the detector socket, to almost any radio receiver, and will improve general results in the all-around characteristics above named. The "Booster Unit" is an additon to the receiver (no parts of which does it render inoperative) of one more R.F. stage; it is simple, inexpensive and may be quickly constructed.—EDITOR.





The above diagrams show in schematic form the way in which the R.F. Booster Unit is connected with two standard types of radio receivers. In Fig. 4 the Unit follows a non-regenerative detector in a tuned-R.F. set; and in Fig. 5 it is placed after a regenerative detector.



This drawing shows the exact location of all holes required for mounting apparatus on front of shield-can. Also, complete details of terminal strip are given.

increase the selectivity. By shortening the length of the antenna, to reduce the pick-up of the receiver somewhat, the selectivity can be still further increased.

THE POINT OF ATTACHMENT

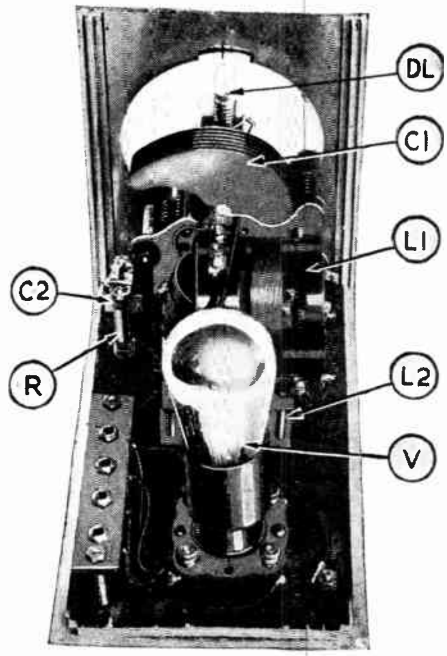
At least half the novelty of this idea consists in the circuit arrangement, whereby no other connections are made with the exception of the insertion of the plug into the detector socket. This is the only socket into which such a unit could be plugged without disturbing the design of the radio-frequency circuit. Any attempt to connect an additional radio-frequency stage in any of the radio-frequency sockets would result in unbalancing, and cause uncontrollable oscillation. It would completely upset a neutralized or neutrodyne receiver, and would ruin the stabilization of a receiver controlled by the "losser" method.

Furthermore, the choice of the detector socket for this unit was controlled by other considerations as well. It is much easier to locate the detector than any of the radio-frequency sockets. The detector has usually a flexible socket or damping springs. The grid leak is generally mounted near this socket. With the set connected up, ready to operate, the detector tube is "microphonic;" that is, it is easy to identify by gentle tapping the tubes with the finger. The tube giving the greatest noise in the loud speaker upon tapping is the tube in the detector socket. The microphonic difficulties in the average receiver were alone sufficient reason for designing this unit for plugging into the detector socket; as changing a standard detector circuit to a radio-frequency stage greatly reduces the microphonic hum, so troublesome when the loud speaker is placed near the receiving set.

The Booster Unit, of course, adds to the receiver one more tube. The additional tube is inserted in a flexible socket at the rear of the tuning unit. The tube which was removed from the detector socket is reinserted in a socket mounted in the top of the plug. (This rule applies only when a standard amplifying tube has been used as a detector; if a special detector of the 200A-type was originally used in the receiver, this tube is inserted in the socket in the Booster Unit and a standard amplifying tube of the 201A-type is placed in the socket mounted in the top of the plug.) It must be noted that the true detector circuit is now contained in the Booster Unit and a special (200A-type) tube is recommended for this circuit.

CONSTRUCTION OF THE PLUG

In Fig. 1 the method of connecting the combined plug and socket is shown. This piece of apparatus is easily constructed from an empty tube-base and the top of a flexible UX-type tube socket of the dimensions given on the next page. The cable leads consist of flexible silk-covered wire, such as that used for winding loop aerials; this has been found to be most suitable because of its small size, mechanical flexibility

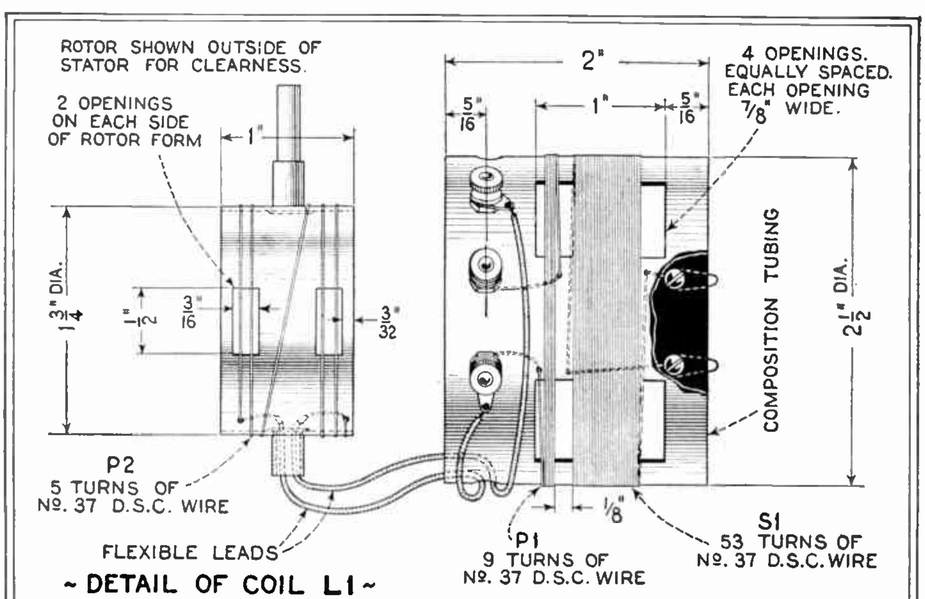


Rear view of R.F. Booster Unit, with sides of shield-can removed. Symbols correspond with those used in text and wiring diagrams.

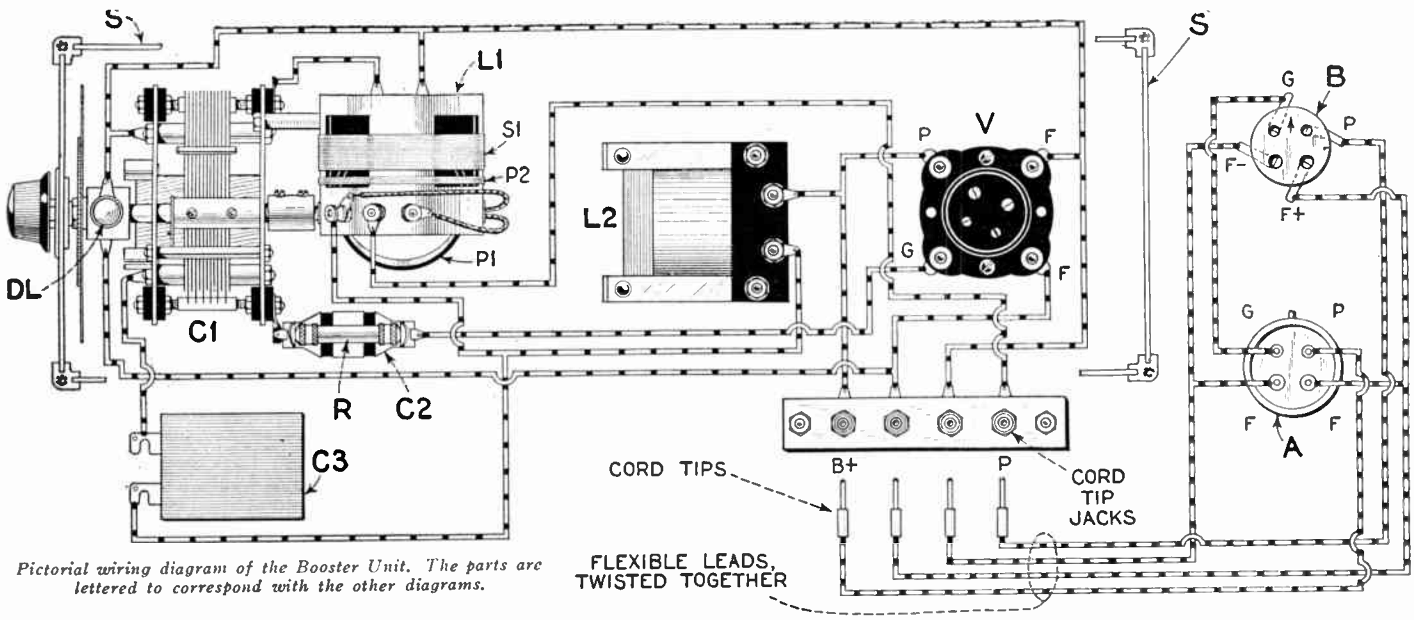
and neat appearance. The free ends of this cord are soldered to cord tips to permit their easy insertion into tip jacks in the unit. This method of connection has been adopted to permit the running of the cord through a small hole in the cabinet; any permanent connection between the unit and the plug would prohibit this convenience. It would be necessary to drape the cord over the top of the set, or a hole sufficiently large to permit the passing of the entire plug would have to be drilled in the cabinet of the radio set.

There are a few minor points, about making the combined socket and plug, that should be here noted. If a new tube-base is utilized, the four brass prongs will be hollow; so that the connection wires may be brought down through and soldered at the bottom. In case an old tube-base is employed, it will be necessary to heat the brass prongs with a soldering iron to melt the solder at the end of the hollow tubes. Then, the connections may be brought down through the prongs and soldered, as in the case of a new tube-base. Some care must be exercised in making the connections between the prongs on the tube-base, the terminals on the inserted tube socket, and the cable leads running out to the unit. Careful attention should be paid to Fig. 1 and the pictorial wiring diagram. The two large prongs in the tube-base constitute the two filament leads which, ordinarily, are connected to the filament of the vacuum tube cemented in the base. The two filament terminals of the socket marked "+" and "—" are connected by leads soldered into the two large prongs above mentioned. No particular care need be taken as to which prong is connected with which filament terminal, for polarity does not matter.

Hold the tube-base with the prongs down and in such a position that the small socket-pin is pointing away from you. It will then be noted that the two large brass (filament) prongs are nearest you. The small upper



The coupler coil L1, which is used in the construction of the Booster Unit, may easily be made at home. Complete details are given in the above drawings.



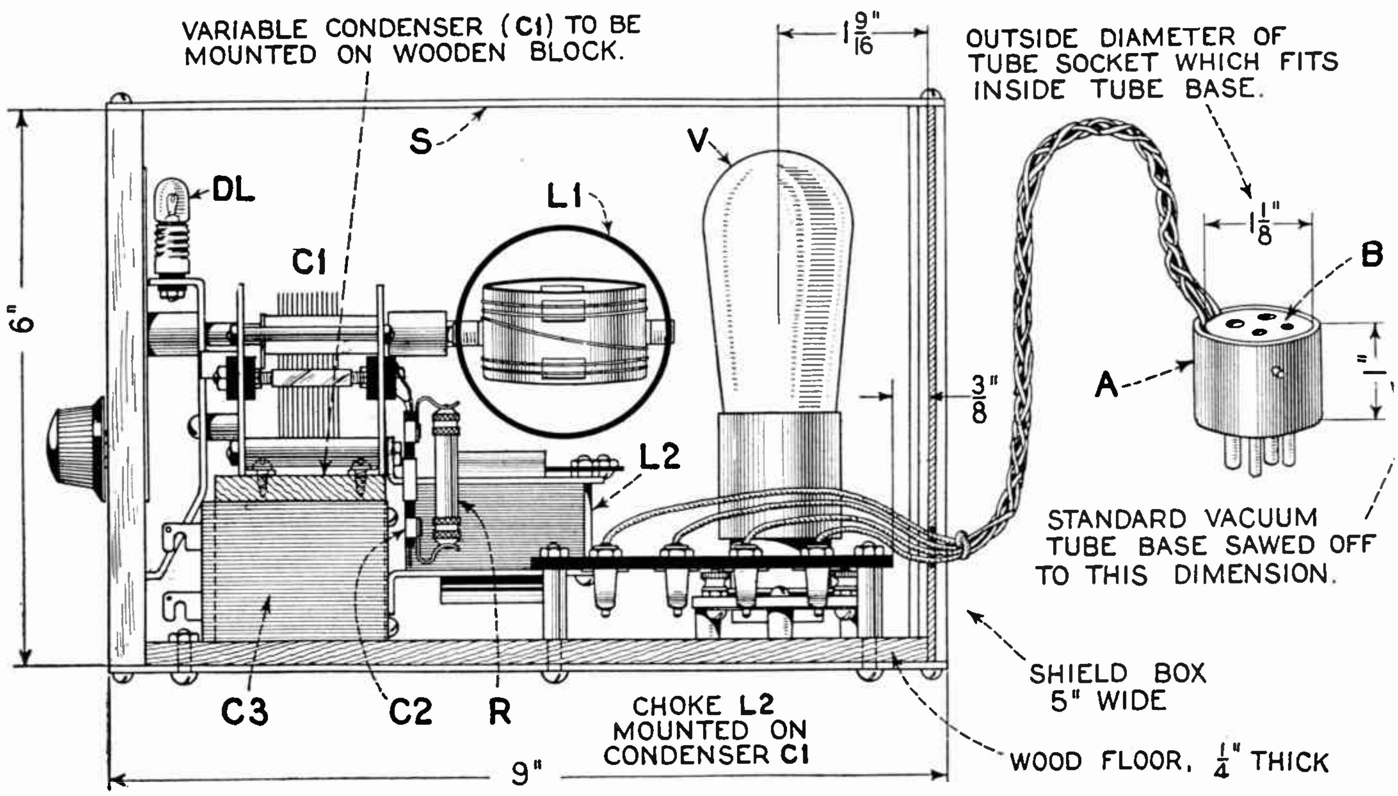
Pictorial wiring diagram of the Booster Unit. The parts are lettered to correspond with the other diagrams.

left prong is the grid connection; the small right prong is the plate connection. The grid spring of the socket is connected directly to the grid prong of the tube base. The plate prong is connected to one of the flexible cable wires and should be marked "B+". The plate terminal of the inserted socket is connected directly to another flexible cable lead to be marked "P." Two additional cable leads are connected to the two filament terminals of the inserted socket, but these are not labeled. The socket is then pushed down into the tube base, with four cable wires extending up on one side. A small hole is then drilled in the base of the plug and melted paraffine is poured in in order to hold the mechanism intact. Only a little will suffice; as too much will plug the entire inside, preventing the insertion of the tube in the socket. The four wires of the cable may then be braided together, forming a compact strand. This in no way impairs their operation; as the cable does not contain any grid wires, but merely one plate wire, one "B" battery wire and two filament wires. This cable should have a length of about two feet, although this is not at all critical. The extension springs on the socket must be sheared off to a length that will permit the socket to be inserted in the tube base, as indicated in the illustration below.

CONSTRUCTION OF THE UNIT

The wiring of the Booster Unit and the constructional details thereof are next in order. The pictorial diagram shows the wiring of the unit in detail. The circuit arrangement is not quite as simple as it first appears, for an audio choke (L2), and audio by-pass condenser (C3) confuse the issue somewhat; yet the entire arrangement is easily explained and more easily hooked up. It must be remembered that the radio-frequency component in the regular detector plate circuit of the receiver must be brought out and employed. This is done through the cable wire leading directly from the plate terminal of the socket. This wire leads to the primary in the tuned-radio-frequency transformer (L1) in the Booster Unit. The other end of this primary must lead back to the "B" battery.

Now, the only possible manner in which to pick up "B" battery voltage by means of the plug-in unit is by means of a connection run to the plug's plate prong, which, in turn, connects to the high side of the primary of the first audio transformer.



How the parts are arranged in the R.F. Booster Unit. The simplicity of construction is apparent.

This explains the reason for the audio choke and condenser, as only the D.C. potential from this transformer is desired. The audio-frequency currents, flowing down through this winding from the plate of the new detector added in the Booster Unit, must not find their way back, nor become mixed with the audio currents set up in the plate circuit of the tube which previously acted as the detector in the radio receiver. The choke and the by-pass condenser accomplish this important task.

COILS OF THE UNIT

The tuned-radio-frequency transformer (L1) in the Booster Unit is built in the conventional manner with sufficient turns on the secondary to cover the broadcast range from 200 to 550 meters with the tuning condenser employed. The primary winding is wound in two sections—one, (P1) a stator winding and the other, (P2) a rotor winding. In the unit herewith presented, the transformer is 2½ inches in diameter. The secondary (S) is wound with fifty-three turns of No. 37 D.S.C. wire. The stator winding (P1) of the primary consists of nine turns of the same-size wire, spaced ⅛-inch from the secondary. The rotor section (P2) of the primary has five turns of the same wire—two and a half turns on each side of the central axis.

For best results, the grid of the Booster's detector tube V should be connected to the end of the secondary farthest removed from the primary. The cable terminal marked "P" should be connected to the terminal of P1 which is nearest to the secondary winding. (The primary and secondary windings should be wound in the same direction.) The rotor P2 is then connected in series with the stator P1 in such a way as *to oppose or stop oscillation at the short waves,* with the tuning condenser C1 in its minimum position. These few rotor turns will then aid at the long wavelengths, with the condenser in its maximum position. Of course, a tuning condenser with an extended shaft will be necessary in order to connect together, mechanically, the rotor of the condenser and the rotor of the primary.

Of course, a grid leak R and a grid condenser C2 are employed in the Booster Unit, as this circuit becomes the new detector. The return from the tuning condenser should go to one side of the filament. The two filament wires coming from the set are then interchanged in the tip jacks, for best results. By reversing these two filament wires the right polarity is ascertained; so that the grid return of the new detector will be on the proper side of the filament. This polarity is not a matter of extreme importance when using the UX-200A detector; although such a tube will give best results when the grid return is connected to the *negative side of the filament.* If a hard (amplifying) tube is used in this detector stage, it is quite necessary that the filament wires be so connected that the grid return will be on the *positive* side of the filament. However, the UX-200A, or soft detector tube, is unconditionally recommended for this unit. The dial-illuminating light (DL) is merely connected across the filament posts of the tube socket in the unit.

OPERATING THE UNIT

It is quite easy to recalibrate the tuning dial so that it will read in wavelengths, rather than in the arbitrary numbers usually found on tuning dials. *This calibration will be entirely independent of that of any receiver on which the unit may be used;* it depends solely upon the tuning condenser and the coil used in the unit. Thus this dial becomes a wavelength indicator and though it is not at all critical in its tuning, gives a very good indication as to the wavelength of the station being received. In ordinary operating practice, the unit is first set at the wavelength desired, and the receiver is then tuned in the same manner previously employed. It will be found that the dials on the receiver have become considerably sharper, while the wavelength dial on the Booster Unit remains conveniently broad.

SYMBOL	Quantity	NAME OF PART	REMARKS	MANUFACTURER ★	
C1	1	Variable Condenser	.0003 mf., removable-shaft type	1	6
L1	1	Variocoupler	Home-made (special design)		
L2	1	Audio Choke Coil	30 Henries	2	
C2	1	Fixed Condenser	.00025 mf., mica type with clips	3	5,7,8,15,16,17,18,19,20,21
C3	1	By-Pass Condenser	0.25 mf., paper type	4	3,7,8,16,17,18,19,22,23,24
R	1	Grid Leak	3 Megohms	5	16,17,18,19,21,22,25,26,27,3
	1	Stage Shield	Aluminum, 5 x 6 x 9 inches	6	
	1	Tube Socket	UX type	7	5,9,11,25,29,30,31,32,33
	4	Tip Jacks		8	9,20,29
	4	Phone Tip Plugs		9	
	1	Illuminated Dial	Back panel mounting type	1	7,10
A	1	Base of Tube	UX type (for plug unit)		
B	1	Tube Socket	UX type (for plug unit)	11	
V	1	Vacuum Tube	200-A type	12	34,35
	1	Binding Post Strip	4 x 3/4 x 3/16 inches	13	36,37
	1	Baseboard	Wood, 4-1/2 x 8-1/2 x 1/4 inches		
	1	Condenser Shaft	Brass, 3 inches long 1/4 inch diameter		
		Connection Wire	Insulated and flexible	14	4,5,28
	1	Shaft Coupling	For 1/4 inch shafts		

NUMBERS IN LAST COLUMN REFER TO CODE NUMBERS BELOW.

1 Wireless Radio Corporation	2 Dongan Electric Manufacturing Co.	3 Dubilier Condenser Corporation
4 Acme Wire Company	5 De Jur Products Company	6 Hammarlund Mfg. Company
7 Pilot Electric Manufacturing Co.	8 Carter Radio Company	9 General Radio Company
10 Martin Copeland Co. (Marco)	11 Benjamin Elec. Mfg. Company	12 Radio Corporation of America
13 Formica Insulation Company	14 Belden Manufacturing Company	15 Sangamo Electric Company
16 Aerovox Wireless Corporation	17 Electrad, Incorporated	18 Polymet Manufacturing Company
19 Leslie F. Muter Company	20 Yaxley Manufacturing Company	21 Micamold Radio Corporation
22 Tobe Deutschmann Company	23 Potter Manufacturing Company	24 John E. Fast Company
25 Amsco Products, Incorporated	26 International Resis. Co. (Durham)	27 Daven Radio Corporation
28 Cornish Wire Company	29 Herbert H. Frost, Incorporated	30 H. H. Eby Manufacturing Company
31 Air-Gap Products Company	32 Alden Manufacturing Company	33 Silver-Marshall, Incorporated
34 E. T. Cunningham, Incorporated	35 C.E. Manufacturing Co. (CeCo)	36 American Hard Rubber Company
37 Micarta Fabricators, Incorporated	38	39
40	41	42

★ THE FIGURES IN THE FIRST COLUMN OF MANUFACTURERS INDICATE THE MAKERS OF THE PARTS USED IN THE ORIGINAL EQUIPMENT DESCRIBED HERE.

No. 54

If you use alternate parts instead of those listed in the first column of manufacturers, be careful to allow for any possible difference in size from those originally used in laying out and drilling the panel and sub-base.

The manufacturers listed in the above list of specified parts represent the original choice of the designer. However, alternates are furnished for those who may have their own favoriets in the parts field.

A complete list of the apparatus required for the construction of the R.F. Booster Unit follows:

One aluminum stage shield, 5 x 6 x 9 inches;
One wooden baseboard, 4½ x 8½ x ¼-inch;
One variable condenser, .0003-mf., C1; extension shaft type for tickler mounting, with ¼-inch coupling;
One variocoupler (home-made—see text), L1;
One audio choke coil, 30-henry, L2;
One by-pass condenser, ¼-mf., C3;
One mica grid condenser, .00025-mf., C2;
One grid leak, 3-megohm, R;
One vacuum-tube socket, V;
Four tip jacks;
One binding-post strip, 4 x ¾ x 3/16-inch;
One illuminated dial;
One 200A-type vacuum tube;
One tube base and socket for plug, A and B.

If it is desired to use the frequency changing principle, the only change in design necessary is to remove a little more than half of the secondary turns in the Booster secondary; the number should be reduced from 53 to about 42. This unit will then tune only *the second harmonic currents;* which will give a 100% increase in selectivity, but reduce the distant pick-up somewhat. It is extremely easy to change your unit from one form to the other in order to determine just what is best for your particular location.

By-Passing the Grid-Bias Resistance

In many instances where a resistor is employed for the purpose of obtaining "C" bias or "C" voltage from the "B" power unit, no by-passing condenser is employed. This is an important oversight, since audio-frequency currents must pass through this part of the tube circuit, with the resistor offering serious opposition to their flow because of its straight resistance, and, in the case of wire-wound resistors, the inductance or choke-coil effect as well. In fact, there is an appreciable loss of volume and tone quality in the absence of a by-pass.

There will be an improvement in volume and tone when a by-pass condenser is shunted across any grid-bias resistor. This condenser should have a capacity of 1- or 2-mf., and may be of the low-voltage type. One with a rated operating value of 180 volts is satisfactory.

An R. F. Short-Wave Broadcast Receiver*

Incorporating an Optional R. F. Stage, Interchangeable Coils for the 10-725-meter Bands, and Push-Pull Amplification

By W. Francis Goodreau

WAVELENGTHS below 200 meters are rapidly becoming established as channels for the broadcasting of radio entertainment. The recent announcements of the decision of a number of popular broadcast stations to operate special transmitters on these waves proves that the industry's growing faith in transmission on high frequencies is beginning to be manifest in a concrete form. On the other hand, the interest of the general public in the construction of short-wave receivers shows that the special programs which are being transmitted on waves outside the broadcast band are being appreciated.

Short waves have many advantages, from the viewpoints of both the broadcaster and the listener. In the first place, they seem to be more efficient, as the programs of low-power stations are frequently heard half-way around the world. Secondly, there is less congestion, as more individual channels are available; and, as a result, a listener may often receive the program from the short-wave transmitter of a station with less interference than would be experienced in receiving the same program broadcast on the regular waves.

ENORMOUSLY GREATER RANGE

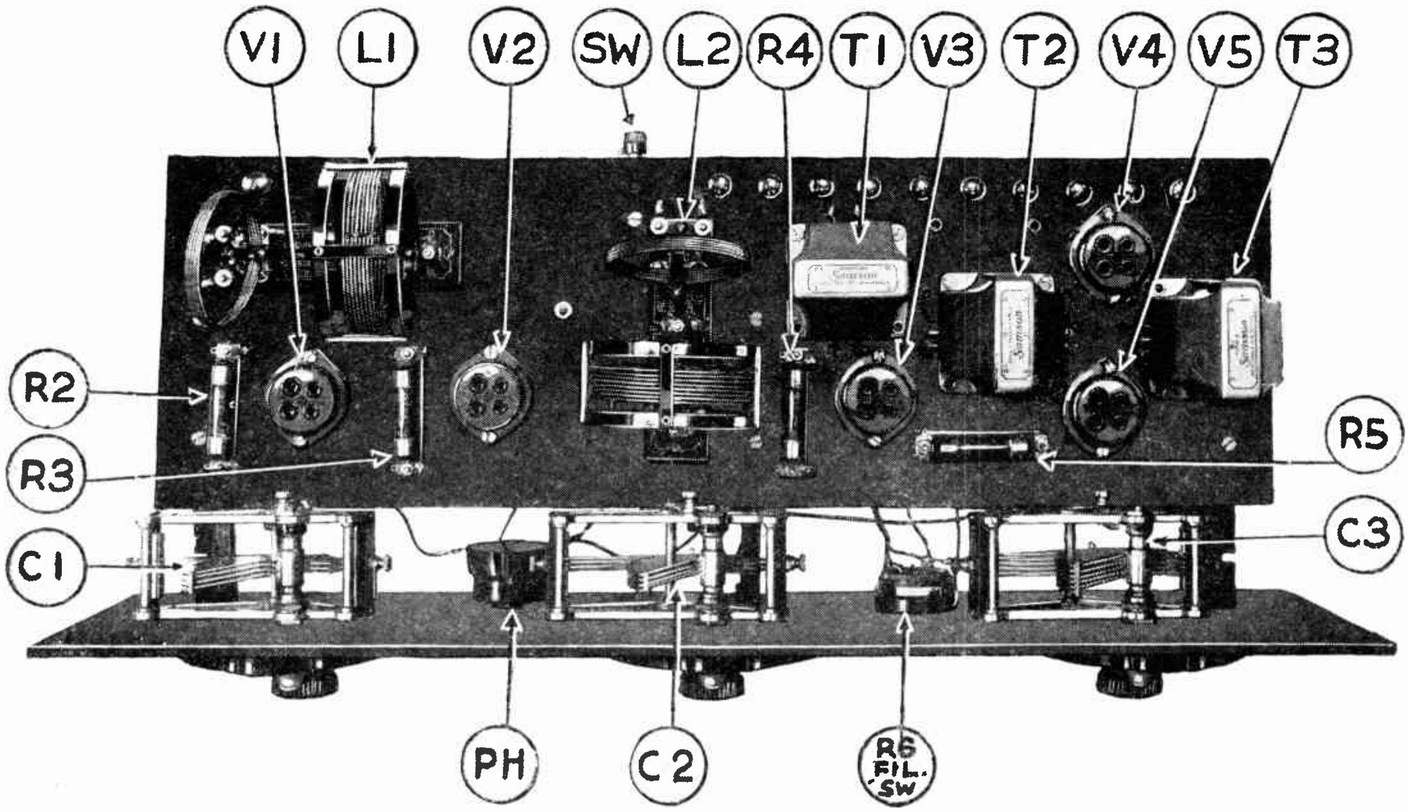
Not only in the United States, but in a number of other countries (including England, France, Germany, Holland, etc.) many stations are broadcasting on waves between 30 and 200 meters. A majority of these programs, even those originating on the other side of the Atlantic, are available to the owner of an efficient short-wave receiver. A number of these stations are broadcasting on regular schedules, while a great number are "on the air" quite frequently, especially when unusual programs are being offered. Practically all of the short-wave stations in this country broadcast the same program simultaneously on their broadcast and short-wave transmitters.

HERE is a receiver which should find favor both with the broadcast listener who desires to enter the short wave field, and the short wave amateur who finds time occasionally to listen to some music.

A commendable feature of this set is that no efficiency is sacrificed either on the short or broadcast waves; in fact, the type of audio amplification employed in this receiver is capable of above-average reproduction. For the code fan who desires reliable short wave work, quality broadcast reception, and 600 meter ship traffic, this receiver is ideal.—EDITOR.

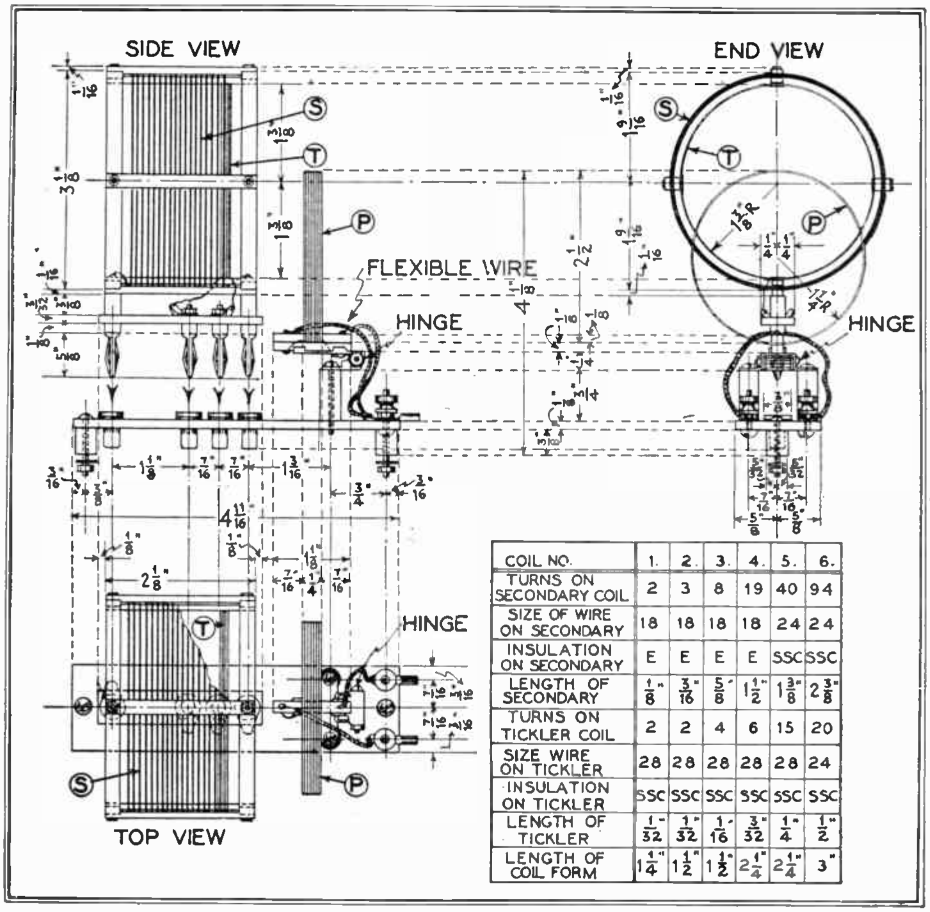
Because of their musical excellence, these programs are interesting to every listener, and especially to the DX fan who, having received practically all of the American and Canadian stations, is looking for new worlds to conquer. Unfortunately, until recently it was not possible to hear the short-wave broadcasts with any degree of satisfaction, because of the lack of suitable receivers. The sets that were used were mostly designed for code reception and, although they were very efficient, they were not designed to give the quality of reception demanded of broadcast receivers today.

Recently, however, articles have appeared in a number of radio magazines describing the construction of sets designed for quality of tone reception on short waves. Most strictly-short-wave receivers use condensers of very small maximum capacity in order to turn to the short wavelengths. When receivers of this type are used for the reception of waves above 200 meters, it is



This picture shows the location of practically all parts used in the construction of this short-wave receiver; the symbols correspond to those used in the wiring diagrams and the list of parts. L1 and L2, R.F. coils; T1, T2 and T3, audio transformers; V1, V2, V3, V4 and V5, tube sockets; C1, C2, tuning condensers; C3, regeneration condenser; R2, R3, R4 and R5, filament ballasts; R6, volume control; PH, oscillation control, Sw, switch controlling R.F. amplifier stage.

* RADIO NEWS *Blueprint Constructional Article No. 52.* (*See page* 104).



COIL NO.	1.	2.	3.	4.	5.	6.
TURNS ON SECONDARY COIL	2	3	8	19	40	94
SIZE OF WIRE ON SECONDARY	18	18	18	18	24	24
INSULATION ON SECONDARY	E	E	E	E	SSC	SSC
LENGTH OF SECONDARY	1/8"	3/16"	5/8"	1 1/2"	1 3/8"	2 3/8"
TURNS ON TICKLER COIL	2	2	4	6	15	20
SIZE WIRE ON TICKLER	28	28	28	28	28	24
INSULATION ON TICKLER	SSC	SSC	SSC	SSC	SSC	SSC
LENGTH OF TICKLER	1/32"	1/32"	1/16"	3/32"	1/4"	1/2"
LENGTH OF COIL FORM	1 1/4"	1 1/2"	1 1/2"	2 1/4"	2 1/4"	3"

Diagram gives complete details for building the six sets of coils required in order to give this set a wavelength range from 10 to 725 meters. The primary coil consists of 10 turns of No. 24 S.S.C. wire wound on a form 2½ inches in diameter, with whichever set of coils it is used.

necessary to use coils having a large number of turns of wire, in order to get an inductance value high enough to cover the waveband between 200 and 500 meters. While it is true that a tuned circuit having a large inductance and a small capacity will usually give louder signals from any given station than a smaller inductance and large capacity tuned to the same station, it is also true that the *selectivity* of the circuit using the small condenser and large inductance will not be as great as that of the other combination.

FAULTS OF EARLY DESIGN

It seems to have been the idea of the designers, of most short-wave receivers, that these were to be used entirely for reception of short waves; and that a separate receiver would be used for the regular broadcast band. While the use of plug-in coils will enable the operator of a short-wave receiver to cover the different bands, it will result in a receiver that is not very selective above 200 meters. The design of most of these short-wave receivers is rather a step backward, when compared with the usual set used for broadcast reception; since practically all of the sets designed for short-wave work are of the plain regenerative type.

It must be admitted that the use of two receivers has some advantages; but it must also be pointed out that the cost of two receivers is beyond the means of many. Besides this, there is the requirement of additional space, not only for the receivers but for the separate sets of batteries that would probably be used.

The special short-wave receiver described in this article was designed to be a flexible receiver, suitable for use on any wavelength band merely by plugging in the proper coils. By referring to the schematic diagram of this set, you will see that a stage of tuned radio frequency has been placed before the usual regenerative circuit. Because of this additional tuned circuit, the receiver is very selective on wavelengths above 200 meters, even though small tuning condensers are utilized. The audio-frequency amplifier has been designed for quality reception; it includes one stage of straight transformer-coupled and one of push-pull amplification. Thus, it will be seen that this set combines the advantages of both the broadcast and short-wave receivers in one flexible all-wave circuit.

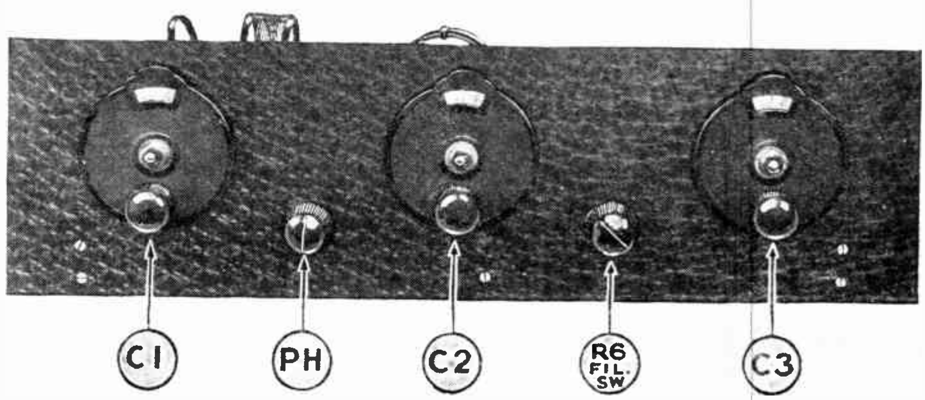
CONSTRUCTION

The set is so designed that the experimenter will find it easy to construct according to his personal desires, since a wide number of types of tubes can be used in the set. If it is not so desired, the audio-frequency end of the circuit need not be of the push-pull type; although the quality of reception will probably be somewhat better if this type of amplifier is used. Another point in favor of this receiver is that, although a complete equipment of coils to cover all the wavebands over which the set is capable of operating would be rather expensive, the constructor may purchase the coil mountings and two coils for the short-wave band at which the receiver is to be operated most frequently, and add the other coils later when finances permit. This feature alone is a good indication of the flexibility of this receiver.

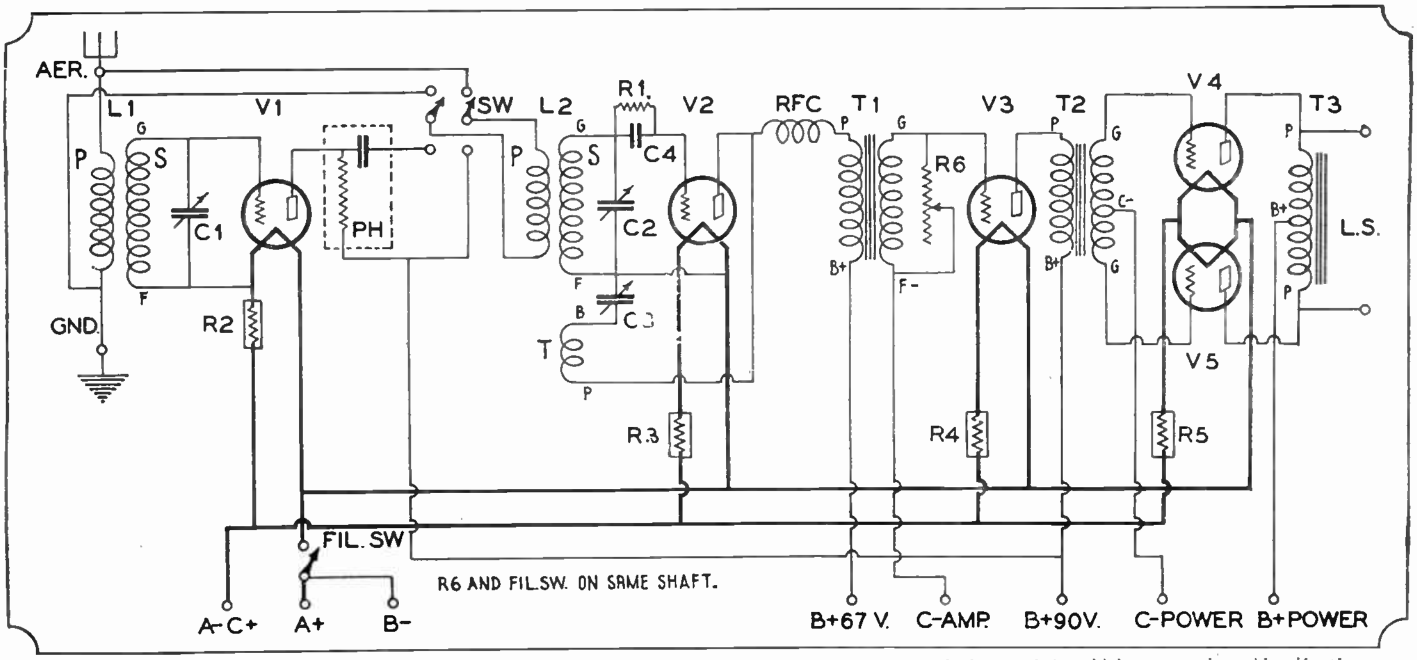
With the panel and sub-panel drilling layouts shown here, it will be a simple matter to place the various parts in their proper positions. It will be noted that, although the front panel measures only 24 inches long, the spacing from center to center of the variable condensers is 8 inches; more than the usual spacing of such instruments. Because of the short wavelengths to which this set can be tuned, this spacing was deemed desirable to prevent interaction between units and eliminate any need for shielding. The coils are placed at right angles to each other and sufficient space is left between them to assure correct operation.

In assembling the set, the sub-panel should be drilled first and the apparatus mounted on it. After this, the front panel should be drilled and the condensers (C1, C2 and C3) volume control (R6) and oscillation control (PH) mounted. Care should be taken in laying out the panel and sub-panel, in order to get the holes at the right points; as otherwise considerable difficulty will be encountered when mounting the apparatus. After all of the parts have been mounted on the panel and sub-panel, the brackets should be screwed into place and the set is ready for wiring. The oscillation control has been mounted on the front panel because of the need of readjusting it with the different coils and tubes that will possibly be used.

It will be noticed that a double-pole, double-throw, jack switch (Sw) has been incorporated in the set between the radio-frequency and detector tubes. This switch is for the purpose of comparing results obtained with the set when the radio-frequency stage is used and when the set is operated as a simple regenerative receiver. It is also helpful in adjusting the receiver when it is first tried out.



This shows the arrangement of controls on the front panel of the set. C1 and C2, wavelength tuning dials; C3, regeneration control; PH, oscillation control; R6-Fil. SW, volume control and filament switch. The plug-in coils are partly visible.



This schematic wiring diagram gives complete details of all electrical connections in the receiver; and the symbols which are used to identify them correspond with those in the other illustrations, as well as the text.

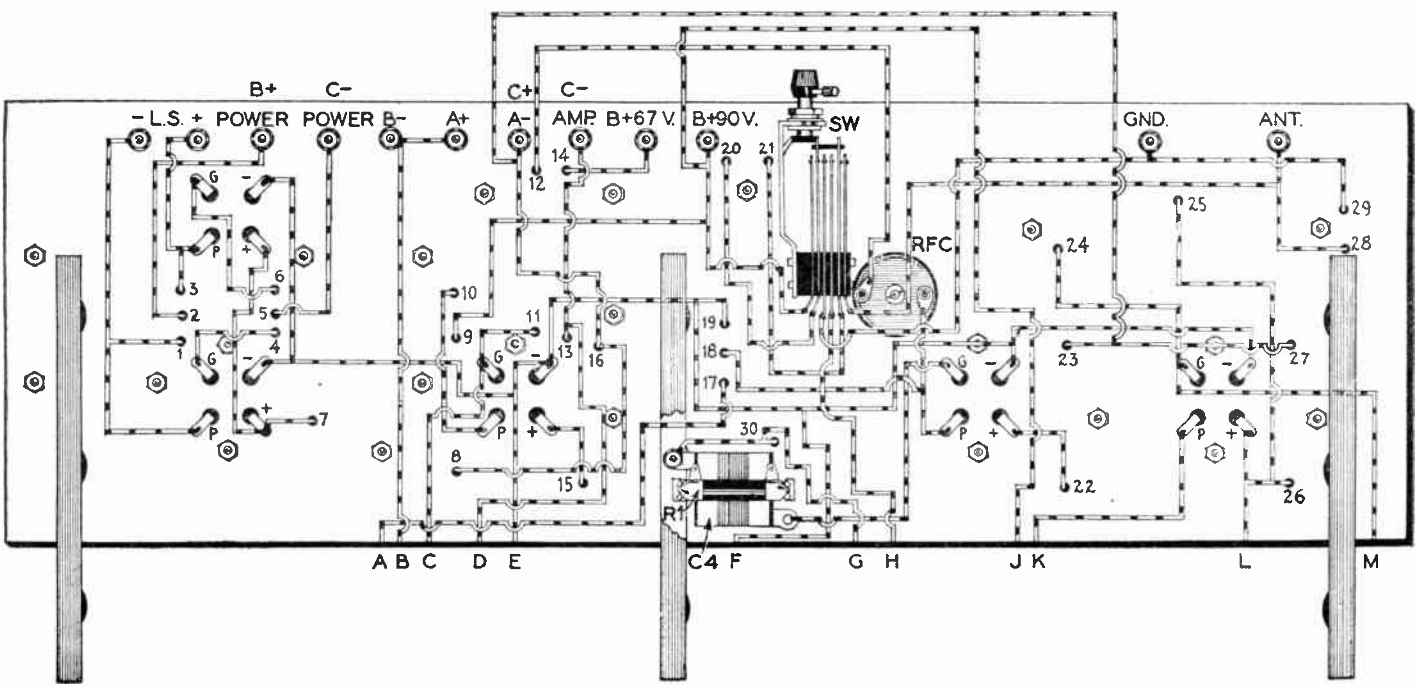
Care should be taken in placing the grid leak R1 and grid condenser C4, to keep them away from the plate wires leading to the radio-frequency tube (V1) and also from the radio-frequency choke (RFC) in the detector plate circuit. The sub-panel mounting brackets are placed as indicated; one slightly off center to provide additional support for the weight of the audio-frequency transformers (T1 and T2).

TESTING AND OPERATING

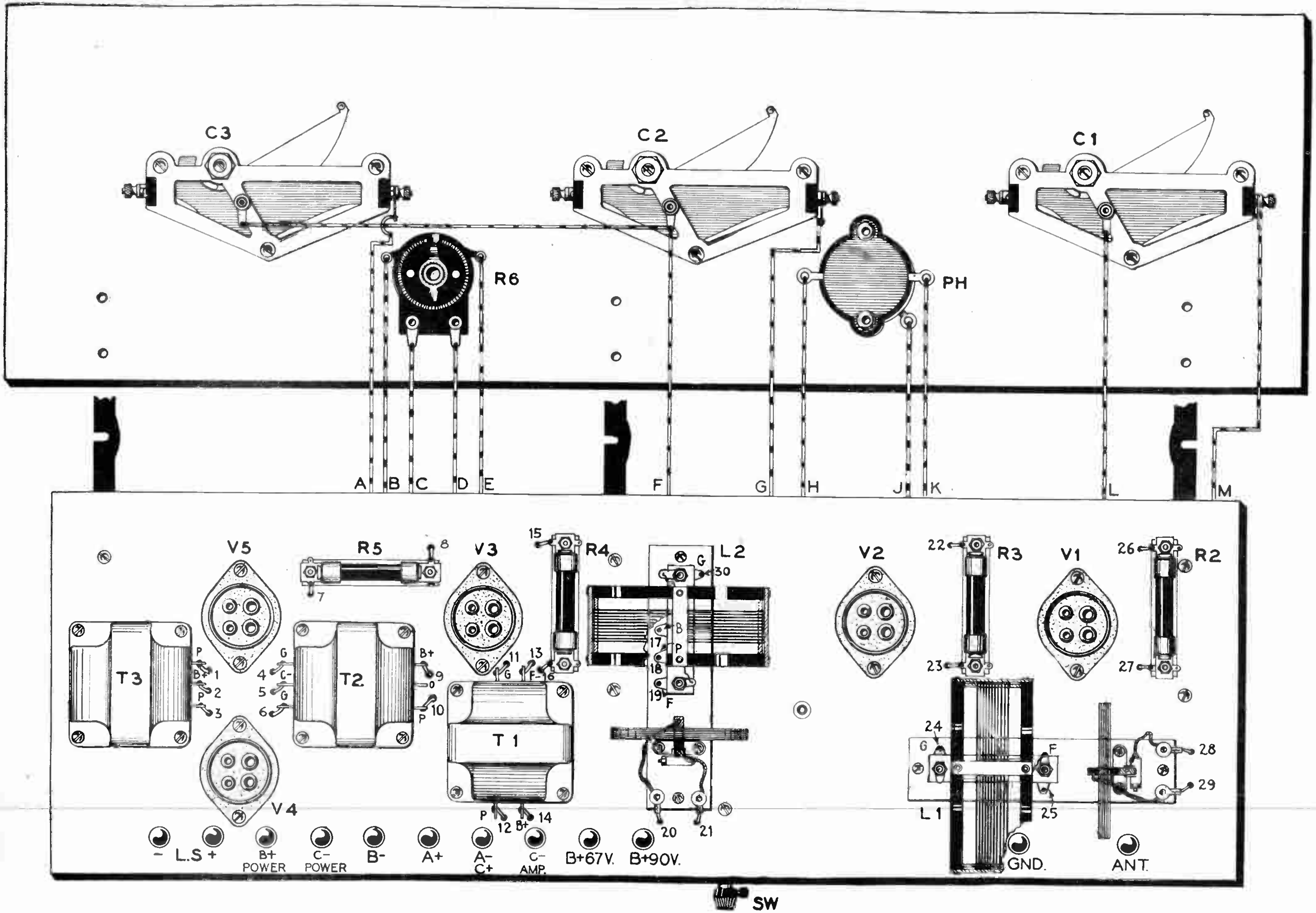
After the wiring is completed the set may be tested. It is best to throw the double-pole switch so that the aerial and ground are connected to the primary of the second tuning unit, in order to get accustomed to tuning the regenerative part of the receiver. It will be noticed that the set is very selective on the short waves; but, the nearer you come to the band between 200 and 500 meters, the more interference will be experienced. However, when the radio-frequency stage is connected in the circuit, the selectivity is very good, on both broadcast and short waves.

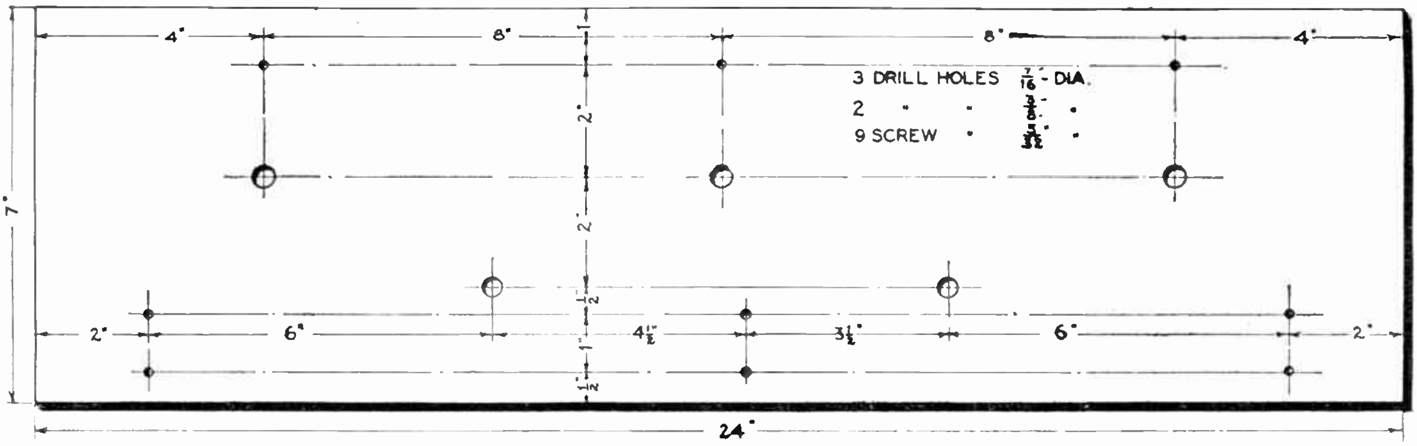
Having spent some time testing the receiver in this manner, the aerial and ground should be connected to the primary of the first tuning unit by throwing the switch (Sw) in the opposite direction. The adjustment of the oscillation control (PH) is not difficult. Tune in a station near the lower end of the condenser scale, turn back the dial of C3 and then slowly turn the dial on the oscillation control (PH) to the left. On returning the dials C1 and C2 no squeals should be heard; if they are heard, turn the oscillation control still farther to the left. If it is found impossible to control the oscillation in this matter, move the primary of the second tuner further away from the secondary. The relation of the primaries on the tuning coils L1 and L2, to their respective secondaries, governs the selectivity of the set.

It was found in testing the receiver that different adjustments of the oscillation control (PH) were needed for some of the coils, although most of the coils could be operated without the adjustment. When experimenting with the set, a 199 tube was tried in the radio-frequency stage and was found to be easier to control than a 201A but, since it was not difficult to adjust the 201A and since the signals were louder with this tube, it was finally chosen. In changing the tubes, the automatic filament controls (R2, R3, R4 and R5) were found very convenient, since they are easily changed, permitting the use of any type of tube without changing the batteries.



This pictorial wiring diagram indicates the exact arrangement of all wiring under the sub-base panel. Letters and numbers in this drawing refer to corresponding wires and holes, which are similarly marked in the diagram of the wiring above the sub-base panel and the leads to panel apparatus, which appears on the opposite page.


C3
C2
C1
R6
PH
A
B
C
D
E
F
G
H
J
K
L
M
V5
R5
V3
R4
L2
V2
R3
V1
R2
T3
T2
T1
V4
L1
- L.S +
B+ POWER
C- POWER
B-
A+
A- C+
C- AMP.
B+67V.
B+90V.
GND.
ANT.
SW



This drilling layout shows the exact location of all holes required for mounting parts on the front panel of the receiver.

In the audio-frequency stages, care should be taken to secure the proper "C" and "B" battery voltages recommended by the manufacturer. This information will be found in the cartons in which the tubes are sold. When using two 171-type tubes in push-pull, it is possible to secure dance-hall volume. Using the 210-type tubes with 425 volts on the plate, terrific volume can be obtained.

The grid condenser (C4) has a capacity of .00025-mf., and the grid leak (R1) has a resistance of 5 megohms. Grid leaks of different values should be tried, in order to determine which produces the best results. If the set has a tendency to howl, try a grid condenser of .0001-mf. capacity.

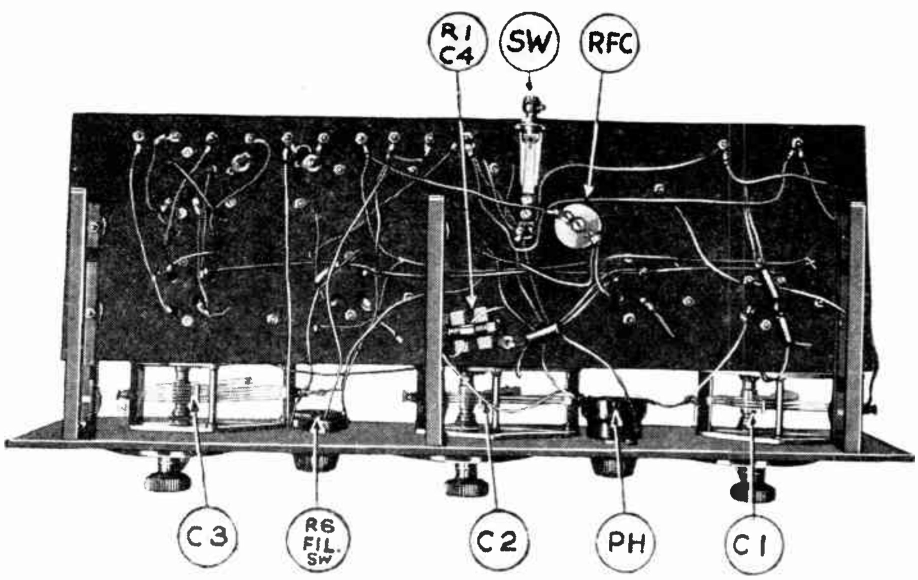
In testing the receiver in the RADIO NEWS Laboratories, coils covering all the wave-lengths from 10 to 550 meters were used. Amateur short-wave stations from great distances were tuned in, and some very interesting phone conversation between amateurs on the Pacific coast was heard on the Atlantic seaboard with sufficient volume to operate a loud speaker. On the regular broadcast band, it was not unusual to find a station at almost every degree on the tuning dials.

COIL DATA

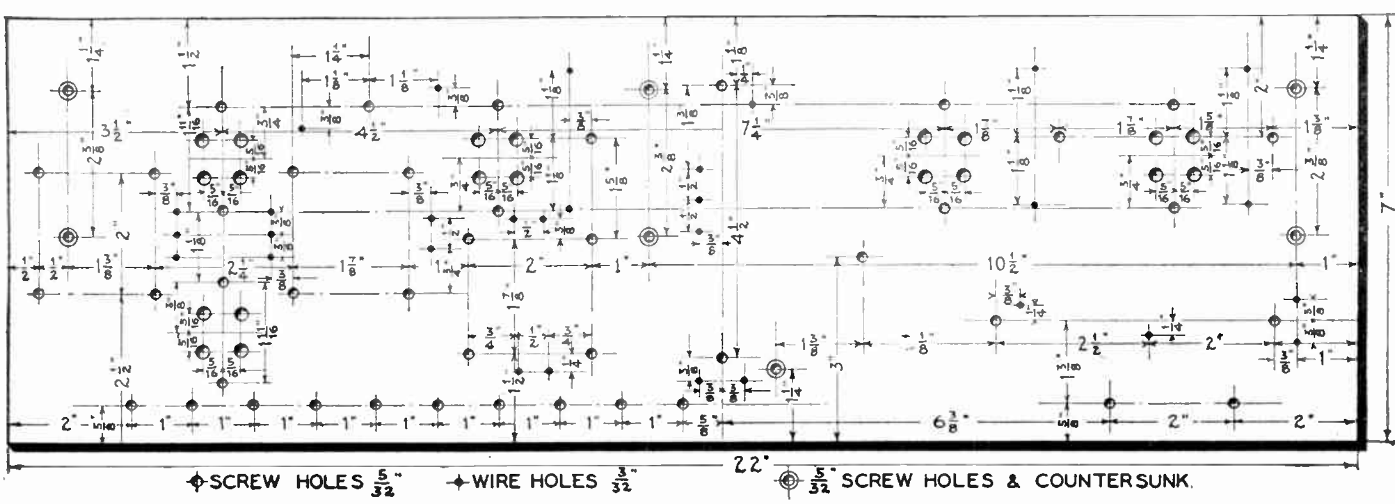
The illustrations of the receiver, which accompany this article, clearly show how various coils may be plugged in the coil sockets in order to receive stations on different wave bands. For receiving stations on any particular wave band two coils of identical construction are required. One coil (L1) is used as an antenna coupler, and the other (L2) as a radio-frequency transformer. Each coil consists of two windings, a secondary (S) and a tickler (T). The primary winding (P) has the same number of turns for all wave-lengths and is attached to the coil socket with a hinge, which makes it possible to adjust the coupling between the primary and secondary coils. The tickler windings of the coils for position L1 are not used. If manufactured inductors are purchased, the tickler connections may be disregarded. If the coils are made at home the tickler may be omitted altogether.

In one of the drawings complete details will be found for making the various coils which are required for receiving stations

(*Continued on page* 102)



Above is shown the arrangement of parts and wiring under the sub-base panel. R1-C4, grid condenser and leak; RFC., R.F. choke coil; SW, D.P. D.T. switch.



The panel layout showing location of holes required for mounting parts on sub-base panel.

A Screen-Grid Short-Wave Receiver*

A Three-Tube Set Employing the 222-Type Tube as an R. F. Amplifier at Ultra-High Frequencies

By Fred H. Canfield

THE screen-grid short-wave receiver described in this article is entirely different from the usual short-wave receiver. Most of the short-wave sets which have been described heretofore have been designed primarily for the experimenter who desires economy and maximum efficiency, rather than ease of control. As a result, the average short-wave set employs only two tubes and is rather complicated in its operation.

In this receiver an attempt has been made to simplify the construction and operation as much as possible, nevertheless retaining a high degree of sensitivity and selectivity. In other words, this set represents an endeavor on the part of the designers to build into a short-wave receiver the desirable characteristics of the usual broadcast receiver.

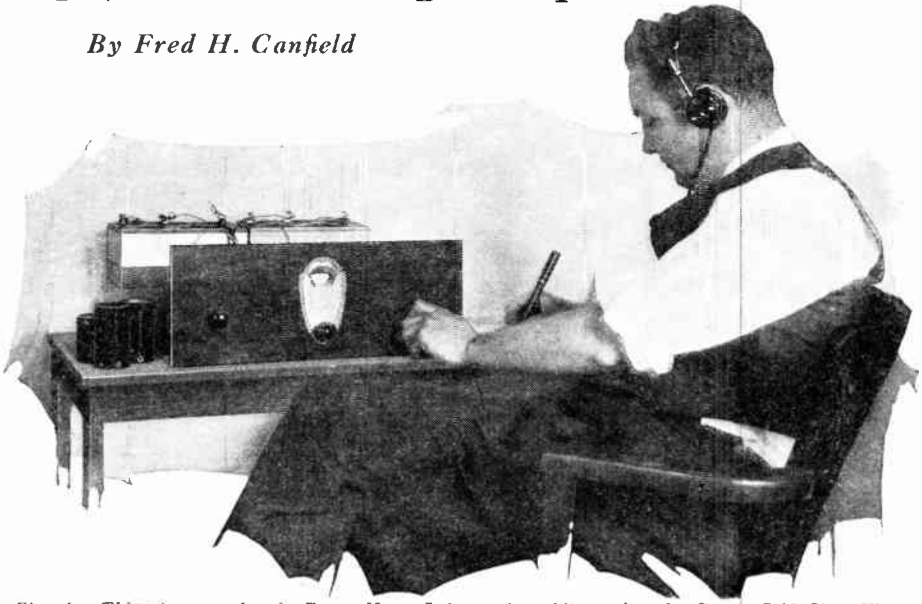


Fig. A. This picture, taken in RADIO NEWS Laboratories while testing the Screen-Grid Short-Wave Receiver, clearly shows the neat, unencumbered appearance of the front panel. The coils for other wavebands are at the left.

At this point it should be explained that there is a great difference between the *efficiency* of a receiver and the *sensitivity* of a receiver. Every efficient receiver must necessarily be sensitive; but it does not follow that a sensitive set must be efficient. For example, a correctly designed three-tube receiver, employing a regenerative detector and two audio stages, may be both highly efficient and very sensitive; whereas a carefully planned five-tube set, employing two R.F. stages, a non-regenerative detector and two A.F. stages, may be equally as sensitive, but not as efficient—because two extra tubes are required to do the same work.

From the example in the above paragraph it may be seen that high efficiency is not always a necessary, nor even a desirable characteristic; as a five-tube tuned R.F. receiver is much to be preferred over the three-tube regenerative; even though both sets are capable of providing practically the same results. The reason is that by slightly lowering the efficiency of the tuned R.F. receiver, the set possesses all the desirable features of the regenerative set and in addition becomes much simpler to operate and the circuits are much more stable.

DESIGN OF THIS SET

The principle of design described above has been applied to this short-wave receiver. In building the set, sensitivity and selectivity were given the first consideration, stability and ease of operation second consideration and then the efficiency was made as high as possible. Of course, it would have been possible to increase the efficiency, but this increase would not have been desirable; as it is not needed, and it would complicate the operation of the set considerably. However, notwithstanding these facts, this receiver is more sensitive and produces greater volume than most short-wave sets of other designs.

The average short-wave set consists of a regenerative detector followed by a stage of A.F. amplification, making a total of two tubes. It is seldom that a short-wave set using more than two tubes is constructed; as the addition of a tuned R.F. amplifier to a receiver of this type might complicate the set to such an extent that the added sensitivity would be of little value. On the other hand, if an untuned R.F. amplifier using a 201A-type tube were connected ahead of the detector, the gain in amplification would be practically negligible. Therefore, up to the present time, the set employing a regenerative detector with a one-stage A.F. amplifier has been considered the best possible combination for short-wave reception.

The screen-grid short-wave receiver has several advantages over the usual regenerative type. It employs a total of three tubes in a circuit consisting of one stage of R.F., a regenerative detector and one stage of A.F. amplification. The R.F. amplifier is of the untuned type and uses the screen-grid (222-type) tube. Therefore, it does not add a tuning control; but it does provide an appreciable gain in amplification, due to the fact that this tube is used. According to James Millen, the designer of the receiver, the amplification of the R.F. stage is between 3 and 4, depending upon the wavelength.

The addition of the R.F. stage has many other desirable effects upon the operation of the receiver. First, it makes the receiver much more stable in operation. Secondly, it prevents the detector tube from radiating energy into the aerial. Thirdly, it makes it possible to calibrate the tuning dial of the set; as the size of the aerial has no effect upon the tuning condenser. Fourthly, the dead spots (points on the tuning dial where the set cannot be made to oscillate because of aerial characteristics) of the set are eliminated, by virtue of the fact that the aerial is not connected to the detector circuit of the set.

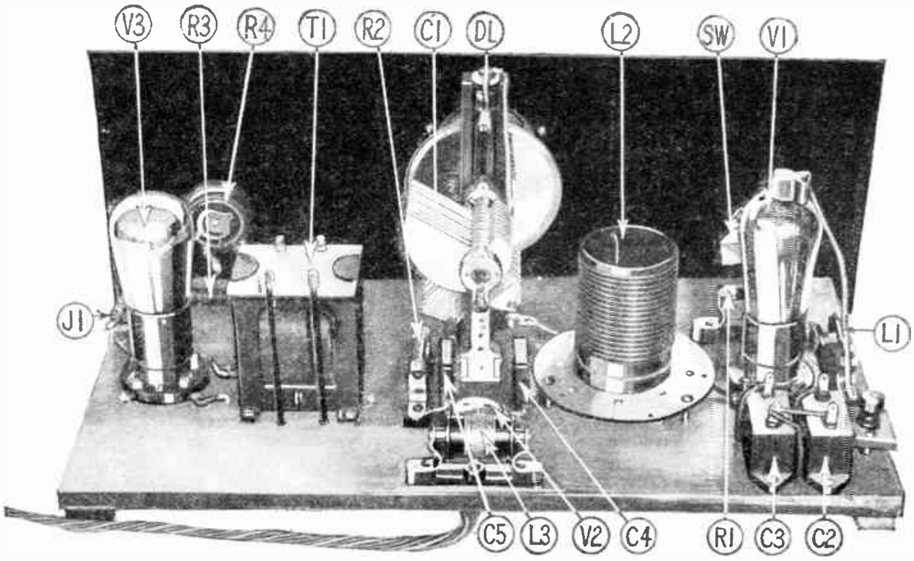


Fig. B. Ample space is available on the baseboard for mounting parts without crowding. This greatly increases the efficiency of the set, especially at the ultra-high frequencies.

* RADIO NEWS *Blueprint Constructional Article No. 62. (See page 104).*

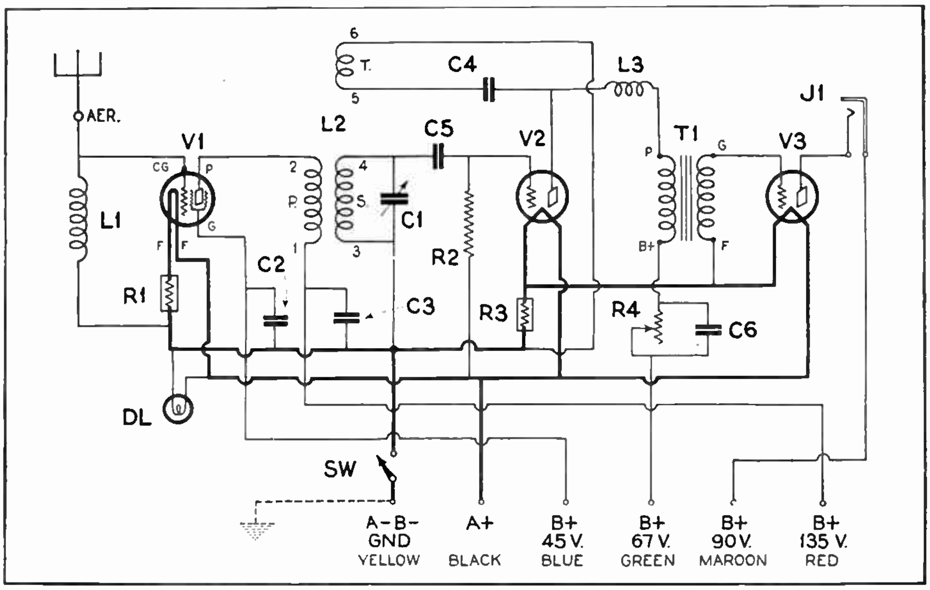


Fig. 1. The symbols used in this complete schematic wiring diagram of the Screen-Grid Short-Wave receiver correspond to those used in the text, list of parts and other illustrations.

The picture shown as Fig. A reveals the simplicity of this receiver as compared with other short-wave sets. In the center of the front panel there is an illuminated vernier dial, and this serves as the only tuning control for the entire receiver. The knob in the lower left corner of the panel controls the battery switch, and that in the lower right corner of the panel the volume-control resistor. These are the only controls; as all rheostats and coupling adjustments were avoided by the designer when building the receiver.

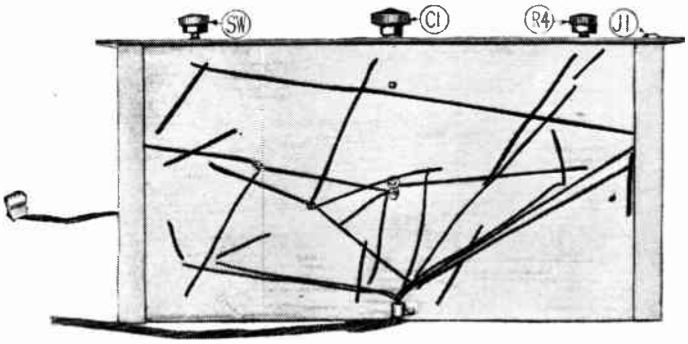


Fig. D. This bottom view of the baseboard shows that the battery-cable leads are attached directly to the parts.

The pictures (Figs. B, C and D) show the simplicity of construction behind the panel and under the baseboard. With the exception of the three instruments mounted on the front panel, all parts of the set are fastened to the wooden baseboard and, in most cases, wood-screws are used for the purpose. Two wooden strips are fastened along the edges of the base on the under side and these make it possible to conceal most of the wiring under the baseboard.

The compactness of the receiver is another important feature. The front panel is 7 x 18 inches and the baseboard measures 9 x 17 inches. The total weight of the set is less than ten pounds.

FEATURES OF THE CIRCUIT

Fig. 1 shows the complete circuit of the receiver. V1 is the screen-grid R.F. amplifier tube, V2 is the detector tube and V3 is the A.F. amplifier tube. It will be noticed that the aerial circuit is untuned, and that an R.F. choke coil (L1), which is connected between the control-grid and the filament of the screen-grid tube V1, serves to couple the aerial circuit to the receiver without the necessity of a tuning control. L2 is a special plug-in R.F. transformer with three windings, which couples the plate circuit of the screen-grid tube with the grid circuit of the regenerative-detector tube. The coupling between the various windings is fixed; P, the primary winding, is in the plate circuit of the screen-grid tube, S, the secondary winding, is in the grid circuit of the detector tube and T, the tickler winding, is in the plate circuit of the detector tube. The receiver is tuned by C1, the variable condenser connected in shunt with the secondary winding. The A.F. circuit of the receiver is standard and employs the usual audio transformer (T1).

A close examination of the circuit will show that it possesses several unusual features and refinements. Automatic filament-ballast resistors (R1 and R2) are used in place of rheostats for controlling the filament current of the tubes. R1 regulates the filament current of the screen-grid tube and R2 controls that of the detector and A.F. tubes. The volume and regeneration of the receiver is regulated by a variable resistor in the plate circuit of the detector. This resistor (R4) varies the voltage applied to the detector tube, and it is shunted by a 1-mf. by-pass condenser (C6). An R.F. choke coil (L3) is connected between the plate terminal of the detector tube and the primary winding of the transformer, and this prevents R.F. current from entering the A.F. amplifier and also improves the control of regeneration.

PARTS REQUIRED

Another feature of the receiver which has not been mentioned previously is that the use of plug-in coils permits a wavelength range of 15 to 115 meters. Also, another coil may be obtained which permits the reception of stations in the broadcast wave band. Four coils are needed to cover the band of short waves mentioned above and these coils are used in the position of L2 in the circuit. They fit into a special six-contact socket and it is a simple matter to change from one coil to another.

A complete list of the apparatus required for the construction of the receiver is as follows:

One variable condenser, double-spaced .000125-mf. (C1);

Two by-pass condensers, 0.5-mf. (C2 and C3);

One fixed mica condenser, .001-mf. (C4);

One fixed mica condenser, .00025-mf. (C5);

One by-pass condenser, 1-mf. (C6);

One special R.F. choke coil for antenna coupling (L1);

One set of four plug-in coils, with socket (L2);

One R.F. choke coil, short-wave type (L3);

One filament-ballast unit, 222-type (R1);

One grid leak, 6-megohm (R2);

One filament-ballast unit, 112 type (R3);

One volume-control rheostat, 0-500,000-ohm (R4);

One A.F. transformer (T1);

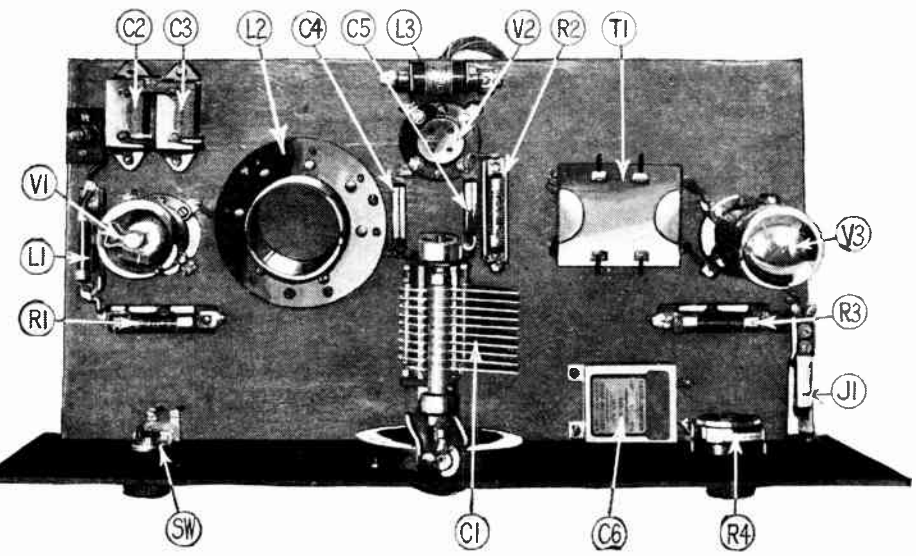


Fig. C. This top view of the receiver shows the exact arrangement of parts; and that on the upper side of the baseboard the wiring, brought through the holes seen in Fig. D above, is invisible.

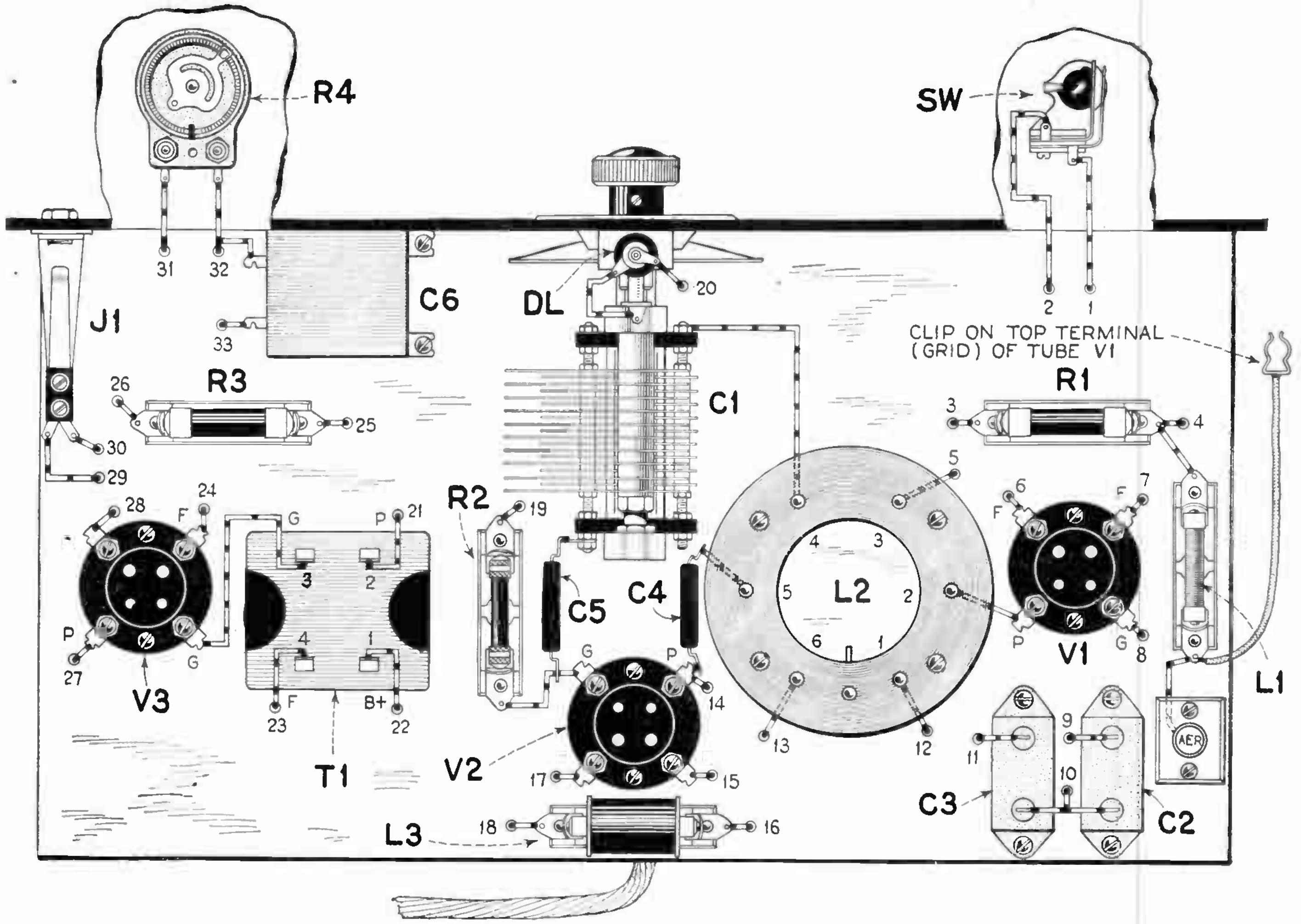


Fig. 3. Layout and upper wiring of the Screen-Grid Short-Wave Receiver.

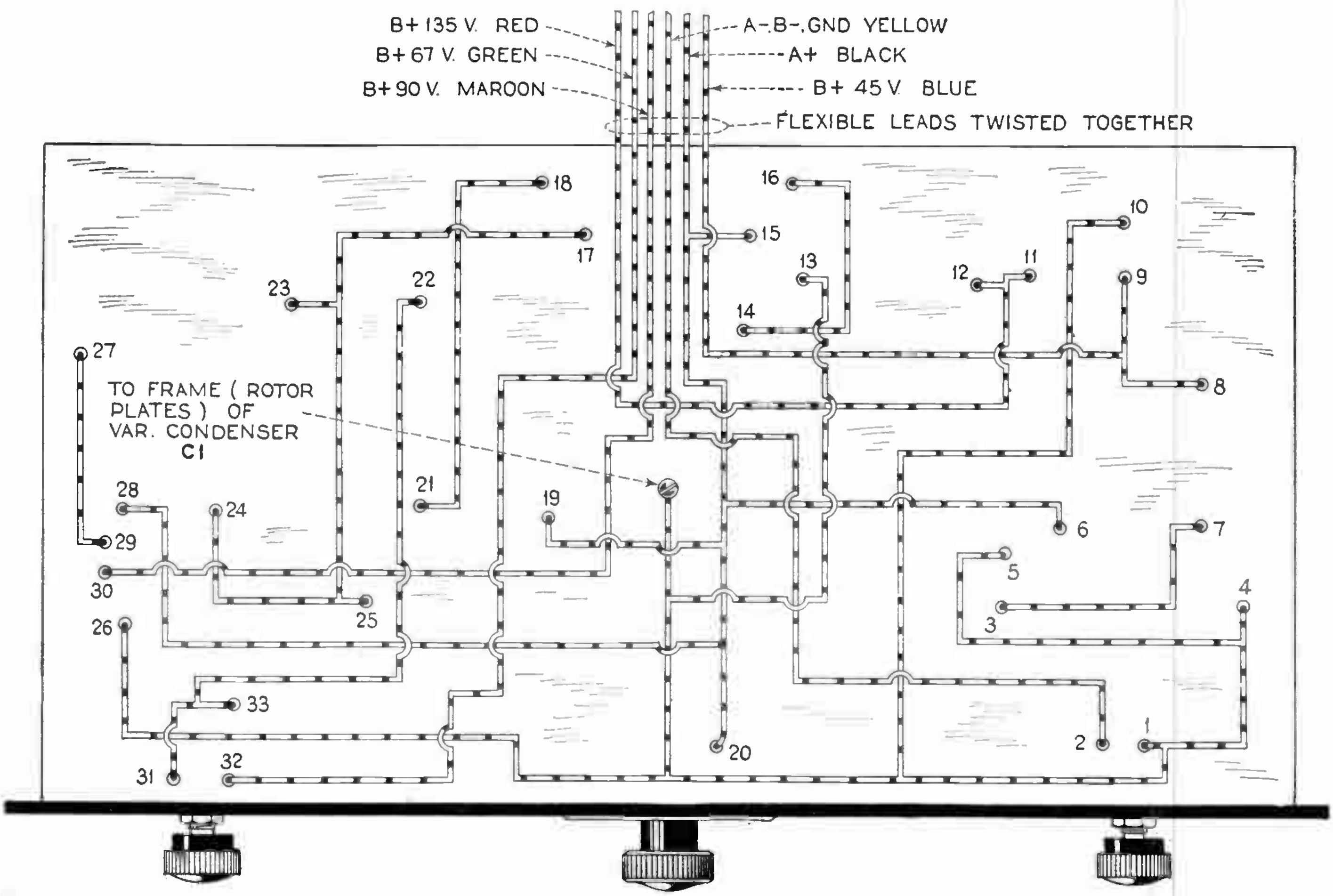


Fig. 4. Wiring below the baseboard. Each hole bears the same number here as in Fig. 3 above.

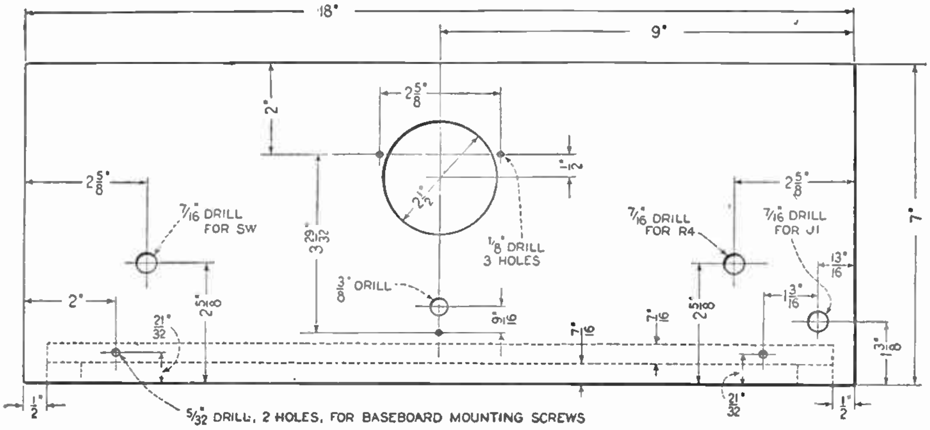


Fig. 5. This drilling layout shows the exact location of all holes required for mounting the various parts on the front panel of this receiver.

One single-circuit jack (J1);
One battery switch (SW);
One vacuum tube, 222-type (V1);
Two vacuum tubes, 201A-type (V2 and V3);
Three tube sockets, UX-type;
Two grid-leak clips for L1 and L3;
One vernier dial, illuminated type;
One front panel, 18 x 7 x 3/16 inches;
One wooden baseboard, 19 x 9 x ½ inches;
One battery cable, 7-wire type;
One binding post;
Connecting wire, screws, solder, etc.

Most of the parts mentioned in the above list are standard. However, the two R.F. choke coils require special mention. The R.F. choke coil L1 was especially designed for antenna coupling on short wavelengths, and is the only one of its kind which has ever been brought to the attention of the writer. It fits in a standard grid-leak clip and has an inductance slightly less than 2 millihenries. It is much easier to buy this piece of apparatus than to attempt its construction; however, the fan who wishes to do so may find it interesting to experiment with coils of various sizes in this position. Also, a resistor might be substituted for the choke coil, but the results would not be quite as satisfactory. In order to determine the size of resistor which will give most satisfactory results, several units of less than 100,000 ohms should be experimented with. The choke coil which is used in the L3 position also fits in a grid-leak mounting, but this is a standard unit, and any short-wave R.F. choke coil may be substituted, if desired.

The tuning condenser specified has a capacity of .000125-mf. and is of the double-spaced type; this condenser is provided with pigtail connections and is of low-loss design throughout. Therefore, it is ideally suited for short-wave reception, but any efficient condenser of this capacity may be used.

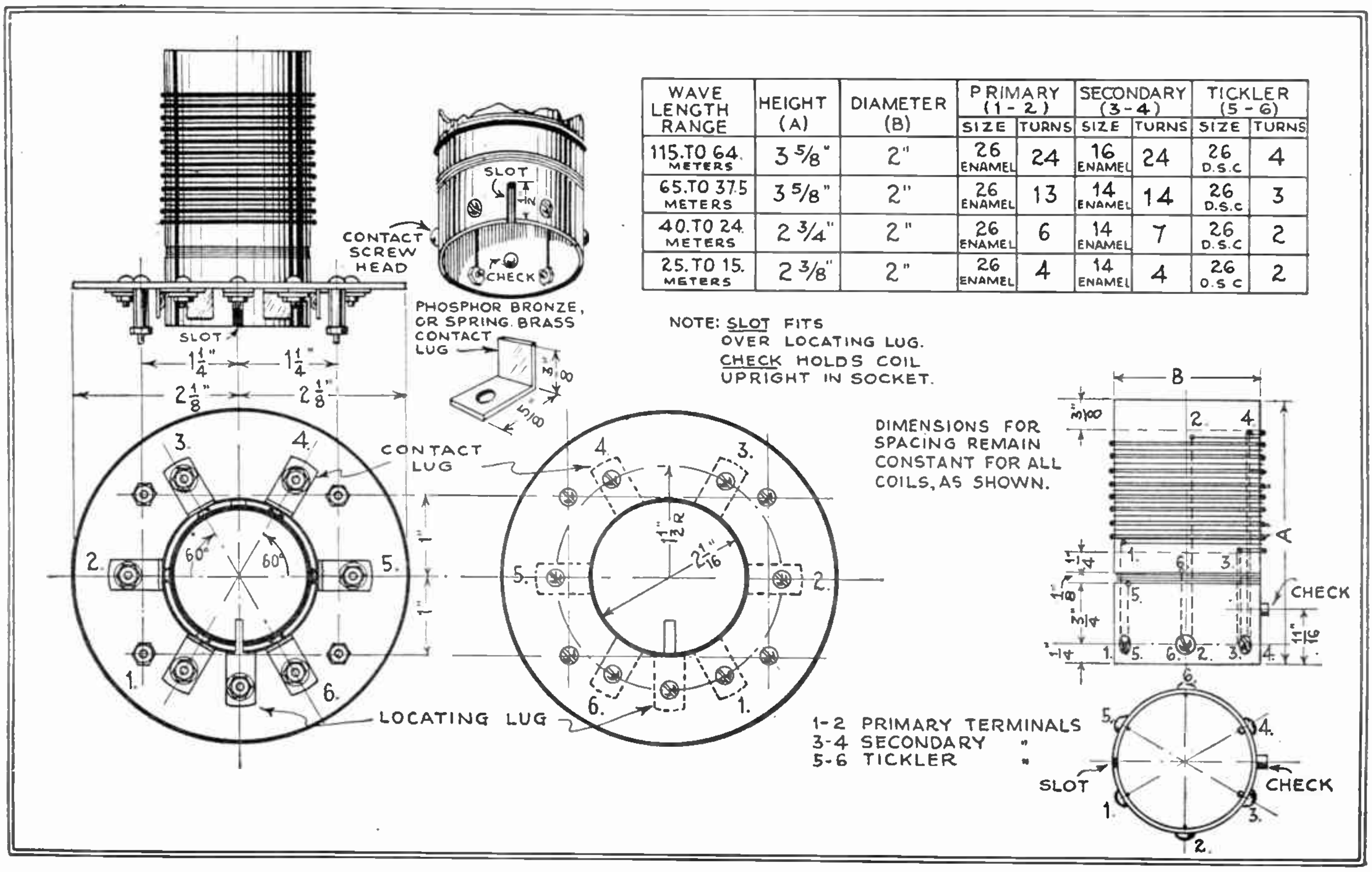
COILS REQUIRED

The four short-wave coils illustrated in this receiver are manufactured units; however, home-made coils may be used, if desired. The following directions tell how to build coils which duplicate electrically the ones shown in the illustrations:

Each of the four coils is wound on a piece of bakelite tubing 2 inches in diameter. The smallest coil requires a form 2⅜ inches long, and this coil has a wavelength range of 15 to 25 meters. The next largest coil, with a wavelength range of 24 to 40 meters, requires a form 2¾ inches in length. The two largest coils, with wavelength ranges of 37.5 to 65 meters and 64 to 115 meters, respectively, are wound on forms 3⅝ inches in length.

Each of the four coils has three separate windings. S, the secondary, is wound with spaced turns of heavy enameled copper wire. P, the primary, consists of turns of fine enameled wire wound between the turns of the secondary coil. The tickler winding T consists of a few turns of wire wound ¼-inch below the end of the primary winding. This method of construction is clearly illustrated in Fig. 2.

In constructing home-made coils provision may be made for using the same type of socket receptacle if desired. This socket consists of a bakelite disc with a maximum diameter of 4¼ inches. A circular hole, 2 1/16 inches in diameter, is cut in the center of this disc, for the coils to fit into. Six contact springs of phosphor bronze or spring brass are mounted at equal distances



WAVE LENGTH RANGE	HEIGHT (A)	DIAMETER (B)	PRIMARY (1-2)		SECONDARY (3-4)		TICKLER (5-6)	
			SIZE	TURNS	SIZE	TURNS	SIZE	TURNS
115. TO 64. METERS	3 5/8"	2"	26 ENAMEL	24	16 ENAMEL	24	26 D.S.C	4
65. TO 37.5 METERS	3 5/8"	2"	26 ENAMEL	13	14 ENAMEL	14	26 D.S.C	3
40. TO 24. METERS	2 3/4"	2"	26 ENAMEL	6	14 ENAMEL	7	26 D.S.C	2
25. TO 15. METERS	2 3/8"	2"	26 ENAMEL	4	14 ENAMEL	4	26 D.S.C	2

Fig. 2. This diagram gives details for making the four short-wave plug-in coils which are required, in order to cover the waveband of 15 to 115 meters with a 125-mmf. condenser, and also how to make the base receptacle, into which the coils are plugged.

apart around the circumference of the smaller circle, and these springs make contact with the contact screws of the plug-in coils. Also, a locating lug, which fits into a slot of each plug-in coil, is mounted on the base to insure that the coils shall be inserted in the socket in the proper manner. The method of constructing the base is clearly shown in the constructional drawings.

Before winding the coils, it is necessary to drill six holes at one end of each of the coil forms. These holes are for the connecting screws which are the means of providing contacts between the coil and the coil socket. They are spaced equally on the circumference of the coil form, and ¼-inch from the end of the tube. After the holes have been drilled, machine screws should be fitted into them, with the head of the screw on the outside of the coil form and a nut on the inside to hold the screw in place. Now, place a number alongside each screw, starting with 1 and continuing in a clockwise direction until the last screw is numbered 6. Next, between screw terminals numbers 1 and 6, cut a slot ½-inch long and ⅛-inch wide in the tube. This slot fits over the locating lug of the coil socket. Also, as a further precaution, a check may be located between the terminals 3 and 4 to support the tube on the other side. This check may be a short machine screw.

In winding the 15-meter coil, the secondary winding should consist of 4 turns of No. 14 enameled wire spaced the equivalent of one turn apart. The primary coil consists of 4 turns of No. 26 enameled wire, wound between the turns of the secondary winding. The tickler coil is wound ¼-inch below the secondary winding and consists of 2 turns of No. 26 D.C.C. wire. All coils are wound in the same direction.

The other coils are of similar construction to the 15-meter coil described above. The 40-meter coil has 7 turns of No. 14 enameled wire on the secondary, 6 turns of No. 26 enameled wire on the primary and 2 turns of No. 26 D.S.C. wire on the tickler. The 65-meter coil has 14 turns of No. 14 enameled wire on the secondary, 13 turns of No. 26 enameled wire on the primary and 3 turns of No. 26 enameled wire on the tickler. The 115-meter coil has 24 turns of No. 16 enameled wire on the secondary, 24 turns of No. 26 enameled wire on the secondary and 4 turns of No. 26 D.S.C. wire on the tickler.

After the four coils have been wound, connections should be made between the ends of the coil and the contact screws mounted at the base of the coil form. Terminal No. 1 connects with the beginning of the primary winding, that is, the end of the winding nearest the base of the coil form; terminal 2 connects with the other end of the primary; terminal 3 connects with the beginning of the secondary winding which is adjacent to the beginning of the primary winding, and terminal 4 connects with the end of the secondary winding. Terminals 5 and 6 connect with the tickler winding; terminal 5 with the end of the winding which is nearest the base, and terminal 6 with the end nearest the primary and secondary windings.

WIRING SIMPLE

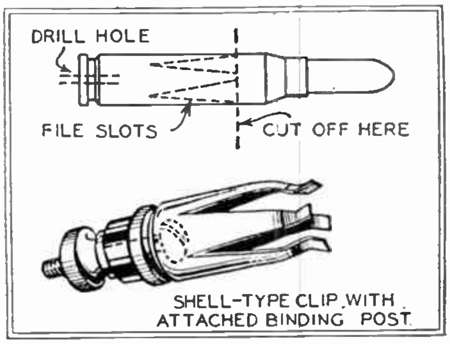
The arrangement of parts on the baseboard is shown clearly in Fig. 3 and Figs. B and C. This placement of parts is probably the simplest from the wiring viewpoint, but it is not essential that it be followed exactly. Good results may be obtained from any arrangement of parts which does not greatly lengthen the wiring required in the R.F. circuits. All of the parts are held in place with wood-screws, with the exception of the variable condenser (C1) which is secured in place by two machine screws which pass through the base.

Binding posts are not used in the power circuit of the set, but the wires of the battery cable are connected directly to the proper terminals in the set. This method greatly facilitates connecting the set to the batteries. In the pictorial and schematic wiring diagrams, a color code is given for the battery cable; but any other code will be just as satisfactory. Also, if the cable has more than the six required wires, three wires may be soldered together in order to provide separate leads for the "A—," "B—" and "Ground" connections.

Ability to obtain good results from the receiver may be gained only by practice in tuning the set. Until the operator has had a little experience it might be well to practice adjusting the coils for the short-wave program of KDKA, which is broadcast on a wavelength of 62.5 meters. This station will be received when using the 37.5-to-65-meter coil. Probably the simplest way to tune in a telephone station is to make the detector tube oscillate by adjusting the volume-control resistor (R4); and then the carrier wave of the station will be received when the variable condenser (C1) is set at the correct position.

A Good Screen-Grid Clip

The accompanying drawing shows a simple way to make a good clip for screen-grid tubes from an empty cartridge shell. Any shell between 30 and 45 calibre may be used for the purpose; but the cartridge should be fired before any attempt is made to use the shell. First, saw or file off the shell about three-quarters of an inch from the primer (closed) end or base; and then file four slots at right angles, making four prongs. Next, with a pair of round-nose pliers, bend the tips of the prongs outward a slight distance. Slightly below this bend the prongs should be bent inward sufficiently to fit the terminal snugly.



An excellent terminal clip for a 222-type (screen-grid) tube may be made from an empty cartridge shell, with the aid of a file and pliers.

A Screen-Grid Short-Wave Receiver

SYMBOL	Quantity	NAME OF PART	REMARKS	List Price Each	MANUFACTURER *	
C1	1	Variable condenser	.000125 mf., double-spaced type	$ 4.50	1	
C2, C3	2	By-pass condensers	0.5 mf., paper type, moulded case	.70	2	
C4	1	Fixed condenser	.001 mf., mica type	.45	2	
C5	1	Fixed condenser	.00025 mf., mica type	.35	2	
C6	1	By-pass condenser	1 mf., paper type	.90	2	
L1	1	R.F. choke coil	2 millihenries	1.00	1	
L2	1	Plug-in coil set	4 Special, plug-in type short-wave coils with socket	10.00	1	
L3	1	R.F. choke coil	Short-wave type	1.25	1	
R1	1	Fil-ballast unit	222 type	1.10	3	
R2	1	Grid leak	6 megohms	.50	4	
R3	1	Fil-ballast unit	0.5 ampere, 5-volt type	1.10	3	
R4	1	Variable resistor	0 - 500,000 ohms	1.50	5	
T1	1	A.F. transformer	3:1 ratio	6.00	6	
J1	1	Telephone jack	Single-circuit type	.40	7	
SW	1	Battery switch	Panel-mounting type	.70	7	
V1	1	Vacuum tube	222 type (screen grid)	6.50	8	
V2, V3	2	Vacuum tubes	201A type	1.75	8	
	1	Tuning dial	Illuminated vernier type	3.25	1	
	3	Grid-leak clips	Standard single mounting	.35	4	
	1	Front panel	18 x 7 x 3/16 inches		9	Prices very
	1	Baseboard	17 x 9 x 1/2 inches			
	1	Battery cable	7-wire type	.55	10	
		Connection wire	Flexible insulation	.40	10	

NUMBERS IN LAST COLUMN REFER TO CODE NUMBERS BELOW.

1 National Company, Malden, Mass.	10 Belden Manufacturing Company, 2300 S. Western Ave., Chicago, Ill.	19
2 Aerovox Wireless Corporation, 70 Wash. St., Brooklyn, N.Y.	11	20
3 Radiall Company (Amperite), 50 Franklin St., New York City	12	21
4 Arthur H. Lynch, Incorporated, Fisk Bldg., New York City	13	22
5 Electrad, Inc. (Royalty), 175 Varick St., New York City	14	23
6 Silver Marshall, Inc. (S-M), 846 W. Jackson Blvd., Chicago, Ill.	15	24
7 Yaxley Manufacturing Company, 9 South Clinton St., Chicago, Ill.	16	25
8 C. F. Manufacturing Company (CeCo), 702 Eddy St., Providence, R. I.	17	26
9 American Hard Rubber Company (Ace), 11 Mercer Street, New York City	18	27

No. 62

* THE FIGURES IN THE FIRST COLUMN OF MANUFACTURERS INDICATE THE MAKERS OF THE PARTS USED IN THE ORIGINAL EQUIPMENT DESCRIBED HERE.

If you use alternate parts instead of those listed in the first column of manufacturers, be careful to allow for any possible difference in size from those originally used in laying out and drilling the panel and sub-base.

A "Junk Box" Short-Wave* Receiver

For the Experimenter Who Wishes to Try His Luck Below a Hundred Meters

By Robert Hertzberg

BECAUSE of the extraordinary DX work that is being accomplished by amateurs and broadcasters on the short waves (*i.e.*, below 100 meters), many radio fans have become possessed of the idea that the apparatus used for such reception must necessarily be complicated, expensive, and difficult to construct and operate. These fans read of the success of listeners in South America, Africa, Australia and New Zealand in picking up programs transmitted on short wavelengths from Schenectady and Pittsburgh in the United States, and from London, in England; and of the similar success of American listeners in hearing broadcasts from England, Holland, Germany, Russia, Siberia and Australia. As a result, they are apt to conclude that the receivers must contain at last eleven tubes and be two yards long.

The truth of the matter is that the receivers employed by the majority of these listeners are of the simplest possible design, rarely containing more than three tubes and usually only two. They are of the "straight regenerative" type, and can be made in an hour or so of spare parts, such as are found in every experimenter's junk box. They enable their owners to pick up the programs of numerous short-wave broadcast stations, conversations between amateurs using voice transmission, and code signals from thousands of amateur and commercial transmitting stations in every part of the world. The "thousands" is no exaggeration; for there are more than 16,000 licensed amateur transmitting stations in the United States alone, and large numbers in other countries. International communication between these stations, over distances as great as there can be between two points on this earth, is a nightly affair.

OUT OF THE JUNK BOX

For the purpose of illustrating how simple an efficient short-wave receiver can be, a member of the staff of RADIO NEWS selected a handful of idle parts from his own private junk box and assembled a complete two-tube set in less than two hours' time. He worked a second evening "juggling" the various coils, to make them cover the short-wave bands from 20 to 100 meters, but the reader of this article will be spared this work; all the data are ready for him. The little outfit produced such gratifying results that we have decided to publish the following description of it. The designer of the set guarantees that any reader who duplicates it exactly will be rewarded with more thrills than he has experienced from any other radio receiver in several years.

FEATURES OF THIS SET

THE little short-wave receiver described in the accompanying article possesses the following features, which will appeal to everyone:

(1) It will pick up short-wave broadcast, amateur and commercial stations operating between 20 and 100 meters.

(2) It may be assembled in two hours.

(3) Its cost is practically nothing; as the necessary parts may be found in almost every experimenter's junk box.

(4) It is easily operated, as it uses only two controls and two tubes in a simple circuit.

The first thing to do, of course, is to gather together the necessary parts. You will need the following:

One wooden baseboard, not smaller than 10¼ by 7 inches and at least ¾-inch thick.
Three UX-type tube sockets.
Two 32-mmf. "midget" variable condensers (so-called "verniers" usually used in broadcast receivers for neutralizing or compensating purposes), C1 and C2.
One .0001-mf. grid condenser and a 3-megohm leak, (a regular .00025-mf, size will work, but the smaller condenser is better on the short waves); C4, R1.
One battery switch, SW.
One R.F. choke coil. (This is important; if you haven't a good one on hand, buy one that will work from 20 meters up); L2.
One A.F. amplifying transformer (anything available); T1.
Two ¼-ampere filament ballast resistors, with mountings; R2, R3.
Nine spring binding posts.
Five burned-out tubes with UX-type bases.
Enough scrap brass to make L-shaped mountings for the two midget condensers and the battery switch and for the aerial coupling condenser, C3.

CONSTRUCTION SIMPLE

The first thing to do is to make the L-shaped brackets to hold the midget condensers and the battery switch upright. Select any odd strips of stiff brass, about ⅝-inch wide, and bend three pieces to form L's about two inches high, with legs half an inch long. Drill the legs to pass small wood screws, and the upper ends to pass the mounting studs of the condensers and the switch. Screw them down along the front edge of the baseboard, as shown clearly in the accompanying illustration, and mount the instruments afterward.

Now nail or screw down seven of the spring binding posts along the black edge of the board, and the remaining two on the right edge, near the back. Continue by screwing down the R.F. choke L2, the transformer T1, the filament ballasts R2 and R3, the three tube sockets. Separate the two sockets on the left enough to leave room for the grid condenser.

The two sockets at the right are for tubes, but the one at the left acts as a receptacle for the plug-in coils used with the receiver. Before making up these coils, construct the aerial coupling condenser C3, as shown in an accompanying illustration. This condenser has a very small capacity, and its adjustment is not at all critical. Any arrangement for separating two pieces of brass or copper each one-half inch square is satisfactory.

Break the glass bulbs off the five burnt-out tubes, and clean the insides of the bases, removing the connecting wires, bulb stems and cement. If the cement defies removal by ordinary scraping, heat the bases gently over a gas flame and scrape it out as it softens. Apply a soldering iron to the prongs in the bases and melt out all the solder so that new connecting wires may be pulled through later. If the solder refuses to flow out, push a toothpick through each pin while the metal is still soft, and ream the opening clean. Also file off the little bayonet-lock pins on the sides of the bases.

MAKING THE PLUG-IN COILS

In order to provide the receiver with a wavelength range of 20 to 110 meters, five plug-in coils, each containing a grid and a tickler winding, are necessary. The tube bases are long enough to accommodate the required number of turns of wire for the first four coils; but the fifth base must be fitted with an extension that will make it about three inches long. Simply glue a piece of cardboard around the base and tie it up with cord until it dries. When the wire is wound on it later it will remain tightly in place.

Following are the specifications of the five coils:

No. 1: Grid and tickler windings, each 7 turns; wavelength range, approximately 19 to 25 meters.
No. 2: Grid and tickler windings, each 10 turns; range, 25 to 35 meters.
No. 3: Grid and tickler windings, each 15 turns; range, 35 to 45 meters.
No. 4: Grid and tickler windings, each 22 turns; range 45 to 64 meters. Tickler wound as double layer to save space.
No. 5: Grid and tickler windings, each 40 turns; range, 62 to 110 meters. Tickler also double-layer.

The grid coils are all wound with No. 24 D.C.C. wire, and the ticklers with No. 28 D.C.C.

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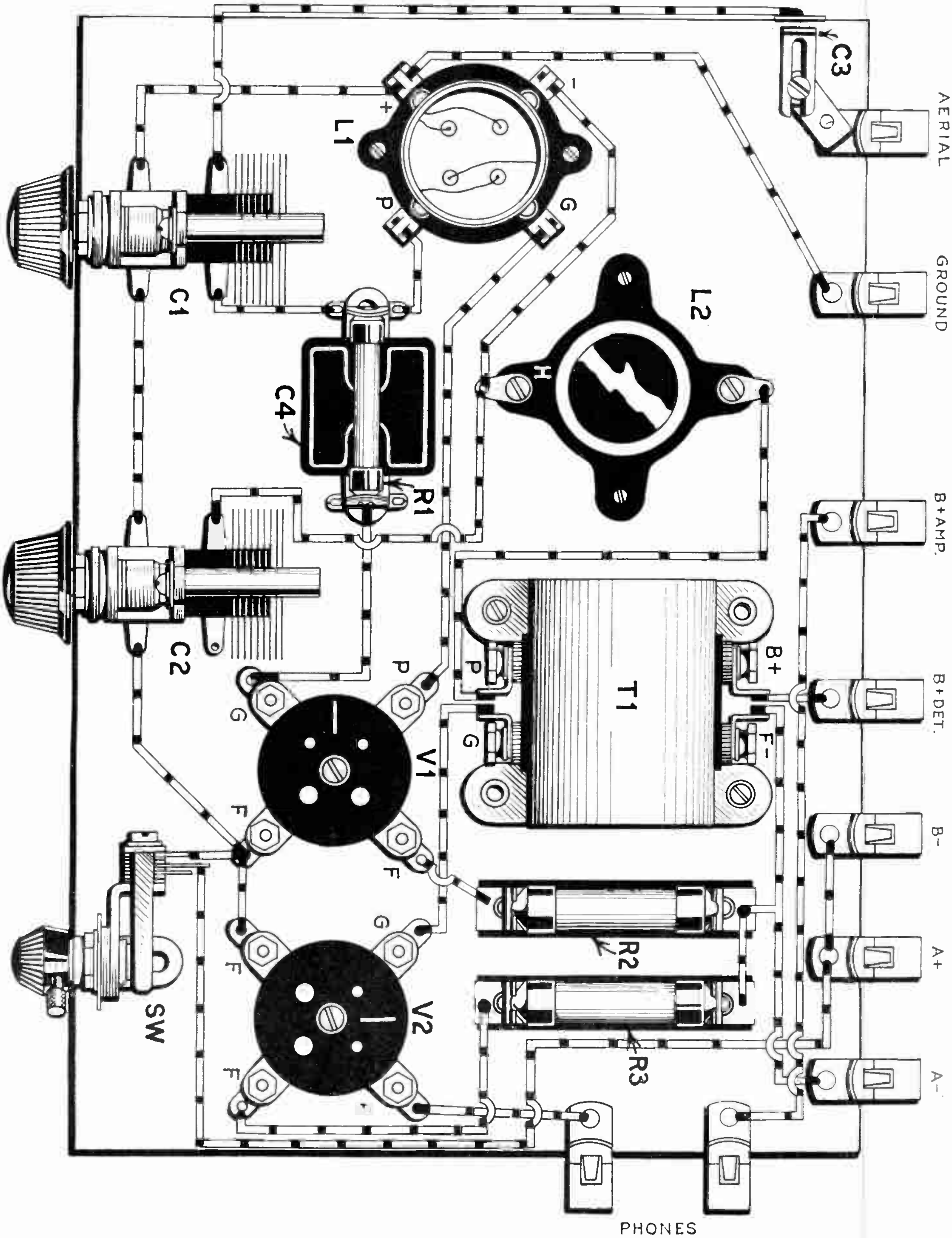
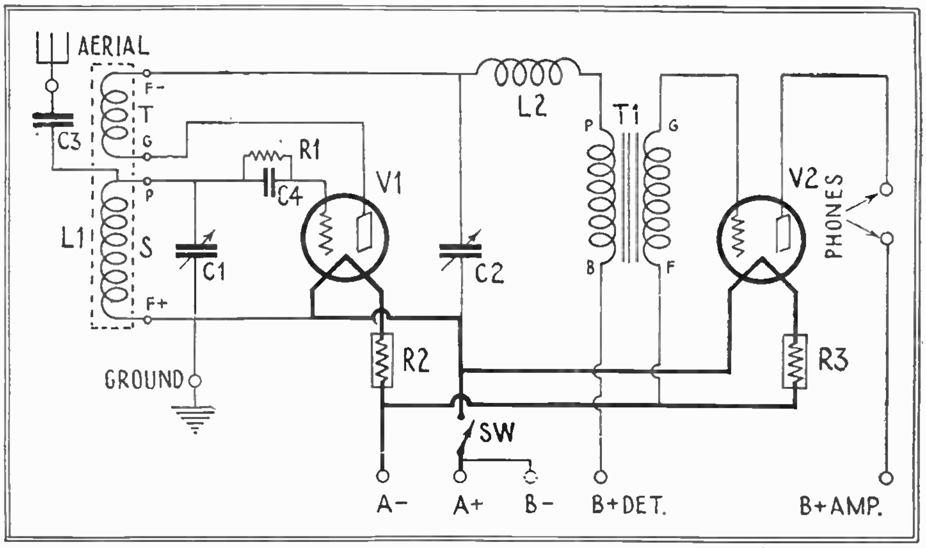
* RADIO NEWS *Blueprint Constructional Article No. 58.* (*See page 104*).



The connections of the "junk-box" short-wave receiver are shown here in straight lines for clearness; but in the set itself, they are run as short and direct as possible—especially the aerial and detector leads carrying R.F. energy, because of the high capacitive transfer of energy at ultra-high frequencies. The constructor, bearing in mind this rule, may depart from the layout here as the apparatus he has at hand suggests.



The simplicity of the construction of this receiver is apparent from a glance at the circuit diagram above, as well as the pictorial layout on the preceding page. The interchangeable inductance, L1, is wound on an old tube-base, and plugs into the tube socket seen in the picture below.

Before starting to wind the coils, drill through each of the bases four small holes to pass the ends of the windings. The proper places for these holes can be determined from a careful study of the illustration, which shows how the various ends connect to the four prongs in each base.

To start coil No. 1, push the end of the spool or roll of No. 24 wire through the hole nearest the open end of one of the bases, leaving a free piece about five inches long. Wind on the required seven turns, cut an extra five inches, and pull the end through the second hole. Start the tickler winding about a quarter of an inch away, and wind in the same direction. Leave generous ends on the wires.

It is extremely important that the four loose ends you now have be connected properly to the four prongs. The loose end of the top of the grid winding is pulled through the pin that makes contact with the plate or "P" terminal of the tube socket. The bottom of this same winding is pulled through the pin that makes contact with the "F+" socket terminal (which should be the one under the "P" terminal and diametrically opposite the "G" post). The beginning of the tickler (the end nearest the grid coil) goes through the other filament pin, while the other end goes to the grid pin. Study the arrangement of the pins in the base, not how they fit into the socket, and you will have no trouble. After pulling through the wires, solder them at the tips of the prongs and cut them flush.

The other coils are wound in exactly the same fashion, except that for Nos. 4 and 5 the ticklers are wound double layer. The wire in all cases may be secured with collodion or other prepared coil binders. This treatment is not absolutely necessary, but it will keep the coils in good condition.

CONNECTIONS

The wiring of the set is so simple, and is made so plain in the diagram and the large illustration, that little comment need be made on it. The letters, "F," "G," "P" and 'F," alongside the coil L1 in the schematic diagram, represent the terminal markings on the socket which acts as the coil receptacle. The connections are short and direct, the grid leads being especially so. The grid condenser need not be screwed down, as the short lengths of wire connected to it will hold it in place.

The rotor connections of the midget condensers are wired together. A short lead extends from C1 to the "F+' post on the coil receptacle, and thence to the ground binding post; while another lead, from C2, runs two inches to the nearest filament post on the detector-tube socket, V1.

The circuit is of the simplest imaginable regenerative type, with the aerial coupled directly to the grid tuning coil by means of the tiny condenser C3. This wavelength range of the set depends on the size of this grid coil and the capacity of the tuning condenser, C1. Regeneration is made possible by the tickler coil, connected in series with the plate-circuit elements, and is controlled by the other variable condenser C2.

Circuits of this type, when used on the regular broadcast band (200 to 550 meters), radiate and cause terrible interference in neighboring receivers; but they are not at all obnoxious on the short waves because the average-size receiving aerial cannot readily be shocked into oscillation at wavelengths as low as 20 to 100 meters.

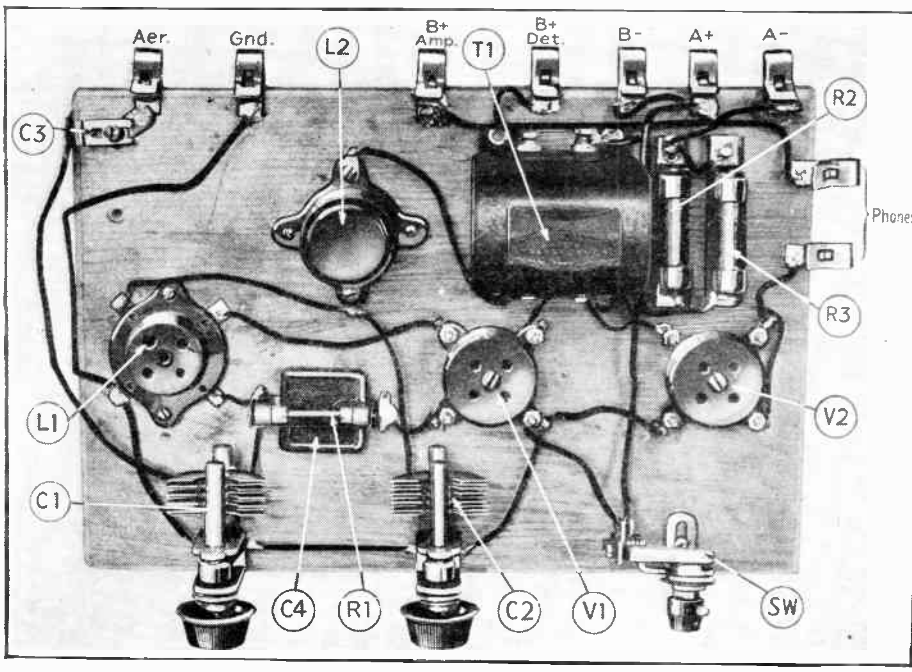
OPERATION AND TUNING

To place the set in operation, connect your regular aerial and ground to the posts provided for them and hook-up the usual six-volt "A" battery and one or two 45-volt blocks of "B" battery. Run a wire from the 22½-volt post on the first block for the detector tube, and use the full 45 or 90 volts on the amplifier. (*Note:* A "B" socket-power unit cannot be employed with a short-wave receiver.) Push the tip connections of a pair of headphones through the two clips on the right hand edge of the baseboard, insert 201A-type tubes in the two tube sockets, plug in coil No. 4 as a starter, and snap on the battery switch.

The set should regenerate without trouble when the condenser C2 is turned in slowly. With the tuning condenser practically all in (near maximum capacity) you should be able to pick up KDKA, Pittsburgh, on its 62.25-meter wave. (This station has what is probably the most consistent short-wave broadcast transmitter in the world.) You should hear it also on coil No. 5 with the condenser all out (minimum capacity). With coil No. 4 you should also pick up, without delay, the signals of WLW, on 52 meters. With coil No. 2 and most of the condenser in, WGY, on 32.77 meters, should roll in nicely. Once you hear these stations you will have some definite condenser adjustments to rely on in "fishing" for stations on other waves.

To obtain smooth control of the regeneration is a simple matter. Each coil, when the tuning condenser C1 is set at maximum, should start oscillating just as the other condenser, C2, is turned to maximum. If the set oscillates before maximum position is reached, remove one turn at a time from the tickler winding until this operating condition is attained.

(*Continued on page* 103)



All the connections employed in this set are made on top of the wooden baseboard, as may be seen in the illustration. The capacity, C3, consists of two separately-movable metal plates.

The "Ham's Own" Short-Wave Receiver

A Constructional Article on a Good DX Set for Amateurs

By John L. Reinartz

IN this article, Mr. Reinartz describes the construction of a receiver of his own design, which can be used for receiving stations operating on wavelengths from 15 to 500 meters. The construction is novel in that all the apparatus is mounted on the front panel, no baseboard being used.

With an antenna stretched across a room, this receiver has brought in amateur stations all over the country. For those short-wave enthusiasts who are on the lookout for a set which will give satisfaction in all ways, we heartily recommend this one.

Mr. Reinartz is best known for the remarkable development work he has done on short waves, and for his contributions to amateur radio.—EDITOR.

DOES the broadcast listener desire to build a real "ham" short wave receiver that will give him real "ham" results? This article describes a receiver which can be easily built by the average "ham" and which will be found to bring stations in not only the amateur band, but the broadcast band as well.

In designing this receiving set simplicity was the goal. As may be seen from the illustrations, no baseboard is used; all the apparatus being mounted on the panel, which is held in an upright position by two L-shaped brackets attached to the variable condensers. In this way connections between the different pieces of apparatus were shortened, and the whole construction made much simpler than is otherwise possible.

The circuit diagram which is shown at the right is that used in the short-wave receiver designed by Mr. Reinartz. As explained in the accompanying text, the coil D is not used when waves of 40 meters and below are being received. When this coil is out of the circuit the variable condenser, C3, is in series with the antenna and the coils A, B and C. The audio-frequency transformer AFT, should have a ratio of 6:1, in order to get maximum amplification from the single stage.

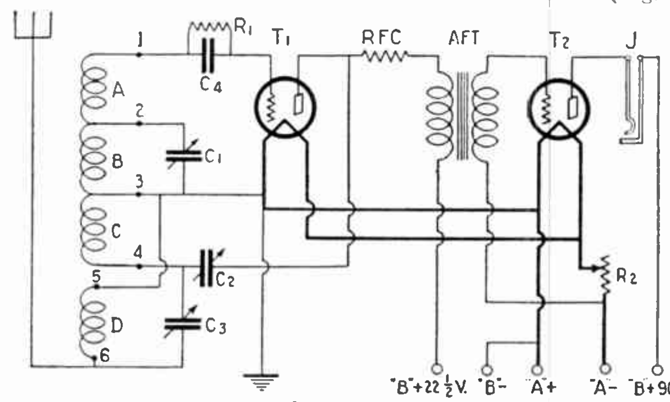
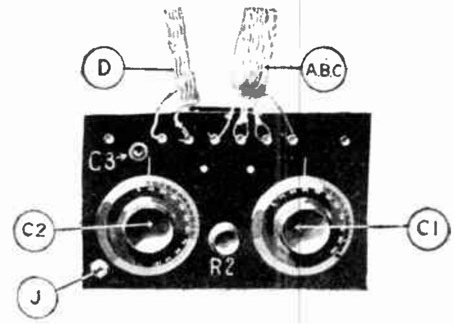


FIG. 1

As may be seen from the schematic diagram, the receiver employs only two tubes, 201A and 112 types (or even two 199's); one a detector and the other an audio-frequency amplifier. The circuit is designed for headphone reception, so there is only one stage of audio-frequency amplification, which is quite sufficient for all work.



Panel view of the short-wave receiver.

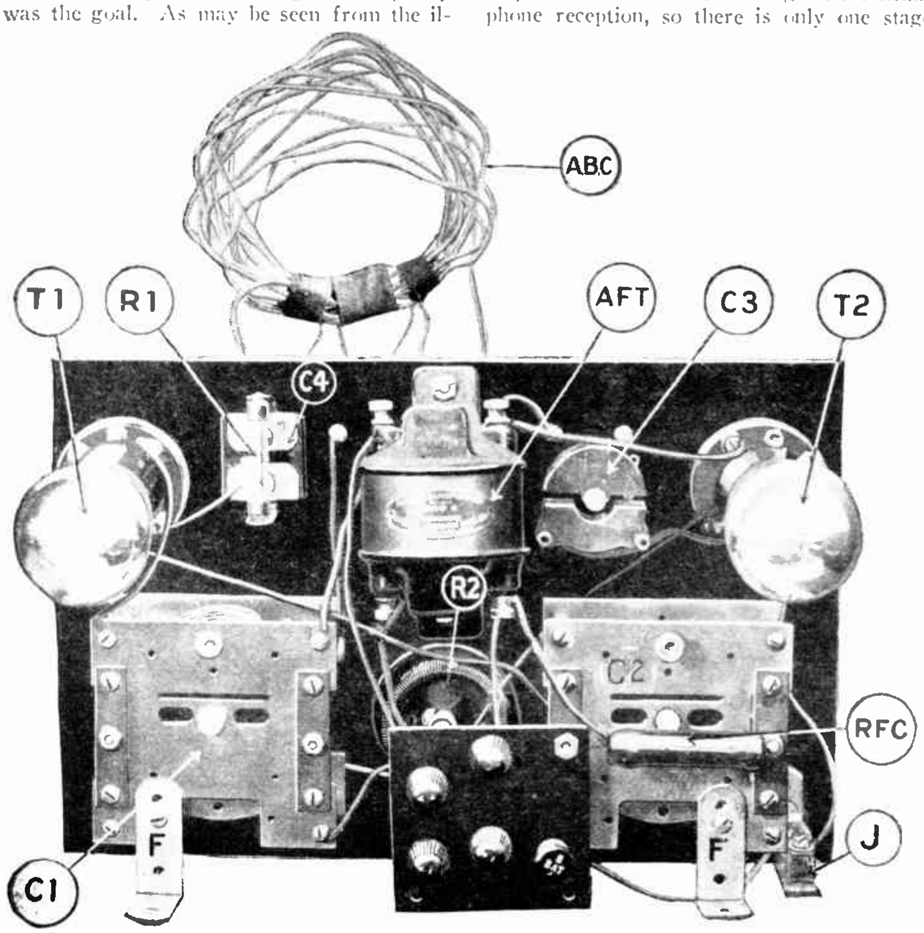
NOVEL CIRCUIT

First let us consider the circuit which is used in this short-wave receiver (Fig. 1).

It will be noticed that there are four inductances, A, B, C and D. As may be seen from the illustrations, these coils are bunch-wound, being wrapped together at the bottom with tape and the opposite sides being spread apart toroid fashion. Across the coil B is shunted a variable condenser C1, which has a capacity of 250 mmf. (.00025-mf.).

This method is used instead of shunting a small-capacity condenser across both coils, A and B, for several reasons. In the first place, if we have just a few turns in a coil shunted by a large capacity, even though there is a smaller voltage impressed on the grid of the detector tube, there is a comparatively small resistance (that of the condenser) in parallel with the coil. Now, if we have a coil composed of more turns and shunted with a smaller capacity, even though we have a greater voltage impressed on the grid, yet there is a much greater condenser resistance shunted across these same number of turns. In order to obtain a compromise between these two conditions, we shunt only *part of the coil* with a relatively *large condenser*, which has less resistance. We get the advantage of a greater voltage impressed on the grid of the detector tube, and the stations spread out over the whole range of the dial, instead of being grouped and crowded in spots. In short, it is well to use as large a condenser for tuning as is convenient and shunt that number of turns which will tune in the desired range of frequencies.

Just as in the transmitting end of the game, a short aerial should be used for the reception of waves under one hundred meters. This would necessitate using two aerials if broadcast stations were received also, but in the receiver here described this is automatically taken care of in this manner. It will be noticed that in the aerial side of the coil D is a small variable condenser C3 which has a value of 55 mmf.



As may be seen from the above illustration, all the apparatus of the receiver is mounted on the front panel. The feet, F, are attached to the rear of the variable condensers.

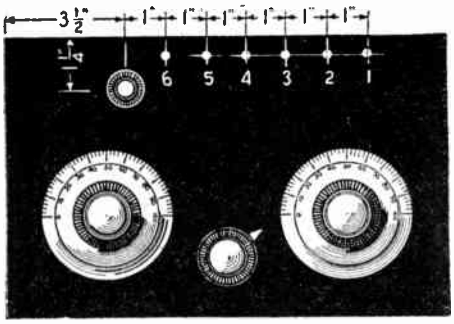


Fig. 2.
The location of the binding posts, to which the coils are attached, are here shown.

top sides of the turns are then spread apart giving them a semi-toroid appearance.

It is very important that these coils be carefully prepared, so that there is a minimum of losses in their make-up. If it is desired to use any means other than binding posts, of connecting these coils to the circuit it may be done; yet the system illustrated is the easiest to build and insures practically no contact resistance, which is sometimes considerable with other types of mountings.

REGENERATION CONTROL

It is highly desirable that the oscillation of the detector tube should at all times be completely under the control of the operator. To insure the set going into oscillation smoothly and without the usual "plop," a large grid leak is employed, 7 megohms. This value is not fixed, however, and should be checked by the constructor. The condenser, C2, which controls the oscillations, should be of a high grade, having the smallest possible minimum capacity. If a condenser of inferior workmanship is used in this position, the additional capacity, when the plates are all out, might necessitate that some turns be removed from C.

As another aid to the control of regeneration, there is inserted in the plate circuit of the detector tube a special radio-frequency choke coil, RFC. This choke can be obtained at any supply store and has a resistance of 1,000 ohms. Naturally the coil must be inductive.

This coil aids in regeneration control, because it brings the output circuit of the tube nearer in value to the internal impedance of the tube, which is about 8,000 ohms. The primary winding of the audio-frequency transformer is about 6,000 or 7,000 ohms. This is a rule that might be well followed by designers; *i.e.*, to have the output of a circuit as nearly as possible equal in resistance or impedance to the generating part.

As mentioned previously, all the apparatus is mounted on the front panel which is relatively small—7 by 11 inches. In the two upper corners of the panel are mounted the two UX-type vacuum-tube sockets; one with the filament holes at the lower side and the other with these holes toward the top of the panel. This is for ease in wiring. In the center of the panel near the top is placed the 6:1 audio-frequency transformer, AFT. To the right of this, looking at the panel from the back, is the 55-mmf. condenser C3 and the socket for the semi-power vacuum tube, these being on the secondary side of the transformer. Above the variable condenser C2 is mounted the radio-frequency choke coil RFC; and in the lower right corner of the panel is the single-circuit jack J. In this way all the output apparatus, if we may call it such, is grouped together, making short connections possible.

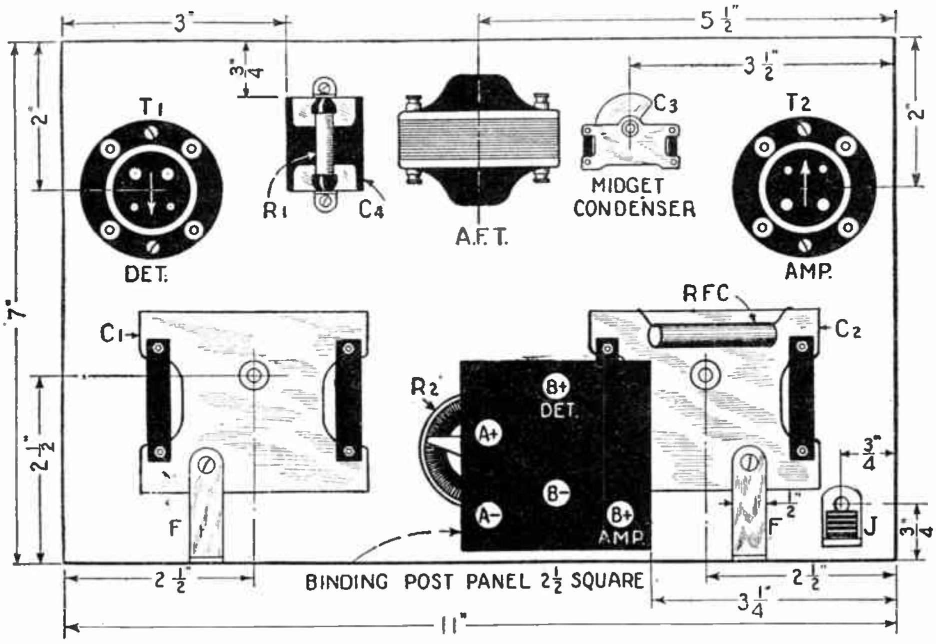


Fig. 3.
The layout of the apparatus on the panel is given above, with the necessary dimensions.

Now, in the coil specifications for use on the 20- and 40-meter bands, this coil D is not specified because it is not used. Therefore, only the coils, A, B and C being in the circuit the condenser C3 is in series with the antenna and the C coil. This has the desired effect of shortening the length of the antenna; so that the one used for broadcast reception can be used on this set with equally good results.

COIL SPECIFICATIONS

Following are the specifications for the different sets of bunch-wound coils to cover a wavelength range from 20 to 500 meters.

Wavelength	Coils—A	B	C	D
20 meters	4	2	2	—
40 meters	8	4	4	—
80 meters	16	8	8	4
150-200 meters	16	16	8	8
200-500 meters	32	16	8	8

These coils may be either wound on a form 3 inches in diameter or bunch-wound as suggested above. No. 16 D.C.C. wire is used throughout. If the coils are wound on a 3-inch form, the turns must be spaced for the wavelength ranges under 80 meters, the spacing being equal to the diameter of the wire. For the higher wavelength ranges the turns may be placed next to each other.

In the case of bunch-wound coils, which the writer uses in his receiver, the coils are all of the same diameter, 3 inches. They are fastened together at the bottom with tape and the leads to the binding posts on the front of he panel are spread out. The

SYMBOL	Quantity	NAME OF PART	REMARKS	MANUFACTURER ★	
C1,C2	2	Variable Condensers	.00025 mf.	1	9,13,14,15,17,18,19,20,21,22
C3	1	Variable Condenser	55 mmf. (midget)	2	17,18,19,20
AFT	1	A. F. Transformer	Ratio 6:1	3	9,12,18,26,27,28,29
C4	1	Fixed Condenser	.0005 mf. with grid leak mounting	4	10,14,30,31,33
R1	1	Grid leak	7 megohms	5	4,10,14,24,25,30,31,32,34,35
R2	1	Rheostat	6 ohms	6	3,9,14,15,18,20,24,26,31,34
	2	Sockets	UX type	7	9,14,18,19,20,22,23,34,36,37
	11	Binding Posts		8	3,14,16,34,37,38
	1	Panel	7 X 11 X 3/16 inches	54	39,40,41,42,43
	1	Binding Post Panel	$2\frac{1}{2}$ X 2- X 3/16 inches	54	39,40,41,42,43
		Wire for Coils	No. 16 D.C.C.	44	45,46,47,48,49
T1	1	Vacuum Tube	Type 201-A	11	50,51,52,53
T2	1	Vacuum Tube	Type 112	11	50,51,52,53
	1	Jack	Single Circuit	38	9, 3
RFC	1	R.F. Resistor	1000 ohms choke	55	

NUMBERS IN LAST COLUMN REFER TO CODE NUMBERS BELOW.

1 National Co.	2 Precise Mfg. Co.	3 Hart & Hegeman Mfg. Co.
4 Dubilier Condenser Corp.	5 Daven Radio Corp.	6 F.A.D. Andrea, Inc. (Fada)
7 Alden Mfg. Co.	8 H. H. Eby Company	9 Pacent Electric Co.
10 Aerovox Wireless Corporation	11 Radio Corp. of America	12 Samson Elec. Co.
13 Heath Radio & Electric Mfg. Co.	14 Pilot Electric Co.	15 United Scientific Lab. (U S L)
16 X-L Radio Labs.	17 Hammarlund Mfg. Co.	18 General Radio Co.
19 Silver-Marshall, Inc.	20 Chelten Electric Co.	21 Thompson-Levering Co.
22 Benjamin Electric Co.	23 Air-Gap Products Co.	24 Allen-Bradley Co.
25 International Resistance Co.(Durham)	26 General Instrument Corp.	27 Amer. Transformer Co. (Amertran)
28 Thordarson Electric Mfg. Co.	29 Jefferson Electric Mfg. Co.	30 Leslie F. Muter Co.
31 De Jur Products Co.	32 Arthur H. Lynch, Inc.	33 Sprague Specialties Co.
34 Amsco Products, Inc.	35 C. E. Mountford	36 Bremer-Tully Mfg. Co.
37 C. R. Leutz, Inc.	38 Yaxley Mfg. Co.	39 Creeradio Corp.
40 Formica Insulation Co.	41 American Hard Rubber Co. (Radion)	42 Fibroc Insulating Co.
43 Spaulding Fibre Co.	44 Cornish Wire Co.	45 Belden Mfg. Co.
46 Rome Wire Co.	47 Ross Wire Co.	48 L. S. Brach Mfg. Co.
49 Alpha Radio Supply Co.	50 Magnavox Co.	51 Ken-Rad Corp.
52 Zetka Laboratories, Inc.	53 C. F. Mfg. Co. (Ceco)	54 Bakelite, Corp.
55 Ward Leonard Elec. Co.		

★ THE FIGURES IN THE FIRST COLUMN OF MANUFACTURERS INDICATE THE MAKERS OF THE PARTS USED IN THE ORIGINAL EQUIPMENT DESCRIBED HERE.

If you use alternate parts instead of those listed in the first column of manufacturers, be careful to allow for any possible difference in size from those originally used in laying out and drilling the panel and sub-base.

An Adjustable "B" Power Unit for That Battery Set*

Easily Made and Readily Adaptable to any Receiver of Eight Tubes or Less, This Power Unit Provides as Wide a Range of "B" and "C" Voltages as the Average Experimenter Would Desire for Use with Present-Day Apparatus

By Fred Canfield

IN the present radio era the public has been enlightened technically to such an extent that it is hardly necessary, even for beginners, to state the purpose of a "B" socket-power unit in an article describing its construction. For almost two years "B" batteries have been replaced by socket-power units in a large majority of the radio-equipped homes where 60-cycle A.C. house supply is available, and no longer is there much mystery for the lay public in such devices. Although much skepticism was manifested, when house-current-operated radio units were first introduced, these accessories are now considered essential in every modern radio installation.

For the benefit of the fan who is still debating whether or not it is wise to discard his "B" batteries in favor of a "B" socket-power unit, it may be explained that, in the present stage of radio practice, a well-built power unit is, not only entirely satisfactory for the operation of any receiver, but much more economical as well, in a large number of cases. It is true that when "B" substitutes were first introduced many were not entirely satisfactory, this being due largely to the fact that they were incorrectly designed; but today the results obtained with modern power units equal those obtained from batteries.

The question of whether it is preferable to build or buy a "B" socket-power unit is the next problem which confronts the beginner. In this connection, it should be pointed out that these devices are very easy to build; in fact, much simpler than a receiving set. The average "B" power unit has only one-fifth the number of parts required by a 5-tube radio receiver, and usually a dozen connections complete the wiring of the unit. In most cases, the parts of a power unit may be screwed to a wooden baseboard and wired in less than two hours' time. After the assembly of the unit is complete, it is ready for operation, as there are no delicate adjustments which must be made. Of course, where a metal case must be made, this requires extra time; but such

Fig. A—A neat metal case like this will add much to the appearance of the power unit. It may be of brass screen, or of iron painted over.

a housing is not essential to the operation of the unit and the unit may be operated before the case is complete.

DESIGN OF UNITS

"B" socket-power units may be divided into several classes, and each type is best suited to a particular class of receiver. For the average five- or six-tube set using a 171-type power tube, "B" socket-power units of two different designs are suitable, generally; the first employs a "full-wave" gaseous rectifier tube, and the second uses either a "half-wave" or a "full-wave," filament-type rectifier. Equally satisfactory results are obtained from both types of power units; however, when a gaseous rectifier of the "filamentless" type is used, the filament winding of the power transformer may be employed for heating the filament of the power tube in the radio receiver. Incidentally, the *rectifier* tube of a "B" power unit is the device which converts the A.C. current obtained from the house-supply wires into direct current, and it may be described as the heart of the system.

Regardless of the rectifier used in a power unit, the general arrangement of the remaining parts is the same in all cases. Every power unit of ordinary present-day construction includes: first, a power transformer which increases the potential of the 110-volt house-supply current to the value required at the rectifier tube; as a modern receiver must have more than 90 volts on the amplifier plates. This transformer is also provided with one or two low-voltage secondary windings which are used for heating the filament of the rectifier tube, or that of the power tube of the set, or both. Both the low- and high-voltage secondary windings of the transformer usually are provided with center-tap connections.

The next important parts of a power unit are the filter choke coils; these are employed to retard the alternating "*component*" of the pulsating direct current which is supplied by the rectifier tube, and in this way they help reduce the hum in the output circuit. Most circuits call for the use of two choke coils in the filter circuit, but this design is entirely arbitrary. Choke coils are supplied in single and double units.

ELIMINATING HUM

Equally as important in the filter circuit as the choke coils are the filter condensers; these by-pass the A.C. component of the pulsating direct current before, after and between the various choke coils and, in this way, make possible the complete elimination of the "hum" created by the 60-cycle alternations of the supply. Most circuits with two choke coils include three filter condensers of various values, depending largely upon the size of the choke coils. The filter condensers must be of high voltage rating, as they are connected in shunt with the maximum output voltage of the rectifier tube, and receive its full force.

After the current has been stepped up to a higher voltage by the power transformer, converted to pulsating D.C. by the rectifier, and filtered by the choke coils and

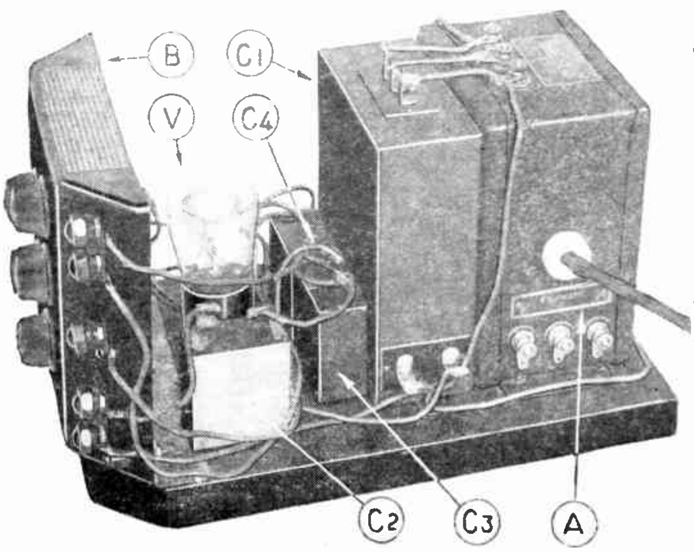
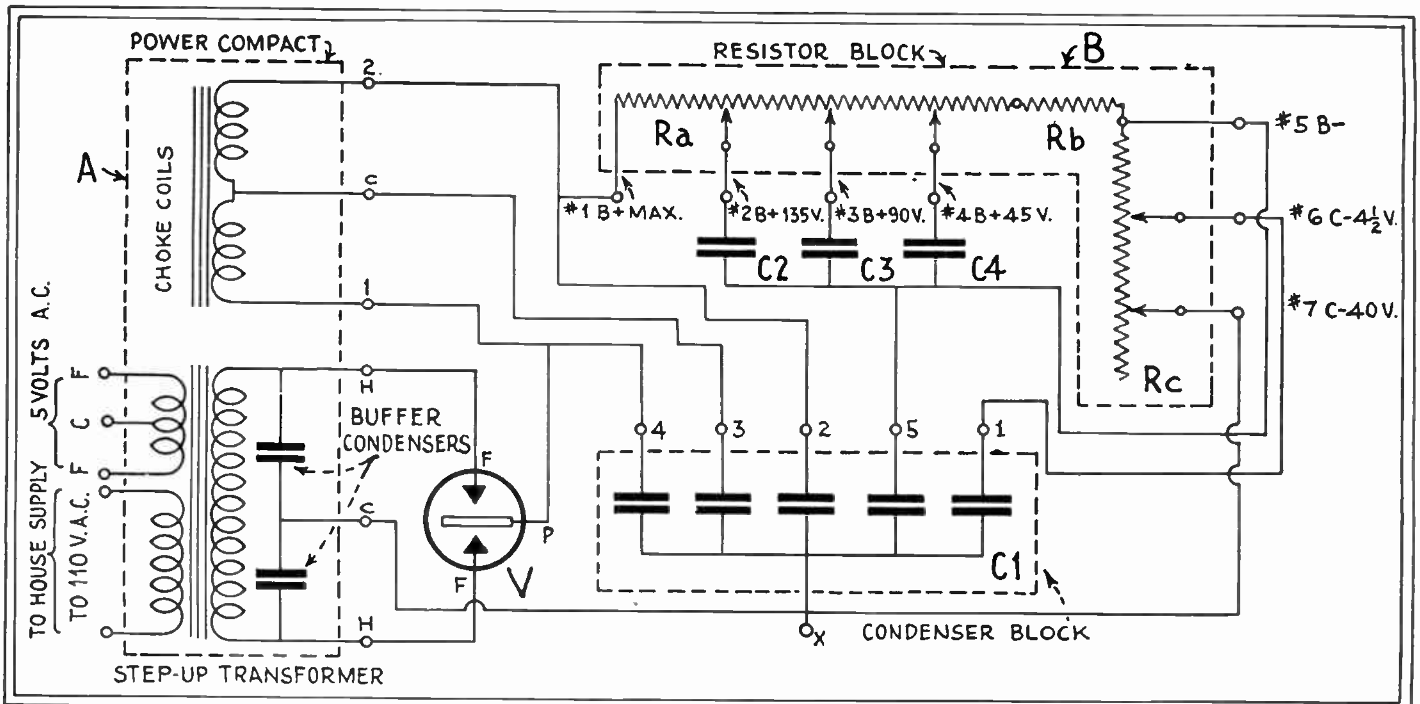


Fig. B—The appearance of the completed power unit; if it is to be placed in a cabinet compartment the metal case may not be necessary. A well-ventilated location should always be selected, however. The only adjustments are those on the front of the voltage-divider B, which thus forms the panel of the instrument, and settings are permanent. A full-wave gaseous rectifier tube V, the power compact A, the condenser block C1, and the three one-microfarad condensers, C2, 3 and 4, are the only parts required.

*RADIO NEWS Blueprint Constructional Article No. 70. (See page 104).



It will be seen from this schematic diagram how simple the connections of the power unit are. The voltages may be regulated to the requirements of any receiver. The 5-volt A.C. winding is unused, unless it is desired to connect this to the power-tube filaments.

condensers in the circuits of the power unit, it is passed to the *voltage-divider* connected in shunt with the output terminals of the filter circuit. This instrument is, in reality, a large potentiometer with several arms, which divides the output of the "B" power unit into the exact values of voltage required for the operation of each of the tubes of the receiver. It consists of a fixed resistor of high value, connected across the high-voltage supply, and provided with taps at suitable points for obtaining the desired voltages. In some arrangements, usually for specific receivers, the position of the taps on the voltage divider is fixed; but in units of a more flexible kind there are adjustment knobs which make it possible to obtain any desired intermediate voltage.

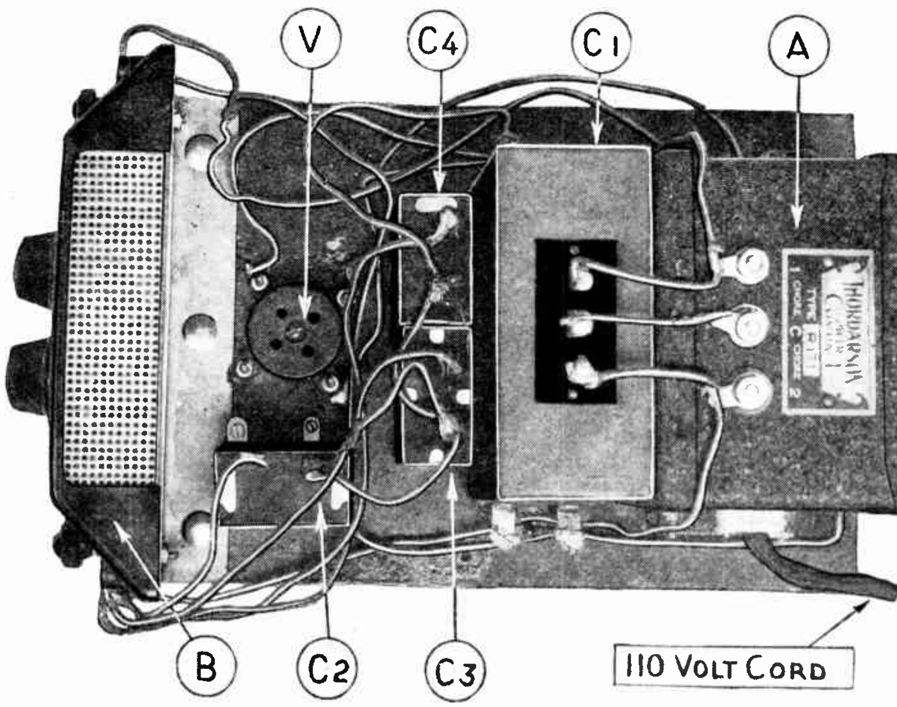
In addition to the parts mentioned several other condensers are used in the "B" socket-power unit, as a rule. In circuits which employ gaseous rectifier tubes, a small buffer condenser is always connected between each side of the high-voltage secondary winding and the center-tap connection. These condensers have a capacity of 0.1-mf. each and serve to by-pass slight R.F. currents that gaseous rectifiers sometimes generate. By-pass condensers also are used in the voltage-dividing circuit between each resistance tap and the "B—" terminal, and have usually a capacity of 1 mf. each.

AN EXCELLENT SUPPLY UNIT

The "B" socket-power unit described in this article is of very simple construction, yet highly efficient and suited especially for the beginner. The output voltages are adjustable, thus making it possible to operate any of a large variety of receivers without making changes in the design. When suitably adjusted it will supply ample current for the operation of a receiver employing as many as eight tubes, with a 171-type power tube in the last stage; but it may also be so adjusted that it will operate a receiver using only two or three tubes. From the output binding posts any positive potential from 1 to 180 volts may be obtained from the plate supply, and any negative potential from 1 to 40 volts for the grid bias of the tubes. The power unit makes available four different "positive" voltages, three of which are adjustable, and two "negative" voltages.

From the viewpoint of the beginner, the ease with which this power unit may be constructed and the simplicity of the wiring are two very important features. In most assemblies each part must be mounted and wired individually on the baseboard; but in the device under discussion practically all of the parts have been combined into three units. For example, the power transformer, the buffer condensers and the choke coils are mounted in one unit, the various resistors of the voltage-divider are in one unit, and five of the condensers are in one "condenser block." This system not only improves the appearance of the power unit, but also simplifies the construction and wiring. In addition to the three parts above named, only three by-pass condensers and a socket for the rectifier are needed, in addition to wire and small hardware.

The arrangement of the circuit is illustrated very clearly in the schematic wiring diagram, Fig. 1. In this diagram the three principal components of the set, which have



This top view shows the seven parts used in the construction of the power unit, so arranged that connections are the most convenient. Compare this with Fig. 2 on the next page, which illustrates the simplicity of the layout, and should be followed in wiring the apparatus.

been mentioned before, are enclosed within dotted lines. The "power compact," which comprises the transformer, chokes and buffer condensers, is inclosed by the dotted lines lettered "A"; the condenser block is enclosed by those marked "C1", and the voltage divider by the lines designated as "B". In each case, all the connections shown within the dotted lines have been made by the manufacturer, and it is necessary only for the constructor to complete the external connections to these units as shown.

PARTS NEEDED

A complete list of the apparatus employed in the construction of the "B" socket-power unit is as follows:

One 171-type power compact, comprising a power transformer, two choke coils and two buffer condensers. The transformer has a center-tapped high-voltage winding providing up to 85 milliamperes at 320 volts on each side of its center, and a low-voltage filament winding, providing a maximum current of 1 ampere at 5 volts. The choke coils have an inductance of 30 henries each, and the buffer condensers have a capacity of 0.1-mf. each. This complete unit is marked "A" in the illustrations;

One 171-type condenser block of five condensers of the following capacities: 2, 2, 8, 1 and 1 mf. One terminal of each of the condensers is connected to a common terminal. The two 2-mf. sections and the 8-mf. section of the block are high-voltage filter condensers and the two 1-mf. sections are by-pass condensers. This unit is marked "C1" in the illustrations;

One voltage-dividing potentiometer consisting of three wire-wound resistors connected in series. Resistor Ra is a 50-watt, 8,000-ohm unit having three slider contacts; resistor Rb is a 2,000-ohm unit with a low current rating, and resistor Rc is a 50-watt, 1,000-ohm unit with two sliding contacts. This divider is marked "B" in the illustrations;

Three 1-mf. by-pass condensers with 200-volt rating (C2, C3, C4).

One UX-type vacuum-tube socket;

REAL VOLTAGE!

IF you have been thinking of tossing out those "B" batteries in favor of a power unit, or if you have always wanted a dependable source of power for your home experiments, build yourself this "B" and "C" unit. Not only will it pay for itself, but the quality of reproduction obtainable with the 171 type tube will more than compensate for any time spent with this apparatus. It employs a filamentless rectifier tube of the gaseous type and a highly efficient and novel voltage divider by Electrad.

One wooden baseboard, 6¾ x 11 x ¾-inch;

Perforated sheet brass or heavy wire mesh for making the metal case. See drawings for quantity required; its use is optional;

One roll of connection wire, flexible-insulation type;

Solder, wood screws, etc.;

One rectifier tube, full-wave gaseous type (V).

ASSEMBLY AND WIRING

Mounting the parts on the baseboard of the power unit requires only a few minutes' time. At one end of the baseboard the voltage divider B is mounted in a vertical position with the aid of the metal bracket which is supplied with the divider. When set up in this manner this instrument provides the front panel, control knobs and binding posts for the power unit, which has no other adjustments.

The power-compact unit A is fastened with four wood-screws at the opposite end of the baseboard from the divider. This unit should be so mounted that the name plate faces the divider, as this arrangement greatly simplifies the wiring. The condenser block C1 has been designed especially for the power compact and its terminals have been arranged to permit the shortest possible wiring. In order to take advantage of this feature, the block must be mounted directly in front of the power compact, with its name plate facing the front. In the space which remains on the baseboard the four condensers and the tube socket are mounted; their positions are indicated clearly in the pictures and diagrams. All of the parts are held in place by wood-screws.

The wiring of the power unit may be accomplished very quickly, as most of the circuit has been completed by the internal connections of the three main units, A, B, and C1. However, all the external connections in the power unit should be soldered, if best results are desired. It may be said that, if tinned hook-up wire and rosin-core solder are used for the purpose, the job will not be found at all difficult. It is highly important, also, to use wire having a good insulating covering; this is necessary because the output voltage of some circuits is in the order of 300 volts, or more, and this might be sufficient to break down the insulation on inferior wire.

After the parts have been mounted on the baseboard, the first step is to wire into the circuit the power compact A. This unit is provided with nine binding posts; three for the high-voltage secondary winding, three for the choke coils and three for a filament winding. The two outside terminals of the high-voltage secondary are each marked "H" and these connect to the "F" terminals on the rectifier-tube socket; the center-tap connection of this winding is marked "C" and this connects to the common terminal (marked "X") of the condenser block and the "C—40" post of the divider. The three terminals on the top of the compact (marked "1," "C" and "2") are for the choke coils, and these are connected to corresponding terminals on the top of the condenser block. Also, terminal "1" is connected to the "P" terminal of the socket and to terminal "4" of the condenser block. Connect terminal "2" to the "B+Max" post of the divider, and to terminal "2" of the condenser block.

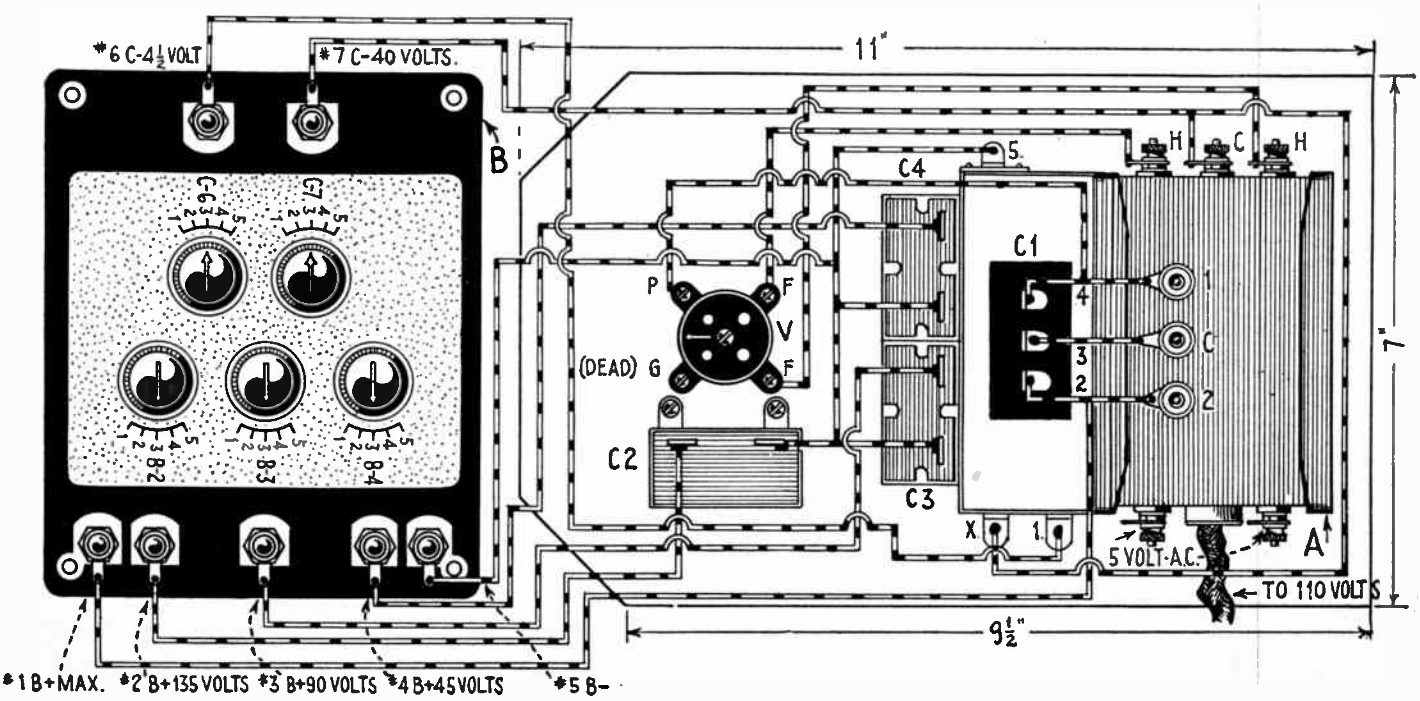


Fig. 2 *Follow this diagram with a pencil as each wire is cut and soldered into place.*

After the connections described above have been made, the unit is wired except for the by-pass condensers. To make these connections, first run a wire from one terminal of each condenser to the "B—" terminal of the voltage divider. Now connect wires from the three slider contacts on resistor Ra to the free terminals of the three by-pass condensers. This completes the task of wiring the unit; but connections should be carefully checked on Fig. 2.

THE METAL CASE

Fig. 3 gives the details for making a metal case for this power unit. This case may be considered as optional equipment, as it has no effect whatsoever on the operation of the power unit; however, it greatly improves the appearance of the unit and serves as a protector. It may be made from perforated sheet metal, or from wire screening of suitable stiffness.

The operation of the power unit should not require explanation. The binding posts on the voltage-divider are used as the output binding posts and these are connected to the proper wires of the battery cable leading to the receiver. To operate the unit, the lamp cord from the power compact is plugged into a socket and the current is turned on. The knobs on the front of the divider should be adjusted until best results are obtained from the receiver, and then they should be considered permanently set.

In operating a receiver with this power unit, it is important always to turn on the set's filament switch *before connecting the power unit with the house-lighting circuit;* and the power unit should be disconnected *before the filament switch is turned off.* Of course, the operation of the receiver may be greatly simplified by using a power-control relay to control the operation of the power unit. When this unit is connected in series with the "A" lead to the set it automatically turns the power unit on and off, as required.

OPERATING HINTS

The builder has the choice of operating his receiver either with both a filament switch on the set and a light switch controlling the power unit, or with an automatic relay which performs the desired switching operations when the filament switch of the receiver is available in various forms, and comprises, primarily, an electromagnet which causes a switch to be thrown whenever it is "energized" by the storage battery Two binding posts on the relay are used to "cut" in on the "A—" lead from the battery; thus allowing current from the battery to flow through the relay magnet when the battery switch on the receiver is turned on. When this switch is turned off, current from the battery no longer energizes the relay magnet; this allows the relay switch to fall back to a different position (a spring is usually used to insure this come-back).

In the first position (when the receiver is turned on), the relay switch connects the power-unit transformer to the house line, and disconnects the trickle charger (if one is used) from the "A" battery. When the receiver is turned off, the reverse action takes place: the power unit is disconnected from the 110-volt line and the trickle charger takes its place on the line. Though two plug outlets (one for the power unit and one for the trickle charger) are part of every automatic relay, a charger need not necessarily be attached to the

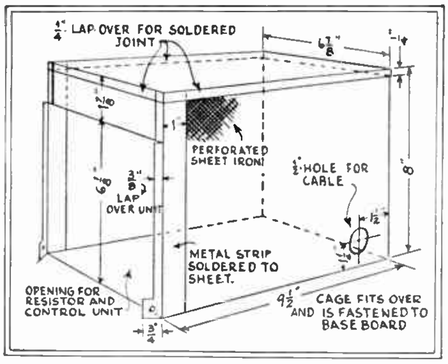


Fig. 3—Constructional details of a perforated metal cabinet (optional) to fit over the power unit.

relay; though it is a great convenience.

After the power unit has been wired to the receiver, halt the proceedings after attaching the final connecting wire. Then if you have no 0-200 volt high-resistance meter, run out and buy, beg, or borrow or—well, get one any way. A meter is almost a necessity in adjusting the output voltages of a power unit; you may, of course, adopt the "blind" alternative of adjusting the power unit until speaker results seem satisfactory, but this system is awkward and rarely allows the receiver to function at its best. A test with a voltmeter after an adjustment has been made in this manner, will convince the reader that meters are a necessity wherever unknown voltages are applied to apparatus calling for definite operating values. After the voltages have been adjusted to the requirements of your receiver, however, the controls of the units are to be let alone.

THE FILAMENT WINDING

There will be noticed, under the 110-volt cord opening of the transformer casing, three binding posts which are not made use of in this power unit. They are marked "F," "C," "F"; and are identified by a small metal plate directly above them as supplying 5-volt A.C. This winding is included in the transformer for the benefit of the builder who may desire to light his last audio amplification tube from this winding and so, to some extent, relieve the strain on his storage battery. Considering, however, the fact that the later type of 171 tube (the 171A), draws but one quarter of an ampere, it is a question whether this negligible reduction of the battery drainage is worth the rewiring of a receiver to use the 5-volt winding.

It, perhaps, will find its use in supplying a push-pull amplifier employing two 171As. Here the current drain may be taken into some consideration, as well as the fact that the amplifier may be a later addition to the receiver or, as in some cases, an external unit for increased amplification. Where the winding is used, a center-tapped filament resistor (such as are being marketed by any number of manufacturers for this purpose) must be used; for the negative or "C" biasing potential for the power stage is run to the center connection of this split, or "two-legged," resistor. *This winding cannot be used for lighting the filament of a D.C. (storage-battery-type) tube used in any circuit but the last stage of audio-frequency.*

A Simple "B" Power Unit.

SYMBOL	Quantity	NAME OF PART	REMARKS	List Price Each	MANUFACTURER ★	
A	1	Power compact	Consisting of step-up transformer, two audio choke coils, and two "buffer" condensers.	15.00	1	
B	1	Voltage divider	Consisting of two variable resistors with five contact arms.	12.50	2	
C1	1	Condenser block	Containing five condensers having the following capacities: 2, 2, 8, 1 and 1 mf. One terminal of each of the condensers is connected to a common terminal.	14.00	3	
C2, C3, C4	3	By-pass condensers	1.0-mf., paper-type - 200-volt	1.25	3	
V	1	Tube socket	UX-type	.50	4	
	1	Rectifier tube	Gaseous filamentless type; fits socket V, 125-milliampere capacity	4.50	5	
			INCIDENTAL MATERIAL			
	1	Baseboard	Wood - 11 x 9½ x 7 x 1 inches			
	12	Wood-screws	11 Round-head 1/2" #6			
			1 Flat-head 1" #6			
	2	Machine-screws	1½" - 6/32 with nuts			
	25 ft.	Hook-up wire	Push-back insulation	.40	3	
		Metal case	Perforated sheet iron 30 x 30 inches	(Optional)		

NUMBERS IN LAST COLUMN REFER TO CODE NUMBERS BELOW.

1 Thordarson Elec. Mfg. Company Chicago, Illinois	10	19
2 Electrad, Incorporated 175 Varick Street, New York City	11	20
3 Acme Wire Company (Parvolt) New Haven, Conn.	12	21
4 Silver-Marshall, Incorporated 846 W. Jackson Blvd., Chicago, Ill.	13	22
5 Raytheon Manufacturing Company Cambridge, Mass.	14	23
6	15	24
7	16	25
8	17	26
9	18	27

★ THE FIGURES IN THE FIRST COLUMN OF MANUFACTURERS INDICATE THE MAKERS OF THE PARTS USED IN THE ORIGINAL EQUIPMENT DESCRIBED HERE.

If you use alternate parts instead of those listed in the first column of manufacturers, be careful to allow for any possible difference in size from those originally used in laying out and drilling the panel and sub-base.

A Two-Tube Reflex Receiver of Simple* Construction

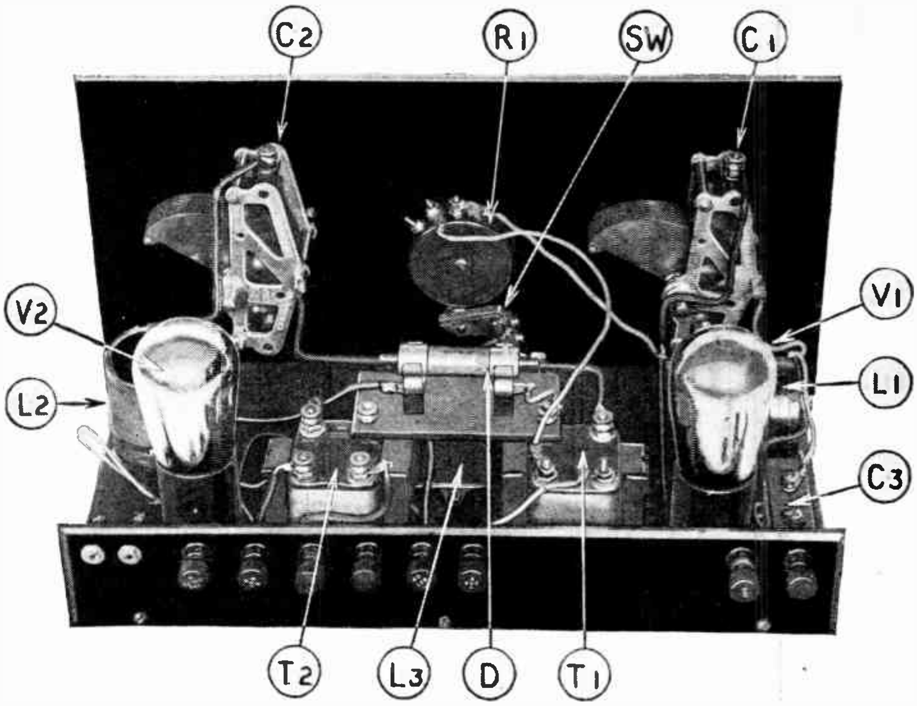


Fig. B. A rear view of the Two-Tube Reflex Receiver.

HUNDREDS of different types of receivers have been described in radio periodicals and newspapers during the last few years, and many of these have attracted considerable attention from constructors. However, almost without exception, the description of a good reflex circuits excites ardent enthusiasm on the part of many readers. Probably this is because everyone considers the reflex the ideal circuit from the viewpoint of economy, and hopes that some day a perfect receiver of this type will be developed.

In some ways the reflex circuit may be compared with a perpetual-motion machine, for there is an attempt on the part of the designer to obtain something for nothing. Of course, this is impossible; but there is no question about the fact that with circuits of this type greater volume is obtained from a given number of tubes than is possible with other methods. Therefore, the cost of parts, and the cost of operating the set is a minimum, considering the results obtained.

WHAT IS "REFLEXING?"

Before continuing further with this article, the principle upon which all reflex receivers operate will be explained. In all circuits of this type the reflexed tubes are called upon to do double duty; that is, they operate *as both audio- and radio-frequency amplifiers*. In the case of a three-tube reflex receiver, for example, the circuit would be aranged so that the three tubes act first as R.F. amplifiers, then the energy is rectified by the detector, and returned to the beginning of the circuit, thus causing the tubes to operate a second time as A.F. amplifiers. In this way, with three tubes, it is theoretically possible to obtain results which compare with those delivered by a six- or seven-tube receiver.

At this point of the explanation the question asked most frequently is: "Why are not reflex circuits used more generally if they possess exclusively this economical feature?" The answer is, that a large number of designers of reflex circuits have become too miserly in their attempt to obtain maximum output from each tube, and, as a result, have impaired the quality of performance. However, if builders were satisfied with slightly less than double performance from their tubes, the over-all results produced by the receiver would be much more satisfactory.

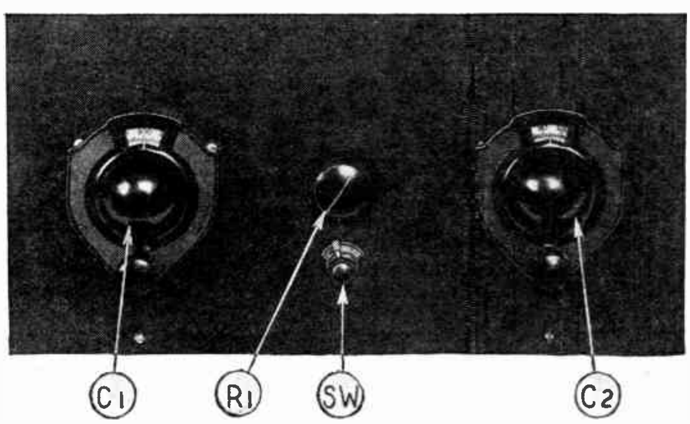


Fig. A. The simplicity of the Two-Tube Reflex is apparent on its panel. While there are two tuning controls, they should keep in step over the waveband. R1 controls volume.

The reflex receiver which is described in this article is a two-tube set, but it does *not* provide five-tube results. In building the receiver, the designer endeavored to secure the maximum from each stage, but was careful not to overload any circuit or tube. As a result the receiver gives excellent performance, but the results more nearly correspond to those obtained from the usual three-tube receiver.

In circuit design the receiver employs a stage of reflexed R.F. amplification, a crystal detector, a stage of reflexed transformer-coupled A.F. amplification, and a straight stage of transformer-coupled A.F. amplification. Semi-power tubes are used in each stage to prevent overloading, and no attempt was made to combine a second R.F. stage with the second A.F. stage; as this would have an undesirable effect on the performance of the receiver.

SIMPLE AND COMPACT

The receiver is very simple in operation. There are only two tuning controls, one volume control and a battery switch mounted on the front panel. The two tuning dials control the variable condensers connected in the R.F. and detector circuits. The volume control is a variable high resistor in the grid return circuit of the first tube. In tuning it will be found that readings of the two dials closely approximate each other for all wavelengths in the broadcast band.

The small size of the set is another important feature of the design The front panel is only 13½x7 inches, and all the parts are mounted on a wooden baseboard 6¾ inches deep. The total weight of the set is only 6½ pounds, but this figure does not include a cabinet. These facts make this set ideal for semi-portable use, as a set of this type, complete with batteries, could be transported to a summer home or camp without difficulty. Since only two tubes are used, it would not be expensive to operate both the filament and plate circuits with dry batteries for short periods of time.

The construction of the receiver is very simple, and a novice should have no difficulty in building a duplicate of the set shown in the illustrations. In fact, it was designed especially to provide an inexpensive set for the beginner to start with. All parts are mounted on a wooden baseboard, with the exception of the instruments on the front panel, and all the wiring is above the base. Therefore, practically the only tools required when building the set are pliers, screwdriver and soldering iron. Of course, a few holes are required in the front panel, which is of bakelite, but the store where the panel is purchased will drill these, if requested to do so.

PARTS REQUIRED

The first step in building the set is to secure the necessary parts. The following is a complete list of the apparatus required:

Two variable condensers, .00035-mf. (C1 and C2);
One adjustable condenser, 2 to 25 mmf. C3);
One fixed condenser, .00025-mf. (C4);
One antenna coil, homemade (L1);

* RADIO NEWS *Blueprint Constructional Article No.* 60. (*See page* 104).

One R.F. transformer, home-made (L2);
Two A.F. transformers, 3½:1 ratio (T1 and T2);
One R.F. choke coil, 85-millihenry (L3);
One crystal detector, carborundum type (D);
One volume-control resistor, 0-500,000-ohm (R1);
Two filament-ballast units, 5-volt ½-ampere type (R2 and R3);
One battery switch (SW);
Two tube sockets, UX type;
Two vacuum tubes, 112A type, or one 112A type and one 171A type (V1 and V2);
Two tuning dials, vernier type;
Eight binding posts;
One baseboard, 6¾x12¾x¾ inches;
One bakelite front panel 7x13½x3/16 inches;
One binding-post panel, 2x12¾x3/16 inches;
One detector panel, 3x1¾x3/16 inches;
Two phone-tip jacks;
Flexible insulated connecting wire, screws, solder, coil mounting brackets, etc.

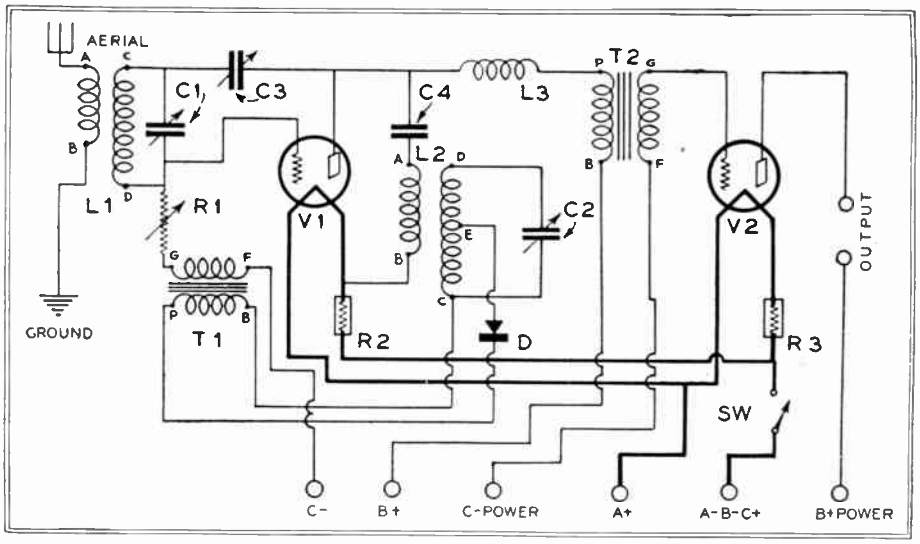


Fig. 1. This circuit diagram shows the characteristic appearance of a reflex circuit. Parts are lettered as in the list and in the illustrations.

MAKING THE COILS

As the coils are home-made, these must be wound before starting the construction of the receiver. Both coils are wound on tubing 1⅞ inches in diameter, and a length of 2¼ inches is required for each coil. The tubing should be bakelite or hard rubber; but a cardboard tube may be used if nothing better is available. However, if a cardboard form is used it should be painted with collodion before it is wound with wire.

For winding the coils No. 28 D.S.C. wire is used throughout. In making the antenna coil (L1) start the secondary winding about ¼-inch from the end of the tube and wind 76 turns of wire. A space of ¼-inch should be left between the end of the secondary and the beginning of the primary winding, which consists of 15 turns of the same size wire. Also, it is important to make sure that the primary and secondary are both wound in the same direction.

The R.F. transformer (L2) is very similar in construction to the antenna coil, but the windings have a different number of turns of wire, and the secondary winding is tapped at one point. The secondary coil is started ¼-inch from the edge of the tube; it consists of 56 turns of wire and it is tapped at the 24th turn from the beginning of the winding (32 turns from the end nearest the primary winding). The primary winding has 22 turns of wire and is wound in the same direction as the secondary.

After winding the coils they should be painted with collodion to protect them from moisture. Then, four holes should be drilled in the tube ½-inch apart and ¼-inch from the edge at the primary end of the coil. These holes are for the various wires of the coil to pass through and they should be marked "A," "B," "C" and "E," respectively. The wire from the outer end of the primary winding passes through hole "A," and the wire from the inside of the primary winding through hole "B." The wire from the inner terminal of the secondary passes through hole "C," and hole "E" is for the wire from the tap in the secondary winding of the R.F. transformer. The wire from the outside end of the secondary winding is *not* brought to the base but passes through a hole marked "D" at the other end of the tubing. It is highly important that the various wires be correctly marked, as these markings are followed in wiring the receiver.

MOUNTING AND ASSEMBLY

After winding the coils the next step is drilling the panels. In the front panel four large holes 7/16-inch, in diameter, are required for the shafts of the instruments mounted on the panel, and eight small holes for mounting screws. The panel layout shows the exact position of these holes. The other layouts give details for drilling the binding-post panel and the crystal-detector panel.

With the panels drilled and the coils wound, the assembly of parts may be started. First, mount the parts on the front panel. Both of the variable condensers (C1 and C2) are of the one-hole mounting type, but three mounting screws are needed to prevent the frame of the vernier dial from turning. Both the resistor (R1) and the battery switch (SW) are of the single-hole mounting type.

The parts on the baseboard are all fastened in place with wood-screws. The coils are mounted on opposite sides of the baseboard, 2 inches from the front and ¼-inch from the edge. L1 is mounted in a horizontal position on the left side of the baseboard and L2 is placed in a vertical position on the right side. One tube socket is mounted in the rear of each coil. They are located one inch from the nearest edge and ¼-inch from the rear of the board. The two A.F. transformers (T1 and T2) are mounted 1¾-inches apart and ½-inch from the rear of the base. When located in this position, each is adjacent to one of the tube sockets. The R.F. choke coil (L3) is mounted in the center of the base 2¼ inches from the front edge, and the filament-ballast resistors (R1 and R2) are mounted on each side. The last part to mount on the baseboard is the adjustable condenser (C3), which is placed on the left rear edge of the base. The pictorial wiring diagram shows the approximate position of the various

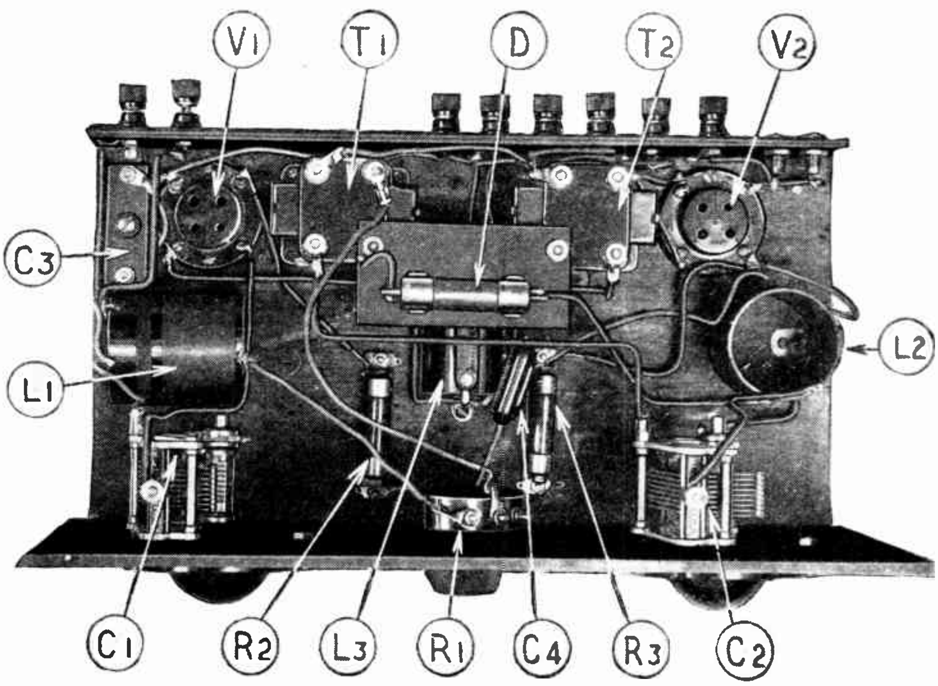


Fig. C. This top view shows the actual size and position of all parts.

pieces of apparatus, but their size has been reduced in some cases to show the wiring more clearly.

After the parts have been mounted on the baseboard, the front panel and binding-post panels may be screwed in place. Two wood-screws are used for the front panel and three screws for the binding-post panel. The panel for the crystal detector (D) may also be mounted at this time. It is held in place by the binding posts of the A.F. transformers (T1 and T2), as shown.

WIRING INSTRUCTIONS

The wiring of the receiver is very simple. All wires are above the base, and flexible insulated wire is used for the purpose. If the builder is not proficient at soldering, the connections may be made with the binding posts on the various parts; but it is always more satisfactory to solder the wire direct to the soldering lug wherever possible.

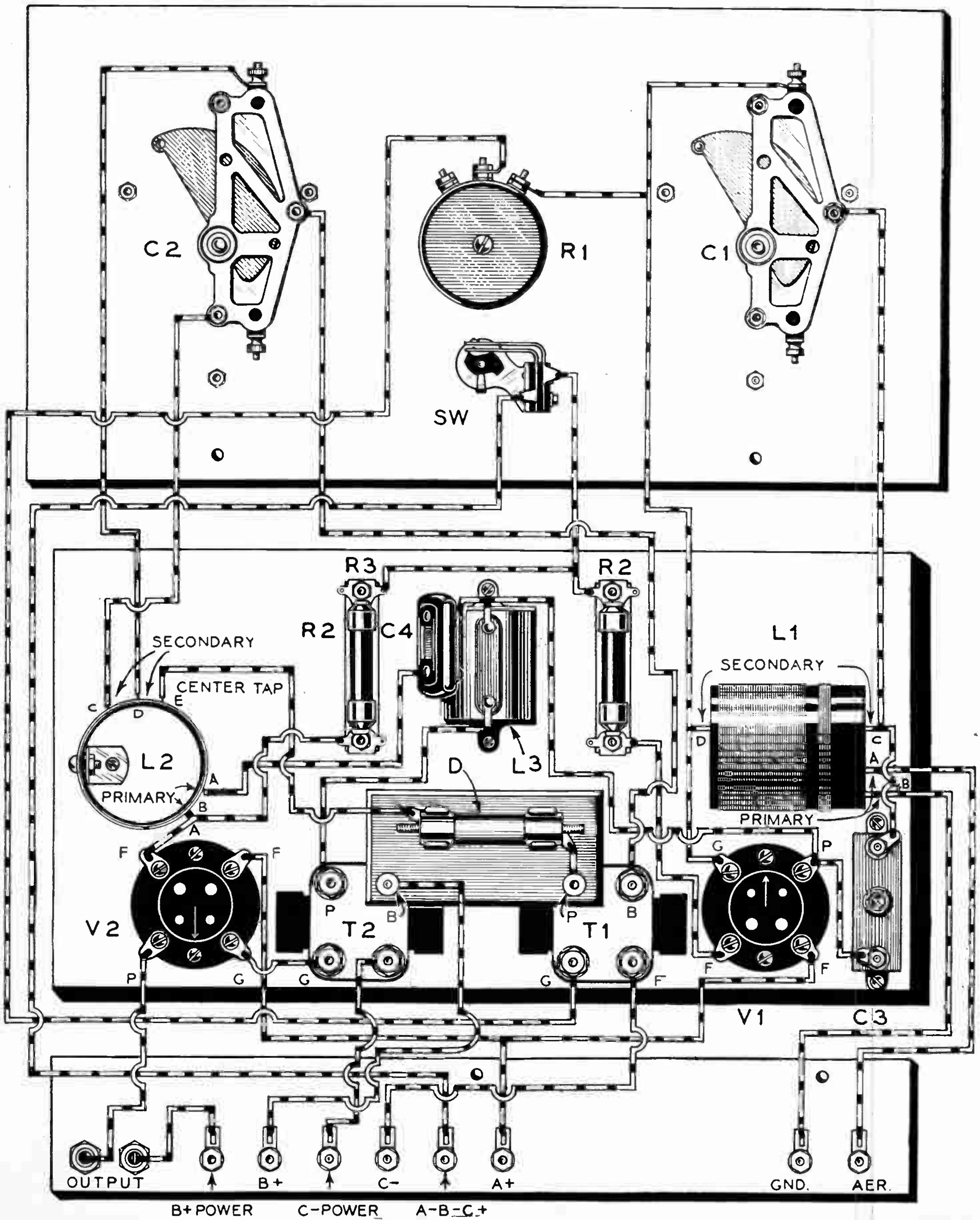


Fig. 2. Pictorial wiring diagram, showing front panel and baseboard of the Two-Tube Reflex. All wiring is in plain view. The small panel for the detector D is held by the binding posts B and P of the A.F. transformers.

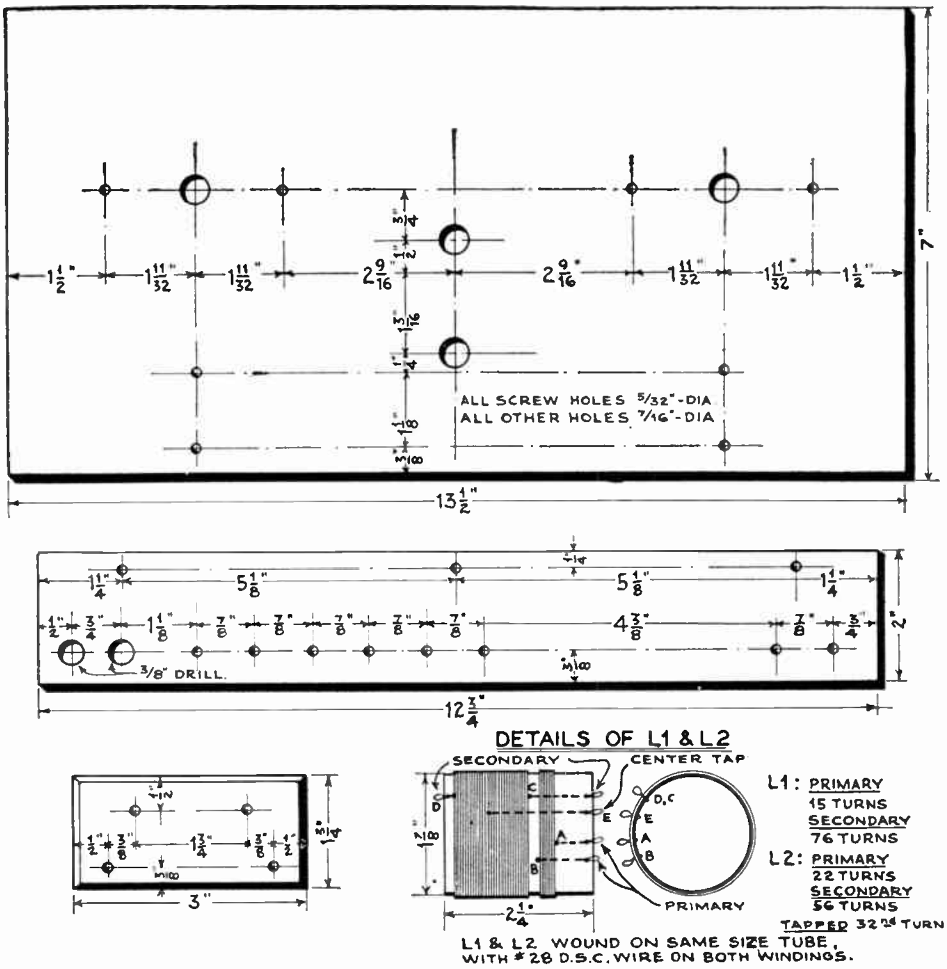


Fig. 3. Panel and coil details for the Two-Tube Reflex Receiver.

the free terminal of the condenser with terminal "P" of the tube socket V1. Terminal "B" of the R.F. transformer connects with the "A—" terminal of V1; terminal "C" connects with the stator plates of C2 and the "B" terminal of the first A.F. transformer (T1); terminal "D" connects with the frame (rotor plates) of C2; and terminal "E" connects with one terminal of the crystal detector.

The next step in wiring should be to complete the connections to the binding posts. The "C—" binding post should be connected by wire to the "F" terminal of transformer T1. The "B+" binding post should be connected to terminal "B" of transformer T2, and the "F" terminal of this transformer should be connected to the binding post marked "C— Power." The binding post marked "B+ Power" should be connected to one of the tip jacks and the other tip jack should be connected to terminal "P" of the socket V2.

Six wires are now required to complete the receiver. First, connect the free terminal of the volume-control resistor R1 with the "G" terminal of transformer T1. Next, connect the "G" terminal of T2 with the "G" terminal of the tube socket V2. Connect terminal "P" of T1 with the free terminal of the crystal detector, and connect P of T2 with one terminal of the R.F. choke coil L3. Now connect the free terminal of the choke coil to terminal "P" of the tube socket V1, and run another wire from terminal "P" of the tube socket to the free terminal of the adjustable condenser.

It is always best to start with the filament wiring. First, one terminal of the battery to the binding post marked "A—B—C+" and the other terminal of the switch with one terminal of each of the filament-ballast units (R1 and R2). The other terminal of ballast unit R2 should be connected with the "A—" terminal (one of those marked "F") of the tube socket V1, and the free terminal of unit R3 with the "A—" terminal of the tube socket V2. To complete the filament wiring, the "A+" terminals of the tube sockets (V1 and V2) should be connected with the "A+" binding post. This part of the circuit may now be tested by inserting tubes in the two sockets and connecting a 6-volt "A" battery to the two "A" binding posts. The tubes should light when the switch (SW) is closed and should be off when the switch is opened.

Next, the antenna coil (L1) may be connected in the circuit. Terminal "A" of this coil connects with the "Aerial" binding post; terminal "B" connects with the "Ground" binding post; terminal "C" connects with the frame (rotor plates) of the condenser C1, and terminal "D" connects with the stator plates of C1. In addition, terminal "C" is connected to one terminal of the adjustable condenser (C3), and terminal "D" is connected to one terminal of the variable resistor R1, and the "G" terminal of vacuum tube socket V1.

In wiring the R.F. transformer in the circuit, terminal "A" is connected with one terminal of the fixed condenser (C4). This condenser has not been mounted on the baseboard, but is held in place with two wires; the other wire being that connecting

A Two-Tube Reflex Receiver of Simple Construction

SYMBOL	Quantity	NAME OF PART	REMARKS	List Price Each	MANUFACTURER ★	
C1,C2	2	Variable condensers	.00035 mf.	$ 2.30	1	
C3	1	Adjustable condenser	1.8 to 20 mmf., neutralizing type	1.00	2	
C4	1	Fixed condenser	.00025 mf., mica type	.30	3	
L1	1	Antenna coil	Home-made (see text)			
L2	1	R.F. transformer	Home-made (see text)			
L3	1	R.F. choke coil	85 millihenries	2.00	4	
R1	1	Variable resistor	0-500,000 ohms	1.75	5	
R2,R3	2	Fil-ballast resistors	1/4-ampere, 5-volt type	1.10	6	
T1,T2	2	A.F. transformers	3½:1 ratio	4.00	7	
D	1	Crystal detector	Carborundum type	1.50	8	
SW	1	Battery Switch	Panel-mounting type	.50	9	
	2	Tube sockets	UX type	.50	10	
V1	1	Vacuum tube	112A type	4.50	11	
V2	1	Vacuum tube	112A or 171A type	4.50	11	
	2	Tuning dials	Vernier type	*	12	
	8	Binding posts	Suitably engraved	.15	13	
	1	Baseboard	12¾ x 6¾ x 3/4 inches			
	1	Front panel	13½ x 7 x 3/16 inches		14	Prices vary
	1	Binding post panel	12¾ x 2 x 3/16 inches		14	Prices vary
	1	Detector panel	3 x 1¾ x 3/16 inches		14	Prices vary
	2	Jacks	Phone-tip type	.12½	9	
	1	Roll hook-up wire	Flexible insulation	.40	15	

* New product, price unannounced on date of going to press.

NUMBERS IN LAST COLUMN REFER TO CODE NUMBERS BELOW.

1 Pilot Electric Mfg. Co., Inc. 323 Berry St., Brooklyn, N.Y.
2 X-L Radio Laboratories 2426 Lincoln Ave., Chicago, Ill.
3 Leslie F. Muter Company Greenwood Ave., Chicago, Ill.
4 Samson Electric Company Canton, Mass.
5 Herbert H. Frost, Incorporated Elkhart, Indiana
6 Radiall Company (Amperite) 50 Franklin St., New York City
7 Thordarson Electric Mfg. Co. Huron Street, Chicago, Ill.
8 The Carborundum Company Niagara Falls, New York
9 Yaxley Manufacturing Company 9 So. Clinton Street, Chicago, Ill.
10 Silver Marshall, Incorporated (S-M) 846 W. Jackson Blvd., Chicago, Ill.
11 E. T. Cunningham, Incorporated New York City
12 Kurz Kasch Company Dayton, Ohio
13 H. H. Eby Manufacturing Company 4710 Stenton Ave., Phila., Pa.
14 Micarta Fabricators 309 Canal St., New York City
15 Belden Manufacturing Company 2300 S. Western Ave., Chicago, Ill.
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№ 60

A Sturdy and Simple "A" Power Unit

Constructional Details of a Device Supplying Suitable Filament Current from the A.C. House Socket

THE "A" power unit described in this article is a simple apparatus which may be used to replace the storage battery of a radio installation. It obtains its power from the 110-volt A.C. lighting circuit, and it has a D.C. output of 6 volts at 2 amperes. Therefore, it may be employed for heating the filaments of any set using eight or less 201A type tubes.

Even the novice will find the construction of the device very simple, and should experience no difficulty in completing the assembly in less than an hour's time. Only five parts are used and ten wires complete the wiring.—EDITOR.

By Herndon Green

MOST readers of this article are aware of the steady march toward simplicity and ease of operation, in the field of radio engineering. There has been a continual development from multi-control receivers to those of but one or two dials. Plate ("B") socket-power units, requiring little or no attention of replacement, have taken the place of batteries, in many cases. And, this year, one of the most outstanding features in radio design is the advent of complete light-socket operation. Some manufactureres have attained this end by incorporating plate-power units in their sets and by making use of the new A.C. tubes—others by employing both filament and plate socket-power units.

For the fan who already owns a satisfactory radio receiver, and who does not feel ready to invest in parts for a new set this year, completely batteryless operation is entirely feasible, and without the slightest change in the wiring of the set, or change in tubes. Any of a great number of standard "B" power units will provide the plate circuits with direct current; while the device which may be used to accomplish the electrification of the filament circuit is a simple home-made "A" power unit, having a direct current output of 2 amperes at 6 volts. This unit may be used for the operation of any standard receiver using eight or fewer 6-volt, ¼ ampere tubes, and to provide "A" current for tubes of the 201A, 200A, and 112, 171, 240 types.

EXTREME SIMPLICITY

Upon examination of the simple wiring diagram, Fig. 1, the principles employed in the design of this unit will be entirely clear to the technical fans. The house-lighting potential is reduced to the required voltage by the step-down transformer T, which is the first unit of the circuit. The output of this transformer is then changed from an alternating current to a pulsating direct current, through the use of the rectifier tube V, which is of the two-element type. This current then enters the filter circuit where it is "smoothed out" to pure direct current for the operation of the receiver. The filter circuit consists of the choke coil L and the condenser unit C1-C2, which has two sections. The advantage of the system is that aside from the current used, there is no expense for upkeep; and there is never a time when the receiver must be out of commission because of lack of "A" voltage; for as long as there is power in the light socket there will be ample current available for the operation of the receiver.

The power transformer T has but two windings; one primary which is connected directly in the house-lighting circuit, in series with a switch for turning the filament current off and on; and a secondary which provides the current for the receiving set and also for heating the filament of the rectifier tube V. The output voltage of the secondary is 7½, and the tap for the rectifier filament is at 1½ volts. The transformer is enclosed in a complete shield which prevents the alternating-current field from being picked up by the receiving set and thus introducing hum.

The rectifier tube V is of the 2-ampere tungar type and fits into a special socket which is somewhat similar to the standard 110-volt receptacle, but has provision for making three connections to the tube. When connected in the circuit the tube acts as a half-wave rectifier. With the tube, the small by-pass condenser C2 is used in the rectifier circuit. It has a capacity of 0.25 mf. and is connected between the plate and filament of the tube.

THE FILTER CONDENSER

For the filter circuit a condenser bank of the electrolytic type (C1 and C2) is used in connection with a heavy-duty choke coil (L). The enormous capacity of the condenser is the secret of the success of this simple filter system. It is estimated that the two sections have a combined capacity of 250,000 mf.

In construction the condenser consists of two sets of plates submerged in an electrolyte in a metal container. The metal container serves as the common electrode for the two condensers, and wires connected to the plates provide the other two necessary contacts. The electrolyte, which is a solution of potassium hydroxide, is covered with a film of oil which prevents excessive loss from evaporation. As a result, it is seldom necessary to add water to the cell and there are no offensive odors or destructive gases which might cause damage to the interior of cabinets. The choke coil L in the filter circuit is very compact, as may be seen.

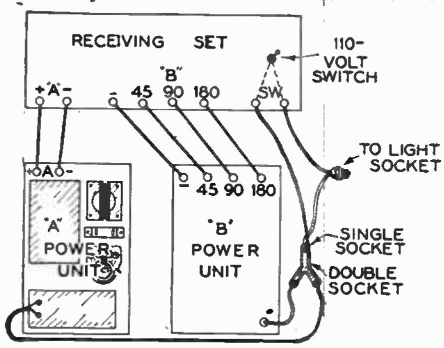


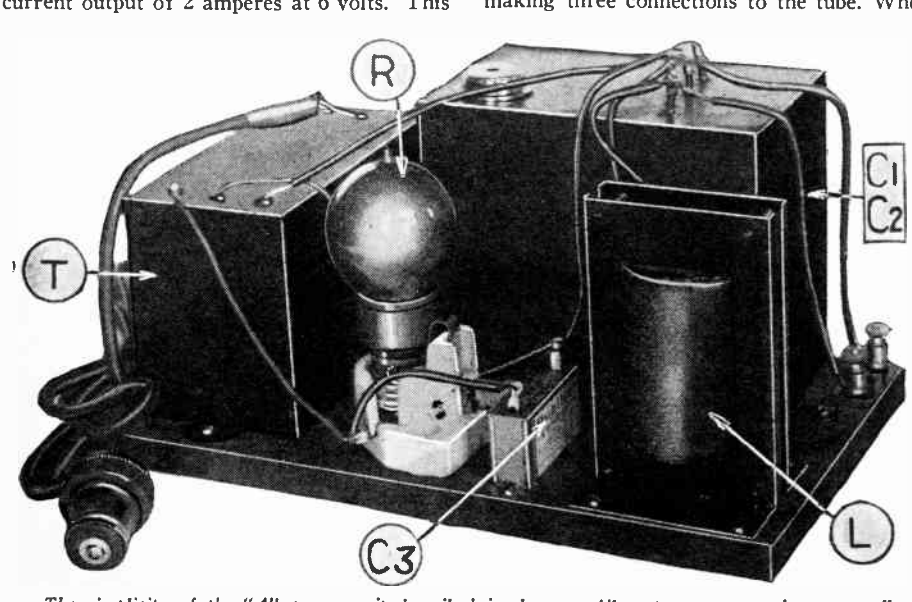
Fig. 2. An approved method of controlling the operation of both "A" and "B" power units is shown above. Devices of this style must be operated with a 110-volt switch in the lighting circuit, and the set's battery switch discarded.

Examination of the accompanying picture and drawings will show the simplicity of construction. All apparatus is mounted on a wooden baseboard, 7x12x¾ inches, and all wiring is above the base. In constructing the entire unit only twelve separate wires are used. The average radio fan should find it possible to complete the entire assembly and wiring in less than one hour's time.

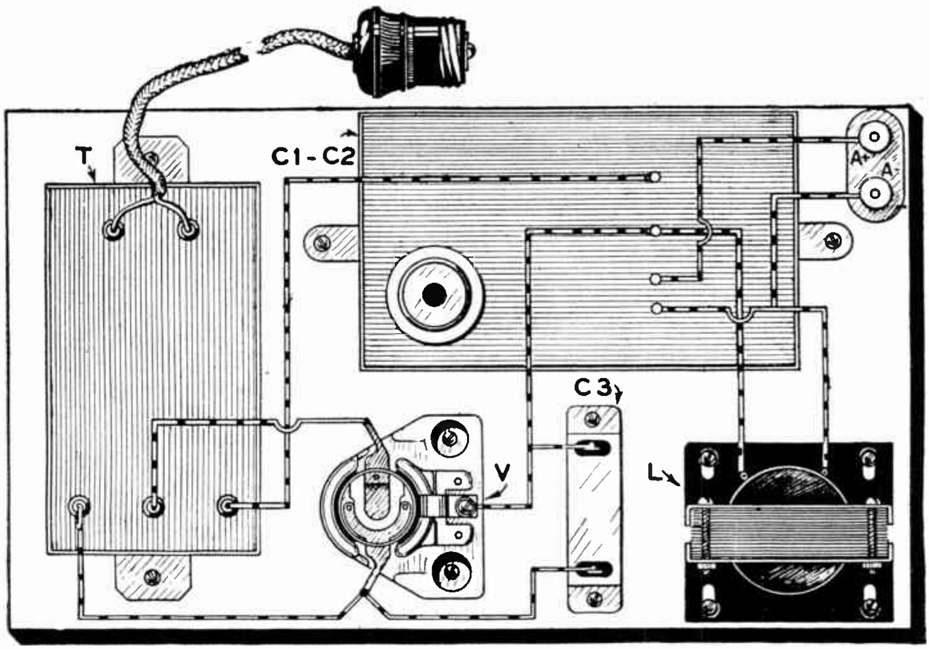
EASY ASSEMBLY

When constructing the power unit it is advisable to follow the arrangement of parts shown in the drawing; all apparatus should be fastened to the baseboard with wood screws. If any other arrangement of parts is desired, do not place the transformer in a position which is near to the wires which connect with the filament binding posts of the receiving set. The transformer sets up a magnetic field, which is confined as much as possible by the metal case; but the leads to the rectifier tube and choke coil might have sufficient effect upon the output wires to cause a hum to be heard in the receiver, if the two were in close proximity to each other.

The wiring of the unit is so simple that it is unnecessary to give complete directions for making each connection. However, it is important to remember that all wires



The simplicity of the "A" power unit described is shown. All parts are mounted on a small wooden base and a few flexible wires are the only connections necessary. The letters designate the parts listed on the following page.



In this pictorial wiring diagram the exact arrangement of parts and methods of wiring the "A" power unit are shown. All parts and wiring are located above the base, which is a block of wood 12x7x¾ inches. Also, when making connections heavy, flexible, insulated wire should be used.

carry currents of large values, and, therefore, it is advisable to use fairly heavy wire in order to reduce resistance losses. Also, remember that the unit is power apparatus, and take particular care to see that it is well insulated.

PREPARING THE CONDENSER

In preparing the unit for operation after the construction has been completed, the first step is to add water to the electrolytic condenser. Proceed as follows: Remove the cork from the filler opening and throw it away. Next, pour half a pint of distilled water into the opening and allow the unit to stand for approximately ten minutes. It will become warm, because of the chemical action which results when the salts in the condenser are dissolved. After ten minutes, add sufficient distilled water to bring the liquid level up to the cross bar, which is plainly visible in the filler opening. Now rock the condenser gently, to help dissolve the chemical, and to assist the liquid in entering the spaces between the condenser plates. Upon examination it will probably be found that the liquid has gone down and, if such is the case, it will be necessary to add more distilled water in order to bring the level up to the cross bar. The rocking operation may be repeated again and then the condenser should be allowed to stand for fifteen minutes. Before using the unit, examine the liquid level again and fill with additional distilled water, if necessary. However, do not fill the condenser above the cross bar. Also, do not place the cork in the filler opening but use the nickel filler cap which is supplied with the condenser.

POWER SWITCH REQUIRED

After the condenser has been prepared as described above, the rectifier tube may be inserted in the socket and the "A" power unit may be considered ready for use. However, provision must be made for turning the unit on and off, and a battery switch *must not* be used for the purpose. If the builder wishes, he may add two extra binding posts to his receiver and connect them to a 110-volt switch which may be mounted on the front panel; or he may turn the unit on and off at the light socket. In either case it must be remembered that the filament switch on the panel of the set can no longer be used to turn the set on and off. It is a wise plan to join together the two wires going to this switch, and remove the switch from the panel. If desired, the 110-volt switch may be mounted in the same space after the old switch has been discarded.

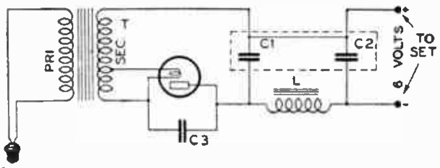


Fig. 1

The above schematic wiring diagram shows the complete circuit of this simple "A" power unit. The parts indicated follow: T, power transformer; V, rectifier tube; C1-C2, electrolytic-condenser bank; C3, by-pass condenser; L, heavy-duty choke coil.

When both "A" and "B" power units are used for the operation of the receiver, still another problem presents itself. Both of these units are turned on in the 110-volt circuit, and they may be operated with the same switch. In the small picture diagram (Fig. 2) a suitable circuit is shown. The plugs of the "A" and "B" power units, which ordinarily go to the light socket, are connected together in a double socket; the double socket is placed in an ordinary receptacle; one wire from the receptacle connects directly with the light socket, and the other wire connects with the switch and then with the light socket.

HINTS ABOUT OPERATION

If, after the unit has been placed in operation, a hum is noticeable in the loud speaker, there are several places to look for trouble. In the first place, make sure that the 110-volt wires do not come in close proximity to the 6-volt wires which go to the receiver. Also, all pairs of wires in the 110-volt A.C. circuit should be twisted. Secondly, the liquid in the condenser cell may be low, and if this is the case distilled water should be added. Lastly, the power unit may be located too close to the detector and audio circuits of the set. It is wise to try moving the unit, as a more satisfactory position may be found.

In connection with the operation of this unit there are several other things which should be remembered by the constructor. The power transformer of this device handles a large amount of current, and as a result becomes hot after continued operation. In normal operation it is too hot to touch.

The liquid in the electrolytic condenser will damage carpets or furniture, if spilled on them. If any of the liquid is accidentally spilled it should be neutralized at once with vinegar and washed off. If it is spilled on the hands, they should be washed immediately with soap and water.

If the liquid of the condenser becomes too low, no harm is done; but the unit will cease to function. It is usually possible to tell by an increase in the hum, when additional water is required. However, on an average, it is wise to add water twice each year.

Frequently it will be unnecessary for the radio fan to buy all of the parts listed below when building this unit If an old battery charger is available, this may, sometimes, be used in place of the rectifier tube and transformer. Most battery chargers consist of a transformer and rectifier, and if one is of efficient design, a filter system of the type used in this circuit will convert it into an "A" power-supply unit. However, the mechanical or vibrating type of charger should not be used, as it will not give satisfactory results. Chargers which are best suited for this purpose should use a rectifier of the tungar-tube, electrolytic-cell, dry-electrolytic or cartridge type.

If a battery charger is used, in place of the transformer and rectifier of the power unit, the constructor should discover whether a transformer or an auto-transformer is used, by testing the windings with a pair of phones and a battery.

SYMBOL	Quantity	NAME OF PART	REMARKS	MANUFACTURER ★	
T	1	Power transformer	Tapped 7½ volt secondary (special)	1	
C1,C2	1	Filter condenser	Electrolytic type	2	
L	1	Choke coil	Heavy-duty type (special)	1	
C3	1	By-pass condenser	.25 mf.	3	6,7,8,9,10
V	1	Rectifier tube	2-ampere type	4	11
	1	Porcelain socket	Three-contact type (for rectifier tube)	1	
	2	Binding posts		5	12
		Hook-up wire	Spaghetti covered	6	
	1	Baseboard	12 x 7 x ½ inches (wood)		

NUMBERS IN LAST COLUMN REFER TO CODE NUMBERS BELOW.

1 Setbuilders Supply Co. (Setco)	2 The Abox Company	3 Dubilier Condenser Corp.
4 General Electric Company	5 H. H. Eby Manufacturing Co.	6 Acme Wire Company
7 Tobe Deutschmann Company	8 Potter Mfg. Company	9 Polymet Manufacturing Co.
10 Aerovox Wireless Corporation	11 Westinghouse Electric Mfg. Co.	12 X-L Radio Laboratories
13	14	15

★ THE FIGURES IN THE FIRST COLUMN OF MANUFACTURERS INDICATE THE MAKERS OF THE PARTS USED IN THE ORIGINAL EQUIPMENT DESCRIBED HERE.

If you use alternate parts instead of those listed in the first column of manufacturers, be careful to allow for any possible difference in size from those originally used in laying out and drilling the panel and sub-base.

How to Build a Dynamic Speaker

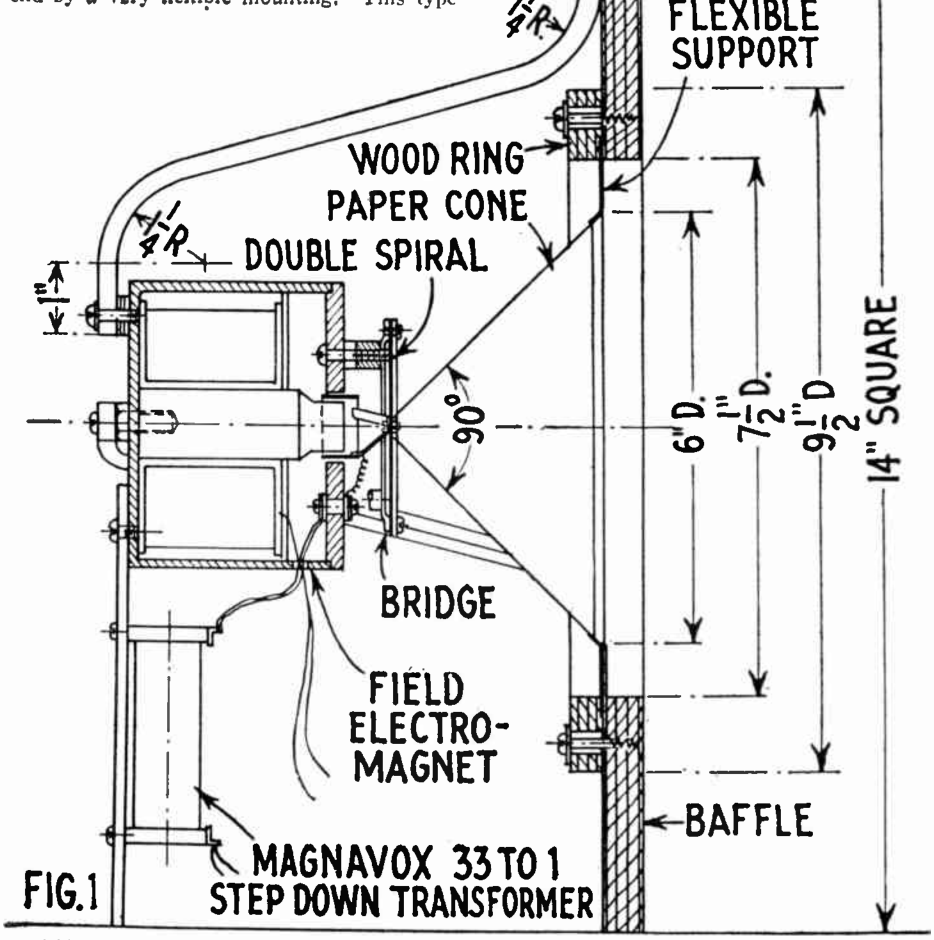
Directions for Constructing an Electrodynamic Cone Loud Speaker Capable of Giving the Finest Quality

By Edgar C. Nichols

GOOD electrodynamic cone speakers are expensive. For this reason a description of how to build one should be of interest to the home constructor. The writer gives here details of the method by which he successfully contructed one.

There are two types of cone speakers, free-edge or the inertia-controlled (ninety-degree) cone type and the fixed-edge or wave or flat-cone type. The former has been chosen as the one which will give the best results for the home speaker, inasmuch as this type reproduces all sound frequencies at any volume. In the flat-wave cone type there is a tendency to cut off the bass notes when operating at lesser volume. This type of cone vibrates within itself, reproducing the higher notes by the vibration of a small area about the center of the cone and the bass notes by vibration of the entire cone area. Therefore, unless sufficient volume is used the bass notes are lost.

In the inertial type of cone speaker the sound is reproduced by the *piston action* of the rigid cone, which is supported at each end by a very flexible mounting. This type requires a baffle, separating the inner from the outer surface of the cone; so that the piston action of the cone will affect as large an air column as possible and there shall be no loss of energy, due to the air slippage around the greatest diameter of the cone. This baffle is very essential for the correct reproduction of the bass notes and should be made as rigid and as large as possible, within reason; that is, from fourteen to eighteen inches square. If the speaker is put in a case, the back should be left open so that volume may not be sacrificed. This case, too, may be considered a part of the baffle.

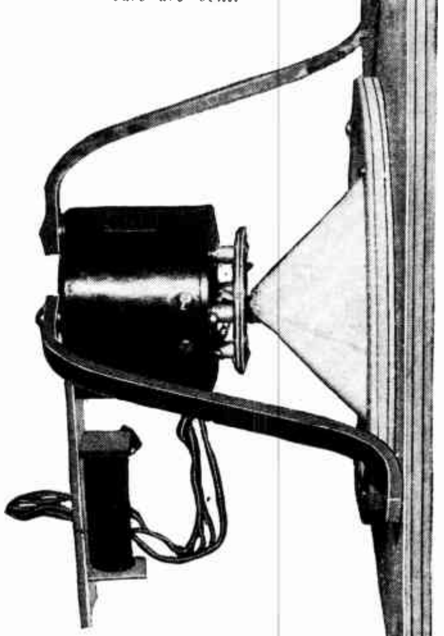


This cross-sectional view of the electrodynamic speaker gives most of the necessary dimensions.

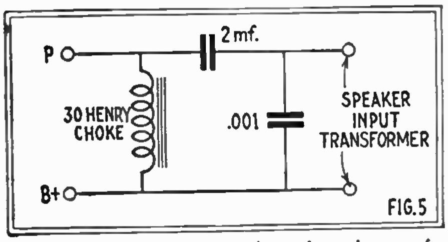
OBTAINING THE COILS

To simplify as much as possible the construction of the speaker, parts from a Magnavox horn speaker, type R3, model B, have been used. These speakers are now antiquated, but many have been manufactured and sold, so there should be no difficulty in securing one at a low cost. From this speaker we may obtain the electromagnet for the field and the armature coil for actuating the cone. To make coils of so many turns is impracticable for the home constructor. The bridge, which was used in the old Magnavox speaker to mount the diaphragm, may be used in our speaker as an adjustable mounting for the armature coil and apex of the cone. The input transformer is used "as is" for the new speaker.

This illustration clearly shows the shapes into which the supporting bars are bent.



The success of the speaker depends upon the rigidity of its construction and, as the field electromagnet is very heavy, it must be well supported. This is accomplished by three ¼ x ½-inch brass rods, which are bent to shape as shown in Fig. 1. The brass is annealed before bending, by heating it to a dull red and then plunging it into cold water. These rods are fastened to the electromagnet by screws at the back of the magnet. The magnet is aligned by using washers as shims under these screws; so that it is actually adjusted to the axis of the cone. There is also required a vertical leg, made of bakelite or hard rubber, for a back support. The input transformer may be mounted on this leg. The electro- or field-magnet draws one ampere at six volts, for a "flux density" of approximately sixty thousand lines per square inch. This current may be supplied from the radio



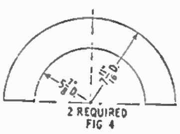
A filter circuit for use before the primary of the speaker input transformer, which is wound with very fine wire.

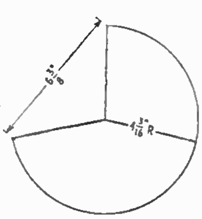
"A" battery or by the use of a full-wave trickle charger.

When dismounting the old speaker great care must be taken to see that the fine wires of the armature coil, which is mounted on the diaphragm, are not broken. This armature coil must be so arranged in the new speaker that it may be adjusted to the field electromagnet. To accomplish this it is mounted in the center of a double spiral made of very thin sheet formica or celluloid. (See Fig. 2). This is done in the following manner: the coil proper is supported on a tripod, which in turn is bolted and cemented, with household cement, to the center of the double spiral. It is very important that the axis of the armature coil shall be at right angles to the plane of the double spiral. This double spiral, in turn, is clamped by the bridge which, in the old speaker, mounted the diaphragm. The old diaphragm is discarded. The armature coil leads are then connected to their terminals on the electro-magnet, by means of helices made of very fine enameled wire. The coil is adjusted so that it cannot strike the poles of the electro-magnet and the double spiral is clamped in place.

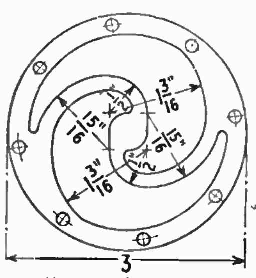
CONSTRUCTING THE CONE

The next step will be to manufacture and mount the cone, which is made of a cold-pressed "water-color" paper. By many experiments this paper has proved to be the best for this purpose. The cone is six inches in diameter and the included angle is 90 degrees. (See Fig. 3 for details of this cone.) The two edges for the glued joint are "feathered" with a razor blade in order to make a smooth job. Liquid glue is used here, being put on both edges, which are then placed together with a 1/16-inch lap and protected on each side by a strip of paper. A pencil is then laid lengthwise of the joint and the whole is clamped by means of a wood clamp to a table until the joint is thoroughly set. When the cone is released the paper strips placed to protect the joint are carefully torn away. A narrow strip will remain along the joint, but this is not objectionable.



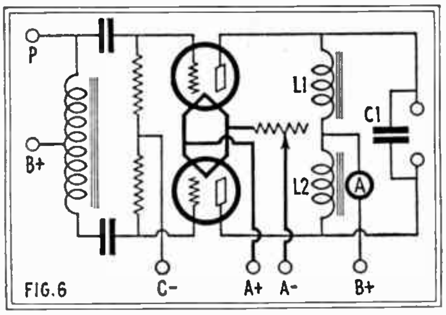


DEVELOPMENT OF CONE
FIG. 3



DETAIL OF DOUBLE SPIRAL
FIG. 2

Fig. 2 shows the double spiral on which is mounted the armature coil; Fig. 3, the dimensions of the paper cone; and Fig. 4 the dimensions of cone support.



A push-pull stage of A.F. amplification will supply undistorted power to the dynamic speaker.

The larger end of the cone is supported by a flexible ring made of bookbinders' "skives" of thin leather, or a support made of "gold beaters' skin" may be used. If the latter is used it must be treated with glycerine after it is mounted, to take out the rustle. Liquid glue is about the only cement which will hold gold beaters' skin to the paper cone and it must set thoroughly. The skin must be cleaned with gasoline to remove any grease, before the glue is applied. Care must be taken that the skin is not stretched tight, especially as the glycerine has a shrinking effect. If it is too tight a drumming effect will be produced, which is undesirable. (See Fig. 4 for details of this flexible support.) ("Gold beaters' skin" is a thin membrane, similar to sausage cases; and it is quite possible that a good quality of the latter, or perhaps a bladder, could be used for this purpose. "Skives" are very thin parings of soft leather, which must be made with an extremely sharp blade.—EDITOR.)

Before the flexible support is glued to the cone, it should be glued to a five-ply-veneer wooden ring which is ½-inch thick, 7½ inches inside diameter, and 9½ inches outside diameter. Here liquid glue is again used. After this the inner edge is glued to the cone, as explained above. The wooden ring is fastened to the baffle by four screws. The holes for these screws in the ring are made somewhat larger to allow for adjustment, washers being used under the screw heads to hold the latter from drawing into the holes.

The baffle is made of five-ply wood veneer, ½-inch to ¾-inch thick. It is fourteen to eighteen inches square and has a hole in the center, 7½ inches in diameter.

ASSEMBLY

The following proceedure is used in assembling the speaker: the baffle is laid flat upon a table, and the cone, mounted in its wooden ring, is placed concentrically on it with respect to the hole in the baffle. The cone is then clamped to the baffle with the four screws in the wooden ring, as explained above. The field electro-magnet, with its three brackets and the armature coil mounted on its bridge, is placed in position and adjusted so that the apex of the cone comes in the center of the double spiral mounting the armature coil. Then the locations for the three wood screws, fastening the brackets to the baffle, are determined and the brackets are fastened in place to the baffle with these screws.

The speaker is then placed in its proper position and the apex of the cone is cemented to the double spiral as follows: the bolt fastening the armature coil to the spiral will extend through into the apex of the cone; and the apex and bolt and spiral should all be securely fastened together with household cement. After the cement has thoroughly set, the speaker is ready to try out. Sometimes we find that it is still necessary to make minor adjustments, because of the armature coil's striking the field magnet poles. This adjustment is accomplished by slightly loosening the clamping of the double spiral in its bridge mounting and adjusting the spiral so that the buzz is eliminated. Any adjustment of the cone for alignment at the larger end is done by loosening the four screws.

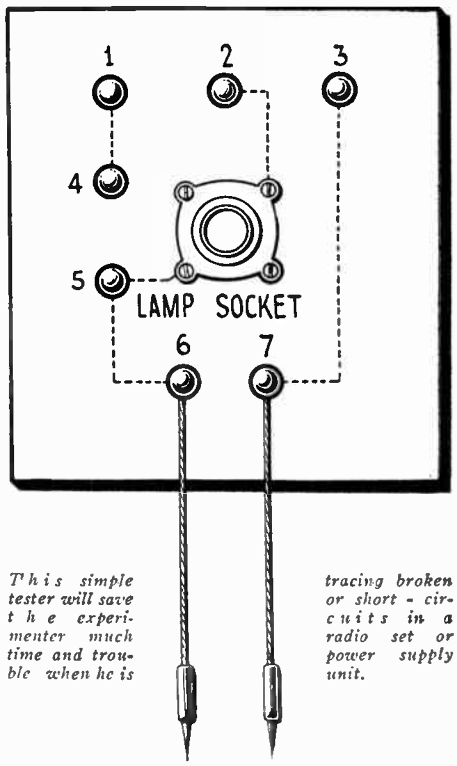
A Cheap and Handy "Trouble Shooter" for the Experimenter

By S. Saunders

A HANDY trouble-shooter that will operate either on the house lighting circuit or on batteries is a useful addition to any radio work shop. A tester of this kind for use in tracing broken wires, short circuits, etc., can easily be made at home at a very reasonable cost.

The mounting board should be 5 inches wide, 8 inches long and at least one-half inch thick. Seven binding posts are required, and should be mounted as shown in the accompanying diagram. The lamp socket should be wired in series with posts No. 2 and No. 5. Use a 110-volt lamp of not over 25 watts rating in this socket. Next, make up two five-foot portable cords and solder two 5-inch pieces of No. 8 copper wire to one end of them. Wooden handles may be slipped over the soldered splices for convenience in handling, and the ends of the wire filed down to a sharp point. These cords are then connected to binding posts No. 6 and 7. A cord and attachment plug should next be made up of sufficient length to feed the tester from the light socket. These feeders connect to posts No. 2 and 3. When using battery current attach the feeders to No. 1 and 3 and connect a pair of headphones to posts No. 4 and 5.

The battery and headphones will be found best for testing high-resistance coils, audio transformers and similar units in the set.



This simple tester will save the experimenter much time and trouble when he is tracing broken or short-circuits in a radio set or power supply unit.

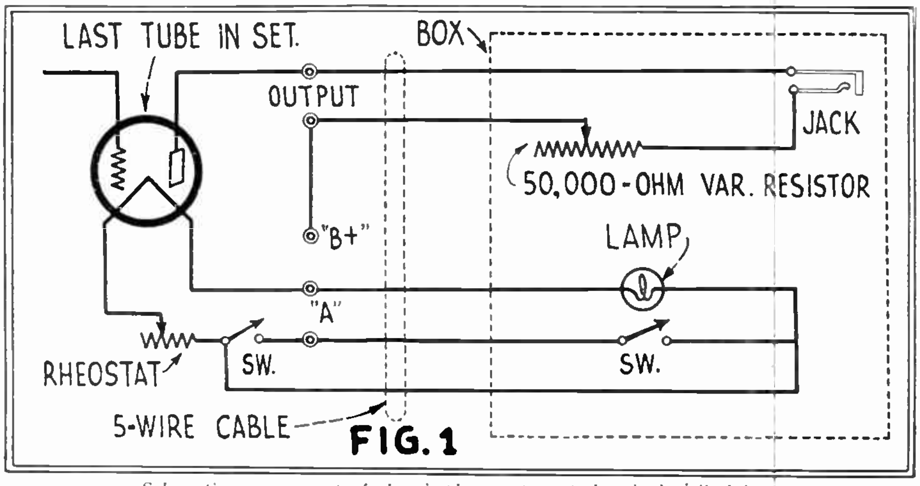
A Simple Remote Control Device

Quite a Demand for an Item of This Type has Brought Forth This Clever Arrangement which has Proved its Worth in a Number of Installations

By William F. Crosby

THE prime requisite of a radio remote-control device is that it be compact. It should be also cheap and easy to make and capable of being adapted to almost any form of circuit. In working along these lines, the writer has reached what he believes to be a practical solution of the problem.

The instrument described in this article *will not tune the set* and was not designed to do so, for several very good reasons. In the first place, the average set-owner's receiver is left tuned to one station most of the time, anyway; and constant adjustment of its dials is not necessary. In the second place, after experimenting with such devices for several months, the writer has been forced to the conclusion that their expense, size, and the fact that they cannot be used on every type of receiver, necessitated the abandonment of the idea of using remote tuning devices, in the ordinary home, in favor of the little instrument about to be described.



Schematic arrangement of the simple remote-control unit described here.

This device is so simple and cheap that anyone can build one in an evening. Where the necessity arises, two, three, four or five of them may be connected in parallel, in such a way that the radio set may be turned on or off from any room in the house. The variable high resistor employed makes it possible to control the volume from a whisper to the full power of the set. One or all of these controls may be used at the same time, to control different speakers in different parts of the house.

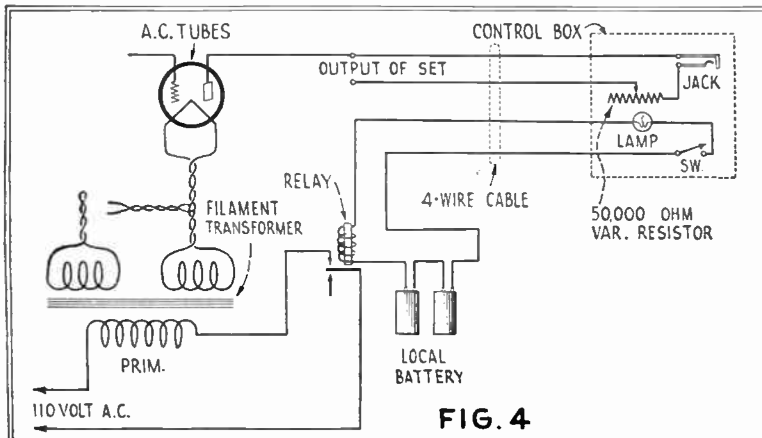
There is just one essential requirement, and that is, that the wires in the cable shall be sufficiently heavy to carry the "A" circuit current without appreciable loss in voltage. The heavy wire (about No. 18) which is used in the average battery cable has been found satisfactory so long as the distance does not exceed twenty-five or thirty feet. For distances in excess of this, the size of the wire should be increased somewhat, because the resistance of the regular wire may be too great. Where several of these remote controls are used, it is advisable to wire the house with heavier cable (No. 14 or No. 12), taking off the leads to the various remote controls as they are wanted in the different rooms.

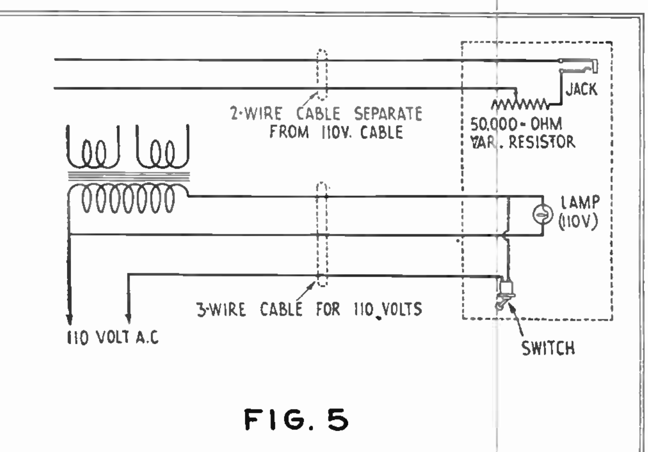
It is highly essential to use wire which has insulation of different colors, in order that the connections may be readily identified; but, where this cannot be done, a "tracer" circuit, consisting of a low-voltage battery and a pair of head receivers, should be used to determine the ends of the various wires. If the ends of the wires are grounded, one at a time, while the other ends are tested with the receiver and battery connected to an adjacent ground, it will be a simple matter to tell the wires apart. Each should be tagged, if the insulation is all of one color.

DESIGN OF THE UNIT

The remote-control unit itself is only about six inches long and two inches wide, and set into a box about two inches deep. The panel may be bakelite, hard rubber or a suitable piece of wood, secured in a wooden or metal box in such a way that the entire assembly will look like a miniature radio set. It is suggested, though, that the panel be placed on top instead of the side, as this will make it somewhat easier to operate.

Exactly in the center of the panel we place a variable high resistor, in the neighborhood of 50,000 ohms as its maximum value. On one side of this we place a pair of tip jacks, or, as in the case of the unit shown in the illustrations, a combination jack. On the other side and spaced at equal distances from the center, we have an ordinary battery switch, of either the push-pull or the toggle type. Above this will come a miniature-lamp socket, fitted with a small six-





At the left, the remote-control unit is used to operate an electric set by means of a local battery and high-resistance relay. With the direct A.C. connection at the right, a power switch and a 110-volt pilot lamp must be used.

volt bulb. Through the panel over this bulb is inserted a ruby lens, which will show a red light when the battery switch is turned on; this is optional, but its use will be found both attractive and advantageous.

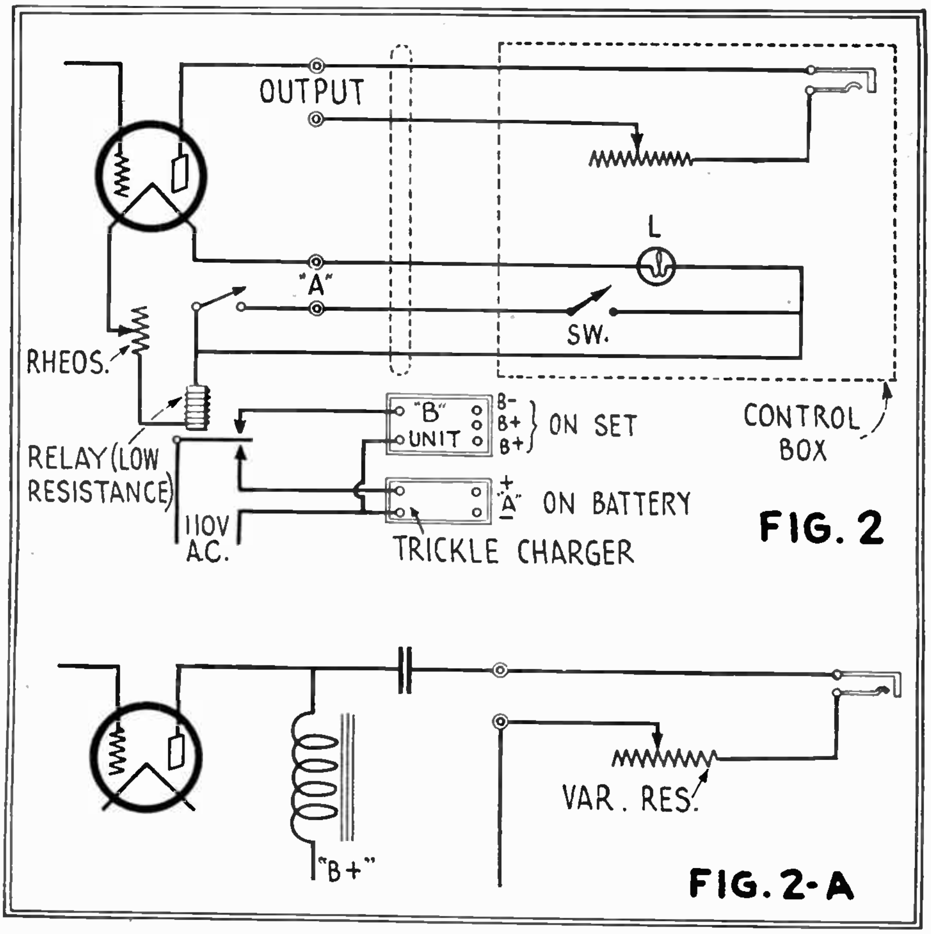
The wiring is clearly shown in Fig. 1 and also in the drawing of the back of the panel, Fig. 6. One side of the lamp socket is connected to one of the terminals on the battery switch, and from here a wire in the cable is taken to the set. The other post on the battery switch will go to one side of the "A" battery circuit, the polarity having no effect in this case; while the remaining terminal on the socket will be connected to the opposite battery terminal. These two battery connections may be made either at the set, direct to the battery or through a cable which may be run throughout the entire house. The variable resistor is simply connected to one of the output binding posts or the output jack on the set; while the other terminal of the resistor is wired to one of the phone tip jacks. The other jack terminal will be wired directly back, through the cable, to the remaining output terminal on the set.

VARIOUS CONNECTIONS

This is shown in Fig. 1, which, in addition, shows the actual terminals as they are connected to the set. Note that one wire (the lowest one) runs inside the set to a point above the battery switch. If no battery switch is used, this connection will be made above the first rheostat. With this connection, the switches on both the set and the remote control are interlocking in such a way that, when either switch is turned on, the red light in the remote control will be turned on.

In Fig. 2, we have the same arrangement, but in this case it is necessary to turn on a "B" socket-power unit when the set is turned on, and a trickle charger for the storage "A" battery when the set is turned off. A low-resistance, double-acting relay does the trick here and it should be connected exactly as shown in the drawing. These devices may be purchased at almost any radio store. You will note that the relay is so connected that, when the "A" battery circuit is closed, the armature will come down and make contact, closing the 110-volt circuit and thus putting the "B" supply unit in action. When the "A" battery circuit is opened, the armature on the relay springs upward and closes the 110-volt circuit to bring the trickle charger into use. It is highly essential that *this relay be of low resistance;* otherwise it will take so much current to pull it down that the "A" battery will not be able to supply enough for the tube filaments. (An old telegraph sounder will NOT do the work.)

Fig. 3 is simply a repetition of Fig. 1 except that it shows how two remote controls may be used at the same time. Additional instruments may be added by simply connecting them in parallel.



Above, the remote-control device wired for use with a "B" unit and trickle charger; at the bottom, the connections when an output filter is added. The "A" battery is connected across the terminals marked "A."

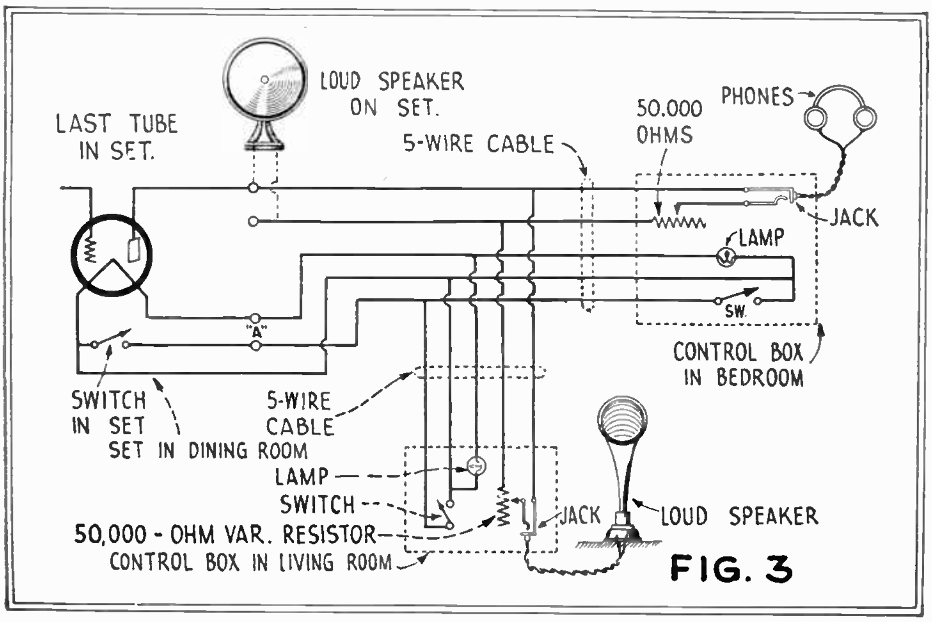
FOR ELECTRIC SETS

Fig. 4 indicates the remote control as connected to a set using full A.C. operation. Here, in order to keep the 110-volt circuit out of the remote control, a small "local" battery (several dry cells) is used to actuate the relay. This closes the 110-volt circuit, the current of which, in turn, passes through the primary of the transformer, the secondary windings of which heat the filaments of the A.C. tubes. Of course, the use of a local battery in the relay circuit is not exceptionally good practice, because sooner or later the batteries run down and then the relay will fail to work. It is for this reason that Fig. 5 has been drawn. Here we have full A.C. operation of both set and remote control. *The relay for use with a local battery should be of the high-resistance type.*

However, it will be necessary to make a few changes in the device, the most important one being the employment of a better and heavier switch, capable of handling the 110-volt circuit without trouble.

A regular electric-light toggle switch will

(*Continued on page* 106)



It is possible to operate several speakers from a number of these remote-control units when wired as shown. The pilot light indicates at every unit if the set has been turned on at any of them.

D. C. to A. C.—And How

How a Receiver Ordinarily Using D. C. Tubes Can Be Converted Into an Electric Set by the Use of Adapters and A. C. Tubes

THERE is considerable confusion in the mind of the general public as to what constitutes an A.C. radio set. Various interpretations may be made of the degree to which any particular power combination can be considered an A.C. unit; it is not the purpose of this article to discuss this question, for its answer is to some extent a matter of opinion. We will briefly describe, however, what is generally accepted as the nearest approach to alternating-current operation; namely the use of raw A.C. directly on the filaments or heaters of all the tubes in the set. Some people have been led to believe that the use of A.C. tubes does away with transformers, "B" power units and the like. Such is not the case, however.

For the benefit of a great many experimenters and home set builders who wish to convert their present battery-operated sets to the use of A.C. tubes, this article covers the changes required in an average six-tube set of the tuned-radio-frequency type.

THE TRANSFORMER

For equipment, a step-down transformer for filament or heater current is the first requisite. The choice of this transformer depends upon whether the constructor wishes to use only the separate-heater tubes of the 227 type; or whether the raw A.C.-filament tubes of the 226 type are to be used for R.F. and first A.F. amplifiers. If only separate-heater tubes of the 227 type are to be used, the transformer should be capable of delivering 1.75 amperes per tube, at 2.5 volts, without any material drop in voltage; it is preferable to have at least a 15% overload factor above these requirements. If the 226-type is to be used in the R.F. and first A.F. amplifying stages, the transformer should deliver also 1.10 amperes per tube, at 1.5 volts.

It is advisable to use for the last audio stage a 171-type tube, which is operated on raw A.C. at 5 volts. The transformer should have an additional 5-volt winding for this tube.

Unfortunately, A.C. line voltage throughout the country varies a great deal in two ways. The designed standard voltage of the particular distributing system may be 104, 110, 115, 125 volts or some point between; and, under certain load conditions, the actual voltage at any given point also may vary from hour to hour, above or below the standard voltage of the power station. This latter condition is not common in large communities, where the load is handled efficiently. However, the situation is a difficult one from the standpoint of transformer manufacturers, but several have met the problem by designing step-down transformers which will deliver full voltage at the *lowest* primary potential that may be expected. This, in turn, means that primary taps, rheostats or resistors of some sort will be necessary when the primary voltage is higher than this minimum.

The reader should not, however, gather the impression that the 226- and 227-tubes are extremely critical on filament or heater current; as in fact a liberal percentage of voltage variation is allowed for in the tube design. Indeed, will it be seldom necessary to change the filament or heater resistances to compensate for temporary line-voltage fluctuation, once *your particular average voltage* is determined and adjusted for.

Another good reason for using a transformer with over-voltage output at the terminals is that, in various converted sets, some may have more voltage drop than others due to the wiring. It is, therefore, considered the best practice to use a step-down transformer with a liberal over-voltage factor.

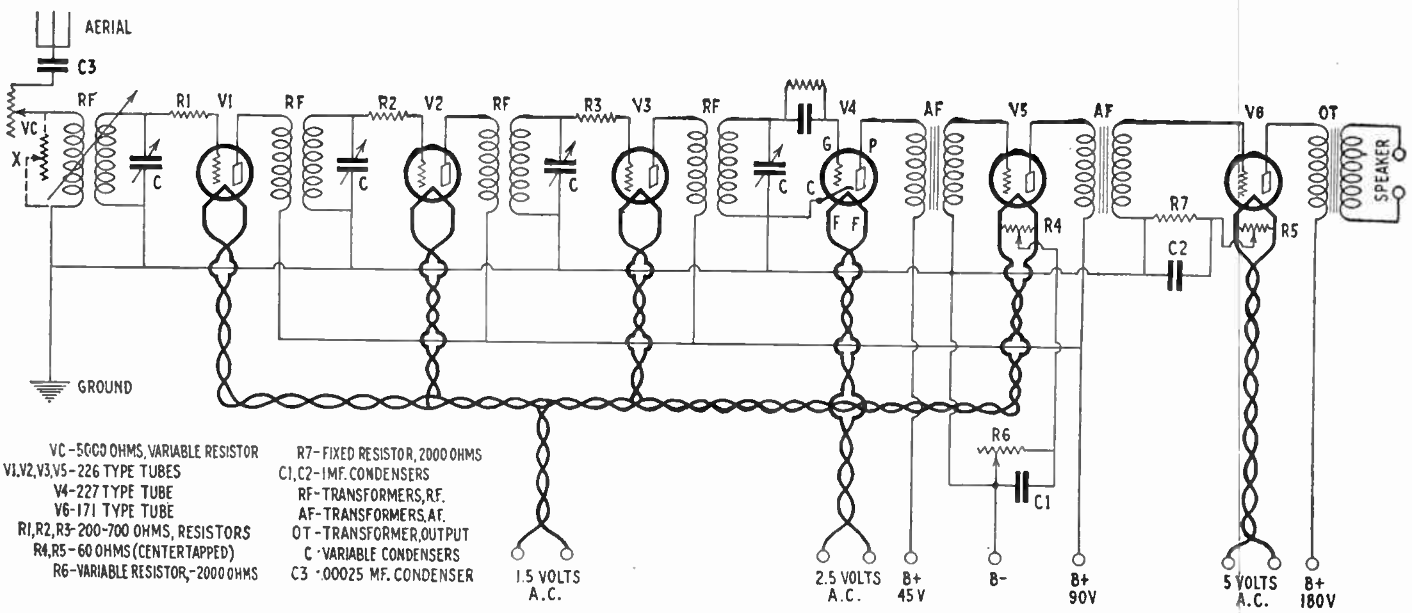
PLATE-POWER SUPPLY

The "B" supply device may be any good unit available and does not differ from that used with the battery-operated sets. Complete "A B C" power packs designed to supply all power requirements for A.C. sets are making their appearance on the market, and will undoubtedly be widely sold. In considering the purchase of these units, care should be taken to see that they meet the conditions previously outlined.

The center-tapped resistors (R4 and R5) may be purchased in the market, or made by winding up with fine resistance wire a 60-ohm unit tapped in the center. If a potentiometer is used, one with a resistance around 20 ohms will be necessary. A fixed 2,000-ohm resistor (R7), shunted by a 1-mf. condenser, is required for the last audio bias; and a similar combination (R6) is used for the amplifier bias except that the latter resistor should be variable or tapped, to meet varying conditions encountered in sets.

NEEDED ALTERATIONS

The actual rewiring and changes in sets to be converted follow in general certain standard practice. We discuss here the average six-tube set, consisting of three stages of R.F., a detector, and two stages of A.F. The accompanying schematic diagram shows the wiring for the conversion when using the 226-type tubes in the R.F.



The schematic diagram shows the wiring connections of a receiver originally designed for D.C. tubes and converted into one operating with A.C. tubes. X is an optional type of volume control; its range should be 0 to 5 megohms.

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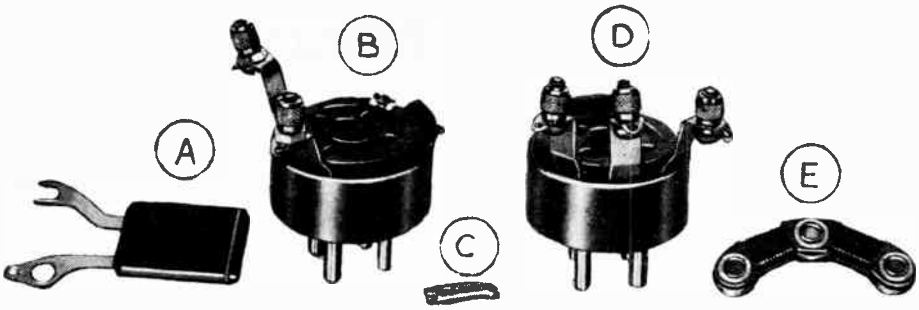
* *Prepared by the Engineering Department of the C. E. Mfg. Co., Inc.*



Parts used in connection with the new wiring harness: A, by-pass condenser; B, tube adapter for R.F. circuits; C, grid suppressor; D, tube adapter for A.F. circuits; E, center-tapped resistance unit.

and first A.F. amplifiers, the 227-type in the detector and the 171-type in the last audio stage. Should the constructor wish to use 227-tubes in all except the last A.F. stages, the procedure is similar; except that the cathode lead of the R.F. and first A.F. tubes is to be substituted as a connecting point for the center tap of the 227-tubes. The use of center-tapped resistors at heater terminals of the 227s, with the center lead going to the cathode, is also advisable.

The fan who wishes to convert his battery-operated receiver into a set using A.C. tubes may easily do so, and he will find that there are two methods which he may follow. In one case it is necessary to remove all filament wiring in the receiving set, and then rewire the filament circuits for A.C. tubes. This is a simple operation, but requires some experience in set construction if best results are to be obtained.

For the radio fan who does not feel competent to rewire his set, or who wishes to convert it for A.C. tubes in the least possible time and with the slightest effort, several manufacturers have developed and placed on the market simple A.C.-tube adapters and harnesses. With these adapters it is possible to convert a D.C. set into one using A.C. tubes in a very few minutes, and without the necessity of changing any wires in the receiver except a few grid returns.

USE OF A.C. TUBE ADAPTERS

As the adapters are of different types, it is difficult to write a general description which applies to all units. However, each kit is supplied with directions which explain exactly how the installation is best accomplished.

Usually each kit contains one adapter for each tube, and these adapters fit in the tube sockets of the set; while the tubes are inserted into the adapter. These adapters connect the grid and plate prongs of the tubes with the proper terminals of the socket, but insulate the filament prongs from the filament wiring of the set. On the adapters terminals are provided which connect with the filament prongs of the tubes, and the harness is connected with these posts; the harness, which is correctly arranged for A.C. tubes, replaces the filament wiring in the set. In order to light the tubes it is necessary only to connect the free ends of the harness with the proper terminals of a filament transformer.

Arrangements have also been made for installing the extra parts which are required; such as center-tapped resistors, by-pass condensers, grid resistors, and biasing resistors. The center-tapped resistors are designed so that they may be correctly connected in the circuit by fastening them to posts provided on the adapter, and the same is true of the by-pass condensers. The 500-ohm resistors (R1, R2 and R3), which are required in the grid circuit of A.C. sets, fit into slots in the adapters of one make; and provision is usually made for installing the grid-biasing resistors in the cable. The only change which is necessary in the wiring of the set is the installation of a new volume control (VC); this is required, as the rheostats in the filament circuits are made inoperative when the harness is installed.

REWIRING THE SET

In converting the set without the aid of adapters and a harness, the first procedure is to cut away all previously-installed filament wiring and install the 5-prong sockets, for whatever number of 227-type tubes are to be used. The filament and heater wires should be twisted conductors; the average lamp cord has sufficient current capacity for this purpose. Many sets are equipped with battery switch on the panel; this cannot be used to control the A.C. current unless it happens to be one originally intended for use on 110-volt lighting supply. Should the power switch be installed on the panel, care must be taken to insulate the primary line with the same precautions usually adopted in all appliances connected directly to the house mains. Grid returns of all stages are brought directly to ground as shown in the diagram. Oscillation control is obtained by use of grid suppressors in the R.F. stages. The correct resistance values for these suppressors may run from 200 up to 700 ohms or over, because of varying circuit and R.F. transformer characteristics; the desired value is the lowest which will keep the R.F. circuits out of oscillations over the entire wavelength range. This method of oscillation control is the simplest for the constructor. Any control system affecting the 226-type tubes, whether it be for oscillations or volume, which in effect reduces the plate current below the minimum "ripple-voltage point" will not be satisfactory; for, below this critical point, the A.C. hum becomes suddenly apparent. Another procedure for controlling oscillation, which is highly efficient and easily adjusted, is to neutralize the R.F. stages by the conventional capacitive or neutrodyne method. If the set to be converted is a neutrodyne reneutralization for A.C. tubes will probably be necessary. Should the set have a coil system depending upon a scarcity of primary turns on the R.F. transformer to make it non-oscillatory, the use of A.C. tubes will increase the tendency to oscillate; in average sets, however, this increase will not reach the spilling point. In general, any method to control oscillation is acceptable, *provided the plate current is not thereby reduced materially.* By-pass condensers in the R.F. stages are usually essential.

VOLTAGE REGULATION

In the previous discussion of suitable transformers, the filament- or heater-voltage situation was brought out. Our conclusions are that, in the first place, the *average* line voltage must be known. Should the transformer chosen deliver the correct voltage to the tubes no rheostats or resistances are necessary. In many cases this will not occur and therefore a rheostat for all 227-type tubes, or separate ones for the 226s and 227s will be required. No rheostat control is necessary for the 5-volt last A.F. tube.

For the dealer or service man who expects to convert a number of sets, it is suggested that he prepare strips of resistance units consisting of brass wire wound on fiber or similar material. When the set is converted and ready to install, the correct tube voltages may be determined by finding the proper point of resistance adjustment and permanently soldering or clamping the lead. This adjustment must be made on the *final set location.* Of course, the use of a *good* low-reading A.C. voltmeter, 0-3 volts, is essential for determining the proper tube voltages; do not use cheap meters, as they are apt to be inaccurate. The dealer or service man should always have a meter of this kind available for A.C.-set adjustment; for the individual who converts only one set it would be more economical to borrow a meter for the occasion, as the meter may never have to be used again. Should rheostats be used for the A.C. tubes, special types are necessary; as the rheostats ordinarily used in battery operated sets are not heavy enough for the purpose. Suitable

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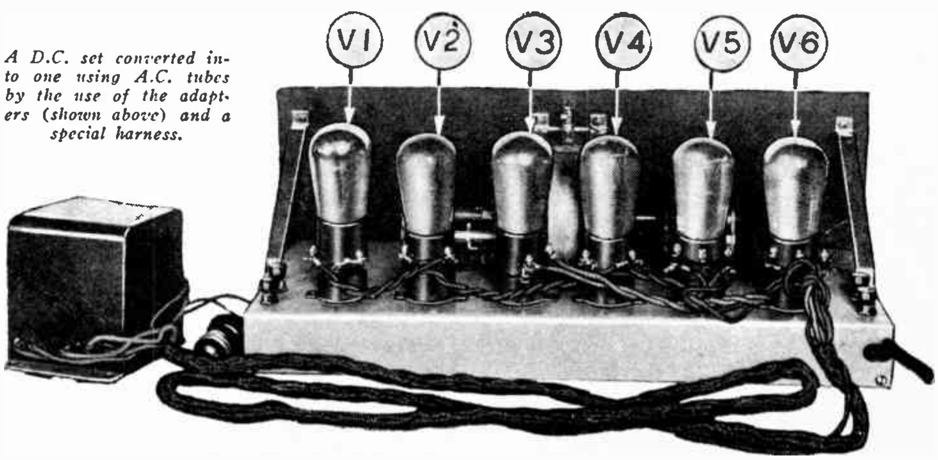


A D.C. set converted into one using A.C. tubes by the use of the adapters (shown above) and a special harness.

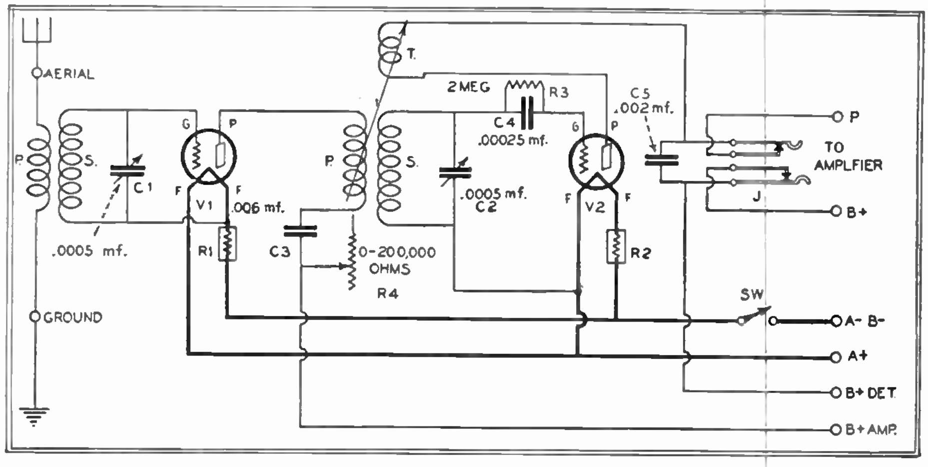
Illustration courtesy Alden Mfg. Co.

*A Simple "Extension" Two-Tube Receiver**

A Simple Receiver Designed for the Beginner Who Desires Efficiency As Well As Simplicity

By Beryl B. Bryant

MANY persons seem to be of the opinion that the simple two- and three-tube receiving sets have gone out of style, and that practically everyone is now using an elaborate receiver employing from five to ten tubes; however this is not the case. Correspondence which we receive from our readers proves, beyond a doubt, that there are just as many beginners today as there ever were; and a large number of these newcomers in the field are anxious to start with simple apparatus.



The "schematic" diagram of a two-tube receiver which may be used with any type of A.F. amplifier. Headphones also may be plugged into the jack, J.

In connection with the frequent requests for data on the construction of simple receivers, it is interesting to note that the type of receiver desired is entirely different from the design which was popular several years ago. In the year 1923 many a broadcast fan, who contemplated the construction of a simple receiver, wished to obtain loud-speaker volume from one tube and was willing to sacrifice quality of reproduction, distance reception and selectivity in order to obtain this end. As a result there was a demand for designs of one-tube reflex receivers employing a crystal detector. At the outset the constructor understood, or should have done so, that the set would not be entirely satisfactory; but he was ready to spend his good time and money to build it in order to get the thrill of receiving broadcast music on a loud speaker.

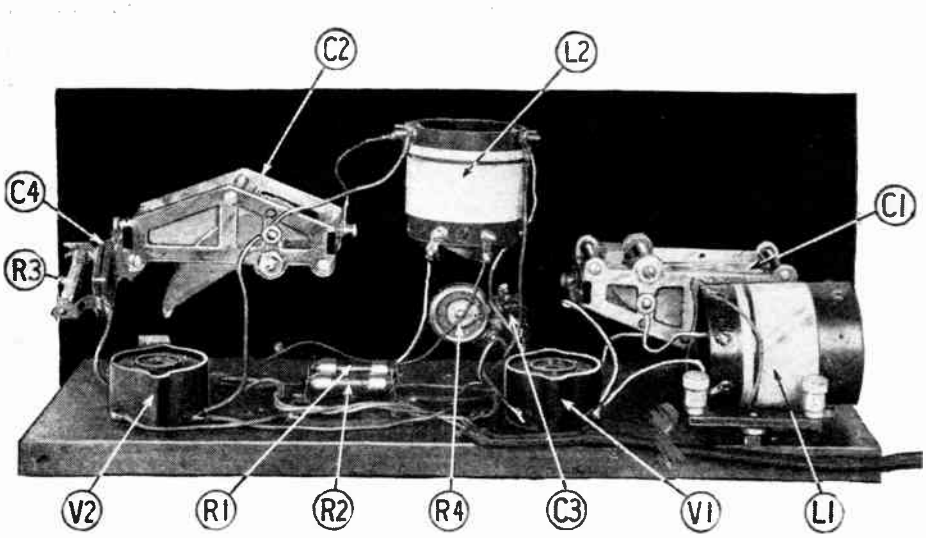
Today conditions are very different. The beginner understands, first, that there are many stations on the air and a radio receiver must be selective enough to separate local stations, in order to assure him any degree of satisfaction from reception. Secondly, he knows that many worth-while programs are broadcast from high-power stations within a few hundred miles and if his receiver is sufficiently sensitive, he can derive much satisfaction from picking up these signals. Thirdly, it has been explained to him that the most desirable feature of a radio set is its ability to reproduce music without appreciable distortion; and, in this connection, he is told also that volume of signal without distortion can be obtained only by using an efficient tuner in connection with a well-designed, high-quality audio-frequency amplifier with a power tube in the last stage.

THE MINIMUM FOR GOOD RESULTS

As a result of the radio education which he receives by reading newspapers and magazines, and by hearing his friends talk over radio problems, the beginner no longer expects the impossible from a simple circuit. He appreciates the fact that freak circuits do not produce the results which are claimed for them, and most satisfactory results are assured by following a standard, accepted design. Also, he does not limit the set which he is to build to one tube, when he has learned from the experience of friends that at least two, and sometimes three tubes are needed when satisfactory headphone reception is desired; *i.e.*, in order that the set shall be selective, sensitive and capable of quality reproduction.

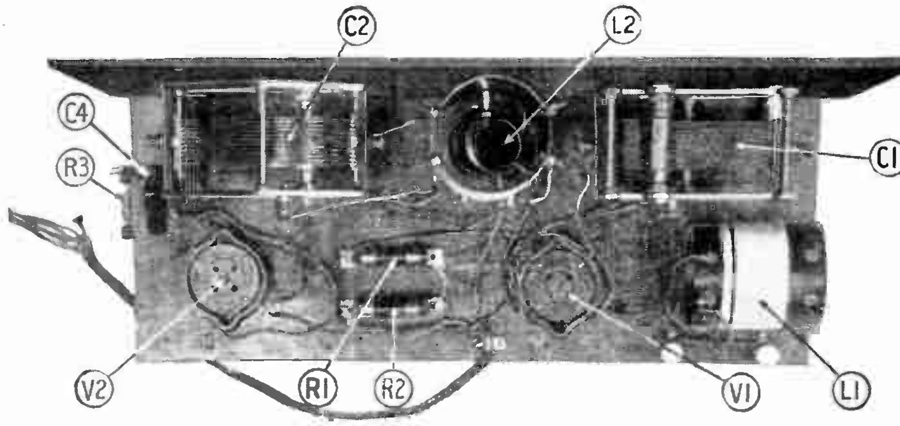
In addition to the points considered above, the beginner, who builds a simple receiver wishes to construct it in such a manner as to permit improvements from time to time; and he desires a set which will compare favorably when such additions have been completed, with the best receivers available. Above all things, he wants to know that his set can be conveniently enlarged so that it will deliver ample loud-speaker volume without distortion.

The receiver described in this article has been designed in the RADIO NEWS Laboratories to satisfy the requirements of the present-day radio beginner. It is a two-tube hook-up employing a well-known standard circuit, which consists of one stage of neutralized-radio-frequency amplification followed by a regenerative detector. When properly constructed, it will be found *equally sensitive and selective with the best of four- and five-tube receivers*; though it will not deliver the same amount of volume, simply because it is not equipped with an audio amplifier, which would require the addition of two or three extra tubes. However, it is readily possible to construct such an amplifier, and connect it to the receiver externally, at any future date, and this addition will make the receiver quite the equal of any four- or five-tube set so far as performance is concerned. In short, it is



Rear view of receiver. L1, antenna coupler; L2, detector-circuit tuner; C1 and C2, variable condensers; R3, grid leak; C4, grid condenser; R4, volume control; C3, .006-mf. condenser.

* RADIO NEWS *Blueprint Constructional Article No. 53.* (*See page* 104).



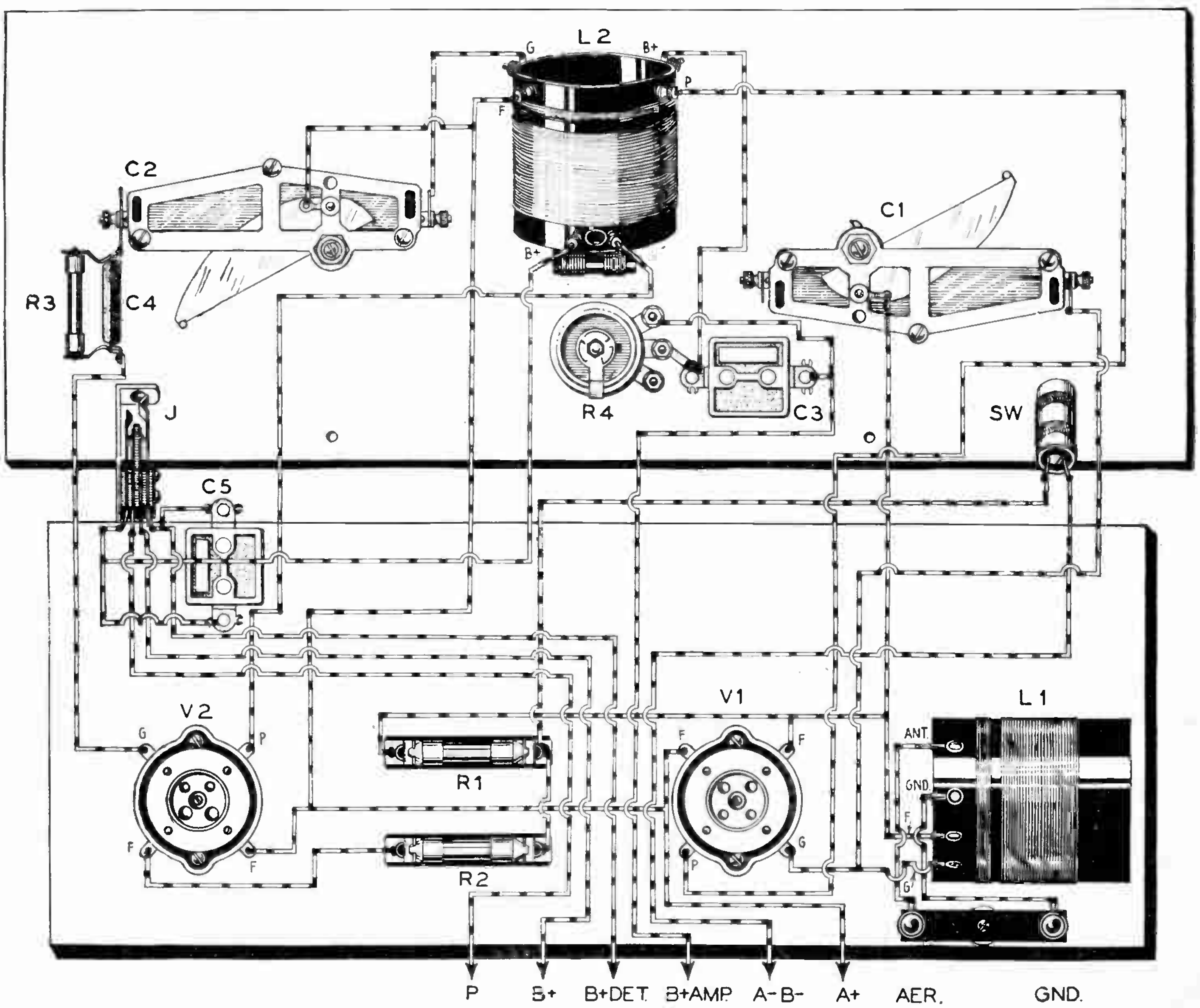
The simplicity and inexpensiveness of the parts necessary for building the two-tube receiver is an advantage. The parts are lettered alike in the illustrations and the lists on page——

a *real* radio receiver which anyone may be proud to own, and must not be considered a joke, or old-fashioned in any sense of the word.

CONVENIENCE OF CONSTRUCTION

Aside from the electrical features of the set, there are many practical advantages possessed by the design. A glance at the pictures will show the prospective builder the features which should require no farther discussion. First, it will be seen that the design of the set is very compact; the panel, on which the tuning controls are mounted, is only 18 inches long and 7 inches high, and the baseboard on which the remaining apparatus is mounted is only 16 inches long and 7 inches deep. This makes it possible to place the set in a small table-type cabinet. Secondly, the mechanical arrangement of the set is very simple and very few tools are required for its construction. The tuning instruments are mounted on a bakelite or hard-rubber panel, but to mount the parts, it is necessary to drill through this panel. The baseboard is wood, ½-inch thick, and this makes it very easy to mount the other parts; as they may be fastened with ordinary wood screws. Of course, if the builder is mechanically inclined he may improve the appearance of the interior of the receiver by using a bakelite or hard-rubber sub-panel, and running all wires under this base. However, this is not necessary, as it would effect no improvement whatever in the electrical efficiency of the tuner.

When the receiver is constructed as shown, the wiring is very simple and also efficient. Flexible insulated wire is used and the "point-to-point" system is followed; that is, each wire is connected directly from one instrument to the next without regard to appearance. This makes possible the use



A pictorial wiring diagram of the extension two-tube receiver, showing all the necessary connections. At the top is the panel, and below the baseboard, shown separated for convenience in following the lines. Black out with a pencil each wire on the diagram as you connect it into the set; this will aid greatly in the wiring.

of the least amount of wire, and, as a result, prevents many electrical complications. All connections should be properly soldered and, if tinned wire is used, this is very easily accomplished, even by a novice at soldering.

COST OF PARTS

Even when the best parts are used the cost of this set is very low. The beginner is warned, at the start, not to try to save money by selecting second-class apparatus. If it is found that the total cost of the parts exceeds the amount allowed by the family budget, it will be better to save money on the decorative items, such as the dials and the cabinet, rather than on the electrical parts. Inferior parts are incapable of giving the results which may be obtained from apparatus of good quality; almost always it will be found that they are inefficient electrically or their mechanical construction is poor, and, in either case, the result is highly undesirable.

In the construction of the set there are only two semi-expensive parts required (the two variable condensers) and these should not cost over five dollars each. The coils may be home-made, if it is so desired; or factory-built units may be purchased. The remaining parts are few in number and very inexpensive.

Before explaining the construction of the set the operating features will be considered. Of course, unless the builder wishes to build or buy a power unit, batteries are required. For the filament or "A" current supply, either dry cells or a storage battery may be used. If 201A-type tubes are used in the sockets of the set, a 6-volt storage battery is needed; but, if 199-type tubes are employed, the set may be operated with three No. 6 dry-cell batteries connected *in series*. The set may be used with tubes of either type, provided the proper filament-ballast units are used at R1 and R2 in the circuit (see above). For the plate voltage of the set, 90 volts of "B" batteries are required. As the set uses only two tubes it is not absolutely necessary to buy the heavy-duty batteries; but a large battery will be found more economical than the smaller size which is intended primarily for use in portable receivers. In addition to the batteries, the only accessories required for the operation of the receiver are a pair of headphones and plug, an aerial with its lead-in, a ground connection and a lightning arrestor.

The actual operation of the receiver will be found very simple as there are only two dials and two knobs which will ever require adjustment. The two dials (C1 and C2) are the *"wavelength controls"* of the receiver, and both of these dials are set in approximately the same position when the set is correctly tuned to any station in the broadcast waveband. The knob marked T is the "regeneration control," and the knob marked R4 the "volume control." Neither T nor R4 is at all critical when tuning in stations. In the lower left corner of the panel the battery switch (Sw) is located; and in the corresponding position at the right the jack for the headphones is located. Also, if the set is to be used in connection with an audio amplifier, this jack makes it possible to plug in on the detector circuit with headphones at any time.

LIST OF PARTS

A complete list of the component parts necessary for building this receiver, with their designations in the diagrams and pictures, is as follows:

One front panel, of bakelite or hard rubber, 18 x 7 x 3/16 inches;

One baseboard, of wood, 16 x 7 x ½-inch;

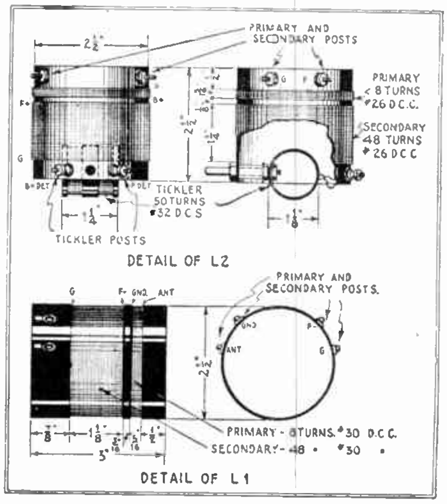
One "antenna coupler," L1 (For details see text and diagrams);

One "detector-circuit tuner," L2 (For details see text and diagrams);

Two variable condensers, .0005-mf., C1 and C2;

Two vacuum tubes, 201A- or 199-type, V1 and V2;

One mica-type grid condenser with grid-leak clips, .00025-mf., C4;



Constructional details of the antenna coupler, L1, and the detector-circuit tuner, L2.

One volume-control resistor, 0 to 200,000 ohms, R4;

One battery switch, Sw;

Two vernier dials;

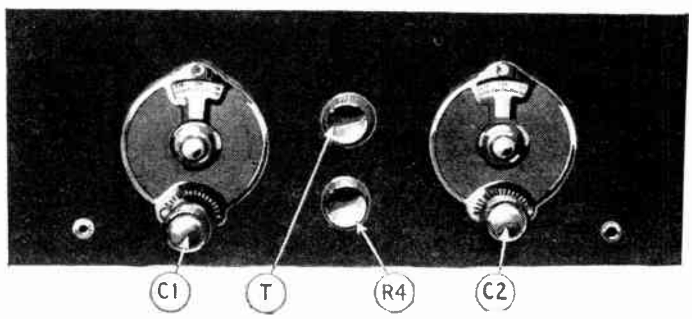
Two "cushioned" vacuum-tube sockets, UX-type;

Two binding posts marked "Aer." and "Gnd.";

One binding-post strip;

One roll of flexible insulated wire for connections;

One table-type cabinet.



The front view of the Beginner's two-tube tuned-radio - frequency receiver. C1 and C2, condenser controls; T, tickler control; and R4, volume control.

One grid leak, 2-megohm, R3;

Two "filament-ballast" resistors, 201A- or 199-type (depending on the tube), R1 and R2;

One mica fixed condenser, .006-mf., C3;

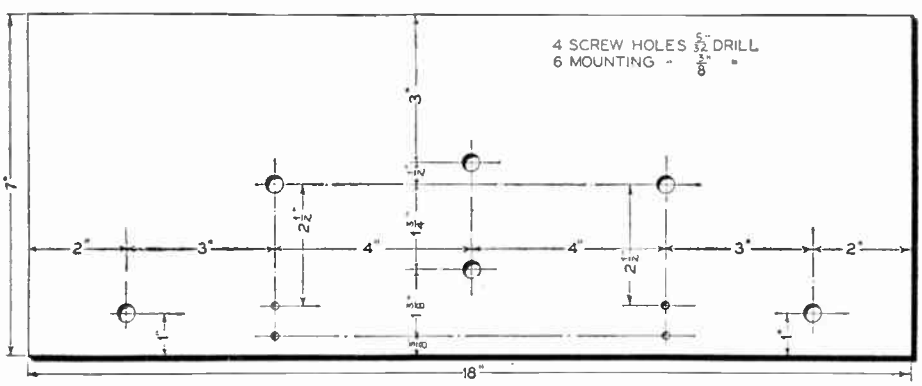
One mica fixed condenser, .0022mf., C5;

One double-circuit jack, J;

Before buying the parts listed above it is necessary to decide whether you wish to build or buy the two coils required. If you decide to wind the coils at home the cost of the set may be materially decreased; as suitable wire and coil forms may be purchased at much less than the cost of a manufactured set of coils. Also, the construction of the coils is very simple.

The antenna coupler is the simplest coil to make. It is wound on a composition or cardboard tube 2½ inches in diameter and 2½ inches long. There are two windings, the primary (P) and the secondary (S). The primary winding may be made by winding 8 turns of No. 30 D.C.C. wire about ½-inch from one end of the tube. After the primary winding has been completed, a space of about 3/16-inch is left vacant, and then the secondary coil is wound. The secondary consists of 48 turns of No. 30 D.C.C. wire wound in the same direction as the primary. After the coil has been wound, it should be painted with collodion or some insulating varnish and it is complete.

In constructing the detector-circuit tuner, a coil wound with No. 26 D.C.C. wire is



How the front panel is drilled for the condensers, switch, jack, regeneration control, and variable resistor in the two-tube receiver.

made, exactly the same as the antenna coupler; and to this is then added the tickler coil (T). The tickler coil should be wound on a tube 1⅛ inches in diameter with 50 turns of No. 32 D.C.C. wire. This coil is mounted on a shaft and is so arranged that it may be rotated by a knob located on the front panel of the receiver. The diagram, which will be found in these pages, shows the mechanical arrangement which should be followed.

CONSTRUCTIONAL HINTS

After all of the parts have been purchased, they should be carefully tested and inspected for mechanical defects. For example, make sure that the plates of the variable condensers do not short-circuit (touch) when they are rotated; and see that the tube makes good contact to the prongs of the socket. In the case of the dials see that there is no appreciable "backlash" and that they do not tend to slip. See that the contact arm of the volume-control resistor makes a good mechanical connection with the wire when it is rotated. Make sure that the phone plug makes good contact with the jack and see that, when the plug is removed, the contacts of the jack are fully closed.

In constructing the receiver, the first step is to drill the necessary holes in the front panel. Accompanying this article will be found a drilling layout for the panel; which will be correct if the parts used in the original model are employed. However, if different parts are employed, it may be necessary to make slight departures from the layout. If different condensers are used, a "template" which usually is supplied with them indicates the exact position of the mounting holes required.

In mounting the parts on the front panel, the detector-circuit tuner is located in the center with the tickler-coil shaft toward the top of the panel. Below the regeneration knob is the volume-control resistor; and one tuning condenser is mounted on each side of the circuit tuner, midway between the center of the panel and the edge. The jack is located in the lower right corner of the panel, and the battery switch is in the corresponding position at the left.

After this, the remaining apparatus should be mounted on the baseboard of the receiver. When looking at the receiver from the front, the apparatus on the baseboard is arranged as follows: the antenna coupler is located directly behind the tuning condenser C1, near the left edge of the baseboard toward the rear. Just behind the antenna coupler, the binding-post strip for the aerial and ground terminals is mounted.

The vacuum-tube socket for V1 is mounted at the right of the antenna coupler, and that for V2 near the right edge of the baseboard toward the rear. The two filament ballast resistors (R1 and R2) are located between the two sockets. The grid condenser with its grid leak (C4 and R3) is fastened directly to the *stator* terminal of condenser C2. Condenser C5 is fastened in place, with its wiring near the jack; and condenser C3 is also fastened in place, with the wiring near the volume-control resistor.

After the parts have been mounted the receiver may be wired. The pictorial and schematic wiring diagrams, which will be found in these pages, clearly show every necessary connection and as a result very little explanation is necessary. When wiring the plate and grid circuits, care should be taken to see that the wires which connect to "P" and "G" terminals of the tube sockets are as short as possible, and that they do not come near other parts or wiring. The battery wires may be bunched together if desired. Every connection should be soldered, and care should be taken to see that the joint is strong and that the solder makes a good connection with both wires. In soldering with rosin-core solder, scrape the parts to be soldered until they are clean, and use tinned wire; and then no difficulty will be experienced.

SYMBOL	Quantity	NAME OF PART	REMARKS	MANUFACTURER ★	
L1	1	Antenna Coupler	Home-made		
L2	1	Det.-Circuit Tuner	Home-made		
C1,C2	2	Variable Condensers	.0005 mf.	1	8,13,14,15,16,17,18,19,20,21
V1,V2	2	Vacuum Tubes	201A or 199 type	2	43,43
C3	1	Fixed Condenser	.006 mf., mica type	3	1,5,6,22,23,24,25,26,27,28
C4	1	Fixed Condenser	.00025 mf., mica type with leak clips	3	1,5,6,22,23,24,25,26,27,28
C5	1	Fixed Condenser	.002 mf., mica type	3	1,5,6,22,23,24,25,26,27,28
R1,R2	2	Fil. Ballast Units	201A or 199 type	12	6,8,26,30,45
R3	1	Grid Leak	3 Megohms	4	1,3,6,8,22,23,25,28,29,30,31
R4	1	Volume Control	C-200,000-ohm variable resistor	5	25,37,46
J	1	Jack	Double-circuit type	7	1,5,27,37
SW	1	Battery Switch		6	1,5,27,37,44
	2	Vernier Dials	Front of panel type	7	18,19,40,41
	2	Tube Sockets	UX type	8	1,17,19,20,23,36,37,38,39
	2	Binding Posts		9	8,20,36
	1	Binding-Post Strip		10	32,33
		Connection Wire		11	1,34,35

NUMBERS IN LAST COLUMN REFER TO CODE NUMBERS BELOW.

1 De Jur Products Company	2 E. T. Cunningham, Incorporated	3 Aerovox Wireless Corporation
4 International Resis. Co. (Durham)	5 Carter Radio Company	6 Leslie F. Muter Company
7 Martin Copeland Company	8 Amsco Products, Incorporated	9 X-L Radio Laboratories
10 Micarta Fabricators, Incorporated	11 Cornish Wire Company	12 Langbein-Kaufman Radio Co. (Elkay)
13 Hammarlund Manufacturing Company	14 Allen D. Cardwell Company	15 Samson Electric Company
16 Camfield Radio Manufacturing Co.	17 Benjamin Electric Mfg. Co.	18 Karas Electric Company
19 Silver-Marshall, Incorporated	20 General Radio Company	21 Gray & Danielson Mfg. Co.
22 Dubilier Condenser Corporation	23 Pilot Electric Company	24 Sangamo Electric Company
25 Electrad, Incorporated	26 Polymet Manufacturing Company	27 Yaxley Manufacturing Company
28 Micamold Radio Corporation	29 Tobe Deutschmann Company	30 Daven Radio Corporation
31 The Carborundum Company	32 American Hard Rubber Company	33 Formica Insulation Company
34 Acme Wire Company	35 Belden Manufacturing Company	36 H. H. Eby Manufacturing Company
37 Herbert H. Frost, Incorporated	38 Air-Gap Products Company	39 Alden Manufacturing Company
40 The National Company	41 Brooklyn Metal Stamping Company	42 Radio Corporation of America
43 C. E. Manufacturing Company	44 Hart & Hegeman Manufacturing Co.	45 Radio Company (Amperite)
46 Central Radio Laboratories	47	48
49	50	51

★ THE FIGURES IN THE FIRST COLUMN OF MANUFACTURERS INDICATE THE MAKERS OF THE PARTS USED IN THE ORIGINAL EQUIPMENT DESCRIBED HERE.

No. 53

If you use alternate parts instead of those listed in the first column of manufacturers, be careful to allow for any possible difference in size from those originally used in laying out and drilling the panel and sub-base

From the pictorial wiring diagram it may be seen that the battery wires of the set are not connected to binding posts; but the connecting wires are soldered to the terminals of the various instruments and led out from the rear of the set in cable form. Label or tag the wires at both ends before cabling. This is the most convenient method; as the wires of the cable may be connected directly to the batteries.

OPERATING THE RECEIVER

After the construction of the receiver has been completed the set should be carefully tested before it is placed in operation. First, place the two tubes in their sockets, turn on the filament switch, and connect the negative terminal (the black one) of the "A" battery with the wire of the cable marked "A— B—." Now connect a wire to the free terminal (the positive one) of the "A" battery; and touch this wire in turn to each wire in the battery cable. The tubes should light when the "A+" wire of the battery is connected to the "A+" wire of the cable; but they *should not light* when the "A+" wire is touched to the "B+Det." and "B+ Amp." wires. If the tubes do light when the "A+" wire of the battery is connected to the "B+" wires of the battery cable, there is a short-circuit in the set *which must be discovered and corrected before the set is placed in operation.*

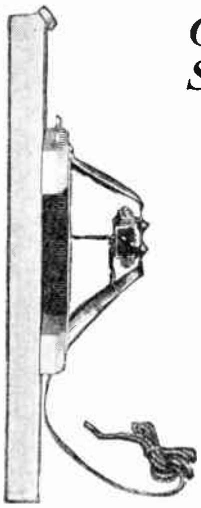
On the other hand, if the test proves that the set is correctly connected, the "A" and "B" batteries may be connected with the proper battery-cable leads; the aerial and ground wires attached to their respective binding posts; and the phone plug with the phone cords attached, inserted in the jack. The set is then ready for operation and may be turned on with the battery switch.

The aerial should consist of a wire about 100 feet long, including the lead-in, strung as high as possible, firmly secured to well-braced supports at each end, and carefully insulated. The wire should be led into the house through a porcelain insulating tube, or similar device. An approved lightning arrestor is a desirable attachment; this should preferably be grounded outside the house. The ground wire from the set should be made to a cold-water pipe if possible, or else to a steam pipe; the pipe should be scraped until it shows a bright metallic surface, and the wire wrapped around it tightly—securely soldered if possible—and the joint wrapped with friction tape to protect it. Upon the electrical contact obtained at this connection will depend a great deal of the results obtained with this receiver.

How to Build a Linen-Diaphragm Loud Speaker

Complete Details for the Construction of a Loud Speaker Which Furnishes Excellent Quality and Volume

By John M. Thompson



The side view of the double - diaphragm loud speaker; this shows how the drive unit should be mounted so that there will be no strain on the driving mechanism.

BACK in the primitive days of radio, when it was a feat worthy of strong men and true to get a station broadcasting music fifty miles distant, loud speakers were something one read about, but seldom saw. If a newcomer wanted to listen to a program, one of the headphones was detached from the headpiece and given him and then, in a very uncomfortable attitude, each sharer of the phone stopped one of his ears with his finger and tried to follow the radio entertainment with the other.

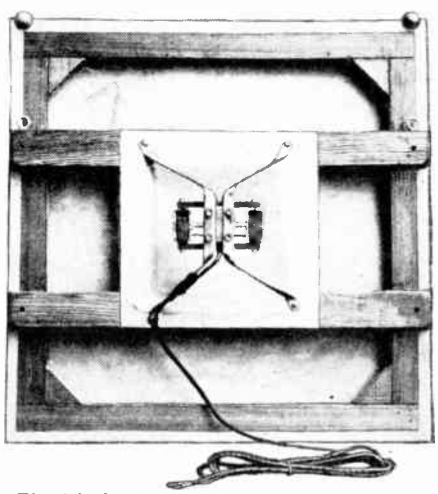
Then came a day when someone suggested that, if a phone were placed diaphragm-down near the bottom of a bowl, music could be heard all over the room—well heard *nearly* all over the room. The truth of the matter is that, as most of us were lucky to have one tube for a detector, and audio amplification was something yet to be dreamt of, it was necessary to place an ear very close to the bowl in order to hear anything at all.

Then came the simple horns to which a headset could be clamped; then the first electrodynamic speakers, using a horn and requiring lots of power to operate; then the electromagnetic horn speakers and cones, the newer types of electrodynamic cones and, lately, the linen-diaphragm speaker.

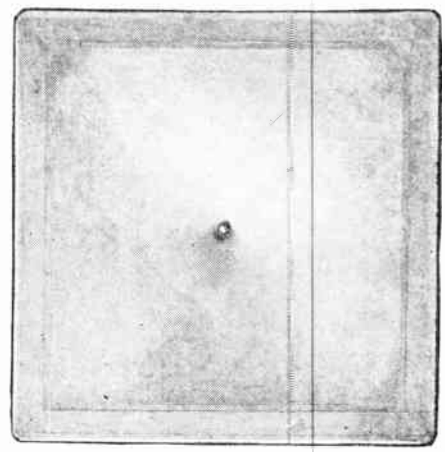
This type of speaker has become popular overnight with experimenters, for it is something fairly simple in construction. The frequency-range and tone quality obtainable from this speaker is remarkable and, if the constructor follows the directions presented herewith, he should have a loud speaker of which he can be proud. The total cost of that built by the writer, according to the specifications below, was under $10.

CONSTRUCTION OF FRAME

The first operation is the assembly of the woden frame upon which the linen diaphragms are stretched. The back view of the frame, Fig. 1, shows how the various pieces of cypress or other suitable wood are cut and mortised together. This construction should be followed for, if the parts of the frame are not securely fastened by glueing, a rattle will be introduced in the speaker that cannot be eliminated without a great amount of trouble. After the pieces A and B have been glued, the corner pieces E are attached. The pieces marked C and D are next joined and screwed to the sides B, making sure that the pieces D are centered.



The 8-inch diaphragm and the unit, mounted in position, are here shown. Compare the frame work with the sketch above.



The front view of the speaker, showing the 24-inch diaphragm.

While the joints of the wooden frame are drying, the two linen diaphragms are prepared. It is necessary that a hem one-half inch wide be sewed along each side of both the large and the small squares; the one being 26 inches square and the other 8 inches.

When the joints are thoroughly dried, the large square of cloth is placed over the front of the frame, tacking down one edge; be careful to place the tacks fairly close to one another, so that there will be little danger of the cloth's pulling out. When one edge has been fastened stretch the linen as tightly as possible and tack down the opposite side. This process is repeated for the other two sides. The 8-inch square of linen is fastened to the rear frame in the same manner.

PREPARING THE DIAPRAGM

Now locate the exact centers of both diaphragms and carefully, with the point of a compass or a sharp nail, force a hole in the linen. Be careful not to break any threads, but spread them apart until the hole is ¼-inch in diameter. Then prevail upon one of the ladies of the family to work a buttonhole stitch around these two holes.

(*Continued on page 102*)

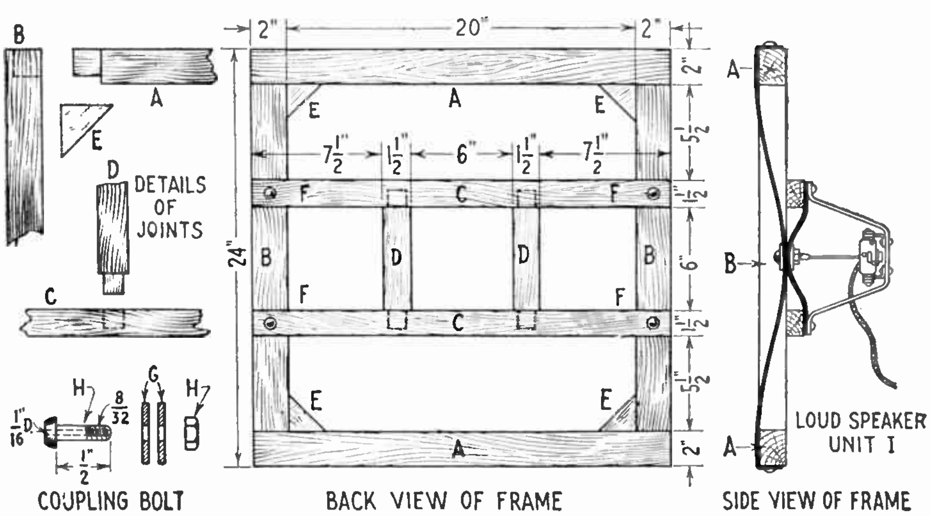


Fig. 1. The details of the construction of the wooden frames, for both the large and the small diaphragm; also, the mounting of the loud-speaker unit.

Television—"Seeing" Music

(*Continued from page 35*)

This rheostat is connected simply in series with the motor. Try any rheostat you happen to have on hand, and see how much control it gives.

Of course, the radio receiver need not be mounted on the top of the framework, as shown. One of the new Stewart-Warner A.C. receivers, which have been submitted to the RADIO NEWS Laboratories for test, happen to fit nicely in this position, so it was used.

The method of connecting the neon tube is shown in Fig. 3. A "B" battery of 180 volts is required for the neon tube itself; although fairly good results will be obtained if the high-voltage side of a "B" socket-power unit is used. The resistor marked R in this diagram is *not* the motor rheostat marked R in the picture on this page, but a universal-range rheostat for adjusting the local current through the neon tube; it should have a resistance of from 200 to 500,000 ohms. The procedure is to adjust this rheostat until the neon tube just lights up; then the signal fluctuations will cause the light to vary and the patterns will appear.

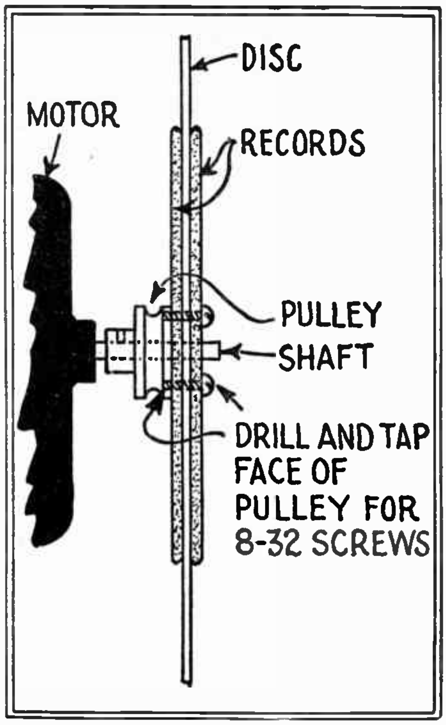


Fig. 2. The method of clamping the scanning disc to the fan shaft. It must be centered exactly.

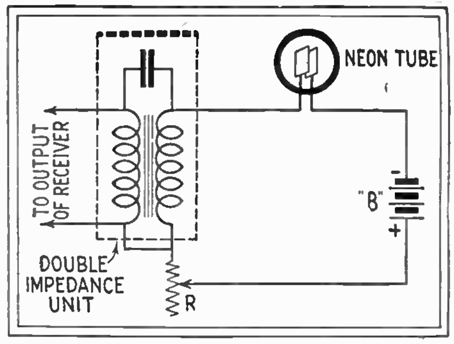


Fig. 3. Schematic diagram of the lamp circuit. This resistor R is not the one pictured in Figs. A, B and C (which is in the motor circuit) and it does not require continued adjustment.

To "see" music with this television receiver, tune in a broadcast station in the usual manner, and then connect the left side of the output impedance unit to where the loud speaker normally attaches to your set. Start up the motor and look through the disc into the neon tube and you will observe the music "pictures," immediately. By varying the speed of the motor, you can make the patterns move back and forth, and up and down, and perform many other interesting antics.

FUTURE issues of works similar to the present book will depend entirely on the reaction of the readers; so if you like the RADIO NEWS AMATEURS' HANDIBOOK (5th Edition), write and let us know. For your convenience, the voting blank follows.

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I was interested in seeing this copy of *Radio News Amateurs' Handibook.* I would like to see you publish another edition of this magazine within.................................months.

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Street and No. ....

City ....State ....

An R.F. Short-Wave Broadcast Receiver

(*Continued from page* 69)

operating on wavelengths between 10 and 550 meters. Six different types of coils and two coils of each type (12 coils in all) are needed to cover this wide band. However, all the coils are not required if the builder wishes to limit the wavelength range of the set to a narrower band. The waveband which each of the six coils cover approximately is as follows: coil No. 1, 10 to 25 meters; coil No. 2, 15 to 33.5 meters; coil No. 3, 31.5 to 68 meters; coil No. 4, 57 to 133 meters; coil No. 5, 125 to 250 meters and coil No. 6, 235 to 550 meters. If it is desired to increase the wavelength range of the set to 725 meters it is possible to do so by connecting a .0001-mf. mica fixed condenser in shunt with each of the tuning condensers (C1 and C2) when coil No. 6 is being used.

In constructing the coils the secondary windings must be spaced. The chart in the drawing gives the number of turns, the size of wire and the length of each secondary winding; and with this data the builder can determine the proper spacing between turns by experiment. The tickler and primary coils are wound with insulated wire and are not spaced. The primary coil consists of form 2½ inches in diameter. The tickler coils are merely glued inside the secondaries, or held in place with a few drops of sealing wax or paraffin from a candle.

The following is a complete list of the parts required for the construction of this short-wave receiving set:

SYMBOL	Quantity	NAME OF PART	REMARKS	MANUFACTURER ★	
L1	1	Coil mounting	Plug-in type (special)	1	
L2	1	Coil mounting	Plug-in type (special)	1	
		Coils	Plug-in type (special). Various sizes to cover different wave bands.	1	
C1,C2	2	Variable condensers	.00014 mf. straight line frequency	2	6,8,10,11,12,13,14,15,16,17
C3	1	Variable condenser	.00025 mf. straight line frequency	2	6,8,10,11,12,13,14,15,16,17
C4	1	Grid condenser	.00025 mf.	3	4,18,19,20,21,22
R1	1	Grid leak	5 megohms	4	3,13,19,21,22,23,24,26
R2,R3,R4	3	Amperites	1/4-ampere type	5	
R5	1	Amperite	1-ampere type	5	
R6	1	Volume control	Equipped with filament switch	4	
RFC	1	R. F. choke	60 millihenries	1	6
T1	1	A.F. transformer		6	2
T2	1	Push-pull trans.	Input type	6	12,27,28,29
T3	1	Push-pull choke	Output choke coil	6	12,27,28,29
PH	1	Phasatrol		4	
	3	Dials	Vernier type	6	2,5,7,8,30,31
	5	Sockets	UX type	7	8,13,15,25,29,32
	1	Panel	7 x 24 x 3/16 inches	38	33,34,35
	1	Sub-panel	7 x 23 x 3/16 inches	38	33,34,35
	3	Brackets	3 inches high	8	15,28,36
V1,V2,V3	3	Tubes	201A type	9	37,39,40
V4,V5	2	Tubes	171 type	9	37,39,40
Sw	1	Jack switch	Double-pole, double-throw type	44	8,20,41
	12	Binding posts		7	8,13,25
		Connecting wire	Insulated	42	43,44

NUMBERS IN LAST COLUMN REFER TO CODE NUMBERS BELOW.

1 Aero Products, Incorporated	2 Karas Electric Company	3 Dubilier Condenser Corporation
4 Electrad, Incorporated	5 Radiall Company	6 Samson Electric Company
7 H. H. Eby Manufacturing Co.	8 Pilot Elec. Mfg. Company	9 C. E. Manufacturing Co. (CeCo)
10 Hammarlund Manufacturing Company	11 Bremer Tully Manufacturing Co.	12 Silver-Marshall, Incorporated
13 Amsco Products, Incorporated	14 General Instrument Company	15 Benjamin Electric Mfg. Company
16 Gray & Danielson Co. (Remler)	17 Camfield Radio Manufacturing Co.	18 Sangamo Electric Company
19 Tobe Deutschmann Company	20 Carter Radio Company	21 Polymet Manufacturing Company
22 Leslie F. Muter Company	23 Aerovox Wireless Corporation	24 Micamold Radio Corporation
25 X-L Radio Laboratories, Inc.	26 Daven Radio Corporation	27 Thordarson Elec. Mfg. Company
28 Precise Manufacturing Company	29 All-American Radio Corporation	30 Martin-Copeland Company
31 Kurtz-Kasch Company	32 Airgap Products Company	33 Micarta Fabricators, Inc.
34 Formica Insulation Company	35 American Hard Rubber Company	36 American Radio Hardware Company
37 Radio Corporation of America	38 Insulating Company of America	39 Ken-Rad Corporation
40 E. T. Cunningham, Incorporated	41 Yaxley Manufacturing Company	42 Acme Wire Company
43 Cornish Wire Company	44 Belden Manufacturing Company	45
46	47	48

★ THE FIGURES IN THE FIRST COLUMN OF MANUFACTURERS INDICATE THE MAKERS OF THE PARTS USED IN THE ORIGINAL EQUIPMENT DESCRIBED HERE.

If you use alternate parts instead of those listed in the first column of manufacturers, be careful to allow for any possible difference in size from those originally used in laying out and drilling the panel and sub-base.

LIST OF PARTS

L1, L2—Two sets of coils (see drawing for details);
C1, C2—Two S.L.F. variable condensers, .00014-mf.;
C3—One S.L.F. variable condenser, .00025-mf.;
C4—One mica fixed condenser, .00025-mf.;
T1—One A.F. transformer, 3:1 ratio;
T2—One A.F. transformer, push-pull input type;
T3—One A.F. choke coil, push-pull output type;
R1—One grid leak, 5-megohm;
R2, R3, R4—Three filament-ballast units, 5-volt, ¼-amp. type;
R5—One filament-ballast unit, 5-volt, ½-amp. type;
R6—One 500,000-ohm volume-control rheostat and filament switch;
RFC—One R.F. choke coil, 60-millihenry;
PH—One oscillation control, variable resistor-condenser type;
V1, V2, V3—Three vacuum tubes, 201A-type;
V4, V5—Two power tubes, 171A-type;
SW—One jack switch, D.P.D.T. type;
Three tuning dials, vernier type;
Five vacuum-tube sockets, UX-type;
One panel, 7 x 24 x 3/16 inches;
One sub-panel, 7 x 23 x 3/16 inches;
Three brackets, 3 inches high;
Twelve binding posts;
Two coil mountings (see drawing for details).

Building a Linen-Type Loud Speaker

(*Continued from page* 100)

The next operation should be performed either outdoors or in a room with the windows open, as otherwise the fumes from the collodion are liable to cause an unpleasant sensation. Paint the face of each diaphragm with the thin collodion and allow it to dry. Four or five coats are required; *let each coat dry before applying the next one.* When the last coat is dried the diaphragms will be stiff and slightly flexible and, when tapped with the finger, will sound like a drum.

The small coupling bolt is next prepared. This is an 8/32 bolt, ½-inch in length, through which is drilled lengthwise a small hole, just large enough to take the driving rod of the loud-speaker unit which is to be used. One of the washers is put over the bolt and the head of the washer is put through the hole in the large diaphragm, from the front. The two diaphragms are forced together until the bolt can be slipped through the hole in the smaller square, after which the other washer and the nut are put on and tightened down.

The mounting of the unit itself is left to the ingenuity of the constructor. The method employed with good results by the writer can be seen in the accompanying illustrations. It is important to remember that the unit must be so lined-up that the driving pin will come exactly in line with the hole in the bolt.

The finished speaker may be placed in a cabinet or hung from the ceiling. If it is desired to color the linen diaphragms this must be done before treating them with the collodion. The tacks should be covered over with an attractive passe-partout binder for appearances' sake.

The material needed for constructing this speaker is as follows:

4 pieces of cypress, 24 x 2 x 1½ inches ("A, B");
2 pieces of cypress, 24 x 1½ x 1 inch ("C");
2 pieces of cypress 7½ x 1½ x 1 inch ("D");
4 triangular pieces cypress 1½ x 1½ inches ("E");
2 squares of medium-weight linen, one 26 x 26 inches, and the other 8 x 8 inches;
4 1¾-inch woodscrews ("F");
2 ½-inch washers ("G");
A ½-inch 8/32 brass screw and nut ("H");
A package of No. 4 cut tacks;
A roll of passe-partout binder;
10 oz. collodion (Obtainable at drug store) or varnish;
A balanced-armature loud-speaker unit with driving rod ("I").

After the unit has been installed and the speaker brought to the point where it functions satisfactorily, it should be left alone. It is risky practice to meddle with the mechanics of a speaker unit unless one is trained in that field. The better practice whenever a unit proves defective is to return it to the manufacturer.

D.C. to A.C.—And How

(*Continued from page 95*)

heavy-duty rheostats are already on the market.

We have previously referred to temporary line-voitage fluctuation; this usually occurs at the time when the heaviest load falls on the lighting company's mains. The voltage at the central station may be maintained constantly at a fixed standard, but the drop in various circuits causes this line fluctuation. If this condition prevails, the tube voltage will naturally follow the rise and fall in the main line. The operating characteristics of the A.C. tubes, however, are such that average fluctuation will not affect their operation or life; but, as we have said before, it is very necessary to know just what the average voltage is and adjust for it. In the re-wiring of the set keep the grid and plate leads away from the filament lines as much as possible.

A properly-converted set should not produce A.C. hum audible more than a few inches from the loud speaker.

It is suggested that some means of identifying easily the last audio socket be adopted by constructors. The accidental insertion of the 226 tube in this position will result in an almost-immediate burn out.

VOLUME CONTROL

Considerable difference of opinion exists regarding the best method to control volume in A.C. sets. The favorite method in battery-operated sets was to vary the filament temperature in one or more of the R.F. tubes. Although some manufacturers of A.C. sets use this method today on A.C. tubes of the 226 type, it is not considered ideal. The heating of the heavy filament is slow in following the rheostat adjustment, and this naturally introduces a very annoying time-lag. It is particularly noticeable when trying for distant reception.

We have previously discussed the necessity for keeping the plate current of the 226 tube at the minimum ripple-voltage point; this happens to be at about 3 milliamperes. If the bias on the R.F. tubes can be reduced simultaneously with the filament temperature, this will hold up the plate current and keep out the ripple. Some bias must be maintained at all times, however; as an uneven flow of grid current, and consequent modulation and distortion of the signal, will result without it.

A high variable resistor across the secondary of the first audio transformer has been used by some; but this method is not recommended as it has a tendency to overload the detector. Varying the grid bias as a means of volume control is quite effective on circuits using 227 tubes as amplifiers, but is not recommended for 226s; as this method is apt to shorten the life of the tube. A high variable resistor (100,000 ohms) in the R.F. plate returns will do the job, in a way, but the disadvantages have already been mentioned. It would seem that the most logical procedure in controlling volume is to go to the heart of the matter and control the signal instead of trying to suppress it after it is amplified or rectified. Naturally this must be done in the antenna circuit. The most approved method is to couple variably a semi-aperiodic primary to the secondary of the antenna-coil unit. Unfortunately this is not always easily done in converting sets, as the antenna coil is usually of the fixed-coupling type. If it is at all possible to rotate the primary antenna winding, or secure a similar effect through taps, it is strongly recommended that this be done to obtain best results. A semi-aperiodic antenna coil of 8 or 10 turns of wire, wound on a bakelite tube and variable in its relation to the secondary, will work out very well.

A variable resistor with a maximum of around 5 megohms, in shunt with the antenna coil, will control volume quite satisfactorily. It is suggested that for local or very strong signals the aerial be disconnected entirely from the set; this may be done by means of a snap switch conveniently placed.

A.C. sets give the very best reproduction when the circuits are tuned to exact resonance with the received signal. Any departure from this condition will detract from one of the most pleasing features of A.C. operation. Volume control is right *only when the strongest signal is not too loud when the set is tuned to exact resonance with the volume control at minimum.* Any attempt to control volume by detuning condensers will result in some distortion and an apparent lack of selectivity.

THE TUBES

Due to the fact that the A.C. tubes of the 226 and 227 types are new on the market, many experimenters are inclined to be skeptical regarding their performance. The actual development of these tubes has been going on for some time, however, and their performance has been under observation over a long period. The characteristics of the 226 are approximately the same as those of the familiar 201A type; long life may be expected, provided the tubes are operated under proper conditions. Maintaining the correct grid bias is quite essential for the successful use of the 226.

The characteristics of the 227 are such that by using this tube in all stages, except the last A.F., greater signal volume as compared with the 226 will result. There will be less tendency towards A.C. hum, although a properly designed or converted set using 226s should be practically free from this trouble. The 227 will probably have a longer useful life, due to the nature of the emitter. *The user of A.C. tubes is particularly cautioned to read thoroughly the instruction sheet accompanying each tube.*

The 227 (separate-heater tube) requires about 30 seconds to come up to operating temperature. The momentary application of excess heater voltage to accelerate emission should never be tried. The A.C. tubes are operative at 25 cycles as well as at 60 cycles.

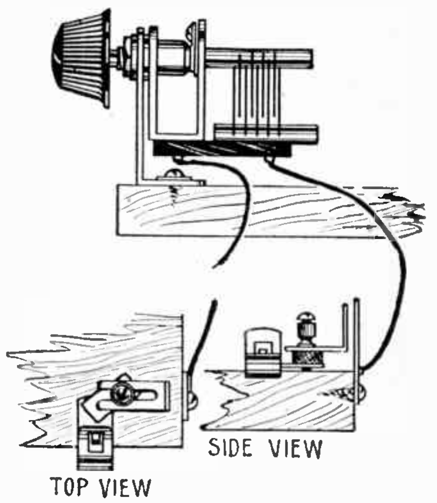
TROUBLES

Pronounced A.C. hum in the set may be due to several causes; the wiring of the filament lines if not twisted may cause hum. Frequently the "B" supply unit is at fault because of a defective rectifier tube. Should an internal leak develop between the cathode and the heater of the separate-heater tube, hum or noise will result; but this latter condition is of rare occurrence. Unshielded power transformers, if in close proximity to the set, will introduce line disturbances which sound very much like static. When separate-heater tubes have an excessive voltage on the filament, signals will gradually become weaker until, in some cases, they disappear. This is due principally to what is called *secondary emission;* namely, that caused when the grid gets sufficiently hot to emit (independently) electrons. This will, of course, disturb the stream of electrons and, consequently, the current between the cathode and the plate.

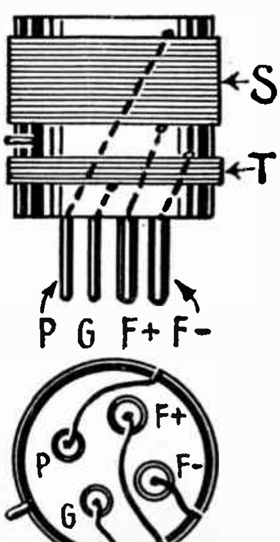
A Junk-Box Short-Wave Receiver

(*Continued from page 77*)

The best adjustment for the aerial condenser C3 must be found by trial; it will depend on the dimensions of the individual aerial. Likewise, different values of the grid leak should be tried.



Above, a side view of the midget tuning condenser C1. One lead runs to the top of the grid winding S and to the aerial condenser C3, formed by the small adjustable plates shown in the top and side views. Its adjustment for the aerial used must be determined by experiment. The two opposed surfaces are about one-half inch square.



The details of one of the plug-in coils used in the "junk-box" short-wave receiver, which is built up on the base of a burnt-out UX-type tube. This is large enough to give room for the tickler winding T and the aerial-secondary S, of suitable size to be tuned by a 32-mmf. condenser (C1) up to 64 meters. Above this it is necessary to add a cardboard extension to the base to increase its height. Details for the five sizes of coils will be found on the first page of this article. The connections shown in plan at the bottom, are as follows: top of grid winding to "P" prong; bottom of grid winding to "F+"; top of tickler (T) to "F—"; bottom of tickler to "G."

How to Build Your Own Television Receiver

(Continued from page 43)

One of the essential components of a television receiver is the glow-lamp; this and its associated scanning device serve the same purpose in the television apparatus that the loud speaker serves in the radio set.

This remarkable device, as most successfully developed, utilizes neon gas as the luminous element, and is the only lamp yet known which, without prohibitive cost, can be made, satisfactorily, to meet the requirements of the present television systems; in which there is required a light-source, of uniform intensity over a large area, which will instantaneously vary in brilliancy with variations in the television signals. The television lamp most strikingly differs from the familiar electric lamp, in that it gives off a soft orange "glow" from a large surface which may be looked at without hurting the eyes, rather than the dazzling white "spot" of an incandescent tungsten filament. The color of this glow may be readily controlled in manufacture by variation in the kind and quality of gas employed within the bulb.

As will be seen, the construction of the television lamp is apparently quite simple; although this simplified appearance has been secured only after a great deal of research work with gaseous-conduction tubes and neon lamps of all types and for many different uses. Indeed, the development and refinement cf this device has involved a review of many rare gases, a deep study of atomic structure, and a long process of reasoning out the acrobatics of electrons. The highly intricate action taking place in the miniature universe of the gas contained in the television lamp is, therefore, not at all in keeping with the utter simplicity of the mechanism and electrical features of the device; yet we must master the first before we can enjoy the second.

The "glow" takes place uniformly over the surface of either one or the other of the two flat and parallel plates; the effect depending upon which plate is connected to the positive and which to the negative side of the power supply. The two parallel plates are so placed with respect to each other as to utilize the principle of "short-path" insulation in order to prevent "glow" *between* the plates which, of course, would not be very desirable.

HOW TO BUILD YOUR OWN TELEVISION RECEIVER

SYMBOL	Quantity	NAME OF PART	REMARKS	List Price Each	MANUFACTURER *
	3	Resistor mountings	Double mounting type	.50	1
C,C,C,C	4	By-pass condenser	0.5 mf., paper-wound	1.00	2
C1	1	By-pass condenser	0.1 mf., paper-wound	1.25	2
L2	1	Output choke	30 henries	5.00	11
L1	1	Grid impedance unit	Fitted with clips for plate resistor	5.50	3
R4,R4,R4	3	Fil. ballast resistors	1/4-ampere type	1.10	4
R2,R3	4	Fixed resistors	250,000 ohms	1.50	1
R1	1	Fixed resistor	100,000 ohms	1.50	1
	2	Vacuum tubes	Hi-Mu "240" type	2.00	7
	1	Vacuum tube	171A type	2.00	7
V1,V2,V3	3	Tube sockets	UX type	.50	6
	1	Filament switch	For baseboard mounting	.50	8
	11	Binding posts	Bakelite heads - engraved	.15	5
	1	Baseboard	Wood - 12 x 5 x 1/2-inch		
			SCANNING APPARATUS		
	1	Motor	Single-phase condenser type	30.00	9
			1/8 horsepower		
	1	Scanning disc	48 hole - 24-inch diameter	15.00	8
R5	1	Variable resistor	0-10,000 ohm	1.50	12
R6	1	Rheostat	10-ohm	.85	12
R7	1	Rheostat	100-ohm	2.50	13
	1	Hand switch	Pear-shaped		
	1	Neon tube	Neon-gas glow lamp	12.50	10
	1	Tube socket	UX-type	.50	6
	1	Jack	Double circuit	.80	8
	4	Binding post	Bakelite head	.15	5
	6 ft.	Lamp cord	Flexible-parallel-silk covered		
	2	Wood boards	31 x 12 x 3/4-inch		
	2	Wood boards	29½ x 12 x 3/4-inch		
	4	Wood board	12 x 1½ x 3/4-inch		
	1	Wood board	29½ x 8 x 3/4-inch		
	1	Beaver board	31 x 31 x 1/4-inch		
	1	Beaver board	31 x 21 x 1/4-inch		
	1	Beaver board	31 x 10 x 1/4-inch		

NUMBERS IN LAST COLUMN REFER TO CODE NUMBERS BELOW.

1 Arthur H. Lynch, Incorporated
1775 Broadway, New York City
2 Acme Wire Company (Parvolt)
New Haven, Conn.
3 National Company
61 Sherman St., Malden, Mass.
4 Radiall Company (Amperite)
50 Franklin St., New York City
5 H.H. Eby Mfg. Company, Inc.
4710 Stenton Ave., Philadelphia, Pa.
6 Silver-Marshall, Incorporated
846 W. Jackson Blvd., Chicago, Ill.
7 E.T. Cunningham, Incorporated
370 - 7th Ave., New York City
8 Carter Radio Company
300 South Racine Avenue, Chicago, Ill.
9 Interstate Elec. Co. (Baldor)
4339 Duncan Ave., St. Louis, Mo.
10 Raytheon Manufacturing Company
Kendall Square Bldg., Cambridge, Mass.
11 Sangamo Electric Company
Springfield, Illinois
12 Electrad, Incorporated
175 Varick St., New York City
13 Clarostat Manufacturing Company
285 N. 6th Street, Brooklyn, N.Y.
14
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27

* THE FIGURES IN THE FIRST COLUMN OF MANUFACTURERS INDICATE THE MAKERS OF THE PARTS USED IN THE ORIGINAL EQUIPMENT DESCRIBED HERE.

If you use alternate parts instead of those listed in the first column of manufacturers, be careful to allow for any possible difference in size from those originally used in laying out and drilling the panel and sub-base.

WHOLESALE PRICES

for Dealers, Community Set Builders, General Repairmen and Agents!

Be sure to get this great 200-page book with net prices to the radio trade.

Radio Specialty Company is radio's oldest radio parts mail order house in the country, and the new confidential prices on standard radio merchandise are the lowest of any radio house.

We are ready now to appoint additional agents in all parts of the country. If you are contemplating mailing big money in radio merchandise, be sure to get in touch with us at once.

Television is here!

Radio Specialty, as usual, is first with all new things. Send at once for free booklet for lowest prices on all televison parts which have been put on the market so far. (If you have Catalog No. 18, just ask for the Television Supplement.)

New 75 HOOKUPS 150 ILLUSTRATIONS

THIS 200 PAGE RADIO CATALOGUE FREE

Those having No. 18 catalog should write to us for new Supplement describing all latest improvements in Radio.

Buy from Radio's Oldest Mail Order House!

We are the oldest established, exclusive radio mail order house in the country. All orders are positively shipped within twenty-four hours; quick, prompt, courteous service. We carry a larger variety of radio parts, radio instruments, accessories and radio findings than any other radio house in the country. You will find in Catalog No. 19 the largest assortment of radio merchandise in this country. Radio Specialty carries more radio parts and radio material than any other house in the country. You will find in this catalog positively the largest variety of radio merchandise.

If you are in need of certain small radio parts that other radio and mail order houses do not bother to carry, get the Rasco Catalog and you will find the small parts there, anything from a screw to copper ribbon, telephone diaphragms, as well as thousands of other small radio findings. Just to mention a few:

Lugs, nuts, jacks, plugs, all kinds of knobs, cords, panels, screws, sliders, washers, selenium, tinfoil, switches, crystals, cap nut, Litz wire, cord tips, brass rods, resistances, binding posts, switch parts, carbon balls, switch points, lock washers, carbon grains, ground clamps, metal pointers, insulated tubing, low melting metal, antenna connectors, as well as thousands of other articles. *We carry the Largest Variety of Small Radio Parts in the World, BUT We also carry All Standard Radio Merchandise.*

"RASCO" has it

ANYTHING IN RADIO

RASCO PRODUCTS

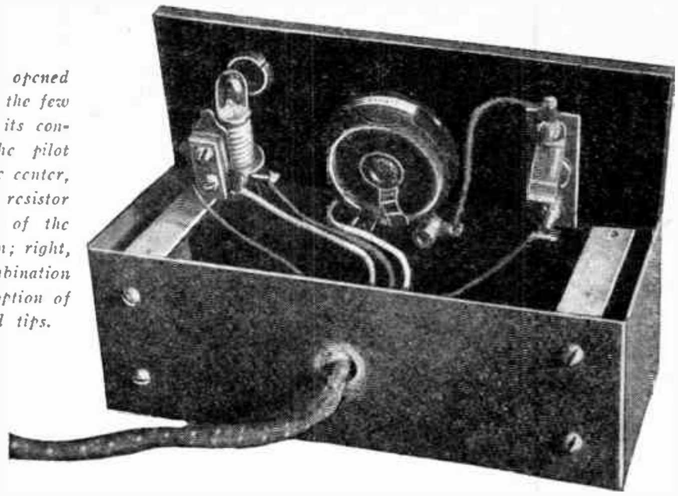
Radio Specialty Co

108 PARK PLACE, NEW YORK

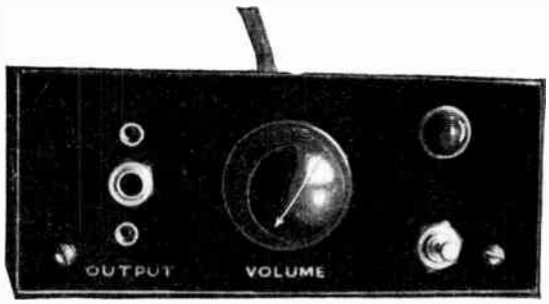
RASCO PRODUCTS

Simple Remote Control Device

(*Continued from page 93*)



The remote-control box is opened here to show the location of the few parts and the simplicity of its construction. At the left, the pilot lamp behind its jewel; in the center, the 0-50,000-ohm variable resistor which controls the volume of the speaker or phones plugged in; right, the speaker jack. The combination shown here will allow the option of using phone plug or cord tips.

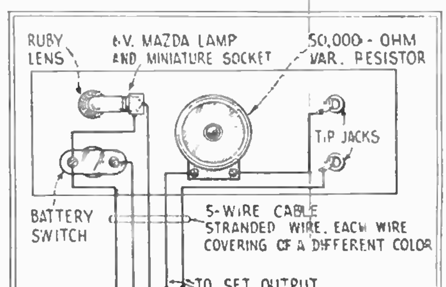


Left, no specifications are given for the panel and box; as the experimenter may construct them to suit his apparatus. That illustrated here is about six inches wide, two inches high, and two inches deep. It may be used as a portable control in the manner illustrated in the heading of this article.

probably be best for this purpose. The wiring, too, will have to be changed, for the (comparatively) lightly-insulated material used for the battery cable will not be very well adapted to carrying this higher voltage. Then, too, it is necessary to keep the wires handling this current entirely separate from those carrying the loud-speaker circuit, as their close proximity might cause a bad hum.

The wires to the variable high resistor will be the same as those used in the others and they will be connected in the usual way. The other three wires, though, will be connected to the lighting mains and the transformer as shown. This, of course, takes it for granted that the "B" supply device is fed from the same transformation that feeds the filaments of the A.C. tubes; if a separate eliminator is used, it should be connected in parallel with the filament transformer in such a way that the switch in the remote control will work both together. This is not a difficult thing to work out.

The volume control in the remote-control unit makes it possible to use a loud speaker in one room and a pair of head receivers in another; because, by introducing more resistance into the circuit, the volume may



INTERIOR WIRING FIG. 6

be reduced at one outlet only. The device is so small that it may be conveniently placed on a table or the arm of a chair; the five-wire cable being run under a rug to the baseboard, where it may be stapled and run to the set. The ideal way is to have the wires in the wall with outlets as needed in various rooms. The loud speaker may be carried about from room to room; or there may be a separate speaker on each remote control, which is more convenient in many ways, if this luxury can be afforded.

Care of Electrolytes

In order to obtain long life and satisfactory service from rectifiers and condensers of the electrolytic type it is essential that nothing but pure distilled water be added to the electrolyte. This rule is just as essential in the operation of electrolytic cells as in the case of storage batteries; for, if city water from the pipes in the house is used, the mineral contents may cause a chemical action which will destroy the efficiency of the unit. If the electrolyte of a cell is evaporating too rapidly, it is possible to correct this by adding a small quantity of thin mineral oil; this will form a film which retards evaporation.

How to Build the Fan Motor Television Receiver

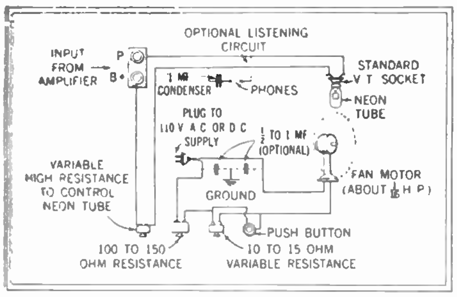
(*Continued from page 39*)

When all ready to listen in for a television signal, you will soon become accustomed to the peculiar whining note of the television signal proper; and if you follow the published program of WRNY, for example, you will receive the proper introduction of the announcer, and then you will make no mistake when you hear the television signals in your phones.

If you "listen in" to the station at first with a pair of headphones and plug them into the detector jack on your set, this is all right; but if you connect your headphones in the last stage wherein the neon tube is connected, be sure to connect a 1 micro-farad condenser in series with the phones, when connecting them in the place of the neon lamp, or across the neon lamp terminals. The television signal sounds in general like a buzz saw cutting through a plank, and the note continually changes as the person in front of the television transmitter moves about.

NEON TUBE NOTES

In adjusting the neon tube circuit, it is the usual practice to adjust the "C" bias on the last amplifier stage, so that the tube just glows over the plate facing the rear of the revolving disc. In other cases the neon lamp is adjusted by raising the "C" bias potential on the last amplifier tube, so that



Above is a schematic diagram of the Fan Motor television receiver. A push button cutting a resistance out of the circuit speeds up the motor when necessary.

the neon lamp doesn't quite glow. In this case, when the television signal comes in, the lamp lights up as the television signal pulses are impressed on the circuit. In some cases it may be possible that you see the image in negative form instead of positive, *i.e.*, you may see the image similar to a photographic negative. In this case the connections to one of the amplifier stages should be reversed; at other times it will be found that if the tuning dial of the set, or one of the dials, if it has more than one, may have to be moved from the right side of the peak of the carrier wave, so to speak, to the left side and vice versa. That is, if you had tuned the dial to say 45 degrees for maximum signal strength, and then detuned a little toward the left; you may have to detune toward the right of the peak, 45 degrees, in order to reverse the image.

Remember that television is not a perfected science. It will require a good deal of experimenting on your part to obtain results which to you may appear mediocre, but as time goes on and you persevere in your own research work the results will more then repay you.

EARNED $500 SPARE TIME WITH RADIO

Coplay, Pa., June 4—(RA)—During the few months that Frank J. Deutsch has been a member of the Radio Association of America, he has made over $500 out of Radio in his spare time.

"Four super-hetrodyne sets of my own construction brought me a profit of $60.00 each, and the other profit was from sales of supplies purchased through the Wholesale Department of the Association," he said. "The Association certainly has a great plan for ambitious men."

In a neighboring state, Werner Eichler, Rochester, N. Y., another member of the Association, has been making $50 a week during his spare time.

They are only two of the hundreds of Radio Association members who are making money out of Radio in their spare time.

BECOMES RADIO ENGINEER IN ONE YEAR

Toronto, Canada, May 20—(RA)—One of the newly admitted associate members of the Institute of Radio Engineers is Claude DeGrave, a member of the engineering staff of the DeForest Company of this city. "I knew nothing about Radio and started from the ground up." Mr. DeGrave stated, "when I enrolled a year ago in the Radio Association. Its easy lessons and superb training made it possible for me to become a Radio Expert in less than a year's time. My income is now about 225% more than at the time I joined the Association."

The Institute of Radio Engineers is a well-known organization, so that Mr. DeGrave has reason to be proud of his election.

Clerk Doubles Income In Six Months Through Radio

Chicago, Ill., May 9—Even though his membership in the Radio Association has resulted in W. E. Thon securing the managership of a Radio Department in a large Chicago store, his ambition was not satisfied. Six months later, he started his own store.

"The Radio Association has an excellent plan for the man who wants to get out of the rut and succeed," says this man who quickly rose from clerkdom to the proprietorship of a profitable radio store. "I attribute my success entirely to the Radio Association of America. Six months after I had enrolled, I had doubled my income through its help."

5 Easy Ways *to make $3.00 an hour in Your Spare Time* in RADIO

EACH of these plans, developed by the Radio Association of America, is a big money-maker. Set owners everywhere want to get rid of static, to have their sets operate from the electric light socket, the tone improved, and the volume increased, and transformed into single-dial controls. Phonograph owners want their machines electrified and radiofied. If you learn to render these services, you can easily make $3.00 an hour for your spare time, to say nothing of the money you can make installing, servicing, repairing, building radio sets, and selling supplies.

Over $600,000,000 is being spent yearly for sets, supplies, service. You can get your share of this business and, at the same time, fit yourself for the big-pay opportunities in Radio by joining the Association.

Join the Radio Association of America

A membership in the Association offers you the easiest way into Radio. It will enable you to earn $3.00 an hour upwards in your spare time—train you to install, repair, and build all kinds of sets—start you in business without capital or finance an invention—train you for the $3,000 to $10,000 big-pay radio positions—help secure a better position at bigger pay for you. *A membership need not cost you a cent!*

The Association will give you a comprehensive, practical, and theoretical training and the benefit of our Employment Service. You earn while you learn. Our cooperative plan will make it possible for you to establish a radio store. You have the privilege of buying radio supplies at wholesale from the very first.

ACT NOW—If you wish *No-Cost Membership Plan*

To a limited number of ambitious men, we will give Special Memberships that may not—need not—cost you a cent. To secure one, write today. We will send you details and also our book, "Your Opportunity in the Radio Industry." It will open your eyes to the money-making possibilities of Radio.

MAIL THIS COUPON NOW

RADIO ASSOCIATION OF AMERICA
Dept., RNH-5 4513 Ravenswood Ave., Chicago, Ill.

Gentlemen: Please send me by return mail full details of your Special Membership Plan, and also copy of your book, "Your Opportunity in the Radio Industry."

Name ....

Address ....

City .... *State* ....

Now—Make Your Radio Clear as a Bell—with Marvelous New GROUND AERIAL!

Sub-Aerial Endorsed by Experts

May 8th, 1928.

"I am very glad to state that after testing many Aerials in my Laboratory I find your Sub-Aerial is the best for clarity of tone and elimination of static, also for greater volume and selectivity.

"Your Sub-Aerial will fill a long-felt want among the Radio Fans."

A. B. Johnson, Radio Engineer.

Aug. 31, 1928.

"I received my Underground Aerial all O. K. It has any aerial beat I have ever seen. I have used every aerial on the market since I have been a radio fan. The first day I installed it I got distant stations that my set had never touched before. It wasn't good radio weather either. I got stations in the East that I had never dreamed of getting and with absolute clearness and without static or interference. I heartily recommend your instrument to any lover of good radio reception."

A. N. Whiteau,
Box 565, El Reno, Okla

Get Amazing Distance—Greater Volume and Finer Selectivity Without Distortion

Why go on listening to terrible static and other maddening outside noises? Now you can get the real music your present Radio is capable of giving, by hooking your set on to the clear, practically static free ground waves with Sub-Aerial. The air is always full of static and your overhead aerial picks it up and brings it to your speaker. So why stay in the air—when you can use the whole earth as a static and noise filter with Sub-Aerial?

SUB-AERIAL is a scientific, proven system of taking the radio waves from the ground, where they are filtered practically free of static. It brings these filtered waves to your radio set clear of static and interference common with overhead aerials. The result is positively clear reception, remarkable selectivity and greatly increased volume. The overhead aerial is a thing of the past because it is the weak link in radio. SUB-AERIAL has replaced overhead aerials because SUB-AERIAL is 100% efficient. How can you get good reception without one?

Low Original Cost—No Upkeep Cost

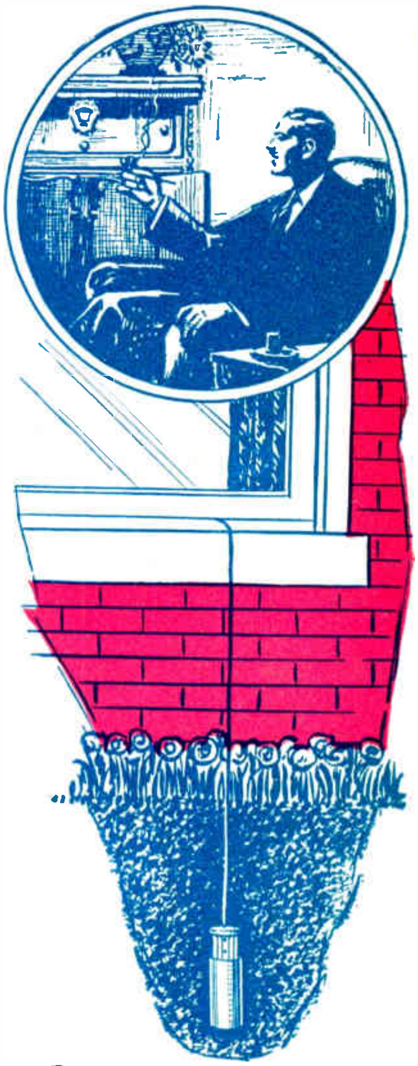
SUB-AERIAL costs no more than an overhead or loop aerial and less than many. Its first cost is the only one. SUB-AERIAL is permanent. No trouble—no hard work, or risking your neck on roofs.

25 Year Guarantee

SUB-AERIAL is guaranteed against any defects in workmanship or material and against deterioration for 25 years. Any SUB-AERIAL which has been installed according to directions and proves defective or deteriorates within 25 years, will be replaced free of charge; and also we will pay $1.00 for installing any such new replacement.

TRY IT FREE!

We know so well the surprising results you'll get that we'll let you put in a Sub-Aerial entirely at our Risk. You be the Judge. Don't take down your overhead Aerial. Pick a summer night when static and noise interference on your old Aerial are "Just Terrible." If Sub-Aerial doesn't Sell Itself to You Right Then on Performance—you needn't pay us a cent. Send for "all the Dope on Sub-Aerial." You'll be surprised. Do it NOW.



Can Be Installed in a Few Minutes

UNDERGROUND AERIAL SYSTEMS
St. Clair Bldg., Dept. 402-S
Corner St. Clair and Erie Sts., Chicago, Ill.

Ground Out Static with SUB-AERIAL

Underground Aerial Systems, Dept. 402-S
St. Clair Bldg., cor St. Clair & Erie Sts., Chicago, Ill.

Send me complete information on Sub-Aerial, Proof and Free Trial Offer. No obligation.

Name ....

Addres ....

City ....

State ....

The *NEW* Scott Shield Grid 9

Radio's Most Powerful Receiver!

FOR those who want radio reception at its highest development this is the set to build! Even more powerful than the preceding Scott receivers that established four world's records for DX reception. More selective. More superbly toned!

In range, the new Scott Shield Grid Nine is practically *unlimited*—the only range limit being the atmospheric noise level.

New Shield Grid Tubes in improved circuit

The *new* Scott uses shield grid tubes in an improved circuit with *new* power pack and amplifier. Through the greater efficiency of the new tubes and circuit, many times the amplification obtainable with the ordinary circuit using 201A tubes is secured. The Scott Power Pack and Amplifier makes it possible to obtain enormous volume—yet so completely is this volume under control that the simple turning of one knob covers the entire range from merest whisper to full auditorium strength.

Perfected matching of parts

Not only is the Scott receiver new in design, but it represents new ideals in accuracy of radio building. All parts are designed especially for this set and are *matched* with absolute precision. The extreme care taken in testing and matching the transformers is one of the reasons why the *new* Scott out-performs in competitive DX tests.

Maximum efficiency from highest to lowest wavelengths

Transformers as well as tubes are perfectly shielded in the *new* Scott. The efficiency of the R.F. stage ahead of the first detector is increased through the use of a special Selectone Two-Gang Condenser and regeneration in the first detector. The Two-Gang Condenser matches the inductance of the antenna and R.F. coils so perfectly that they line up throughout the entire scale, affording *razor-edge* selectivity with maximum amplification all the way from the lowest to the highest wave lengths.

One spot reception

All stations come in at one point only on the dial in this "one spot" super. A further improvement is evidenced in the fact that both dials track practically together—making tuning particularly easy.

Costs little to operate

The Scott Shield Grid Nine can be economically operated with dry batteries if desired and will give ample volume for the average home. The eight tubes incorporated in the receiver draw only 29 mils. Maximum volume is obtained by the use of the Scott Power Pack and Amplifier, incorporating the ninth tube for the second stage of audio. This is the latest 250 power tube, a new radio development that gives tremendous volume with perfect tone quality.

SCOTT TRANSFORMER COMPANY
4462 Ravenswood Ave., Chicago, Ill.

Build the new Scott in four hours
RESULTS GUARANTEED

New and highly developed as the Scott receiver is, anyone can build it—*easily*—and in four hours! Panel and sub-panel are drilled to receive each part, and the shielded grid amplifier unit comes fully tested and wired, ready for hook-up into the circuit. No adjustments whatever are needed. No possible chance for errors in the assembly.

We positively guarantee that you will get the same results with the Scott Shield Grid 9 that we obtain from our laboratory models.

SCOTT POWER PACK and AMPLIFIER

Especially designed to supply B current for the new Scott set. Incorporates the second stage of audio, using 250 power tube.

FREE
Circuit Diagram and Particulars

Write at once for particulars! Get the facts about this amazing new world's record set—its low cost—limitless range—tremendous power—10 kilocycle selectivity. Build this set *now* and enjoy radio at its best! FREE circuit diagram. Also copies of 6,000 and 9,000 miles reception verifications. Write today. NOW!

SET BUILDERS! We offer an unusual plan that will treble your custom set business. Ask your jobber. Or write us direct.

Clip this and Mail today

SCOTT TRANSFORMER CO.,
4462 Ravenswood Ave., Chicago, Ill.

Please send me FREE circuit diagram, records, and full particulars of the new Scott Shield Grid Nine.

( ) I am interested in your proposition to professional set builders.

Name ....

Street ....

Town .... State ....