RADIO NEWS

Amateurs' Handibook

by the most eminent RADIO EXPERTS

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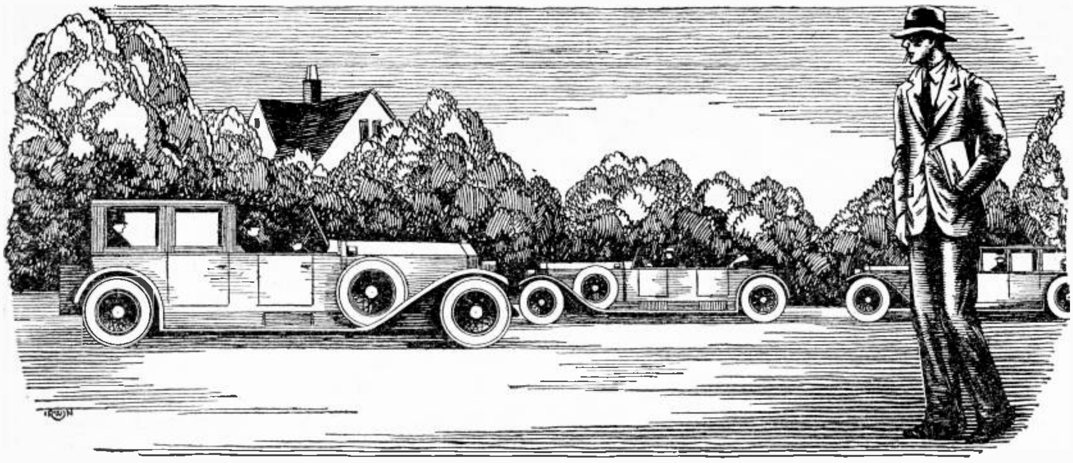

Many times in the old days, while I trudged home after work to save carfare, I used to gaze enviously at the shining cars gliding by me, the prosperous men and women within. Little did I think that inside of a year, I, too, should have my own car, a decent bank account, the good things of life that make it worth living.

I Thought Success Was For Others

Believe It Or Not, Just Twelve Months Ago I Was Next Thing To "Down-and-Out"

TODAY I'm sole owner of the fastest-growing Radio store in town. And I'm on good terms with my banker, too—not like the old days only a year ago, when often I didn't have one dollar to knock against another in my pocket. My wife and I live in the snuggest little home you ever saw, right in one of the best neighborhoods. And to think that a year ago I used to dodge the landlady when she came to collect the rent for the little bedroom I called "home"!

It all seems like a dream now, as I look back over the past short months, and think how discouraged I was then, at the "end of a blind alley." I thought I never had had a good chance in my life, and I thought I never would have one. But it was waking up that I needed, and here's the story of how I got it.

I WAS a clerk, working at the usual miserable salary such jobs pay. Somehow I'd never found any way to get into a line where I could make good money.

Other fellows seemed to find opportunities. But—much as I wanted the good things that go with success and a decent income—all the really well-paid vacancies I ever heard of seemed to be out of my line, to call for some kind of knowledge I didn't have.

And I wanted to get married. A fine situation, wasn't it? Mary would have agreed to try it—but it wouldn't have been fair to her.

Mary had told me, "You can't get ahead where you are. Why don't you get into another line of work, somewhere that you can advance?"

"That's fine, Mary," I replied, "but *what* line? I've always got my eyes open for a better job, but I never seem to hear of a really good job that I can handle." Mary didn't seem to be satisfied with the answer but I didn't know what else to tell her.

It was on the way home that night that I stopped off in the neighborhood drug store, where I overheard a scrap of conversation about myself. A few burning words that were the cause of the turning point in my life!

With a hot flush of shame I turned and left the store, and walked rapidly home. So that was what my neighbors—the people who knew me best—really thought of me!

"Bargain counter sheik—look how that suit fits," one fellow had said in a low voice. "Bet he hasn't a dollar in those pockets." "Oh, it's just 'Useless' Anderson," said another. "He's got a wish-bone where his back-bone ought to be."

As I thought over the words in deep humiliation, a sudden thought made me catch my breath. Why had Mary been so dissatisfied with my answer that "I hadn't had a chance." *Did Mary secretly think that too?* And after all, wasn't it *true* that I had a "wish-bone" where my back-bone ought to be? Wasn't that why I never had a "chance" to get ahead? It was true, only too true—and it had taken this cruel blow to my self-esteem to make me see it.

With a new determination I thumbed the pages of a magazine on the table, searching for an advertisement that I'd seen many times but passed up without thinking, an advertisement telling of big opportunities for trained men to succeed in the great new Radio field. With the advertisement was a coupon offering a big free book full of information. I sent the coupon in, and in a few days received a handsome 64-page book, printed in two colors, telling all about the opportunities in the Radio field and how a man can prepare quickly and easily at home to take advantage of these opportunities. I read the book carefully, and when I finished it I made my decision.

WHAT'S happened in the twelve months since that day, as I've already told you, seems almost like a dream to me now. For ten of those twelve months, *I've had a Radio business of my own.* At first, of course, I started it as a little proposition on the side, under the guidance of the National Radio Institute, the outfit that gave me my Radio training. It wasn't long before I was getting so much to do in the Radio line that I quit my measly little clerical job, and devoted my full time to my Radio business.

Since that time I've gone right on up, always under the watchful guidance of my friends at the National Radio Institute. They would have given me just as much help, too, if I had wanted to follow some other line of Radio besides building my own retail business—such as broadcasting, manufacturing, experimenting, sea operating, or any one of the score of lines they prepare you for. And to think that until that day I sent for their eye-opening book, I'd been wailing "I never had a chance!"

NOW I'm making real money. I drive a good-looking car of my own. Mary and I don't own the house in full yet, but I've made a substantial down payment, and I'm not straining myself any to meet the installments.

Here's a real tip. You may not be as bad off as I was. But, think it over—are you satisfied? Are you making enough money, at work that you like? Would you sign a contract to stay where you are now for the next ten years, making the same money? If not, you'd better be *doing* something about it instead of drifting.

This new Radio game is a live-wire field of golden rewards. The work, in any of the 20 different lines of Radio, is fascinating, absorbing, well-paid. The National Radio Institute—oldest and largest Radio home-study school in the world—will train you inexpensively in your own home to know Radio from A to Z and to increase your earnings in the Radio field.

Take another tip—No matter what your plans are, no matter how much or how little you know about Radio—clip the coupon below and look their free book over. It is filled with interesting facts, figures and photos, and the information it will give you is worth a few minutes of anybody's time. You will place yourself under no obligation—the book is free, and is gladly sent to anyone who wants to know about Radio. Just address J. E. Smith, President, National Radio Institute, Dept. M-93, Washington, D. C.

J. E. SMITH, President
National Radio Institute,
Dept. M-93, Washington, D. C.

Dear Mr. Smith:

Please send me your 64-page free book, printed in two colors, giving all information about the opportunities in Radio and how I can learn quickly and easily at home to take advantage of them. I understand this request places me under no obligation, and that no salesmen will call on me.

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Address ....

Town .... State ....

RADIO NEWS

AMATEURS' HANDIBOOK

by the most eminent Radio Experts

A Selected Series *of* Practical and Instructive Articles *for* the Radio Set Owner, the Set Builder, the Experimenter and the "Ham"

Vol. No. 4

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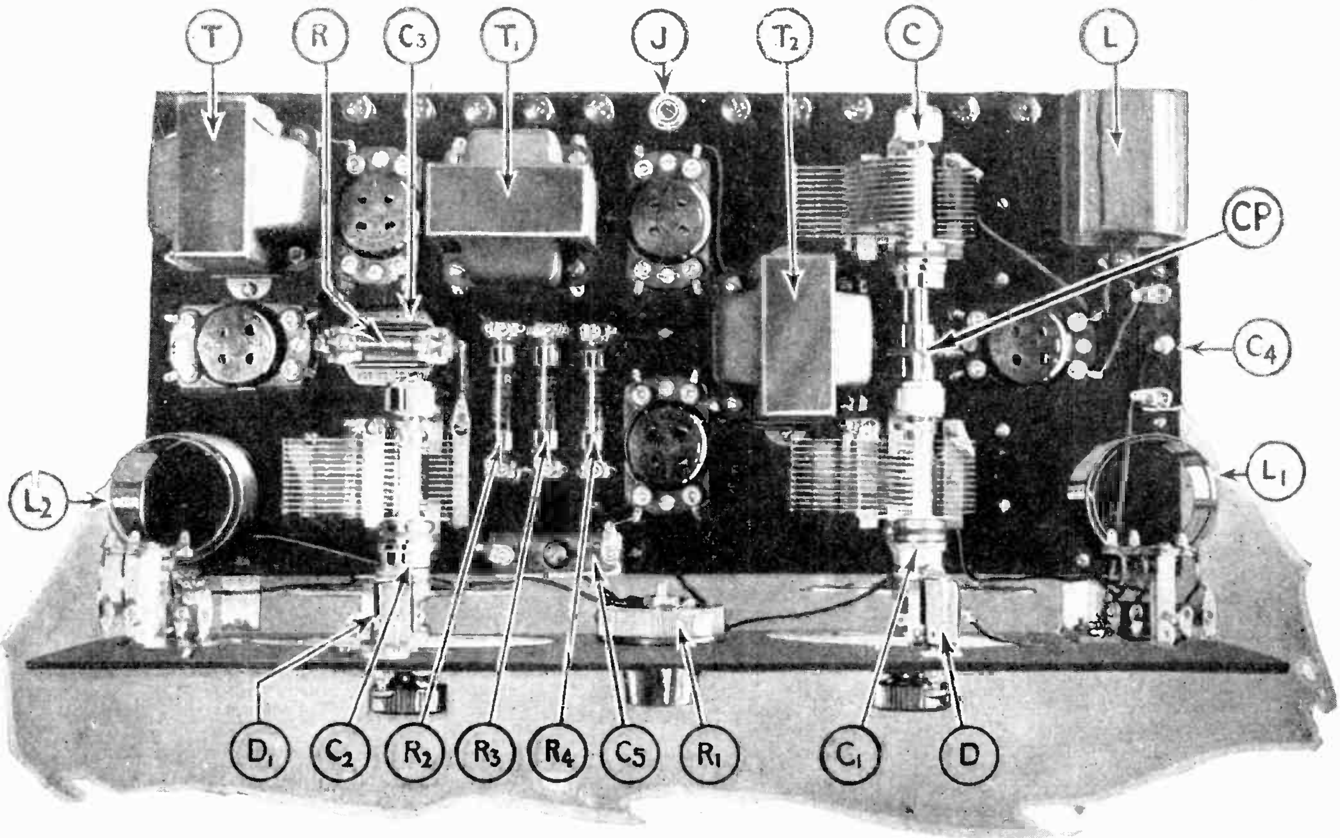
The Loftin-White Constant-Coupled Receiver*

Employing a New System of Stabilizing R.F. Amplification

By ROBERT H. MARRIOTT†



A top view of the completed Loftin-White receiver. The parts are: D and D1, the illuminated vernier dials; C, C1 and C2 the tuning condensers; C3, grid condenser; C4 and C5, phase-shifting condensers; L, antenna coupler; L1 and L2, R.F. transformers with adjustable primaries; R, grid leak; R1, rheostat; R2, R3 and R4, self-adjusting rheostats; T and T1, A.F. transformers; T2, output transformer; J, jack for external power amplifier and CP the coupling unit connecting condenser C to C1.

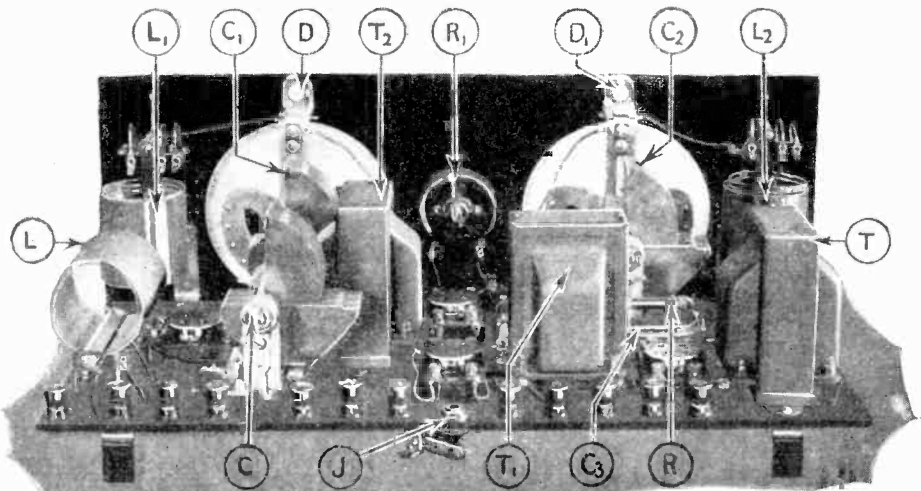
YOU have probably noticed, through experience with your own radio set, that you do not get as good results on the longer wavelengths as you do on the shorter ones; that is, the short-wave stations, even those some distance away, have more of a "kick" to them. The reason for this is that your set does not amplify the long waves as well as the short ones. Now, if you were to try to make the set more sensitive on these long waves, it would be too sensitive on the short ones and we would run into the difficulty known as oscillation.

The limit of sensitivity is just below this point of oscillation; any point above it is unsuitable for the reception of broadcast programs. It is obvious that the ideal plan would be to have a receiver with some sort of automatic control, requiring no manual adjustment, which would maintain the receiver at the maximum point of sensitivity irrespective of the wavelength to which it was tuned. It sounds very simple but, really, it isn't any such thing. Engineers have been doing their best to develop just such a circuit, but until the arrival of the Loftin-White arrangement the best any of us could do was to snub oscillation tendencies at the low wavelengths with some sort of neutralizing device and be philosophical concerning the sacrifice made at the longer wavelengths —just to keep the set from being a nuisance.

The trouble we had with most of our neutralizing devices came out of the fact that none of them which was anywhere near efficient was independent of wavelength or frequency. You could adjust them for some particular band of frequencies, at which points they did the trick, but, as soon as the set was tuned to the very high or the very low broadcast frequencies, the electrical value of the device would automatically change and consequently its main purpose would be defeated. We have used coils and condensers and many combinations of the two in our circuits in an attempt to stabilize them, but since both of them vary through wide ranges with a change of frequency, we have always ended up exactly where we started.

Inductance vs. Capacity

Messrs. Loftin and White use coils and condensers for the very purpose we have been discussing, but they started out in a new way in the beginning and did not encounter downfalls. The idea they have is so simple, after it has been told you, that it



A rear view of the completed receiver. The symbols are the same as in the illustration above. The R.F. transformers L1 and L2 are not attached to the variable condensers, but have screws so that the degree of coupling can be adjusted. The rheostat R1 controls the filament current to the two R.F. amplifier tubes.

*RADIO NEWS *Blueprint Constructional Article* No. 16. (See page 109).
†First President, Institute of Radio Engineers

seems surprising that someone didn't think of it before. We have mentioned that both coils and condensers vary in value with a change of frequency, but the odd thing about them is that they vary in opposite directions; *i.e.*, the resistance of a coil *decreases* as we increase the wavelength, but the resistance of a condenser *increases*, and vice versa. If we show this increase or decrease in resistance (impedance and reactance) with a change in wavelength or frequency, as curves on graph paper, we see that in one case the curve rises and in the other case it descends.

The Loftin-White Principle

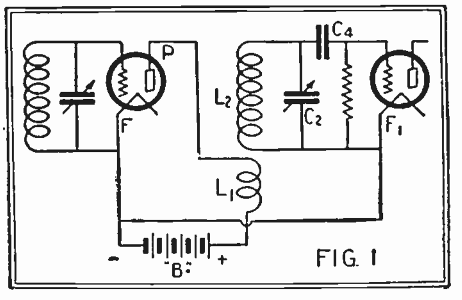
If we take the two curves, one for a condenser and one for a coil and place one over the other so that both can be observed, we note immediately that one compensates for the other. So that, if we combine a coil and a condenser in a radio circuit and get their proportionate values correct, the resistance in the circuit will be practically constant irrespective of the wavelength or frequency; for, as one decreases in resistance the other is increasing by a like amount. That is the backbone of the Loftin-White principle. They call it the "constant-coupling" system because the combination of the coils and the condensers is such that the transfer of energy from one circuit to the other is the same for all wavelengths; in other words the coupling between the circuits is made constant.

Fig. 1 shows one stage of a radio-frequency-amplifier system, the first tube being an amplifier and the second tube a detector. Fig. 2 shows the corresponding Loftin-White circuit, applied between the amplifier tube and the detector tube. Fig. 3 contains graphs of the grid voltage of the first tube and the feed-back voltages in circuits like Figs. 1 and 2.

A glance tells us that the two circuits are quite different. Fig. 1 has one plate circuit while Fig. 2 has two. Fig. 1 has one coupling, while Fig. 2 has two couplings between the R. F. plate circuit and the grid of the detector tube. Fig. 1 has no condensers in the plate circuit, while Fig. 2 has two condensers in one of its plate circuits. Also, Fig. 3 indicates that the feed-back voltages and resulting voltages in Figs. 1 and 2 are quite different.

Two Plate Circuits

In Fig. 1 both the radio circuit and the direct current circuit of the "B" battery are through F to P, L1, the "B" battery and back to F; while in Fig. 2, the "B" battery circuit is from F to P, through the choke coil, CH, through the "B" battery and back to F, because C3 and C1 will not pass the direct current from the "B" battery. The radio-frequency circuit in Fig. 2 is through F to P, C3, L1, C1, and back to F, because the choke coil, CH, will not pass much radio-frequency current.



The common form of tuned-radio-frequency circuit coupled to the detector, as employed in most present-day receivers. Compare this with the circuit of Fig. 2

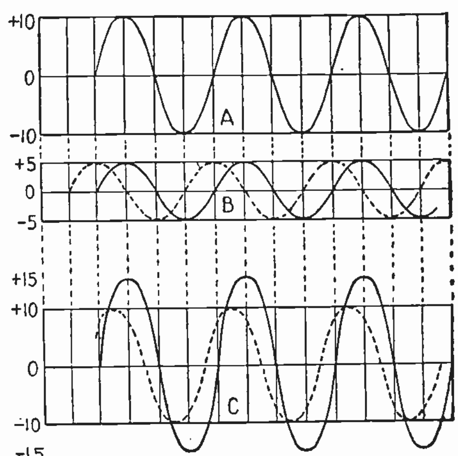
The plate circuit in Fig. 1 is coupled to the grid circuit of the detector tube only by the inductive relation of the primary, L1, to the secondary, L2; or, we can say, by the mutual inductance of L1 and L2.

The plate circuit in Fig. 2 is coupled to the grid circuit of the detector tube, not only by the mutual inductance of L1 and L2, but in a second and additional way by the mutual capacity, C1.

Mutual inductance is less effective for transferring energy at the higher wavelengths than at the shorter ones. Mutual capacity behaves in an opposite manner; that is, it is more effective for the long-wave broadcasts than it is for the shorter. Also, as the tuning condenser, C2, is increased in capacity for tuning to the long waves, it automatically changes the relative coupling value of C1, making the latter still more effective for the transfer of long-wave signals. In Fig. 2, the coupling abilities of the mutual inductance and the mutual capacity are adjusted so that they combine to produce the same signal transfer for all wavelengths. This is the needed improvement over Fig. 1; because the latter depends on inductive coupling only, and, therefore, does not transfer all frequencies equally well.

Phase-Shifting Condenser

In Fig. 2, the condenser, C3, is provided to shift the phase of the radio-frequency alternating current in the plate circuit; so that any feed-back that may occur from the plate, P, to the grid circuit of that tube, will be out of phase with the same frequency in

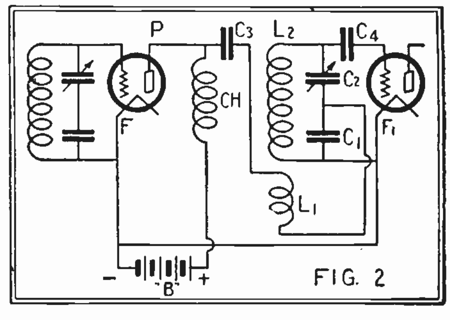


A graphical comparison of the grid voltages and feed-back voltages developed in the circuits of Figs. 1 and 2.

that grid circuit. When sufficiently out of phase, it will not add itself to the grid frequency to build up an amplitude out of proportion to the other broadcast frequencies in the grid circuit. Such adding-up does occur in receivers employing circuits like Fig. 1, producing serious signal distortion. Too much feed-back causes the grid circuit components to oscillate of their own accord; and oscillation in a tuned-R.F. receiver is ruinous, as it produces distortion and uncontrollable squealing when stations are tuned in. Condenser C3 prevents both the distortion and squealing.

In Fig. 3 the graph, A, is intended to represent the alternating voltage in the grid circuit at the frequency with which the grid circuit of the first tube in Fig. 1 is in tune. Now the conclusion to which Loftin and White came, in their study of regenerative and oscillating tube circuits, was that, in tuning the grid circuit of the second tube, the normal tuning adjustment over-shoots the mark; to the extent of increasing the inductive reactance of the first tube's plate circuit to such a point that the voltage feed-back from the plate circuit is shifted forward to the position of the solid graph, B. That solid graph, B, is in phase with the graph A and adds to A to make the solid graph C. For example, +5 adds to +10 and −5 adds to −10, in combining these graphs.

This adding up of the energy represented by A and the solid graph B produces distortion. That is, A has been made to grow from its normal size to the size represented by the solid graph, C; while the other different frequencies which go to make up broadcast signals are not built up in proportion



A circuit embodying the Loftin-White principle. It is non-reactive and provides constant electrical coupling at all broadcast frequencies. Note that the primary L1 is "floating."

(if we follow out the Loftin-White theory) because they do not bear the same relation to the frequencies to which the grid circuits of the first and second tubes are tuned. If the feed-back represented by the solid graph B is large enough, then the solid graph C will become larger, and excessive feed-back or oscillation will result.

Loftin and White, working on this theory that oscillations are produced by the inductive reactance of the plate circuit in shifting the voltage forward in phase, placed capacity reactance in the plate circuit to shift the voltage backwards.

The dotted graph, B, represents the feed-back shifted backwards in phase, so that when the dotted graph B is added to graph A, the resulting dotted graph C is no larger in amplitude than the original graph A. For example, the dotted graph B is at about 0 when A is at 10, and nothing is added toA.

Correction for Stray Couplings

In all receivers there are both inductive and capacity couplings which are not wanted, but are there because parts must be placed fairly close together and connected by wires. These parts and wires couple, inductively and capacitatively, with others or each other.

Because the Loftin-White circuit contains both inductive and capacity couplings and the phase-shifting reactance, as shown in Fig. 2, it contains three elements that may be adjusted to offset undesired inductive and capacity couplings and stray feed-back. This works out so that little shielding and sometimes none at all, is required, where it would be reasonable to expect that shielding would be necessary.

At All Wavelengths

Interesting comparisons can be made between a receiver with a circuit like Fig. 1 and a receiver with a circuit like Fig. 2. With the Fig. 1 arrangement and suitable "B" battery, the receiver will squeal probably for every broadcast station from 200 to 250 meters. For some stations above 250 meters, it will noticeably distort the voice or music. Stations higher up the scale will not be distorted, but will be weaker than they should be.

With C3 removed (short-circuited), the circuit of Fig. 2 will also squeal for every broadcast station from 200 meters up to 250, but it will not stop there; it will squeal for every station in the broadcast band.

Then, if we reduce the filament current or the "B" battery voltage so that the tube is not amplifying as it should, we can just stop the squealing and get distorted signals from all stations. In other words, the circuit treats the stations all alike from one end of the scale to the other. If C3 is put back where it belongs, and the filament current and "B" battery voltage are raised to their proper values, the circuit will be restored to condition, and will not distort or squeal. It will resume its ability to handle all broadcast wavelengths alike.

Accurate Parts Required

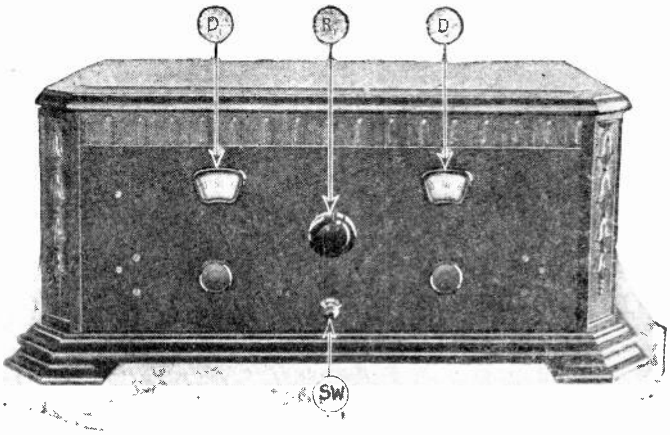
Of course, C3, L1, L2, C1, C2 and CH must be properly proportioned and related to each other, and to other parts in the set, to produce these desirable results. In fact, if the elements are not properly proportioned and related, some strange circuit actions will result. For example, if L1 is connected backwards, the set may not pick up any broadcasts at all in the middle of the scale. If C3 is too large and C1, C2 and L2 are not properly related, the set may squeal at one place or another, or it might even squeal at two places.

Designing the Receiver

Because of the great increase in efficiency obtained with this system, it seemed likely that there would be no call for a set having more than two stages of radio-frequency amplification; as early observations indicated that two stages were sufficient for practically all purposes. Consequently, when it came to the design of a set suitable for the radio fan, this number was decided upon. Since the amount of energy delivered by the detector tube is above normal, the receiver was built to employ a power tube in the last stage of audio-frequency amplification so there would be no chance of overloading. Straight transformer coupling was found to be satisfactory from all angles, as very efficient audio-frequency transformers with large iron cores and high impedance windings were available.

The complete receiver is shown in the accompanying illustrations. The condensers which tune the aerial or first R.F. circuit and the second radio-frequency stage are mounted together that they may be operated by a single dial. The other dial controls the detector input. The rheostat, R1, which

A panel view of the completed Loftin-White receiver in its cabinet. SW is the filament switch, R1, the R.F. tube rheostat, and D and D1 are the illuminated vernier dials, the knobs of which are directly below the scales.



controls the flow of filament current to the two R.F. tubes, is employed as a volume regulator. All other tubes employ automatic filament controls. Since a power tube of the 171 type is employed it is necessary to use an output device to protect the loud speaker from harm. An output transformer, T2, the characteristics of which match those of the two A.F. transformers, T and T1, is used for this purpose.

The aerial coil, L, is mounted at the rear right of the sub-base, directly next to the aerial and ground binding posts. The two R.F. transformers, L1 and L2, are mounted on either side of the panel and near the variable condensers to which they connect.

The R.F. choke coils and the fixed condensers are mounted on the underside of the sub-base.

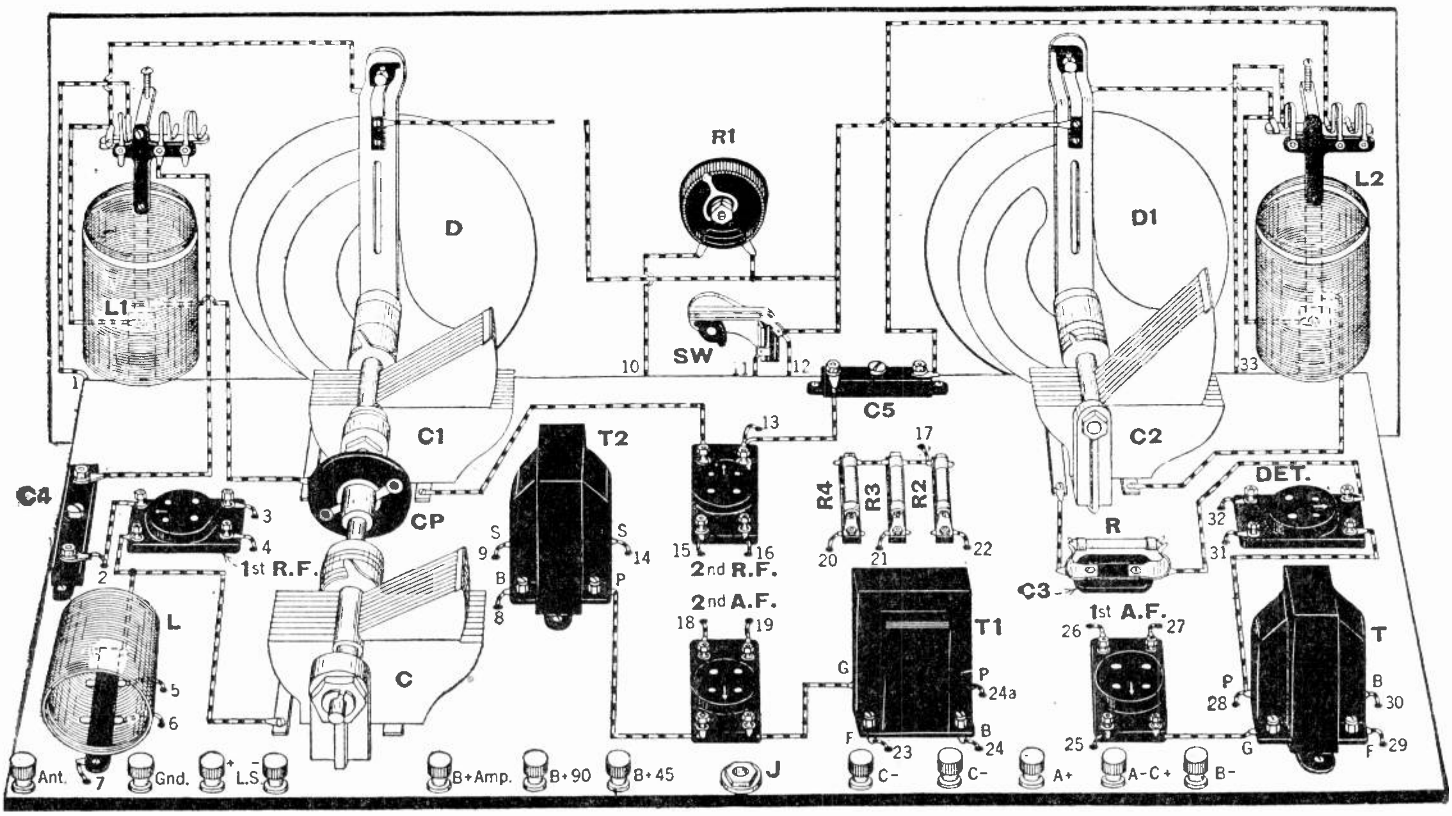
Now let us get down to the actual construction of the receiver.

Assembly and Wiring

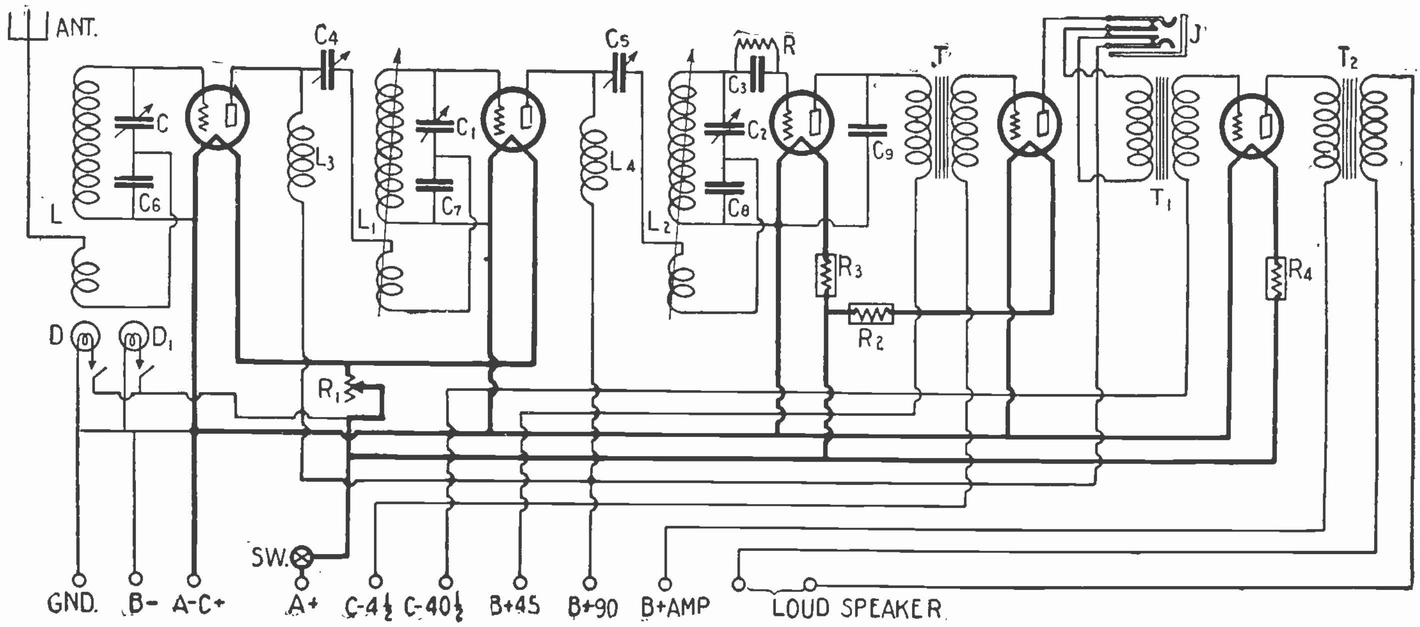
Mount the rheostat, R1, with two screws, and with the binding posts toward the bottom of panel. When mounted, the contact arm should turn without touching the mounting screws. Mount the switch, SW, with the springs up, parallel to the lower edge of the front panel. Next mount the two illuminated dials, D and D1. Remove the mounting brackets, as they are not used in this set. Mount bezel and dial as per instructions, but do not tighten the mounting nuts. Lay the sub-panel so that the large hole is toward you, the side with six small holes is to your right and eight small holes to the left.

Mount the first R.F. socket at the extreme left of the panel. The screws and nut on the grid end of the socket are used to hold, to the panel, the mounting bracket, which should be mounted at the same time as the socket. Place a soldering lug under the nut on the bottom of the panel. Mount the "ground" binding post through the small hole at the back of panel and the hole in the mounting bracket; place a soldering lug under the nut on the bottom of the panel. Mount the other four sockets in positions as shown in the illustrations. Mount the two phasing condensers, C4 and C5, and place a soldering lug under each binding post.

Mount the self-adjusting-rheostat bases with flat-head screws. Bend the soldering lugs on the jack, J, down, being careful that they do not touch each other;



The layout wiring plan for the upper part of the receiver. Note that one terminal each of the R.F. transformers L1 and L2 connects to both the dial lights and the sub-panel brackets. Also, the grid return of the detector tube goes to the "A—" lead, which is most satisfactory when using a tube of the 200-A type. Each wire is numbered where it passes through the sub-panel, and carries the same number on the view of the under side.



The complete schematic circuit diagram of the Loftin-White receiver described in this article. Condensers C6, C7 and C8 have a capacity of .004-mf. It is important that C6 and C7 be within 5% of this value. The R.F. Chokes L3, L4, are 125 millihenry; they may be made by 300 turns of No. 36 D.C.C. wire on a 1½-inch form.

then mount the jack in the large hole at the back of the sub-panel. Mount the twelve binding posts in the holes in the back of panel, with a soldering lug under each, putting two lugs under the "B—" post.

Remove the mounting screws and mounting nut from one of the variable condensers. These may be thrown away as they are not used. Loosen the brake-band screw as far as it will go without coming off. Then

SYMBOL	Quantity	NAME OF PART	VALUE OF PART	REMARKS	MANUFACTURER ★	
L	1	Ant. Coupler			1	
L1,L2	2	R. F. Trans.		With adjustable coupling	1	
L3,L4	2	R. F. Chokes		Special	2	
C,C1	2	Var. Condensers	.0005 mf.	Straight line tuning type	1	11,12,13,18,31
C2	1	Var. Condenser	.0005 mf.	Straight line tuning type	1	11,12,13,18,31
C3	1	Grid Condenser	.00025 mf.	With mounting clips for leak	3	14,34,35
C4,C5	2	Adj. Condensers	.0005mf.max	Phase shifting condenser	4	
C6,C7,C8	3	Fixed Condensers	.004 mf.	Accuracy of value important	3	
C9	1	Fixed Condenser	.001 mf.	By-pass	3	14,15,34,35
R	1	Resistor	2 megs.	Grid leak	5	14,15,26,27
R1	1	Rheostat	10 ohms	For R. F. tubes	2	7,8,13,16,17
R2,R3	2	Auto. Fil. Cont.	5 v. ¼amp.		6	
R4	1	Auto. Fil. Cont.	5 v. ½amp.	For power tube	6	
T,T1	2	A. F. Trans.	3 to 1 ratio		2	11,12,13,32,33
T2	1	Output Trans.	1 to 1 ratio		2	11,13
SW	1	Fil. Switch			7	16,17
D,D1	2	Vernier Dials		With pilot light and switch	8	9,11,12,31
J	1	Jack		Double circuit short jack	7	16,17
CP	1	Coupling Unit		For condensers C and C1	2	
	5	Sockets		UX type, non-microphonic	2	9,11,13,17,18
	12	Binding posts			9	4,13
	2	Brackets		For mounting panel	2	
	1	Pillar Post		For supporting sub-base	2	
	1	Panel		7 X 18 X 3/16"	10	28,29,30
	1	Sub-base		8 X 17 X 3/16"	10	28,29,30
	25ft.	Hook-up Wire		Flexible	2	23,24,25
	4	Tubes	5v. ¼ amp.		19	20,21,22
	1	Tube	5v. ½ amp.	Power amplifier	19	20,21,22

NUMBERS IN LAST COLUMN REFER TO CODE NUMBERS BELOW.

1 Hammarlund Mfg. Co.
2 Pacent Elec. Co.
3 Sangamo Elec. Co.
4 X-L Radio Labs.
5 International Res. Co. (Durham)
6 Radiall Co. (Amperite)
7 Yaxley Mfg. Co.
8 Martin-Copeland Co. (Marco)
9 H. H. Eby Co.
10 Micarta Fabricators
11 Silver-Marshall, Inc.
12 Samson Elec. Co.
13 General Radio Co.
14 Electrad, Inc.
15 Tobe Deutschmann Co.
16 Carter Radio Co.
17 Herbert H. Frost, Inc.
18 Benjamin Elec. Mfg. Co.
19 Radio Corp. of America
20 E. T. Cunningham, Inc.
21 C. E. Mfg. Co. (Ceco)
22 Magnavox Co.
23 Belden Mfg. Co.
24 Acme Wire Co.
25 Cornish Wire Co.
26 Dubilier Condenser Corp.
27 Daven Radio Corp.
28 American Hard Rubber Co. (Radion)
29 Diamond State Fibre Co. (Bakelite)
30 Insulating Co. of Amer. (Insuline)
31 National Co.
32 American Trans. Co. (Amertran)
33 All-American Radio Co.
34 Aerovox Wireless Corp.
35 Polymet Mfg. Co.

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

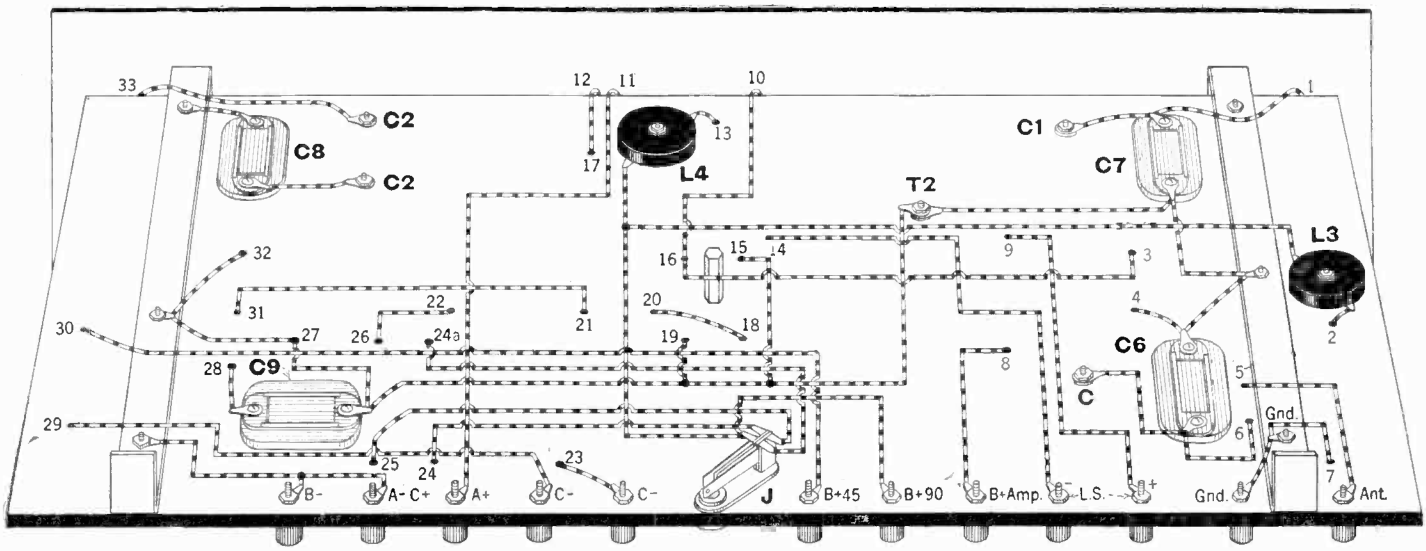
mount the condenser on the right side of the base panel, through the holes in the bottom of the condenser frame. Mount the first audio transformer (T) with the "F—" and "G" posts to the rear; the two screws which hold this transformer in place pass through and hold the right-hand mounting bracket. Mount soldering lugs under both nuts. Complete the mounting of the brackets by putting the screws in place at the front of the base panel, with a soldering lug under the one on the right-hand bracket.

Then mount the middle or second audio transformer (T1). If the fourth socket is in the way it may be taken out in order to get the mounting screws in. Mount the transformer so that the "B+" and "F—" posts are to the back of the panel. Mount the output transformer (T2) with posts "B+" and "P" to rear, placing two soldering lugs under the front mounting nut. Mount the pillar post in the center of the base panel. Mount the .001-mf. condenser (C9) on the screw holding the "B+P" side of the second audio transformer (T1). This condenser is mounted with one screw only.

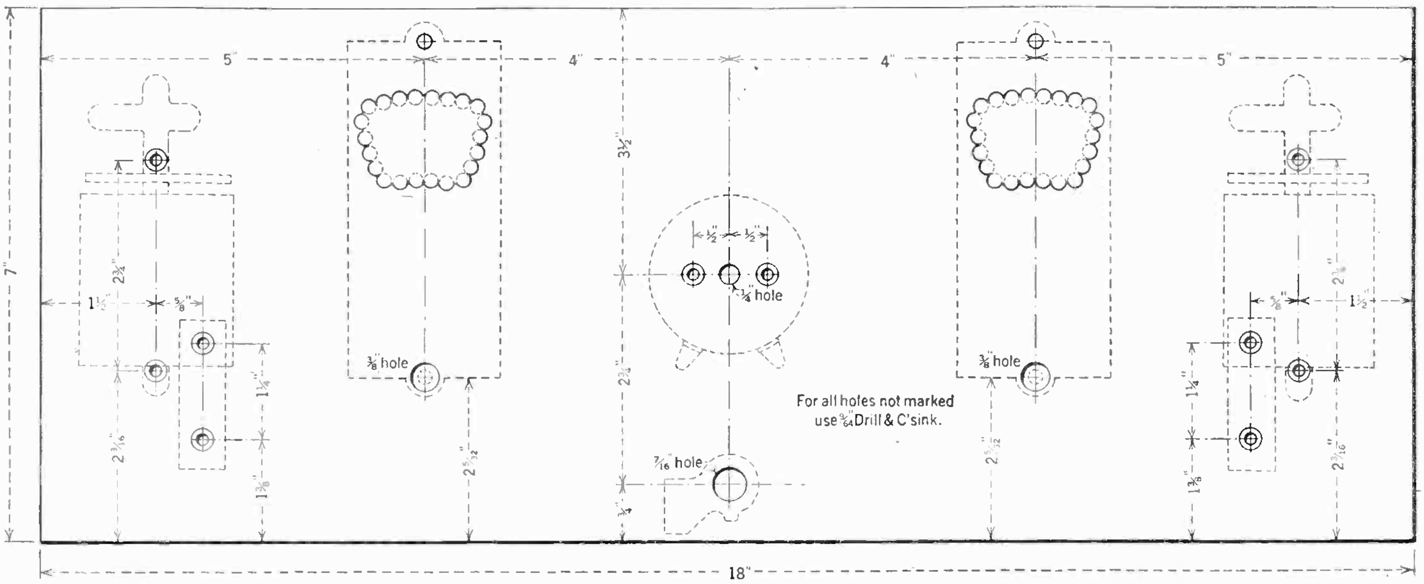
Remove the mounting screws and nuts from the other two variable condensers, loosen the brakes as far as possible, and mount them in holes provided on the left-hand end of panel. Loosen the set screws on condenser shaft and mount the condenser coupling (CP) between them by sliding the shaft of the back condenser forward far enough to engage the set screws in the coupling. Tighten the screws in the coupling, but not on the condensers. Loosen the set screws in the back of the dials on the front panel and slide the front panel forward until the condenser shafts are fully engaged in the shaft holes of the dials.

Fasten the mounting brackets to front panel, mounting a soldering lug under the top screws of both. Tighten the set screws on the dial. Hold the condensers fully in and turn dials until they read exactly 100, then tighten the set screws on condenser shafts.

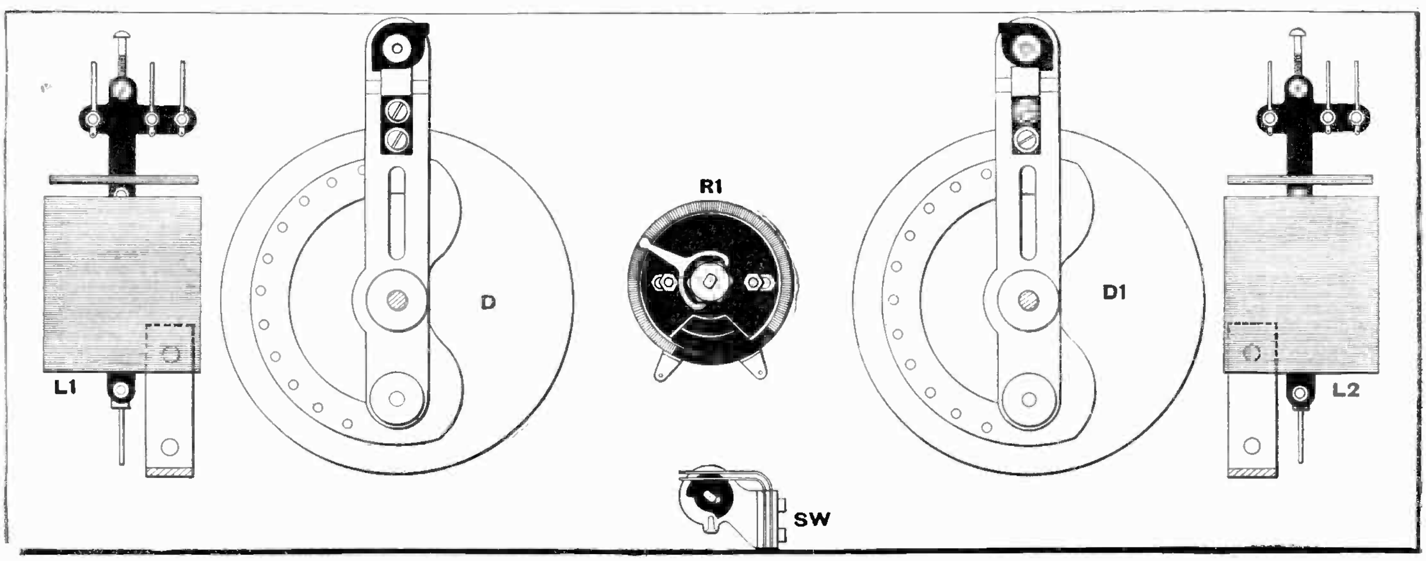
Mount the two choke coils, L3 and L4, putting the screws through from the top of the panel. Screw three nuts on tight and then put the choke coil on, holding it in place with another nut. All apparatus except the coils, L, L1 and L2, is now mounted. These should not be put in position until needed, on account of the danger of damaging them in handling. The wiring of the set is plain from the accompanying schematic and picture diagrams. Study them closely, and you will have no trouble in connecting the instruments correctly.



A pictorial wiring plan of the under side of the sub-panel. Note that a great many connections are made to the two support brackets. The brackets form a common "A" battery connection. L3 and L4 are the two R. F. chokes; C6, C7 and C8 are the .004-mf. fixed condensers, while C9 is the .001-mf. by-pass condenser connected across the primary of the A.F. transformer T. The terminal posts marked C, C1, C2 and C2 are the connections from the rotor plates of the variable condensers. Terminal post T2 is one of the mounting screws on the output transformer T2. Note the supporting pillar directly in the center of the sub-panel, between holes 15 and 16.



Drilling and layout details for the panel. This gives the locations for the holes for mounting the R.F. transformers, the filament switch, the rheostat and the vernier dials. The metal templates, which are furnished with these dials, are shown in the drawing for the sake of explicitness. All necessary dimensions are given for the spacing of the apparatus.



Constructional layout for the front panel, as seen from the rear. Parts of the brackets which support the sub-panel are shown. Note that there is a cam-type switch at the top of each dial; these are for turning the dial lights on and off.

Adjustment and Operation

I will now tell how to adjust the receiver. Mr. G. J. Kelley has adjusted a great many of the experimental models of the Loftin-White circuit and therefore I am using his experience largely in trying to describe the simplest way to adjust this receiver No other receiver is adjusted in this same way. The receiver is different; therefore, the method of adjustment is different.

The first thing to do is to check over the set, step by step, using the schematic and picture diagrams as guides.

As a further check, to be sure that there is nothing wrong, take the terminal wires of the "A" battery and touch them to the "A" posts. Then touch one of the "A" leads to the "B—" battery terminal, and the other to each of the "B+" posts in succession. Then touch the "C" connections the same way. If there are no short circuits nothing will happen when the "A" leads are touched to the posts in this manner. If there is a flash it means a short circuit, which will have to be traced down and corrected.

The next thing to do, if everything is all right, is to connect the "A," "B" and "C" batteries according to the markings in the drawings. This connection provides for 90 volts "B" battery on the R.F. tubes, 45 on the detector, 90 on one A.F. tube, and 135 or 180 volts on the last tube.

The tubes go in place next. A tube of the 171 type should be placed in the last-stage socket, if 180 volts of "B" battery is to be used with a 40-volt "C" battery. If 135 volts of "B" battery with 9 volts of "C" battery is to be used, then a tube of the 112 type should be placed in that socket.

Now it is about time to connect the antenna and ground, and to plug in the loud speaker. The antenna should be about 75 feet in length from the receiver to the far end. After this the switch and the rheostat knobs on the panel front should be turned to the right. The tubes should light up and the loud speaker should produce sounds. If, when the condenser knobs are turned, excellent results are obtained from all broadcasting stations within your normal range, the job may be considered entirely complete.

Setting the Condensers

The first purpose of the Loftin-White circuit is to transfer all radio frequencies equally well, so that all broadcast stations within the broadcasting band can be brought in with volume in proportion to the strength of signals they lay down on your antenna. The second purpose of the circuit is to prevent the R.F. amplifier tubes from oscillating and producing distorted broadcasts. These results are obtained by carefully adjusting the phasing condensers, C4 and C5, with a screw driver, and by adjusting the coupling screws on coils L1 and L2 just back of the top corners of the front panel. The phasing condensers are at the front center and right end of the base panel; their adjusting screws are in the middle of their tops.

Now we will suppose that the parts are out of adjustment; say the phasing condensers are screwed down too far. If they are, the set will squeal. You cannot see whether or not they are down too tight or up too loose; therefore, the best way is to screw them down tight. We can tell when they are tight; but, when they are loose, we cannot tell how loose they are. Also, to get the same starting place for the coupling coils even though it may be the wrong place, suppose we screw them up or down so the tops of the inside or primary coils are about level with the outside or secondary coils.

With the condensers and coils in these conditions the set should squeal. Probably it will squeal for every broadcast station between the shortest (200 meters) which is at about 10 on the dial, to the longest (547 meters), which is at about 97 on the dial. That is, if the two condenser knobs, D and D1, are turned at the same time, a squeal should be heard at several points on the dials, say when both dials are on 15, 25, 35, 55, 75 and 90. At least there should be one station broadcasting on a wave length near 15, and another near 65, and another near 90. Of course, both dials may not be exactly on the same figures. Tubes, windings and other things change the settings somewhat.

The next operation is to turn the two dials to the station that causes a squeal near 65. Then loosen the set screw on the right-hand tuning condenser shaft at the front end of the coupling, CP, and turn the *coupling* disc with one hand while holding the right-hand knob with the other. Fiddle these back and forth until the squeal comes in loudest, then tighten the set screw in the coupling. If the squeal is too loud to judge by, turn the volume-control rheostat, R1, to the left and then make the adjustment.

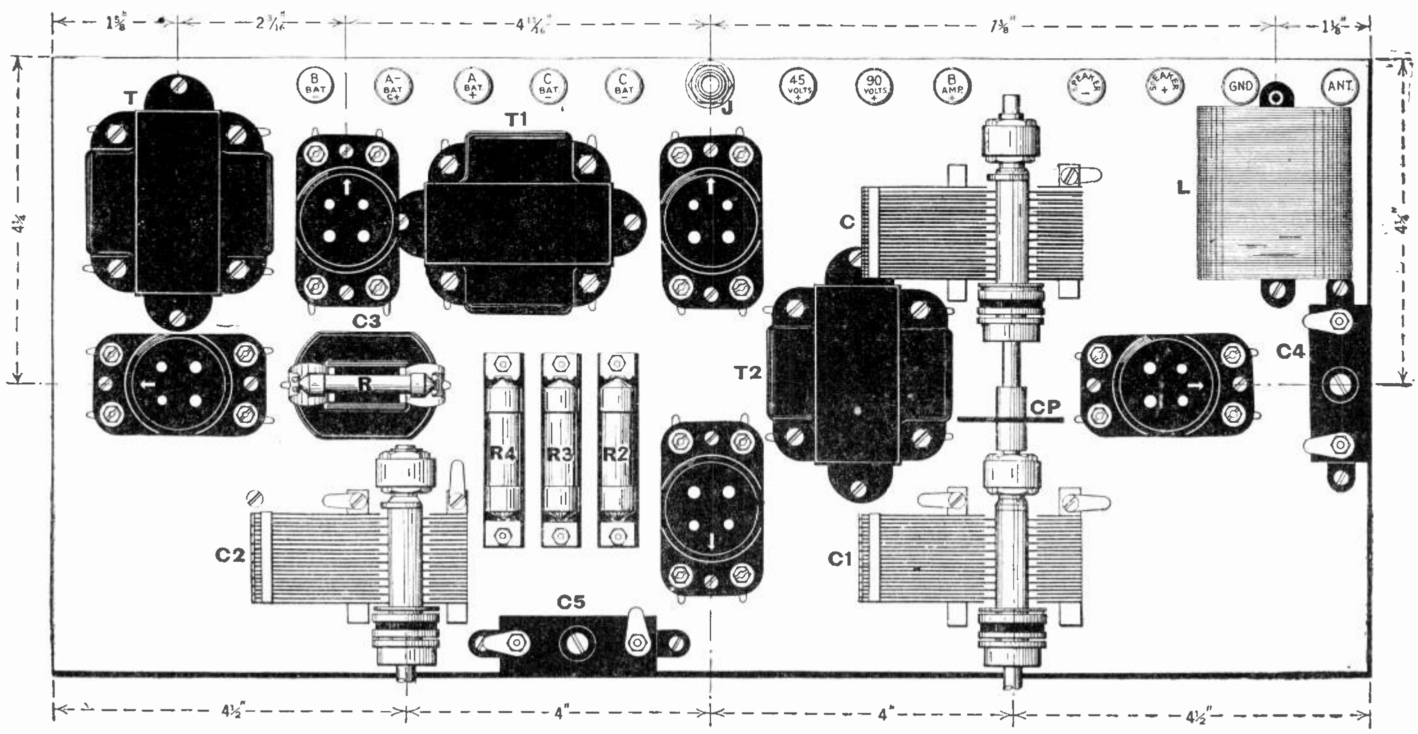
After the tuning condensers have been adjusted as above, turn the volume control, R1, to the right again and turn both condenser knobs to the squeal near 90 and then to the squeal near 15. Then turn the volume control to the left until the squeal near 15 disappears. Next turn back to the squeal near 90. Now one of two things is to be done; first, if the squeal is still there, turn back to 15 and move the primaries of coils L1 and L2 into the secondaries until the squeal comes back at 15. Second, if the squeal is not there at 90, turn back to 15 and turn the volume control to the right until the squeal comes back and no further. Then raise the primaries out of the secondaries slowly until the squeal disappears.

Now turn the volume control all the way to the right, leaving the dials on 15. Next take a screw driver and alternately turn the screws in the two phasing condensers, C4 and C5, one-quarter of a turn to the left until the squealing stops. Now turn the dials slowly across the scale. If no stations squeal, but they come in as they should all the way across the scale, nothing further needs to be done in that respect. If they do squeal at some point, loosen up on the phasing condensers alternately, a quarter of a turn at a time, until the squealing ceases.

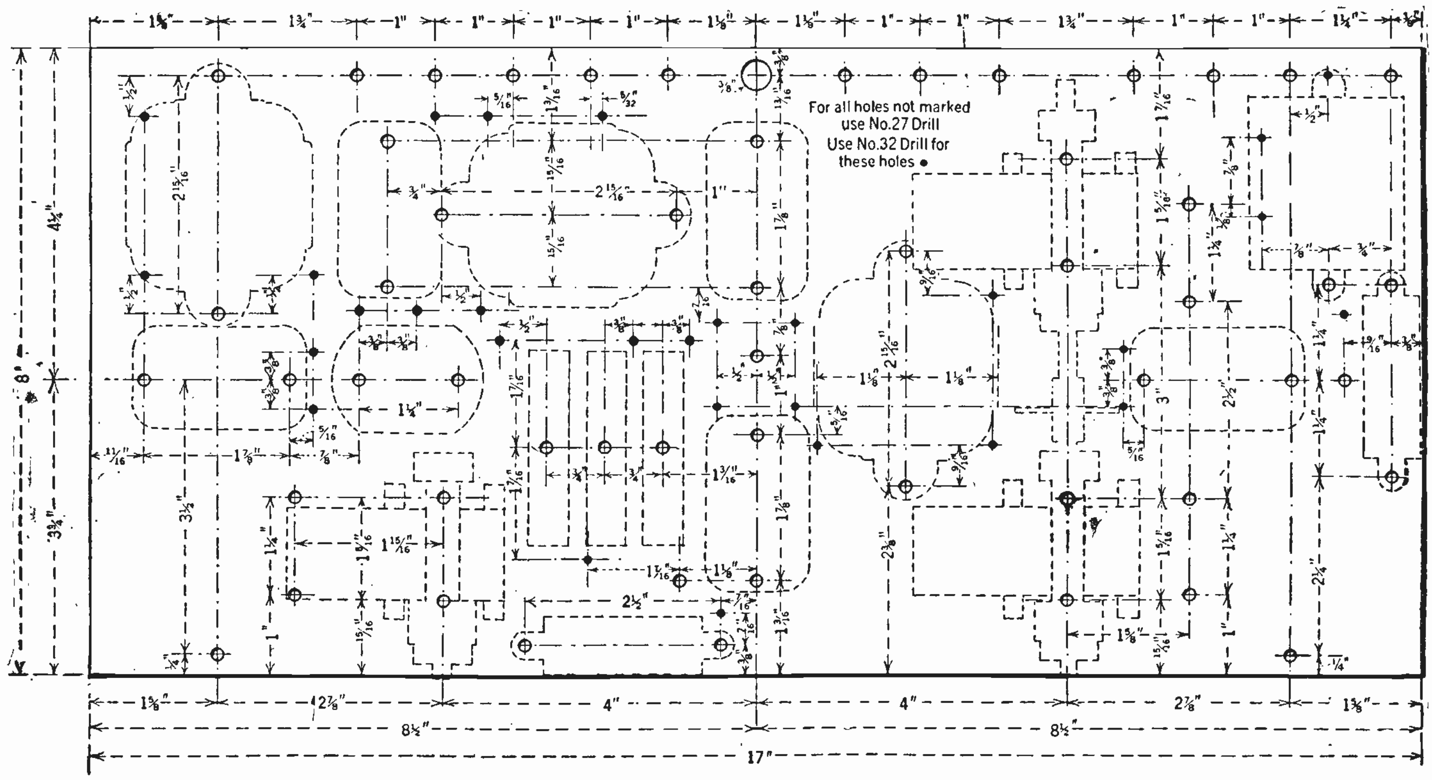
The two variable condensers on the right-hand knob may be set more accurately now, by turning to a weak station or one that is weakened by turning the volume control to the left. While this weak signal is coming in, loosen the set screw on the front-end of the coupling, CP, between the shafts and by turning the coupling disc with one hand and the knob with the other, adjust for the loudest sound from that weak signal, and then tighten up the set screw.

All of the above is to correct for several possible errors, for example, the differences of tube capacities, also the variations in coils and condensers. These directions should be read over carefully at least twice, and then followed step by step. Like every new thing, it is puzzling at first but easy later.

Of course this squealing process is a bad method to use, in one respect at least, be-



Constructional layout drawing of the sub-panel. It is advised that this arrangement of the apparatus be strictly followed. It has both mechanical and electrical advantages.



Layout and drilling plan of the sub-panel of the receiver. The holes shown in full black are for the connecting wires which pass through to the under side. Dotted lines indicate the positions of the apparatus on top of the sub-panel. All the necessary dimensions for layout and drilling are given.

cause when the receiver is in that condition it can bother the neighbors. Therefore, it is desirable to complete the adjustment as quickly as possible, and at a time when very few people are listening to broadcasts.

Any receiver kit can be connected up wrong, and this receiver is no exception. If connections are run to the wrong place the wrong effects will be produced. In general, the usual wrong results will be obtained if this kit is improperly connected up. However, there are some improper connections and adjustment results that can be obtained in this receiver, which will give different results. For example, if L1 or L2 is connected backwards, the receiver will be nearly or entirely dead at about 300 meters, which is about 50 on the scale. If the phasing condensers are screwed down too tight and the primaries of the coils L1 and L2 are too far out of the secondaries, the receiver will squeal on long wavelengths and not on the short, which will seem odd because other receivers usually squeal on the short waves.

Now as to operation: there isn't much to be done. After the parts are properly connected and adjusted it is simply a matter of turning the two dials to the stations. Of course, in "fishing" for distance, for example with headphones plugged into the jack, J, it is a good plan to turn one dial slowly with one hand and the other dial back and forth over the same numbers with the other hand.

Use of "High-Mu" Tubes

The Loftin-White circuit, with high-mu tubes (amplification factor of 20 or more), is sensitive and capable of producing loud sounds without the use of regeneration; which means that the customary distortion due to regeneration is agreeably absent. This circuit is interesting, not only because of its advantages, but also because it can be made to do just the opposite of what we have been used to when handling other radio-frequency amplifier circuits. With the average radio-frequency amplifiers, operating near the oscillating point on low filament current, increasing that current causes oscillation and squeals. With high-mu tubes in the Loftin-White circuit, adjusted to operate without regeneration when the rheostat is turned to put five volts on the filament, that circuit will frequently oscillate and squeal if the rheostat is turned to reduce the filament potential to about 3.8 volts.

The explanation which has been given for this peculiarity is that lowering the filament current, in effect, increases the resistance between the cold electrodes and hot filament in the tube. The phase-shifting ability of the capacitance in the plate circuit depends upon its ratio to such resistance as is effective in the total impedance in the feed-back path. If that resistance changes then the amount of the phase shift changes. With the amount of phase shift decreased and everything else the same, for example, then the circuit can oscillate.

Adjustments for Tubes

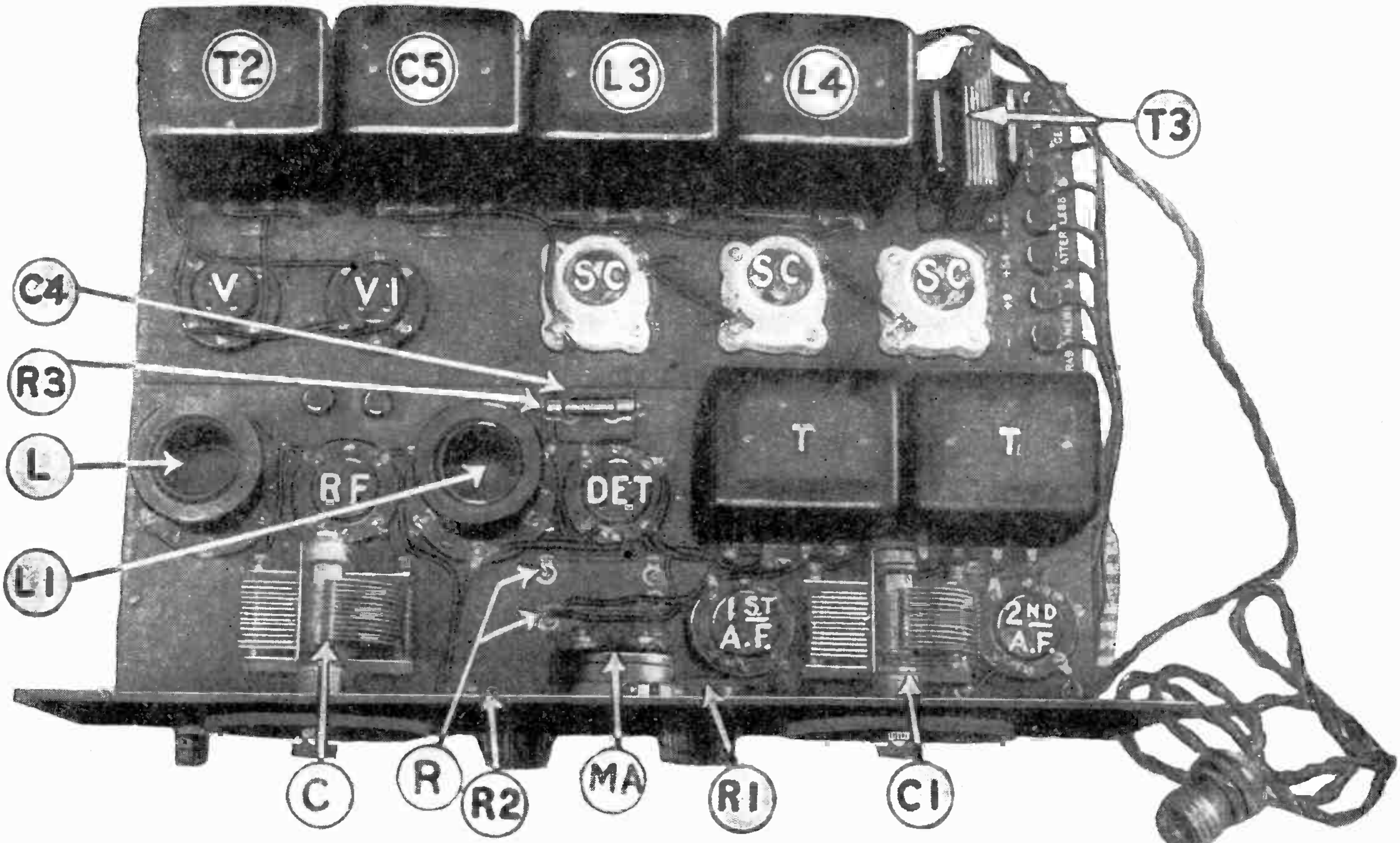
Therefore, to adjust the Loftin-White receiver circuit with high-mu tubes, the phase shifting condensers are adjusted so that the circuit will just oscillate operated on too low a filament current. The filament current is then increased until regeneration effects are no longer heard; high-mu tubes are placed in the radio-frequency amplifier and detector sockets, and a 171-type in the last A.F. stage, with a 201-A-type in the first A.F. Now, with 67 to 90 volts on the detector post marked 45, 90 on the first audio-frequency post marked "90" and 180 on the "B+ Amp" post, together with the first "C" post at 4½ volts and the "C" posts near the jack at 45 volts, the set is ready to work. (It is to be understood that, because a higher "B" voltage is required for the high-mu tubes, it has been necessary to make a simple change in the "B" wiring. As the receiver was originally designed, the plates of the radio-frequency tubes connect to the binding post marked "B+ 90." They should be connected to the "B+ Amp." post for the high-mu tubes. This is easily done if reference is made to the layout and wiring drawing of the underside of the sub-panel, shown at the top of page 9. It will be noted here that a wire connects the two radio-frequency chokes, L3 and L4. Branching off from this lead, and near choke L4, is another wire which connects to the lower left lug of the jack J. This last mentioned wire should be unsoldered from the jack lug and soldered instead to the binding post lug marked "B+ Amp." That is the only change necessary.)

With the volume-control-rheostat arrow straight up and the storage battery fully charged, the plate condensers should either be tightened or loosened, as required. As explained before, the receiver should be just at the squealing point at short and long wavelengths, which can be accomplished by moving the primaries up or down slightly. Then, on turning the volume control to the right, all tendency to regenerate should disappear and the set should work nicely on all wavelengths.

As this circuit is not like others to which we have been accustomed, it is necessary to follow directions carefully. Also, if directions are not clear to the constructor, it is sometimes desirable to write to the kit makers for advice on points that are not thoroughly understood.

High-mu tubes, because of their high resistance, are more desirable than low-mu tubes in the non-regenerative condition. A simple way to explain this is to say that putting *a very high resistance* across the condenser of a tunable circuit does not broaden its tuning as much as putting a lower resistance across that condenser. Another advantage of high-mu tubes is their low "B" battery consumption.

Summarizing this article, it may be said that another step has been taken in radio development by the introduction of the Loftin-White circuit; in fact it may be said to be three or more steps. It handles all radio frequencies equally well, which is one improvement; it prevents oscillation and regeneration equally well for all frequencies, which is another, and it permits the use of high-mu tubes for radio-frequency amplification, which is a third improvement, effecting greater sensitivity, greater volume and greater selectivity and better quality.



A top view of the RADIO NEWS Eatteryless Receiver. There are actually two sub-bases; that in front being for the receiver, while the power unit is mounted at the rear. The power unit is comprised of a power transformer T2, a filter condenser bank C5, two filter chokes L3 and L4, a filament ("bell-ringing") transformer T3, two tube sockets V and V1 and three lamp sockets SC. The receiver is composed of an antenna coil L, a radio-frequency transformer L1, two variable condensers C and C1, fixed filament resistors R, rheostat R1, potentiometer R2, milliammeter MA, grid condenser and leak R3-C4, and A F. transformers T and T1.

The Radio News Batteryless Receiver*

A Receiver and Power Amplifier Operating Direct from the Lamp Socket

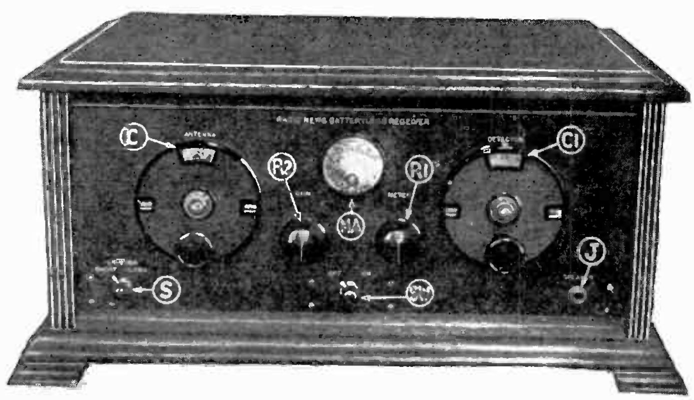
By McMURDO SILVER

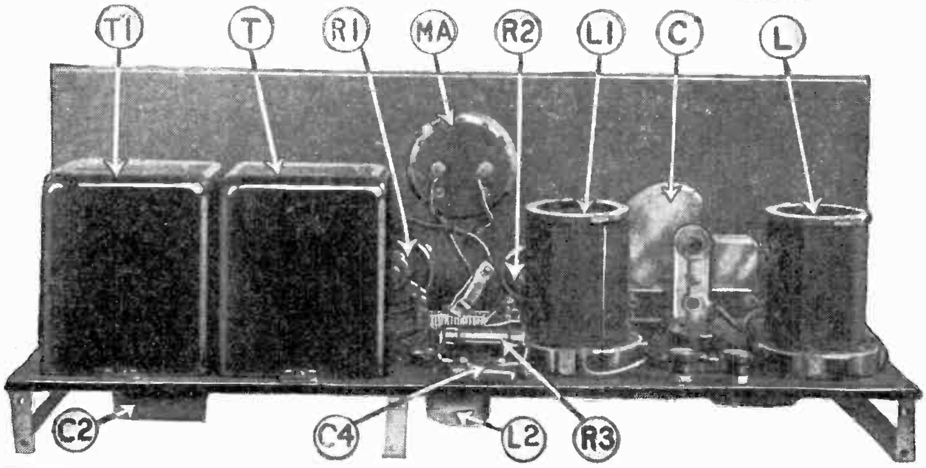
THE RADIO NEWS Batteryless Receiver consists of two units, the first being the receiver proper and the second its power-supply unit, designed to furnish power for the operation of the receiver directly from a 110-volt, 60-cycle lighting circuit.

The receiver itself consists of one stage of tuned-radio-frequency amplification, a regenerative detector, and two stages of audio, mounted upon a 7x18-inch front panel and a 6½x17-inch sub-panel.

The receiver will be seen to consist of an antenna coil, L, to the primary of which is connected a switch, S, allowing the use of either half or all of the primary in the antenna circuit. The secondary of this coil is tuned by a .00035-mf. variable condenser,

Right: A panel view of the RADIO NEWS Batteryless receiver. C and C1 are the two main tuning controls. R2 is the regeneration control and R1, a 1200-ohm rheostat, controls the filament current to the 3-volt tubes. Below: A rear view of the receiver unit only. The position of the power unit, when both are assembled, is shown in the illustration at the top of the page.



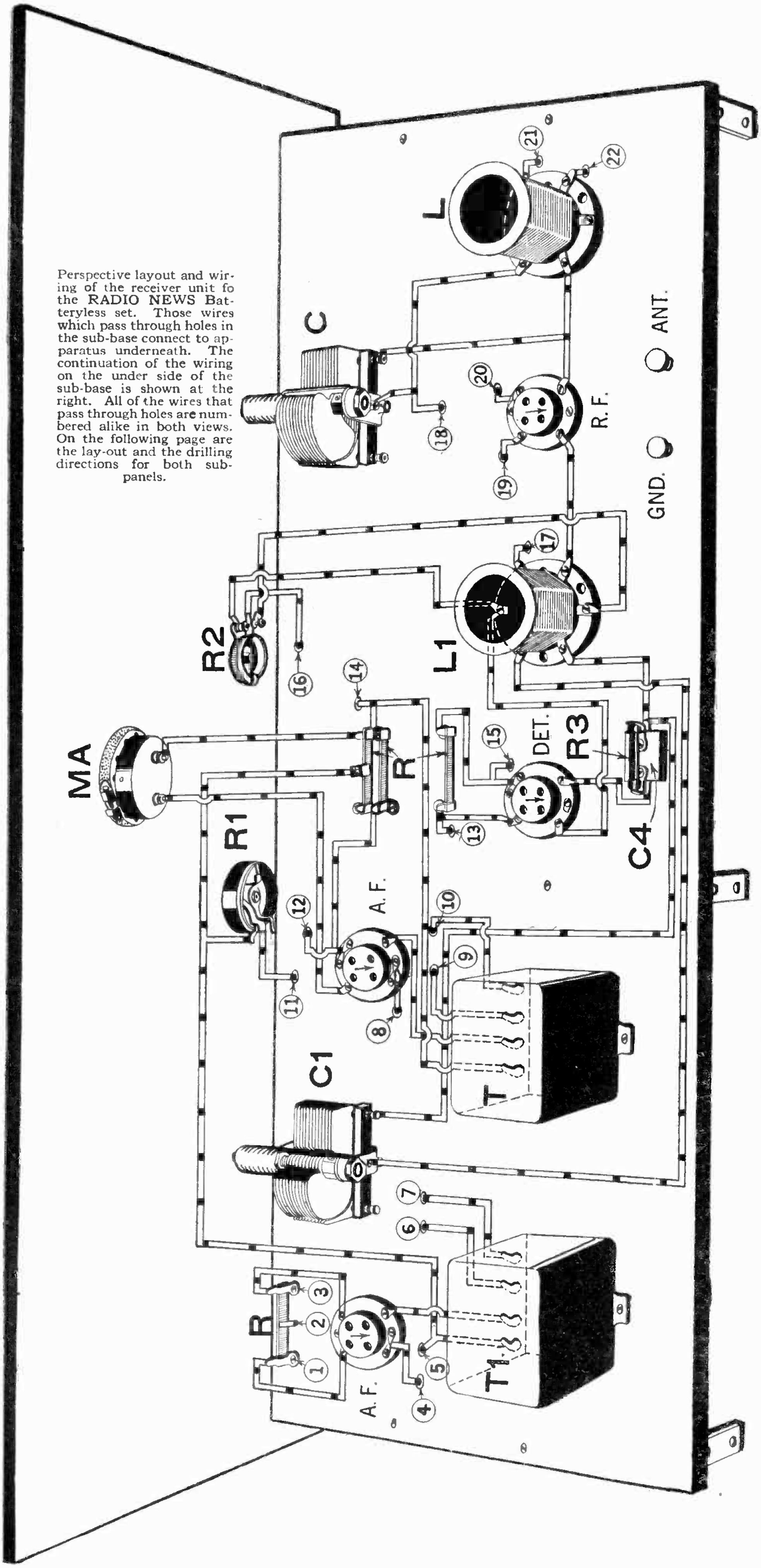


C, and feeds into the first (R.F. amplifier) tube; which, in turn, feeds out into the R.F. transformer, L1. This is especially designed, with a space-wound primary extending over the entire length of the secondary winding; thus providing a maximum of magnetic coupling with a minimum of primary inductance and inter-winding capacity.

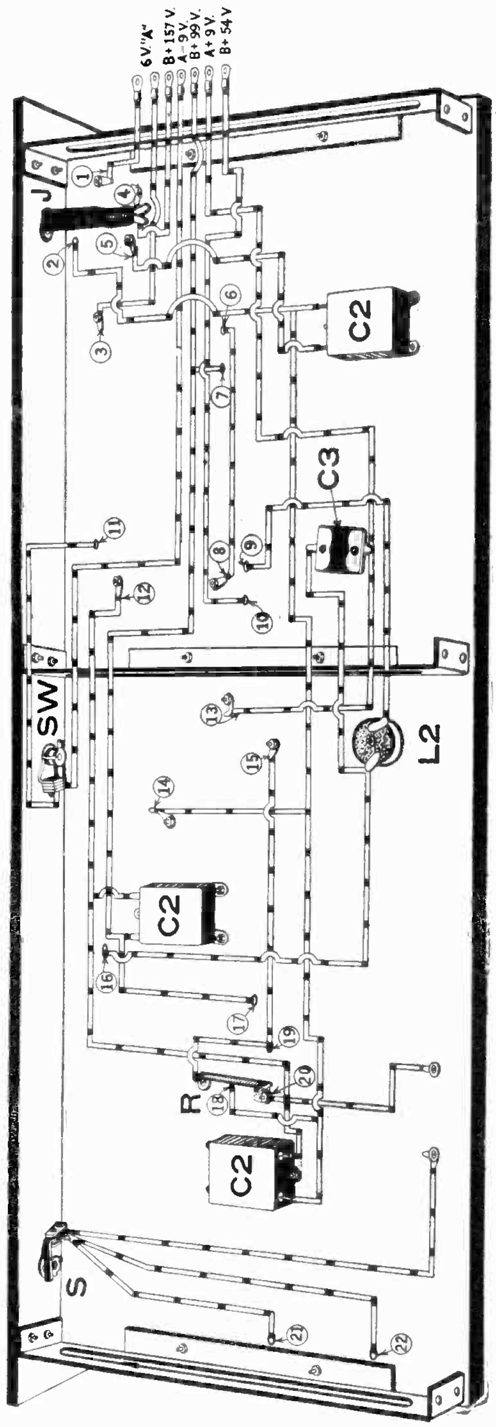
Regeneration Control

The detector tube is of the conventional grid-condenser-and-leak type, with regeneration controlled by a high-resistance potentiometer, R2, connected across a small tickler coil. The tickler coil has 9½ turns and regeneration seems easy to obtain, though it may be necessary to increase the number of turns to 15. The detector tube feeds into the first audio transformer, T, then into a first A.F. amplifier tube, through another

*RADIO NEWS *Blueprint Constructional Article No. 6.* (See page 109).



Perspective layout and wiring of the receiver unit fo the RADIO NEWS Batteryless set. Those wires which pass through holes in the sub-base connect to apparatus underneath. The continuation of the wiring on the under side of the sub-base is shown at the right. All of the wires that pass through holes are numbered alike in both views. On the following page are the lay-out and the drilling directions for both subpanels.

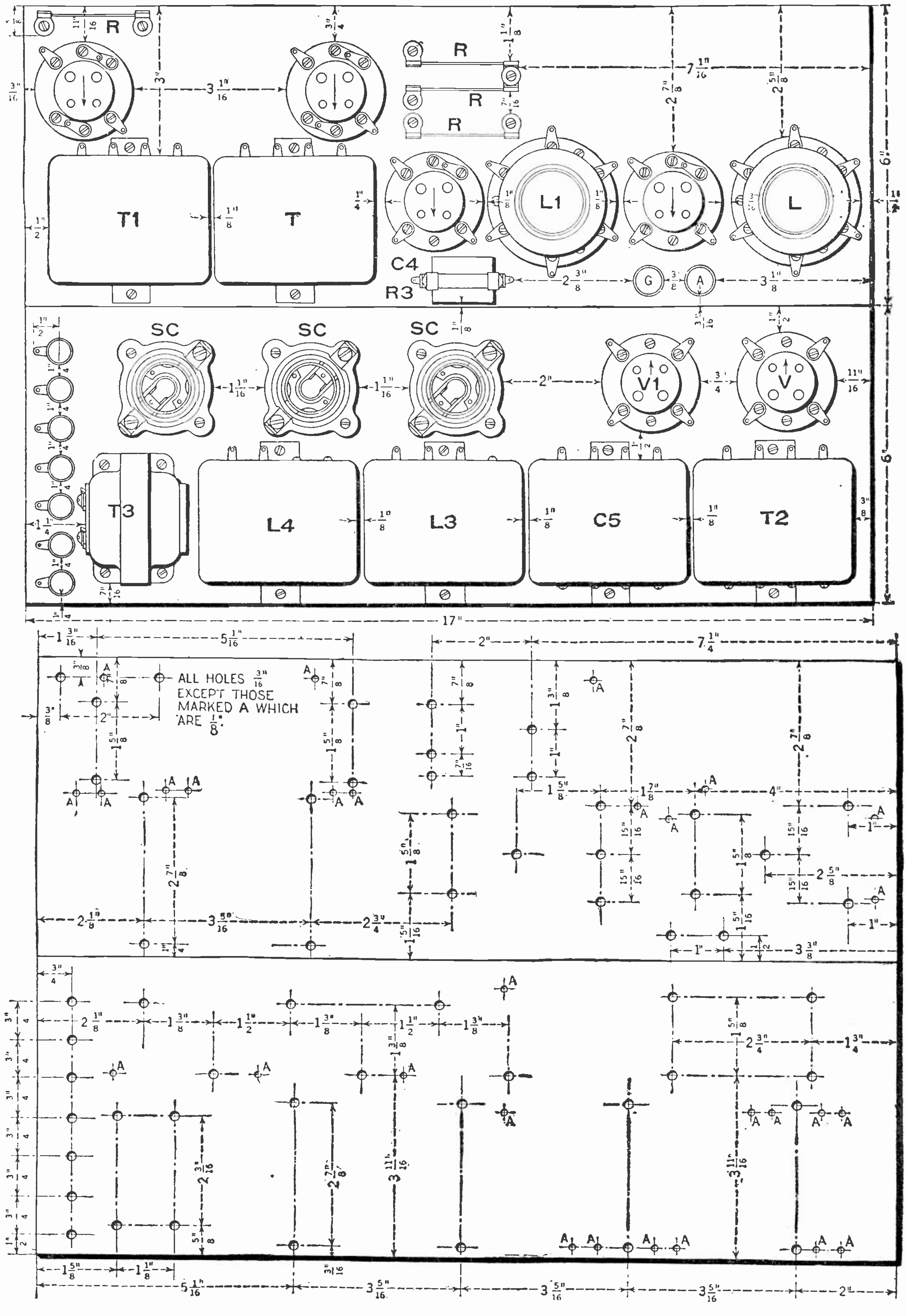


audio transformer, T1, and out to the last tube. No provision is made for using less than four tubes.

The first three tubes in the receiver are of the 199 type, with filaments in series and operating from the output of the power supply. The last tube is a 112-type, the filament being energized by a standard bell-ringing transformer.

Use of Resistors

Across the filament of each 199 tube is connected a 200-ohm fixed resistor, R, intended to by-pass the plate current of the receiver around the filaments of the tubes, for the purpose of improving audio reproduction. Another 200-ohm resistor, with a center tap soldered to it, is used across the filament of the power tube, to balance out the hum from the bell-ringing transformer. Still another 200-ohm resistor, with a clip attached to it, is used in series with the negative line from the power supply, to provide


R
R
R
R
T1
T
L1
L
C4
R3
G
A
SC
SC
SC
V1
V
T3
L4
L3
C5
T2
6"
6"
17"
ALL HOLES 3/16" EXCEPT THOSE MARKED A WHICH ARE 1/8".

suitable grid potential for the second audio amplifier. The 1200-ohm rheostat, R1, in series with the negative lead, is used to adjust the filament current of the 199 tubes to a proper value, (indicated by the 0-100 milliammeter MA) which should be about 60 to 75 milliamperes for normal operation.

Three 1.0-mf. by-pass condensers, C2, are used in the circuit at important points, as will be noted. A small radio-frequency choke L2, and a by-pass condenser, C3, are connected in the detector plate circuit, their purpose being to isolate effectively the audio and radio sections of the receiver.

The Power Unit

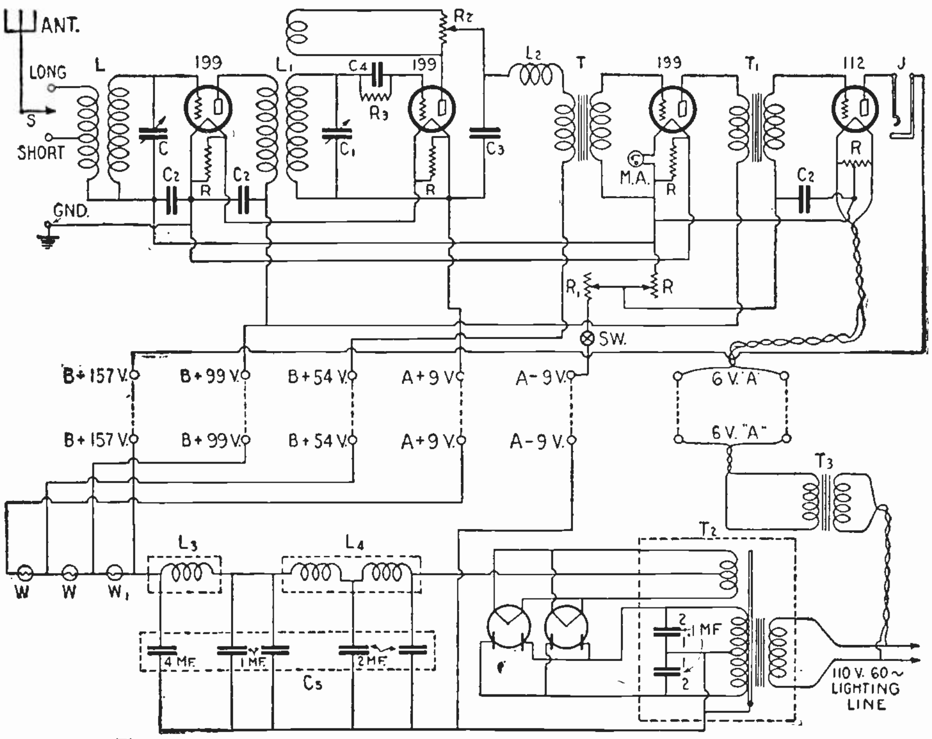
The power-supply unit, which really is flexible and may be used with any standard type of receiver with 199 filaments wired in series, is comparatively simple.

The power transformer, T2, feeds two-213-type (rectifier) tubes, each tube having its plates connected together and working as a half-wave rectifier; the filaments of the two tubes are connected in parallel. This provides for an allowable current drain of 120 milliamperes, without tube overload. In actual operation the system will supply to the receiver a current of about 80 milliamperes at a maximum of 157 volts, approximately.

The first filter choke, L3, together with a section of the condenser bank, C5, forms a combination selective-and-"brute-force" filter using the "Clough principle." (The mutual inductance of the opposed windings of the first choke is such that, with the first condenser, a resonant circuit is obtained practically without resistance at 120 cycles.) The second choke, L4, serves to improve the filtration by pure "brute-force" action. The over-all filtration of the unit is more than ample for adequate receiver operation. The excellence of the filtration will be appreciated only when it is realized that the audio transformers will operate very satisfactorily at 30 cycles, in which respect they differ from others.

Reserve Power Insured

In order to maintain the power output of the unit constant, a higher amount of current is drawn than would normally be required for the operation of the receiver, the excess being wasted in the various lamps and filament-shunt resistors. The three lamps (ordinary 110-volt lighting type) serve to reduce the voltage to the required value for the operation of the receiver. These



The complete schematic circuit diagram of the RADIO NEWS Batteryless Receiver.

should be of the tungsten-filament type; W1 is of 15-watt and W are of 25-watt size.

In actual operation the on-off switch provided is of little value, unless the set is to be used with batteries. The entire receiver is turned on and off by means of the separable attachment plug, through which current is supplied for the power transformer and the 6-volt bell-ringing transformer, T3.

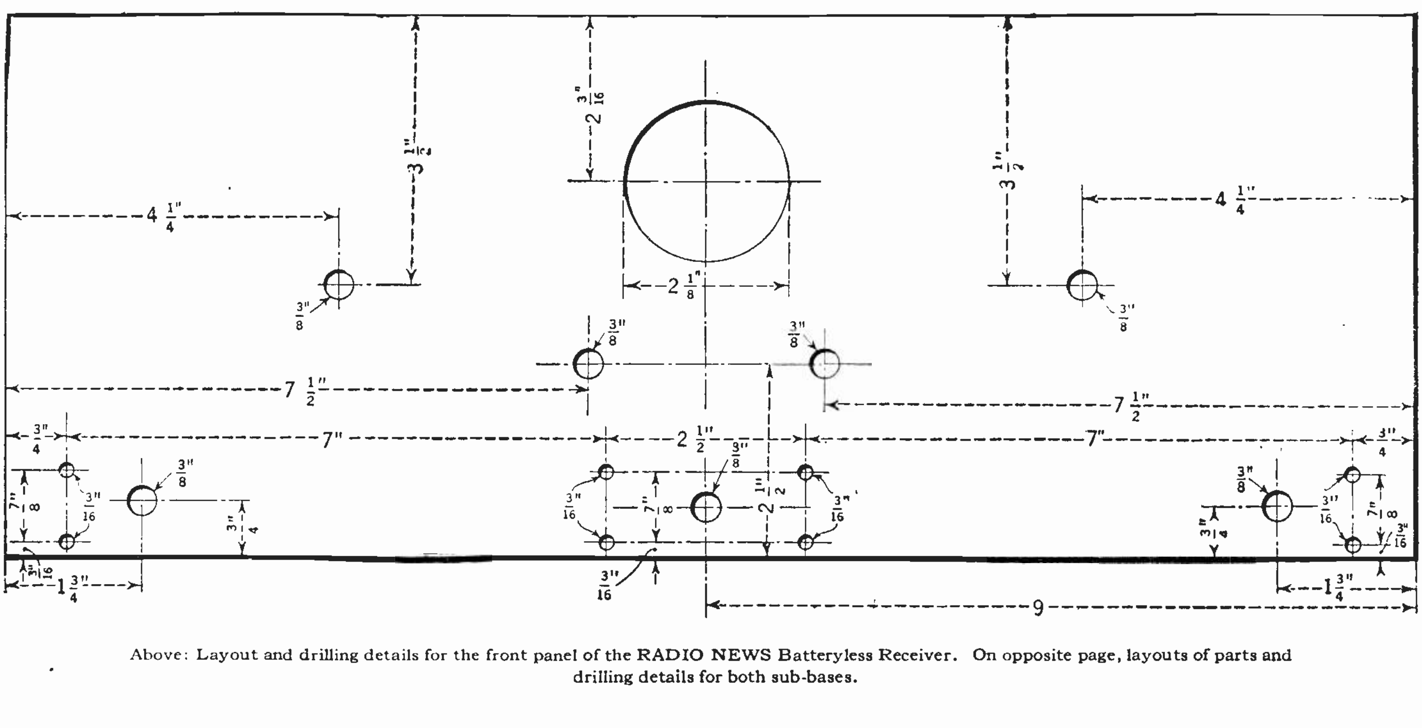
The power pack is connected to the receiver by means of flexible cables along the right-hand sides of the sub-panels, as it is intended that both units be placed in a standard 7x18x12-inch cabinet. The proximity of the power pack to the receiver has no deleterious effect upon the operation as a whole.

Details of Construction

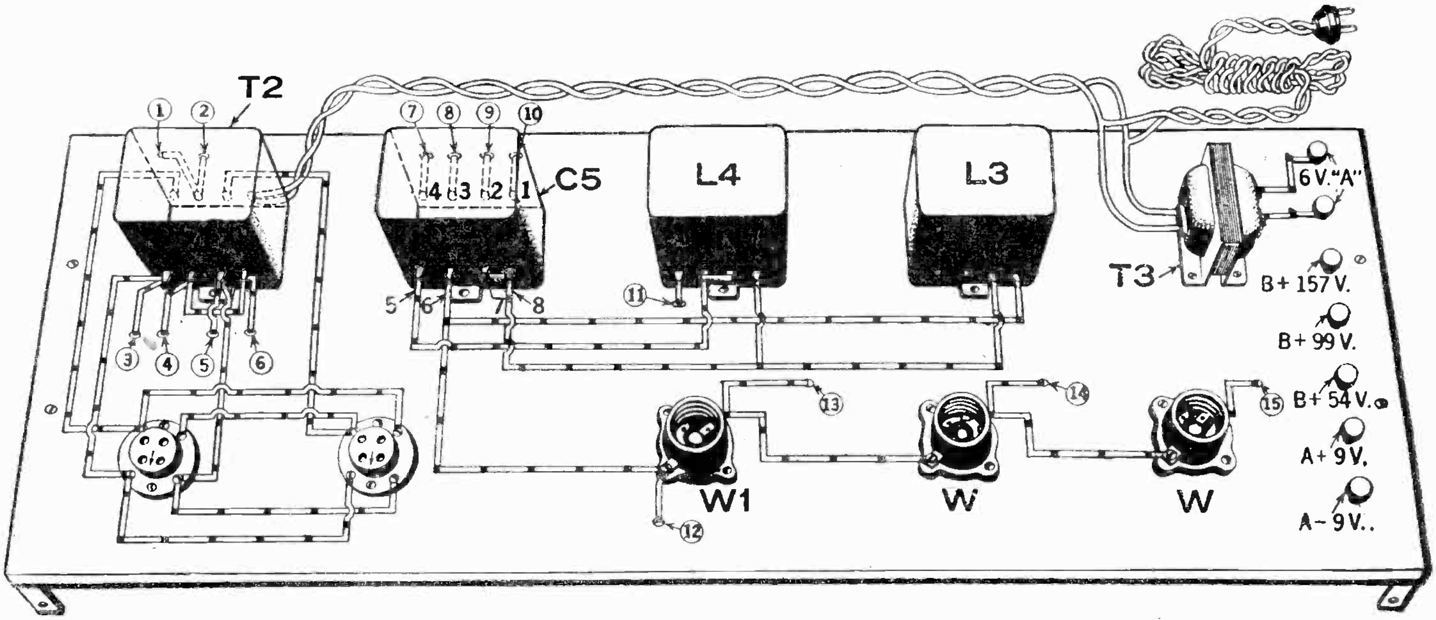
The receiver proper and the power-supply unit are made as two separate sections, which fit together to form what amounts to a single composite outfit. The horizontal sub-panel holding the components of the power-supply is of the same dimensions as the sub-panel holding the sockets, tuning coils, transformers, etc., of the tuner and amplifier, the two being placed edge to edge.

In the construction of the Batteryless Receiver, the first operation is to mark the three panels (front and two sub-panels) for all the instruments that go on them. Use a hard pencil and an ordinary carpenter's square for this work; if you have no square you can buy a passably good one for as little as ten cents. In laying out the front panel, make all your pencil lines on the *back* side, so that no marks will show when the set is completed. Remember that you are working backward, and do not fail to hold the panel before you occasionally so that you can visualize the parts in place.

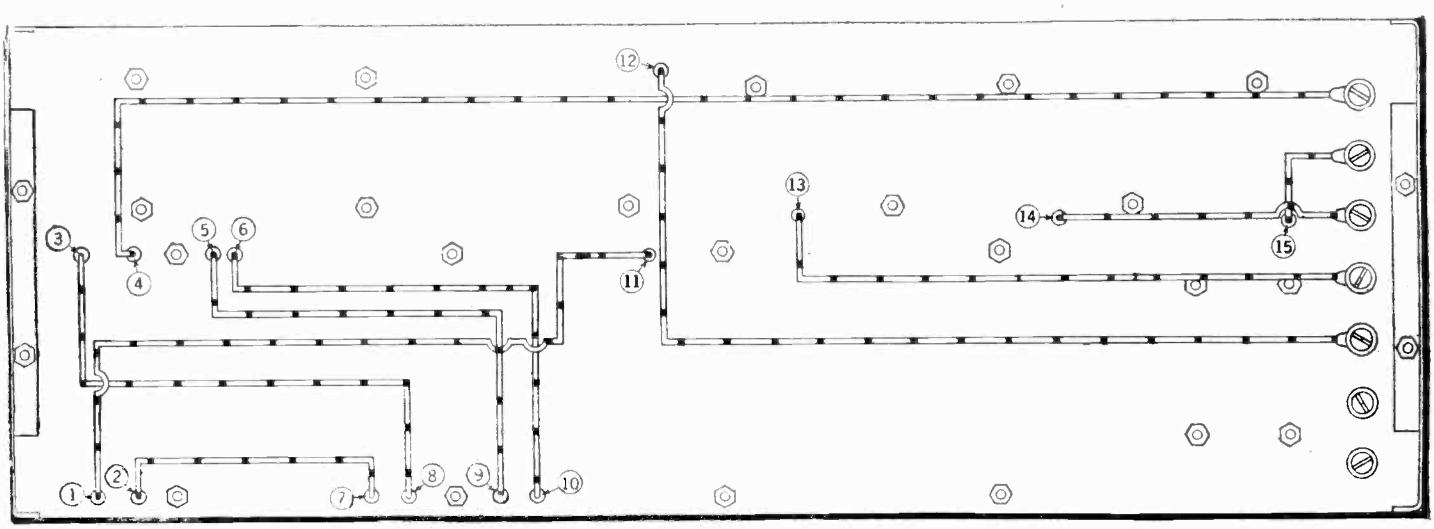
Before drilling, with a center-punch and hammer make dents in the panels at every point a hole'is to be made. Under no conditions attempt to drill without the aid of these dents; the drill will invariably slip and will probably make a hole a considerable distance out of the way.

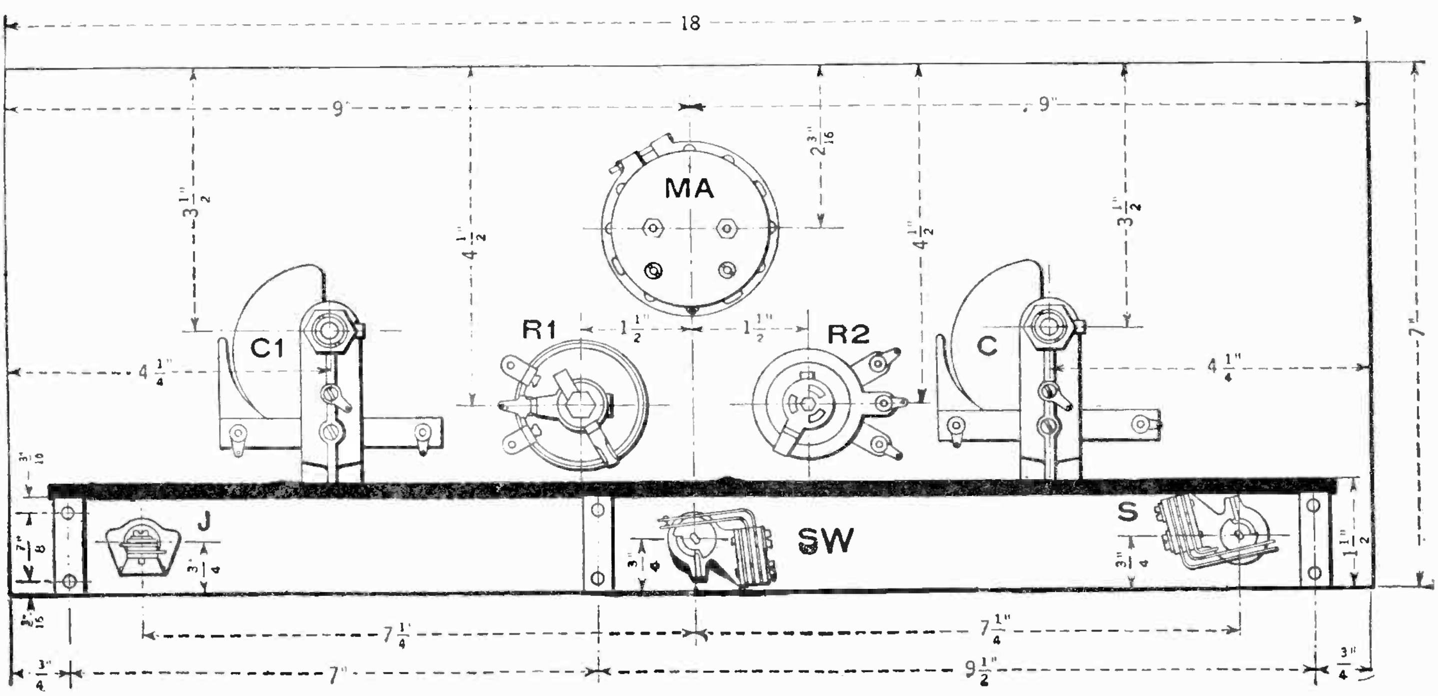


Above: Layout and drilling details for the front panel of the RADIO NEWS Batteryless Receiver. On opposite page, layouts of parts and drilling details for both sub-bases.



Above: The perspective layout and wiring of the power unit, which is mounted directly behind the receiver. All the wires designated by numbers in circles pass down to the under side of the sub-base through holes; at which points they are similarly numbered, in the bottom-view below. The numbers not in circles designate the markings on the respective parts. The wiring of the under side of the sub-base is shown below.





Above is the constructional layout of the panel for the receiver. All the necessary dimensions are given. The constructional layouts for both sub-bases, as well as the drilling layouts, are given on page 14. In all the illustrations and sketches the apparatus is similarly marked.

As you drill the holes for any instrument, mount the part in place temporarily to make sure the screw holes are in the correct positions. If a hole is slightly off center, simply ream it out carefully with the tang of a file until the screw goes in straight.

After you have made all the necessary holes and tested them for fit, next assemble the parts on the receiver sub-panel. Then mount the bottom brackets, and place the bare front-panel in its final upright position. With the panel so supported, it will be an easy matter to mount on it the condensers, switches, resistors, meter, etc. Now assemble the power-supply unit.

Wiring and Operation

As the receiver and the power-supply are two entirely separate units, they may be wired separately and then simply placed back to back. The seven flexible wires connecting the former to the latter should be left about a foot long and their ends cut to length *after* the two units have been placed together. The ends should be bent, L-shape, and tied together with ordinary string; so that they match nicely with the seven binding posts arranged along the right-hand edge of the power-unit baseboard.

Round lugs soldered to the wires will enhance their appearance and insure good connections to the posts. The fixed resistors across the filaments of the tubes are fastened to the set sub-panel by means of similar lugs, which in turn are held down by small screws.

The power transformer of the supply unit is equipped with a suitable length of standard flexible lamp-cord, and connected to the most convenient socket or other 110-volt outlet by means of a regular two-piece attachment plug.

The antenna system, for use with the Batteryless Receiver, may consist of an ordinary single-wire aerial between fifty and one hundred feet in length, well insulated and suspended as high and as clear of other objects as local conditions permit. The ground may be made on a cold-water or steam-pipe with the aid of a good clamp.

The operation of the receiver is more or less obvious, as there are so few controls. The various tubes are inserted in their respective sockets, the 110-volt A.C. turned on at its source, and the switch on the front panel snapped on. The 1,200-ohm rheostat is adjusted so that the meter indicates the proper flow of "A" current (between 60 and 75 milliamperes) and the two dials are then adjusted until a station is heard. The set may be logged; that is, the dial readings for stations may be noted on a sheet of paper, and then duplicated at any time when it is desired to hear those stations again.

If a slight hum should be discerned, this can be stopped immediately by moving the clip of the 200-ohm resistor slightly backward and forward until the receiver is balanced. Once the correct position of the attachment clip is ascertained, no further adjustment is necessary.

Coil Construction

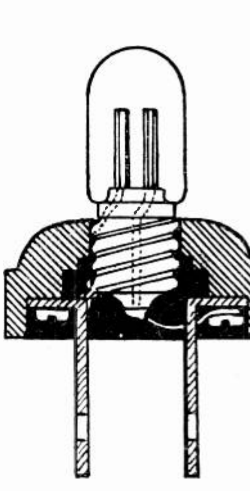
The inductances L and L1 may be wound by the constructor, if so desired, instead of his employing those which are shown in the illustrations. Coil L has a primary of 20 turns of No. 28 D.S.C. wire, tapped at the center turn, and wound on a 1⅜-inch tube. The secondary has 90 turns of No. 24 enameled wire, space-wound on a 2-inch tube. Coil L1 has a primary of 35 turns of No. 28 enameled wire, space-wound on a 1⅜-inch tube; its secondary has 90 turns of No. 24 enameled wire, space-wound on a 2-inch tube; and the tickler has 20 turns of No. 28 D.S.C. wire, bunch-wound on the same tube as the secondary, and at a distance of one turn from the grid end.

SYMBOL	Quantity	NAME OF PART	VALUE OF PART	REMARKS	MANUFACTURER ★	
T, T1	2	A. F. Trans.			1	11, 14, 15, 16, 17, 18, 19, 33
L	1	Ant. Coil & Base			1	
L1	1	R.F. Trans. & Base		With tickler	1	
C, C1	2	Variable Cond.	.00035 mf		1	14, 15, 17, 20, 23, 29, 33
C2	3	Fixed Cond.	1 mf.	By-pass	2	3, 21, 22
C3	1	Fixed Cond.	.002 mf.		3	2, 21, 22
L2	1	R.F. Choke Coil			1	
J	1	Jack		Single circuit	4	15, 17, 29
S	1	Ant. Switch	S.P.D.T	For long and short antenna	4	5
SW	1	Fil. Switch			4	5, 24, 25, 29
R	5	Fixed Resis.	200-ohms		4	5
C4	1	Fixed Cond.	.00025 mf.		3	2, 21, 22
R3	1	Grid Leak	2 megs.		3	2, 21, 22, 23, 26, 27, 33
	4	Sockets		UX Type	1	20, 23, 28, 29, 33
R1	1	Rheostat	1200-ohms		4	5, 33
R2	1	Potentiometer	25,000-ohms		5	23, 24, 30, 33
MA	1	Milliammeter	0-100 M.A.		6	31, 32
	2	Binding Posts		Removable tops	7	33
	1	Panel		7" x 18" x 3/16"	8	34, 35
	1	Sub-Panel		6½" x 17" x 3/16"	8	34, 35
	2	Brackets			1	20, 35
	2	Dials		Vernier	9	15, 17, 29, 36
				ELIMINATOR		
L3, L4	2	Filter Chokes			1	
C5	1	Condenser Bank			1	
T2	1	Power Trans.			1	
V, V1	2	Sockets		UX Type	1	
SC	3	Bulb Sockets		Porcelain	10	20, 37
	2	Brackets			1	20, 35
T3	1	Bell Ringing Trans.			11	15
	7	Binding Posts			7	33
	1	Sub-Panel			8	34, 35
	1	Cabinet			12	13
W	2	Lamps	25 watt	115 volt tungsten		
W1	1	Lamp	15 watt	115 volt tungsten		
	3	Tubes	3v. 60 M.A.	199 Type	38	
	1	Tube	5v. ½ amp.	Semi-power tube	38	
	2	Rec. Tubes		Full wave	39	

NUMBERS IN LAST COLUMN REFER TO CODE NUMBERS BELOW.

1 Silver-Marshall, Inc.	17 Bremer-Tully Mfg. Co.	33 General Radio Company
2 Electrad, Inc.	18 American Trans. Co.	34 Diamond State Fibre Co. (Celeron)
3 Polymet Mfg. Corp.	19 Ferranti, Inc.	35 Ins. Co. of America (Insuline)
4 Yaxley Mfg. Co.	20 Benjamin Elec. Mfg. Co.	36 Kurtz-Kasch Company
5 Carter Radio Company	21 Aerovox Wireless Corp.	37 Hart & Hegeman
6 Weston Elec. Inst. Co.	22 Dubilier Radio & Con. Corp.	38 Perryman Elec. Co.
7 Waterbury Button Co.	23 Amsco Products, Inc.	39 Radio Corp. of America
8 Formica Insulation Co.	24 H.H. Frost, Inc.	40
9 Martin Copeland Co. (Marco)	25 Howard B. Jones	41 NOTE TO SET BUILDERS:
10 Bryant Elec. Co.	26 A.H. Lynch, Inc.	42 If you use alternate parts
11 Jefferson Elec. Mfg. Co.	27 International Resis. Co.	43 instead of those listed in
12 Baker Yacht Basin Inc.	28 Alden Mfg. Company	44 the first column of manu-
13 Fritts Company	29 Pacent Elec. Company	45 facturers, be careful to
14 Acme Apparatus Co.	30 Central Radio Labs.	46 allow for any possible
15 Samson Elec. Co.	31 Burton-Rogers	47 difference in size from
16 Thordarson Elec. Mfg. Co.	32 Jewell Elec. Inst. Co.	48 those originally used in laying out and drilling the panel and sub-base.

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



A "wattless" neon miniature lamp, soldered in the cap of an ordinary base-plug, will show when socket devices are in operation.

AN INEXPENSIVE TELLTALE LAMP

HAS it ever been your misfortune to forget to switch off the power unit some evening, after you have finished listening-in with your set; then fail to discover the fact until the next night? In the accompanying sketch is shown an arrangement originated by Hugo Gernsback, Editor of RADIO NEWS, whereby a telltale indicator is provided; its maintenance cost is almost negligible. It consists of a small "wattless" neon lamp of such a size that the screw base can be inserted in the cap of an ordinary socket plug. Two leads are soldered to the end of the base of the lamp (one to the tip and the other to the screw threads) and these wires in turn to the two terminal screws in the cap.

This little device can be placed in a twin socket with the connecting wires for the power unit running from the other side. The lamp will, therefore, be lighted while the eliminator is operating, and its pinkish-orange glow will act as a telltale.

A New Era in Push-Pull Amplification*

A Push-Pull Power Amplifier of New Design

By JOSEPH RILEY

IT has been a long while since we have heard much of push-pull amplifiers; they had just about passed out of existence. Now comes a revival, but the push-pull amplifier this time appears in a new dress. It is designed expressly for sets having an output of very large energy, and will take care of any receiver, including the largest superheterodynes. This amplifier uses two power tubes of the 171 type in the push-pull stage and, with only 180 volts "B" supply, is capable of delivering the same amount of output energy to the loud speaker as one 210-type power tube using 350 volts "B." The transformers and the impedance employed are of new design and have excellent frequency characteristics.

The push-pull amplifier, because of its excellence, created quite a sensation when it was put on the market several years ago. At that time there was available no other type of amplifier which could even run a race with it. What counted most was results; and adding a push-pull amplifier to a set of early vintage was like moving the street band off the block and substituting the Philadelphia Symphony Orchestra. Judging by the enthusiasm created by the push-pull amplifier, the foregoing simile is not exaggerated.

Why "Push-Pull"?

What did the push-pull amplifier actually do to better reproduction so much? Any radio fan will tell you that it push-pulled; but that is not exactly the definite answer one might expect. In the first place, the real and original push-pull amplifier used the first power tubes deserving of the name. Today, almost every fan knows that, if any of his audio-frequency amplifier tubes is overloaded by excessive input energy, the result is a nasty form of distortion. If a big "he-man" tube is used in the last stage of amplification, there is very little chance of overtaxing it with the energy output from the average receiver; the tube is perfectly capable of handling "power" without muddling it. All this has a great deal to do with what we call "*grid swing*" and, in any audio tube, we always want to be sure that the grid of the tube is not allowed to "go positive"; for as soon as it does we get very unequal amplification, or a rectification, which in itself is a form of distortion. That is why we use power tubes with high "B" and "C" voltages.

The push-pull amplifier used three power tubes (we would call them semi-power tubes today); one for the first and two in the second stage of audio. The last two *were not connected in parallel*, as so many radio fans seemed to imagine. Here is how it was done.

The first audio tube worked into a push-pull transformer which had an orthodox primary winding, but a very unorthodox secondary coil. The secondary was really one long winding with a tap taken off at its exact center. One end of the secondary was connected to the grid of one of the last two tubes, and the other to that of the final tube. The center tap connected to the negative filament leg, or to the negative post of a "C" battery. The next push-pull transformer had an orthodox secondary, but a primary with a center tap. The plates of the two last tubes connected to the outside primary terminals, and the center tap to the

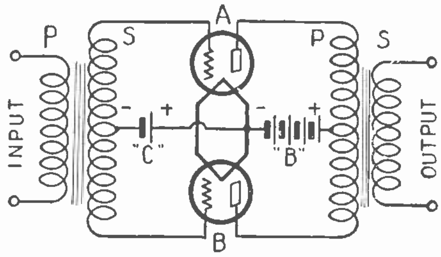


FIG. 1

The basic circuit of a push-pull amplifier as originally devised.

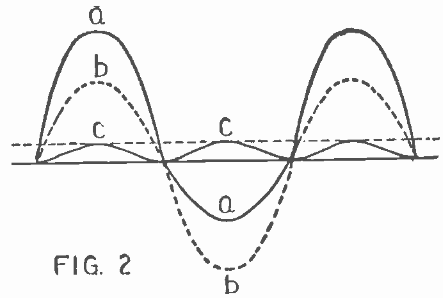
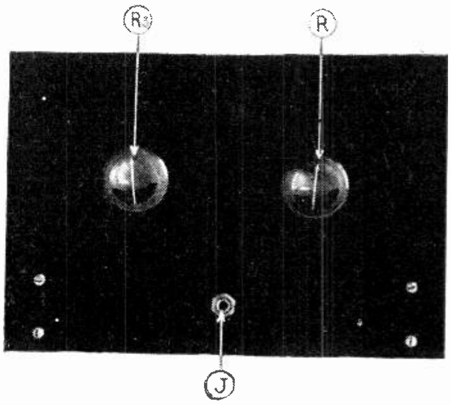
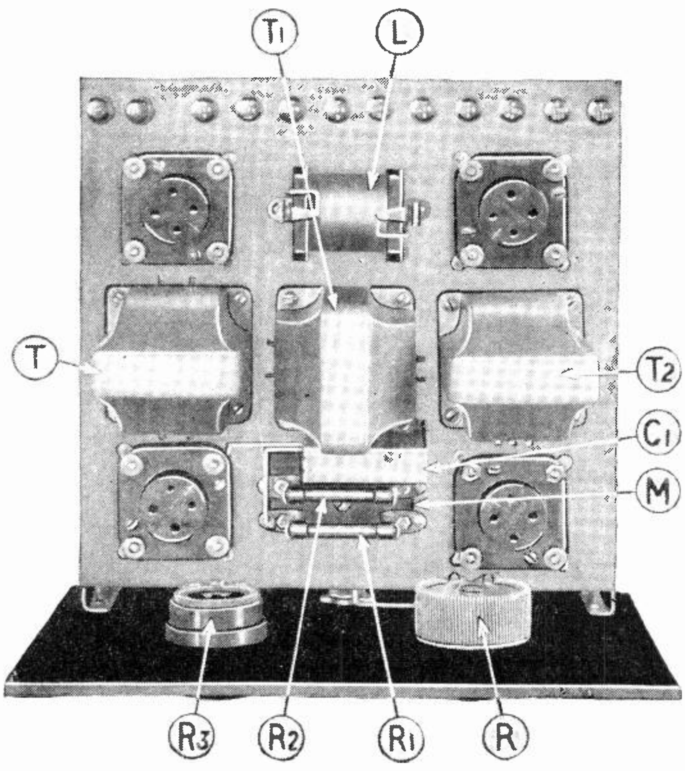


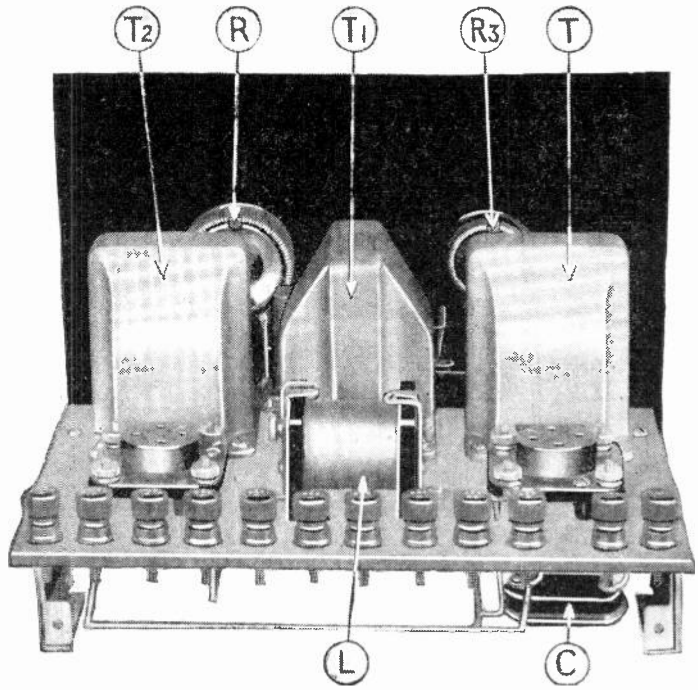
FIG. 2

These curves show, a, the A.F. output current wave as amplified by a transformer; b, the fundamental wave; and c, the harmonic. The action of the push-pull circuit is such as to eliminate the harmonics thus introduced.



A panel view of the completed push-pull power amplifier. R is the power rheostat, R3 the volume control and J the loud-speaker jack.





Top and rear views of the complete push-pull power amplifier. The parts are: R, filament rheostat; R1, plate resistor; R2, grid resistor; R3, volume control; M, resistor mounting; L, R.F. choke; C, by-pass condenser; C1, coupling condenser; T, A.F. transformer; T1, push-pull A.F. transformer and T2, push-pull output impedance.

* RADIO NEWS *Blueprint Constructional Article No.* 20. (See page 109)

positive post of the "B" battery. The total work to be accomplished was equally distributed between the last two tubes; that is, each tube took care of one half of the cycle, while in the usual amplifier one tube handles the whole.

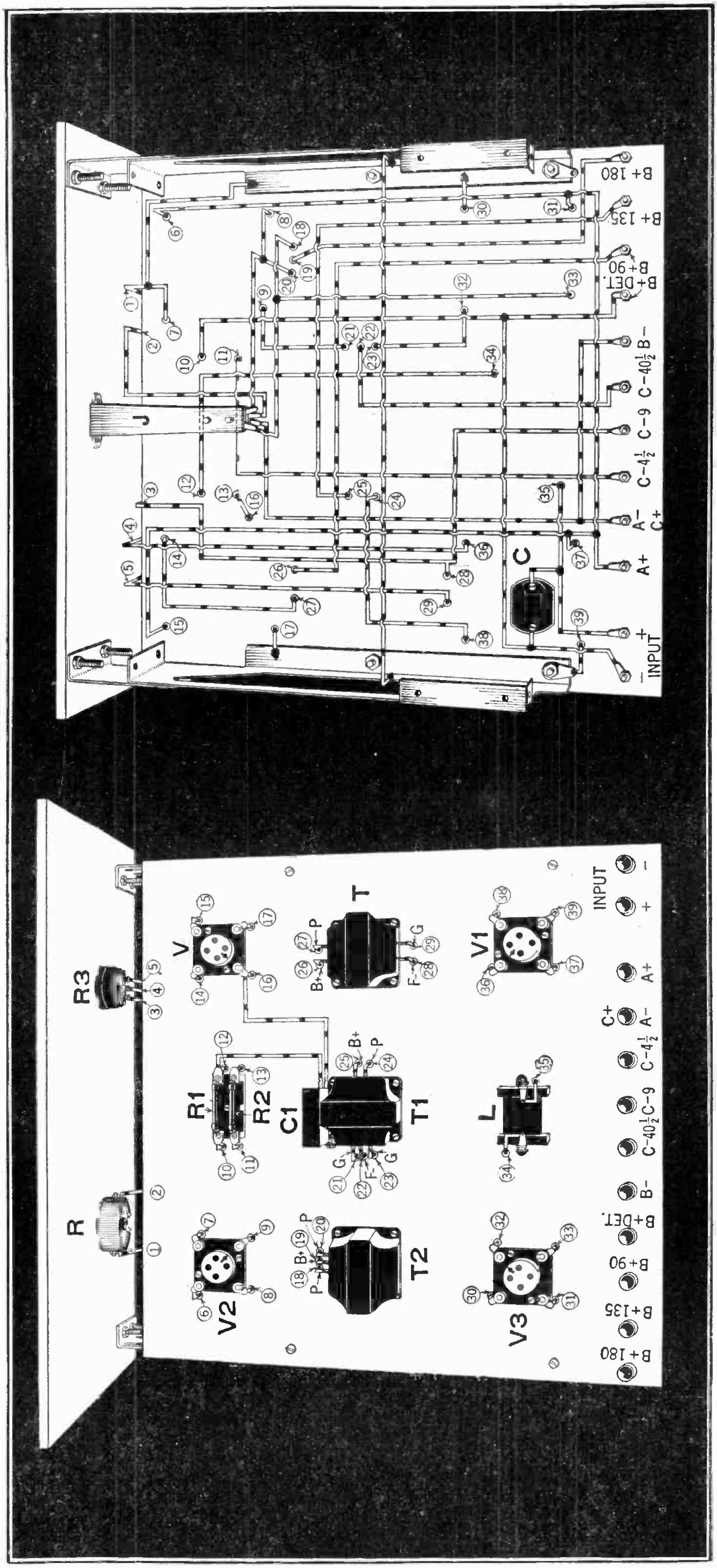
This arrangement is obviously an advantage, as there is practically no chance of overloading, but the push-pull amplifier accomplishes even more than this. It absolutely abolishes the harmonic and amplifies only on the fundamental frequency. Let us get a getter understanding of this.

In the first place, there is a definite output current, which, after passing through the transformer, resolves itself into the fundamental and a harmonic of the fundamental. This harmonic, which is artificially created, is undesirable, as it can introduce serious distortion. All this is delineated in Fig. 2, where *aa* is the undistorted output current wave, bb the fundamental and cc the harmonic. Referring to this diagram and that of Fig. 1, it is obvious that the wave-shapes in both tubes (A and B) are identical, but that the fundamental bb in tube B is 180 degrees out of phase with the fundamental wave bb in tube A, while the harmonic is in phase in both tubes, as it varies merely in amplitude. In consequence, the fundamental waves as amplified by the two tubes are additive in the output circuit, while the harmonic waves, being in phase, will neutralize each other. The resultant output to the loud speaker is an amplified reproduction of the fundamental wave only.

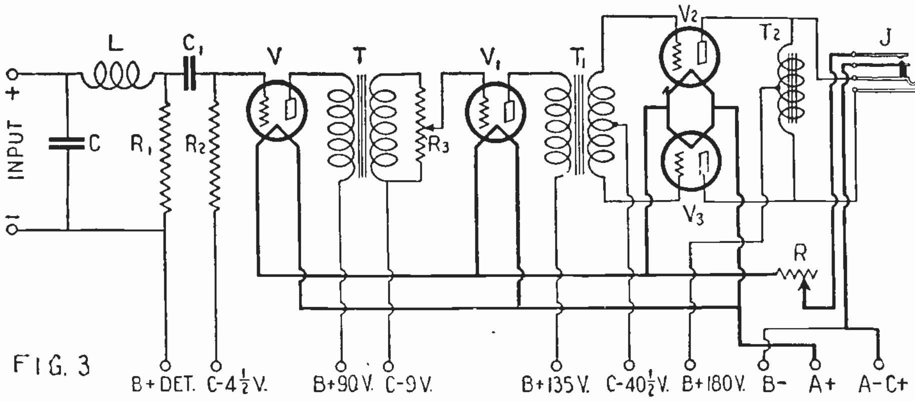
A New Amplifier

We admit, without even being questioned, that the original push-pull amplifier was a big step ahead and certainly worth the money, if it was well made; but push-pull amplification suffered a good deal of discredit because of the inferior apparatus placed on the market by some manufacturers, and also because of lack of knowledge on the part of radio fans concerning the system. This, coupled with the fact that since then there have become available very fine power tubes, improved A.F. transformers, impedances and so on, helped to shove the push-pull amplifier into the background. Now, here we are with a bit of momentum behind us, all set to push or pull the push-pull amplifier into the limelight again. And with good reason, for we have with us one of these amplifiers, employing two of the new 171-type power tubes in the last stage, a push-pull transformer of new design with large iron core and high-impedance primary, and a new design push-pull output impedance. There are actually three stages in this amplifier. The first or input stage is of the resistance-coupled type, noted for its undistorted amplification; the second is of the transformer-coupled type. The transformer used has excellent characteristics and is capable of amplifying the low notes. These two stages, working together in the order outlined, show a frequency curve which is very nearly flat. The last stage, of course, is the push-pull and, by virtue of the system and the new design of transformer and impedance, completes the amplification without altering the excellent frequency-curve obtained in the first two stages.

As previously mentioned, two of the 171-type power tubes are desirable in the push-pull stage. If the very best results are desired this type should be used, with a 112-type semi-power tube in the second stage and a 201A-type tube in the resistance-coupled stage. However, it is not absolutely necessary that this combination be



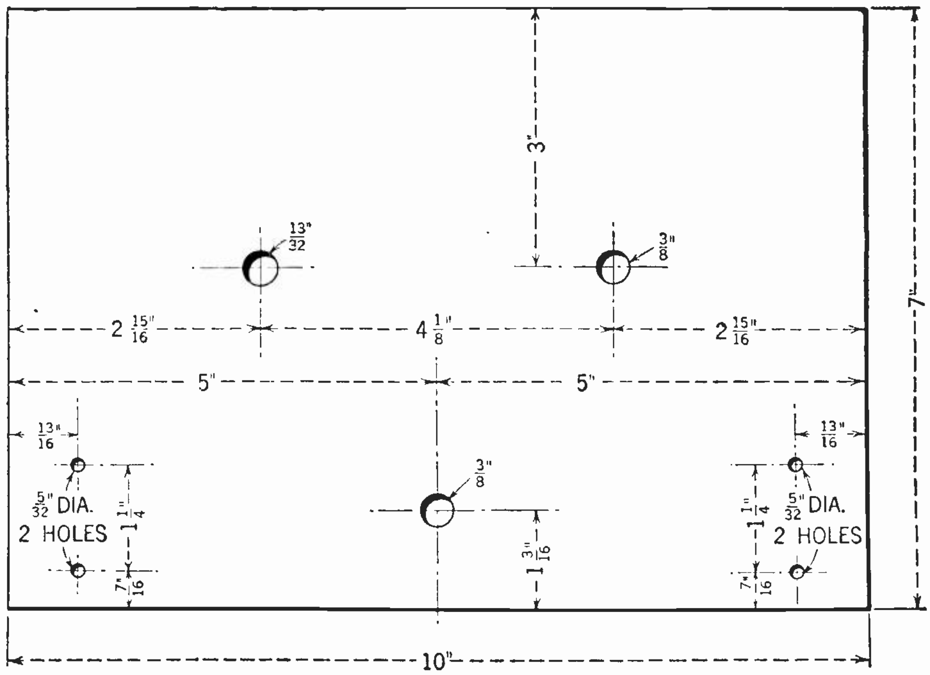
At right, the pictorial wiring diagrams, showing, at top, the sub-base wiring, and beneath, that on the panel and upper side of sub-base. The hole through which each lead passes is numbered alike in both views, so that every connection may be readily traced.

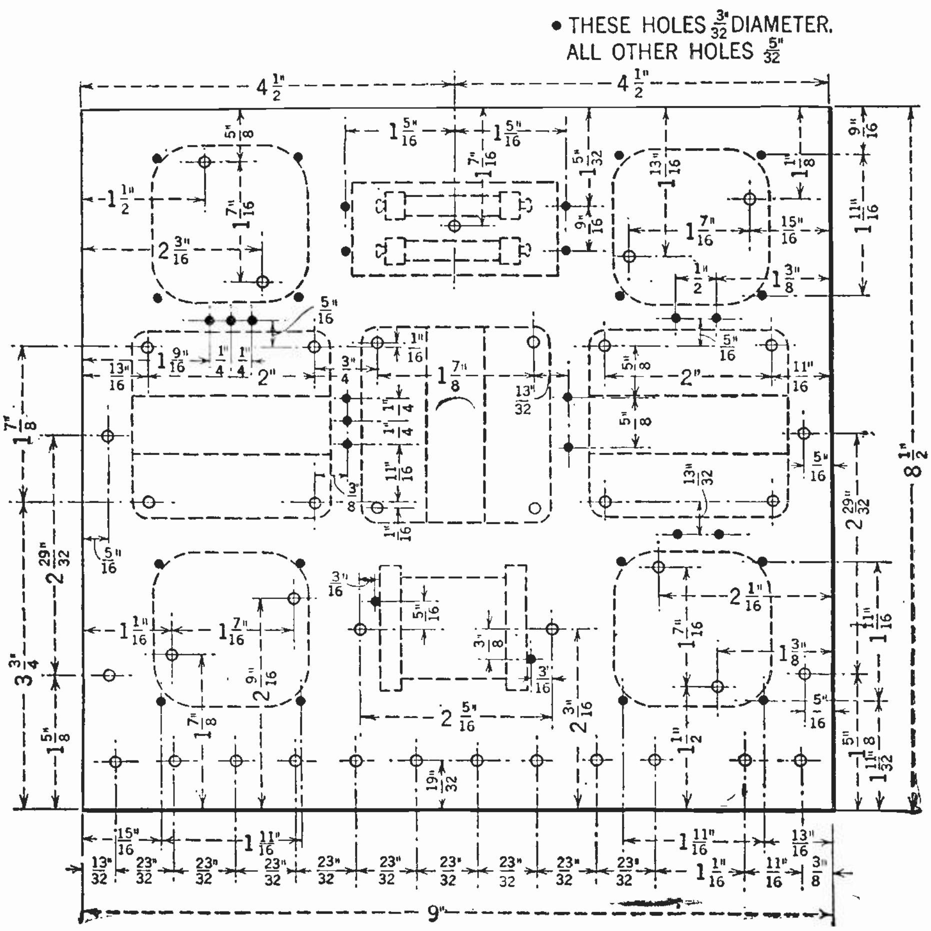


Above, the complete schematic wiring diagram of the push-pull amplifier.

carried out, as good results can be had from other tubes. Dry-cell tubes can be used; two of the 199 type for the first and second stages, and two of the 120 type for the push-pull stage. As for storage-battery tubes, a very good combination is obtained by using two 201A-type tubes, with two 112's in the push-pull stage, or even 201A tubes throughout. Still, it should be kept in mind that if *real* results are desired, the combination of tubes specified should be used.

Whatever tubes are utilized, it is best to apply the "B" voltages specified by the manufacturer. This is important, for if the "B" voltages are too high the tubes cannot function properly. Take note of the fact that rather a high "B" voltage is supplied to the detector tube through the detector post on the amplifier; this for the reason that there is a large drop in voltage across the plate resistor of the first-stage amplifier, which is in series with the plate of the detector tube. The correct voltage here depends a great deal upon the type of detector tube used; it is a good idea to try voltages ranging from 90 to 135.





Above, drilling details for the panel; at left, complete dimensional and drilling details for the sub-base. The parts are shown in dotted lines to make the drawing more easily followed.

Volume With Quality

The importance of this amplifier lies in its ability to handle energy without "smearing" it or, in other words, to provide undistorted reproduction with immense volume; an output that can equal the volume of a full orchestra, should you want it. And there are many people who do, for it is just at this point that real tonal results become available. Whether you want this quantity of sound or not, certainly it is a pleasure to have an audio amplifier that will handle all of the output energy from your receiver. Most amplifiers will not; that is why we have power amplifiers. If an amplifier cannot handle the output energy from the receiver, the sounds will not seem natural.

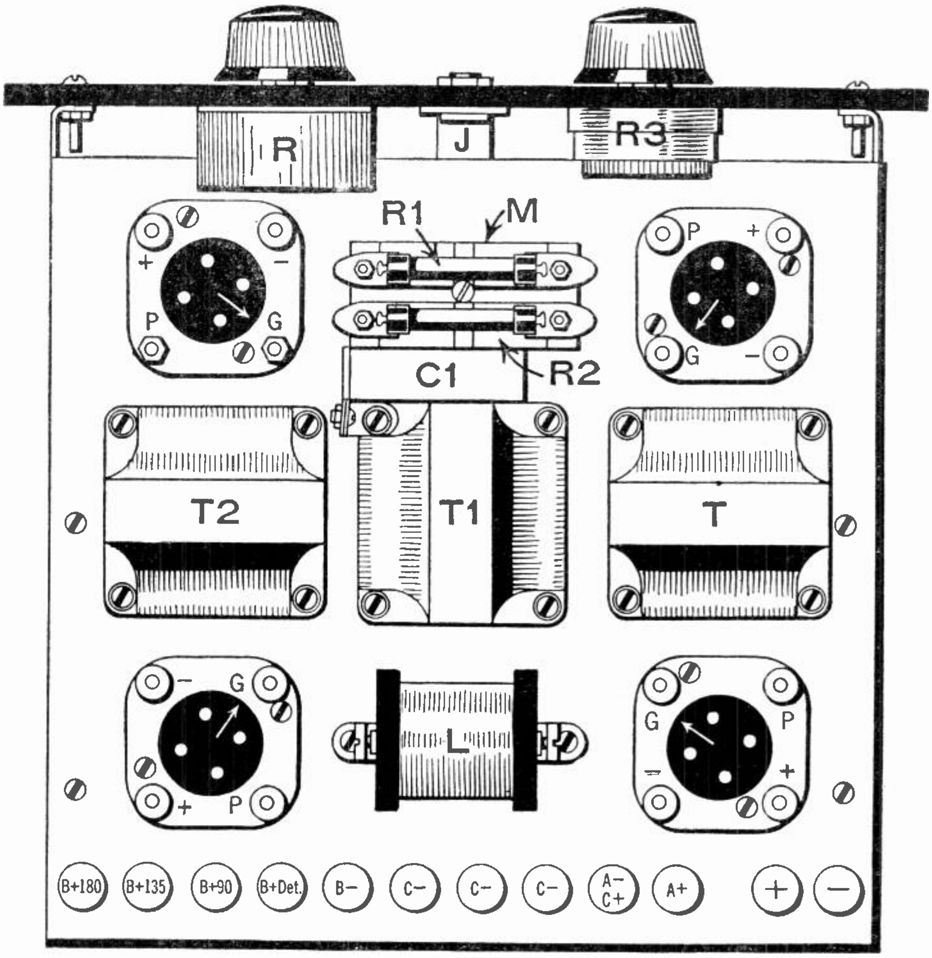
The present push-pull amplifier has been designed with two ideas in mind relative to its adaptability. First, its electrical characteristics are such that it can be used with any type of radio receiver, irrespective of the type of detector tube used. This is not true of all audio amplifiers. Secondly, it is made in compact form, so that it will not "hog" space, but can be placed at some distance from the receiver itself to eliminate electrical coupling between them. It operates independently of the receiver; that is, it does not go into operation until the speaker is plugged into the jack on the panel. When the speaker plug is pulled out the tubes are automatically turned off. If the user does not like this idea, the speaker may be left connected and the amplifier turned off by turning the single rheostat knob full to the left. This single rheostat, which controls all four tubes, is of the power type with very heavy resistance wire. The volume can always be controlled by the knob on the left of the panel; this governs a 500,000-ohm potentiometer, which regulates the effective voltage reaching the grid of the second amplifier tube. Thus, the volume can be increased from a whisper to a roar; and when we say roar we don't mean blast.

In order that this push-pull power amplifier may operate at maximum efficiency, a radio-frequency choke L, with a value of 85 millihenries, is placed in the plate lead of the detector tube and by-passed by a fixed condenser C, of .0005-mf. capacity. Because of this arrangement, none of the radio-frequency currents can get into the audio-frequency circuits. Usually, a good deal of this current passes by the detector tube without being rectified, and is detrimental to the operation of the audio amplifier if it is allowed to leak into these circuits. The R.F. choke blocks its passage in this direction, but the fixed condenser offers it a free path to the filament end of the detector circuit, which is the normal point for the completion of the R.F. circuit. The R.F. choke, however, does not obstruct the passage of the rectified currents, while the capacity of the by-pass condenser is too low to allow these audio-frequency currents to leak off. Consequently, they are passed on to the radio-frequency circuits and are amplified by them.

Output Device

Another point of interest is that the loud speaker is fully protected at all times, as the output impedance arrangement does not allow the heavy direct current of the plate circuit to flow through the loud-speaker windings. This also allows the loud speaker to operate more freely. The usual blocking or stopping condenser employed in output filters is not necessary in this case; as the "B" battery current feeds into the center of the output impedance, through the center tap, and can find a complete circuit only through the plate circuits of the two power tubes.

The construction of this amplifier is comparatively simple, the accompanying wiring and constructional drawings giving all the necessary details. The panel carries the rheostat, the volume control and the loud-speaker jack. The rest of the apparatus, except for the fixed by-pass condenser C, is mounted on top of the sub-base. It will be noted that practically all of the wiring is completed on the underside of the sub-base. This makes a neat job and at the same time is most satisfactory from the electrical standpoint.



Above, layout of the apparatus on the sub-base.
The parts carry the same symbols as in the other illustrations.

SYMBOL	Quantity	NAME OF PART	VALUE OF PART	REMARKS	MANUFACTURER ★	
L	1	R. F. choke	85 MH		1	12,13,28
T	1	A. F. trans.	3 to 1		1	
T1	1	A. F. trans.		Push-pull type	1	
T2	1	Impedance		Push-pull type, output	1	
C	1	Fixed Condenser	.0005 mf.	By-pass	2	3,5,7,14,29,30
C1	1	Fixed Condenser	.1 mf.	Coupling condenser	3	2,5,7,14,29,30,32
R	1	Rheostat	6 ohms	Power type	4	7,15,16,17,20
R1	1	Resistor	.1 meg.	Plate resistance	5	3,6,14,18,19
R2	1	Resistor	1. meg.	Grid resistance	5	3,6,14,18,19
M	1	Res. mounting		Double mounting	6	5,14,18
R3	1	Potentiometer	500000ohms	For volume control	5	4,7,16,17
J	1	Jack		Single circuit filament control	7	4,16,20
	4	Sockets		UX type non-microphonic	8	9,12,15,20,27
	12	Binding posts			9	15,21
	1	Panel		7 X 10 X 3/16"	11	22,23,31
	1	Sub-panel		8½ X 9 X 3/16"	11	22,23,31
	2	Brackets			8	
V	1	Tube	5 v. ¼ amp	201-A type	10	24,25,26
V1	1	Tube	5 v. ½ amp	112 type	10	24,25
V2, V3	2	Tubes	5 v. ½ amp	171 type	10	24,25,26
		Hookup wire				

NUMBERS IN LAST COLUMN REFER TO CODE NUMBERS BELOW.

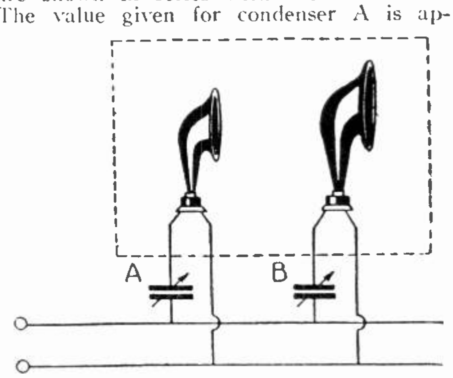
1	Samson Electric Co.	17	Central Radio Labs.
2	Sangamo Elec. Co.	18	Int. Res. Co. (Durham)
3	Tobe Deutschmann Co.	19	Dubilier Condenser Corp.
4	H. H. Frost, Inc.	20	Pacent Elec. Co.
5	Electrad, Inc.	21	X-L Radio Labs.
6	Arthur H. Lynch, Inc.	22	Amer. Hard Rubber Co. (Radion)
7	Carter Radio Co.	23	Insulating Co. of Amer. (Insuline)
8	Benjamin Elec. Mfg. Co.	24	Radio Corp. of America
9	H. H. Eby Mfg. Co.	25	E. T. Cunningham, Inc.
10	C. E. Mfg. Co. (Ceco)	26	Magnavox Co.
11	Micarta Fabricators	27	Grey & Danielson (Remler)
12	Silver Marshall, Inc.	28	Precision Coil Co.
13	Bremer-Tully Mfg. Co.	29	Wireless Spec. Apparatus Co.
14	Aerovox Wireless Corp.	30	Sprague Electric Co.
15	General Radio Co.	31	Diamond State Fibre Co.
16	Yaxley Mfg. Co.	32	Potter Mfg. Co.

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

MULTIPLE LOUD SPEAKERS

A RECENT patent covers a system in which two or more loud speakers are connected in parallel to the output terminals of the receiving set. In series with one lead of each loud speaker is inserted a variable resistor, a variable inductance or a variable condenser. It is stated that the most satisfactory results have been realized with this hook-up in which two condensers, A and B, are shown in series with the instrument. The value given for condenser A is approximately .005-mf., that of condenser B being .01-mf.



Better reproduction can be had by using two loud speakers, connected in parallel, and tuned by high-capacity condensers

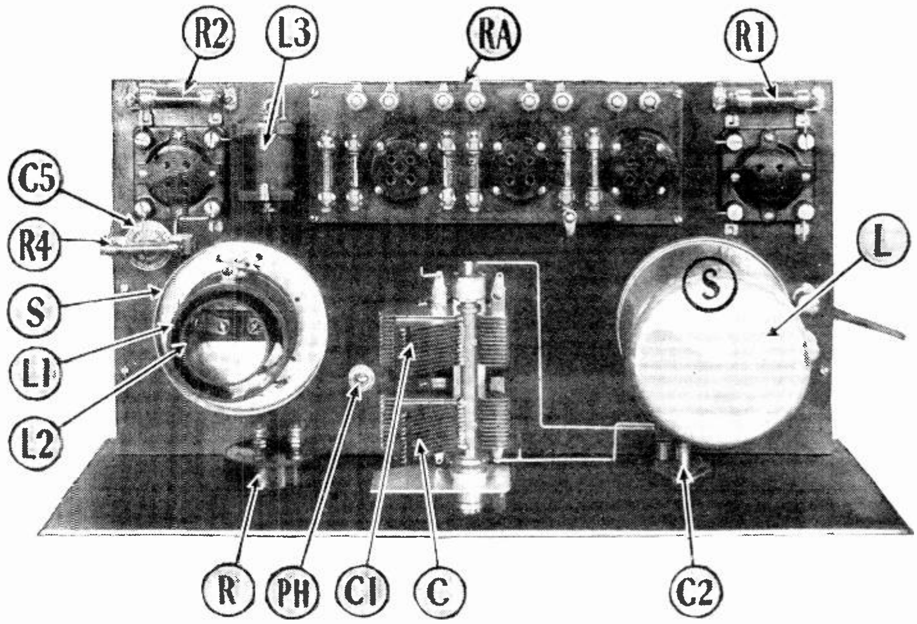
The use of two loud speakers of differing characteristics from one receiver is well known, but "tuning" loud speakers, in order to accentuate still further the varying characteristics, opens up rather an interesting line of development.—*Wireless Trader.*

The Interbalanced Regenerative Receiver*

Single Control Adjusts R.F. Coupling and Detector Regeneration

By ANDREW BARBIERI

THE "Interbalanced Regenerative Receiver" is a five-tube set whose circuit comprises one stage of tuned-radio-frequency amplification, a regenerative detector, and three audio amplifier stages of the resistance-capacity-coupled variety. It derives its name from its main features: *i.e.*, the simultaneous adjustment, by one control, of both the coupling between the R.F. and detector tubes and the regenerative action of the latter. This control takes the form of a variable resistor of 10,000 ohms maximum, connected in such fashion that it provides the closest coupling and the strongest regeneration when its resistance is highest. This action is assisted by the phase-shifting device known as the "Phasatrol," which is connected in the plate circuit of the R.F. tube, between the plate and the primary of the R.F. transformer.



A top view of the completed receiver. The parts are: L, aerial coupler; L1—L2, R.F. transformer with tickler; L3, R.F. choke; C—C1, tuning condensers; C2, balancing condenser; C5, grid condenser; R, regeneration control; R1—R2, filament ballasts; R4, grid leak; PH, Phasatrol; RA, three-stage resistance amplifier, and S, coil shields.

Series Tickler-Primary

The operation of the system can be understood from a brief study of the schematic circuit shown herewith. The diagram shows an antenna coupler L (consisting of the usual untuned primary and the secondary tuned by the large condenser, C, and the "vernier," C2, wired to the grid of the first (the R.F.) tube. The plate is coupled to the detector by a similar transformer, L1, which is fitted in addition with a fixed tickler-coil, L2. The tickler is connected to the plate of the detector though the fixed condenser C6, completing its circuit back through the *primary of the R. F. transformer.* It should be noted particularly that the tickler is actually in series with the primary; *both coils, therefore, act upon the secondary of the transformer as feed-back mediums.* The variable resistor is connected across the outer ends of the respective coils, and thus acts as a throttle (in a way, as a variable short-circuit) on them. The fixed condenser and resistor enclosed in the dotted circle represent the elements of the Phasatrol.

The latter device prevents oscillation in the R.F. stage by shifting the phase relationship of the feed-back current (through the grid-plate capacity of the tube) to the original signal impulse. Its presence also accounts for another phase shift in the feed-back current flowing through the tickler coil L2 (and also through the primary, L1) from the plate of the detector; this shift taking place in such a manner that the inductive effects of both the legitimate tickler and the erstwhile primary on the secondary coil are *additive*. In other words, the primary, in addition to acting as such, acts also as a tickler coil.

As previously mentioned, the variable resistor R regulates the dual effects of the primary and of the tickler. It is adjusted for maximum response while the set is being tuned to various wavelengths.

The R.F. choke L3 is very important in that it prevents leakage of the R.F. currents through the "B" circuit.

Simple Control Methods

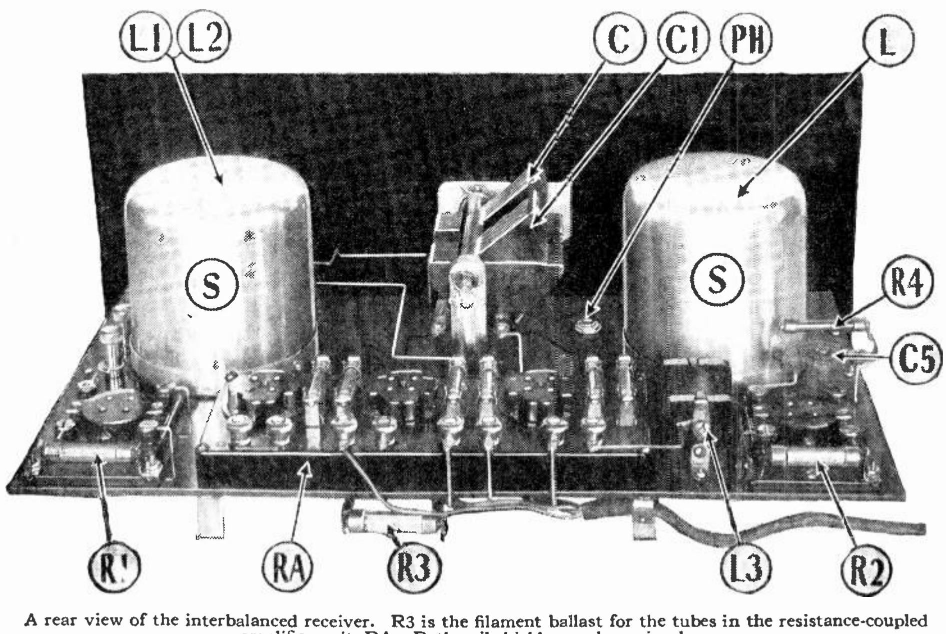
The advantages of the Interbalanced Regenerative Receiver are obvious. The manual operation of the receiver is simplified, for what ordinarily are two fairly critical adjustments are reduced in number to one. Also, the system of control reduces the detuning effect of the tickler on the secondary coil of the R.F. transformer, and allows the use of a double variable condenser for the tuning of the R.F. and detector circuits. A midget condenser (C2), for supplementary adjustment of the R.F. condenser (C), is provided; but in actual use it is set once and then left alone. The tuning of the receiver then resolves itself into the mere manipulation of the condenser dial and the resistor knob.

An Interbalanced receiver was constructed in the RADIO NEWS Laboratories, and works very successfully. It is selective and highly sensitive, the dual regeneration control permitting the circuit to be adjusted to maximum effectiveness. The quality of reproduction, as might be expected from the use of a straight resistance-capacity coupled audio amplifier, is well-nigh perfect.

Any radio constructor of average ability and mechanical facilities can duplicate this excellent outfit at little trouble and expense. The accompanying illustrations give complete data.

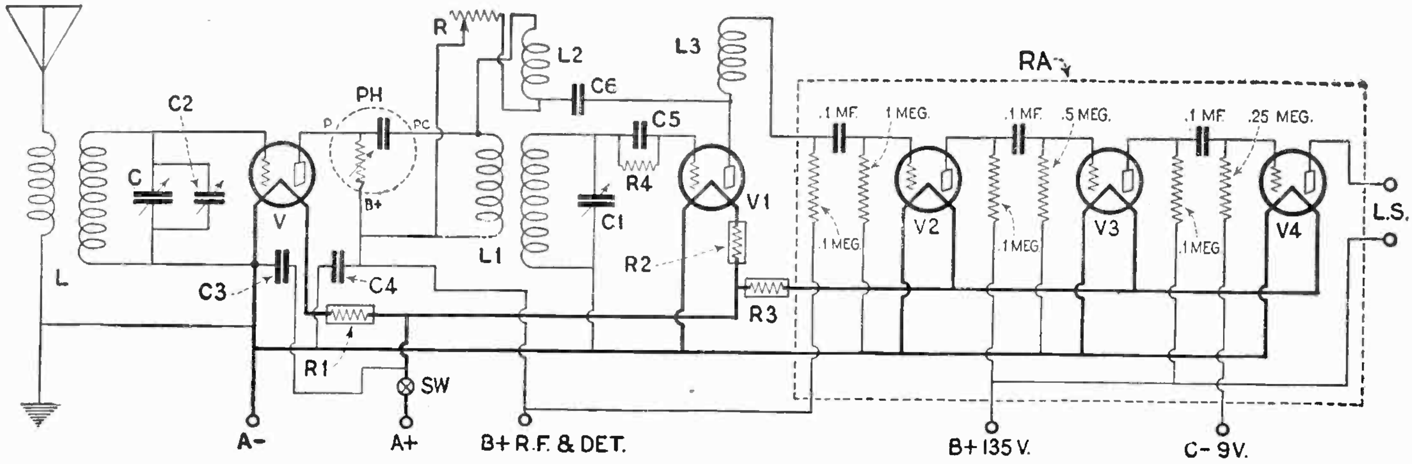
Assembly

The set consists of two essential units, a vertical front panel, a rear horizontal one (sub-panel), fastened to the former by a pair of sub-panel brackets and with the additional aid of the frame of the double variable condenser. The front panel holds the double condenser C-C1 in its center, the variable resistor R, at the left, the midget condenser C2 at the right, and the battery switch SW directly below the dial. The sub-panel



A rear view of the interbalanced receiver. R3 is the filament ballast for the tubes in the resistance-coupled amplifier unit, RA. Both coil shields are shown in place.

*RADIO NEWS *Blueprint Constructional Article* No. 21. (See page 109).



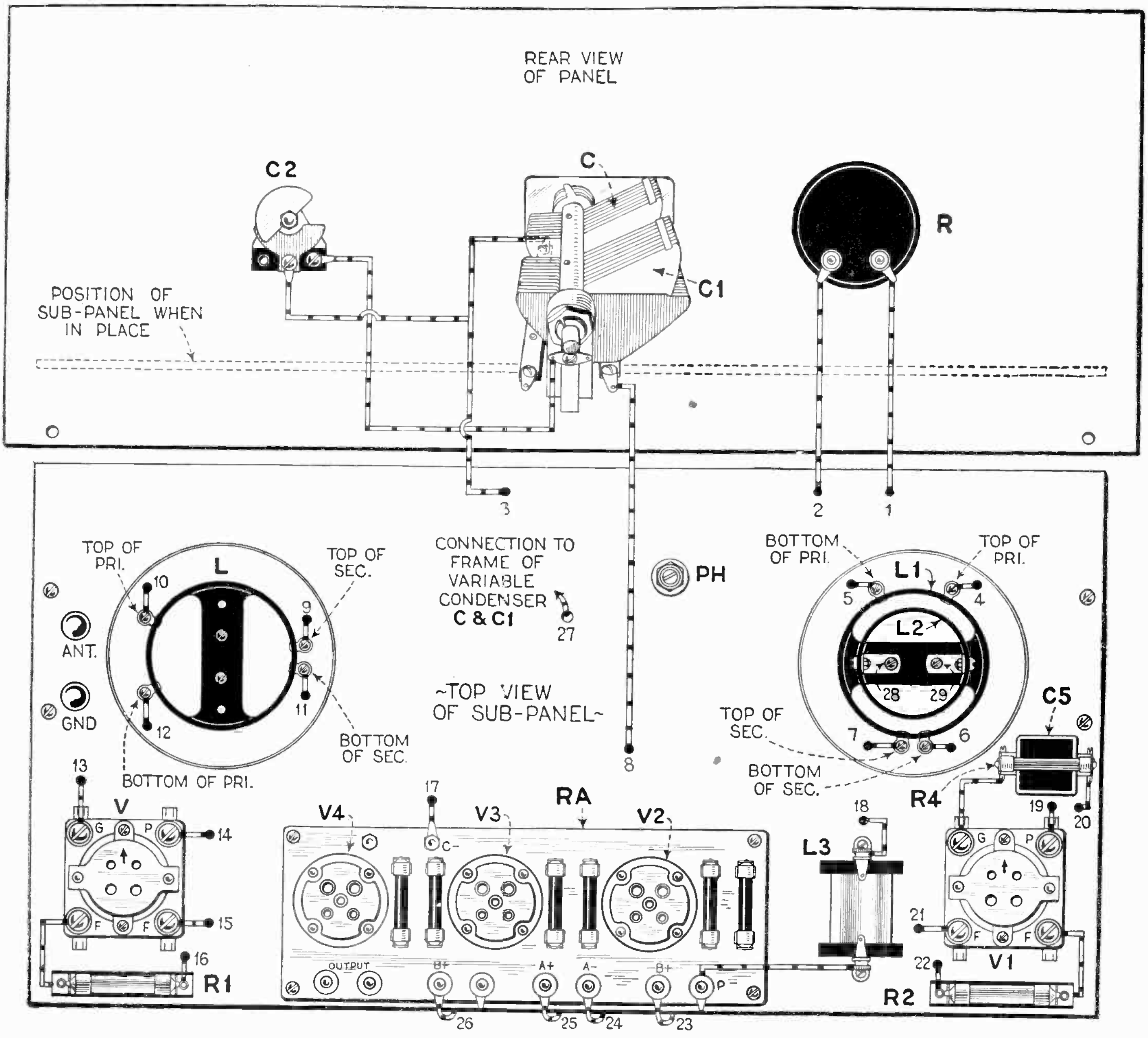
Schematic diagram of the Interbalanced Regenerative receiver. Its novel feature is the control of regeneration through the variable resistor, R, between the primary and tickler, L1 and L2.

holds the rest of the parts, including the two shielded inductors L, L1-L2 in the shields S, two separate tube sockets V and V1, the R.F. choke L3, the grid condenser and leak C5-R4, the filament ballasts R1 and R2, and the complete three-stage resistance amplifier unit RA. The Phasatrol PH is mounted on the sub-panel in a position between the double condenser and the right-hand coil L1-L2. The under side of the sub-panel holds the fixed condensers C3, C4 and C6, and also the filament ballast R3. The filament switch, which is on the front panel, is below the level of the sub-panel.

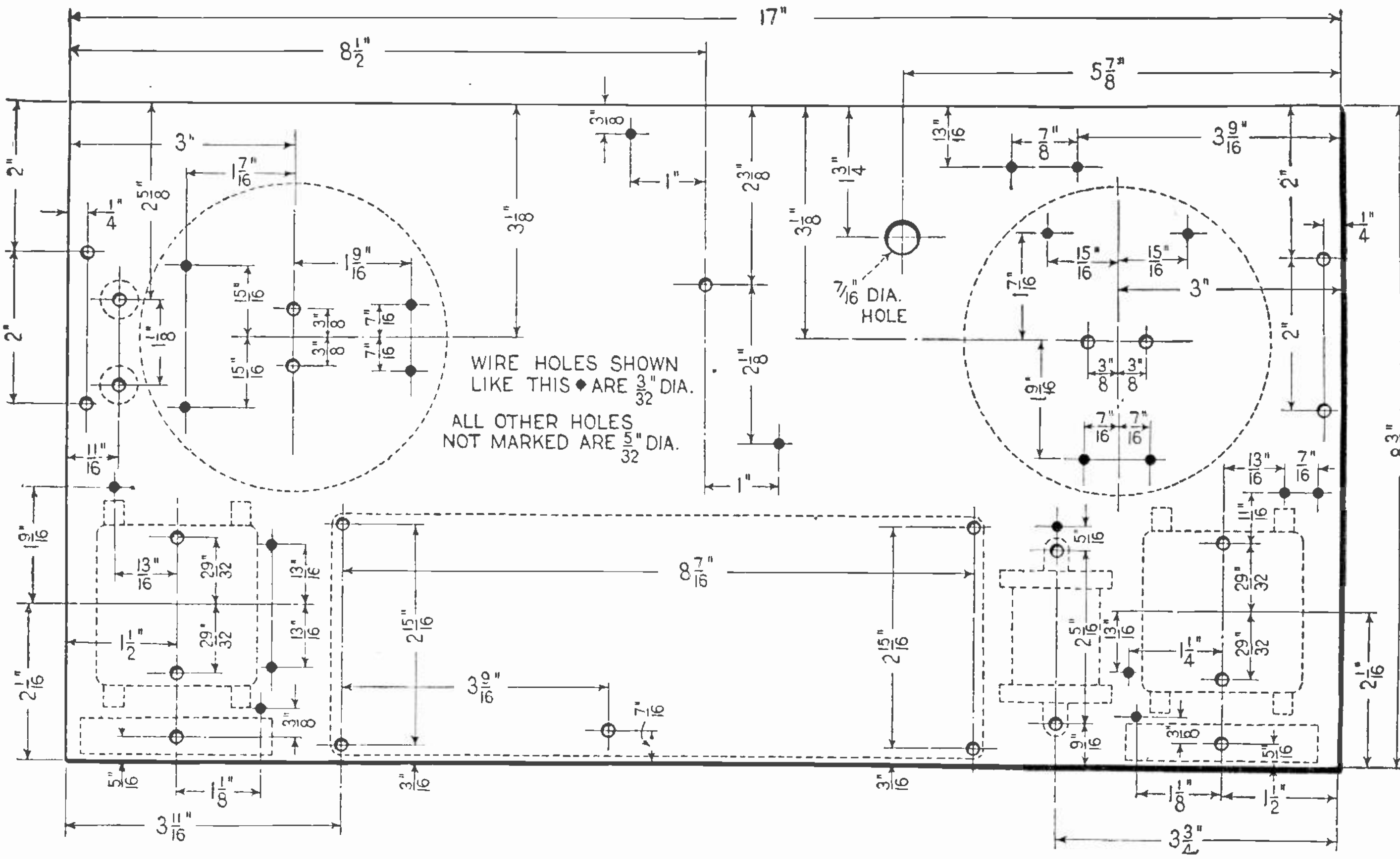
Two binding posts are provided for the aerial and ground connections, and a five-wire flexible cable for "A," "B," and "C" leads.

Wiring

In making the Interbalanced Regenerative Receiver, the constructor should first mark

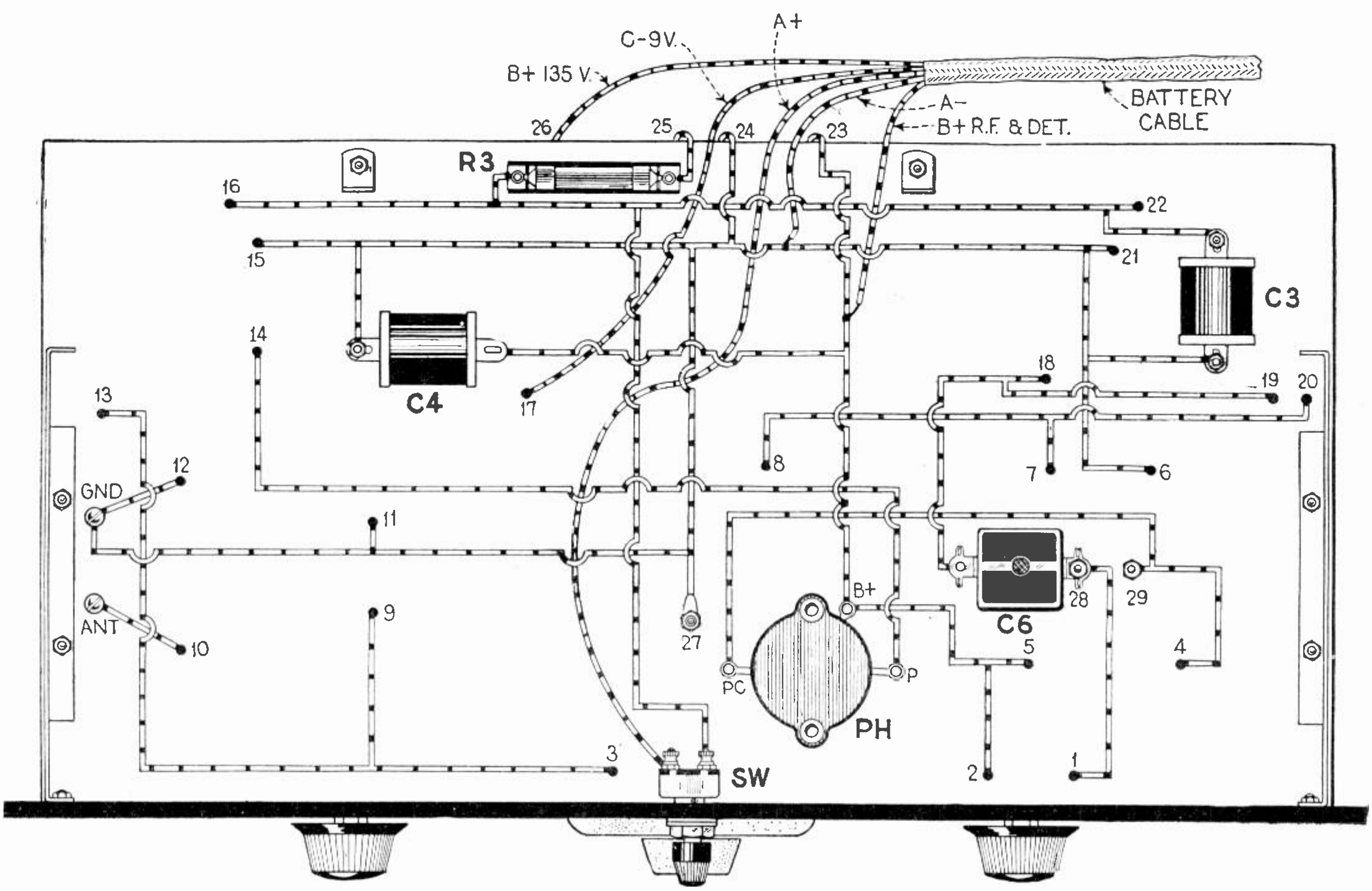


The wiring diagram of the front panel and the top of the sub-panel. See next page for the wiring on the bottom of the sub-panel. The balancing condenser, C2, has a maximum capacity of 50-mmf.

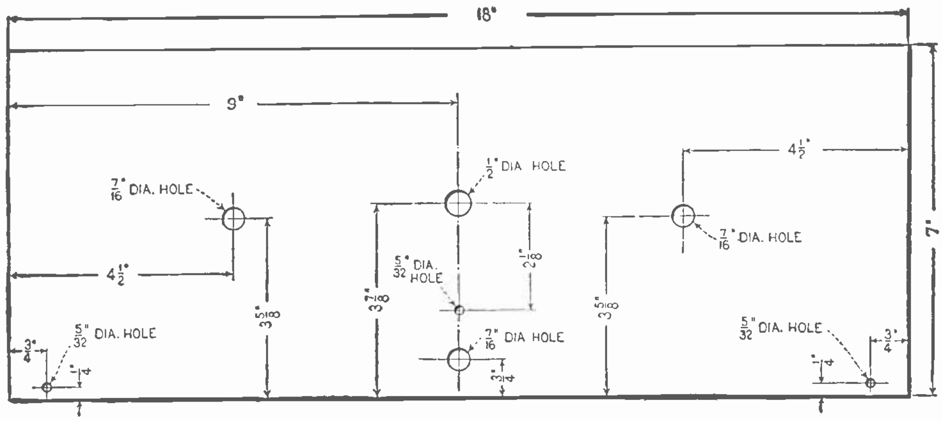


Drilling layout for the sub-panel. The instruments are indicated in their proper positions by dotted outlines.

and drill the front and sub-panels in accordance with the fully-dimensioned drawings shown herewith. The fit of each instrument in its proper holes should be tested before it is mounted in place permanently; it is much easier to enlarge holes or to drill new ones when the panel is flat and empty of parts than it is when the set is half wired and some error in placement is discovered.



The wiring diagram of the under side of the sub-panel. C3 and C4 are by-pass condensers of large capacity. C6 is the small by-pass condenser leading from the plate circuit of the detector tube.



Dimensional drilling details for the front panel.

The front- and sub-panel assemblies should be completed first as separate jobs, and the two sections then joined together by means of the brackets. The constructor should not fail to insert a machine screw through the hole marked 27 in the picture wiring diagrams, to hold the bottom of the condenser frame against the sub-panel. This screw acts also as a connector between the condenser frame and several wires beneath the sub-panel.

The dimensions of the two R.F. coils L and L1-L2 are given in the accompanying drawing. The antenna coupler is a straight solenoid of the dimensions indicated, with the ten-turn primary wound over one end of the secondary. The inter-stage coupler L1-L2 is identical with L1 as far as the primary and secondary are concerned; differing only in that it holds a fixed tickler (L2). This is placed inside the secondary tubing.

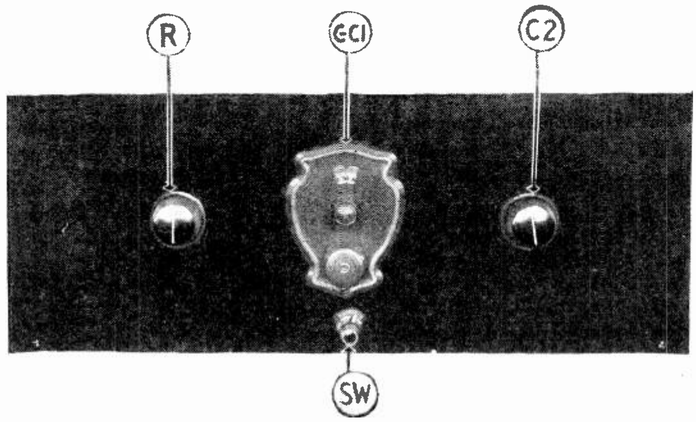
Both coils are mounted upright inside round aluminum shields four inches in diameter and four inches high. These cans comprise very shallow bottoms, over which the cans proper are fitted after the set has been completely assembled and wired.

The wiring of the set can be done quite easily with the aid of the schematic and picture diagrams. The filament end should be tackled first, completed and tested before anything further is attempted. It will be seen that the filament ballast R1 is connected to the R.F. amplifier tube alone, R2 to the detector alone, and R3 to the three audio-amplifier tubes. The filament switch is in the positive leg of the circuit. After all the wires have been fastened in place and the "A" ends of the battery cable soldered, five tubes should be inserted in the sockets, the cable connected to the "A" battery and the switch snapped on. If all the tubes light up, remove them, disconnect the battery and proceed with the rest of the set. If one or more remain dark, go over the wiring. It is very easy to forget a short section at some vital point and thus to leave the circuit open.

The use of a complete audio-amplifier unit saves much labor in both the assembly and wiring operations.

Power Supply

The "A," "B" and "C" power requirements are standard. A six-volt storage battery, two small "C" batteries, and 135 volts of "B" battery will provide the receiver with its power. The success of a "B" socket-power unit with a straight resistance-capacity amplifier is problematical, as any radio experimenter knows. Some units work beautifully, without producing the slightest trace of a hum; others generate a terrific "motor boating" noise. In general, the use of additional filter and by-pass condensers will cure the trouble; sometimes the substitution of a high-inductance grid choke for the grid leak of the last A.F.-tube is very effective.



Front panel view of the set. C2 is the 50-mmf. balancing condenser.

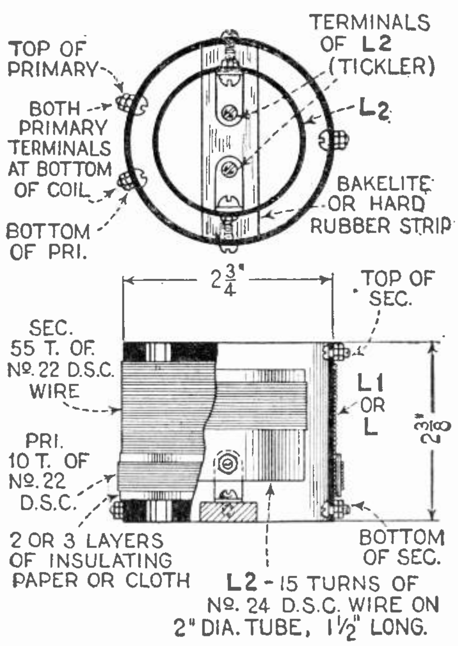
SYMBOL	Quantity	NAME OF PART	REMARKS	MANUFACTURER ★	
L	1	Ant. coupler		1	2
L1	1	R. F. transformer		1	2
L2	1	Tickler coil	Special (See drawing)		
L3	1	R. F. choke	85 millihenries	2	10,17
C,C1	1	Gang condenser	.0005 mf.	3	4,10,16,17,18
C2	1	Balancing condenser		4	1,3,10
C3,C4	2	Fixed condensers	0.5 mf. By-pass	5	8,19,20,21,22,23,24,25
C5	1	Grid condenser	.00025 mf. With grid leak clips	5	21,22,23,24,25
C6	1	Fixed condenser	.002 mf. By-pass	5	8,19,20,21,22,23,24,25
R	1	Var. resistor	0 to 10,000 ohms. Regeneration control	6	5,8,26,27
R1, R2	2	Fil. ballast res.	5 v. 1/4 amp. For R. F. & Det. tubes	7	28,29,30
R3	1	Fil. ballast res.	5 v. 1 amp. For A. F. tubes	7	28,29,30
R4	1	Grid leak	2 megohms	8	7,9,19,21,24,27,28,31,32,33
PH	1	Phasatrol	Stabilizing device	8	
RA	1	Res. amplifier	Complete three-stage unit	9	27,31,34
S	2	Coil shields	Aluminum	10	
SW	1	Fil. switch		5	8,10,26,27,34
	2	Sockets	UX type	11	1,10,17,35,36,49
	2	Binding posts	("Ant." & "Gnd.")	12	1,11
	1	Dial	Vernier type	13	2,10,11,17,37
	2	Brackets		10	36,38
	1	Panel	7 X 18 X 3/16"	14	38,39,40,41
	1	Sub-base	8 3/4 X 17 X 3/16"	14	38,40,41
	roll	Hookup wire		15	42,43
	1	Battery cable	5 wire	15	42,43
V,V1	2	Tubes	5 v. 1/4 amp. Standard type	44	45,46,47
V2,V3	2	Tubes	5 v. 1/4 amp. High-Mu	44	45,46
V4	1	Tube	5 v. 1/2 amp. Semi-power	44	45,46,47

NUMBERS IN LAST COLUMN REFER TO CODE NUMBERS BELOW.

1 General Radio Co.	2 Samson Electric Co.	3 Hammarlund Mfg. Co.
4 Allen D. Cardwell Mfg. Co.	5 Carter Radio Co.	6 Central Radio Labs. (Centralab)
7 Langbein & Kaufman Co. (Elkay)	8 Electrad, Inc.	9 De Jur Products Co.
10 Silver-Marshall, Inc.	11 H. H. Eby Mfg. Co.	12 X-L Radio Labs.
13 Cornell Electric Mfg. Co.	14 The Celoron Co.	15 Belden Mfg. Co.
16 Karas Electric Co.	17 Pacent Electric Co.	18 General Instrument Co.
19 Tobe Deutschmann Co.	20 Sprague Specialty Co.	21 Dubilier Condenser Corp.
22 Potter Mfg. Co.	23 Wireless Spec. App. Co. (Faradon)	24 Aerovox Wireless Corp.
25 Sangamo Electric Co.	26 Herbert H. Frost, Inc.	27 Allen Bradley Co.
28 Arthur H. Lynch, Inc.	29 The Radiall Co. (Amperite)	30 L. S. Brach Co.
31 Daven Radio Corp.	32 Int. Resistance Co. (Durham)	33 The Carborundum Co.
34 Leslie F. Muter, Inc.	35 Amsco Products Co.	36 Benjamin Electric Co.
37 Martin-Copeland Co. (Marco)	38 Amer. Hard Rubber Co. (Radion)	39 The Lignole Corp.
40 Micarta Fabricators, Inc.	41 Insulating Co. of Amer. (Insuline)	42 Acme Wire Co.
43 Cornish Wire Co.	44 Radio Corp. of America	45 E. T. Cunningham, Inc.
46 C. E. Mfg. Co. (Ceco)	47 The Ken-Rad Corp.	48 The Van Horne Co.
49 Alden Mfg. Co.	50	51
52	53	54

★ 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.



Details of construction of the radio-frequency coils, L, L1, and the tickler coil, L2.

The Ultra-5 Receiver*

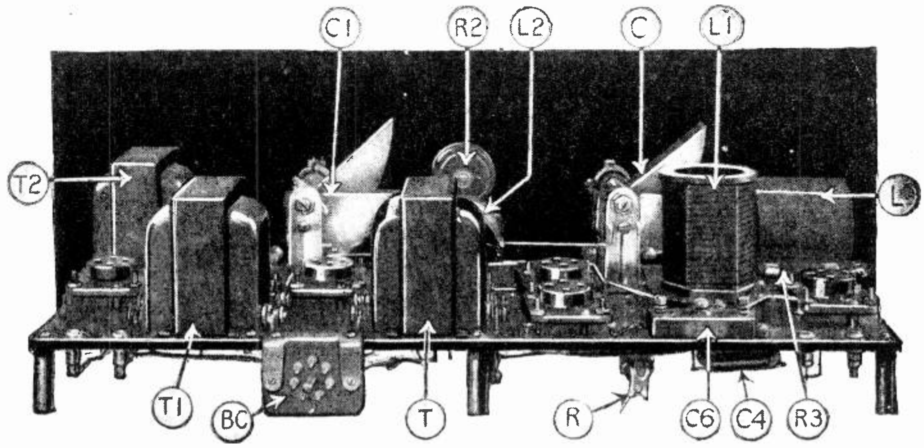
A Midget Regenerative Superheterodyne with a High Degree of Selectivity and Sensitivity

By THEODORE H. NAKKEN

THE principle feature of the set described in this article is its ability to unscramble the mess of interference in congested districts. The set is also very sensitive; consequently DX reception is possible while local stations are still on the air. As a whole, it is as selective as a standard superheterodyne and as sensitive as a five-tube tuned-radio-frequency receiver.

The circuit comprises a "modulator" tube, an oscillator and a regenerative detector. It is actually a "midget" superheterodyne, except that the regenerative detector takes the place of the usual intermediate stages. Because regeneration takes place at a different wavelength from that to which the input circuit is tuned, there is very little chance of oscillation difficulties.

This circuit is one which requires careful adjustment, because of its extreme sensitivity; but it should prove of the greatest interest to the experienced builder of superheterodynes.



A rear view of the Ultra-5 receiver. The parts are: L, antenna coupler; L1, long wave R.F. transformer L2, oscillator coupler; C, tuning condenser; C1, oscillator condenser; C4, by-pass condenser; C6, coupling condenser; R, grid leak; R2, volume control; R3, authmatic filament control; T, T1, A.F. transformers; T2, output choke, and BC, the battery cable receptacle.

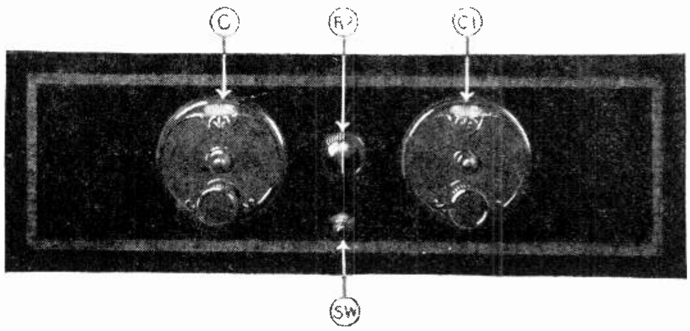
The Ultradyne Circuit

A difficulty in the operation of the average superheterodyne is that the first detector tube has a tendency to oscillate. It also stands to reason that the presence of two different detectors introduces the possibility of detector distortion, not only once, but twice. This last objection against the superheterodyne was overcome a few years ago in the creation of the Ultradyne circuit by Mr. R. E. Lacault, whose modification of the first detector circuit did away with the troubles that might be laid to the use of the first detector. Its first detector has no constant plate potential, and, in fact, does not act as an ordinary detector at all. The oscillator output is not connected to its grid circuit, so that the danger of radiation is practically obviated.

A plate current can flow only when the plate of a vacuum tube is made positive. If we apply an alternating potential to the plate of this first detector, the tube will function only at the moments when its plate is positive, and not at all when its plate is zero or negative.

Lacault accomplished this in a very simple way. He connected the plate of the first detector, through its intermediate primary, to the grid of the oscillator tube. This grid varies in potential from a maximum negative to a maximum positive value. This varying potential is thus applied to the plate of the first detector, so that the latter tube functions more or less intermittently.

Through this peculiar action, the detector works as a true mixing tube. The signal is detected by it, and reduced to a frequency which is exactly equal to the difference in the two frequencies of the incoming signal and the local oscillator.



Panel view of the Ultra-5 receiver. C is the tuning control; C1 the oscillator control, which is a tuning factor also; R2 the volume control; and SW the filament switch.

It is this intermediate-frequency signal which, in our Ultra-Five, is fed directly to the regenerative second detector.

I believe that as far as sensitivity is concerned, there has not yet been developed a circuit which, even with a plurality of radio-frequency amplifying tubes, can surpass a regenerative detector. In a superheterodyne receiver there is no barrier against the use of a detector in a pure regenerative circuit. With such a circuit, we can do away with the difficulty of finding an adequate set of intermediate amplifying transformers and we can eliminate several tubes.

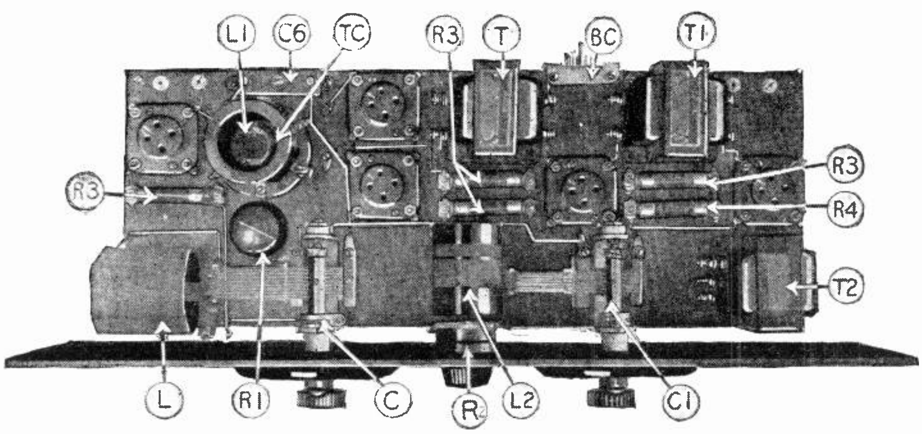
A circuit of this kind enables the average constructor to build himself a receiver in which all doubtful parts (the intermediate-frequency transformers with their potentiometer control and the first detector) are eliminated. A receiver with most of the good qualities of the superheterodyne will be the result, with the added advantage that its use will not disturb the reception of programs by neighboring set-owners.

Arrangement of the First Stages

In looking over the schematic wiring diagram which is given in Fig. 1, we see that an ordinary antenna coupling coil is employed, so that the receiver can be hooked to either an indoor or an outdoor aerial, or to a lamp-socket antenna. A variable condenser serves to tune the receiver to the desired signal.

It will be observed that no grid condenser or grid leak is attached to the first or mixing tube; but that the antenna is coupled directly to the grid. Neither is necessary, because the plate of this mixing tube is not connected to any positive point of the general "B" battery, but is connected through the primary of the intermediate-coupling coil to the grid of the oscillator tube. When this is done it follows that the plate potential of the mixing tube will be alternatingly positive and negative; because it swings up and down in unison with the potential of the oscillator grid. Thus, plate current flows only intermittently in this tube, and the frequency of the application of a positive potential to the plate can be regulated completely by the tuning of the grid circuit of the oscillator tube.

In this way the incoming signal is caused to beat with the intermittent surges of current through the mixing tube; and the result is that the plate current flowing through this tube is modulated by the incoming signal, at any beat-frequency that may be desired.



A top view of the completed Ultra-5 receiver. Note the tickler coil TC in the long wave inductance L1. The tickler is set once and thereafter regeneration is controlled by R1 should any further adjustments be found necessary. The adjustable condenser C6 is instrumental in eliminating local interference from harmonics

*RADIO NEWS *Blueprint Constructional Article No.* 13. (See page 109).

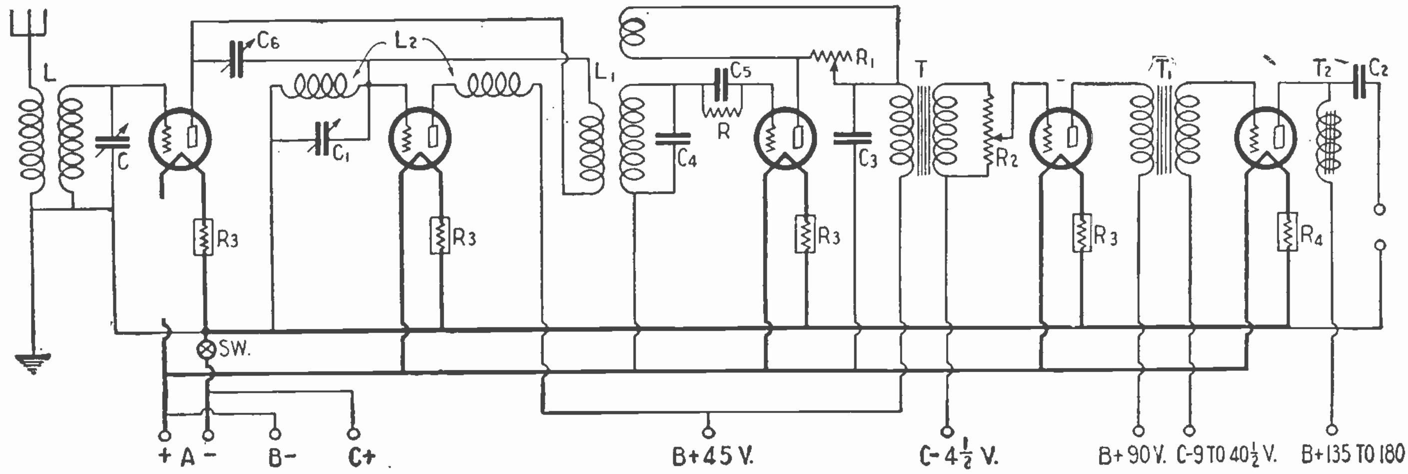
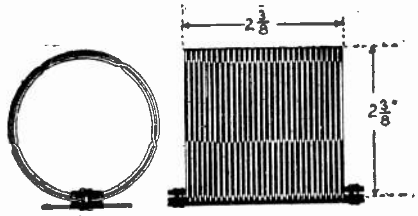


Fig. 1. The schematic circuit diagram of the Ultra-5 receiver. It is suggested that a power or semi-power tube be used in the last audio stage. The correct "B" and "C" voltages to use depend on the tube. Consequently two voltage values are given in each case in the diagram above.

The intermediate transformers of the ordinary superheterodyne or Ultradyne receiver have been replaced by a coil unit consisting of a primary, a secondary and a tickler coil, and having six terminals.

In order to make the construction of the receiver as simple as possible, a plug-in coil L1 with a six-terminal base has been chosen; this is available in almost every radio store. It is tuned by means of an adjustable condenser C6 across the primary and a fixed condenser across the secondary. The regeneration in this system is controlled by means of a non-inductive variable resistor, R1, across the tickler coil which is placed in the immediate vicinity of this plug-in coil inside of the receiver, because it need

Secondary, 80 turns No. 24 D.S.C. wire; primary, 16 turns No. 24 D.S.C. wire.



Constructional details of the antenna coupler, L. This may be wound on ordinary insulating tubing if desired

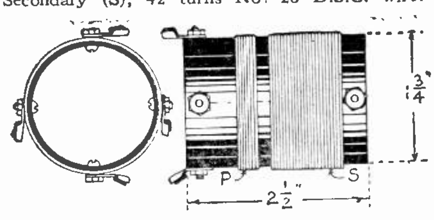
be adjusted only once for every particular detector tube used. The regeneration control, therefore, need not be placed on the front panel of the receiver.

Other Features

As a volume control, a 500-000-ohm potentiometer R2 is placed across the secondary of the first audio-frequency transformer, so that the volume of the receiver may be adjusted at will.

To permit the use of different kinds of

Primary (P), 15 turns No. 26 D.S.C. wire. Secondary (S), 42 turns No. 26 D.S.C. wire.



Constructional details of the oscillator coupler, L2. The two coils are wound on a section of insulating tubing.

power tubes in the last audio stage, a proper output device, comprising a 30-henry choke and 2.0-mf. condenser T2, C2, has been incorporated in the receiver. In case "B" batteries are used, a 112-type tube can be successfully employed; but when a good "B"-power device with sufficiently high voltage is employed, a 171-type power tube can be inserted without any changes in the wiring of the receiver.

In order to eliminate as many controls from the front panel as possible, all the tube filaments are controlled by means of self-adjusting rheostats. The use of these insures the proper operating current to each tube, so that distortion, which often results from the improper use of hand-operated rheostats, is prevented. At the same time, it is possible, by changing the self-adjusting rheostats, to operate the receiver with any kind of tubes fitted with UX bases.

Constructional Details

The panel measures 7 x 21 inches and the distance between the shafts of the condensers

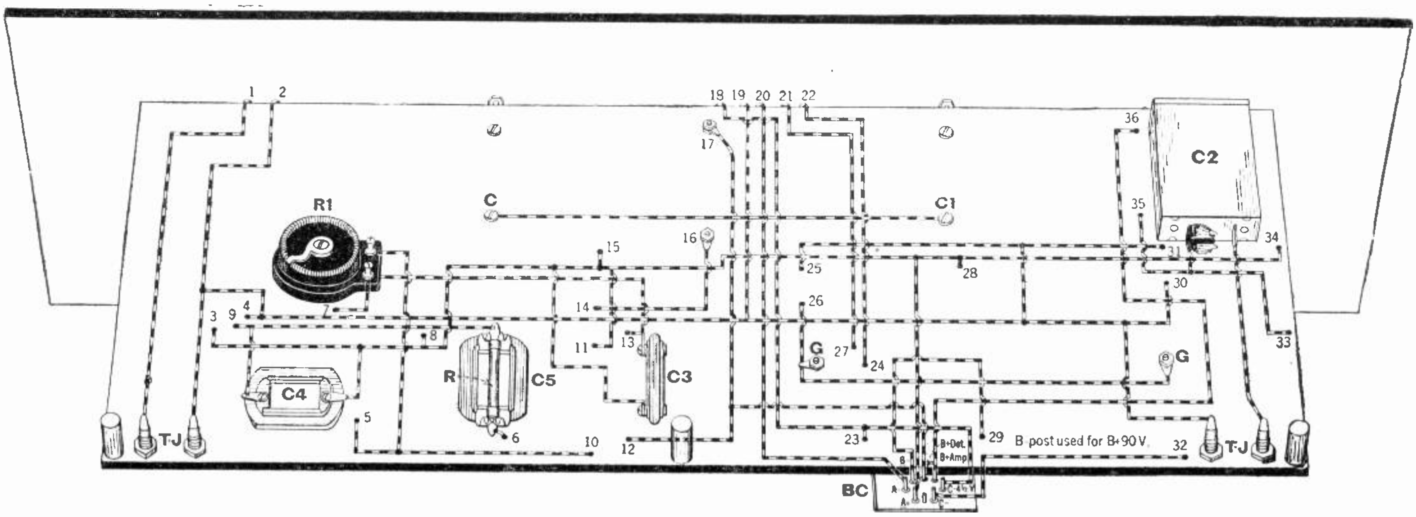
SYMBOL	Quantity	NAME OF PART	VALUE OF PART	REMARKS	MANUFACTURER ★	
L	1	Ant. Coupler			1	2,3,16,17,41
L1	1	R.F. Coil & Base		Long Wave Plug-in Type with Tick.	2	
L2	1	Osc. Coupler		Special		
C	1	Var. Cond.	.00035 mf.		3	1,2,16,17,18,29,46
C1	1	Var. Cond.	.00025 mf.		3	1,16,17,18,29,46
C2	1	Fixed. Cond.	2 Mf.	For Output Filter	4	5,20,21,22,23,28
C3	1	Fixed Cond.	.002 Mf.	Bypass	5	4,19,20,21,23
C4	1	Fixed Cond.	.0005 Mf.	Bypass	5	4, 19, 20,21,23
C5	1	Grid Cond.	.00025 Mf.	With Grid Leak Clips	5	4,19,20,21,23
C6	1	Adj. Cond.	Max..001Mf.	Neutralizing	9	
R	1	Grid Leak	2 meg.		6	4,20,21,23,24
R1	1	Var. Resistance	0-2000ohms	Regeneration Control	4	23,25,26,27
R2	1	Potentiometer	0-500000ohm	Volume Control	4	23,25,26,27
R3	4	Auto.Fil.Control	5v. ¼ Amp.		7	
R4	1	Auto.Fil.Control	5v. ½ Amp.	For Power Tube	7	
T, T1	2	A.F. Trans.			8	2,16,17,18,42,45
T2	1	Choke		For Output Filter	8	2,16,28
	5	Sockets		UX Type	1	2,15,23,46
SW	1	Fil. Switch			10	23,25
TJ	4	Tip Jacks		For Aerial,Gnd, & Loud Speaker	10	25,26,30
BC	1	Battery Cable		7 Wires	10	31
	1	Insulating Tube		2¼"long,1¾" dia. For osc. coupler	11	32,33
	½lb.	Copper Wire		#26 Double Covered Silk	12	13,34
	one roll	Hook-up Wire		Spaghetti Covered	13	12,34
	1	Panel		7"X21"X3/16"	14	11,32,33,47
	1	Sub-Base		7"X18", 3/16"	14	11,32,33,47
	2	Dials		Vernier	15	2,16,17,35,43
	4	Tubes	5v. ¼ Amp.		36	37,38,39,40,44,48
	1	Tube	5v. ½ Amp.	Semi-Power Amplifier	38	36,39,40,44,48

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.

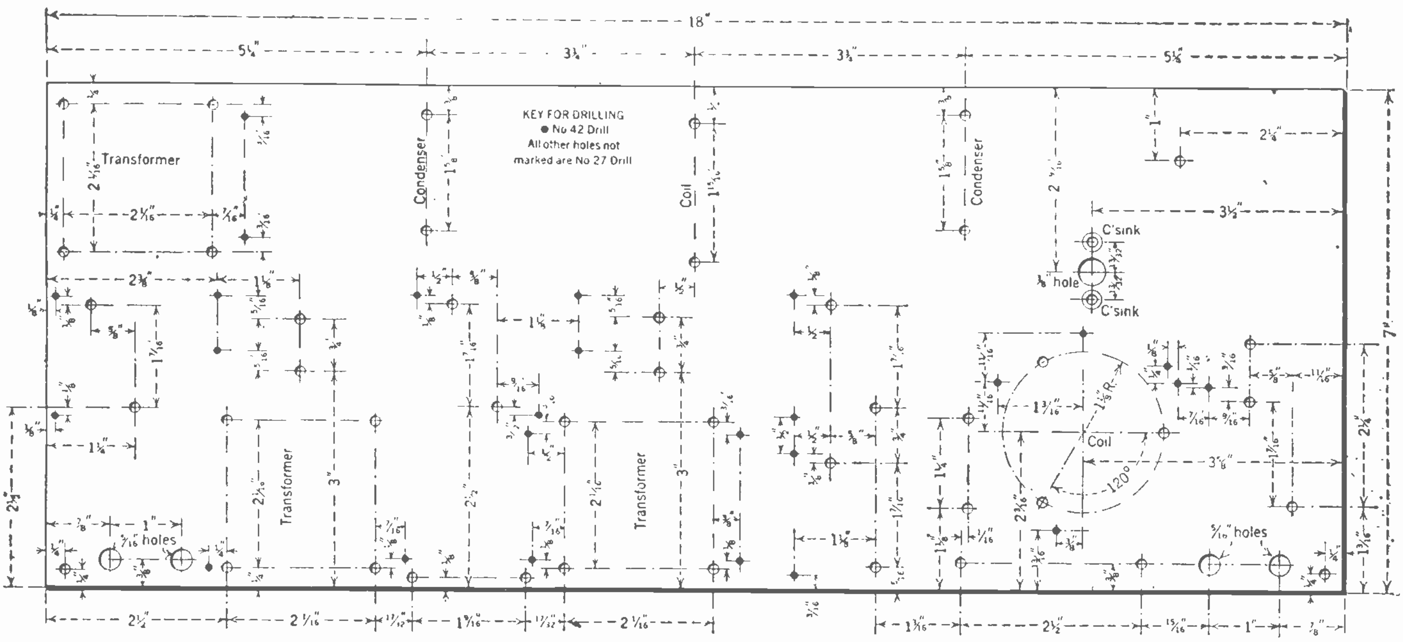
NUMBERS IN LAST COLUMN REFER TO CODE NUMBERS BELOW.

1 Benjamin Elec. Mfg. Co.
2 Silver-Marshall, Inc.
3 Hammarlund Mfg. Co., Inc.
4 Electrad, Inc.
5 Sangamo Elec. Co.
6 Int. Resis. Co. (Durham)
7 Radiall Co., (Amperite)
8 Thordarson Elec. Mfg. Co.
9 X-L Radio Labs.
10 Yaxley Mfg. Co.
11 American H. Rubber (Radion)
12 Cornish Wire Co.
13 Acme Wire Corp.
14 Lignole Corp.
15 H. H. Eby Mfg. Co.
16 Samson Elec. Co.
17 All American Radio Corp.
18 Bremer-Tully Mfg. Co.
19 Wireless Specialty Appar. Co.
20 Aerovox Wireless Corp.
21 Polymet Mfg. Corp.
22 Tobe Deutschmann
23 Leslie F. Muter Co.
24 A. H. Lynch, Inc.
25 Carter Radio Co.
26 H. H. Frost, Inc.
27 Central Radio Labs.
28 Precision Coil Co.
29 National Co. Inc.
30 Brooklyn Metal Stamping Co.
31 Howard B. Jones
32 Formica Insulation Co.
33 Diamond State Fibre Co.(Celeron
34 Belden Mfg. Co.
35 Martin-Copeland Co. (Marco)
36 Perryman Elec. Co.
37 Moulded Products, Inc.
38 Radio Corp. of America
39 E. T. Cunningham, Inc.
40 C. E. Mfg. Co.
41 Bodine Elec. Co.
42 American Trans. Co.(Amertran)
43 Cornell Elec. Co.
44 Magnavox Co.
45 Acme Apparatus Co.
46 Alden Mfg. Co.
47 Ins. Co. of Amer.(Insuline)
48 Van Horne Co.

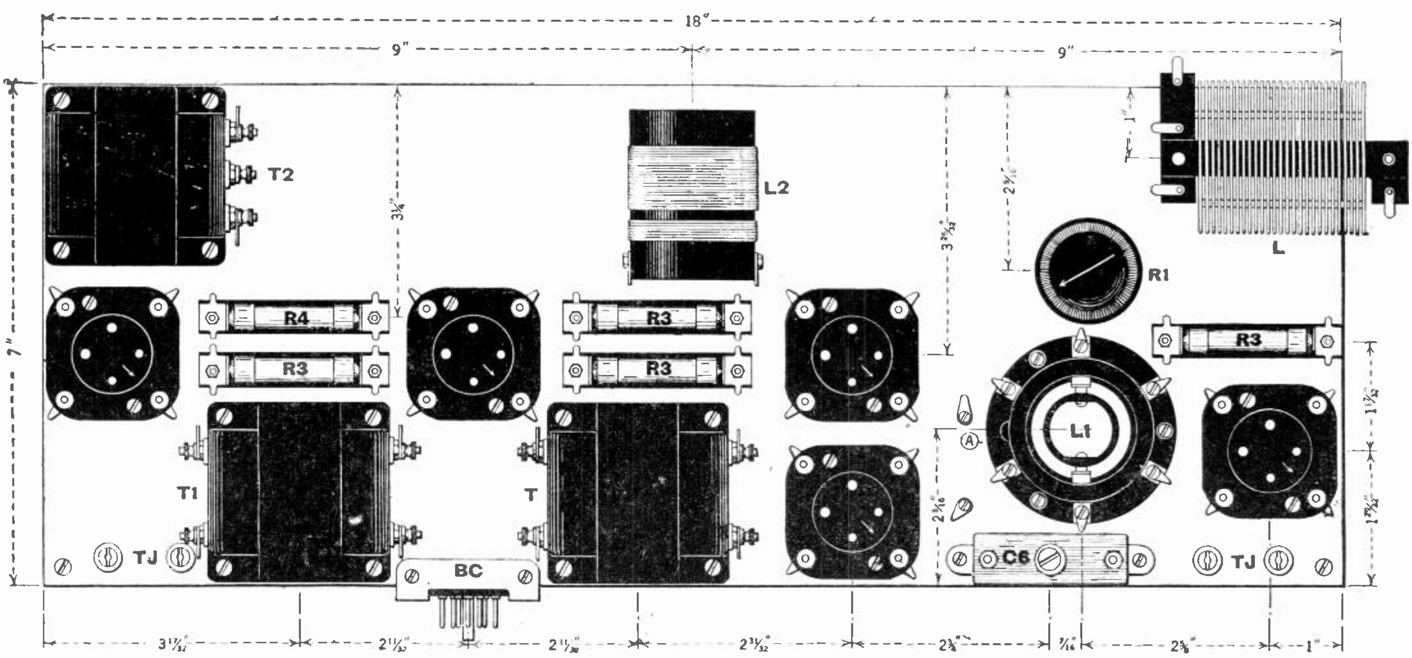
★ THE FIGURES IN THE FIRST COLUMN OF MANUFACTURERS INDICATE THE MAKERS OF THE PARTS USED IN THE ORIGINAL EQUIPMENT DESCRIBED HERE.



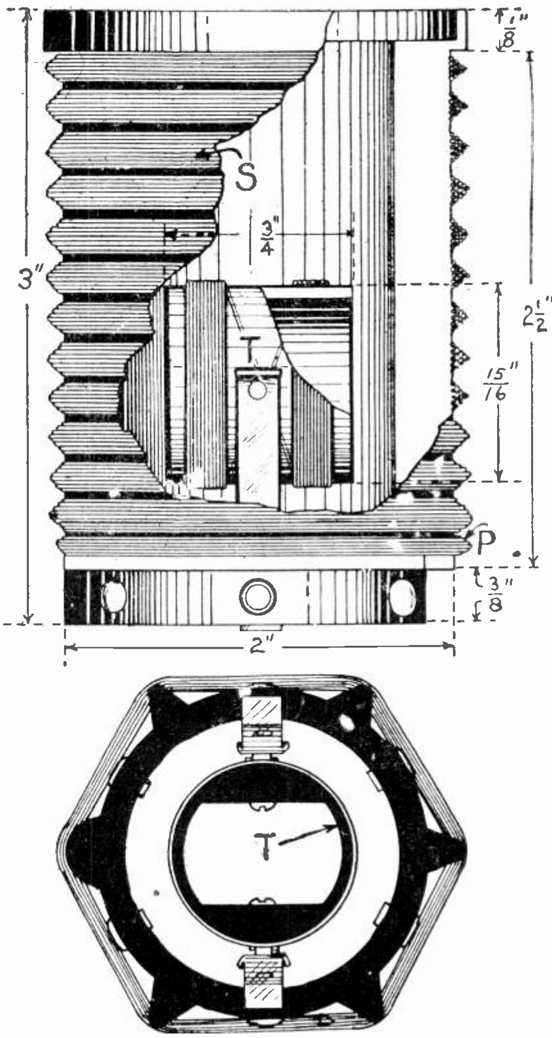
The layout and wiring of the underside of the sub-base. Take note of the fact that the "B –" prong on the battery cable receptacle is to be used as the "B +" 90-volt lead. Connect the "B –" to the "A +" on the outside of the set. The two terminals G indicate the frames of the A.F. transformers, which are grounded through "A –" by way of the filament controls. C-C1 connects the grounded condenser rotors.



Details of the drilling for the sub-base. All holes in full black are for passing connecting wires through the sub-base



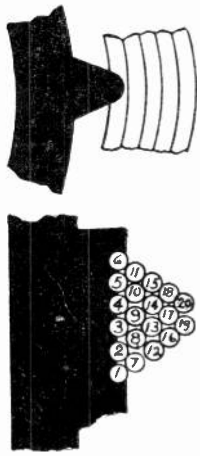
Constructional layout of the apparatus on the sub-base. Be sure to mount the base of the R.F. transformer L1 so that the depression, indicated by A, is pointing towards the left as shown.



Primary (P): 100 turns No. 38 D.S.C. wire, layer-wound.

Secondary (S): 260 turns No. 24 D.S.C. wire, layer-wound.

Tickler (T): 52 turns No. 38 D.S.C. wire, layer-wound.



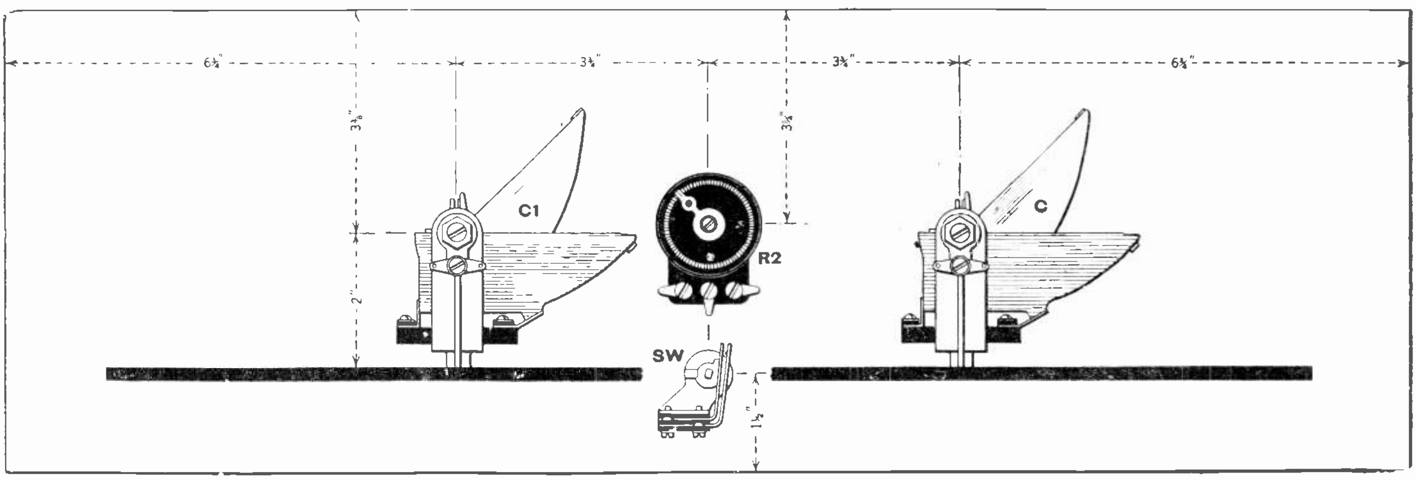
Constructional details of the long-wave R.F. transformer, L1 (this is a type 111-D). The secondary coil is layer-wound. The small sketches below show the manner in which the wire is wound. To make it clear, each turn is numbered. The tickler coil is also layer-wound, but there are only two layers on this coil. Ordinary insulating tubing can be used as the form if desired.

is 7½ inches. The sub-panel is 7 x 18 inches. The variable condensers are of the straight-line-frequency type. These are provided with drilled L-shaped frames, which are used to support the sub-panel. It is not necessary, therefore, to employ additional brackets. The dials completely cover the screws used for fastening the condensers and the volume-control resistor. The sub-panel is laid out in accordance with the accompanying sketch.

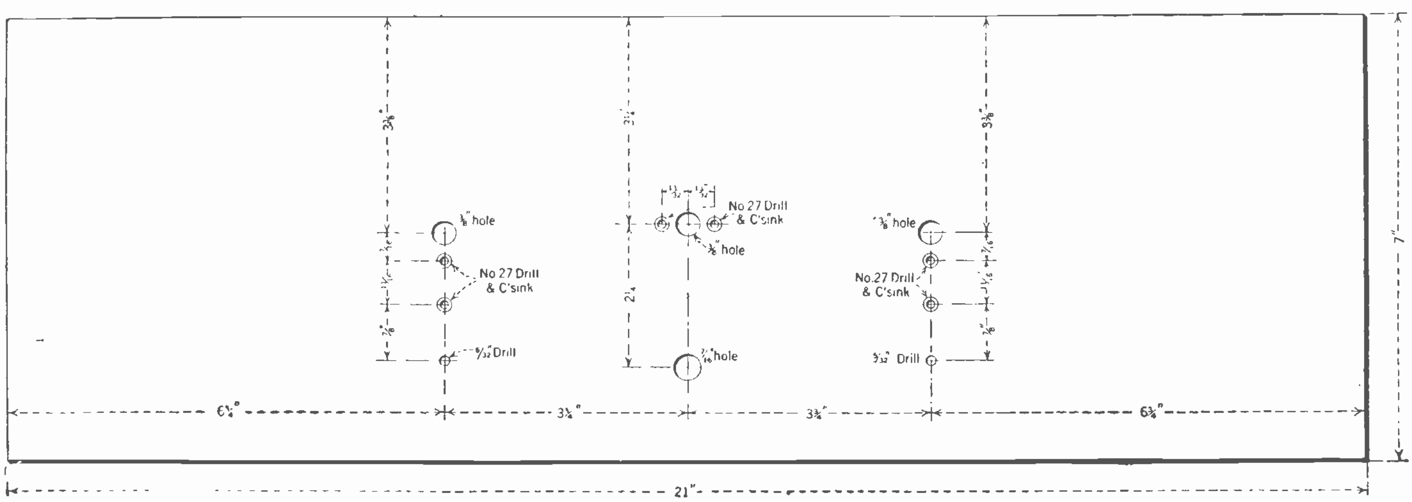
When building this receiver, it is advisable first to mount carefully the sockets, the transformers and choke, and the self-adjusting rheostats, by means of small screws and nuts held by lock-nut washers. The last parts to be mounted and wired are the coils, because these might otherwise be damaged in the handling of the receiver, while the circuit is being wired.

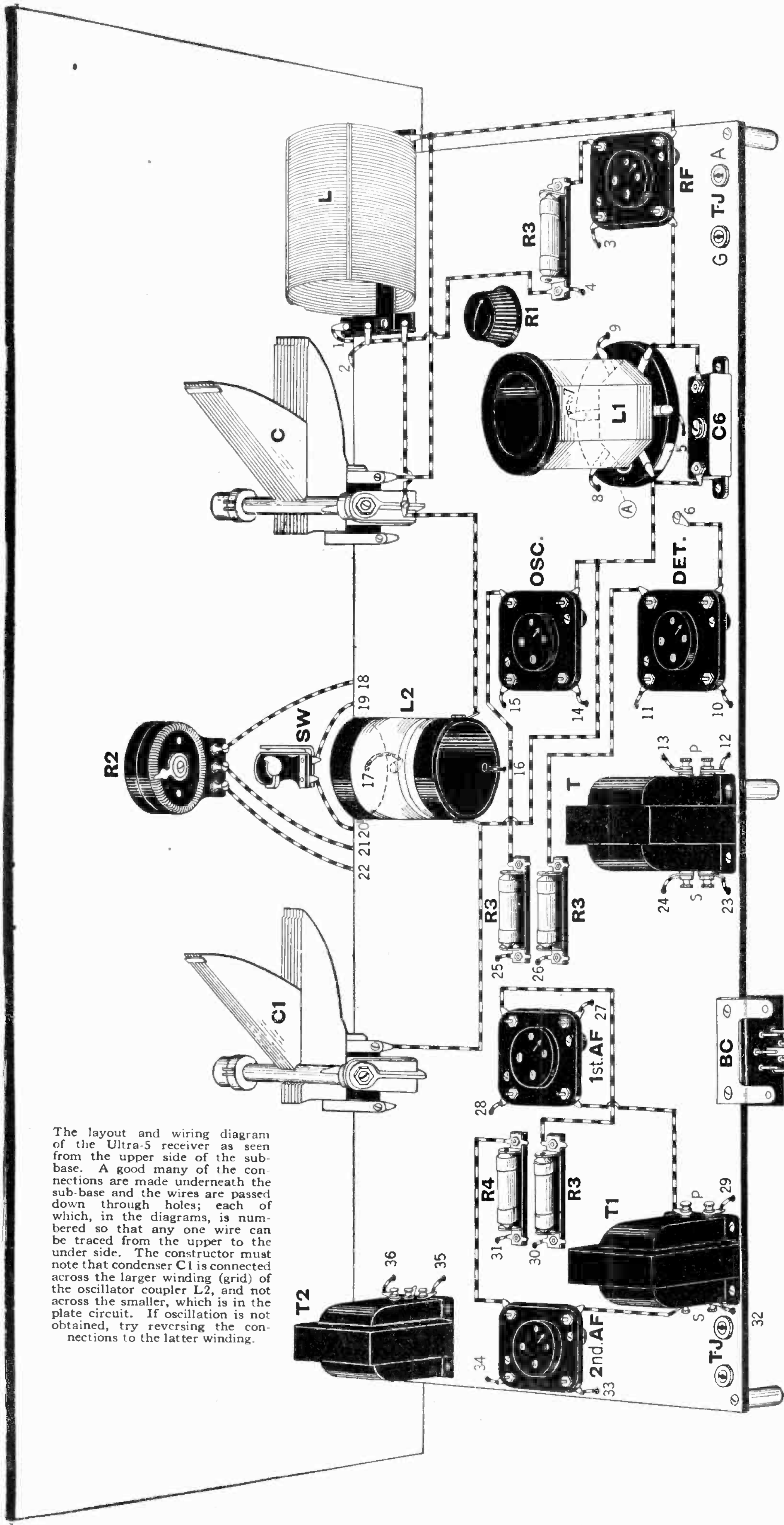
The "B+" terminal of the second amplifying transformer is connected directly to the "B−" point on the cable jack which is fastened between the two amplifying transformers. We have selected the "B−" lead for this function because the first amplifying tube is provided in this particular receiver with 90 volts, and the last tube should be adaptable to any plate voltage, required by type 112 or 171 tubes. This necessitates the use of two different "B" and "C" battery voltages for the amplifying tubes and if we did not use the "B−" lead for this purpose we would be one lead short in the cable.

The six-terminal coil base is fastened in such a way that the lug on the coil form points to the left of the finished receiver. This coil requires three mounting screws, which we can utilize to additional advantage for the support of the three fixed condensers, which are tapped for No. 6 screws. The sketch of the various parts mounted on the sub-panel shows exactly how these condensers are located. We may now install



Layout and drilling sketches (above and below respectively) for the front panel of the Ultra-5 receiver. All the necessary dimensions are given.





The layout and wiring diagram of the Ultra-5 receiver as seen from the upper side of the sub-base. A good many of the connections are made underneath the sub-base and the wires are passed down through holes; each of which, in the diagrams, is numbered so that any one wire can be traced from the upper to the under side. The constructor must note that condenser C1 is connected across the larger winding (grid) of the oscillator coupler L2, and not across the smaller, which is in the plate circuit. If oscillation is not obtained, try reversing the connections to the latter winding.

the various coils in the R.F. end; specifications for all these are given in the diagrams.

After the receiver has been thoroughly checked, the cable is inserted and a single tube is placed in one of the sockets. This tube should light if the "A" is turned on. The various connections can be checked further by means of a voltmeter connected between the various points where voltage differences should exist. When you have made sure that no short circuits are present in the receiver, insert all the tubes. The antenna and ground leads being provided with phone-tip plugs these are inserted in the antenna and ground jacks (TJ), at the left of the baseboard, while the speaker tips are inserted in the output jacks, TJ. The receiver should then be turned to a nearby station; and, as soon as the broadcasting is heard, the resistor R1, controlling the regeneration, should be adjusted to give good volume. Once this regeneration has been adjusted, it can be left alone until another detector tube is inserted.

Tuning

The receiver tunes extremely sharp; the right-hand dial, which controls the oscillator, is particularly sensitive. Tuning should be done carefully, because if the dials are turned too fast, it is possible to pass right by even the very strong local broadcasting stations.

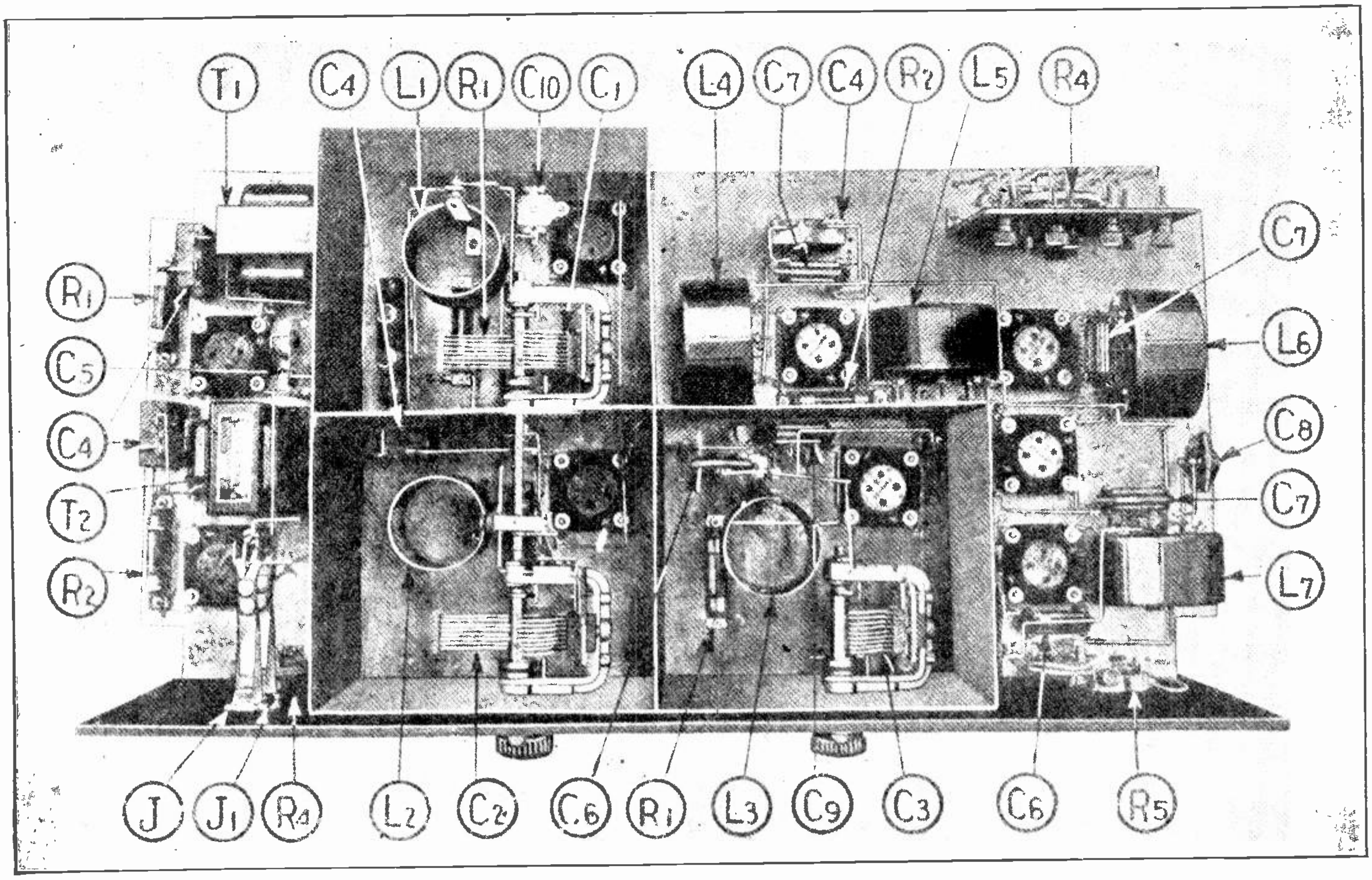
Depending on the location of the receiver, the regeneration should be adjusted in such a way that the best quality of reproduction is obtained. If the Ultra-5 is used in a large town, for which purpose it is specifically recommended, the regeneration does not have to be advanced to the highest point; but out in the country regeneration, of course, is desirable to the utmost extent. This, however, is entirely up to the individual user.

It is advisable to compile a tuning chart of the receiver, because the tuning is so sharp that no indication of the presence of a station is given except when the tuning is exactly right.

Many people experience trouble with superheterodyne receivers, due to excessive whistling on some stations. When we remember how the superheterodyne functions, it will come to mind that there are three distinct frequencies involved in its operation; the signal wave, the oscillator wave and the intermediate wave. The latter is created deliberately, as explained.

If, however, the receiver is located in a crowded district, where several powerful stations are broadcasting at the same time, there is a possibility that two or even three waves from different broadcasters will be impressed on the detector circuit. These different frequencies may intermingle freely, and combine individually or jointly, perhaps, with the oscillator frequency. In this manner they may, therefore, give rise to serious interference, squeals and undesirable noises. Of course, in order to be capable of doing this, the beat notes resulting from such

(Continued on page 43)



A top view of the new shielded Ultradyne LR4 receiver, which is very compact in form. The two-stage transformer-coupled audio amplifier can be seen at the extreme left of the base. The left rear shield contains the single stage of constant-coupled tuned-radio-frequency amplification which precedes the modulator circuit contained in the left front shield. The right-hand shield encloses the oscillator circuit. The three intermediate-frequency amplifier stages and the detector are grouped around the oscillator shield. Note that the condensers which tune the radio-frequency and the modulator circuits are on the same shaft, making a single control.

The New Shielded LR4 Ultradyne*

A Simplified 9-Tube Set Using Standard Parts

By R. E. LACAULT

ALTHOUGH the majority of the receivers that have appeared on the market within the past few months have, on an average, six tubes, there is a great deal of interest displayed in sets having many more. It is true that the five- or six-tube receiver is good for reception up to about one thousand miles—of course in some cases this is exceeded—but when the experimenter goes after really distant stations he turns to a receiver having eight, nine or ten tubes.

On stations within the radius of a few hundred miles the set having five or six tubes will give every bit as good reproduction as will a receiver having a greater number; but, as pointed out numerous times, if distance is wanted there must be sufficient amplification; and this means more tubes, in the radio-frequency end of the set.

Convenient Shielding Available

When more than two stages of amplification are employed before the detector tube, there is likely to be trouble unless suitable precautions are taken. In the past few months radio engineers have incorporated in set design shielding about the radio-frequency stages to reduce interstage coupling, finding that reception is bettered thereby. In the new LR4 Ultradyne receiver which is described in this article shielding is used around the stage of tuned radio-frequency amplification, the modulator and the oscillator circuits.

In the "old" days of radio—four or five years ago—when an experimenter wanted to build a new receiver, it was necessary for him to make the greater part of the apparatus at his own work-bench. Today this condition has been changed, for there are very few accessories that are not manufactured. This is true particularly of the shields, which formerly had to be laboriously cut from sheet metal, but which now can be obtained all ready to install in a receiver.

The LR4 receiver is one designed for assembly with a minimum of effort on the part of the builder. By this is meant that everything that is installed in the set may be purchased; nothing having to be made by the builder unless he so chooses.

What the LR4 Is

It is impossible to say what a set will do in a given location, expecially in cities, there being too many factors involved to permit any broad and sweeping claims to be made. However, if a set such as described in this article is properly assembled and adjusted, it will give excellent results. On a short indoor antenna many distant stations have been tuned-in, the amplification being such that most of them were heard on the loud speaker. The selectivity is sufficient to permit the separation of stations very close in frequency; the radio-frequency stage and the shielding preventing much interference and noise from getting through the set.

As can be seen from an inspection of the wiring diagram of the receiver, it consists of a stage of tuned radio-frequency amplification, an oscillator, a modulator, three stages of long-wave radio-frequency amplification, a detector, and two stages of transformer-coupled audio-frequency amplification.

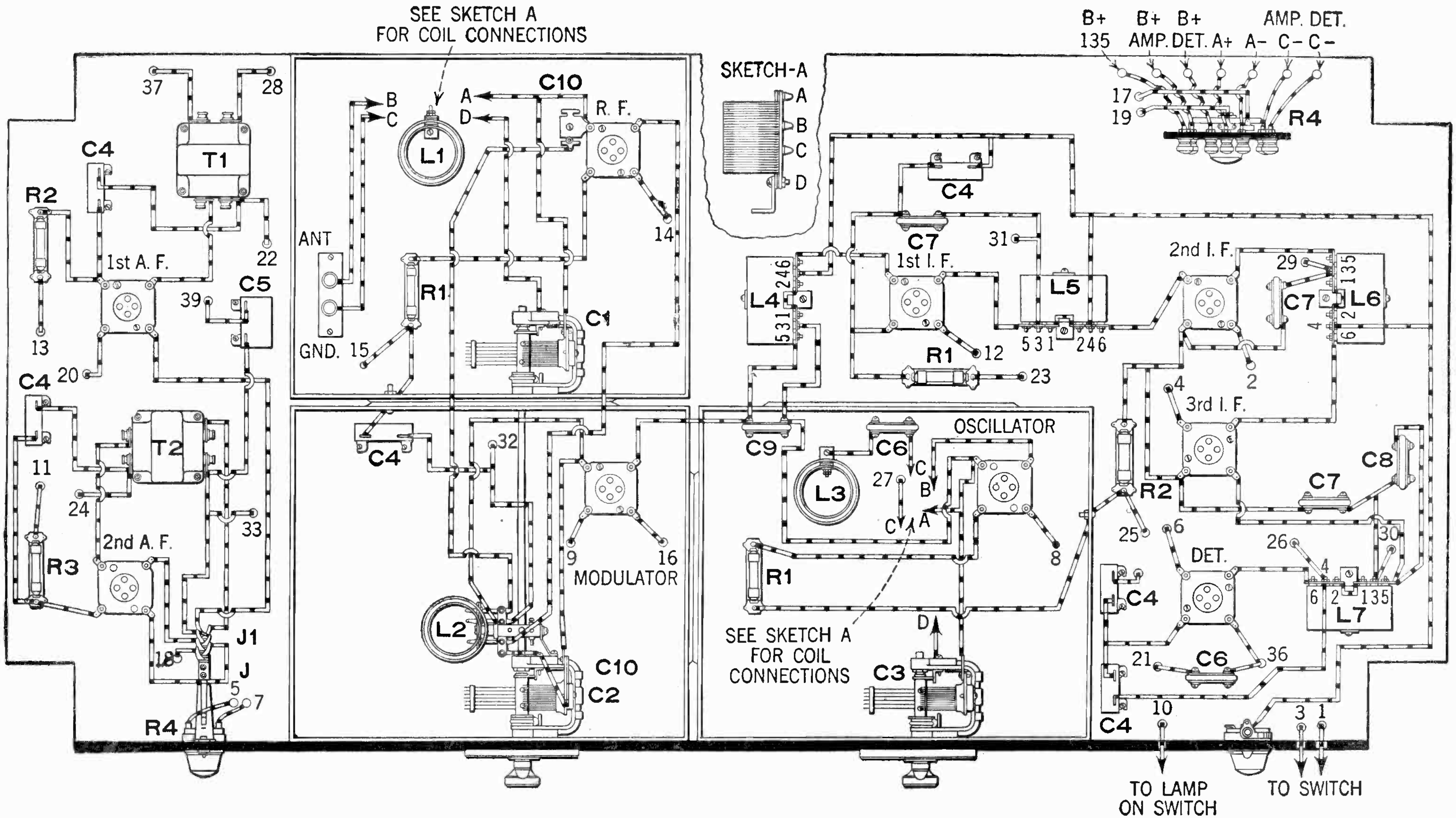
The stage of radio-frequency amplification is *auto-coupled*. By this is meant that the primary of the radio-frequency transformer is automatically varied in its inductive relation to the secondary merely by a rotation of the dial of the variable condenser. This stage of amplification is shielded, and is thereby isolated from the rest of the receiver.

The audio-amplifier is designed to produce volume and good quality and, when used with a good loud speaker, will reproduce all audio frequencies with fidelity.

The detector circuit is so wired that it may be employed with a "C" battery, if use is made of the bend in the "characteristic curve" of the tube. The grid return is connected to a binding post, which, in turn, may be connected to the "C" battery or the plus or minus of the "A", as the case may be.

A rheostat also is provided to control the detector filament; it is mounted on the binding-post panel inside of the set; because,

*RADIO NEWS *Blueprint Constructional Article No. 2.* (See page 109).



This shows the complete wiring of the LR4 above the baseboard; the wiring on the under side of the baseboard is shown in another illustration. It will be noted that many of the wires pass through holes to the under side; in each such case the hole is numbered alike in both views, so that there should be no difficulty in following out each wire to its destination. The suggestion is made that each connection on this sketch be marked with colored crayon when it has been made in the wiring of the receiver.

Sketch A in the upper centre of the drawing is for reference purposes only; it serves to indicate the proper posts for the free wires A, B, C and D in the R.F. circuit and wires A, B, C and D in the oscillator circuit. The other free wires (marked "to lamp on switch" and "to switch") can easily be traced to the switch and the lamp on the panel by referring to the other illustrations.

Your attention is also called to the fact that on all the Unichokes or intermediate-frequency transformers (L4, L5, L6, L7), binding posts 1 and 2 are connected together. All of the binding posts are numbered to assist in the wiring.

The small binding-post panel, mounted at the rear right of the baseboard, takes all the connections from the "A", "B" and "C" batteries. Each post is designated in the sketch.

Note that all the metal shields are connected together by small machine screws and grounded through the connection leading to the self-adjusting rheostat R2, the other lead of which passes down through the hole 25.

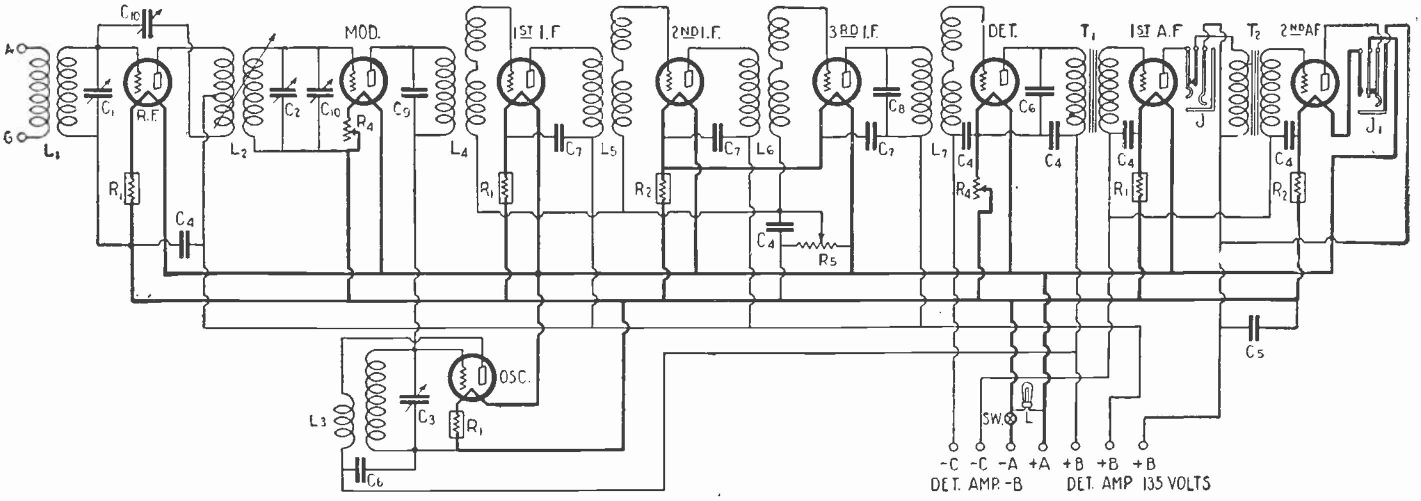
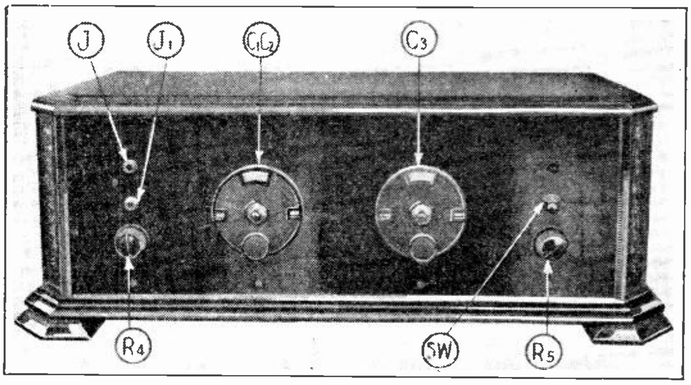


Fig 3. The complete circuit diagram of the LR4 nine-tube Ultradyne. Note that the last or power stage of audio-frequency amplification employs a filament-control jack; so that this stage is in operation only when the loud-speaker plug is inserted in the jack referred to.

once adjusted for the particular tube used, it need not be re-set.

In order to produce the results of which it is capable, this receiver should be built with the best parts obtainable. This has been said and repeated a great many times by designers of good sets, and will never be emphasized too strongly. The amount of energy received from distant stations is so small that it is of the utmost importance to avoid bad contacts and high-loss parts which absorb energy; otherwise the signals are so weak they are not heard at all.



A front view of the completed receiver: J and J1 are the two jacks in the audio-frequency stages; R4 is a rheostat which controls the current to the filament of the modulator tube; C1, C2 the radio-frequency-modulator tuning dial; C3 the oscillator dial; SW the filament switch; and R5 the potentiometer.

The construction of the LR4 receiver is comparatively simple because the shielded stages, which are the most delicate parts of the receiver, may be built with standard parts which are all ready for assembling and designed to fit without further adjustment. The radio-frequency coils and auto-couple coil are designed to be mounted directly on the condenser or on small brackets. The shields are all drilled for the mounting of the condensers and sockets, so that a screw driver is all that is necessary for the work of assembling these units.

The panel should be first traced and drilled with the aid of a square, center punch and hammer. All dimensions should be taken from the left and lower edges of the panel, as shown.

Assembly Work

After the panel is completely drilled, the switch, rheostat and potentiometer may be mounted on it. Turn them so that when you look at the front of the panel the center lug of the left rheostat points to the left and that of the potentiometer to the right. Next the small binding-post panel should be traced and drilled, as shown in Fig. 2, and the rheostats and binding posts mounted, as illustrated in the baseboard wiring diagram.

The partitions of the shields should also be drilled for the connections running from one shielded compartment into the other. The drilling of the baseboard for the wiring is done after the parts are mounted upon the board.

Before mounting the parts, it is necessary to place the bottom of the shields and in order to do this accurately, and properly line up the condensers mounted on the same shaft, one should proceed as follows:

First place the baseboard in the cabinet so that the clearance is even all around and mount the panel against it by means of four wood screws.

In order to prevent the board from splitting, first mark the spots for the screws through the panel holes with a sharp point. Then drill, but before doing so, make sure that the center of the hole is exactly ¼-inch below the top edge of the board. This is very important, because if it is not exact the shield may not fit properly. If the baseboard is properly fastened its upper face should be exactly 7¼ inches from the upper edge of the panel. After the panel has been fixed against the edge of the board, the left .00035-mf. condensers should be mounted against the shield and panel so that the screws pass through both of these, as shown. Next, the bottom of the shielded compartment should be placed under the bent edge of the front section of the shield; so that the holes come just under those punched in the bent lower edge of the shield mounted against the panel.

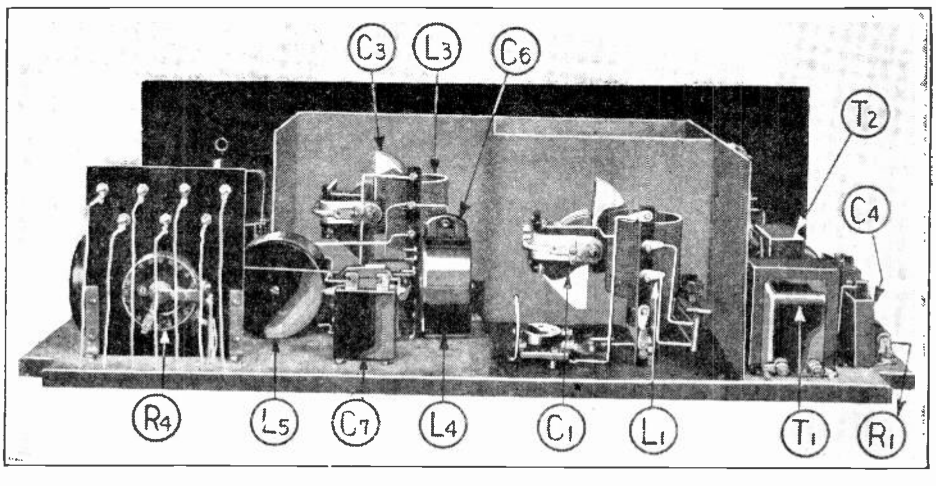
Take care in placing this bottom section to have the two holes punched for the socket mounting screws on the right and back of the condenser when you look from above. Two wood screws may then be inserted through the holes to fasten the bottom of the front compartment on the baseboard, and the socket may also be screwed down.

The next step is the mounting of the other variable condenser on the front section of the back shield and back partition of the front shield. These two sections are mounted back to back, as shown, and maintained by the mounting screws of the condenser. This ensemble should then be placed on the baseboard, and the double-length shaft pushed through both condensers after the individual shafts have been removed.

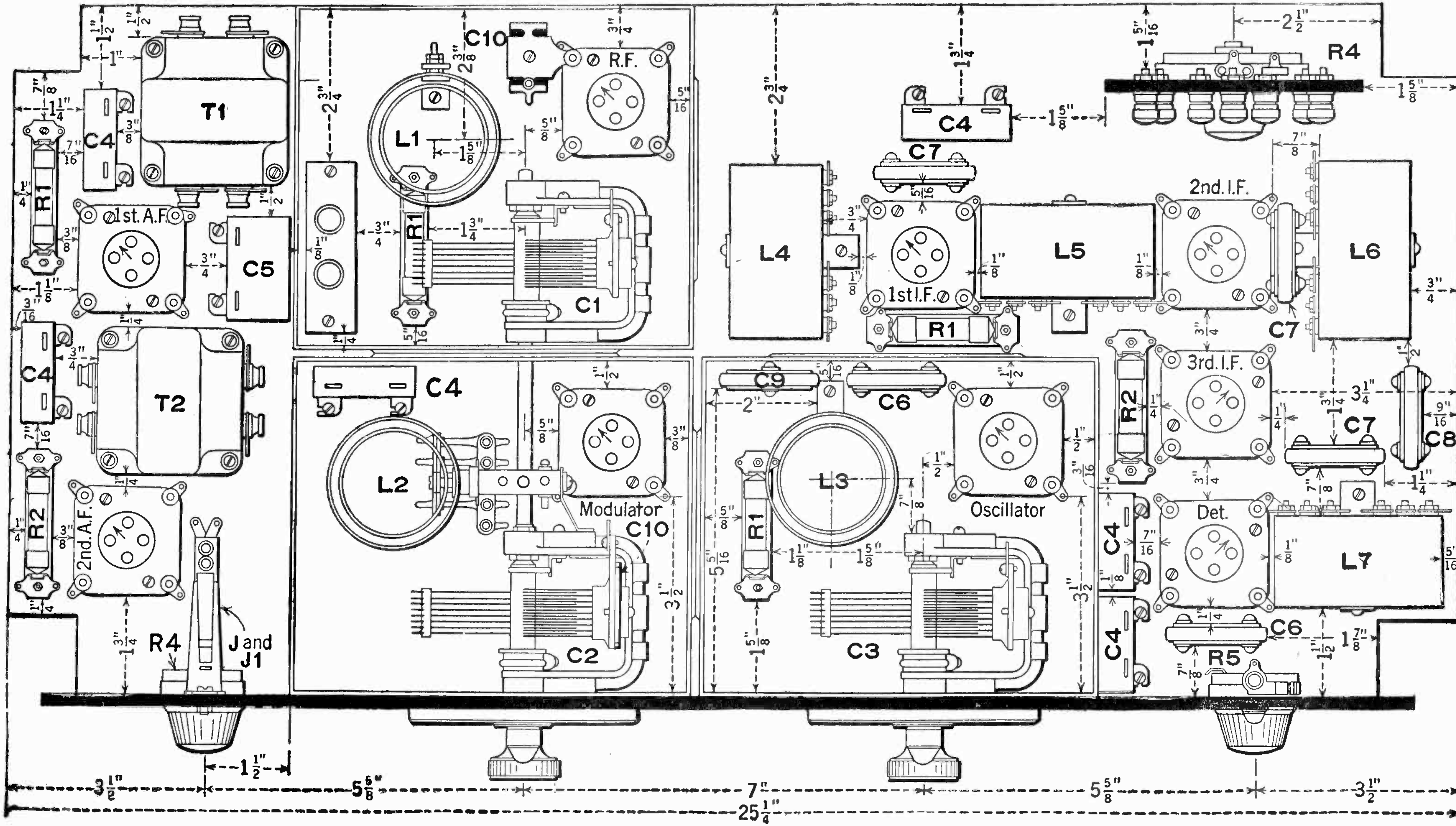
The long shaft provides the proper alignment for the condensers, which should both turn freely without binding at any point. The double partition supporting the back condenser may then be screwed down on the board. The holes on the lower edge should correspond exactly with those in the bottom of the front shield.

The bottom of the back shield is screwed down exactly like the front one. Turn it so that the mounting holes for the sockets are on the right of the condenser.

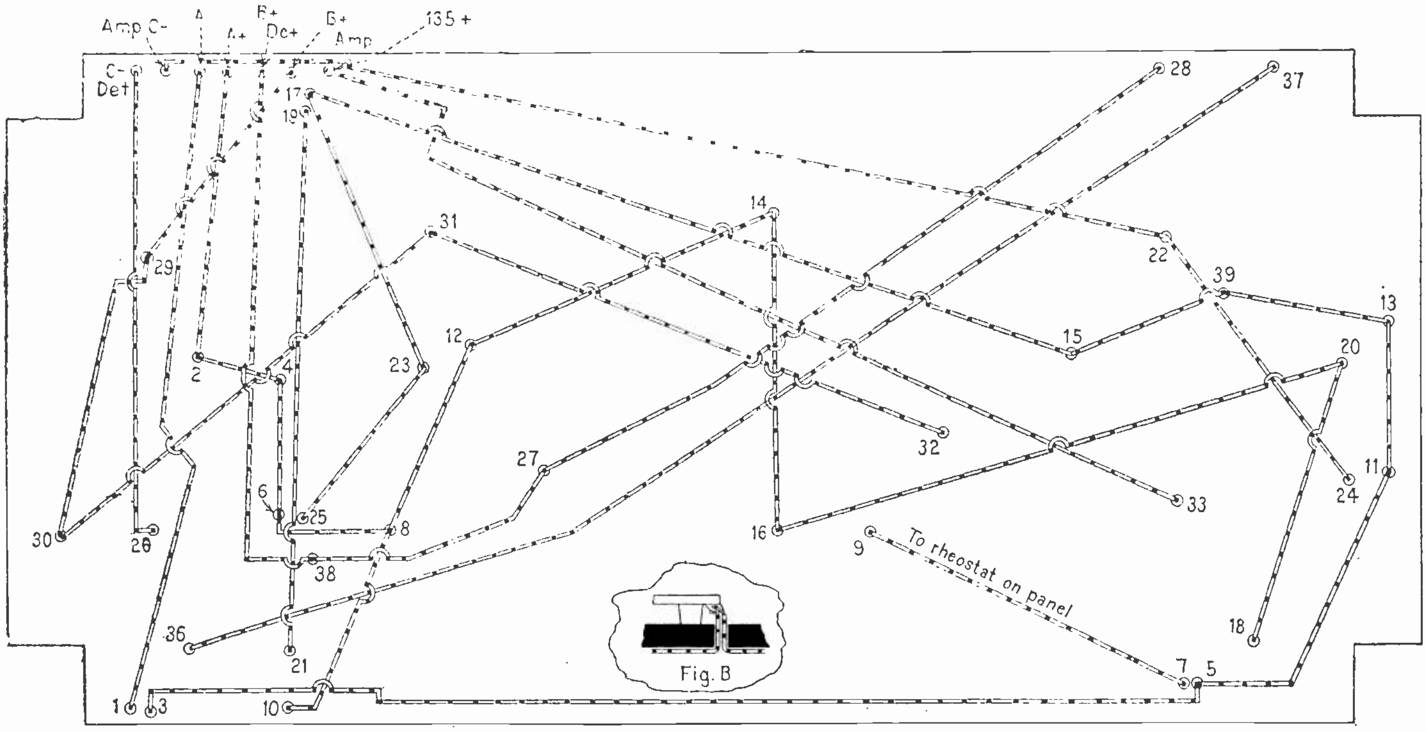
The other partitions of the shield are



The receiver as seen from the rear, with part of the shielding removed to give a clear view of the placement of the parts. Note the rheostat R4 mounted on the binding-post panel; this controls the filament current to the detector tube.



Complete constructional drawing of the LR4 Ultradyne receiver. All of the necessary dimensions are given for the placement of the various components. Jack J is mounted over J1, so that only one jack shows up in this drawing. However, both of them can be seen on the panel view of the set; and the correct dimensions are given in the constructional drawing of the panel (Fig. 1). The rheostat R4 is beneath both jacks. The holes, through which some of the wires are to pass, are not shown in this sketch; as they should be drilled through the baseboard after all the apparatus is mounted. At this time you may find it more satisfactory to change their positions slightly. There is no hard-and-fast rule in this case; just so long as the numbers in the wiring sketch are followed there should be no difficulties. Though a good many of the parts can be changed slightly in their position, if desired, it is advised that the coils within the metal shields be placed exactly as shown. At any rate, do not get any of them too close to one side of a shield. It should be noted that all of the tube sockets are not so mounted as to face in the same direction. Be sure to mount them as shown, with the arrows pointing in the directions indicated; as otherwise the connections to the sockets would be incorrect.



The "golf wiring" on the under side of baseboard. This is comparatively easy to follow; as all of the holes are similarly numbered in both diagrams of the sides of the baseboard. The lead to the rheostat on the panel passes through hole No. 7.

mounted later and held in the corners by means of the slides provided for this purpose.

The other variable condenser is mounted in the other shield and fastened against the panel and baseboard in the same manner. After the condensers are properly aligned, and the shield screwed down, the condensers should be removed, filament-ballast base, coils, binding post and by-pass condenser mounted upon the bottom of the shields, and the holes for the wiring drilled as shown, through both shield and baseboard. Then screw down all the sockets, bases, audio-frequency transformers, multichokes, by-pass condensers and the binding post panel. Mount also the auto-couple coil on the left forward condenser and remount the three variable condensers.

Wiring

The wiring operation, which might be called "golf wiring," because the underboard wires run directly from one hole to the next, is very easy if done as explained further. One may use wires of different colors for each circuit, although this is not essential. Pliable wire rather than bus bar is recommended for the underboard wiring.

If this type of wire is used it may be bent double where it passes through a hole in the board and a loop left long enough to reach the soldering lug. The loop is then cut, the two ends scraped clean and soldered to the lug. (See Fig. B). The wiring is best done in the following order:

Start at "A−" binding post and run the wire through hole 1 to switch, then back through 3 to 5, 11, 13, 39, 15, 17, 23 and 25, also from the left rheostat through 7 to 9 and from the back rheostat through 19 to 21.

Starting at "A+" binding post run the wire through 2, 4, 6, 8, 12, 14, 16, 20 and 18, also from 8 to 10.

From "B+Det" run the wire directly to 38, 27 and 28.

From "B+Amp" to 29, 30, 31 and 32.

From "135v" to 33.

From "C−" for the audio amplifier to 22 and 24 and from "C−" for the detector to 26.

After all the connections are made and soldered, the jacks may be mounted and the wiring above the baseboard done with either the same wire or bus bar. Care should be taken, when wiring the parts inside the shields, not to run the grid and plate leads too close to the shield. Insulate all the wires or bus bars passing through the partitions with spaghetti tubing, even if insulated wire is used. During the wiring operation check each lead often. Be sure to make good soldered joints as this operation is very important. Use a properly-tinned soldering iron and not too much flux. Also be sure to have the wires or lugs clean before you try to solder them.

The wiring diagrams given here show all

SYMBOL	Quantity	NAME OF PART	VALUE OF PART	REMARKS	MANUFACTURER ★	
C1,C2,C3	3	Variable cond.	.00035 mf.	Straight-line-tuning type	1	
C10	2	" "	3 to 50mmf.	Equalizing	1	
C4	6	Fixed "	.5 mf.	By-pass	2	12, 13, 14
C5	1	" "	1.0 mf.	" "	2	12, 13, 14
C7,C8	3	" "	.005 mf.	" "	2	12, 13, 14, 15
C6	2	" "	.001 mf.	By-pass and blocking	2	12, 13, 14, 15
C9	1	" "	.00025 mf.	By-pass	2	12, 13, 14, 15
L1,L3	2	R. F. Trans.		For .00035 mf. variable condenser	1	16, 17, 18
L2	1	R. F. Trans.		Auto. Var. Coupling	1	
T1,T2	2	A. F. Trans.	3 to 1	Large size	3	19, 20, 21, 22
	9	Sockets		Spring supporting type	4	8, 23, 24
	2	Dials		Vernier	5	20, 24, 25, 42
R4	2	Rheostats	20-ohms		6	12,14,23,26,30,41
R5	1	Potentiometer	400-ohms		6	12,14,23,26,30,41
R1	4	Auto. Fil. Cont.	6v.¼ amp.	For standard type tube	7	16, 27
R2	2	" " "	6v.½ amp.	For Semi-power tube	7	16, 27
	9	Binding posts			8	24, 28, 29, 31
L4,5,6&7	4	Chokes		Special (used as trans.)	9	
J	1	Jack		Double Circuit	6	23, 30, 32
J1	1	"		Single " Fil. Control	6	23, 30, 32
SW	1	Switch		With pilot light	6	30, 31, 33
	1	Panel		8X24X3/16 inches	10	34, 35, 36
	1	Cabinet		8X25½X12 1/8 " (inside diameter)	11	37, 38, 39
	1	Baseboard		½X25½X12 inches (wood)		
	3	Shields	6X6X7	Aluminum	1	40

NUMBERS IN LAST COLUMN REFER TO CODE NUMBERS BELOW.

1 Hammarlund Mfg. Co.	17 Feri Radio Mfg. Co.	33 Pilot Elec. Mfg. Corp.
2 Sangamo Elec. Co.	18 Heintz & Kohl Moos, Inc.	34 Diamond State Fibre Co. (Celeron
3 Thordarson Elec. Mfg. Co.	19 American Trans. Co.	35 Ins. Co. of Amer. (Insuline
4 Benjamin Elec. Mfg. Co.	20 Samson Elec. Co.	36 Amer. Hd. Rubber Co. (Radion)
5 Martin-Copeland Co. (Marco)	21 All American Radio Corp.	37 Electrotype Blocking Co.
6 Yaxley Mfg. Co.	22 Jefferson Elec. Mfg. Co.	38 Baker Yacht Basin, Inc.
7 Radiell Co. (Amperite)	23 Pacent Elec. Co., Inc.	39 Southern Toy Co.
8 H. H. Eby Mfg. Co.	24 Amsco Prods, Inc.	40 Aluminum Co. of America
9 Madison Radio Corp.	25 Kurz-Kasch Co.	41 Central Radio Labs (Centralab)
10 Formica Insulation Co.	26 H. H. Frost, Inc.	42 National Co., Inc.
11 Fritts Cabinet Co.	27 Langbein Kaufmann Radio Co.	43
12 Electrad, Inc.	28 X-L Radio Labs.	44
13 Aerovox Wireless Corp.	29 Waterbury Button Co.	45
14 Polymet Mfg. Co.	30 Carter Radio Co.	46
15 Micamold Radio Corp.	31 Bruno Radio Corp.	47
16 Daven Radio Corp.	32 Millimeter Machine Works	48

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

the connections, which should be carefully checked after the wiring is completed.

To make sure that everything is connected correctly, insert all the tubes in the sockets, turn the rheostats up full and connect the "A" battery *only* to the "A+" and "A−" posts. If the filament wiring is correct, all the tubes will light.

To check the "B" battery circuits, leave the "A−" connected as before; but connect the plus terminal of the 6-volt storage battery to the "B+Det" binding post. If this circuit is O.K., none of the tubes should light.

Repeat the test by connecting the plus "A+" lead to the "B+Amp" and the "B+ 135v." If during these tests one or more tubes should light, it is because there is a wrong connection somewhere.

If dry-cell "B" batteries are used, the large size or heavy-duty types should be selected because they last much longer. Storage "B" batteries may be re-charged and can deliver more current; or a good socket-power unit may be used.

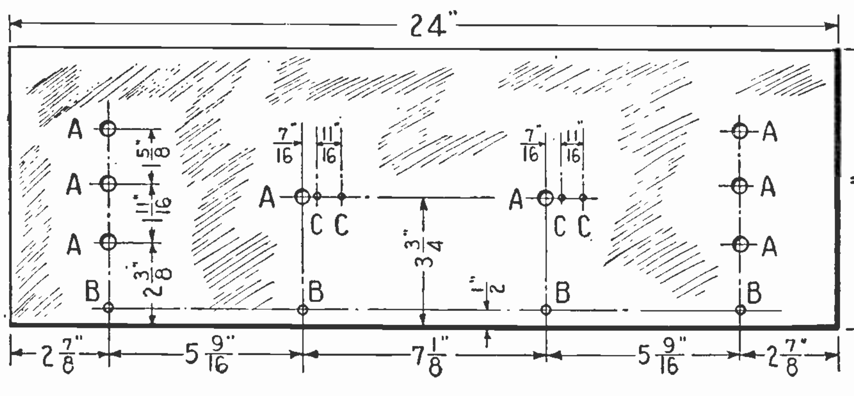


FIG. 1

Details for drilling the panel of the receiver. Drill "A" holes $\frac{7}{16}$"; drill "B" holes $\frac{3}{16}$" and countersink; drill "C" holes $\frac{5}{32}$" and countersink. There are very few holes, as most of the apparatus is mounted on the baseboard. Below, details of the small binding-post panel, which also takes the detector rheostat.

Accessories

In the binding-post arrangement of the LR4 a binding post is provided for the detector voltage so that 45 volts or more may be used on the plate of the detector tube. With 201A bulbs 90 volts should be used in the radio-frequency tubes and 135 or more on the audio tubes. The "C" battery voltage depends upon the audio "B" voltage and is given by the tube manufacturer in the sheet of instructions furnished with each tube. The "C" battery voltage on the detector should be adjusted experimentally, because it varies with the plate voltage and the type of tube used. The rheostat provided for the control of the detector filament permits the use of various types of tubes, and after being set may be left fixed.

An aerial is used with the LR4 receiver because of the necessity of matching the input and radio-frequency stage accurately. Another reason for using an aerial is that it picks up more energy than a loop. If installed indoors it may be fastened around the picture moulding in the room and thus be invisible, while a loop is always more or less bulky and sometimes unsightly.

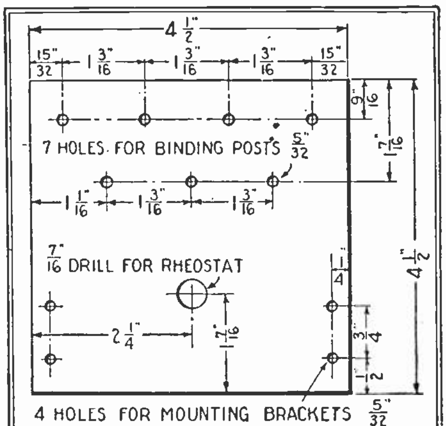


FIG. 2

It is possible to use a loop with the LR4 receiver, but if this is done a midget condenser connected in parallel with the second variable condenser is required for balancing the inductance between the loop and autocouple coil.

The ground connection may be taken on the radiator or water pipe, previously scraped clean. In some locations, where the set is installed high above the ground, it is possible to use the ground alone as an antenna. In this case the ground lead is connected to the antenna binding post and nothing is connected to the ground post.

Although the receiver will work satisfactorily with any good tubes, we recommend the use of the 201A type. It may be employed throughout the set; but it is of advantage to use a 112 type in the last stage of the audio amplifier. If 135 volts or more are used on the plate of the audio tubes, it would even be preferable to use two of these tubes in the two stages of audio-frequency amplification.

Tuning

Once the batteries, antenna and ground are connected, the set should be adjusted as follows: turn the rheostats on almost full; then turn the dials until some station is heard.

Once a signal is tuned in, adjust the potentiometer for maximum signal strength.

If a whistle is heard, it may be that the balancing condenser in the circuit of the first tube is not adjusted correctly. If this is the case, turn the adjusting screw slowly until the whistle stops. To check this adjustment, tune in a short-wave and then a long-wave station. The first tube should not oscillate in either case if the balancing condenser is properly adjusted.

If everything is properly adjusted the set is now ready to tune on any broadcast frequency. It should be noted that the rheostat on the panel should be re-adjusted when weak signals are being received.

(One of the earliest, and at the same time most popular, superheterodynes was the Lacault Ultradyne. We believe we shall not be contradicted if we say that more Ultradynes were built than of any other type of superheterodyne—certainly in all foreign countries the Ultradyne enjoyed a greater popularity than any other superheterodyne. This new shielded LR4 presents some new features and many refinements.—EDITOR.)

List of Parts for "A" and "B" Socket-Power Unit—see opposite page

SYMBOL	Quantity	NAME OF PART	VALUE OF PART	REMARKS	MANUFACTURER ★	
Ch	1	"A" Bat. Charger	2½ Amp.	Bulb or electrolytic type	1	12,13
A	1	Abox			2	
T	1	Power Unit		Power trans. and filter chokes	3	
C	1	Condenser bank	4-4 & 6mf.	14-mf. total capacity	4	14,15,16
C1, C2	2	Fixed Condensers	1-mf.	By-pass	4	14,15,16
R	1	Rectifier tube		Filamentless type	5	
R1,R2	2	Var. Resistors		Voltage regulators	6	7,17,18
SW	1	Switch		10 amp. 115 volt rating	7	
S	1	Socket		For rectifier tube	8	9,19
	9	Binding posts			9	19,20
	1	Panel		8½ X 8½ X 3/16"	10	21,22
	1	Sub-base		9½ X 16 X 1/2" (wood)		
	One Roll	Hookup Wire			11	23

NUMBERS IN LAST COLUMN REFER TO CODE NUMBERS BELOW.

1 Fansteel Products Co., Inc.
2 Abox Company
3 Thordarson Elec. Mfg. Co.
4 Sangamo Electric Co.
5 Raytheon Mfg. Co.
6 Amer. Mech. Labs. (Clarostat)
7 Allen-Bradley Co.
8 Alden Mfg. Co.
9 H. H. Eby Mfg. Co.
10 Micarta Fabricators
11 Belden Mfg. Co.
12 General Electric Co.
13 Westinghouse Elec. & Mfg. Co.
14 Tobe Deutschmann
15 Wireless Specialty App. Co.
16 Dubilier Cond. & Radio Co.
17 Electrad, Inc.
18 Central Radio Labs.
19 General Radio Co.
20 X-L Radio Laboratories
21 Amer. Hard Rubber Co. (Radion)
22 Insulation Co. of Amer. (Insuline)
23 Acme Wire Co.

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

A Complete "A and B" Socket-Power Unit

Adaptable to All Receivers But Designed Expressly for the LR4 Ultradyne

By R. E. LACAULT

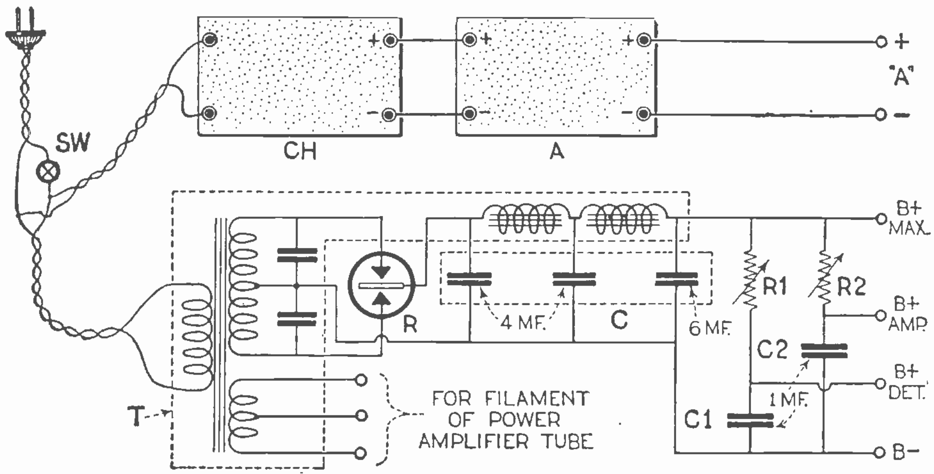
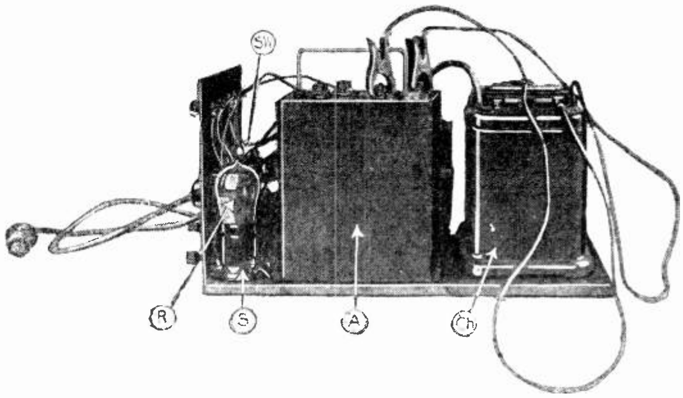


FIG. 1



Above: The circuit diagram of the "A" and "B" socket-power unit. Note the position of the control switch SW. The extra winding on the power transformer with three terminals will supply current and "C" voltage for a power tube if connected as shown in Fig. 2.

Right: Side view of the "A" and "B" power unit. The parts are as designated in the large view, below.

THE last year has witnessed several improvements in radio receivers. Shielding, power amplification and socket-power supply have been the most outstanding, and they show a trend to bring radio to the point where receivers will be as simple, practical and efficient as any of the many electrical appliances now used in the home.

The problem of using A.C. current is hardest to solve for the home builder; because it is difficult to rectify and filter enough current to supply the filaments of the tubes when connected in *parallel*. In a factory-built receiver the circuit may be altered and adapted to a series-connection system, or small low-consumption tubes may be used; the set may thus be "electrified," but these methods cannot always be adapted to home-made sets. We are pleased to present here an "A and B" socket-power unit, which is built entirely from standard parts and which may be used with any set to supply the filament and plate current from the 60-cycle A.C. lighting system. This unit was first developed to supply the new LR4 Ultradyne receiver, but may be used with any receiver.

The "A" unit delivers 6 volts and up to 3 amperes, depending upon the type of charger used. This is sufficient to supply a maximum of twelve ¼-ampere tubes or their equivalent. By the use of a series connection, as explained herein, even more tubes may be operated from the "A" unit. The "B" supply unit delivers up to 250 volts depending upon the load, and will supply superheterodynes or other multi-tube sets without generating a hum. A filament winding is provided to light the filament of the power tube, this arrangement increasing the number of tubes which may be used in the receiver.

Constructional Detail

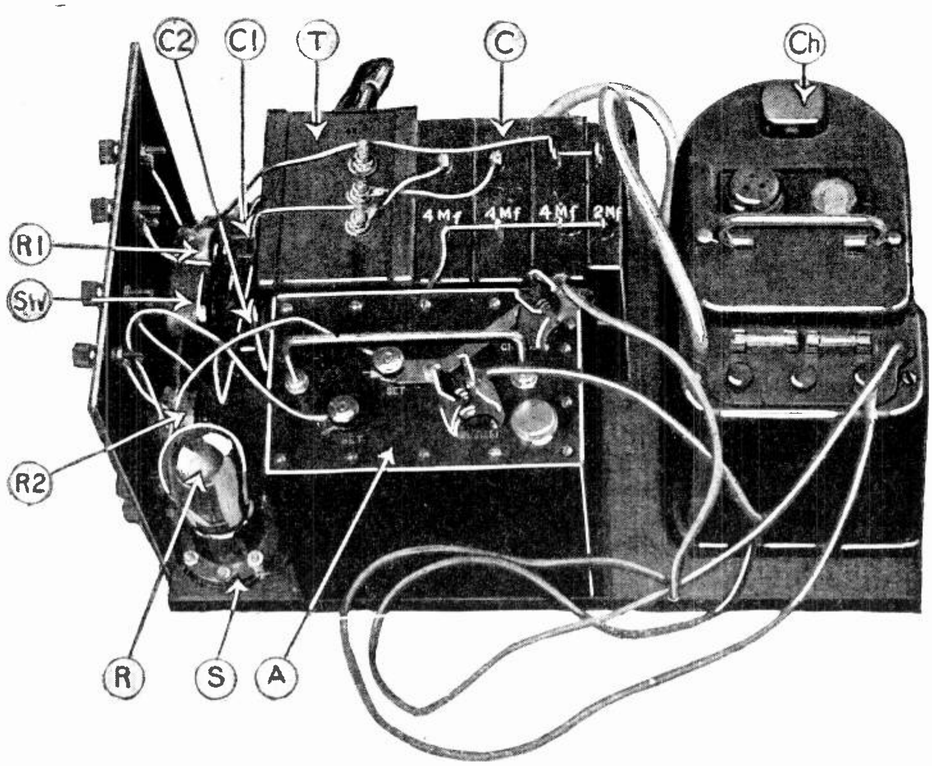
The power unit is built entirely of standard parts and is composed of a "B" socket unit, a standard "A" battery charger and a special filter (the "Abox") through which the charger supplies the tube filaments directly.

The list of parts required for the construction is given in the specification sheet (see page 36). The size of charger to use is determined only by the number of tubes to be supplied by the "A" power unit. For six tubes or less, a 2½-ampere charger of the chemical type is satisfactory, but for larger sets a bulb charger of five-ampere capacity is required.

The connections are clearly shown in the diagram, no lengthy explanation of the hook-up being necessary. The "B" supply unit comprises a special metal casing, containing the power transformer, two filter chokes and the 0.1-mf. buffer condensers. The usual bank of condensers is used, together with the necessary variable resistors to control the "B" voltage supply to the set.

If the filament winding provided for the power tube is employed, the leads from the set to the power unit should be twisted together, as this removes the tendency to hum and leaves the output of the receiver clear and free of noises.

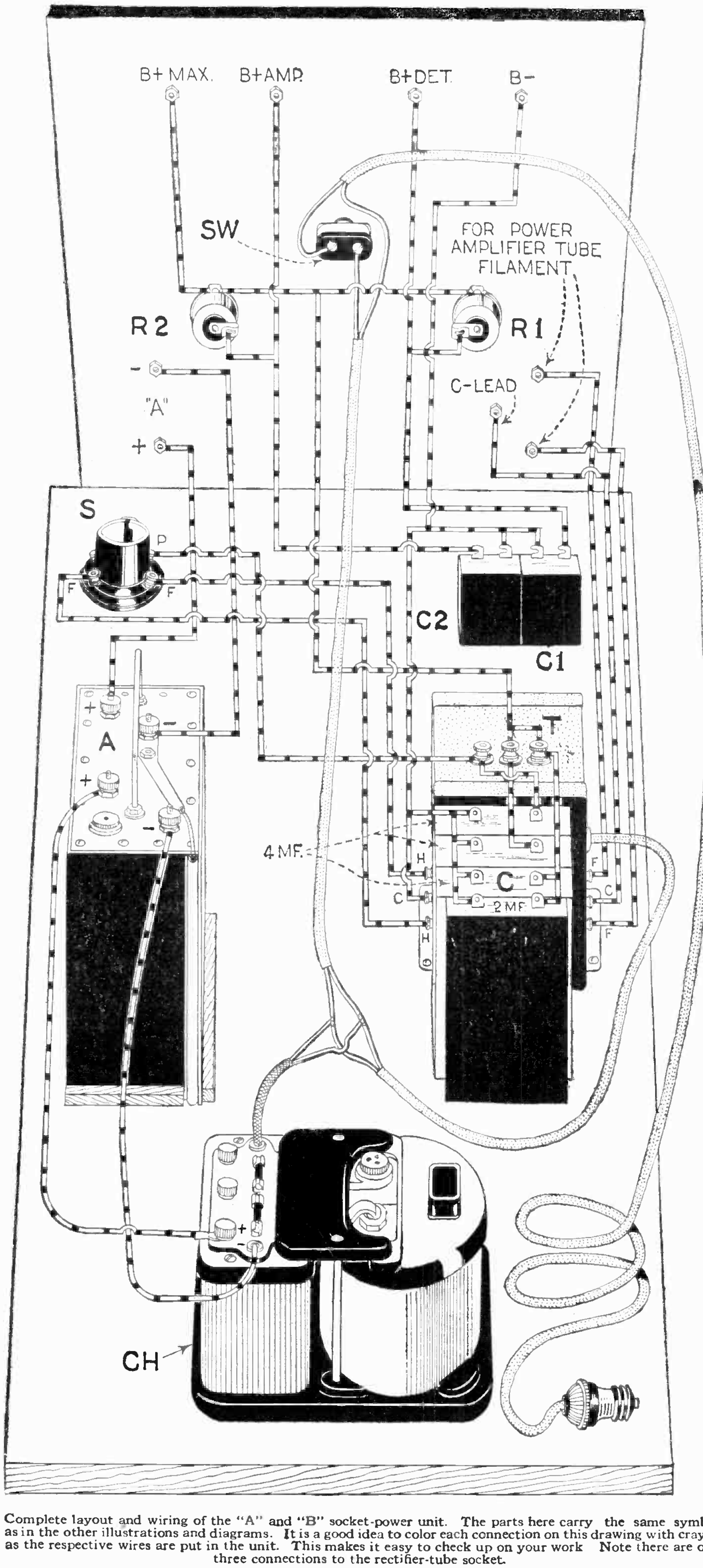
Fig. 2 shows the connection of the power tube, which may be installed in any set. It is necessary merely to change the connections to the filament, grid and plates so



A top view of the alternating-current "A" and "B" socket-power unit. Ch is the charger which is a filter unit. T is the power-compact of the "B" power unit. C is a condenser bank totaling 14 mf. in capacity used in conjunction with T. A is the Abox. R is the filamentless rectifier tube and S its socket. R1 and R2 are the "B" voltage regulators, "by-passed" by condensers C1 and C2. SW is the main control switch, which turns on and off the whole unit.

(Photo courtesy of Radio Electric Laboratories.)

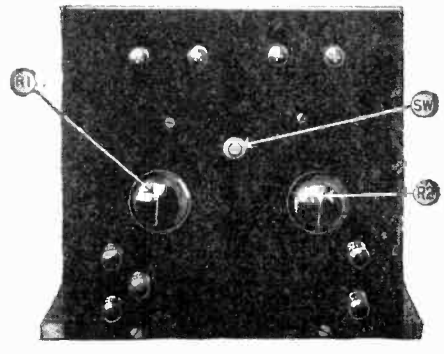
*RADIO NEWS *Blueprint Constructional Article No. 14.* (*See Page* 109).



Complete layout and wiring of the "A" and "B" socket-power unit. The parts here carry the same symbols as in the other illustrations and diagrams. It is a good idea to color each connection on this drawing with crayon, as the respective wires are put in the unit. This makes it easy to check up on your work. Note there are only three connections to the rectifier-tube socket.

that the proper voltages may be applied to this tube.

If a small charger is available and it is desired to use this with a set containing



A front-panel view of the completed unit. R1 and R2 are the "B" voltage regulators (each having a maximum resistance of about 50,000 ohms) and SW is the control switch. The four "B" posts are at the top of the panel.

seven or eight tubes, or even more, some of the filaments may be connected in series, as shown in Fig. 3, which is a diagram of the mid-frequency amplifier of the Ultradyne. In this case it is necessary to use a slightly different arrangement to control the grid bias, since the filaments are connected in series.

Use of Small Tubes

The arrangement shown in Fig. 3 is entirely satisfactory for any standard super employing potentiometer control to stabilize the amplifier, and may be used if it is desired to reduce the filament consumption. In this case, small tubes consuming only ¼-ampere at 1.1 volts, such as the WX-12, are used. When they are connected in series, five of them take no more current than one 5-volt, ¼-ampere tube.

The use of such small tubes increases the selectivity, due to their small grid-plate capacity, and is recommended in the circuit if the set is to be "electrified."

The diagram shows also the hook-up of the potentiometers and resistors required to control the intermediate-frequency amplifier, which is quite stable and functions with negative grid bias on the tubes. This arrangement increases the efficiency of the amplifier.

The whole unit is built on a board, with a control panel supporting the various binding posts, voltage regulators and switch.

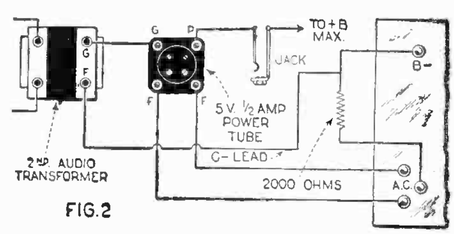


FIG. 2

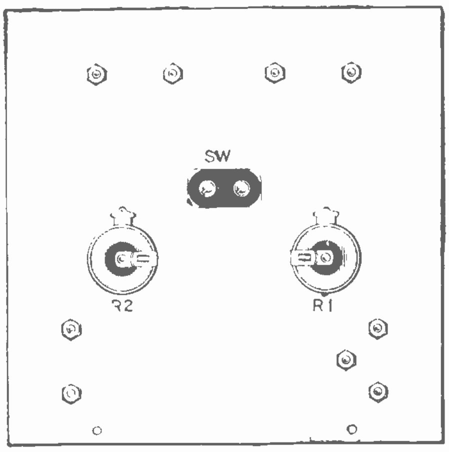
This shows how to connect the filament of the power tube to the power supply unit. "C" voltage for the grid is supplied by the drop of potential across the 2,000-ohm resistance.

The cord supplied with the power transformer of the "B" unit may be cut and spliced with that of the charger, thus permitting a single switch to control both instruments. This is shown in the diagram. The use of a filament switch on the receiver itself is unnecessary, since the "A and B" power may be turned on and off by means of the switch on the power unit.

Assembly of Unit

It will be well to offer a few words of explanation relative to the assembly of the complete "A and B" socket-power unit. All of the weighty apparatus is mounted on the wooden sub-base, as can be seen from the illustrations. The power compact T, which includes the power transformer, the two filter chokes and the buffer condensers, is mounted on the left side and close to the panel. Directly behind the power compact are mounted the four fixed condensers which compose the condenser block. Three of these condensers have a capacity of 4 mf. each, while the fourth has a capacity of 2 mf. This last one is furthest away from the panel and is connected in parallel with the third 4-mf. condenser to make a total capacity of 6 mf. The battery charger CH, which in this case is one of the electrolytic type, is mounted upon the extreme rear of the sub-base.

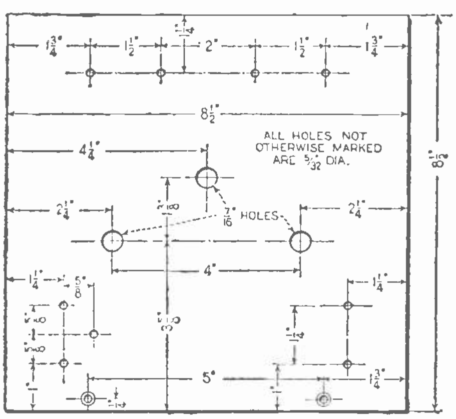
The cable carrying the plug, which would ordinarily connect to the light socket, is cut and spliced with the cable leading from the power compact. The two leads with battery clips on their ends are attached directly to the Abox (A), which is mounted to the



Layout of panel for the "A" and "B" socket-power unit, as seen from the rear.

right of the power compact. The output posts of the Abox connect to the two binding posts on the panel which are marked "A+" and "A−." The filamentless rectifier tube R and its socket S are mounted between the Abox and the panel. This tube is connected in the "B" power unit only and has nothing to do with the "A" supply.

Between the panel and the power compact



Drilling layout of the panel for the "A" and "B" socket-power unit.

we find two small fixed condensers C1 and C2, each of 1.0-mf. capacity, which by-pass the two voltage controls R1 and R2 mounted on the panel. The only other instrument on the panel is the main switch SW, which turns on and off both the "A" and the "B" supply. Four "B" binding posts are mounted along the top, two "A" posts on the lower right, and the three for the power amplifier tube on the lower left part of the panel.

(The list of parts needed will be found on page 36.)

Right: Circuit diagram showing the use of a series-filament connection for five WX-12 tubes, to equal 6 volts, and the method of biasing the grid of each one. This method can be applied to almost any superheterodyne receiver.

Below: Constructional layout of apparatus mounted on the wooden sub-base. A is held in place by wooden strips. The condenser bank C is bound to T with a brass bracket.

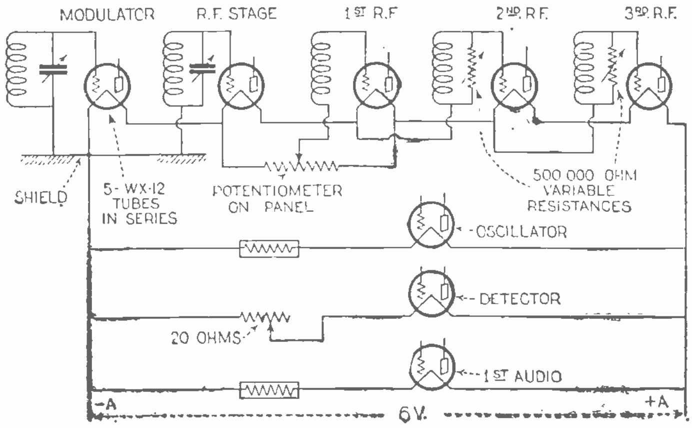
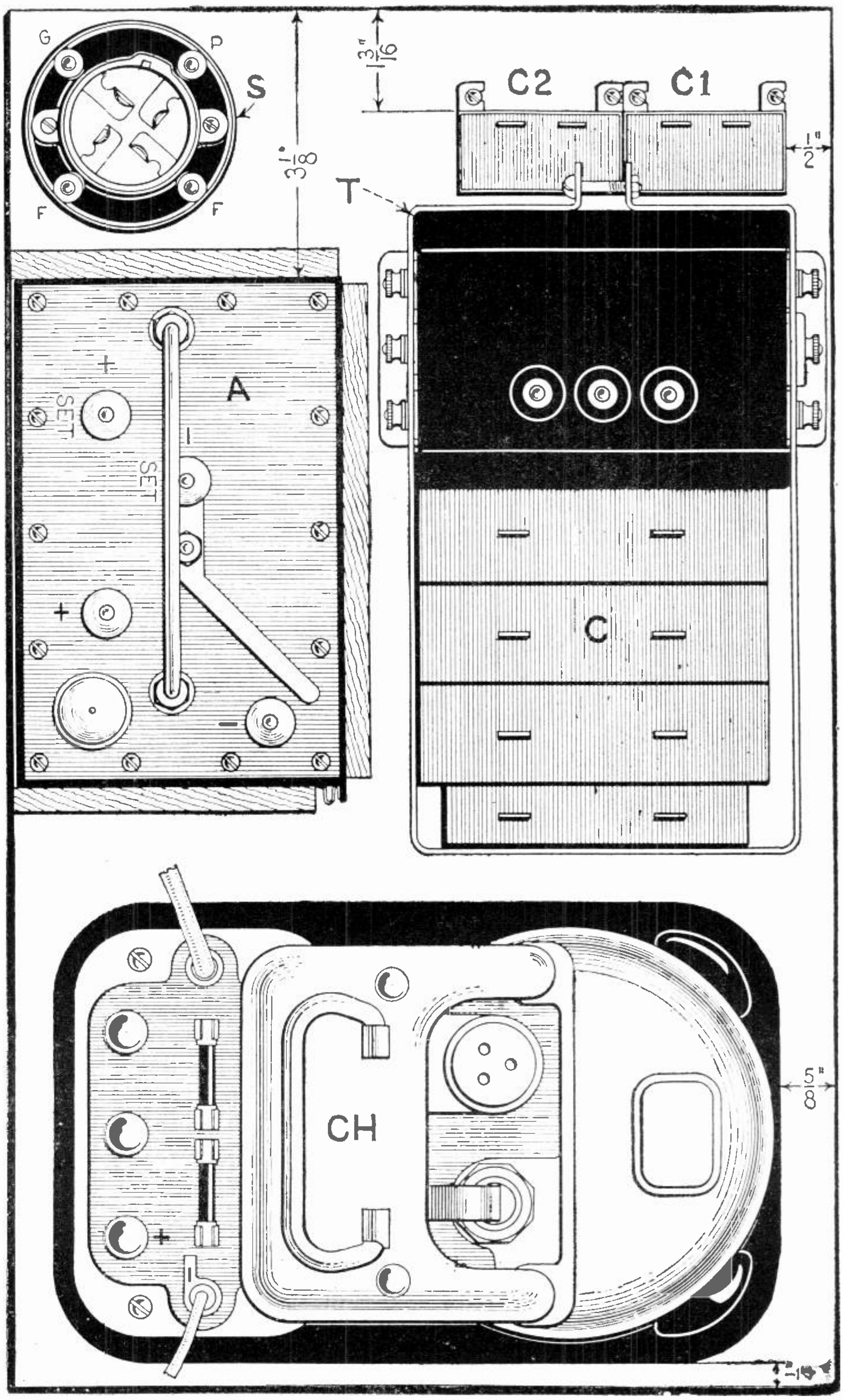
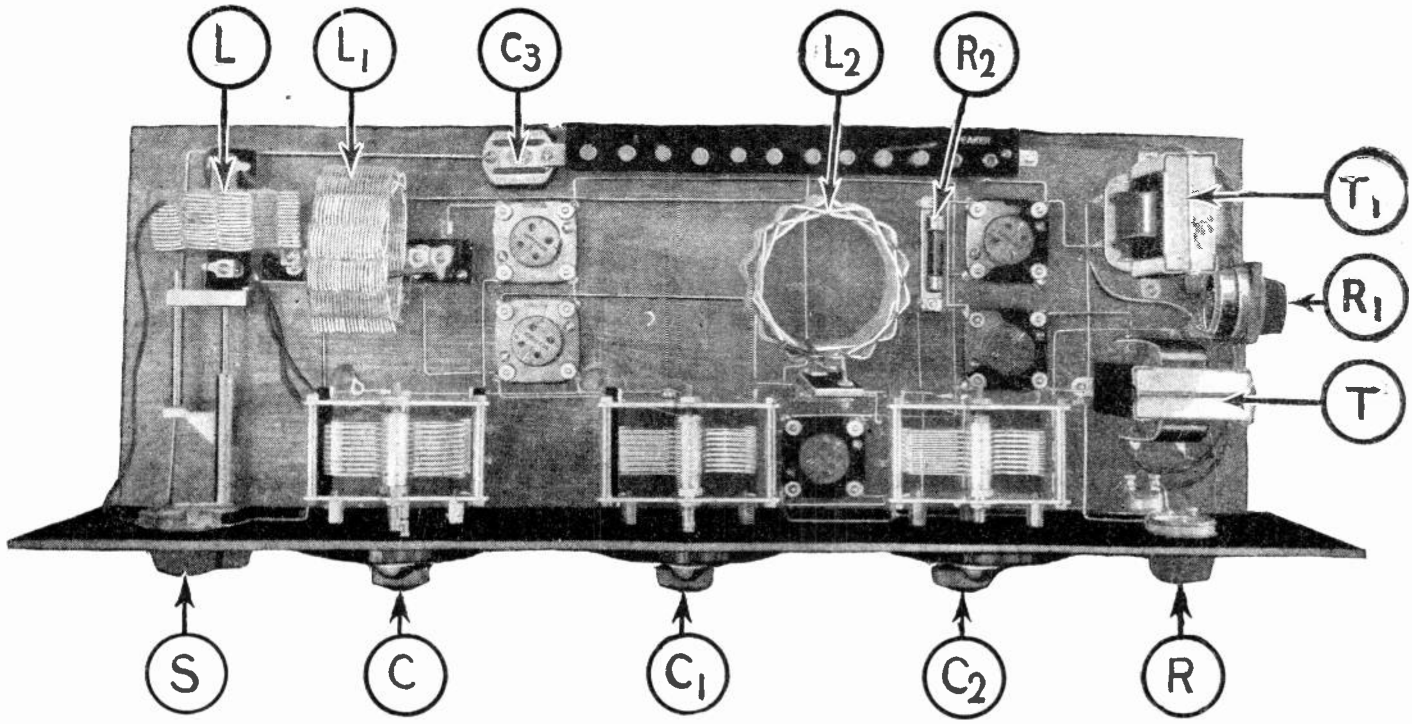


FIG. 3





The top view of the Powers-Casem 5-tube receiver. L, L1, and L2 are the antenna coil, and the radio-frequency transformers respectively; C, C1, and C2 are three tuning condensers; R is a 30-ohm rheostat; R1, a 200,000-ohm variable resistor; R2, self-adjusting rheostat; T, and T1, A.F. transformers; and C3, a .0001-mf. fixed condenser. The balancing control L (left) slides back and forth to adjust the coupling of L with L1.

The Powers-Casem Receiver*

A Simple Five-Tube Set Employing a New System of Variable Neutralization

By DAVID G. CASEM and ALVIN J. POWERS

TO be adopted in more than a thousand receivers, made in the homes of as many radio fans in less than one month, is a record for any circuit. It would have been so even in the days when uncritical credulity was the outstanding characteristic of said fans. Today a designer must have a real circuit, and it must include some meritorious idea, to appeal to the average "bug;" or it will be just another of "those things."

When the Powers-Casem receiver (which is designed to appeal only to those who make their own) was made public, it had the advantage of being previously heard by more than 3,000 fans, who were so struck by its sensitivity, selectivity, volume and quality, that they were impatient to get it going.

Its designers began the set about two years ago, first drawing up a working program with a view to seeing that it should be cheaper, as well as better in quality and in all-around general performance, than any other five-tube receiver we had seen or heard. That meant we had to throw out apparatus for which many claims of "efficiency" had been made. We even took the grid condenser and leak out of the circuit, and made the set so simple that any novice could put it together.

The efficiency of this receiver is due to two novel arrangements. One is the method used to balance the radio-frequency amplifier tubes, and the other is the detector circuit used.

Balancing is accomplished through the use of the magnetic fields of the transformers. Ordinarily the stray magnetic fields are the chief source of trouble in a radio receiver. The coils must be placed in exactly the right relationship, so there is no transfer of energy from one to the other, or the set cannot be neutralized.

However, in the set under discussion, the magnetic fields are used to balance out the capacity feed-back due to the internal elements of the radio-frequency amplifiers. In order to eliminate an undesirable current it is necessary to oppose it with another of equal strength but of opposite phase, which can be produced by placing the radio-frequency transformers in the right relationship to each other. An arrangement that can be readjusted at will is also necessary, since the current to be overcome varies with the frequency of the amplified signal.

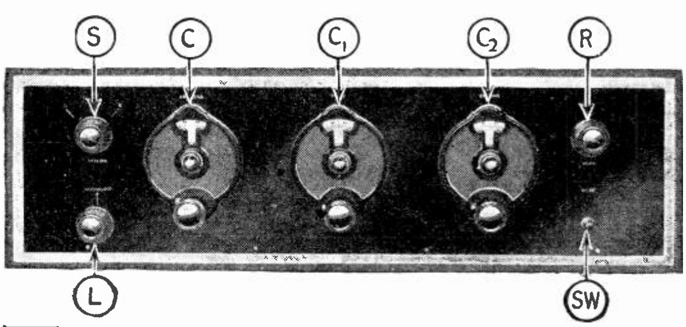
The antenna inductance and the two R.F. transformers L, L1 and L2 (See illustration) are placed at right angles to each other; the first is attached to a device which makes it possible to vary its relationship to the adjacent transformer at will.

While they are in a right-angle position, one coil can be moved to any position across the end of the other. When the first coil is at the center position no transfer of energy will take place from one to the other. But just as soon as the first passes the center of the other, in either direction, the coils are in mutual magnetic relationship to each other. Equal distances on both sides of the center line will produce currents of equal magnitude, but the phase of one will be directly opposite to that of the other. This holds true with the current induced in either coil.

Suppose now, that the first two coils of a two-stage tuned-radio-frequency receiver are arranged as just described. The feed-back current, due to the capacity of the internal elements of the R.F. tubes, will be of a certain strength, depending upon the type of tube used, the frequency of the signal and the characteristic lay-out of the set. If the first coil is moved in one direction, the induced current in both coils will add to the strength of the feed-back current; but if it is moved in the other direction a current of opposite phase will be produced and the undesirable current will be eliminated. The coil should be moved to the point where the tubes are neutralized, and left in this position until a different station is tuned in.

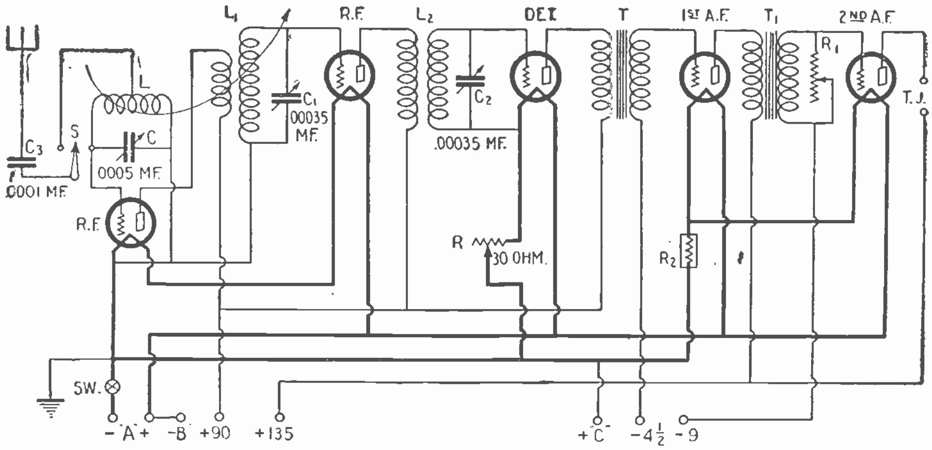
There is a limit to the amount of current that can be produced with the arrangement just described. Some tubes have such a high internal capacity that they cannot be neutralized in this manner. One stage of radio frequency, using the 201A-type tube, can be neutralized very easily; but the current becomes so great when two stages are used that it is unmanageable. Two stages can be employed, however, when the 199-type tubes are used.

Many radio fans will be interested in the theoretical explanation of the phenomena just described. The same principles of magnetic induction are used here that we find in



The panel view of the 5-tube Powers-Casem receiver. The three tuning condensers, C, C1, and C2, can be so adjusted that they will have approximately the same dial readings. The control, L, is for balancing the set by sliding back and forth the antenna coil.

*RADIO NEWS *Blueprint Constructional Article No.* 3. (See page 109).



Schematic diagram of the Powers-Casem receiver. It will be noticed that there are comparatively few connecting wires (see next page) thus making the construction of the set easy.

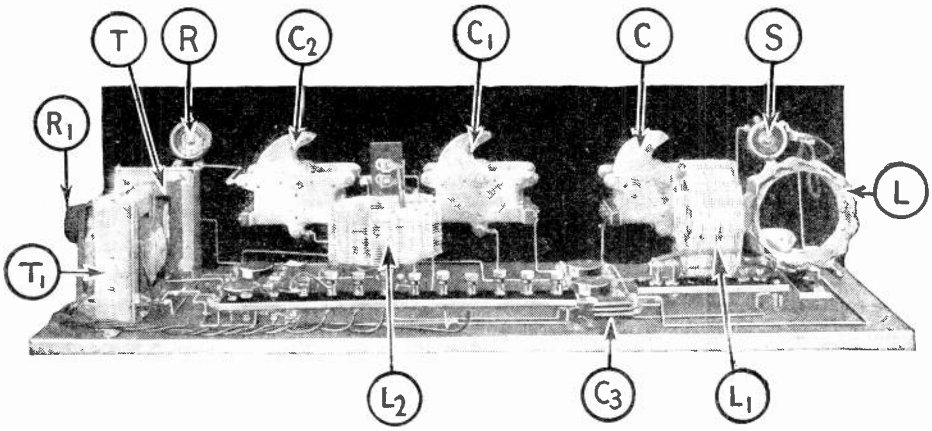
the case of electric motors and generators. Each coil acts exactly like a bar magnet in its effect upon the other coil. When one end of an inductance is turned toward the other coil, a current will flow in a certain direction; and when the other end of the first coil is closest the current will flow in the opposite direction. Of course, the polarity of the coils alternates with each oscillation of the signal. The effect is the same as though a bar magnet were rotated, end for end, in the field of the coil.

High Detector Voltage

Such a tremendous signal can be built up, with the radio-frequency amplifier just described, that the conventional detector circuit cannot handle it without a great deal of distortion. The detector would also break into violent oscillation, especially when the higher-frequency signals were detected. This led to a number of experiments in search of a better detector system.

Almost everyone is familiar with the distortion caused in audio-frequency amplifiers when the bias of the grid is not sufficiently negative, or when the plate voltage is not great enough. Experiments proved a similar condition to be the cause of distortion in the detector; so an arrangement was made whereby the negative bias of the detector grid was controlled by the rheostat. It was found that the best plate voltage was 90; but as high as 135 volts can be used on the detector plate.

The remainder of the circuit follows along conventional lines. Some trouble may be encountered as a result of oscillations in the last audio amplifier, but a variable resistor placed across the secondary of the last transformer will generally cure this trouble. There are on the market several makes of high resistors that answer the purpose.



Rear view of the Powers-Casem receiver. The antenna coil, L, slides back and forth before L1; this being the manner of controlling oscillations.

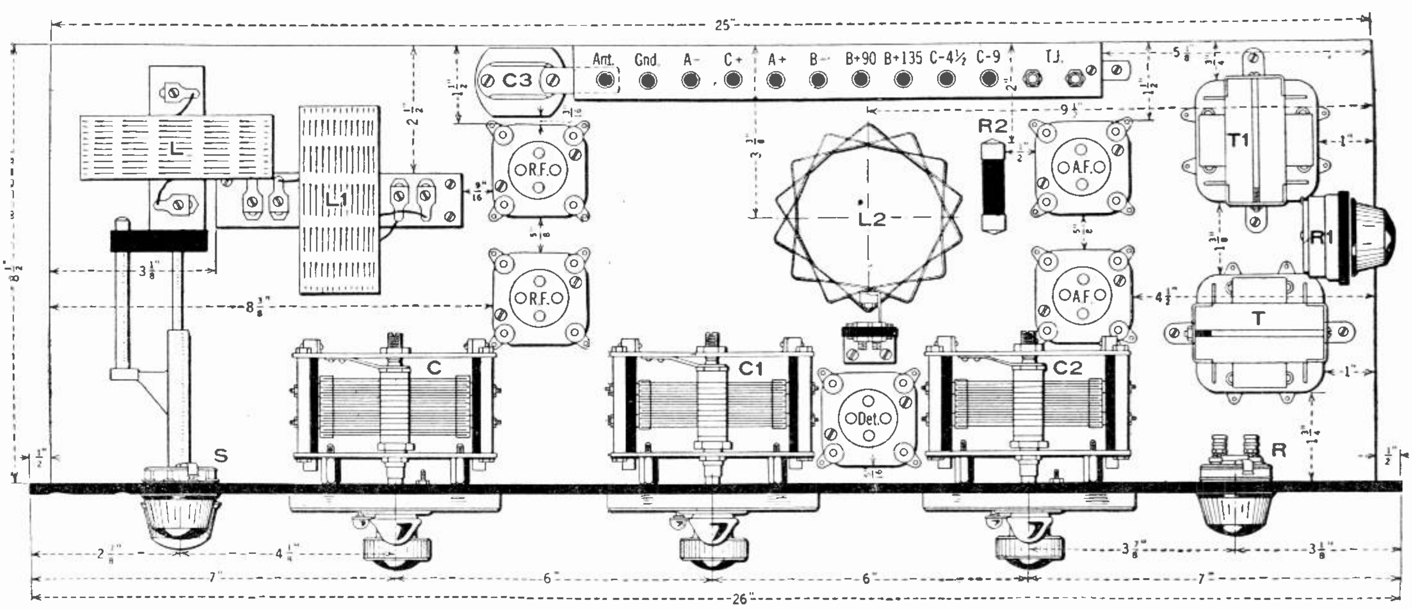
The receiver illustrated consists of two stages of tuned radio frequency, detector and two stages of transformer-coupled audio amplification. The constants of the three tuned inductances (L, L1 and L2) are quite important and depend upon the type of coil used. Several kinds of coils were used with success, but that which gave the best result was the loose basket weave.

The antenna coil, L, consists of 48 turns of No. 20 triple cotton-covered-wire impregnated with paraffin. It should be tapped in the middle for use with a long aerial, and for tuning on the shorter waves. This coil is tuned by condenser C, which has a capacity of .0005-mf. The first radio-frequency transformer, L1, has a secondary of 60 turns of No. 20 wire similar to that just described, while the primary consists of 26 turns of No. 30 wire, also triple cotton covered, and impregnated with paraffin. This transformer is tuned by the condenser C1, which has a capacity of .00035-mf. The second R.F. transformer, L2, is similar to the first, except that its primary consists of but 12 turns. The capacity of its tuning condenser, C2, is .00035-mf.

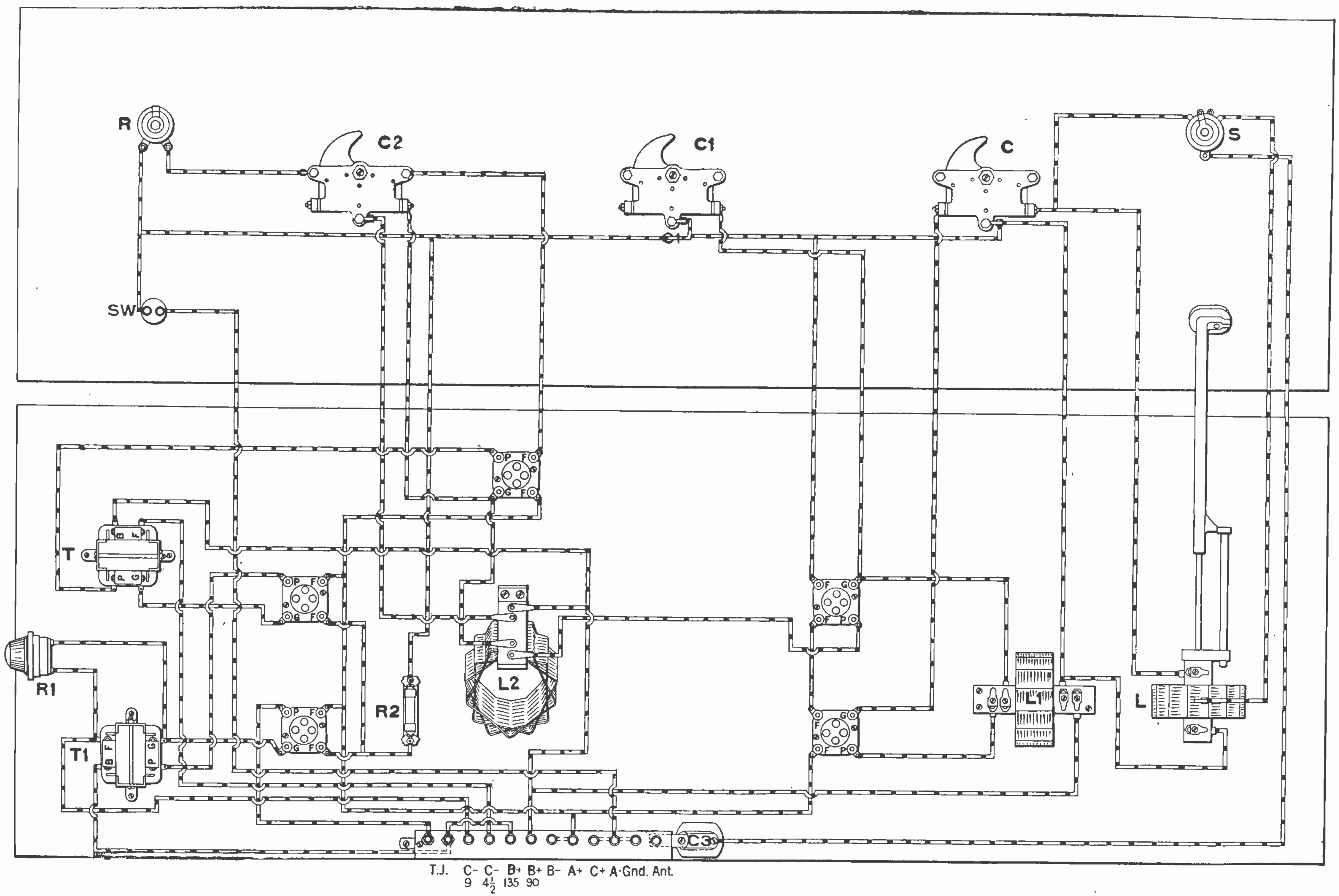
The primaries are wound with the secondaries at the filament ends of the latter coils. The 90-volt battery leads should be made to the outer terminals of the primary windings, with the plate leads going to the inside ends.

If ordinary solenoids are used, the number of turns in the primaries will have to be increased about ten in each case. This is because the exceptionally close coupling in the basket-weave type of coil requires fewer turns.

A 199-type tube should be used in each of the radio-frequency stages. The internal capacity of the 201A is too great to permit it to be used in this receiver. One stage of



If the apparatus specified by the designers of this set is used, the placement of the apparatus may be exactly as shown here. However, considerable latitude is possible in the arrangement of parts to suit the builder's preference.



Above is shown, in easily-followed picture form, the complete wiring of the Powers-Casem receiver. As you solder each wire in place, run a pencil line through the dotted line representing that wire on the diagram; when you have blocked out all the lines you know that you have completed the set. The component parts shown herewith have been purposely drawn small, in order to make the connecting wires stand out. For accurate scale drawings of the receiver panel and baseboard, see the other plates accompanying this article.

stray R.F., using a 201A can be controlled very easily; but when another stage is added it becomes uncontrollable.

It is not absolutely necessary that the apparatus be placed as shown in the diagrams. There are any number of ways in which the apparatus may be mounted in the set, yet no difficulty encountered. The set has been placed successfully in an ordinary phonograph cabinet, the panel being only fifteen inches in length. Of course, in this case, the audio amplifiers were placed behind the other apparatus.

Assembling the Set

The panel should be drilled and all its apparatus mounted before it is placed on the baseboard. The mounting for the first radio-frequency coil L1 should be the first thing after the panel has been secured to the baseboard. It is important to get this device in exactly the right place. The neutralizer plunger should be pushed to the half-way position and the antenna coil L placed in its mounting. Coil L1, in its mounting should now be placed so that the center of L is exactly in front of the center of the open end of L1; the coils are then removed and the mounting for L1 secured to the baseboard.

Mount the binding-post strip in a central position at the rear of the baseboard. Place the sockets for the two radio-frequency tubes between the first and second R.F. transformers. The filament posts should be at the right and the grid and plate lugs at the left; this arrangement shortens a great many leads. The second R.F. transformer coil should be mounted at least five or six inches to the right of the other. If home-made coils are used, care should be taken to get the coils at the right height from the baseboard; their center points should be at the same distance above the baseboard.

The detector socket may be placed between the second and third tuning condensers and the two A.F. sockets just to the right of the last coil, with the two audio transformers at the extreme right end of the baseboard. This is a particularly good position for the audio transformers, since they are entirely out of the field of the coil. If they are placed too near the R.F. coils the efficiency of the receiver will be lowered, and the tuning dials thrown out of alignment. The R.F. coils are so constructed that they should tune exactly alike if proper condensers are used and if the lay-out is right. The tuning of the first dial will depend upon the length of aerial used.

Adjustment and Operation

The receiver will operate with an aerial of almost any length. For the best results, a good ground should be secured; the cold-water pipe is usually the best. When a short aerial is used, the tuning becomes extremely sharp. The radiator may sometimes be used as an aerial.

When the set is first being tested, the headphones should be used; the detector rheostat should be turned to about the mid-position, and the three tuning condensers set for a loud local station. If the set is functioning at all, some signals will be received. If the set squeals or whistles, move the neutralizer back and forth until a position is found where the set no longer oscillates. If this operation does not properly neutralize the set, try transposing the two radio-frequency tubes. Sometimes when the tubes are new, the filament emission is considerably greater than it will be after the tubes have been used a short time. This will sometimes cause a set to oscillate badly, and as a result, the detector becomes overloaded and cannot handle the signal. This trouble can generally be overcome by an adjustment of the detector rheostat. In fact, regeneration in the detector tube can be controlled by the rheostat; in order to produce more regeneration the rheostat is tuned toward the off position. The set can be accurately logged; it is recommended for best results that a log be made of all important stations.

Proper use of the balancer and the detector rheostat, and careful adjustment of the tuning condensers will result in the reception of distant signals. Of course, it takes some practice before the best results on DX stations can be obtained; little trouble, however, should be encountered in the reception of locals.

Plug-in coils have been adopted so that the set may be used on the short waves; with three sets of coils, it has a range from 40 to 550 meters. On the shorter waves a variable condenser of .0005-mf. capacity should be used, in series with the aerial. If an arrangement of this kind is not used, the set will not oscillate on certain wavelengths.

SYMBOL	Quantity	NAME OF PART	VALUE OF PART	REMARKS	MANUFACTURER ★	
C1,C2	2	Variable cond.	.00035 Mf.		1	2,3,19,27,31,32,33,40
C	1	Variable cond.	.0005 Mf.		1	2,3,19,27,31,32,33,40
L,L1,L2	3	Coils		Set covering 220 to 570 meters	4	
	5	Sockets		UX type	5	6,10,28,31
C3	1	Fixed cond.	.0001 Mf.		7	13,14,31
S	1	Switch		2 point inductance	8	18,5
R	1	Rheostat	30 ohms		8	14,13,17,15,31
SW	1	Switch		Filament	8	18,5,17,14
	3	Dials		Vernier	9	16,32,33,34,31
TJ	2	Tip Jacks		For loud speaker	8	17,18,29
	9	Binding posts			10	19,24,31
T,T1	2	A.F.Trans.			5	20,21,22,32,33
	1	Panel		7" x 26"	11	23,24,35,36
	1	Baseboard		8½" x 25" x 5/8"	11	23,24,35,36
	3	Tubes	6V. ¼ amp.	Standard type	12	25,26,30
	2	Tubes	3V.60M-A.	Dry cell type	12	25,26,30
	1	Binding post strip		1"x 10"x 3/16"	11	19,23,24,35,31
	1	Neutralizer		Part of coil	4	
R1	1	Var. Resis.	200,000 ohm		14	18,
R2	1	Auto.Fil.Control	¼ amp.		37	38,39

NUMBERS IN LAST COLUMN REFER TO CODE NUMBERS BELOW.

1 A.D.Cardwell Mfg. Corp.	17 H.H. Frost, Inc.	33 Kares Elec. Co.
2 General Instrument Corp.	18 Yaxley Mfg. Co.	34 Kurz-Kasch Co.
3 Hammarlund Mfg. Co. Inc.	19 X-L Radio Labs.	35 DuPont Viscoloid Co. Inc.
4 Radio Eng. Labs.	20 American Trans. Co. (Amertran)	36 Formica Insulation Co.
5 Pacent Elec. Co. Inc.	21 Thordarson Elec. Mfg. Co.	37 Radiall Co. (Amperite)
6 Benjamin Elec. Mfg. Co.	22 Bremer-Tully Mfg. Co.	38 Langbein Kaufmann Radio Co.
7 Sangamo Elec. Co.	23 Diamond State Fibre Co. (Celoron)	39 Daven Radio Corp.
8 Carter Radio Co.	24 Ins. Co. of Amer. (Insuline)	40 National Co. Inc.
9 National Co. Inc.	25 E.T.Cunningham, Inc.	41
10 H. H. Eby Mfg. Co.	26 C. E. Mfg. Co. (Ceco)	42
11 Amer. Hard Rubber Co.(Radion)	27 Gardiner & Hepburn, Inc.	43
12 Radio Corp. of America	28 Alden Mfg. Co.	44
13 Polymet Mfg. Corp.	29 Union Radio Corp.	45
14 Electrad, Inc.	30 Van Horne Co. Inc.	46
15 Central Radio Lab.(Centralab)	31 Amsco Products Inc.	47
16 Martin-Copeland Co. (Marco)	32 Samson Elec. Co.	48

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

ENGRAVING PANELS

By H. R. Wallin

BUILDERS of radio sets usually wish their panels engraved, to make a neat appearance and give the cabinet a professional look. A simple method of doing this is to mark the arrows, letters, or whatever is to be engraved, on the panel with a lead pencil. A prick-punch with a sharp point is then used to go over the lines drawn, tapping lightly. With a little practice, these punch marks can be made to give the panel a fine appearance. The small holes can be filled with engraving enamel or whiting or left as they are.

The Ultra-5 Receiver

(*Continued from page 30*))

waves must have a frequency equal to that to which the intermediate amplifier is tuned. If, therefore, we have a means of tuning the intermediate stage or stages to a different frequency, when we find such interference occurring, we possess a means of preventing this nuisance.

In ordinary superheterodynes this is almost an impossibility, because the intermediate stages are previously tuned by the manufacturer of the intermediate transformers. In the Ultra-5, however, we have but one intermediate stage, and we therefore need not hesitate to change its intermediate frequency; because no other circuits will be put out of resonance by this move. It is for this reason that the primary of the long-wave coil L1 is shunted by the adjustable condenser, C6. We could as well have applied this variable condenser across the secondary; in fact, its place is optional.

After we have attached the receiver to the antenna and it is functioning properly, we will wander slowly over its entire scale. If no squeals at all develop, so much the better. If squeals are encountered at any point, we vary the capacity of the condenser C6 slightly by means of a screwdriver. This variation affects the wavelength of the coil combination, and thus it is impossible for the particular interference to occur again.

In this way it is quite easy to find, for any locality, a setting of the condenser C6 where interference between local broadcasters is prevented or reduced to a minimum.

A second advantage of the use of this adjustable condenser is that it enables the builder to bring the primary and the secondary of the intermediate transformer in close resonance. In this condition the transfer of energy will be at a maximum, and the signal will be passed on to the detector with the highest efficiency.

The Transoceanic Radiotelephone Interflex*

A New and Simplified Receiver Which Will Bring In Transatlantic Conversation

By MARK HINDER

POSSIBLY there have not been enough recent noveltics in regular broadcasting to keep the radio fan content; but, at any rate, with the announcing of radiotelephone service between this country and England, the whole world seemed to sit up and take notice. The romance of it was enough to set the imagination afire and it became the desire of almost every radio fan to "take a listen-in" on the buzz of commerce and the interesting conversations.

The Editors of RADIO NEWS took it upon themselves to provide radio fans with a set by which they could listen in on the otherwise private talk. Due to the fact that "single-sideband transmission" is used, a special receiver is required; the regular type broadcast receiver cannot pick up the conversations. The set described in this article is very simple and based somewhat on the principle of the original Interflex circuit, devised by Mr. Hugo Gernsback. With a good-sized outdoor aerial no difficulty is found in receiving the conversation on both sides of the ocean. This receiver can also be used for reception on the regular broadcast wavelengths by merely changing the coils.

BUILDERS of this set are cautioned that any overheard radio message, either in code or speech, must go no further than the listener. as the United States Statutes provide (Sec. 27, Radio Act of 1927): "No person not being authorized by the sender shall intercept any message and divulge or publish the contents, substance, effect, purport or meaning . . . or use the same or any information therein contained for his own benefit, or for the benefit of another not entitled thereto." This does not apply, of course, to regular broadcasts.

—EDITOR.

Effect of the Crystal

The use of the Interflex principle immediately simplifies the whole arrangement; for, whereas in the former set two vacuum tubes were required, one for producing the necessary missing sideband-frequency and the other for detection, only one tube is required here for both functions. This tube (V) is set into oscillation at the same frequency as the single-sideband transmission. This is accomplished by the tickler coil L2. The crystal detector D handles the rectification but, like all rectifiers, does not make a complete job of it. Further rectification takes place in the tube V which is actually oscillating.

If a grid leak and condenser are substituted for the crystal detector the set will not function properly; the crystal is *absolutely necessary* for the correct operation of the set.

The first tube, which is a detector, oscillator and amplifier combined, is controlled by the filament rheostat R1, and it will be found that the adjustment of this is important in bringing in the conversation at its best. The adjustment however, is not at all critical.

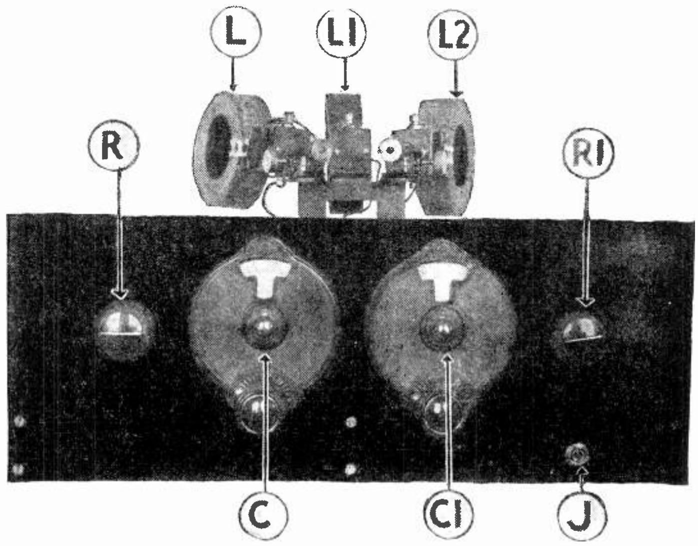
The Audio Amplifier

The audio amplifier is of the transformer-coupled type, there being two stages. The two A.F. tubes V1 and V2 are both controlled by the same filament rheostat R Constant readjustment of this is not necessary; it can be set for the best response and left in that position. This, of course, is true of the rheostat for the first tube too; because the receiver is always operating on the same wavelength and receiving from the same transmitters, both in use simultaneously.

Since it is desirable to receive the conversations undistorted, so that all of the overtones of the human voice are amplified, the best type of A.F. transformers, with large cores and high-impedance primaries, is recommended.

The two A.F. tubes are of the 201A type and unsuited to power amplification, but great volume is hardly desirable in this instance. Also, high "B" voltages are unnecessary, and it will be noted from the circuit diagram that no more than 90 volts is employed. If it is desirable to have greater volume the "B" voltage should be increased to 135, and a tube of the 112 type used in the tube socket marked "2nd AF" (V2) in the illustrations.

Either phones or a loud speaker can be used on this set, and a jack (J) is provided for this purpose. When the plug is inserted in this jack the set is automatically turned on. When the plug is removed the tubes go out. This is a very nice arrangement for, after the set is once adjusted for the reception, it need not be touched again. Then, all one has to do to hear the telephone conversations is to plug in the phones or loud speaker.

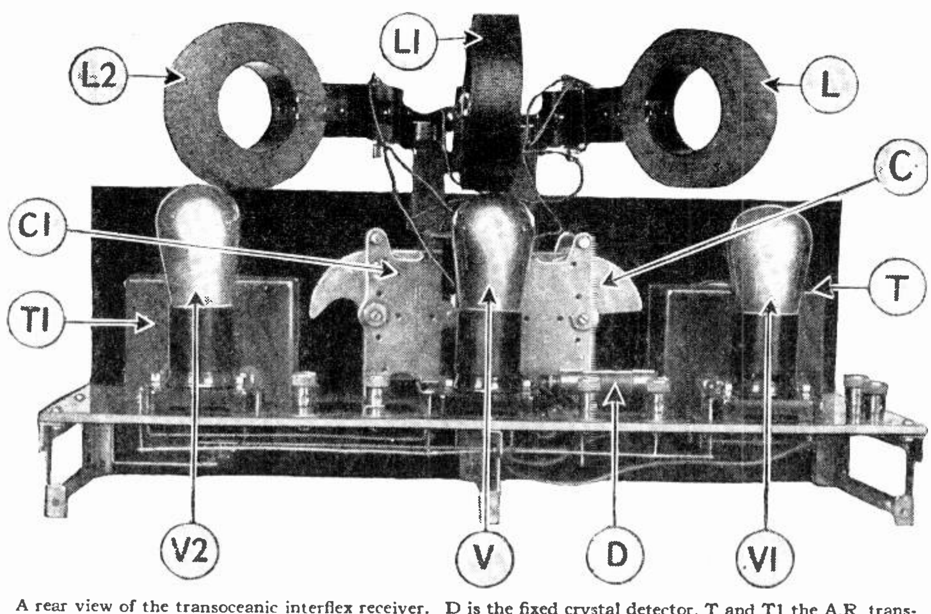


Front-panel view of the completed Transoceanic Radiotelephone Interflex. L, L1, and L2, respectively, are the primary, secondary and tickler coils. C and C1 are the tuning condensers, R and R1 the filament rheostats and J is the loud-speaker jack.

The Construction

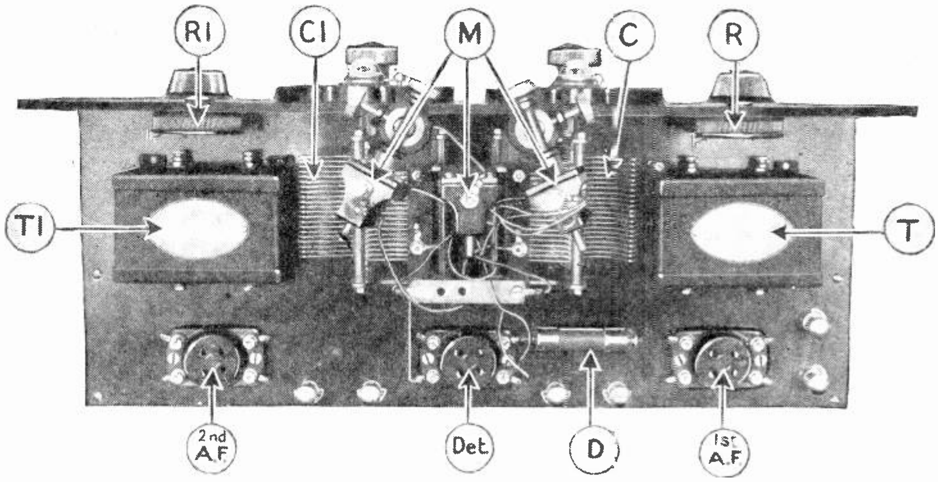
The construction of the Oceanic Radiotelephone Interflex is comparatively simple, as there is not a great amount of apparatus to complicate the layout. It is best to drill both the panel and the sub-base according to the sketches and then mount the parts on each before attaching them together. The panel layout includes the two rheostats, the two variable condensers, the filament-control jack and the three-coil mounting. It will be noticed that the last is supported by the variable condensers. This simplifies matters considerably.

The sub-base layout includes the tube sockets, the two A.F. transformers, the fixed crystal detector (D) and the binding posts on the top and the brackets and fixed by-pass condenser (C2) on the bottom.



A rear view of the transoceanic interflex receiver. D is the fixed crystal detector, T and T1 the A.R. transformers; V. the detector-oscillator tube and V1 and V2 the A.F. amplifiers.

*RADIO NEWS *Blueprint Constructional Article No. 22.* (See page 109).



Top view of the receiver. This shows the coil mountings very well and it will be noticed that there are knurled adjusting screws, which make it possible to "lock" the coils in position after this has been correctly determined. The center coil-mounting is stationary.

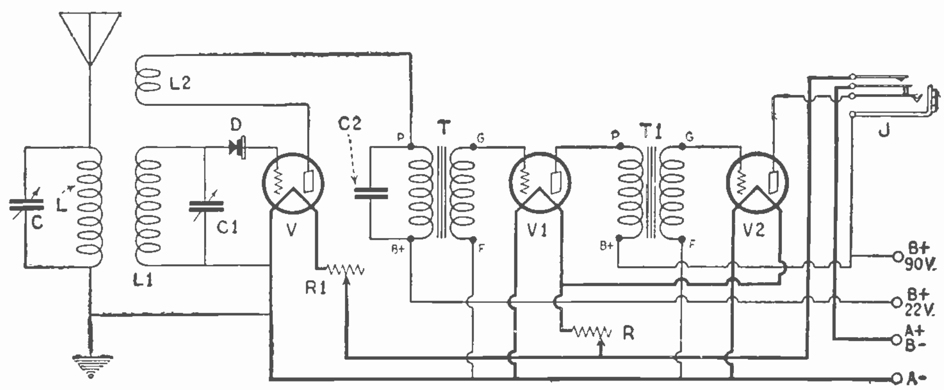
After all the parts are mounted, go ahead with as much of the wiring on both the panel and sub-base as can be completed before the two are attached. After this is done, attach the panel to the sub-base by means of the brackets and complete the wiring between the two.

Note that a great deal of the wiring is under the sub-base. This is not absolutely necessary; but it makes a very neat job and in the long run is probably more satisfactory than any other arrangement.

All of the wiring can be easily followed from the two large wiring sketches shown. Wherever a wire passes through a hole to the under side of the sub-base it is numbered alike on both sides in the diagrams, so that it can be traced out to its termination.

Installation

There isn't a great deal that can be said about the installation, as all of the post markings are shown in the accompanying sketches. One thing of importance, however, is the aerial and ground installation. It has been pointed out before that, if the best results are desired, *a large aerial should be used. It should be at least* 100 *feet in length*, well insulated and as high above the ground as it is possible to get it. The ground connection should be made to the water pipe and *be sure that a good contact is made.* Remember, that, if the English conversation is to be picked up well, the resistance of the antenna system must be low. This can be accomplished only by making good, clean connections.

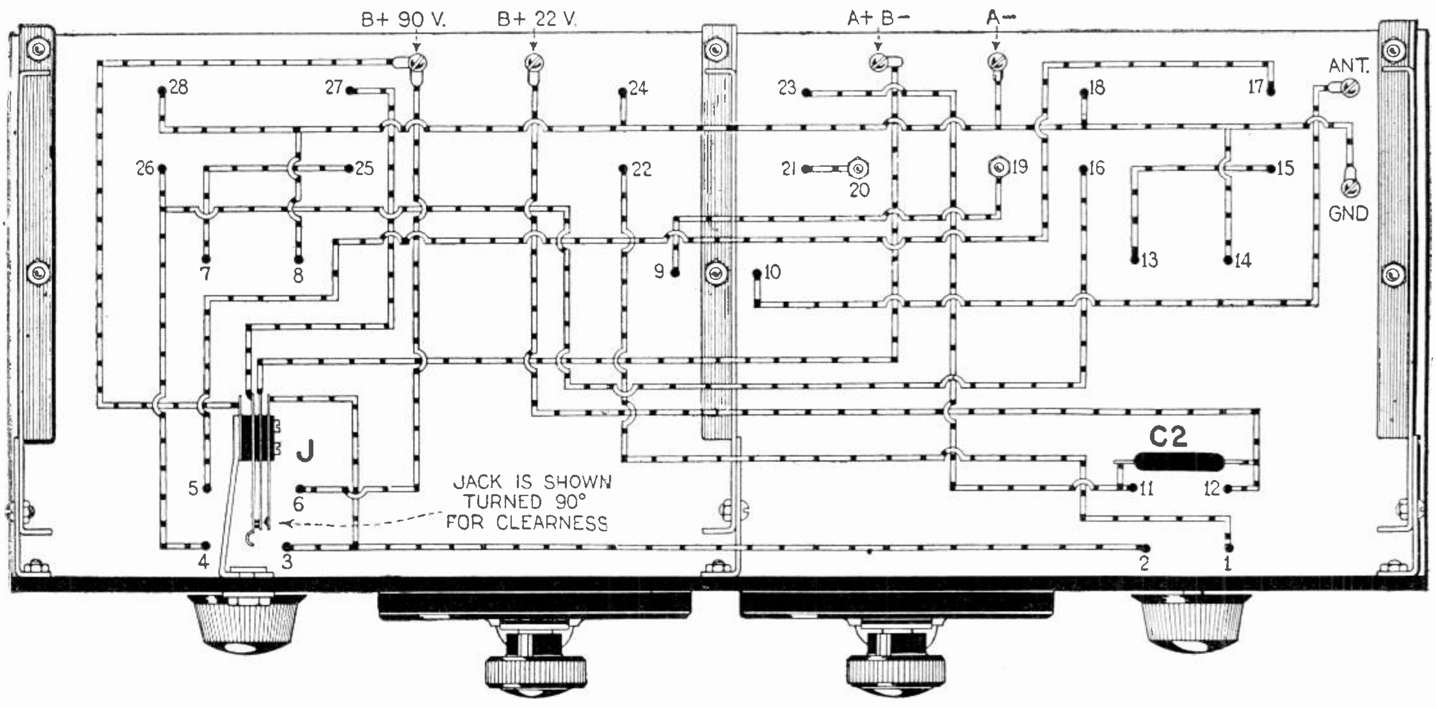


The schematic circuit diagram of the Transoceanic Interflex

As previously mentioned, after the receiver is once adjusted for the best reception of the transatlantic telephone conversations, it need not be touched again. Of course, as the storage "A" battery runs down it will probably be necessary to make occasional readjustments of the filament rheostat R1, which controls the detector-oscillator tube, to compensate for the drop in voltage.

After the set has been hooked up, plug a pair of headphones into the jack and use these for the preliminary adjustments. This automatically turns the set on. The antenna coil L and the secondary coil L1 should be *closely coupled*; that is, they should be close against each other, rather than spread apart as they are shown in one of the illustrations. The tickler coil L2 should be loosely coupled for the best results; that is, spread apart from the coil L1. For the preliminary adjustments, however, place L2 fairly close to L1 so that the tube V oscillates. This is denoted by a clucking noise in the head phones. Now tune the set by adjusting the two variable condensers C and C1, until the Rocky Point station is picked up. This should be very easy. The dial reading on the condenser C will be about 10 degrees and on the condenser C1 about 20 degrees.

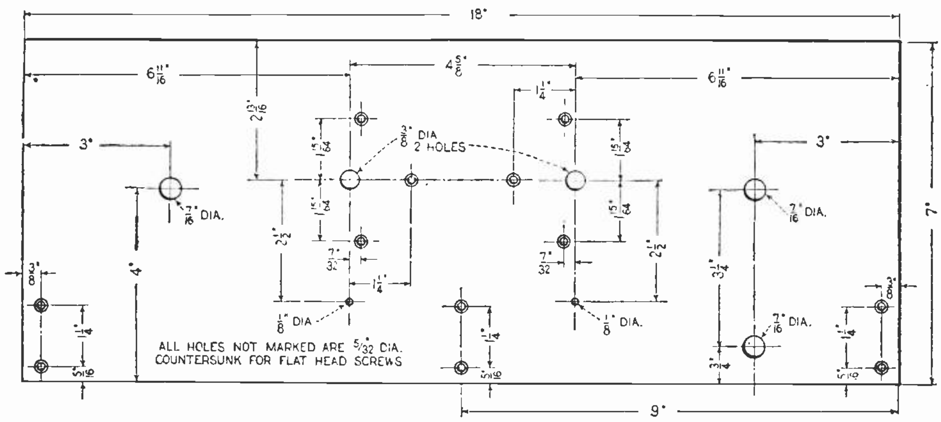
It will be found that the adjustment of the condenser C is not critical, but that the adjustment of C1 is. Now, the job at hand is making the set sensitive enough to bring in the talk from the other side of the Atlantic, as well as from this side. This will take a bit of time and patience and will require careful adjustment of the variable condenser C1, the tickler coil L2 and the



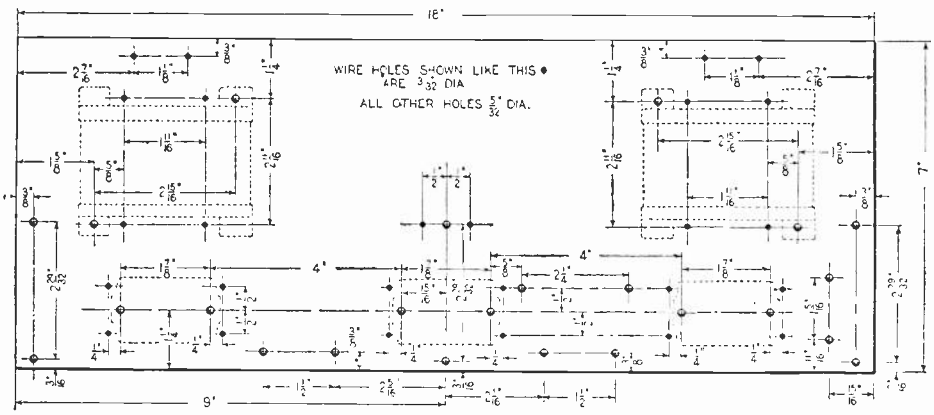
Thw wiring of the Transoceanic Interflex under the sub-base. C2 is the fixed .001-mf. by-pass condenser which connects across the primary winding of the first A.F. transformer T.

rheostat R1. They should be set for maximum volume and clarity. Distortion of voice will disappear only when the settings of these three devices are correct.

After these adjustments have been made, it should be possible to plug in a loud speaker and hear the talk anywhere in a room. When you wish to turn the set off just pull the plug out of the jack. Thereafter, the telephone conversations will be heard at any time phones or a speaker are plugged into the jack, providing the American and English transmitters are operating.



The drilling and dimensional details of the front panel



Drilling and dimensional details of the sub-base. The instruments are shown in dotted lines and will be readily recognized.

SYMBOL	Quantity	NAME OF PART	REMARKS	MANUFACTURER ★	
L	1	Duo-lateral coil	1000 turns	1	
L1	1	Duo-lateral coil	1250 turns	1	
L2	1	Duo-lateral coil	1000 turns	1	
C,C1	2	Var. condenser	.001 mf.	2	11,23,27
C2	1	Fixed condenser	.001 mf. By-pass	3	6,14,15,16,17,18,19,20
R	1	Rheostat	10 ohms. For detector tube	4	1,6,14,21,22,23,27,39,40,41
R1	1	Rheostat	6 ohms. For audio tubes	4	1,6,14,21,22,23,27,39,40,41
D	1	Fixed detector	Crystal detector with mount	5	
M	1	3 coil mount	For L, L1 and L2	1	
J	1	Jack	Double circuit fil. control	6	1,21,22
T,T1	2	A. F. transformers		7	1,24,25,26,27,28,29,30,31
	3	Sockets	UX type	1	10,25,27,28,32,33,34
	6	Binding posts		8	27,32
	1	Panel	7 X 18 X 3/16"	9	35,36,37,38
	1	Sub-base	7 X 18 X 3/16"	9	35,36,37,38
	3	Brackets		10	9,28
	2	Dials	Vernier type	11	1,25,28,31,32,39,40,41,42
V,V1,V2	3	Tubes	5 v. 1/4 amp. Standard type	12	43,44
	roll	Hookup wire		13	45,46,47,48

NUMBERS IN LAST COLUMN REFER TO CODE NUMBERS BELOW.

1 Pacent Electric Co.	2 Allen D. Cardwell Mfg. Corp.	3 Micamold Radio Corp.
4 Central Radio Labs. (Centralab)	5 The Carborundum Co.	6 Carter Radio Co.
7 Jefferson Elec. Mfg. Co.	8 X-L Radio Labs.	9 Amer. Hard Rubber Co. (Radion)
10 Benjamin Electric Co.	11 The National Co.	12 Belden Mfg. Co.
13 Radio Corp. of America	14 Electrad, Inc.	15 Tobe Deutschmann Co.
16 Aerovox Wireless Corp.	17 Sprague Specialties Co.	18 Dubilier Condenser Corp.
19 Potter Mfg. Co.	20 Wireless Spec. App. Co. (Faradon)	21 Yaxley Mfg. Co.
22 Herbert H. Frost, Inc.	23 Allen Bradley Co.	24 All-American Radio Corp.
25 Bremer-Tully Mfg. Co.	26 Ferranti, Inc.	27 General Radio Co.
28 Silver-Marshall, Inc.	29 Karas Electric Co.	30 Thordarson Elec. Mfg. Co.
31 Samson Electric Co.	32 H. H. Eby Mfg. Co.	33 Gray & Danielson (Remler)
34 Alden Mfg. Co.	35 Formica Insulation Co.	36 The B. F. Goodrich Rubber Co.
37 The Lignole Corp.	38 Micarta Fabricators, Inc.	39 Martin-Copeland Co. (Marco)
40 Wireless Radio Corp.	41 Pilot Elec. Mfg. Co., Inc.	42 Brooklyn Metal Stamping Co.
43 Acme Wire Co.	44 Cornish Wire Co.	45 E. T. Cunningham, Inc.
46 C. E. Mfg. Co. (Ceco)	47 The Magnavox Co.	48 The Van-Horne 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 All-Wave Receiver

It is not at all difficult to adapt this receiver to reception on any wavelength from approximately 200 to 8,000 meters. All that is really necessary is to change the size of the coils L, L1 and L2 to correspond to the band of wavelengths you wish to cover. These coils are sold in all sizes and it is easy to determine from the tables just what size of coils should be used with .001-mf. variable condensers to cover the different wavebands. Since the variable condensers in this receiver are of such high maximum capacity, it will be found that a very wide band of wavelengths can be covered with a single set of coils.

It is understood, of course, that the tube V should be oscillating only when the receiver is used for the reception of transatlantic telephony. At all other times the coil L2, which is the tickler, should be so adjusted that the tube V does not oscillate but is, nevertheless, near to the point of oscillation. The nearer the tube is to this point, the more sensitive the receiver will be. Regeneration or oscillation is easily controlled by the tickler coil L2.

The advantage of this arrangement is that you can have on hand a complete set of coils to cover all the important wavebands and whenever you want to shift from, say a 200- to 550-meter band, up to around 3,000 meters or so, all you have to do is to take out the three smaller coils and replace them with those suitable for the 3,000-meter band. The coils are easily plugged in and out.

This receiver is really not adaptable to wavelengths below 200 meters because of the extremely high capacity of the two variable condensers C and C1. It is necessary to use these, however, in order to reach the high wavelengths employed by the transatlantic telephone transmitters.

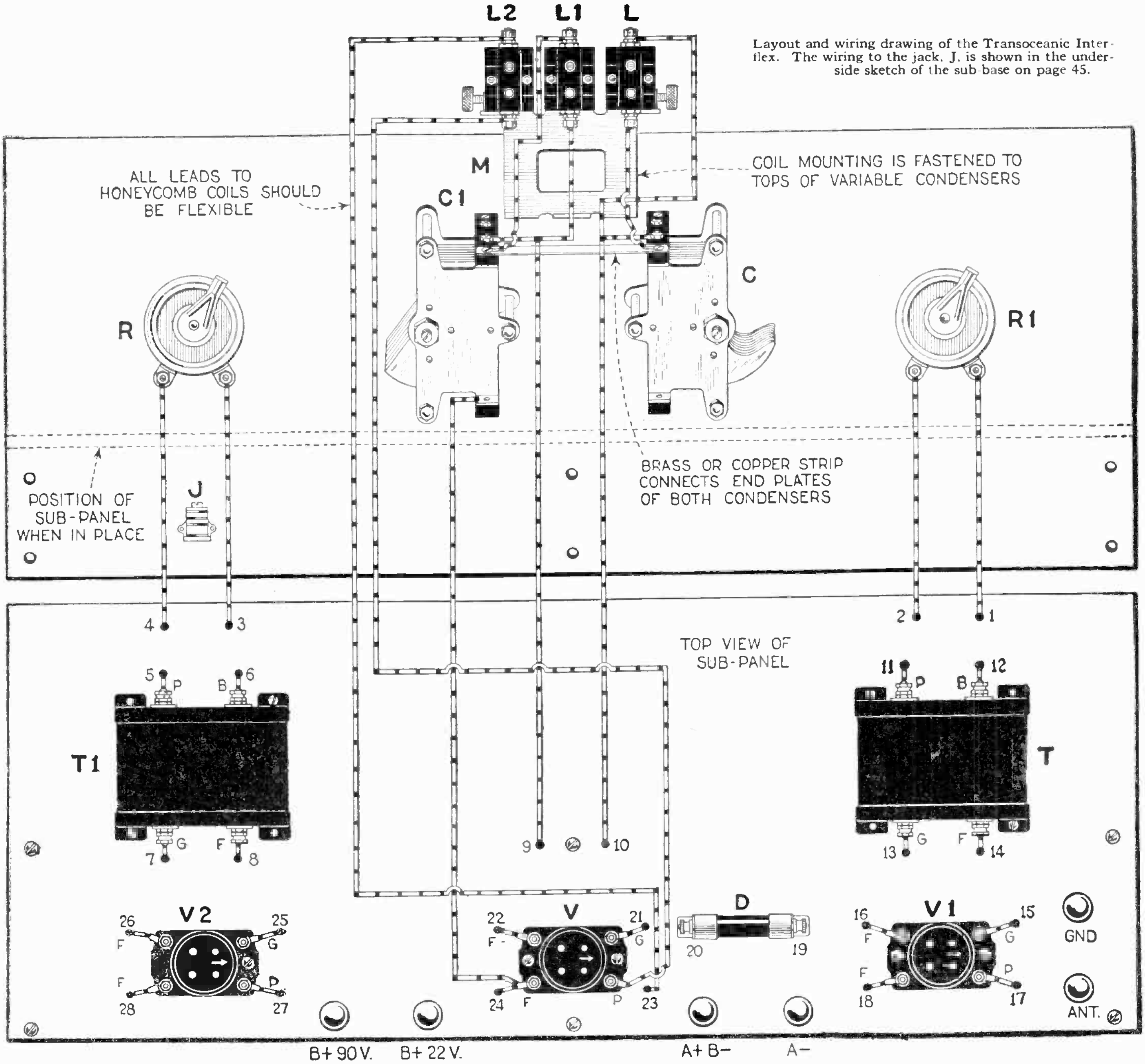
Though the tables usually available are fairly correct on the upper limits of the wavebands which may be covered with a given coil and size of condenser, many assign too high a figure for the minimum wavelength; possibly through allowing too large a minimum capacity for the circuit. For instance, some would indicate that the coils used in this set do not tune down to 5,000 meters—*as they do.* The transatlantic radiophone signals on 5260 meters come in with the dial of condenser C reading about 10, as we have said; though some tables indicate that this should be between 7,000 and 8,000 meters. A very slight change in frequency corresponds here to a very large difference in wavelength, making long-wave receivers seem apparently very broad in tuning. For the broadcast band, 50-turn coils are most suitable, 75-turn coils being large and 35-turn coils somewhat too small, even with these large condensers.

(*For wiring diagrams, see opposite and preceding pages.*)

Drilling Panel Holes Without a Template

By N. V. Churchill

IT is often difficult to locate holes for mounting condensers and other instruments without a template. A very simple way of doing this is as follows: The shaft hole is located first and drilled. The condenser or other instrument is then placed on the panel with the shaft through the hole, and the condenser resting on the panel in the exact position in which you wish to mount it. A little white flour is sprinkled on the panel around the instrument and the instrument is then removed. This leaves circles of flour around the bushings. The center of each circle is marked with a center punch and drilled. It will be found that holes so drilled line up perfectly.



Layout and wiring drawing of the Transoceanic Interflex. The wiring to the jack, J, is shown in the underside sketch of the sub-base on page 45.

Improving the Single-Circuit

By **David Jenkins**

HERE are two methods of changing a single-circuit to a three-circuit, without tampering with the inside wiring at all.

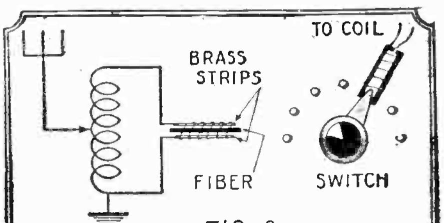


FIG. 2

Details and connections for the contact strip which is placed between the switch blade and one of the points.

Fig. 1 shows the simplest way and probably the best. The aerial is disconnected from its terminal and the aerial and ground terminals are connected by a short piece of wire. This shunts the variable condenser across the tapped inductance. The inductance switch is usually so connected that turning it to the right increases the number of turns in the circuit. The setting of this switch must be found by trial; but it will usually be at about the fifth tap from the left, and cut in about fifty turns. A piece of flexible wire (tinsel cord) is connected to the antenna lead-in wire and a small brass clip soldered to the other end of the flexible wire. This clip is to connect with one of the switch points and should usually be clipped to the first to the left of the switch lever. This will put about ten turns in the aerial-ground circuit, which will make it similar to the Haynes circuit.

The circuit arrangement for the single-circuit receiver. It will be noted that the aerial and ground posts are connected together and the aerial attached to the contact strip. The arrow indicates the clip.

Another method which employs an external coil is shown in Fig. 2. The coil used has thirty turns, tapped every five turns. A piece of thin fiber or cardboard, with a thin brass strip held on each side with thread, is made so that it will slip under the switch blade, with one brass strip making contact with the switch point and the other with the switch blade. Pieces of tinsel cord are soldered to each of the brass strips. Each cord is connected to one end of the coil, placing the coil in series with the coil in the set.

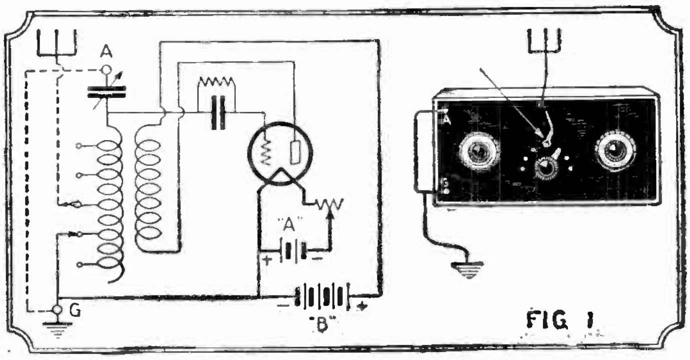


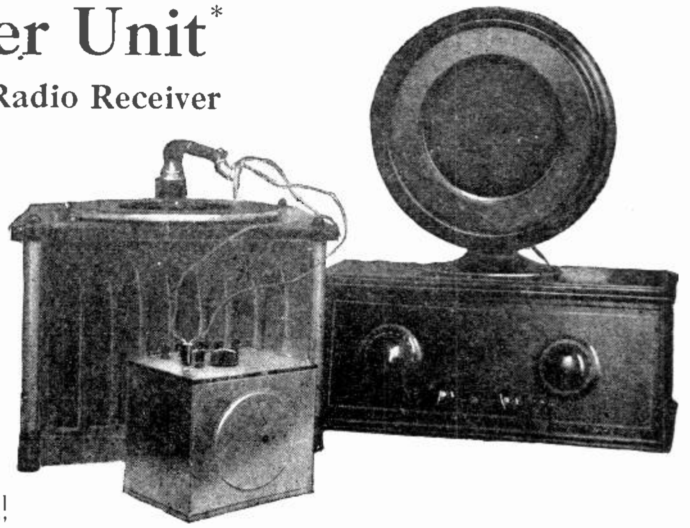
FIG. 1

The El-Fonic Adapter Unit*

Combining the Phonograph With any Radio Receiver

By F. A. JEWELL †

MANY people who have heard phonographs of the new types that have lately appeared on the market have said to themselves, "I would like to have one of those." Then, when they inquire what the cost is and what they can get for their old phonograph, they find that it involves a considerable outlay of money. With the idea in mind of providing something more simple and easier of construction, the little device described in this article was developed. As may be seen from the circuit shown in Fig. 1, it is simply an oscillator coupler and a vacuum tube which generates a constant radio-frequency current. The amplitude of this constant frequency is varied by the small condenser in the pick-up, and the radio-frequency current thus modulated is fed into the receiving set through the antenna and ground binding posts. Within the set this current is treated in the same manner as a similar current received over the air from a broadcast station. As a matter of fact, this adapter is nothing more than a miniature station, by means of which you can have whatever type of entertainment you desire—limited only by the records in your phonograph album.



Here the Adapter is shown connected to the capacity pick-up on the phonograph. The output of the adapter is connected to the antenna and ground binding posts of the tuned-R.F. receiving set, the music issuing from the loud speaker.

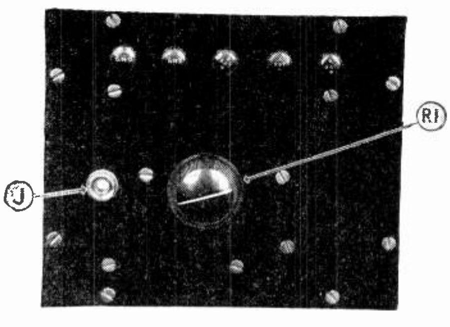
The Pick-Up's Function

Let us consider for a moment just how this pick-up operates. It is a well-known fact that there are on the market at the present time several types of pick-ups for phonographs, among the best known being the magnetic and the carbon types. Both of these types have grave disadvantages, which need not be gone into here; but these disadvantages are overcome in the pick-up developed by the writer. In the matter of "needle-scratch," for example, by no other type of pick-up is this annoying feature of the phonograph reduced to a minimum as it is in the El-Fonic.

It is readily apparent that in electrical reproduction, the quality of sound from the loud speaker can be no better than the speaker itself, the amplifier that feeds it; and both in turn depend on the record "pick-up."

Obviously, in this process of perfecting electrical reproduction, we should begin with the "pick-up," because it has not been perfected to the point that amplifiers and loud speakers have; yet they both depend on the "pick-up," as they amplify and reproduce only what is fed to them.

Of course we have the magnetic and the carbon types of "pick-up," but, although they are superior to the old air-column method of reproduction, they are far from perfect, and their faults are many. For instance, in the carbon type, the instability of the carbon grains causes a fuzzy blowing sound, and they soon become packed. Furthermore, the modulated electrical current is far from being an exact duplicate of the sound waves that are cut on the record. In the magnetic type there is the inertia of a relatively heavy iron armature, held by a stiff spring to overcome the magnetic pull of the pole pieces to prevent the armature from "freezing" to one of the poles. Therefore, the inertia of the heavy iron armature and the tension of the spring make it very difficult for the instrument to respond to the delicate harmonics and overtones. Also, the natural frequency of vibration of the armature, which is in the audio band, causes a "blasting" on certain notes.

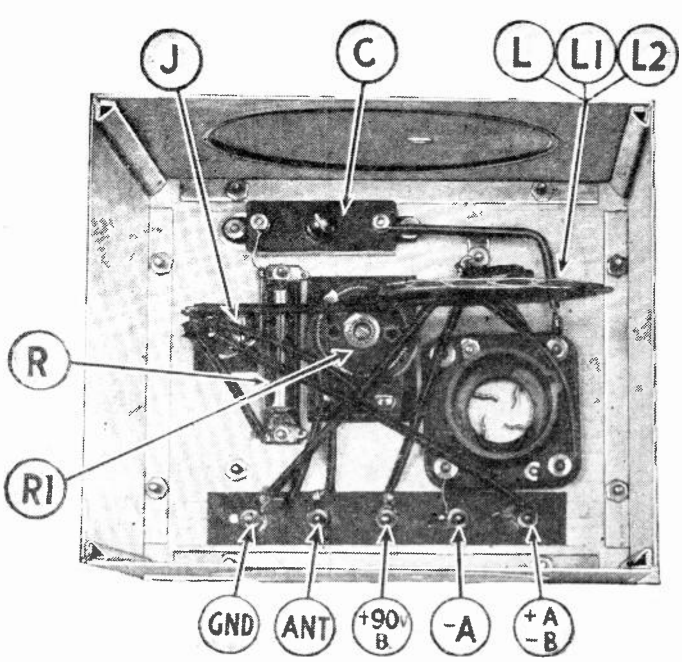


The top-panel view of the Adapter; R1 being the variable resistor and J, the jack.

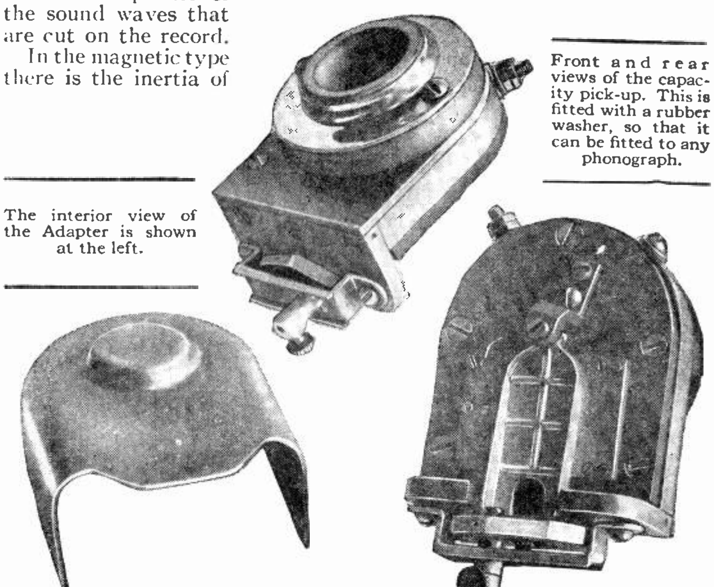
Then again, the energy generated by the movement of the armature to and from the pole pieces is in proportion to the *square* of the distance of travel; which means that the current output is distorted, relatively to the sound waves cut on the record. The realization of these faults, the limitations of each type of "pick-up," and the desirability of overcoming them have prompted the development of this new system of converting sound waves into electrical pulsations by mechanical means, and are responsible for the remarkable results obtained.

"Broadcasting" a Record

Apparently most of the objections to both the phonograph and the radio have been eliminated with this new system, while most of their advantages have been retained. This has been accomplished by utilizing the *principles of radio* for phonograph reproduction throughout. What is meant is



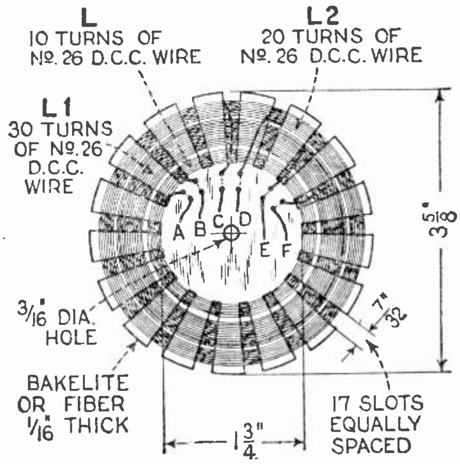
The interior view of the Adapter is shown at the left.



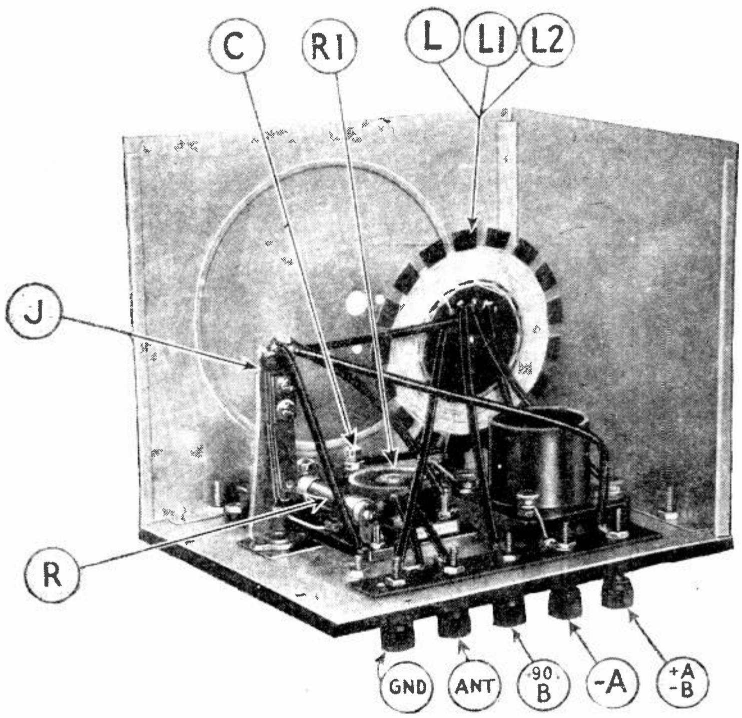
Front and rear views of the capacity pick-up. This is fitted with a rubber washer, so that it can be fitted to any phonograph.

*RADIO NEWS *Blueprint Constructional Article No. 23.* (See page 109.)

†*Consulting Engineer, Adams-Sibley Development Corp.*



Dimensions of the basket-weave coils of the adapter.



In the upper left-hand corner are the necessary details for winding the oscillator inductor, L, L1 and L2. At the left is the interior of the adapter, showing the different parts. J is the jack; R, the filament-ballast resistor; C, the adjustable condenser; R1, the 5,000-ohm variable resistor; L, L1 and L2, the oscillator coil. These symbols apply to all the illustrations and the list of parts below.

this: a *radio-frequency carrier wave* is modulated by the sound wave cut on the record and is rectified, amplified and reproduced just as it is in radio; which gives you the same effect as a broadcast station sending direct to your receiver. In other words, you have your own broadcast station sending direct to you the program you most desire in the form of the records you select, without interference, static, fading, etc.

When the modulated radio-frequency current is rectified in the detector circuit and filtered, an electrical wave, which exactly corresponds to the sound waves cut on the record, is transmitted to the audio amplifier for additional amplification. If distortion is not encountered in this circuit, it is then passed on to the loud speaker in a form as pure as it was when it was cut on the record. With the new electrical-process records, the modulation is equal to, and, in most cases, better than that of the best broadcasting stations, without the scratching of the needle on the record, with a perfect quality of tone and with all the volume that could be desired.

Right here a reasonable question may be asked: how is the scratching of the needle on the record overcome? The answer is this: it is a well known fact fact that from 80 to 90 per cent of the scratching is caused by the needle's scraping along the bottom of the groove of the record, causing a vertical movement, while sound waves are cut laterally on the side of the record. Advantage is taken of this fact in this way: any vertical movement will not cause an electrical change and the remaining 10 to 20 per cent, caused by the lateral movement, or what is known as "side-wall scratch," is damped out to a negligible point.

The El-Fonic Pick-Up

This pick-up device consists of a small condenser of two plates, one being of brass and the other, the movable one, of aluminum. To this latter is attached an ordinary needle holder. As the whole device weighs only a few ounces, the needle practically floats in the groove of the record; the needle, thereby, being free to transmit all the tones and harmonics, inscribed on the sides of the groove, to the movable plate of the condenser. Now, as the scratching of the needle in the majority of cases is caused by its scraping along the bottom of the record's groove and giving a vertical motion to the mechanism, in the capacity type of pick-up this is impossible for the only motion that is translated into electrical energy is lateral. The modulated-frequency current, flowing in the primary of the R.F. transformer, is transferred to the secondary and rectified by any of the conventional detector circuits, and is then passed through the usual filter circuit and on to the audio amplifier and loud speaker.

Now, inasmuch as the frequency passing through the pick-up is very high (in the millions) its plates are very small. Consequently, the vibrating member is very light, being made of aluminum. Furthermore, as this vibrating member does not have to perform any appreciable mechanical work (such as moving an air column or working against a heavy spring tension, as in a magnetic type of a "pick-up") it is allowed to float in the record groove. As it has very little inertia, it can readily respond to all the delicate overtones, as well as all the fundamental notes. Also, as there is only one frequency to contend with, that of the oscillator, and since the only function of the capacity type of "pick-up" is to vary the amplitude of this frequency, no difficulty is encountered in designing a circuit to respond to it.

We are assuming, of course, that the set used has radio-frequency amplification, which the majority of sets on the market today have. However, this device will function with a set of any type at all that employs vacuum tubes, and has sufficient volume for loud-speaker operation.

Construction

The El-Fonic adapter is very simple to construct and can be made by anyone who has any knowledge whatsoever of radio set construction. First of all the bakelite panel is laid out, drilled and screwed on to the bottom piece of the shield. As may be seen from the illustrations, all the apparatus is hung from this shielded panel, making the construction easy.

The oscillator coupler is a basket-weave coil 3⅝ inches in diameter, and the three coils, L, L1 and L2, are all wound on this in the same direction, using No. 26 D.C.C. wire. There are wound for the coil, L, 10 turns, for L1, 30 turns and for L2, 20

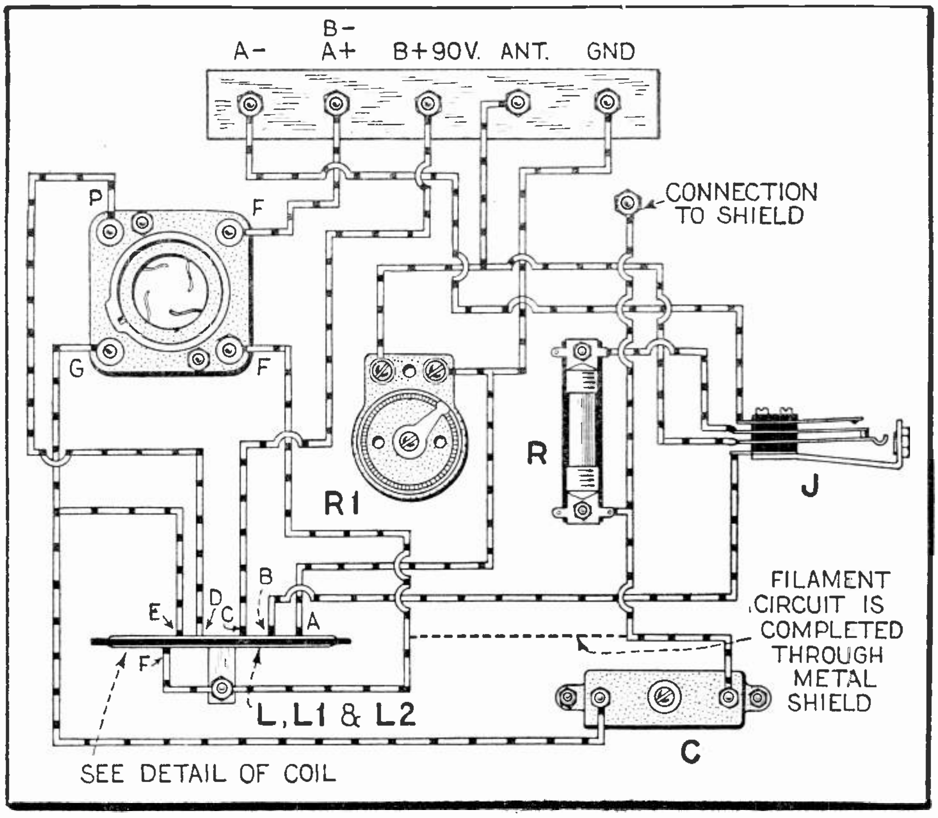
SYMBOL	Quantity	NAME OF PART	REMARKS	MANUFACTURER ★	
L, L1, L2	1	Coupler	Special (See drawing)	1	
C	1	Adj. condenser	.0001 to .0005 mf.	2	12,13
R	1	Fil. ballast	5 volts, 1/4 amp.	3	14,15,16,23,37,38
R1	1	Var. resistance	5,000 ohms	4	5,17
J	1	Jack	Single circuit fil. control	5	18,19,20,25
S	1	Shield	Aluminum	6	
	1	Socket		7	8,13,20,21,22,23,24,25,26,40
	5	Binding posts		8	2,21,22,23
	1	Ins. panel	5 7/8" X 6 15/16" X 3/16"	9	10,27,28,29
	3	Insulating strips	(See sketch)	10	9,27,28,29
	1	Tube	5 v., 1/4 amp. 201-A type	11	30,31,32,33,34,41,42
	roll	Hookup wire	Insulated	35	36,39

NUMBERS IN LAST COLUMN REFER TO CODE NUMBERS BELOW.

1 Adams-Sibley Dev. Corp.	2 X-L Radio Labs.	3 The Radiall Co. (Amperite)
4 Electred, Inc.	5 Carter Radio Co.	6 Hammarlund Mfg. Co.
7 All-American Radio Corp.	8 H. H. Eby Mfg. Co.	9 Amer. Hard Rubber Co. (Radion)
10 Micarta Fabricators, Inc.	11 Radio Corp. of America	12 Leslie F. Muter Co.
13 Bremer-Tully Mfg. Co.	14 Langbein-Kaufman Co. (Elkay)	15 Arthur H. Lynch, Inc.
16 L. S. Brach Mfg. Co.	17 Allen-Bradley Co.	18 Yaxley Mfg. Co.
19 Herbert H. Frost, Inc.	20 Pacent Electric Co.	21 Silver-Marshall, Inc.
22 General Radio Co.	23 Amsco Products, Inc.	24 Benjamin Electric Co.
25 Pilot Electric Co.	26 Gray & Danielson (Remler)	27 Insulating Co. of America
28 Formica Insulation Co.	29 The Celoron Co.	30 E. T. Cunningham, Inc.
31 C. E. Mfg. Co. (Ceco)	32 The Van-Horne Co.	33 The Magnavox Co.
34 Ken-Rad Corp.	35 Acme Wire Co.	36 Belden Mfg. Co.
37 Daven Radio Corp.	38 Tobe Deutschmann Co.	39 Cornish Wire Co.
40 Alden Mfg. Co.	41 Zetka Laboratories	42 Gem Tube Co.

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

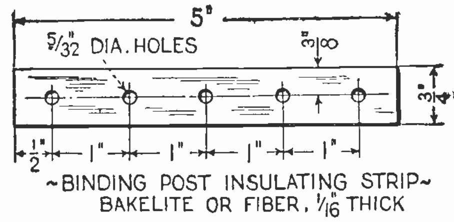
If you use alternate parts instead of those listed in the first column of manufacturers, be careful to allow for any possible difference in size from those originally used in laying out and drilling the panel and sub-base.

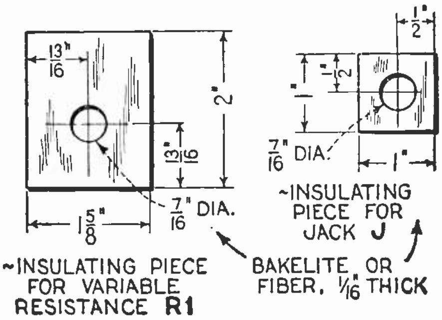


Wiring diagram of the adapter unit. The metal shield is used as a connection, as indicated.

turns. Across L1 is shunted the small-capacity adjustable condenser, C, having a value between .0001- and .0005-mf. This adjustable condenser is included in the circuit in order that the frequency of the oscillator may be adjusted so that it will not be on the wavelength of any broadcast station in the vicinity and heterodyne with it, which would cause a whistle when the phonograph is being operated. Once this condenser is adjusted it need not be touched again.

The form on which the coils are wound





The details of the bakelite or fiber insulation for the jack, resistance and binding posts.

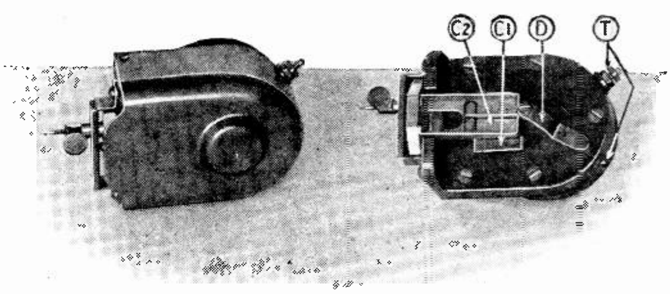
is held in place by a bracket bent in an "L" shape, which is slightly bowed so that the metal will not come in contact with the wire of the coils. One end of this bracket is screwed into the metal of the shield, and the other to the center of the coil form.

The jack, J, and the variable resistor, R1, have a thin sheet of fiber to insulate them from the metal shield. Every other piece of apparatus, with the exception of the binding posts, is mounted directly on the shield. The shield is used also as an electrical connection for the negative side of the filament circuit, thus saving wiring.

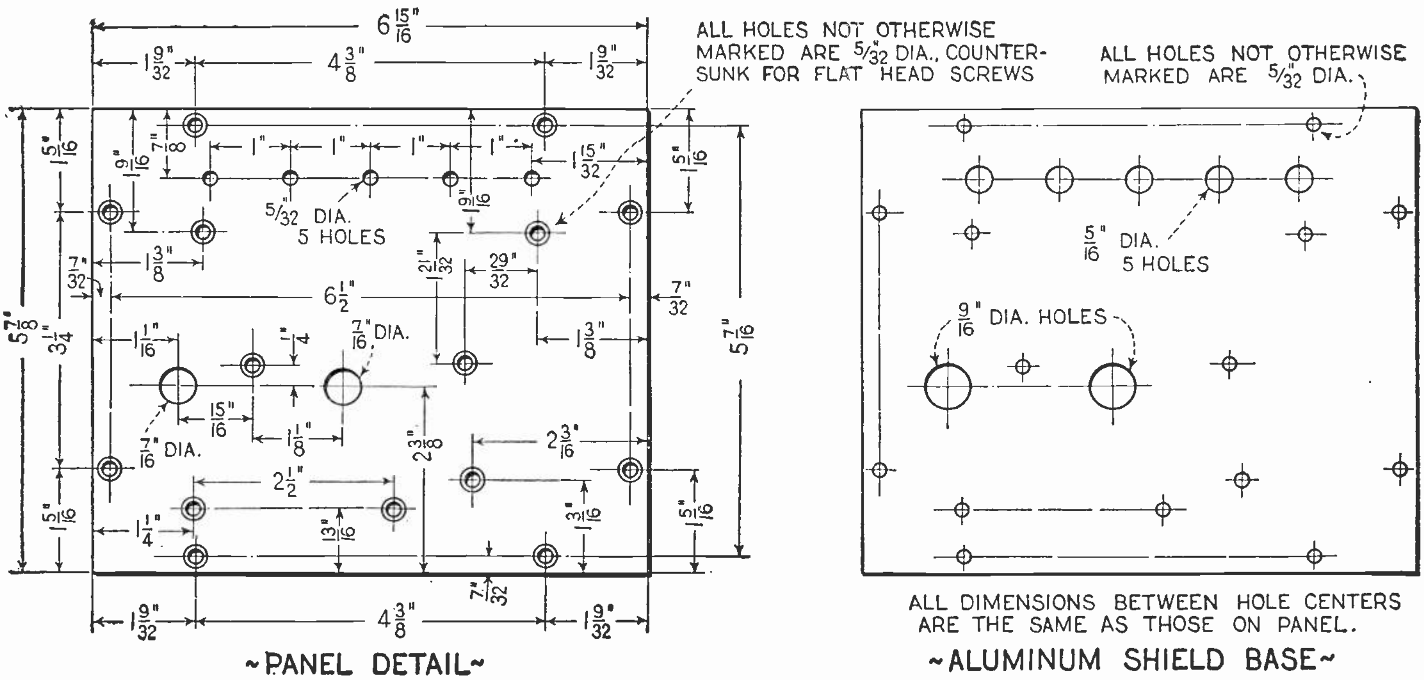
The terminals of the pick-up device are connected to the terminals of a plug. When this plug is inserted in the jack, J, the pick-up is thereby connected in the circuit of the pick-up coil, L, and at the same time the filament of the vacuum tube is lighted. The filament is controlled by a filament-ballast resistor, one side of which is connected to the metal shield.

The variable resistor, which has a value of 5000 ohms, is placed in the output circuit of the oscillator in order to cut down the

(*Continued on page* 58)



At the right are shown two views of the "pickup" device which converts mechanical energy into electrical. C1 is the stationary and C2, the movable, plates of the condenser, D is the damping device and T, the terminals.



The drilling details for the bakelite panel and the metal shield base of the El-Fonic adapter unit are given above.

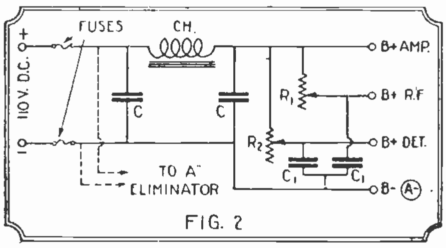
'A and B" Supply from Direct Current*

Socket-Power Units to Work With D. C. Lighting Are Easily Constructed

By H. B. WHIFFEN

A WEALTH of information has been published on "A" and "B" socket-power devices designed for use on alternating-current lines, and very few radio fans nowadays are not acquainted with the systems employed. However, very few data relative to those suitable for use on direct-current light lines have been available to them.

A direct-current "B" supply is a comparatively simple affair, as there is no need for a step-up transformer, a rectifier and a larger filter network, all of which are required in an alternating-current "B" unit. A small filter, comprising two fixed condensers and a single choke coil, is sufficient for suppressing the "ripple," which is created in the D.C. generator at the power house as the brushes pass from one segment of the commutator to the next. The 60-cycle hum in an A.C. light line is far more difficult to weed out.



Circuit diagram of the "B" supply unit of the eliminator. The dotted lines show the wires which lead to the "A" supply unit.

Step-Up Not Possible

The one disadvantage of a D.C. "B" supply is that the higher voltages, required for operating a power amplifier, cannot be had from the light mains. The usual voltage of a D.C. line is 110. Since there is a voltage drop through the filter system, the maximum voltage obtainable, with the device on load, is about 95 to 100. If a higher voltage is required, it will be necessary to connect batteries *in series* with the unit; that is, the user must connect the negative post of a "B" battery to the highest-voltage positive post on the power unit and use the free positive post of the "B" battery as the high-voltage terminal for the power amplifier. Obviously, any number of "B" batteries may be added to obtain the desired extra voltage.

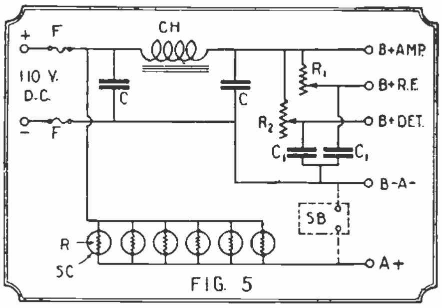
An important point relative to D.C. "B" devices is that, whatever the output voltage is, it will remain *constant*. In some A.C. devices the output voltage varies considerably with changes in the amount of current drawn by the vacuum tubes. On certain musical frequencies, and when the signals are very loud, the amplifier tubes will draw more than the usual amount of current. If the "B" voltage does not remain fairly constant, distortion will occur. In many cases, poor reproduction of low notes or "blasting" in the loud speaker is due to a drop in the output voltage because the rectifier is not capable of handling the excess load. Though the output voltage of a D.C. power unit is very seldom greater than 100 volts, one can be assured that under normal conditions it will remain 100 volts, even when the amount of current being drawn is comparatively excessive.

RESISTANCE TABLE						
TOTAL Nº OF TUBES	5 VOLT ¼ AMP TYPE	5 VOLT ½ AMP TYPE	TOTAL CURRENT CONSUMP. IN AMPS	Nº OF 440 OHM RESISTANCES	Nº OF 220 OHM RESISTANCES	TOTAL NUMBER OF RESISTANCES
1	1		¼	1		1
3	1	2	1¼	1	2	3
3	3		¾	1	1	2
3	2	1	1.0	2	1	3
5	5		1¼	1	2	3
5	4	1	1½	2	2	4
6	6		1½	2	2	4
6	5	1	1¾	1	3	4
8	8		2	2	3	5
8	7	1	2¼	1	4	5

FIG 4

The most suitable combination of resistances to employ for a given number of tubes may be determined from the above table.

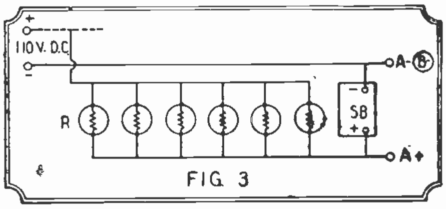
"A" power units for use on A.C. lines are necessarily more expensive devices, if they are to be at all satisfactory. An "A" supply of this type, in order to operate vacuum tubes with their filaments connected in *parallel*, must be able to deliver high amperage, anywhere from ¾ ampere to 2 or 3 amperes. To accomplish this, it is necessary to employ one or more large rectifier tubes, capable of passing a great amount of current, or else use the system which comprises a low-capacity storage "A" battery and a "trickle charger." The problem is greatly simplified when the filaments of the vacuum tubes in the receiver are connected in *series*; for in such a case (assuming that all of them are 201A's) only ¼ ampere of current is required. But as soon as a power tube is added, the size of the rectifier must be increased.



Schematic circuit diagram of the complete direct-current "A-and-B" unit. SB is a storage battery which is not essential, but may be connected in as shown and employed as a filter

An "A" socket-power supply for use on D.C. is an entirely different proposition. One of this type is very inexpensive, causes no bother, has no parts to wear out, and operetes extremely well with any type of set employing any combination of vacuum tubes with their filaments connected in *parallel*. The only requisites for its construction are a few lamp sockets and some heavy-duty fixed resistors.

Some of the D.C. "A" devices which have been used in the past, employ a choke in the positive lead for filtering out the commutator ripple. Though this method of eliminating the noise of the generator is fairly satisfactory, the chokes usually do not have sufficient *inductance* to act as perfect filters. The reason is simple; the wire used in the choke must be very large in order to handle the high currents delivered to the vacuum tubes; and consequently a choke of sufficient inductance would be too large and too costly to be practical. The method employed in the eliminator to be described is far more effective, and yet is not expensive.



Circuit diagram of the "A" socket-power unit, showing a storage battery on "floating charge." The battery is used as the filter.

How To Build the "A-and-B" Socket-Power Unit

The D.C. "A-and-B" device shown in the illustration (Fig. 1) was found to be perfectly satisfactory from all standpoints. Being quite an inexpensive and practical affair, it is well worth building, if you have the advantage of a D.C. lighting system. As can be seen in Fig. 1, the "B" portion of the device is mounted on the back of the

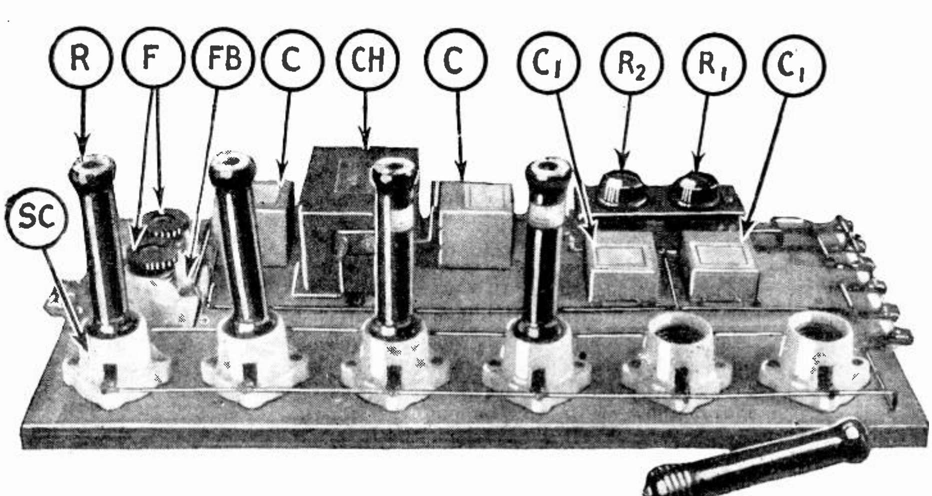
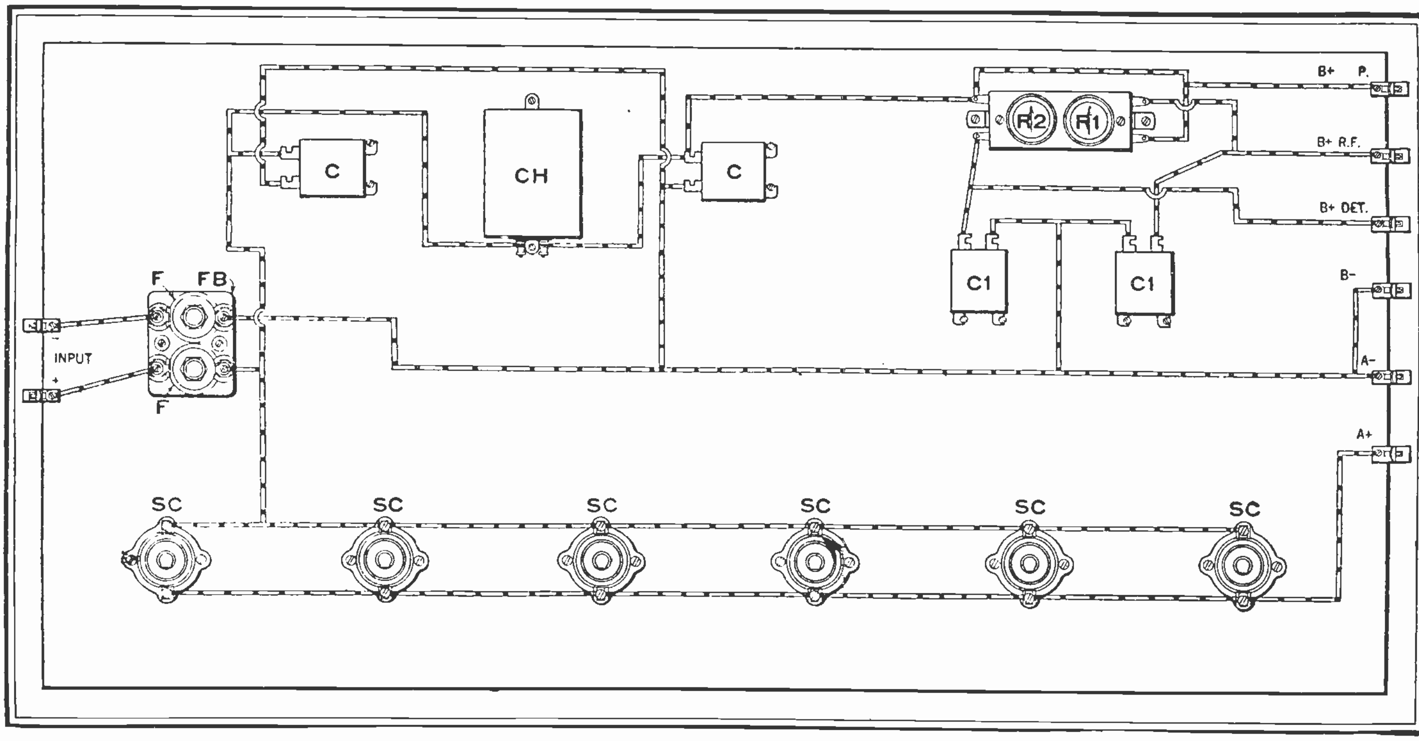


Fig. 1. A view of the completed layout. F are the fuses, FB the fuse block, C the filter condensers, CH the filter choke, R1 and R2 the variable voltage controls, C1 the by-pass condensers, SC the lamp sockets and R the special resistors.

*RADIO NEWS *Blueprint Constructional Article, No. 1.* (See page 109).



Layout wiring diagram of the complete direct-current "A-and-B" socket-power unit. This is comparatively simple to follow, as all the wiring is made on the top of the baseboard. F are the fuses, FB the fuse block, C the filter condensers, CH the filter choke, R1 and R2 the variable voltage controls, C1 the by-pass condensers, and SC the lamp sockets. All of the binding posts are marked. The parts are shown on a reduced scale for clearness in illustrating the wiring, which may be traced with a colored pencil, as completed.

board. It comprises two 2-mf. filter condensers C, a single "B"-unit-type choke coil CH, two variable resistors R1 and R2, two

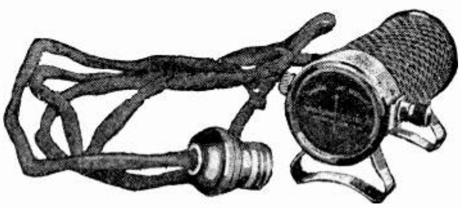


Fig. 6. A direct-current trickle charger which will deliver three-tenths (0.3) of an ampere to any six-volt storage battery. Incidentally, it can also be used for charging storage "B" batteries. (*Photo courtesy of Ward Leonard Electric Co.*)

0.5-mf. by-pass condensers C1, and a double fuse block. The two resistors R1 and R2 supply two variable voltage taps which can be used for the R.F. and detector tubes in the set. From 20 volts to maximum can be had on the first tap, and from 40 volts to maximum on the second. It is understood that these two taps will show a difference in voltage from the high-voltage tap *only when the unit is connected to the receiver and in operation.* In other words, until a load is placed on these two taps, the voltage of each will be practically equal to that of the third, irrespective of the position of the knobs R1 and R2. This is mentioned only as a reminder that, if you wish to measure the voltage at each of the three taps with a voltmeter, you should do so while the set is operating.

The two fixed condensers C1 serve to by-pass the radio-frequency currents around the variable resistors R1 and R2.

Nothing need be said relative to the assembling and wiring of this part of the apparatus, as the circuit diagram (Fig. 2) and the two detailed layouts shown give all the necessary information.

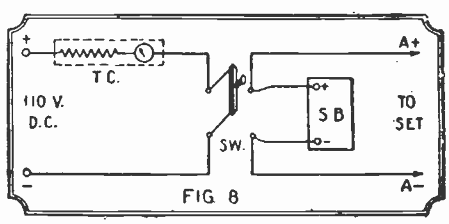
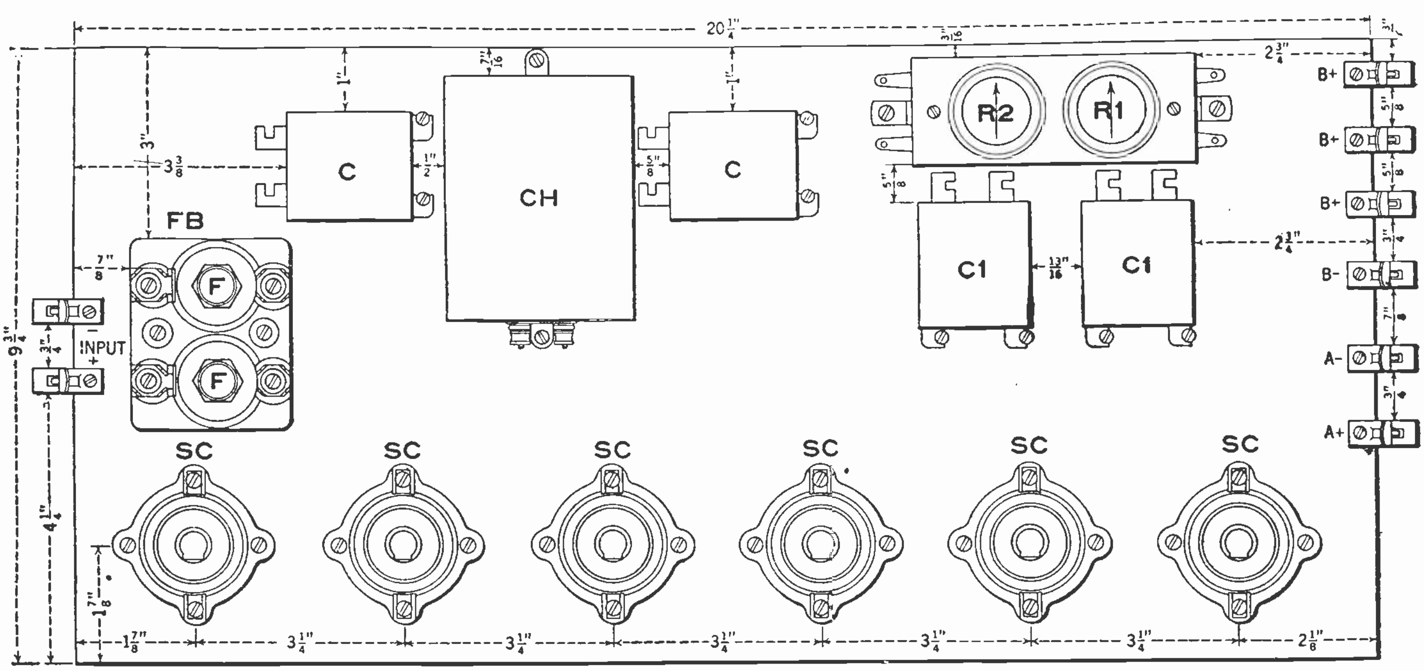


Diagram showing how the trickle charger is connected up with the D.C. line and the storage battery through the double-pole, double-throw switch.

Now let us consider the "A" supply part of the unit. It can be seen, from Fig.



Constructional and layout details of the D.C. socket-power unit. All the necessary dimensions are given. The parts may be mounted as shown and then wired as indicated in the large sketch above. The apparatus is lettered to correspond with the other illustrations and list of parts.

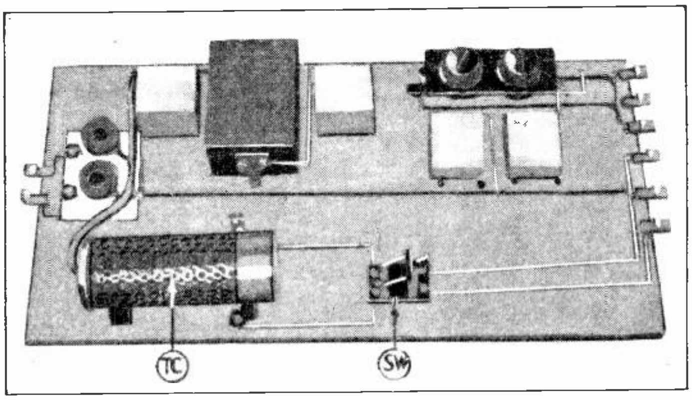


Fig. 7. A view of a slightly different type of device. The "B" unit remains the same, but the "A" unit in this case comprises a trickle charger and a double-pole, double-throw switch which is used in conjunction with a regular storage battery. This arrangement is the same as in the now well-known "A" Power Units.

1 and the constructional layouts, that it consists of merely six ordinary porcelain lamp sockets and a number of fixed-resistance units R. The wiring diagram is Fig. 3.

Use of Resistances

The idea is very simple. In the combination shown there are two 440-ohm resistors, three 220-ohm resistors and one 700-ohm resistor. The first type will pass ¼-ampere, the second type ½-ampere, and the 700-ohm resistor approximately ⅛-ampere. For a single 5-volt, ¼-ampere tube, one 440-ohm resistor is inserted into any one of the sockets; this will pass the required ¼-ampere. For two tubes of the ¼-ampere type, two 440-ohm resistors, or one 220-ohm resistor are employed and so on. The number of resistors required depends upon the number and type of vacuum tubes in your set. As an example, suppose four 5-volt, ¼-ampere tubes and one 5-volt, ½-ampere (power amplifier) tube are used. The total current drain will then be 1½-amperes. To supply this, three 220-ohm resistors are inserted in the sockets, or two 220-ohm resistors and two 440-ohm resistors, or six 440-ohm resistors.

Precautions

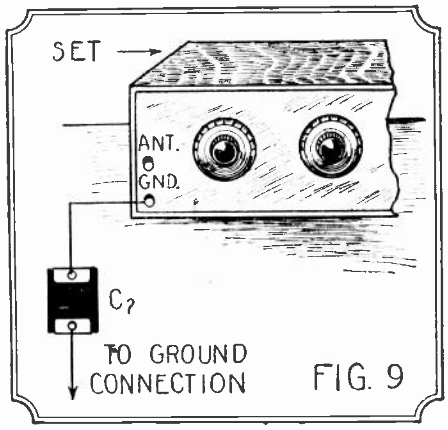
It is very important to remember that no vacuum tube should be taken out of its socket or the filament turned off while the "A" supply is working, unless one of the resistors R has been first removed. If a ¼-ampere tube is to be disconnected, one of the 440-ohm resistors should *first* be unscrewed from its socket. If a ½-ampere tube is to be disconnected, first remove one 220-ohm resistor. Failure to heed this may mean serious damage to the tubes; as they would, under such circumstances, be receiving too much current and an abnormal voltage. The 220-ohm and 440-ohm resistors are specified for the reason that it is often desirable to turn off one or both stages of audio-frequency amplification. The use of separate resistors makes this possible. At any rate, never have more resistors screwed into the lamp sockets than are required for the number of tubes in operation.

It is obvious that six lamp sockets will not be required in all cases; the number depends on that of the resistors employed. The table (Fig. 4) gives the type and number of resistors suggested for different tube combinations.

Filtering out the Ripple

On most D.C. lines, the generator ripple is not troublesome, or so intense that it is noticeable, during the reception of local stations. However, it is sufficient to interfere with the reception of distant stations. The simplest and most effective way to eliminate this ripple is to "float" a storage "A" battery on the line.

The battery is connected directly across the output of the "A" power unit (see SB in Fig. 3) and should be in a fully-charged condition. Since enough parallel resistors are employed to deliver the *exact amount* of current required by the tubes, the storage battery is neither charged nor discharged. When employing a storage battery as a ballast in this manner, there is little need to worry about the number of resistors screwed



When the D.C. supply is used in connection with your set, a small fixed condenser (C2) should be inserted in the ground lead, as shown. This is merely a protective measure.

into the sockets; as the battery will take up the excess current, if any. As a matter of fact, an extra 440-ohm resistor inserted into one of the sockets will provide a trickle charge for the battery while the set is operating. If, for some reason, one wishes to use the storage battery alone for lighting the tubes, assuming that it has sufficient capacity for the purpose, all that is necessary is to unscrew all the resistance units from the sockets; a turn or so will disconnect them. After use, the battery may be replenished; the set is turned off and one or more of the resistors screwed in. The charging rate can be regulated from ¼-ampere, with one resistor in circuit, up to an amount equal to the current drawn by all the tubes in the set, with all the resistors in use. The battery may be also put on trickle charge while the set is operating if another 440- or 220-ohm resistor is added. Here is where the 700-ohm resistor is useful. This unit will pass about ⅛-ampere, enough to keep the battery fully charged at all times. As previously explained, there is no actual current taken away from the battery; but a battery will slowly lose its charge if left idle. Whether the resistor should be left in circuit at all times during the operation of the set can be only determined by trial. Probably it should not, but much is dependent on the condition of the storage battery. Poor operation of the set may indicate that the battery is taking current from the tubes, because it is not fully charged. The use of the 700-ohm resistor should rectify the trouble in short order.

Experimenters who have storage "A" batteries can easily make a simple "A" Power Unit similar to the A.C. models now on the market. All that is necessary is a direct-current trickle charger (See Fig. 6) and a double-pole single-throw switch. With the switch closed and the set turned off, the battery may be left on trickle charge.

Protective Condenser

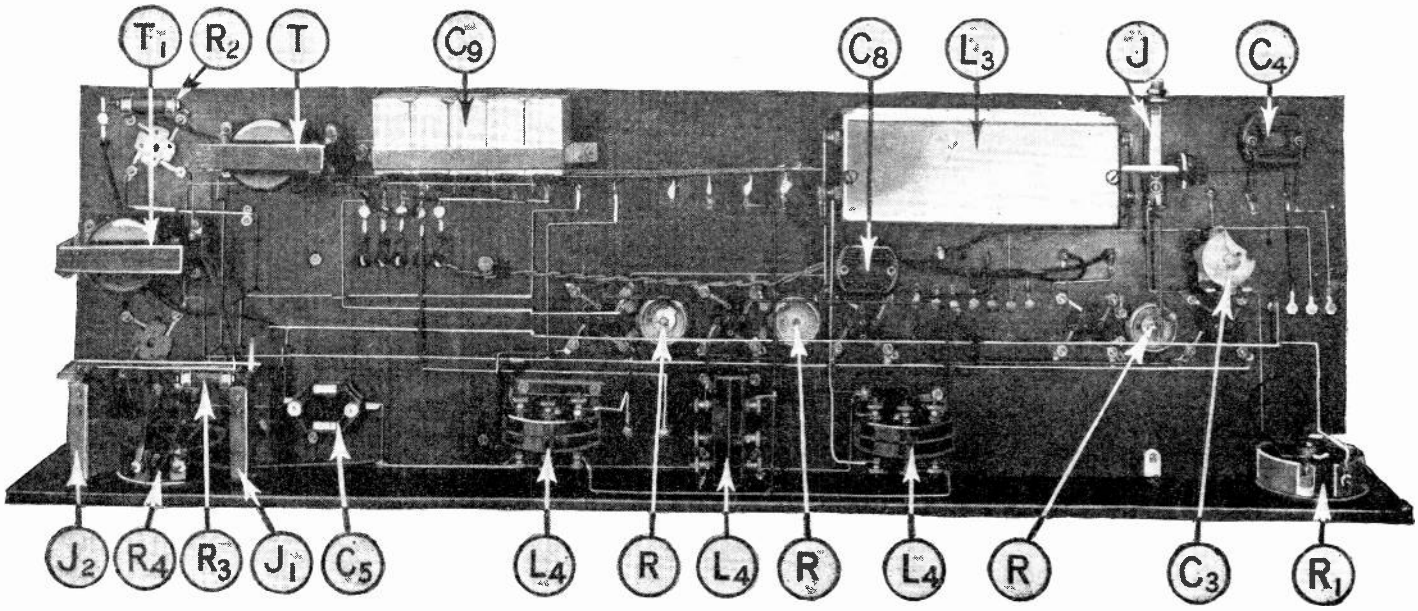
Since one side of a D.C. light line is grounded, it is essential to connect a .006-mf. fixed condenser *in series with the ground wire* to the receiving set, so that there will be no possibility of short-circuiting the 110-volt mains. This connection is shown in Fig. 9. As a special safety measure, the double-fuse block, employing 10-ampere fuses, is included in the "A-and-B" power unit.

SYMBOL	Quantity	NAME OF PART	VALUE OF PART	REMARKS	MANUFACTURER ★	
CH	1	Filter choke	30 or 60 H.	"B" Eliminator type	1	7, 8
C	2	Fixed condenser	2 mf.	Filter	2	3, 9, 10
C1	2	Fixed condenser	.5 mf.	By-pass	2	3, 9, 10
C2	1	" "	.006 mf.	Protective (See Fig.9)	3	9, 10
R	6	" resistance	(See table)	To fit lamp sockets	4	
R1	1	Var. resistance	10,000 ohms	Variable voltage control	3	11, 12
R2	1	" "	50,000 ohms	" " "	3	11, 12
FB	1	Fuse block		Double		Electrical Sup.
F	2	Fuse	10 amp.			" "
SC	6	Lamp socket		Standard size Porcelain		" "
	8	Binding posts			5	13
	1	Mounting board		20¼ X 9¼ inches		
	1	Insulating strip		4½" X 1¼" X 3/16".	6	14

NUMBERS IN LAST COLUMN REFER TO CODE NUMBERS BELOW.

1 Dongan Elec. Mfg. Co.	17	33
2 Tobe Deutschmann	18	34
3 Electrad, Inc.	19	35
4 Ward Leonard Elec. Co.	20	36
5 Fahnestock Elec. Co.	21	37
6 Amer. Hd. Rubber Co. (Radion)	22	38
7 Amer. Transformer Co. (Amertran)	23	39
8 Thordarson Elec. Mfg. Co.	24	40
9 Polymet Mfg. Corp.	25	41
10 Aerovox Wireless Corp.	26	42
11 Central Radio Labs. (Centralab)	27	43
12 H.H. Frost, Inc.	28	44
13 X-L Radio Lab.	29	45
14 Ins. Co. of America (Insuline)	30	46
15	31	47
16	32	48

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



A view of the completed Carborundum Superheterodyne receiver from directly beneath the sub-base. The metal case at the right rear contains the input filter I.F. transformer L3. C9 is a bank of five by-pass condensers connected into branch circuits. No difficulty should be experienced in recognizing and definitely locating all the parts, as each instrument is lettered to correspond with the rest of the illustrations.

The Carborundum Superheterodyne Receiver*

An Ultra-Sensitive Long-Distance Circuit Using a Crystal Second Detector

By DR. M. L. HARTMANN† and JOHN R. MEAGHER††

THIS superheterodyne has given better results in tone, volume and distance than any receiver which the writers have previously investigated. *Without aerial, loop or ground*, it brings in distant stations with more volume than an exceptionally good five-tube radio-frequency receiver working on an aerial in the same location. With either a loop or aerial the sensitivity and volume are almost unbelievable; so that its sponsors have no hesitancy in recommending this circuit to radio set-builders who want to get distant stations with excellent quality and volume to spare.

The circuit is the culmination of experiments extending over the past two years; it incorporates tuned-radio-frequency amplification, neutralization, regeneration, the superheterodyne principle and a crystal second detector. It adds the receiving range of a good superheterodyne to the receiving range of a "Roberts"-type circuit. The circuit has been made up in two different forms. One of these is completely shielded, while in the other this feature is applied only to the oscillator. Both sets are practically non-radiating and hence do not interfere with neighboring receivers. Construction of the unshielded model is relatively simple; so this form is recommended to the average set-builder and described here.

The circuit has eight tubes and a crystal second detector; there are one stage of neutralized tuned-radio-frequency amplification, a regenerative vacuum-tube first detector, an oscillator, three stages of intermediate-frequency amplification (at 2000 meters—150 kilocycles), a carborundum detector unit as second detector, and two stages of transformer-coupled A.F. amplification.

The neutralized T.R.F. stage is of standard design, a split plate coil and balancing condenser being used for neutralization. A rheostat is included in the filament circuit to afford a check on regeneration and self-oscillation of this first tube; this is a much smoother and less critical control than the neutralizing condenser, which is mounted on the sub-panel and used only for rough adjustment. A jack is arranged in the grid circuit for connection to a loop, while an antenna coupler is provided with suitable primary connections to accommodate aerials of different lengths.

The first detector does not utilize a grid condenser and leak. The grid return is brought through a "C" battery to the "A—." The pick-up coil is connected directly in the grid lead; actual test and comparison have proved this to be the best of a number of possible arrangements. It minimizes overloading of the first detector, as the grid-voltage operating range is appreciably extended. This is an important consideration, as the first detector must handle both the received and the locally-generated (oscillator) energy.

It will be noted that the "pick-up" coil leads are twisted; this makes them partially "non-inductive," so that they have less influence on other connections.

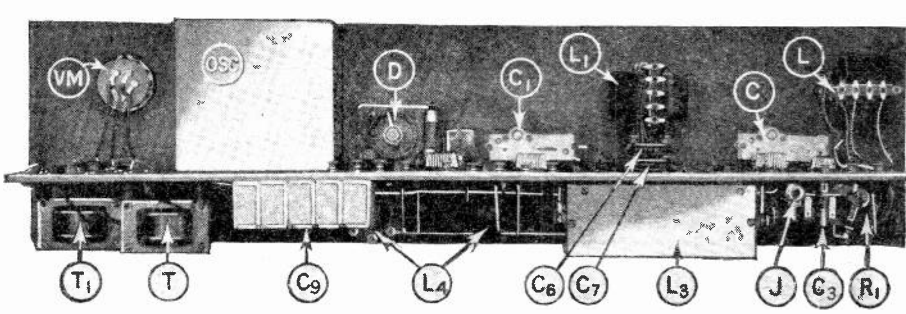
The regenerative feature of the first detector is very desirable, as it increases the receiving range. The regenerative control is used only on very distant stations; it need not be adjusted on locals or stations up to about 1500 miles.

Intermediate-Frequency Stages

The input I.F. transformer is designed with a small primary winding, so that a large fixed tuning condenser may be used; its secondary is also tuned and the over-all selectivity (when the I.F. amplifier is adjusted slightly below the point of self-oscillation) is such as to cut off only those frequencies differing by about 10 per cent or more from the intermediate frequency. As a result, all the audio-modulated frequencies ("side-band" components of the intermediate frequency) are passed through the amplifier without suppression; therefore no distortion takes place.

The input (instead of the output) of the amplifier is tuned for two reasons: first, so that the primary of the input I.F. transformer may be shunted with a sufficiently large tuning condenser to "by-pass" both the oscillator and received frequencies; second, because it is possible to secure better selectivity, by first selecting the desired frequency and amplifying only this frequency, than by amplifying the desired frequency *together with* interfering frequencies and then endeavoring to pick the desired frequency from the amplified interference.

The intermediate frequency of 2000 meters



The rear of the set. This provides an excellent view of the instruments on the panel and both the under and upper sides of the sub-base. The small square condenser at the right of the carborundum detector D should be disregarded.

†*Research Director, Carborundum Co.* ††*Radio Research Engineer, Carborundum Co.*

Complete schematic diagram of the Carborundum Superheterodyne. All instruments are lettered to correspond with the illustrations.

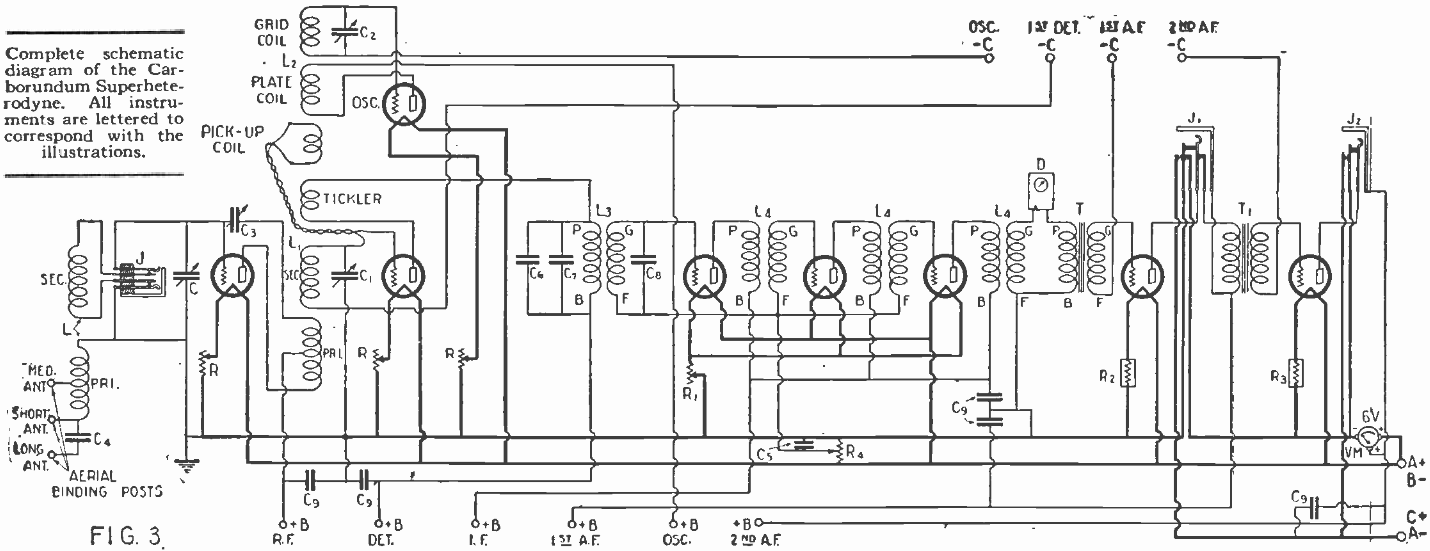
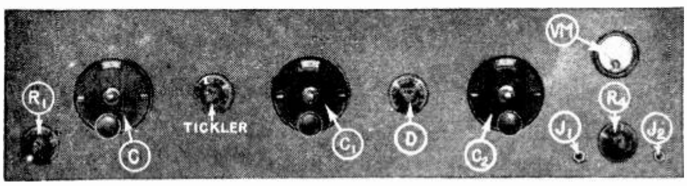


FIG. 3

was selected because it separates the oscillator frequency sufficiently from the signal frequency to eliminate detuning and erratic operating effects.

The intermediate-frequency amplifier itself is of standard design and employs potentiometer grid-bias for control of self-oscillation and regeneration.



Panel view of the completed receiver; C, C1, and C2 are the principal controls.

The Crystal Second Detector

The second detector circuit includes the secondary of the last I.F. transformer, a carborundum detector unit and the primary of the first A.F. transformer; its low-voltage side is grounded to the "A—" lead.

The effective capacity of the detector unit is such that the instrument may be connected to an intermediate-frequency transformer of the same type as that connected between the intermediate-frequency amplifying tubes. Therefore, all three intermediate-frequency transformers are of the same make.

The fixed carborundum detector is in series with an adjustable bias, the value of which is controlled by the potentiometer. When the external detector circuit is completed through the primary of the first A.F. transformer and the secondary of the third I.F. transformer, a portion of the biasing voltage is impressed across the detector. Adjustment of this bias serves to regulate the normal resistance or impedance of the detector over wide limits. The proper value may be selected for best results while a distant station is being received.

In this superheterodyne circuit the unit adjustment is not at all critical; in fact the carborundum detector alone may be used if so desired, or if space is limited. The particular advantage of the entire unit is that it makes this portion of the circuit foolproof. It also prevents self-oscillation of the A.F. amplifier which might be caused by an open circuit across the primary of the first audio transformer. Some readers may have noticed that the removal of the detector tube preceding an A.F. amplifier frequently causes the amplifier to oscillate. Replacement of the tube puts the plate-filament resistance across the transformer primary; and this tends to absorb energy, or form a load on the amplifier, which prevents self-oscillation of the amplifier. Similarly, an ordinary fixed crystal detector followed by an A.F. amplifier may have resistance so high that it does not form a sufficiently high load on the amplifier. However, with the bias provided in the detector unit, the resistance of the detector may be decreased until it produces the desired action.

The audio-frequency amplifier is of the usual transformer coupled design. Automatic filament controls are used on the two amplifier tubes. Adjustable rheostats are used on the other six tubes.

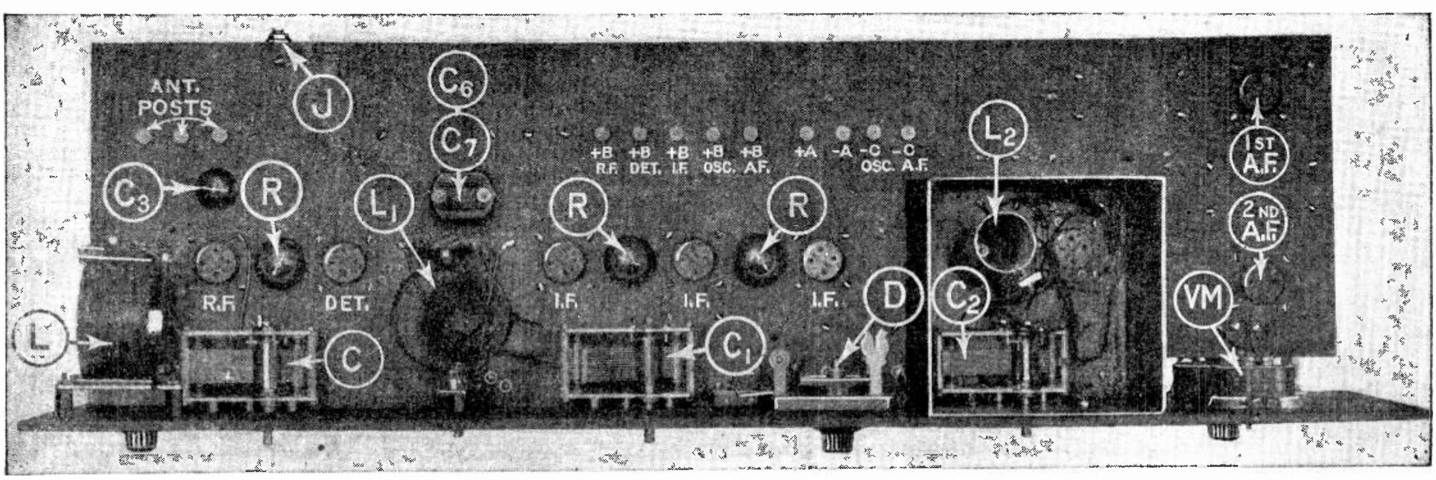
Separate "B" and "C" battery connections are provided wherever necessary. This affords great flexibility in the choice of tubes and allows maximum efficiency to be secured from each section of the circuit.

The Transformer

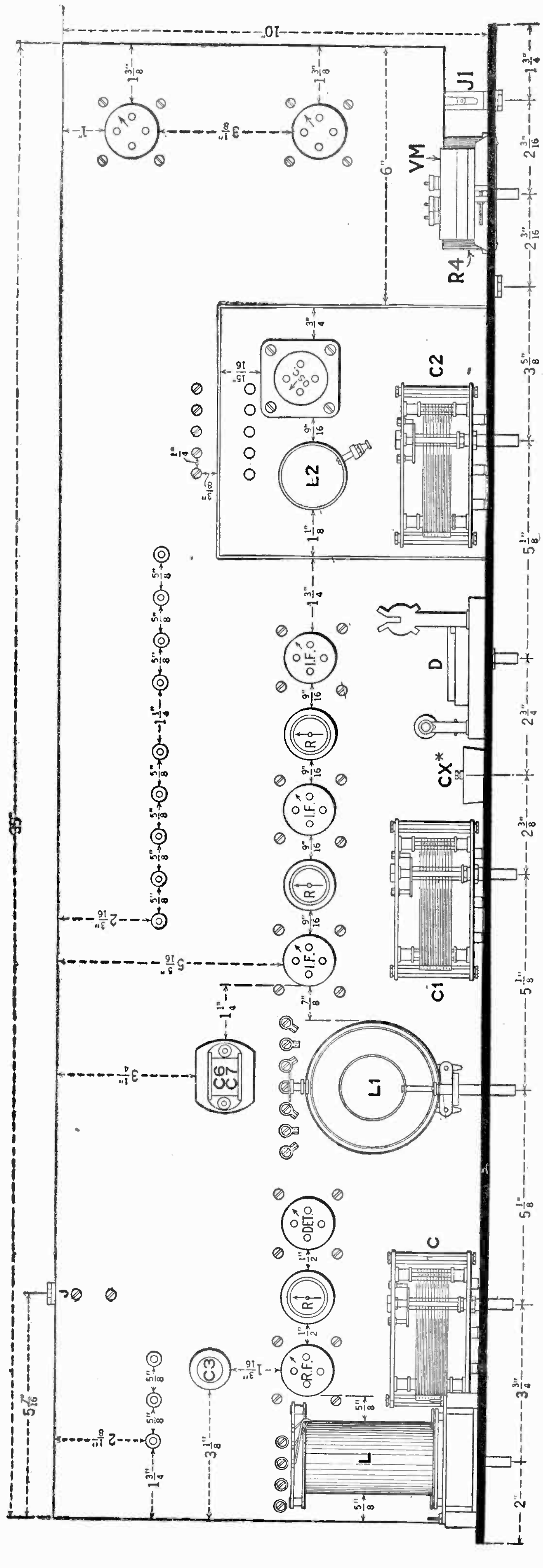
The antenna circuit and regenerative T.R.F. transformers are similar to those used in the "Roberts" circuit. These transformers may be constructed from the specifications given below, or, if desired, regular Roberts-circuit transformers may be purchased.

Antenna circuit transformer: Form 3-inch tube, 3 inches long; secondary, 45 turns No. 24 D.C.C. wire; primary, 20 turns No. 30 D.C.C., tapped at center and wound over filament end of secondary. The primary should be separated from the secondary by a few layers of paper or strips of cardboard.

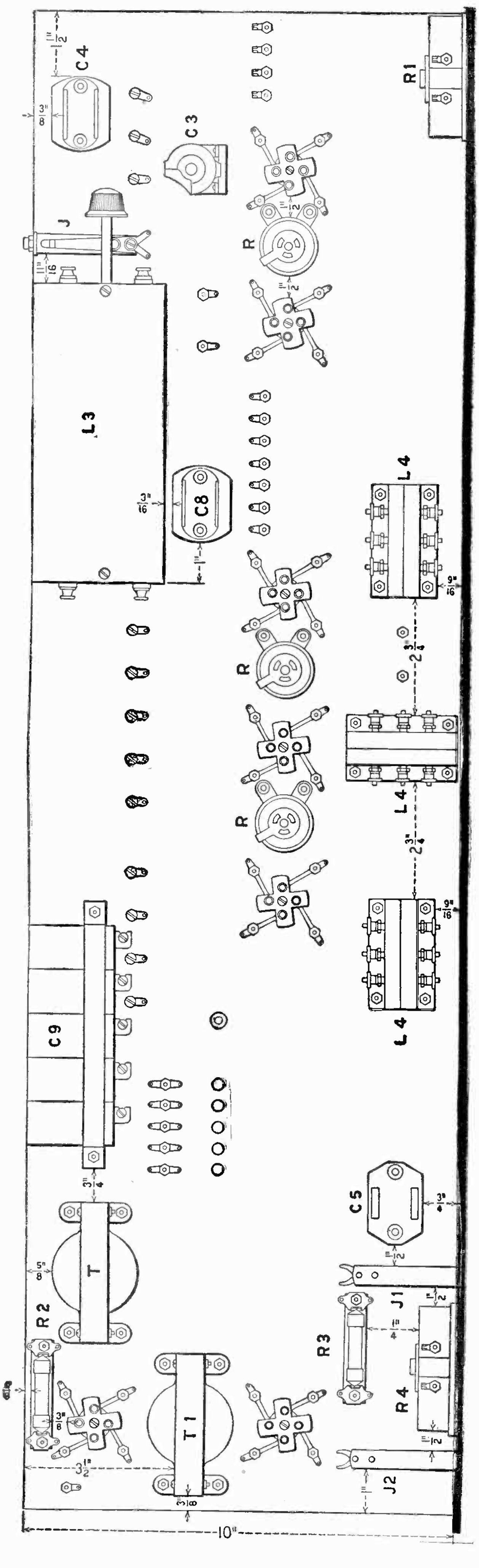
Regenerative transformer: Form 3-inch tube, 3 inches long; secondary, 45 turns No. 24 D.C.C.; plate coil, 30 turns No. 30 D.C.C., tapped at center and wound over filament end of secondary. (The plate coil should be separated from the secondary by a few layers of paper or strips of cardboard). Tickler, 30 turns No. 30 D.C.C. on a 1-inch tube, 1 inch long. The tickler should be mounted in adjustable inductive relationship to the grid side of the secondary. (Its small size obviates detuning effects). Flexible leads, preferably tinsel



A top view of the Carborundum Superheterodyne receiver with the cover removed from the shield to show the disposition of the instruments composing the oscillator. Note that all the binding posts are lined up immediately behind the I.F. tube sockets.



Above is shown the arrangement of the apparatus on top of the sub-panel; and below is the arrangement beneath the sub-panel, for the carborundum superheterodyne receiver.
*The fixed condenser, CX, in the sketch above should be disregarded; this is included in the base of the carborundum detector unit.



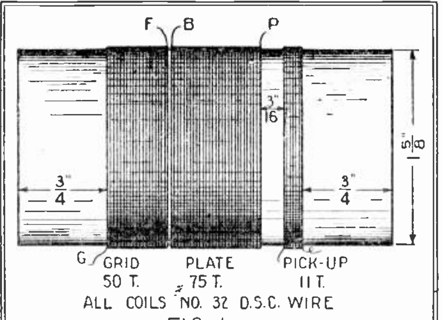


FIG. 1

Constructional details of the oscillator coupler (L2) which is housed within the metal shield.

braid, should be provided for connection to the tickler.

Oscillator coupler: The oscillator in this circuit must cover a range from about 222 to 431 meters (200 meters minus the intermediate frequency, or 1500 kc. minus 150 kc.—to 550 meters plus the intermediate frequency or 545 kc. plus 150 kc. It is better, however, to have the range extend from about 180 to 431 meters, so that a different setting of the oscillator condenser may be used for each received wavelength. This extended range is secured with the oscillator coupler specified in Fig. 1.

Input intermediate-frequency transformer: The constants given in Fig. 2 enable this transformer to be tuned to 2000 meters with fixed condensers of approximately the capacity indicated (see list of parts). The method of tuning this transformer will be described later.

The form for the input transformer may be built up from alternate wooden discs, 1-inch and ½-inch in diameter and ¼-inch thick; or it may be turned out of a solid block of wood or hard rubber.

The coils should be wound haphazard; that is, with no effort to place the turns side by side. The coils may be dried out in a warm open oven and given a light coat of collodion, which should, however, be used sparingly, as it has comparatively low resistance.

All of the home-made transformers should be provided with terminals consisting of short round-head 6/32 machine screws, nuts and soldering lugs.

The intermediate-frequency transformers: Fixed T.R.F. transformers (500-5000 meters) were used in this circuit. Other makes of transformers may be used if they cover the 2000-meter range.

Bear in mind that the amplifying peak of a fixed broadly-tuned transformer, as usually rated on the manufacturer's test, is not necessarily the best wavelength for an amplifier using these transformers. The best wavelength is that at which the amplifier tends to oscillate; and this wavelength may be quite different from the rated transformer peak.

Actually the wavelength at which the amplifier tends to oscillate, when fixed broadly-tuned transformers are used, is dependent to a great extent upon the tuning of the input transformer. The amplifier generally oscillates at the wavelength to which the secondary of the input I.F. transformer is tuned.

If I.F. transformers having a wavelength including the 2000-meter range are not available, any good transformers with a wavelength between 1000 and 3000 meters may be used. In this event it is necessary first, to tune the input I.F. transformer to the rated wavelength of the other transformers; second, either to remove a few turns from the grid coil of the oscillator coupler, if the intermediate frequency is below 2000 meters, or to add a few turns to the grid coil, if the intermediate frequency is above 2000 meters. In general, we recommend an intermediate frequency below, rather than above, 2000 meters. When the superheterodyne is not shielded the I.F. transformers themselves should be shielded or else have a partially-closed iron core. If the superheterodyne *is* shielded, the I.F. transformers may be of any suitable make, iron- or air-core, shielded or not shielded.

The I.F. transformers may be constructed if desired, according to the specifications given here for the input transformer. The secondary condenser should be omitted, though primary condensers of the same value as used on the primary of the input transformer should be employed.

The front panel of the receiver is 9x36 inches; the sub-panel is 10x35 inches.

The disposition of parts is clearly shown in the illustrations. The metal case shown in the top view enclosed the oscillator coupler, oscillator variable condenser and oscillator tube. It has a removable cover and is 6x6x6 inches. The knobs of the I.F. oscillator and first detector filament rheostats, and of the neutralizing condenser, are also shown in this top view.

The long metal case enclosing the input I.F. transformer is shown in the bottom view. The adjustable-coupling feature of this transformer has been found of no advantage. In this same view may be noted the holes through which connections are brought from the oscillator, and the long twisted leads connecting the pick-up coil to the grid circuit of the first detector. The loop circuit jack is mounted at the rear of the sub-panel, so that the loop connections are kept free from the front of the panel and the operator's hands.

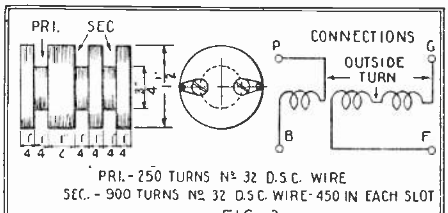


FIG 2

Constructional details of the special input-filter intermediate-frequency transformer. Note that the secondary is wound in two sections.

This set may be operated without loop, aerial or ground, the antenna and detector-circuit transformers acting as the pick-up medium. The first-R.F. and the first-detector tuning-condenser controls are not critical on nearby stations; the selectivity, however, is excellent.

General Construction

Before laying out the panels: All the parts should be secured before the panel is laid out. *Each part should be carefully*

SYMBOL	Quantity	NAME OF PART	VALUE OF PART	REMARKS	MANUFACTURER ★	
C,C1	2	Variable cond.	.0005 mf.	SLF type	2	5,11,17,19,23,48
C2	1	" "	.00035 mf.	SLF type	2	5,11,17,19,23,48
C3	1	" "	32 mmf.	Neutralizing	5	11,17,19,20
C5	1	Fixed "	0.1 mf	By-pass	3	4,21,22,24,25
C9	5	" "	1.0 mf.	" "	3	4,21,22,24,25
C4	1	" "	.0001 mf.		4	21,22,24,25
C6	1	" "	.0005 mf.	Filter condenser	4	21,22,24,25
C8	1	" "	Approx. .0001 mf.	Capacity determined by trial	4	21,22,24,25
C7	1	" "	.00025 mf.	Input filter	4	21,22,24,25
L	1	Ant. coupler		T.R.F. trans. type	5	26,27,12
L1	1	R.F. Trans.		With tickler coil	5	
L2	1	Oscillator coup-		Special		Hand-made
L3	1	I. F. Trans.	150 K.C.	Input filter	6	28,29
L4	3	I.F. Trans.	150 K.C.	Tuned, fixed	6	28,29
T,T1	2	A. F. Trans.			40	9,18,19,23
D	1	Crystal detec.		Carborundum unit	1	
VM	1	Voltmeter	0-7,0-140	"A"&"B" readings 3 post type	7	31,32,33
R	3	Rheostats	20-ohms		8	2,9,21,24,34,35
R1	1	Rheostat	10-ohms		8	2,9,21,24,34,35
R2	1	Auto.Fil. Cont.	6v.¼ amp.	For first A.F. tube	10	36,37,2
R3	1	" " "	6v.½ amp.	For Semi-Power tube	10	36,37,2
R4	1	Potentiometer	400-ohms		9	2,21,24,34,35
J	1	Jack		Double circuit type	11	8,9,34,38
J1	1	"		Double cir. fil. control	11	8,9,34,38
J2	1	"		Single " " "	11	8,9,34,38
	8	Sockets		UX type without base	12	9,11,18,39
	12	Binding posts			13	2,39,41
	1	Panel		36 X 9 X ¼ inches	14	41,42,43
	1	Sub-Panel		35 X 10 X ¼ "	14	41,42,43
	1	Metal case		6 X 7 X 7 " Aluminum	5	
	3	Dials		Vernier	16	11,18,19,15,48
	1	Vacuum tube	6v. ½ amp.	Semi-Power Amplifier	6	36,44,45
	7	Vacuum tubes	6v. ¼ "	Standard type	6	44, 45, 46
	1	Loop		Optional for .0005 mf. cond.	8	47

NUMBERS IN LAST COLUMN REFER TO CODE NUMBERS BELOW.

1 Carborundum Company	17 Gardiner & Hepburn, Inc.	33 Burton Rogers Co.
2 Amsco Products, Inc.	18 Bremer-Tully Mfg. Co.	34 H.H. Frost, Inc.
3 Tobe Deutschmann Co.	19 Samson Elec. Co.	35 Central Radio Labs. (Centralab)
4 Sangamo Elec. Co.	20 Allen D. Cardwell Mfg. Corp.	36 Daven Radio Corp.
5 Hammarlund Mfg. Co.	21 Aerovox Wireless Corp.	37 Langbein-Kaufman Radio Co.
6 Radio Corp. of America	22 Leslie F. Muter Co.	38 Millimeter Mach. Wks.
7 Weston Elec. Inst. Co.	23 All American Radio Corp.	39 H. H. Eby Mfg. Co.
8 Carter Radio Co.	24 Polymet Mfg. Corp.	40 Federal Radio Corp.
9 General Radio Co.	25 Electrad, Inc.	41 Ins. Co. of America (Insuline)
10 Radiall Co. (Amperite)	26 Aero Prods., Inc.	42 Amer. Hard Rubber Co (Radion)
11 Pacent Elec. Co.	27 University Radio Co.	43 Diamond State Fibre Co. (Celeron)
12 Benjamin Elec. Mfg. Co.	28 Madison Radio Corp.	44 E.T. Cunningham, Inc.
13 X-L Radio Labs.	29 Geo. W. Walker Co.	45 C.E. Mfg. Co. (Ceco)
14 Formica Insulation Co.	30 Silver-Marshall Co.	46 Sonatron Tube Co.
15 Kurz-Kasch Co.	31 Jewell Elec. Inst. Co.	47 English Whitman Prods.
16 Martin Copeland Co. (Marco)	32 Beede Elec. Inst. Co.	48 National Co., Inc.

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

tested with a headset and 22½-volt "B" battery to determine whether it is satisfactory. In addition, all bolts and nuts on the parts should be tightened and, if possible, equipped with lock-washers.

The front panel should be rigidly fastened to the sub-panel with radio angle-brackets, extending the full height and depth of the panels.

The filament circuit should be wired first and tested before anything else is done. The grid and plate circuits are next in order. Different-colored wiring may be used for the filament, grid and plate circuits. The oscillator shield should be connected to the "A—."

Tuning

When the set is wired and ready for operation a spare .0005- or .00035-mf. variable condenser should be connected temporarily across the secondary of the input I.F. transformer (in the place indicated for C8) and set at zero, or minimum capacity. When a distant station has been tuned in the capacity of this variable condenser should be increased slightly, and the oscillator condenser and I.F. potentiometer, (R4) readjusted for best results. This action should be repeated in small steps up to the full capacity of the variable condenser. Careful comparison should be made of the volume at different settings, and that adjustment of the variable condenser which gives the best results should be retained. The capacity of the condenser at this setting may be estimated and a fixed condenser of approximately the same value substituted and permanently connected across the secondary, (of the input I.F. transformer).

This condenser value is *not* critical, because broadly-tuned transformers are used in the rest of the amplifier and because it is practically impossible to detect a difference in audibility of less than 25%. The main idea of this procedure is to tune the secondary to the wavelength of the primary.

In tuning, after the input I.F. transformer has been adjusted as described above, it will be found that the oscillator condenser (C2) is most critical and requires careful adjustment. The two other variable condenser are relatively broad in tuning, but they must be set properly in order to bring in distant stations. We have thus the paradox of a broadly-tuned set that is sharply selective.

After tuning in a distant station, adjust the radio-frequency rheostat to the most sensitive point, and make slight readjustment of the aerial tuning condenser C if necessary.

Likewise, when receiving very weak signals, adjust the tickler of the first detector and retune the R.F. variable condenser C1.

The detector unit may be set for best results, while a distant station is being received, and then left alone. Similarly, the I.F. potentiometer may be set for nearly maximum sensitivity and then left alone; if its slider is set too closely to the negative side, the I.F. amplifier will oscillate and the set will apparently go dead. In this case, when the trouble is recognized, it is necessary merely to readjust the potentiometer until the I.F. amplifier is operating slightly below the point of self-oscillation.

It should be remembered that there are three self-oscillation controls: the radio-frequency rheostat, the tickler of the first detector and the I.F. potentiometer. Proper results can not be secured if any one of these controls is set above the oscillating point. Yet it is necessary, in order to secure maximum amplification, that each of the three sections (R.F. amplifier, first detector and I.F. amplifier) governed by these controls be capable of regeneration and self-oscillation. Normally each control is smooth and quiet in operation.

Tubes and Batteries

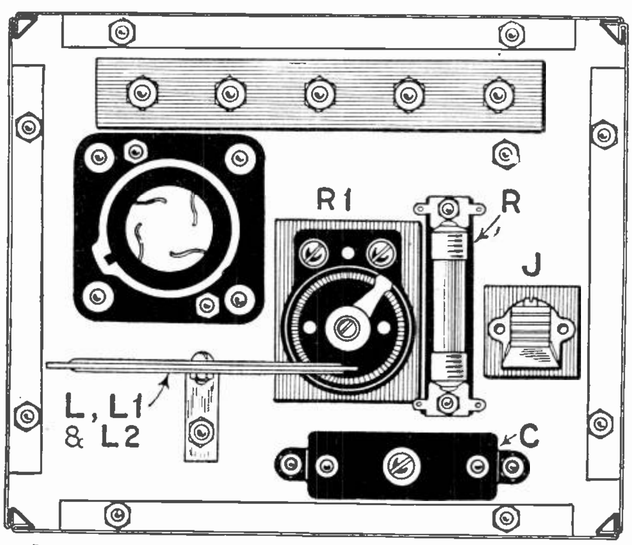
We recommend the use of 201A-type tubes in all except the last audio-frequency stage, where a 112-type tube is best. With this combination the following (approximate) "B" voltages have given good results: 60 volts on the first R.F. and on the I.F. amplifier; 40 to 60 volts on the first detector; 135 volts on the oscillator and on the first audio; 135 or 160 volts on the second audio. The corresponding "C" voltages are: 7½ volts on the oscillator and first audio; 9 or 11 volts on the second audio; 0 to 7½ volts on the first detector. The circuit is so arranged that with *good* tubes there is no necessity for matching or changing them around for best results.

The El-Fonic Adapter Unit

(*Continued from page* 50)

volume to such an extent that it will not overload the radio-frequency amplifier tubes. The pick-up is designed to be used feeding directly into a detector tube and, if there is any amplification before the detector, there must be inserted some device like the resistor, R1, to reduce the output. If this is not done the music reproduced in the loud speaker will be mushy and distorted, clearly a case of overloading.

The operation of the set is far from difficult. The antenna and ground binding posts of the adapter are connected to the antenna and ground posts of the radio receiver, the plug is inserted in the jack, thus lighting the filament of the tube, and the pick-up is placed on the revolving record of the phonograph. If there is a whistle superimposed on the music the condenser, C, should be varied until this disappears.



Illustrating the arrangement of apparatus on the panel of the small El-Fonic Adapter Unit. Drilling dimensions are given on a previous page.

are excellent. An outfit of this kind will be found to be just the thing for summer dancing when the ordinary small portable phonograph does not deliver enough volume for a good-sized dance floor. For the highest quality of reproduction from this combination, however, a loud speaker of real merit is necessary.

The author has devised also the Phono-Radio Receiver, which may be used as a reproducer of phonograph records or, by the throwing of two switches, is converted into an effective broadcast receiver. It incorporates a special amplifier of high quality.

Doubtless many other combinations of a radio receiver and the capacity type of pick-up will suggest themselves to the keen-minded radio experimenter. There are many radio receiving circuits which will adapt themselves admirably to a combination of this kind; but it should be born in mind by the constructor that, in order to get the best results that are possible with this device, it is necessary to have an audio-frequency amplifier and a loud speaker of the highest possible types.

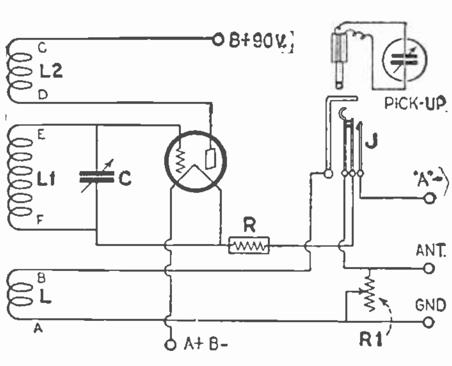
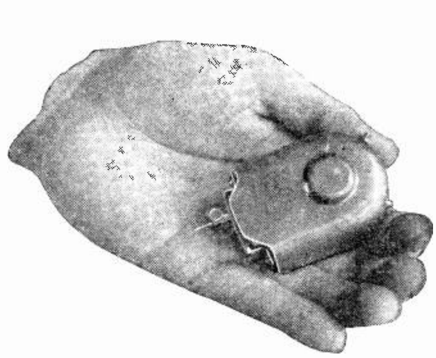


Fig. 1 The schematic diagram of the unit. The terminals of the coils are lettered for clarity.

If the music is distorted try varying the variable resistor, R1. If this does not clear it up entirely the fault is not in the adapter, but somewhere in the receiver; more than likely in the A.F. amplifier.

With the average five-tube, tuned-radio-frequency receiver, the results obtained with the El-Fonic adapter should be far superior to the average phonograph; the volume should be greater and both the high and low notes should come through with a snap and brilliancy not found ordinarily. This adapter lends itself admirably to portable outfits also. Many portable radio receivers on the market today will give loud-speaker volume and, when this adapter is used with one of these and a portable phonograph, the results


This shows the comparative sizes of the pick-up device and a man's hand. The two terminals are seen beside the thumb and forefinger.

A Versatile Superheterodyne

A Unit-Construction Superheterodyne of Increased Flexibility

By LESLIE RAYMOND JONES

IS THERE anything more disheartening to the live experimenter than the realization that, so far as changing or trying out any new stunts on his wonderfully finished product is concerned, he is absolutely licked; unless he wants to rip practically the whole thing apart and make it over, as we all have done in the past?

Suppose that, after some elaborate change you have made upon reading some convincing article, which propagated a "new stunt" that "surely" works, you gradually come to

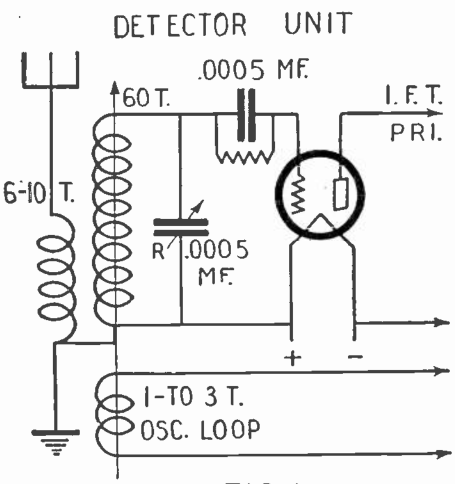


FIG. 1

Circuit diagram of first-detector unit employing a grid leak and condenser for obtaining grid bias.

the conclusion that it does not seem to work that way for you. What are you going to do about it? You will have to go all over it again, and finally arrive just where you started from.

Now just think how nice it would be simply to open the cover, disconnect two or three wires and—"presto"—the unit comes out and we can change that particular part just as we wish. Back goes the unit and we sit down again and listen to some thrilling aria from the opera while we take up our everlasting search for an improvement or a new "kink," none the worse for our little experiment. And, furthermore, the set is none the worse for it, either. We haven't harmed the panel by drilling extra holes or damaged the balance of any of the other parts of the circuit in any way.

Unit Construction

The superheterodyne described here is just an ordinary one with a few special features that, while not in themselves new, are relatively little used. Versatility, or flexibility, is obtained in this receiver by building each unit on a separate baseboard of its own. All connections to other units are made to clips, the method best adapted to this style of construction.

This means then, that separate units are to be built for the first detector, the intermediate amplifier, the second detector, the audio amplifier, and the oscillator.

The big advantage of this scheme is that if, for instance, we decide to try a new kink or stunt on any one of these we can easily do it by simply disconnecting that particular unit, removing it from the cabinet for the work to be done upon it. Upon completion it is replaced in the cabinet, the clips reconnected and the receiver is none the worse for the experiment or change made upon it.

The apparent simplicity of construction is also real. Each unit can be tested and balanced up to its highest point of efficiency.

Another decidedly worth-while advantage is the panel arrangement. Even as it is arranged here we have enough apparatus on it to adapt it admirably to almost any possible change you wish to make. And in the meantime, the outside of the set is uniformly neat and attractive.

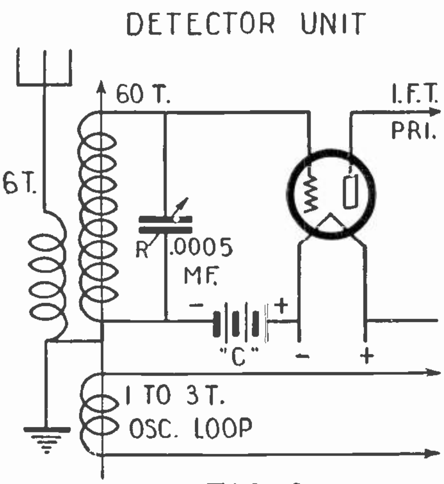
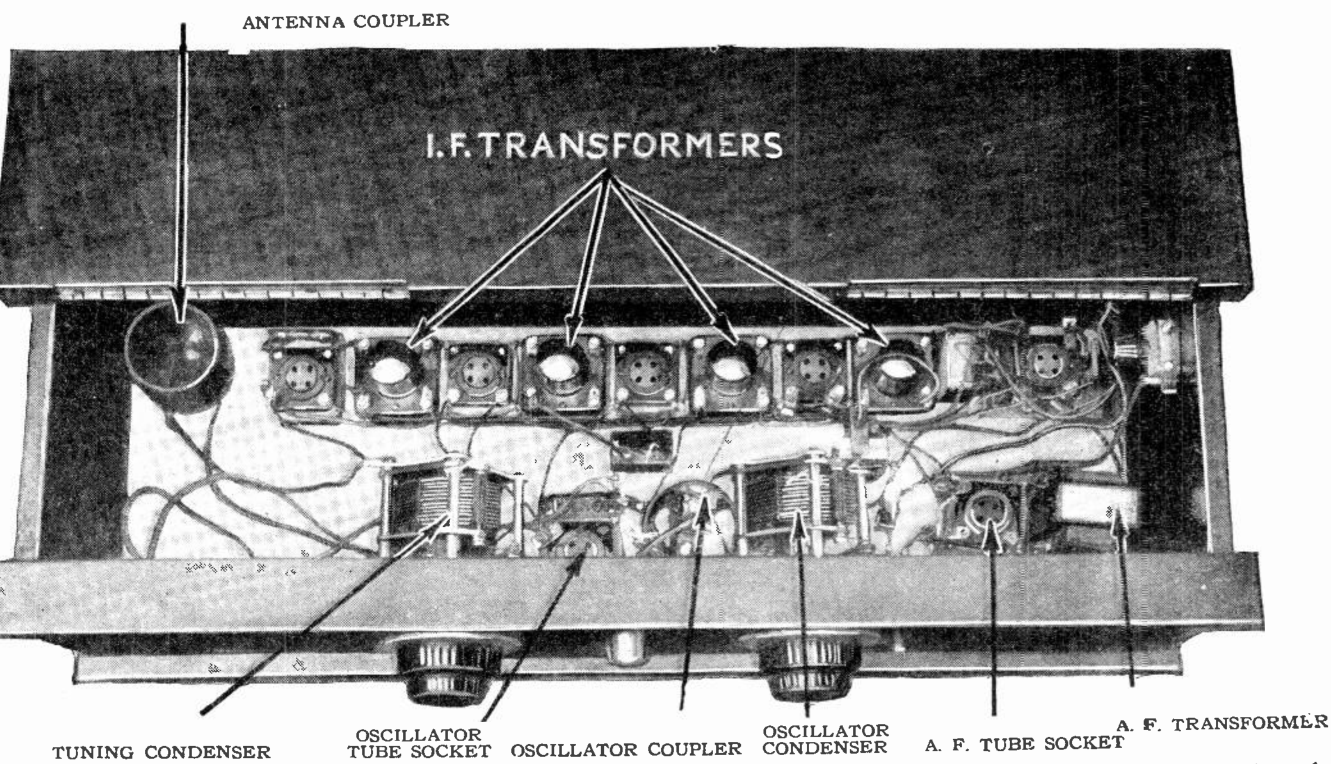


FIG. 2

A first-detector unit employing a "C" battery, instead of a grid leak and condenser, for the grid bias.

On the panel are mounted: Two .0005-mf. double-section variable condensers; one battery switch; one 300-ohm potentiometer; one pilot light; one single-circuit jack; two dial markers or pointers; two vernier dials, 4-inch type.

The elimination of many parts, such as jacks and switches, will add to the efficiency of the set. Whatever jacks are used, be sure to use the best and thoroughly inspect



Clip-leads are used for connections throughout this experimental superheterodyne receiver, so that new circuits and apparatus may be tried with little difficulty, and the original hook-up easily restored in a few minutes, if preferred.

DETECTOR UNIT

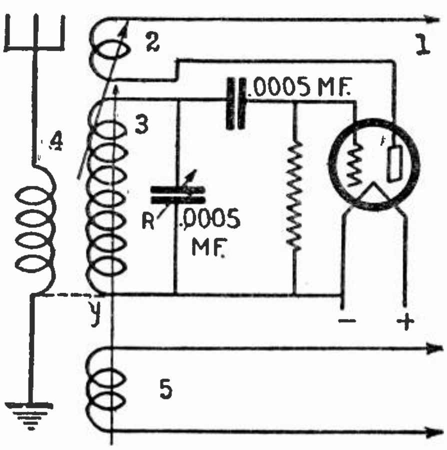


FIG. 3

A first-detector unit wherein regeneration is employed through the use of the ten-turn tickler coil.

them for contact and insulation. A good jack should have long phosphor-bronze springs and well defined points of contact, also a flexible action to follow up the spreading or closing action.

With the one-stage amplifier used here and a good loud speaker, anything that can be heard on the phones clearly can be heard on the speaker, unless extreme distance is desired. In this case either the detector circuit can be tapped by the clips on the output jack or you can plug in directly on the one-stage audio unit. However, it is better to listen in for distance on the detector, using the ear phones if you want to do real work. If the phones are used on the amplifier here described, it will be advisable to cut down the "B" battery to around 90 volts instead of using from 130 to 150 volts. Failure to do this may damage the phones in some cases.

Compact and Economical

Compactness is more or less optional; depending on the builder's point of view, so to speak. The set shown in the illustrations is large enough to make a good-looking job, and the parts are all amply spaced without being excessively separated.

The tuning is simple, having only two controls. The potentiometer or volume control, also used for sensitivity, is not critical while picking up stations. It can be set and left alone, except on extreme distance. Calibration is readily accomplished if so desired. The dials go step by step very uniformly, varying only two or three degrees over the entire scale.

(*Note.* In order to have this matching up of condensers it is necessary to use coils and condensers of known uniformity; otherwise, the dials will vary more than this.)

As far as battery drain is concerned, this set will be found fairly economical, depending upon the balancing and biasing of the different component parts. It draws about 2 amperes from the "A" battery, and approximately 15 milliamperes "B" current, varying with the potentiometer setting, etc.; this is not excessive and the results are well worth it. Properly balanced and operated this "super" will not take, on the average, any more than some neutrodynes and other tuned-radio-frequency sets. To prove this, just connect up a milliammeter in the negative "B" lead and measure the respective amounts of "B" current from different sets to which you have access; you will be surprised at the results.

Permanent Filament Adjustment

The filament control is affected by the use of a master rheostat, placed inside of the cabinet and out of the way of meddling hands. There is no quicker way of spoiling your tubes than applying excessive voltage to the filaments. After placing the rheostat inside of the cabinet, the adjustment is made for a setting of approximately 4.5 volts, and then left alone. This requires an accurate voltmeter, the only way of really knowing what voltage is impressed across the terminals of the filaments.

Your tubes will last their maximum life expectancy if used properly, and filament temperature is extremely important in this case. Now, why have all the tubes on one rheostat? Why not have one on each tube? From actual tests and experience the writer has repeatedly found that on superheterodynes this is not at all necessary; in fact it is a waste of time and money. For all practical purposes, one rheostat is sufficient.

ULTRADYNE DETECTOR UNIT

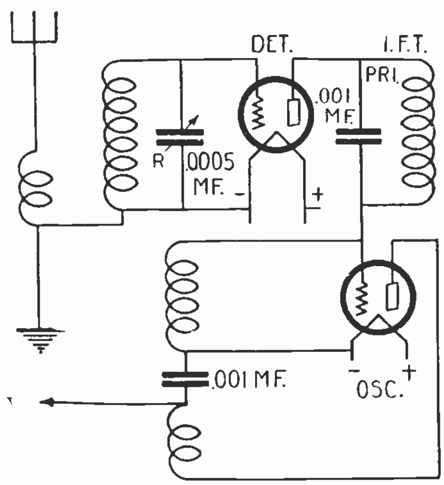


FIG. 4

In the detector unit or "Modulator", there is no "B" voltage on the plate of the tube.

Another feature which makes for versatility is the incorporation of plug-in coils. By simply plugging in coils of proper inductance, wavelengths from 50 to 600 meters are easily received. Many interesting things are going on below 200 meters. If you don't believe it, try it and see; you will find much of interest there. The changes are readily made and there is nothing cumbersome or inefficient in the method, with good parts and care in design.

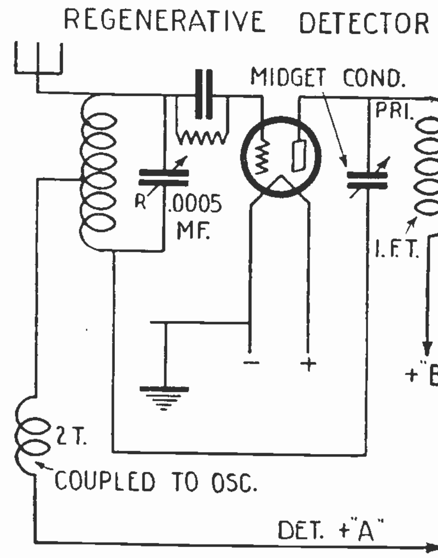


FIG. 5

Another regenerative first-detector unit, employing capacity feed-back instead of inductive plate-to-grid coupling.

This set can be easily adapted to indoor or outdoor antennas, or to loops of popular types. All variations can be used with apparently equal success, by slight changes to facilitate their adoption.

One A.F. Transformer Sufficient

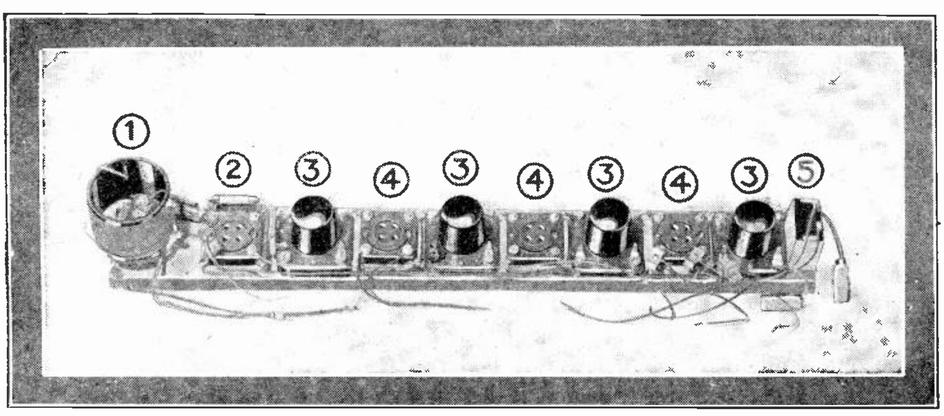
Now for the audio amplifier: if your "super" is functioning properly, you will never need more than one stage of audio, if transformer coupling is used.

If you want real loud-speaker operation, use a UX- or CX-112-type tube with 130 to 150 volts on the plate and have the grid biased about 9 to 12 volts negatively. If you have a good superheterodyne and a good loud speaker you will have volume and tone, and lots of both. If you do not get these results, investigate your receiver, because something is surely wrong. Begin an immediate diagnosis, so to speak, and get the intermediate amplifier working to its maximum without oscillation.

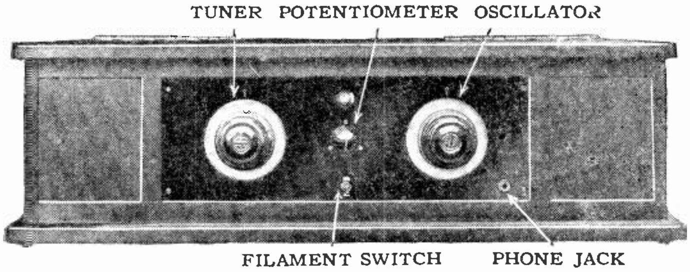
A word here about audio transformers; use a real one, if it costs you ten dollars. If it produces volume, tone and power, all in one stage, it's worth it. Your output will not have any better tonal quality than your transformer is capable of furnishing. Buy a transformer having a charted curve for frequencies between 100 and 5000, and choose one exhibiting a comparatively flat curve.

This or any other good superheterodyne certainly will produce sufficient useful selectivity, if properly handled and constructed. This is so well known that any further emphasis would be monotonous. However, the coupling of all the circuits must be kept *loose.* This means the oscillator pick-up loop, and the coupling in the antenna circuit, especially.

Only a small antenna is needed and, of course, the smaller it is the more selective the set becomes. Nevertheless, the selectivity is only useful when tone qualities are not sacrificed to obtain it. So use discretion if you want tone.



No. 1 is the antenna coupler; 2, the first detector; 3, I. F. transformers; 4, I. F. sockets; and 5 is a by-pass condenser.



Although the units or parts of this superheterodyne receiver are interchangeable, the controls on the front panel remain the same. The different controls are here indicated.

Precautions in Building

Be extremely careful to have none of the grid wires parallel to any plate wires. This is probably the most important "don't" in the radio catechism. Parallel plate and grid wires will cause whining or howling, undesirable oscillations, and seriously interfere with selectivity and calibration. Because a "super" has lots of power, don't think good results can be had if all kinds of liberties are taken with the construction. Good parts must be used throughout, and precaution taken against poor joints, both mechanical and soldered, on all apparatus.

The detectors must be kept below the oscillating point; in fact all tubes must be, for that matter, except the oscillator tube, which must oscillate to function as a frequency changer.

Be careful of grid leaks. Adjust their values carefully where and when they are used. Grid leaks have an important function; although they might seem only trivial, they are most important to clear-cut reception.

Keep all batteries up as nearly to full rating as possible. Good, clear reception can't be had with poor, run-down "A", "B", or "C" batteries. Use a tester frequently and know their condition. Don't guess at it.

Keep all coupling coils loosely coupled. The antenna coupling should be especially

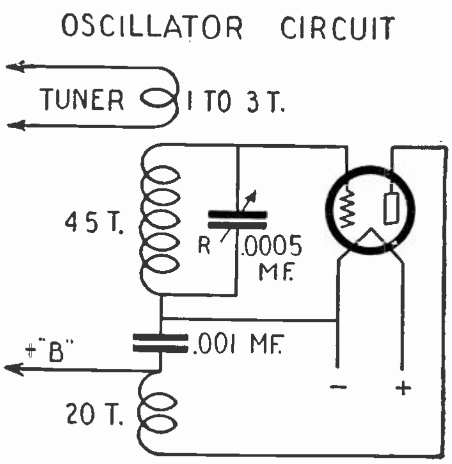


FIG. 7

A typical oscillator circuit. Note that the variable condenser is connected across the grid coil only. A small pick-up coil induces the oscillations in the first detector circuit.

loose. Many foreign noises and much so-called static can be eliminated by doing this, while at the same time increasing selectivity to a remarkable degree. Keep all the wires as short as consistent with the layout.

Use the best tubes you can buy. Poor tubes are of no use when results are the objective. Have them tested occasionally to check up on their condition.

Use as small a collecting agency as is consistent with the distance desired. Long antennas collect more than the desired signals, so be careful here.

Use a loud speaker that you *know* will reproduce notes over the entire range of audio frequencies with faithfulness. Don't economize here if you want music.

And lastly, don't force the tubes beyond their reasonable capacity. When all circuits are tuned to their maximum sensitivity, even though the set does get the distance, it may be found that the tone has been sacrificed.

Some Suggested Combinations

Some *different* circuits that may be tried are shown and will be more or less self-explanatory to the experimenter. All of these have been tested by the author and, while they all "work," different combinations can be used to ascertain what particular circuit will best suit the builder's needs, likes and dislikes.

Nearly any combination may be used as a

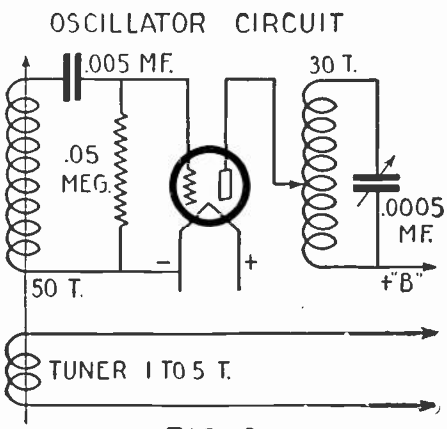


FIG. 8

An oscillator circuit of novel type. The grid leak should be adjusted carefully. This is fairly critical but the arrangement functions very well.

circuit, and certainly every true radio enthusiast should try the various combinations. This can readily be done with this "unit" scheme with practically no additional outlay. Moreover, a thorough tryout of these various circuits will also contribute much to the experimenter's radio and electrical education.

The use of regeneration in the first detector by the method shown in Fig. 5, is more efficient, the writer finds, when a loop is employed. From experiments he determined that the tonal quality was also much affected by the use of so-called fixed regeneration and, therefore, discarded its use. Sensitivity gained by the sacrifice of tone in the output is not particularly advantageous, except in the quest for distant stations.

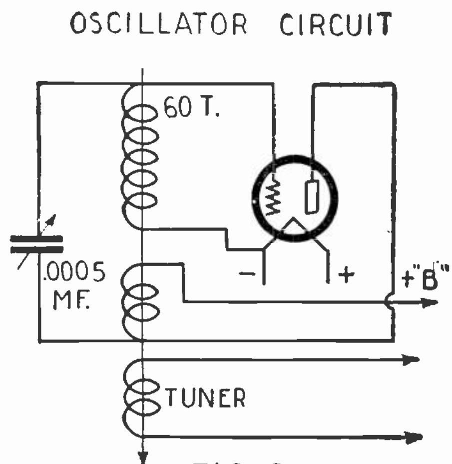


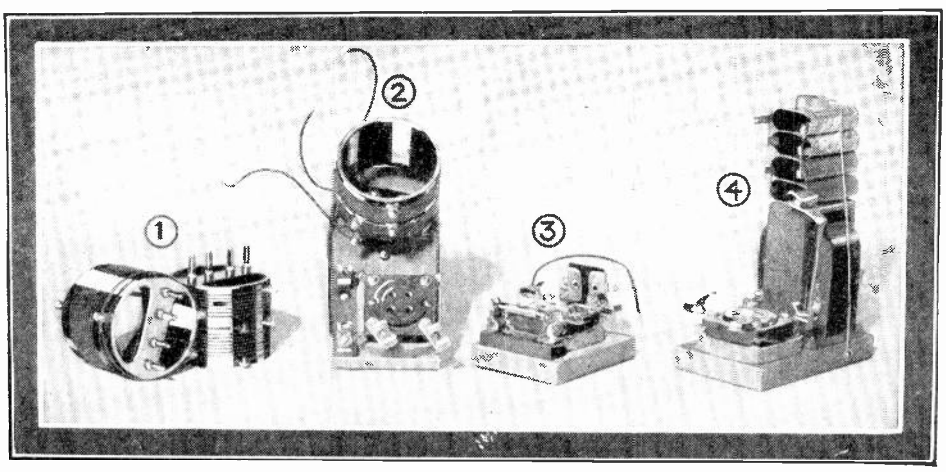
FIG. 9

An oscillator circuit wherein the variable condenser shunts both the grid and plate coils. A pick-up coil is employed, instead of direct coupling, and is more satisfactory, particularly if the coupling is variable.

So, the non-regenerative R.F. stage seems to offer the most practical way to increase the sensitivity of the first detector and still safeguard against mushy reception. (See Figs. 1, 2, and 3.)

The Ultradyne

Another interesting first detector circuit that may be used is the "Ultradyne" modulation system. (See Fig. 4). From tests on the writer's receiver this method was by far more sensitive on weak signals. In fact, according to the theory of the circuit as explained by Mr. Lacault, its inventor, a signal response is effected, no matter how small the amount of received energy from the collecting system. From practical audibility tests the writer has, to his own satisfaction, proved this to be true; and furthermore, the tonal quality is of the best. Excellent results are obtained using only 45 volts on the oscillator tube; and although higher voltages may be used and recommended, this seemed sufficient for all practical purposes. Keeping the "B" voltage as low



No 1 shows the plug-in type of coil employed; 2, the oscillator unit; 3, detector unit; and 4, the A.F. transformer unit with "C" batteries.

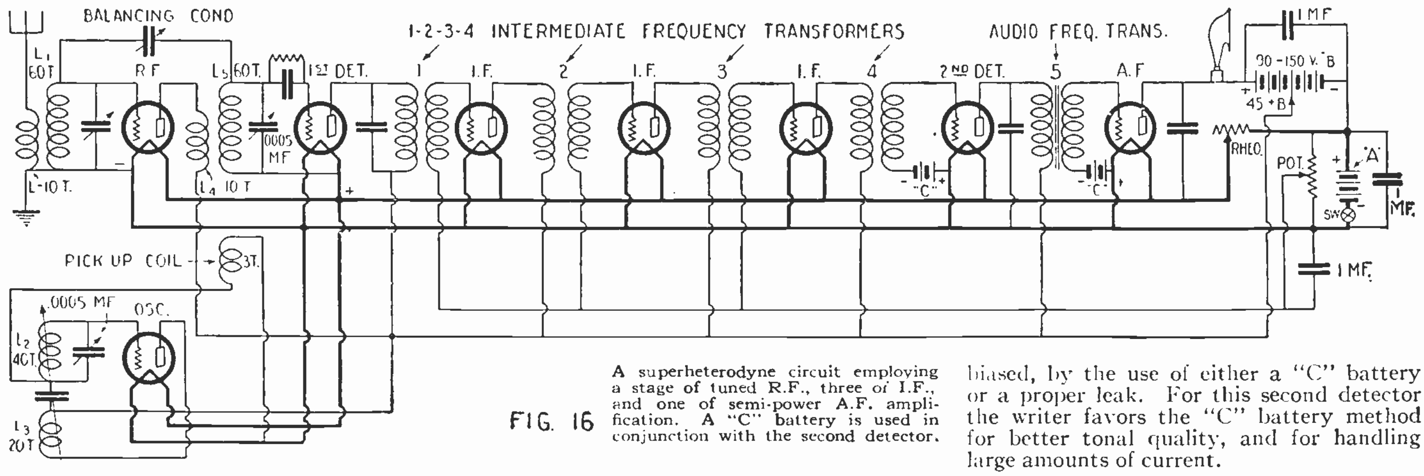


FIG. 16

A superheterodyne circuit employing a stage of tuned R.F., three of I.F., and one of semi-power A.F. amplification. A "C" battery is used in conjunction with the second detector.

as possible is advantageous, as the use of excessive voltage here will have a tendency to cause the formation of harmonics which interfere with calibration.

If higher voltages are used on the Ultradyne oscillator, the employment of a larger tube and the use of a "C" battery to bias the grid will overcome this difficulty. A thorough try-out of this Ultradyne modulation system will well repay the builder; for the circuit has wonderful possibilities and, as here developed, represents one of the best methods of reception in use at the present time, especially on weak signals.

The detector circuit used for the first tube may be the usual one, employing a condenser and leak for rectification, or it may incorporate the use of a "C" battery. Either system will produce probably equal results if handled properly. It will be noticed that the Ultradyne does not employ either.

Intermediate-Frequency Transformers

The intermediate amplifier may be of any standard make or construction. However,

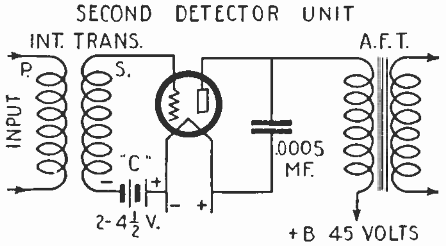


FIG. 10

A second-detector unit employing a "C" battery for obtaining the necessary grid bias. The "C" voltage should be adjusted while the set is in operation.

care should be taken to select transformers having charted curves; so there will be no guesswork in their use. Those made to work between 3000- and 5000-meter wavelengths (100 to 60 kilocycles) are recommended. They may be either iron or air-core: the writer is inclined to believe that air-core transformers, properly designed to

PUSH PULL DETECTOR

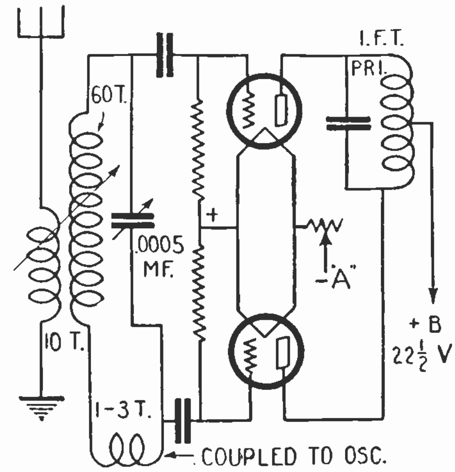


FIG. 6

This push-pull arrangement can be used in the second detector as well. It is capable of handling excessive energy without overloading.

allow a sufficiently wide waveband to pass, are less liable to produce distortion.

If the Ultradyne circuit is used, the input transformer should be shunted by a fixed condenser. Satisfactory results will probably not be obtained without it.

About 45 volts will be found most practical for the intermediate amplifiers in general use. Higher voltage requires much care and discretion, so keep it as low as consistent with good volume and amplification.

The second detector circuit (Figs. 10 and 11) may be any of the conventional arrangements. Take caution to have it properly biased, by the use of either a "C" battery or a proper leak. For this second detector the writer favors the "C" battery method for better tonal quality, and for handling large amounts of current.

Oscillator Unit

The oscillator units (Figs. 7, 8 and 9) are typical and, whatever circuit is chosen, tests should be made to determine whether or not it oscillates vigorously over the entire scale of wavelengths used. Some of the circuits are bad for hand capacity; especially those having no ground or zero potential connection to the rotor plates of the variable condenser. Circuits with the "A—" going to the rotor will generally be free from this effect. Figs. 13 and 14 show two methods of effecting a coupling between the oscillator and tuner for the superheterodyne. It does not particularly matter whether a loop is pulled out of the tuner and carried over to the oscillator or whether a loop is taken out of the oscillator and carried over to the tuner. However, the method shown in Fig. 14 is preferable, as it increases the efficiency of the tuner. Whatever method is used, keep the coupling loose, using only a few turns. Care should be taken in selecting a good oscillator tube for this unit.

Moderate Selectivity Desirable

The tuner circuits available are numerous,

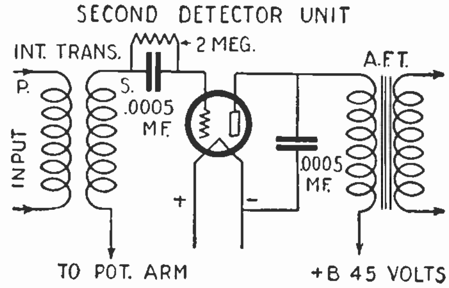


FIG. 11

A second-detector unit employing a grid leak and condenser to obtain the grid bias.

but a few stand out as most practical for the superheterodyne. Of course, nothing can be amplified that doesn't get into the first

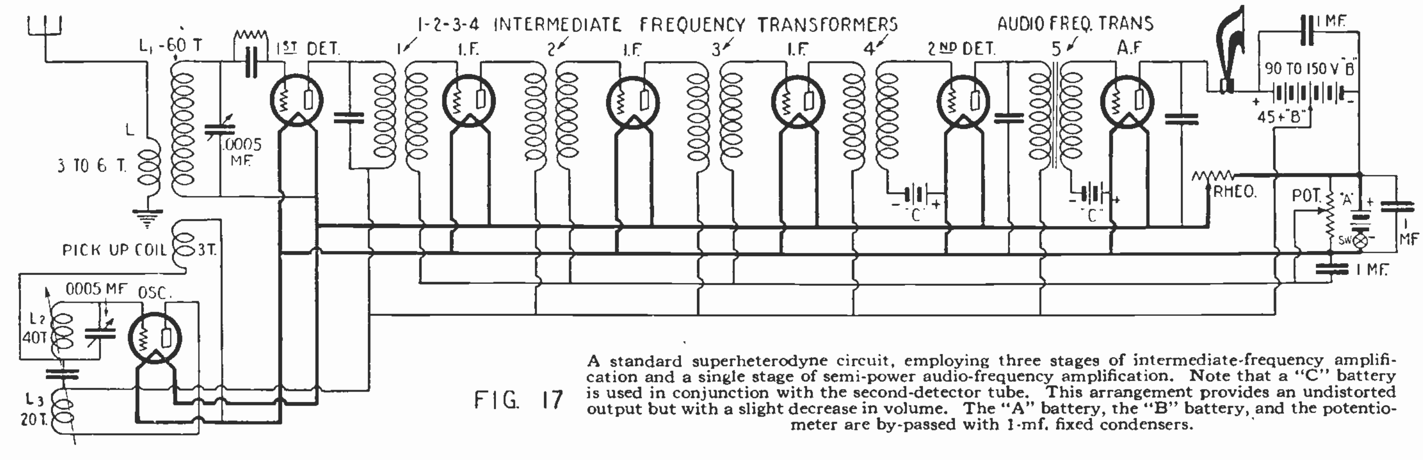


FIG. 17

A standard superheterodyne circuit, employing three stages of intermediate-frequency amplification and a single stage of semi-power audio-frequency amplification. Note that a "C" battery is used in conjunction with the second-detector tube. This arrangement provides an undistorted output but with a slight decrease in volume. The "A" battery, the "B" battery, and the potentiometer are by-passed with 1-mf. fixed condensers.

detector; so construct the tuner with the best materials and design, as laxity here will certainly destroy its value as a DX-getter.

However, one usually must choose between extreme efficiency and ease of operation, and this is no exception. Perhaps a moderately selective tuner is the most practical for general use, as the tuning is usually more easily accomplished. For this reason no circuits have been shown using more than one control; which, with the oscillator control, gives two-dial tuning.

In regard to tubes, the 201A type is the best all-around to use. It is rugged, powerful, and flexible. Wherever smaller tubes like the 199-type are used great care should be taken in checking filament voltages; otherwise short life must be expected. Tests should be made while the set is in actual use to ascertain the best position for the respective tubes. Some tubes perform much better as detectors than others, and the same is true of amplifiers.

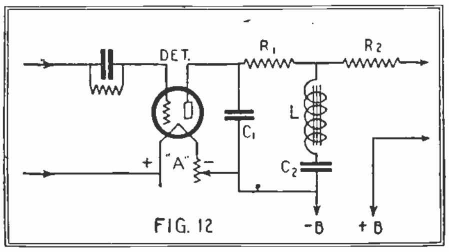


FIG. 12

A filter for the input of the audio power stage. The values are; C1, .001-mf. to .006-mf.; C2, .0001-mf. to .0002-mf.; L, 100 millihenrys; R1 and R2, 12,000 ohms fixed. C1 should be adjusted carefully.

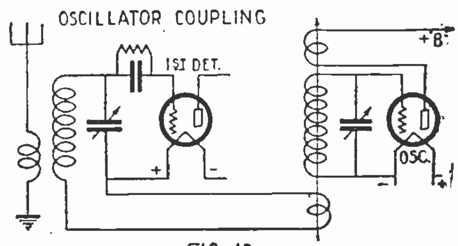


FIG. 13

Showing one method of coupling the first detector to the oscillator.

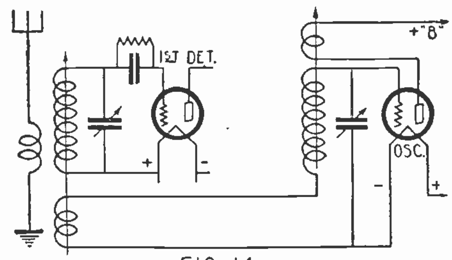


FIG. 14

Another method of coupling the first detector to the oscillator.

Shielding

The subject of shielding has been purposely neglected. Shielding practice is complicated; and as generally used it is more of a "losser" than a shield. During experiments on "supers" the writer has tried several types; but unless the reader is going into it for a scientific proposition, and is absolutely sure of the methods and technique of shielding, he should be advised against its use—at least, until he becomes very familiar with "super" construction.

The experimenter who wants to build a superheterodyne that will permit further experimenting to advantage will be well satisfied with the results he will get from a thorough tryout and investigation of the wealth of experimental information herewith presented.

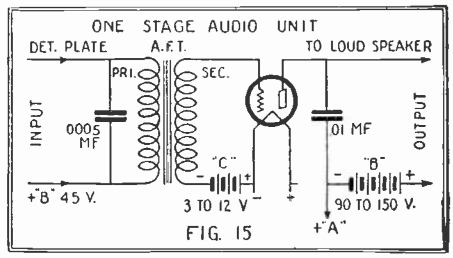


FIG. 15

Circuit diagram of the one-stage semi-power audio amplifier. Note that high "B" and "C" voltages are employed.

The Radio Burglar Alarm

A System Safeguarding by "Capacity Effect" Against Intrusion

THE well-known phenomenon of "body capacity," which every builder of a radio set has encountered, may be employed for the purpose of detecting the intrusion of a human being into the neighborhood of radio apparatus; but it is not necessary that any of the instruments should be in the immediate vicinity of a safe which it is desired to guard. It is necessary only to have a wire running to the safe, and another to the ground; or any large insulated sheet of metal may be used to create an electric "atmosphere," which cannot be entered without upsetting the balance of the system and giving an electrical signal—which will operate a relay and set off bells or an electric siren, turn on lights, or otherwise give warning as desired by its constructor.

The radio burglar alarm "sees in the dark," so to speak; it is much less expensive than the complicated maze of wires now used for electric protection systems; and it transmits its warning to the guards, watchmen and police who will answer its summons, without apprising the intruder of his danger until it is too late.

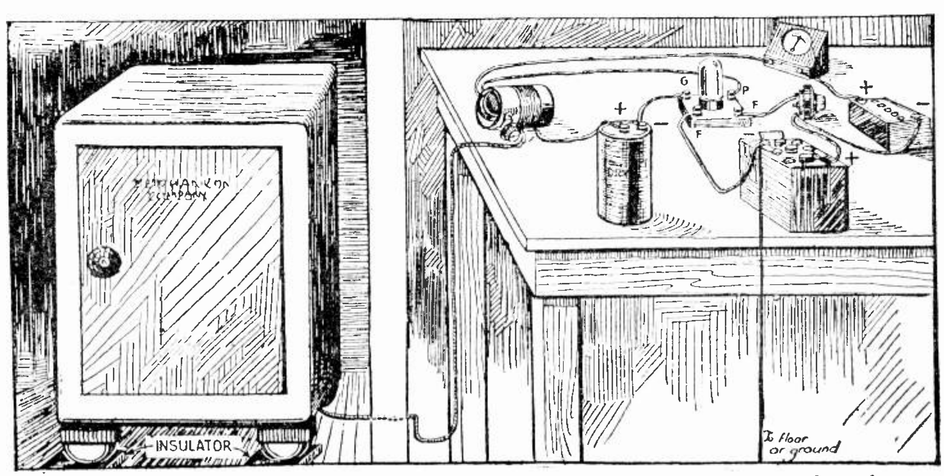
Building a Burglar Detector

In the pictorial diagram is shown a circuit, which is very easily built and which will prove to be an efficient burglar alarm. It will be seen that the safe, which is insulated from the floor, is one plate of a condenser and the floor (or ground) is the other. The inductance has 55 turns of No. 26 D.S.C. wire wound on a 2½-inch tube, inside of which is the rotor coil, 1¾ inches in diameter and consisting of 28 turns of No. 32 D.S.C. wire. The vacuum tube used is a 201A-type, having 38 volts on the plate and 1½ volts negative "C" battery.

A reading of 3½ milliamperes was observed when the rotor was suitably adjusted and no person was nearer the safe than 10 feet. The adjusting was done by means of a rod of insulation about 15 inches long. (As the operator had to be nearer the safe than 10 feet, when the adjustments were made, it was found that the reading on the meter was about 2½ milliamperes, when he was using the rod. But when this reading was obtained on the meter and he withdrew to a distance of 10 feet or more, the meter reading increased to about 3½ milliamperes.) When any one approached the safe the meter reading gradually fell, and dropped almost to zero when he was within one foot of the safe. The same thing happened whether one touched the safe with his bare hand or while wearing rubber gloves, or by means of some other high insulator. This is because the *conductivity* does not enter into consideration at all, but only the *capacity* effect. The meter reading will fall to zero, of course, if either of the wires leading to the system should be cut.

It will be noticed that instead of a relay there is shown in this diagram a milliammeter. Of course in an alarm system, using a circuit of this type, it would be necessary only to employ instead of the meter a relay of the galvanometer or polarized type; that is, one which operates on a very small current. Such a relay may be connected to any type of alarm that the constructor wishes to use.

All these facts show experimentally that, no matter in what way one might approach the safe, or otherwise interfere with the system, the burglar alarm would operate.



The burglar alarm described. The insulated safe and the floor of the room compose the plates of a condenser connected with the vacuum-tube-oscillator arrangement on the table.

The Construction of Wavetraps

Simple Devices by Which the Set Owner May Eliminate Station Interference

By JAMES WOOD, Jr.

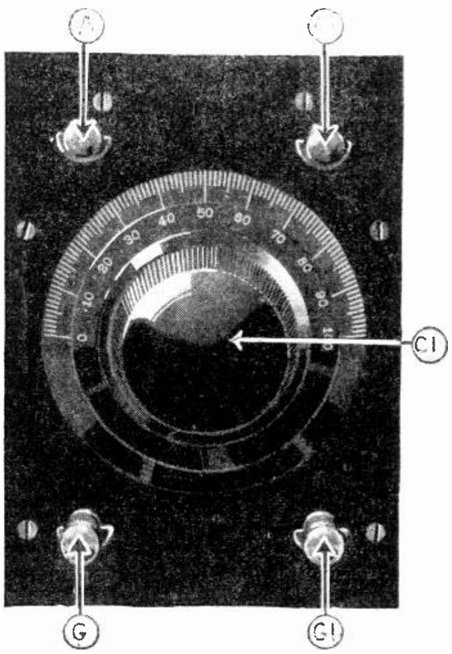


Fig. 11. A front view of the wavetrap, the circuit of which is shown in Fig. 4 A. Note that there are two aerial and two ground posts.
Photos courtesy of X-L Radio Laboratories.

THE wavetrap is more or less familiar to every radio fan. How it works, and when it will work, are facts that are not, however, as well known. We will, therefore, consider the wavetrap in several different forms.

There are several ways in which a wavetrap may be electrically connected to a radio receiver. Fig. 1 shows the commonest and probably best-known method of connection. Fig. 2 is much the same, except that the trap circuit T is connected directly in the antenna lead, instead of being coupled by means of a small coil **a**, as it is in Fig. 1. The tuning of the receiver is not appreciably affected in either of the connections when the trap circuit is varied. While, for a given filter, Fig. 1 shows the more *selective* connection as regards the elimination of interference, Fig. 2 shows a connection which affords more *complete elimination* of interference. This is due simply to the fact that in Fig. 2 the trap circuit is more closely coupled to the antenna circuit than in Fig. 1. Which circuit should be employed depends upon the conditions under which the wavetrap is to be used.

Selectivity vs. Sensitivity

For example, suppose we wish to receive WRNY on 309 meters, but we are located in Boston only a short distance from WBIS, operating on 303 meters. We have a fairly selective set, but some interference from WBIS is experienced. To eliminate the latter station, and still retain WRNY, we would have to use the connection in Fig. 1. That in Fig. 2 would eliminate WBIS; but WRNY would be reduced in intensity considerably.

Now, suppose again we wish to receive WRNY, but we have an unselective receiver, and WBZA on 333 meters interferes. If the interference were strong, Fig. 2 would be the better connection, otherwise we could use Fig. 1. In general, then, we may say that Fig. 1 will give the desired results in all but exceptional cases, and is, therefore, to be preferred. Fig. 3 shows a third method which, on paper, appears to be very good. Practically, however, it has one very serious fault, that the tuning of the receiver is very materially affected when the trap circuit T is adjusted. This makes the arrangement unsatisfactory for use. The same may be said of Fig. 4, which it will be seen, shows a tuned antenna circuit to which the wavetrap is coupled by means of a small coil. The arrangement shown in Fig. 4A, however, is satisfactory.

Building a Wavetrap

We come now to the construction of a wavetrap suitable for use in the broadcast band of wavelengths. Such a trap is shown in the illustration (Fig. 10). The condenser has a maximum capacity of about .00045 mf. The inductance is made up of two coils arranged "binocular" fashion, and consisting of 45 turns each of No. 18 bell wire. Over each coil are wound 10 turns of No. 24 D.C.C. wire. The method of connection is shown in Fig. 5. The binocular arrangement helps to reduce the external field of the coils, and thus minimizes the possibility of undesired coupling between the trap circuit and other circuits in the vicinity.

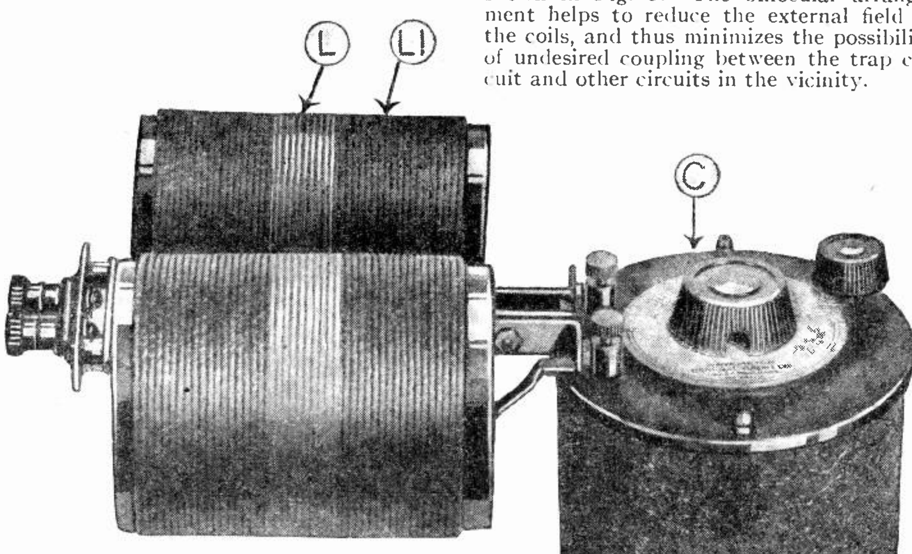
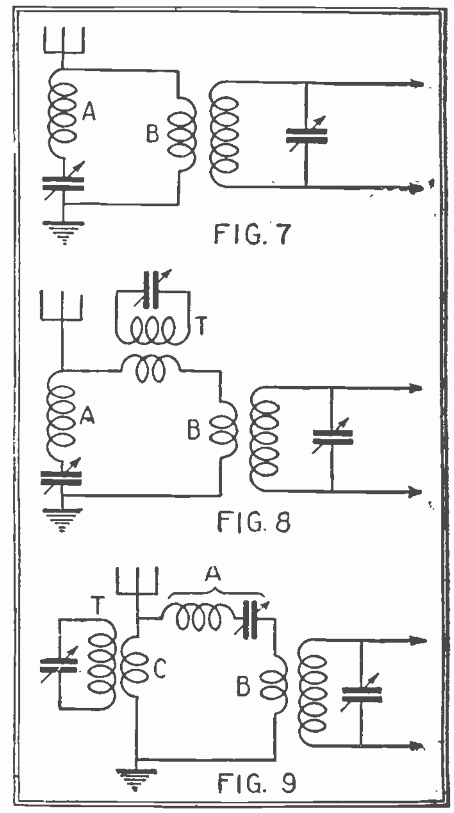


Fig. 10. A very effective form of wavetrap employing "figure-eight" coils. L is the primary or aerial inductance; L1 the secondary or tuned inductance, and C the variable condenser which tunes it. Circuit is Fig. 5.
Photo courtesy of General Radio Co.

Sometimes, in order to insure a minimum of undesired coupling, the coils and condenser of the wavetrap are shielded. Sheet copper is, everything considered, the best material for the purpose. It need not be particularly heavy, No. 30 B. & S. gauge being sufficiently thick to reduce the disturbing electric and magnetic fields to about 1/50 of their value at 300 meters. This is usually sufficient for wavetrap work.



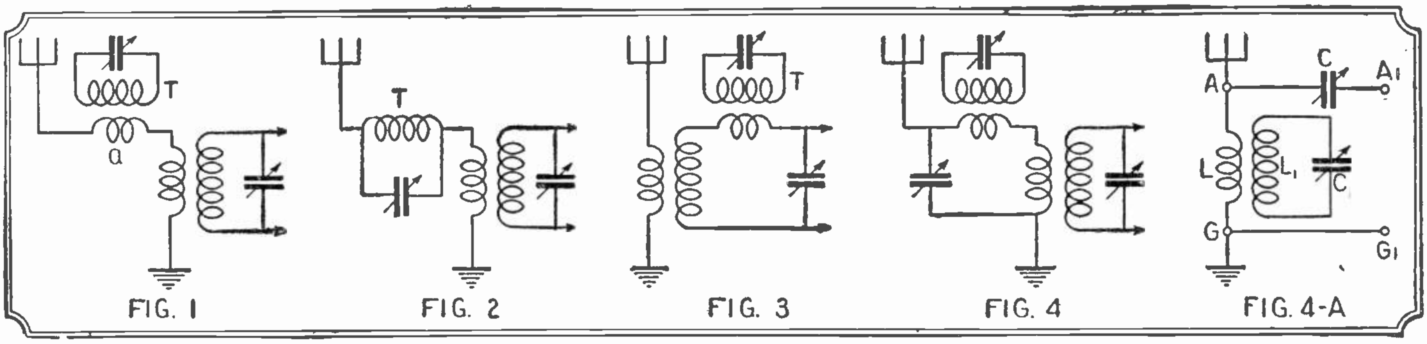
Three distinctive types of wavetrap circuits, which can be employed in connection with any receiver for the elimination of interference. The output connection (to the aerial and ground posts of the receiver) is at the right of each wavetrap diagram.

If brass were used instead of copper, the shield would have to be considerably heavier for the same shielding effect. With brass of high zinc content (66% copper and 34% zinc) it would be necessary to use No. 22 B. & S. gauge to obtain the same shielding effect as can be obtained with No. 30 copper.

Whatever material is used, it is very important that the shield be as completely closed as possible. There must be no edges left unsoldered, as a very narrow slit of any appreciable length will reduce the shielding effect very considerably. In general, shielding need not be resorted to in the broadcast band. Occasionally, however, when a powerful broadcast station is close enough to cause interference due to the pickup of the coils themselves, shielding of both the receiver and wavetrap may be necessary. Another form of wavetrap, employing the circuit of Fig. 4A, is illustrated in Figs. 11 and 12. The coil L consists of 8 turns of No. 18 D.C.C. wire. Coil L1 has 60 turns of No. 22 D.C.C. wire. The adjustable condenser C has a capacity range from .0003 to .001 mf. C1 has a maximum capacity of .00035 mf.

Multiple Wavetraps

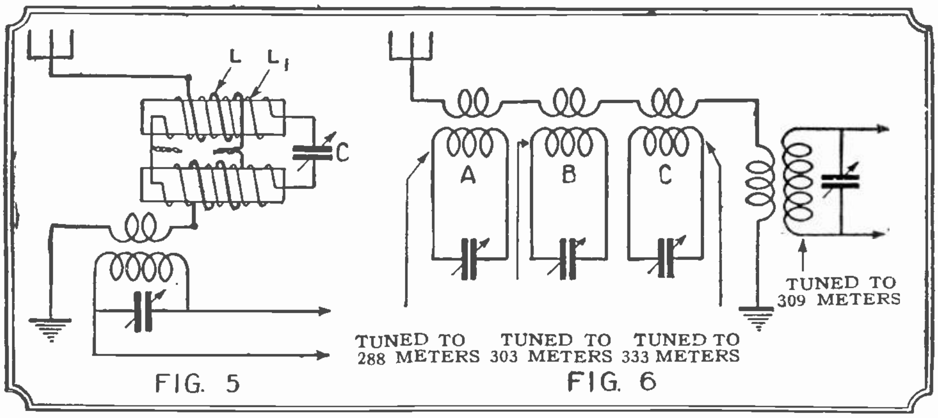
Suppose now we have a more difficult interference problem to solve. Suppose as be-



A group of both series and parallel wave-trap circuits that can be used for eliminating unwanted stations as described in the text.

ore that we wish to receive WRNY on 309 meters, and that the interfering stations are WTAG on 288 meters, WBIS on 303 meters, and WBZA on 333 meters. Fig. 6 show a method for eliminating the three undesired stations and retaining the desired station.

The order of tuning shown in the figure need not, of course, be followed. For example, we might tune A to 303 meters, B to 333 meters, and C to 288 meters. In order for the circuit as a whole to work successfully, however, it is necessary that A, B, and C be all of low-loss construction. This is even more important here than in a circuit employing only one trap. Incidentally, *if one of the interfering stations is a "spark" station, it cannot be eliminated by means of a wavetrap, for its wave-trains are so short that the current in the trap circuit cannot assume a steady-state value.*



Left: The circuit diagram of the wave trap illustrated in Fig. 10. Right: A circuit containing a series of wave traps for eliminating the signals from three stations at one time. This is a good arrangement to employ where there are a number of local stations creating interference.

Other Types of Circuits

So far we have been discussing only the so-called series-resonance filter. There is also a parallel-resonance filter circuit, illustrated in Fig. 7. Branch A is tuned to resonance with the interfering station. Under these circumstances the branch offers a very low impedance to the interfering signal and hence the latter does not pass through branch B to any extent. The desired signal, on the other hand, does not pass as readily through A. The tendency is, therefore, to eliminate the undesired station, and to retain the station being received. A modification of Fig. 7 is shown in Fig. 8. Here the small portion of the interfering signal that tends to pass through branch B is prevented from so doing by the trap circuit T.

Fig. 9 shows a circuit similar to Fig. 8, except that the positions of the parallel- and series-resonance circuits are reversed, and the two trap circuits are tuned to the desired signal, not the interfering signal. Fig. 9 will, as a rule, give better results than Fig. 2.

Before discussing the theory it may be well to conclude this rather general discussion by pointing out several precautions that must be taken for successful operation of wave-trap systems in general:

(1). Use only low-loss coils and condensers.

(2). Never mount the condenser inside the coil.

(3). Be sure that there is as little coupling as possible between the wavetrap and the receiver, and between the separate wavetraps, if more than one is being used.

(4). Tune the wavetrap carefully, so that when the undesired station has been eliminated the desired station has not been reduced in intensity.

(5). If shielding must be resorted to in order to make the wavetrap function properly, be sure to allow at least 2 inches between the metal and any part of the wavetrap inside. When the shield is in place there must be as nearly as possible a continuous metal surface around the coils and condenser. Binding-post holes should be the only openings present.

Theory of Wavetraps

We come now to the theoretical discussion. Consider Fig. 2. This is a *rejection* circuit and is not, as it is very often referred to, an *absorption* circuit. The undesired frequencies are rejected or prevented from flowing in the antenna circuit, but they are not absorbed. The ideal filter (that is, one without resistance, which would be the best obtainable) would have zero I^2R loss. To be sure, all filters do absorb a little energy from the circuits to which they are coupled, because of the I^2R loss. The filter action, however, is hindered rather than helped by this absorption.

Suppose (Fig. 2) that T is tuned to the undesired signal. Suppose further that the resistance of the circuit is zero, and that a voltage E is impressed across the filter circuit. Then, the inductive current L lags 90° behind E, and the capacitative current L leads E by 90°. The resultant current is, therefore, zero (the two currents being equal and opposite), and the interfering signal would not be heard.

Practically, this state of affairs can never be realized, because both the inductance and the condenser must have some resistance. There is a resultant current, because the inductive and the capacitative currents cannot be 180° out of phase. Since there is a resultant current in the antenna, the interfering signal is not entirely eliminated. It is thus evident that, for the best results, the resistance of the trap circuit should be as low as possible.

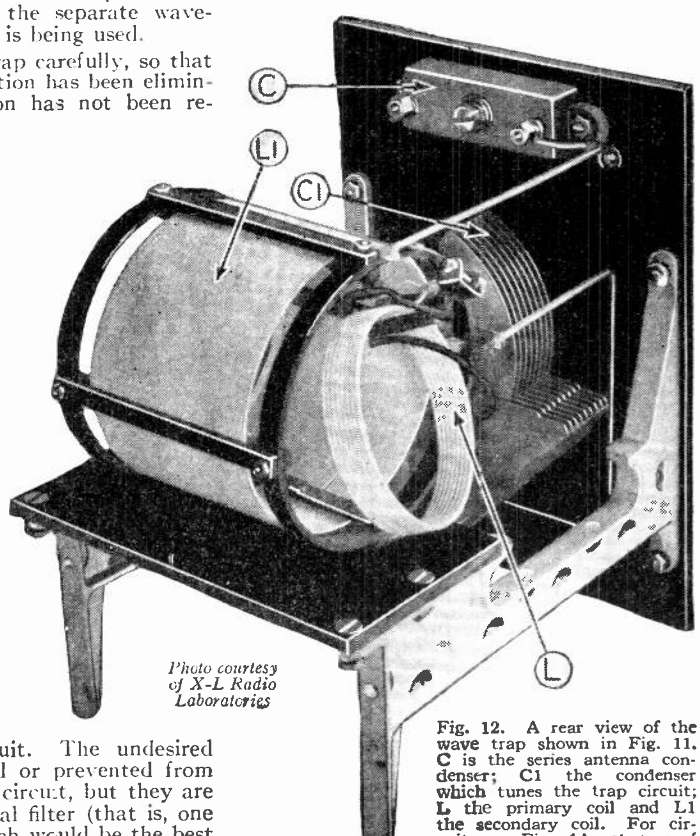


Photo courtesy of X-L Radio Laboratories

Fig. 12. A rear view of the wave trap shown in Fig. 11. C is the series antenna condenser; C1 the condenser which tunes the trap circuit; L the primary coil and L1 the secondary coil. For circuit see Fig. 4A, at top of this page.

Home-Made Coils for the Browning-Drake and Similar Circuits

Simple Construction Lightens Home Builders' Task

By C. A. OLDROYD

THE keen experimenter and the "Doubting Thomas" cannot do better than begin with a modest two-tube set, consisting of R.F. stage and detector. When this is working properly, the fan has mastered the most tricky part of the set and the final set will give no trouble. The addition of an audio-frequency amplifier should not be a difficult matter.

Whether you will use home-made or commercial coils, for the "final" set, depends entirely upon your skill and the time you are prepared to sacrifice to experiments. With commercial coils you can be sure of good results with least effort.

The patient and skillful worker will be able to turn out splendid home-made coils for the finished set; particularly if he has gained experience by constructing a small two-tuber to begin with. This personal experience will stand him in good stead when building other sets, of whatever type they may be. Best of all, he has the feeling that he is working on his own and getting away from the beaten track.

During the past six months, the writer has built many experimental Browning-Drake sets, and he has come across some possible improvements—as yet not fully developed—which may be of interest to brother fans.

Before we deal with the coils, however, we may perhaps answer the often-asked question: "Is the B.-D. really better than other sets using the same number of tubes?" Quite unbiased, the writer can affirm that it is, as far as his own experience goes. To show the efficiency of this circuit, a personal experience seems worth mentioning.

An experimental two-tuber was hooked up on the "bread board"; the first tube was a R.F. amplifier, the second the detector, no audio amplification being used at all. Yet this set, by no means adjusted to maximum efficiency, brought in on the loud-speaker a moderate-power broadcast station located nearly seventy miles away. The volume was not great, as might be expected, but sufficient to allow the music to be heard clearly all over a quiet room.

Antenna Coil

Now for the coils: In the original design, the antenna coil has only one winding, all necessary data being given in the diagram, Fig. 1. The capacity of the tuning condenser should be .0005-mf. Between antenna and beginning of winding a small fixed condenser is inserted to give greater selectivity. The antenna coil is provided with a center tap (marked "X") and the antenna should be connected to this point (via the small condenser, of course), if its length exceeds 100 feet.

Fans, who prefer an aperiodic primary, may care to try the antenna coil shown in Fig. 2, which has given exceptionally good results in the writer's hands. This coil should be tuned by a variable condenser of about .00035-mf. A few experiments will soon show the right number of turns to use.

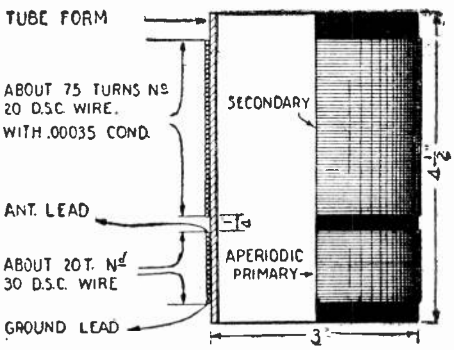


FIG. 2

The antenna coil shown here has an aperiodic primary winding. The secondary is designed to be used with a .00035-mf. condenser.

R. F. Transformer

The special radio-frequency transformer is the heart of the Browning-Drake, and great care should be taken to get this stage working at maximum efficiency. The winding data for the coil are given in Fig. 3. The primary is wound in a slot, usually cut in the circumference of a hard-rubber or dry-wood disc. The slot-wound primary lies under the first turn of the secondary, at the end which goes to the "A+" lead.

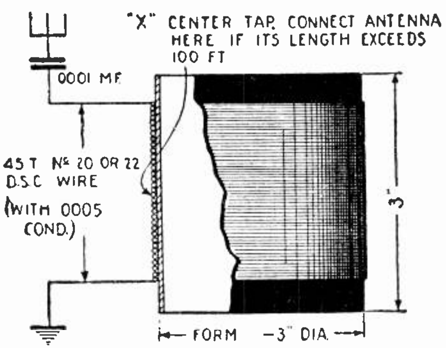


FIG. 1

Above are given the specifications for the antenna inductance. Notice the center tap for antennas over one hundred feet in length.

Here the average set builder is up against a difficulty right away; few of us are fortunate enough to own a lathe on which the groove can be cut. A very satisfactory form can, however, be made from three cardboard discs as shown in Fig. 4.

Two of the discs are just large enough to fit the inside of the form; the third disc is slightly smaller. A small screw clamps the three discs together, the smaller one lying in the center. The completed form is shown in the picture (Fig. 5.) The small strip of hard rubber serves merely as a handle and makes the inserting and removing of the primary very easy; it proved a great convenience in the writer's experimental set. The number of turns given for the primary can be regarded as only approximate, for the best number of turns must be determined by experiment.

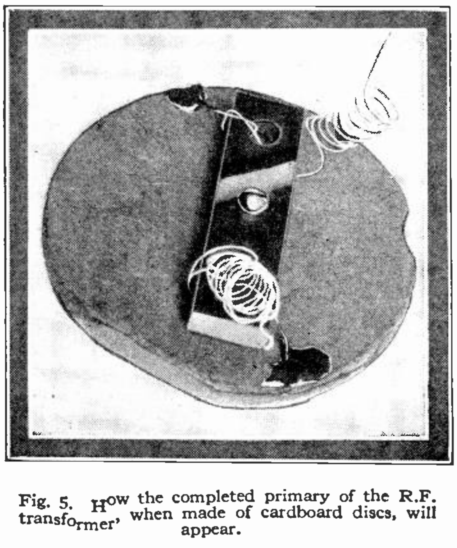


Fig. 5. How the completed primary of the R.F. transformer, when made of cardboard discs, will appear.

A Low-Loss Coil

For a more finished coil, the skeleton form illustrated in Fig. 6 will be hard to beat. It is built up from four strips of thin dry wood; cigar-box wood is preferable, as it is easy to work. All four pieces are alike, and notched to fit into each other. The lay-out of the strips is given in detail in the illustration; measure the inner diameter, R, of the tube form used, and draw a circle of this diameter on a sheet of drawing paper.

Divide each quarter of the circumference ("A" in sketch), into three parts, the inner one being twice as large as the two outer. This gives us points C and D. Connect the corresponding points and you have the center lines of the wood strips; draw in the wood strips, and you find automatically the position of the notches.

When the four pieces have been cut and finished, they are glued together. The ends of the arms are finally slotted with a saw to give the winding space. Between the arms, the winding lies free, and is surrounded by air only. We are therefore justified in calling our primary a low-loss coil. The appearance of the completed form is shown in Fig. 7.

Fig. 8 shows the primary in position, inside the end of the R.F. transformer coil. The beginning and end of the winding can be secured by drilling two small holes through the arms of the skeleton frame, the wire is passed through the hole and a turn taken around the outside of the arm.

For an experimental hook-up, it is advisable to solder the ends of the winding to

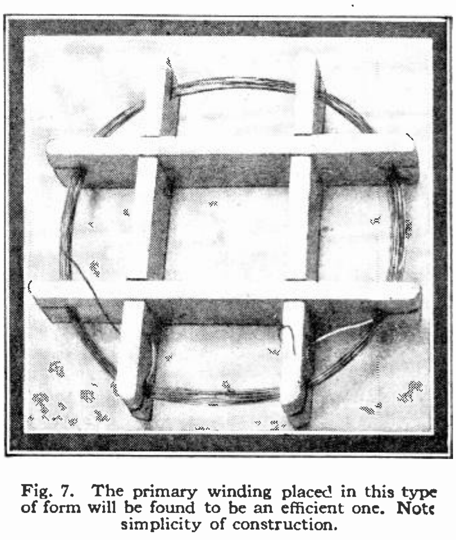
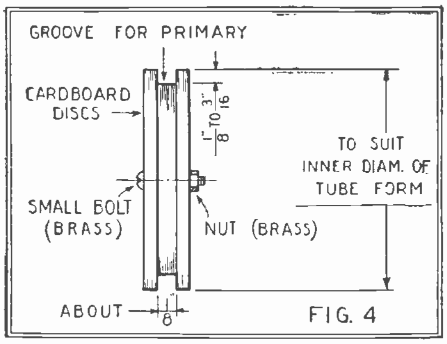


Fig. 7. The primary winding placed in this type of form will be found to be an efficient one. Note simplicity of construction.



The primary of the R.F. transformer can be made from three cardboard discs, as shown in the diagram above.

short pieces of flexible wire, so that the primary can be removed without breaking a joint. Different colors may be used for the leads to show the beginning and end of winding.

Fixed Tickler Coil

There remains only the tickler winding. To be really efficient and comfortable to adjust, the mounting for the rotating tickler must be well made; and few amateurs will be able to produce a mounting as good as those used by professional coil makers. The best way seems therefore to use a fixed-tickler winding, which does not tax the skill of the set builder to any extent. The data of the winding are given in Fig. 3.

With a fixed-tickler winding, regeneration is controlled by a variable high resistance. This is connected across the ends of the tickler winding; the resistance should be variable from about 400 to 40,000 ohms. A very delicate control is possible with this arrangement.

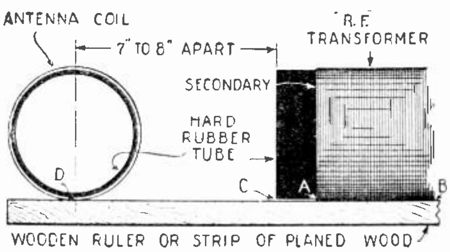


FIG. 10

As indicated in Fig. 9, the coils should be placed at an angle of 90° to each other; other information is given above.

Novel Regeneration Control

There is another method of controlling regeneration when using a fixed-tickler winding, which deserves more attention than has been given to it. Our coil is wound as before, the tickler winding being about ¼-in. from the end of the secondary. (See Fig. 3.) A turn of stranded wire, or of thick copper wire, say about No. 14 gauge, is wound in the gap between the two windings, as indicated by "X" in Fig. 3. The ends of this one-turn loop are connected to the terminals of a carbon-pile filament rheostat, having a maximum resistance of about fifty ohms. (See Fig. 12, on page 68.)

When the rheostat is fully "in," offering but little or no resistance, regeneration is at a minimum; with the rheostat fully "out," (having in this condition a high resistance), regeneration reaches its peak. The explanation of this method seems the following:

The secondary winding induces a current in the one-turn loop, the latter transmits energy to the adjoining tickler winding. With little resistance in the circuit (rheostat "in"), no high voltages are built up in either loop or tickler winding.

Higher voltages are induced in the loop and tickler winding as the resistance is increased, for the current must be able to overcome this resistance to complete its journey. The regeneration effect is accordingly greater.

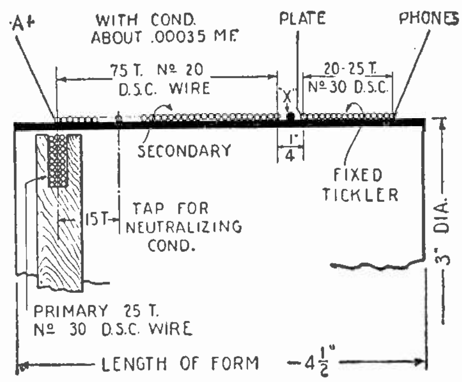


FIG. 3

The heart of the Browning-Drake circuit, the R.F. transformer, is shown here. The primary is wound on a special form.

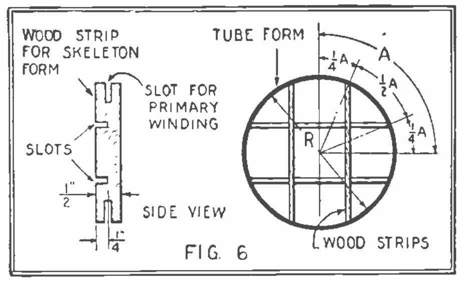
This method of regeneration control is a severe test for any rheostat, as everything depends upon a smooth and gradual variation of the resistance. A good carbon compression rheostat will, however, be found equal to the task.

In determining the correct number of turns for the tickler, the fan must experiment a little on his own. Much depends upon the tube used and the plate voltage applied.

Mounting the Coils

Our coils are now complete and we can mount them in the set. Fig. 9 shows a set of home-made Browning-Drake coils fixed to the sub-panel. The coils must be spaced well apart to avoid interaction; and their axes must be at right angles to each other. In addition, the centers of the windings should lie in the same plane. (Dimensions for spacing are indicated in Fig. 10.)

The lining-up can be easily carried out if the plan indicated in Figs. 10 and 11 is followed. Fig. 10 shows the coils as seen from above. Place a ruler or wood strip with planed edge against the coils; with the coils in line the rule should touch them at the points A, B, and D. The rule must not lie against point C, for this is the tube form lying slightly below the winding.



Specifications of a more substantial primary form for the R. F. transformer. It is indeed simple to construct

It only remains to line up the coils in a vertical direction. Proceed as shown in Fig. 11. Make a cardboard gauge of the shape indicated and hold it first against the antenna coil. Mark the beginning and end of the winding by lines penciled at the edge of the gauge strip. The resulting marks are shown as I and II.

Repeat with the other coil, the R.F. transformer; this will give us marks III and IV. If the coils are located at the right height, the distance from I to III will be the same as that between II and IV. One of the coils must be either raised or lowered until this is the case.

How the writer adjusted his antenna coil can be seen in Fig. 9. It was slightly raised by placing it on a thin wood strip; under the latter lie some small pieces of hard-rubber packing. Wood-screws hold the assembly firmly in position.

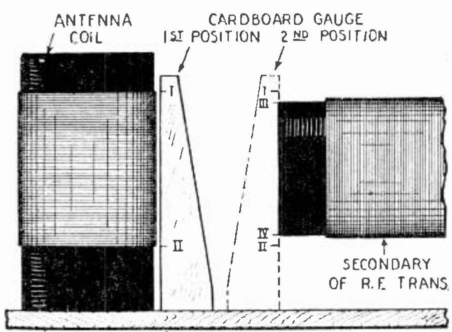


FIG. 11

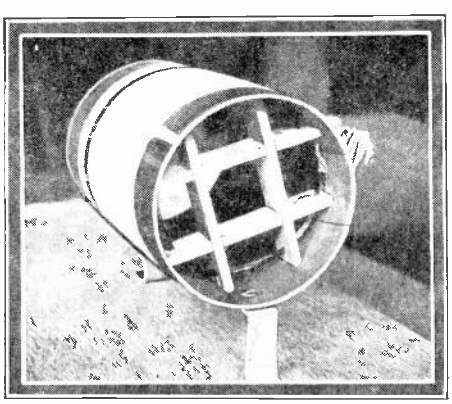
In order to have the windings of the two inductances in this exact relation the use of a gauge is necessary.

Fieldless (Figure-8) Coils

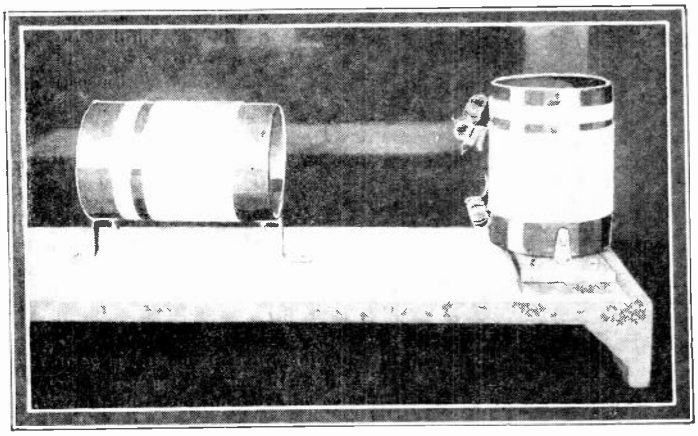
To eliminate the necessity for lining up the coils, and to make the set more compact, various types of fieldless coils were tried.

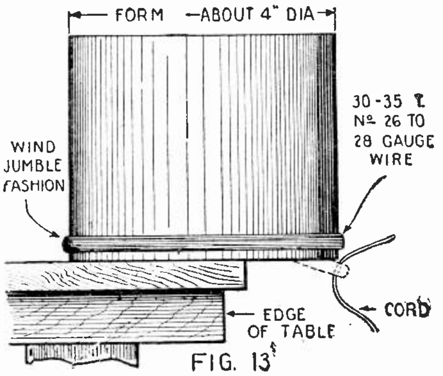
If we wish to retain the high efficiency of the Browning-Drake R.F. transformer coil, with its solenoid winding and the slot-wound primary, we must leave it as it stands at present. But the antenna coil can advantageously be a fieldless coil.

Such coils can be made very small, and



We see in Fig. 8 (left) the primary coil and form, shown in Fig. 7, in position within the tube supporting the two other windings. Fig. 9 (right) shows the proper manner of mounting these coils, with the windings at right angles to each other for the reduction of strays.





Illustrating the initial step in the preparation of the "Figure-8" coils; the "jumble" winding on a 4-inch cylinder.

it becomes possible to mount them underneath the sub-panel, leaving the top free for tubes and other parts. Toroid coils are "big fellows," consequently unsuitable for our purpose. But the simple "figure-8" coil fills the bill.

Figs. 13 to 15 show the gradual steps when constructing a "figure-8" coil which is perhaps the easiest to make. First of all, we need a winding form about 4 inches in diameter; the writer used a tobacco jar that happens to be of the right size. It has a wide opening and a very good grip can be obtained on it when winding the coil; a point of some importance when working single-handed.

The experimental coils are wound with D.C.C. wire of No. 26 gauge and enameled wire of No. 28 gauge; other sizes may prove as good or even better. Leave sufficient wire for the connections, and hold the beginning of the winding against the outside of the form with your thumb. Now wind on about thirty to thirty-five turns of the wire; this is the secondary.

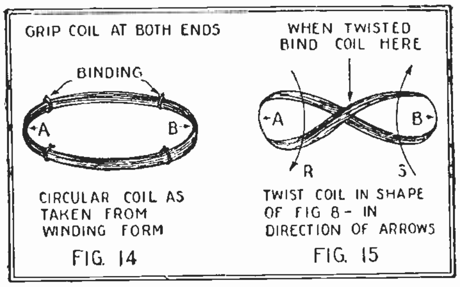
Without cutting the wire, make a long loop and continue winding for another ten or twelve turns, and we have the primary. The latter is of course needed only if we decide to use a semi-aperiodic primary.

Finishing the Coil

Twist beginning and end of winding together to hold the wire in position and place the form with the coil on it on the table, the front edge of the form projecting about two inches. (See Fig. 13). Gently work down the winding till it is clear of the form, and pass a short piece of cord through the gap. Replace the wire on the form and secure the ends of the cord with a knot. Repeat this in three other places; the coil can then be slipped off the form and we have a ring-shaped self-supporting coil.

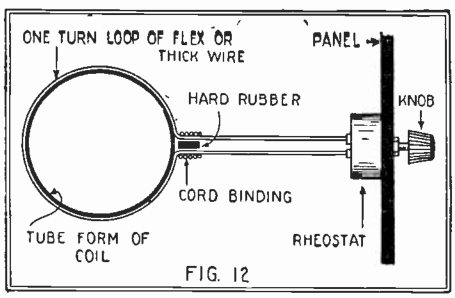
It is not exactly a low-loss coil, as the turns are close together, but still it proved very efficient on test. When winding, two points should be watched; the wire must not be wound on too tightly, and an effort should be made to produce a "jumble" winding by varying the angles of its windings. Then the wires cross and re-cross at a slight angle, and the self-capacity will be kept reasonably low.

To form the "figure-8" coil, twist the coil into this shape while holding it at opposite ends. (Fig. 14). The completed coil will resemble that shown in Fig. 15. Where the winding crosses over, the coil should be bound with thin cord or tape to prevent it from springing back again.



When the wire has been taken from the form (Fig. 13) it is twisted, as shown here, to form the fieldless coil.

The result is a self-supporting coil of the fieldless type. Such coils could be fixed to the under-side of the sub-panel by placing a narrow strip of hard rubber or thin wood across it; two wood screws passing through clearance holes in the ends of the strip will hold a coil securely in position. If a hard-rubber strip is used, small terminals can be fitted to it to facilitate connections.



This illustrates the method of rheostat-regeneration-control.

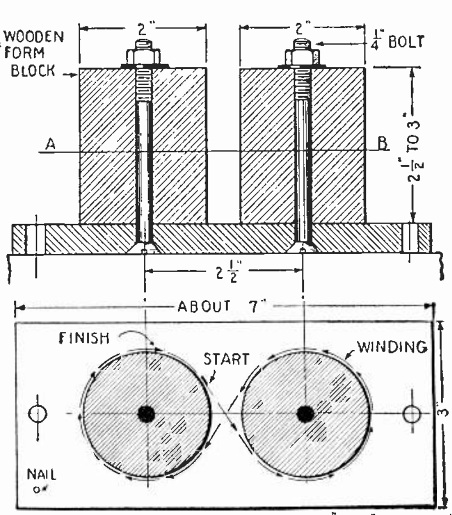
"Double Pickle-Bottle" Coils

Another excellent fieldless coil that can be readily made is the "double pickle-bottle" coil. It is wound over a double form of either circular or hexagonal cross-section. Fig. 16 shows the double form in detail; the form blocks have here a circular cross-section.

Two short round pieces of wood are bolted to a small baseboard, and long bolts pass through clearance holes in the forms and hold them firmly. The winding direction is indicated by the arrows in the plan view.

Winding can be carried out with more comfort if the form is screwed to the work table or bench; for this purpose two clearance holes for wood screws are provided at the ends of the wooden base. If the constructor has a large vise, he may clamp the base supporting the form in it while carrying out the winding.

Before starting the winding, two or three strips of surgical plaster, or paper strips coated with common glue, are placed, evenly spaced, over each form, just as in the case of a "pickle-bottle" coil. These strips may be held in position by rubber bands slipped over their ends, or still better by push-pins pressed into the form. The latter method is preferable, since the pins locate the strips definitely, and no slipping is possible.



Above is illustrated a form for winding "Figure-8" coils, which is easily constructed and handy to use.

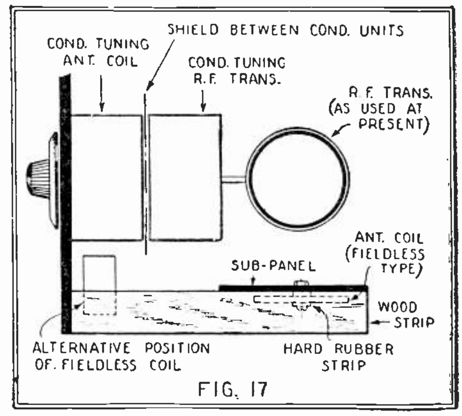
To hold one end of the wire while the winding proceeds, a short nail or small wood screw is driven into the wooden base. A few turns of wire are taken around this, and when the winding is completed, the other end of the wire is fastened in a similar manner.

The strips of tape are bent over the finished layer of wire, after the drawing pins or rubber bands have been removed. The strips should be long enough to overlap about ½-inch. Finally, the strips are pressed down upon the wire, to bind well.

The nuts are now taken off the bolts, and the coil, with the form blocks still in position, can be withdrawn from the base, which is clamped to the work-bench. The forms are freed and taken out by twisting them gently; if the wire has been wound with the right tension, and not too tightly, they will come out quite easily. The center of the coil, where the wires cross over, is bound with a few turns of thin cord, or tape, as before.

The number of turns required for a given variable condenser must be determined by experiment; for a start, thirty to forty turns of No. 26 D.C.C. wire may be tried. Care must be taken when winding these coils to space the wires slightly on their forms, else the coil will bulge out at the center.

This brings us to the final development the writer has in mind; a Browning-Drake equipped with tandem condensers. At the end of the rear condenser a R.F. transformer of the present-day type is carried (Fig. 17). Under the sub-panel, or anywhere else out of the way, lies the fieldless antenna coil.



Arrangement of apparatus for a Browning-Drake receiver employing tandem condensers.

With one stroke, we have single-control, no more interference between coils, and a far more compact set: in short—the ideal Browning Drake! It may yet prove the four-tuber of the future!

PREVENTING CORROSION OF BATTERY LEADS

By Raymond B. Wailes.

THE leads from the storage battery, whether it be "A" or "B", will soon lie across the vents and become impregnated with the electrolyte and eaten away. When the battery is on charge, the spray rapidly eats into the battery leads.

One method of preventing such corrosion is to soak the leads, for about a foot or two of their length, in melted paraffin. For this operation a coffee can placed upon the kitchen stove is very satisfactory in impregnating the leads. The first one or two feet of the wire is simply crammed into the can of melted paraffin and allowed to remain for several minutes for sufficient penetration.

Shielding In Radio Receivers

Better Reception Results from the Use of Metal Shields

By M. L. HARTMANN, Ph. D.* and JOHN R. MEAGHER**

SHIELDING has become popular with radio set builders only within the last year or more; but it has been used with marked success in commercial receivers for more than ten years. It is not a passing fad; as through the intelligent use of shielding receivers can be made many times more sensitive than is otherwise possible.

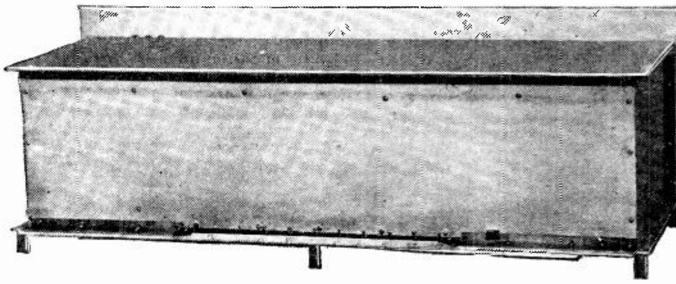
For greatest efficiency and sensitivity, in cascade or multi-tube amplifiers, it is essential to prevent the amplified or output energy from feeding back to the input circuit. This is necessary because, when the energy fed back exceeds a certain value, the amplifier oscillates; and this action limits the amount of amplification that may be obtained. The amplifier will amplify only up to the point of self-oscillation.

If, in some way, the point of self-oscillation can be removed to a higher value, the amount of amplification may be increased up to this new point, where self-oscillation will again occur. This increased amplification may be secured through reduction of losses, through increase of the plate-circuit impedance (more turns on the plate-circuit coils), or through additional stages of amplification.

Feed-back in an amplifier is caused by additive interaction of the input and output electromagnetic and electrostatic fields, as well as through additive resistance- or impedance-coupling of the electrical energy in the input and output circuits.

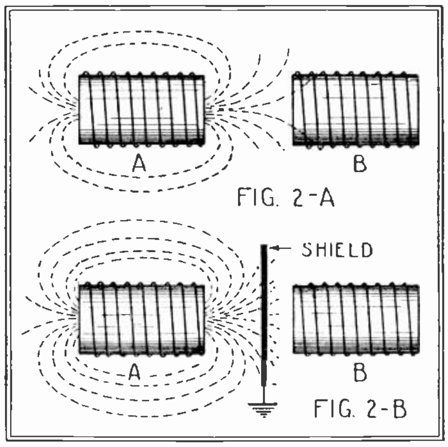
In order to reduce this interaction between the "charged" parts of a radio receiver, it is customary to space the coils, condensers and other parts well away from each other; and usually the coils are arranged at angles such that each will be least affected by neighboring fields. Likewise, direct electric coupling, as through the resistance of a common battery, is reduced by means of large "by-pass" condensers. Though this design tends to reduce coupling between the parts, it does not entirely eliminate feed-back.

It might be imagined that the field surrounding a coil is restricted to the immediate vicinity of the coil; but actually the field extends for a distance in all directions practically unlimited. Thus, it is not unusual for a good superheterodyne, without aerial or ground or loop, to be strongly affected by the field of a transmitter probably 2,000 miles away. We must appreciate this conception, of unlimited field extent, to understand the need of shielding.



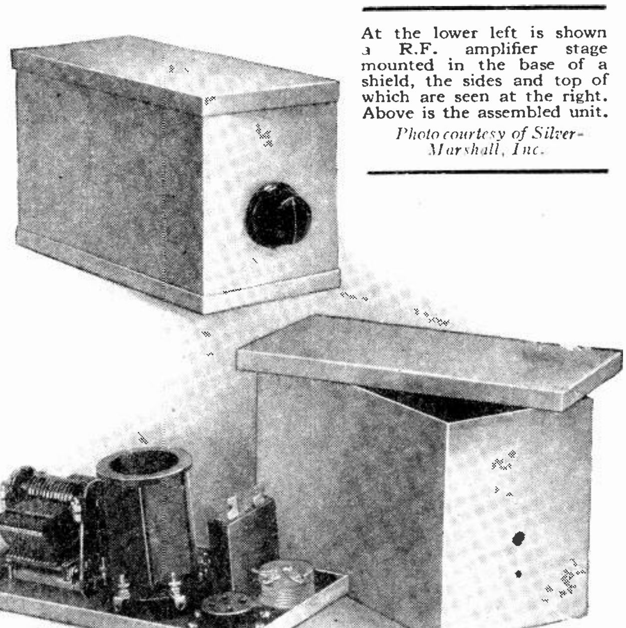
Rear view of the shielded superheterodyne; the base and cover are made of 1/8-inch aluminum; the sides, back and partitions are of 24-gauge aluminum.

Photo courtesy of The Carborundum Company



In 2-A the coil A extends its magnetic field and induces a current in B. In 2-B this induced current is shown to be almost entirely stopped by the grounded shield.

At present the only reliable method of definitely limiting the extent of the electromagnetic and electrostatic fields, and consequently the only method of reducing undesired feed-back, is through the use of thorough shielding.



At the lower left is shown a R.F. amplifier stage mounted in the base of a shield, the sides and top of which are seen at the right. Above is the assembled unit.

Photo courtesy of Silver-Marshall, Inc.

Primarily, the advantage of shielding is in reducing the feed-back or advancing the point of self-oscillation, so that *increased amplification may be attained.* In this way it is possible to make amplifiers far more sensitive, and capable of receiving over much greater distances, than is possible without shielding.

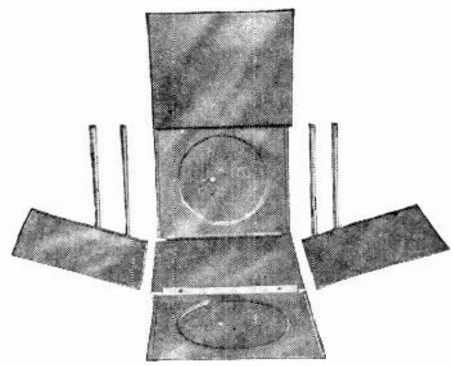
There are other advantages of shielding which will be mentioned briefly before the design and construction of shields in radio receivers are taken up.

Permits More Amplification

By employing thorough shielding and thus advancing the point of self-oscillation, it is possible to use a greater number of radio-frequency amplifying stages without undue difficulty in preventing or controlling self-oscillation. At the present time unshielded tuned-radio-frequency amplifiers are practically limited to two stages. If more than this number are used, very great losses have to be introduced to stop self-oscillation; and the efficiency of the system consequently is very low. But with shielded tuned-radio-frequency amplification, it is not at all difficult to use three and even four stages. Obviously, such an amplifier will give comparatively wonderful results in long-distance reception.

Easier Neutralization

Because the shielding reduces electromagnetic and electrostatic coupling between grid and plate circuits until the only remaining coupling is that caused by the grid-plate capacity of the vacuum-tube elements and their connecting leads, neutralization can be applied much more effectively and much more easily than is the case with unshielded receivers. In addition—and this is quite important—the neutralizing adjustment is more smoothly effective through the entire wavelength range; and consequently there is no "drop-off" in efficiency at the higher wavelengths, as is customary with unshielded neutrodyne receivers.



An example of a "knock-down" metal shield, which when assembled forms the shield shown on the following page.

Courtesy of Hammarlund Mfg. Co.

Grounded-rotor condensers have made most receivers free from body-capacity detuning effects; but in some sets, and particularly at short wavelengths, this annoying action is still evident. Thorough shielding absolutely eliminates this trouble, as the grounded conducting plate or shielding prevents changes in the field on one side of the plate from affecting objects on the other side. Therefore, changes in the field between the body

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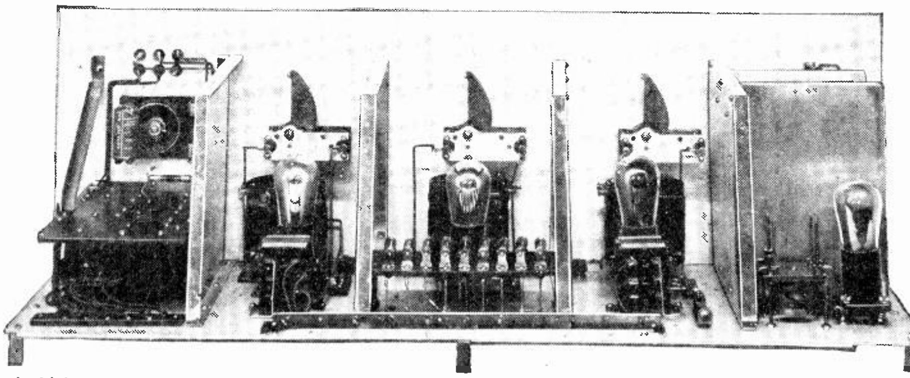


A shielded superheterodyne, showing the shielding partitions between the amplifier stages. The remainder of the shielding is shown in place on the opposite page.
Photo courtesy of The Carborundum Company

and the shielding, which might be caused by movements of the hand or body toward or away from the panel, do not influence objects inside the shield.

The coils and wiring in a thoroughly-shielded receiver are not affected by the field or by local or distant transmitters. Consequently, there is practically no possibility of interference from this source.

The radio- and audio-frequency fields, set up and carried from place to place by the lighting circuits, do not reach the coils and wires in a thoroughly-shielded receiver. For this reason shielding reduces interference from motors, buzzers, starters, telephones, arc-lights, defective insulators, etc. Of course, to take full advantage of this protection, the aerial must be erected as far as possible from lighting circuits.

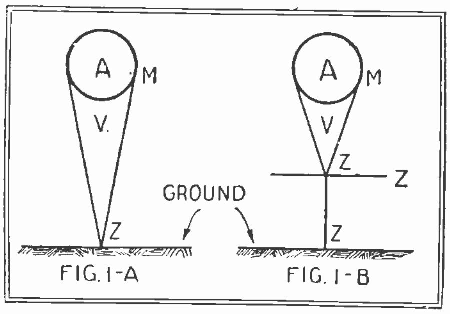
A thoroughly-shielded oscillator has a negligible external field and therefore does not annoy nearby listeners. Shielding prevents direct radiation, from the oscillator in superheterodyne receivers, and from the regenerative detector in Roberts, Browning-Drake and similar circuits.

Importance of Proper Design

Experiments show that, when a metal sheet is placed close to a coil of wire, there is a decrease in the apparent inductance and an increase in the apparent resistance of the coil. This is caused by the short-circuiting action of the metal sheet on the electromagnetic field surrounding the coil and by the energy losses in *eddy currents* set up in the metal. Both effects are greatest when the plane of the metal is parallel to the plane of winding of the coil, as eddy currents tend to flow in a direction at right angles to the plane of magnetization.

Fortunately both effects may be made practically negligible if the coil is spaced away from the surrounding metal. *The shielding should be kept at least 1½ inches from the ends and 1 inch from the sides of the coils.* Under this condition, and when small coils are used, no allowance need be made for reduction of inductance when the coil is placed in the shield.

It is advisable to use coils of small dimensions, and a diameter of 1½ inches and not more than 2 inches is to be preferred. No. 28 or 30 D.C.C. wire may be used for all coils and tuned-radio-frequency transformers. The data for a good R.F. transformer, to be tuned with a .0005-mf. variable condenser, are as follows: *form*, light shellacked cardboard or thin, hard rubber, 2 inches in diameter and 3 inches long; *secondary*, 50 turns of No. 30 D.C.C. wire (With .00035-mf. condensers the secondaries should have 60 turns); *primary*, 30 turns of No. 38 D.C.C. wire wound over the filament end of the secondary, a few turns of bond paper or empire-cloth separating the two coils. The antenna coil may have about 10 or 15 turns of No. 30 wire. Give the entire transformer a light coat of collodion, and provide five terminals for the connections. When using three or more stages of T.R.F. amplification, reduce the primary (plate coil) to 15 turns. A tap should be made on the secondary at the same number of turns from the filament end of the secondary as there are turns in the primary (*i.e.*, either 30 or 15).



In Fig. 1-A is shown a charged object, A, with a charge, M, greater than ground potential, Z. Between M and Z an electrostatic and electromagnetic field, V, exists. This field can be confined to a smaller area, as in Fig. 1-B, by the introduction of a grounded object in the field. Compare with Fig. 2.

This is for the neutralization-condenser connection, in case neutralization is used.

Wiring

The "A," "B", and "C" battery leads, if properly insulated, may be run against the shielding, as this does not introduce any bad effects; in fact this practise is to be recommended.

However, plate and grid leads and connections to neutralizing coils and condensers must be removed as far as possible from the metal, in order to minimize their capacity to ground and any detuning effects that might occur. This is particularly important in fixed tuned circuits, such as plate and neutralizing circuits, and also wherever fixed T.R.F. transformers are used. If slightly-excessive capacity is placed across an "untuned" or fixed coil (such as the plate-circuit coils), the latter immediately loses its characteristics and acts as a tuned circuit with resultant inefficiency over the rest of the range.

Grid-and-plate neutralizing connections that must be brought outside the shields (as might happen when separate cases are used for the different stages of amplification) should be enclosed in metallic tubing, which must be connected to the rest of the shielding. It is necessary to keep the capacity between the lead and the tubing as low as possible. For this reason use fairly large tubing and fine wire (No. 36 or 38) for the lead. Also have the lead run through the center of the tubing, so that it will be as far as possible from the metal. Such leads should be used only when absolutely necessary; and they must be kept as short as possible.

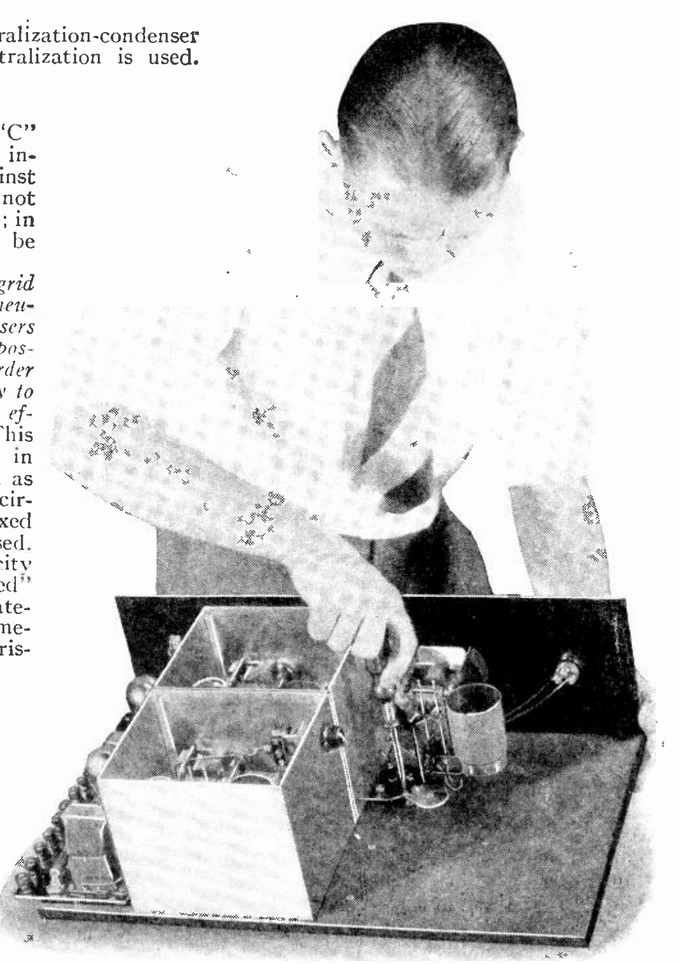
No. 18 plain rubber-covered stranded wire is excellent for use in shielded receivers. Cotton-covered rubber-insulated wire is not recommended, as the cotton covering frays and gets dirty.

Choice of Metals

With well-designed coils well spaced from the shielding, either magnetic or non-magnetic metal may be used. The popular preference is for non-magnetic metal. Aluminum is highly satisfactory because of its light weight. Copper and brass sheeting may also be used.

Practically any thickness is satisfactory at broadcast frequencies; 20 and 24 gauge have been used extensively. Sometimes the base is made from ⅛-inch metal and, in this case, there is no necessity for the usual wood base.

Solid sheet-metal is recommended instead of netting, because it can be built up into cases more easily than the netting. If netting is used it should be fine-mesh copper screening. (*Though netting or screening does not provide a satisfactory electromagnetic shield, it is effective as an electrostatic shield.* —Editor.)



How shielding is employed in a tuned R.F. receiver. The tops of the shields are removed to show construction, which is illustrated also on page 69.
Photo courtesy of Hammarlund Mfg. Co.

It is essential that the shielding around any one section of a receiver should be practically air-tight. When holes are necessary, as for leads, they must be of the smallest possible size. All seams and covers must fit snugly and touch all the way round. If this is not done the shielding will lose the greater part of its effectiveness.

It is also essential that the shields be interconnected and coupled to the battery circuit, preferably to the "A—" line, which should then be grounded; though the ground is not absolutely necessary, as the batteries and battery connections serve as a "phantom" ground.

When a shielded set is being wired, care should be taken, that only those leads which are to be connected to the "A—" or to ground touch the shielding. All other wires, binding posts, jacks, fixed condensers, etc., must be insulated from the shield. For this reason it is advisable to tape all exposed connections in the battery circuits or other wires that come close to the shield.

Methods of Construction

A common method of construction is to use the regular bakelite or rubber front panel and wooden base. The back of the panel and the top of the baseboard are covered with sheet metal of about 24 gauge. The shield on the front panel should be drilled at the same time as the panel. Any holes in the shield made to prevent contact with certain parts, such as jacks, should be enlarged sufficiently for this purpose. The front edge of the base shield should be turned down over the front edge of the baseboard in order that the base shield may make contact with the front shield along its entire length. The parts are then mounted in place, being grouped together in such a manner that each R.F. stage may easily be surrounded on all sides.

Thus, in an ordinary five-tube set, the first or antenna-circuit radio-frequency transformer, the first tube socket and the first variable condenser would be arranged in one group; the second radio-frequency transformer, the second tube socket and the second variable condenser in a second group; and the third radio-frequency transformer, third variable condenser and third or detector tube socket in a third. The two audio stages may also be advantageously grouped together and shielded.

This may be done by laying out, cutting and bending the metal to form three-sided boxes with flaps (⅜- or ½-inch wide) along the bottom and front for attachment, to the base shield and base, and to the front shield and panel, respectively. The box flaps may be fastened to the base with round-head wood-screws and to the panel with round-head 6/32 machine screws ⅜-inch long. Enough fastening screws should be used to make the boxes fit closely against the base and front shields at all points.

The covers may have three edges bent over to make a snug fit on the boxes; small holes may be made in the sides of the boxes for interconnections, and the battery leads may be bunched and brought through one hole.

This method of construction may be modified in a number of ways. If desired and providing metal other than aluminum is used, all the seams and flaps, etc., may be soldered.

A much more workmanlike job may be accomplished with ⅜-inch (on a side) brass or aluminum angle strip. The angle strip is built up in the form of a skeleton girder to provide a solid foundation for the metal shielding pieces and panel. Thus, in a set having five separate sections, the angle foundation would consist of six rectangular angle frames, about ½-inch lower than the inside height of the front panel and as deep as necessary.

These six frames would be joined at each corner by four string pieces, also of angle brass, as long as the panel. All joining may be done with 6/32 machine screws. The panel and shielding is then screwed to the foundation, making a neat and most rigid assembly.

In all shielded sets the sheet metal and angles, etc., should be sandpapered clean and coated with lacquer or collodion to prevent tarnishing. This also acts as a more or less useful partial insulator.

Tinfoil pasted on cardboard: A very light construction consists merely of medium-weight tinfoil, shellacked or glued to stiff cardboard, and used instead of stiff sheet metal. The idea might advantageously be extended to tinfoil-coated thin sheet rubber or bakelite, or even wood.

For some radio constructional purposes and in experimental work, it is possible to use large coffee containers, cracker-boxes, wash boilers and what not, but these are not to be recommended for average use. A few radio manufacturers make special shielding cases, very convenient for the constructor.

Radio Reception with Two Grounds

By H. A. EVEREST

Experiments with all kinds of underground antennas have convinced the writer that two grounds, with a condenser in the circuit, give best results. See Fig. 1.

This antenna system is slightly directional, though this cannot be detected on local stations. This directional effect may be due to the shielding action of the first ground on the second one. This theory is supported by the fact that, if the two grounds are over 75 feet apart, better results are secured by using two ground connections, ten feet apart, at the end nearest the station desired, as shown in Fig. 2.

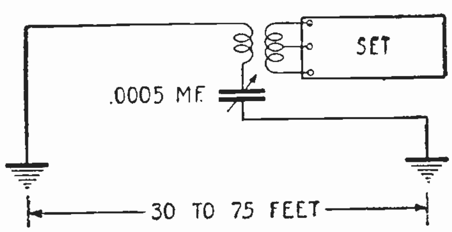
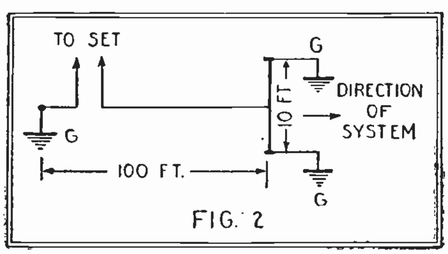


FIG. 1

Instead of a wire-antenna system, two ground connections may be used as shown above.

However, 60-foot spacing gives fine results and is recommended to those wishing to experiment. For an ordinary wide city lot, three grounds, spaced in an equilateral triangle, give complete control of directional effects by using various combinations. See Fig. 3. The size of the condenser in series with the system is not critical. A .0005-mf. variable condenser can be used, or the following fixed condensers can be tried; .005-, .00025- and .0001-mf., using the one which gives the desired selectivity.



Excellent results are obtained when the receiving system is grounded in three places, at the distances indicated.

To test this method get two ¼-inch or larger rods 42 inches long (old solid brass curtain rods do very well). Solder or clamp a 60-foot length of No. 14 rubber-covered wire to each rod. Attach one end of a wire to the antenna post of your set through a condenser; and drive the rod in damp ground, trying different spacing and directions with your regular ground and with the two rods until you determine the best positions. Using a double-throw, single-pole switch, you can make quick comparisons with a regular aerial.

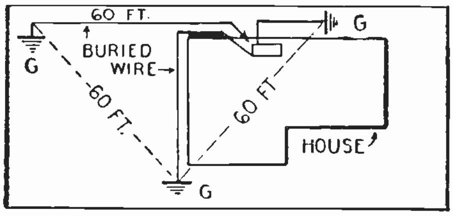
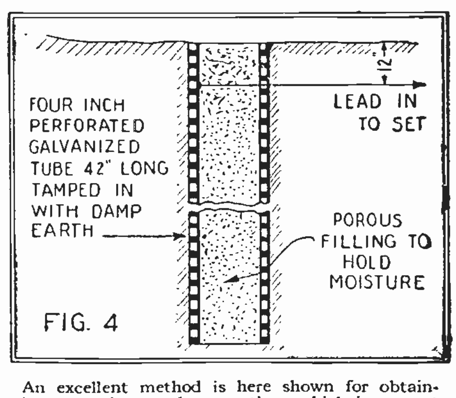


FIG. 3

The three grounds triangularly spaced give better directional effects, and are easily located on a good-sized city lot.

After the best spacing and directions have been determined, the rods should be replaced with a good permanent ground and the wires buried a foot or so under the surface. The problem of keeping these grounds moist can be solved as follows: make a 4-inch tube of galvanized sheet iron, 12 x 42 inches, well perforated. Set it in a four-foot post hole, after soldering to the tube the rubber covered wire. Fill the center of the pipe with gravel, coarse sand, coke or other porous material, and tamp stiff mud around the outside of the tube. Be sure to set the top of the tube below the level of the ground so that a small depression can be left to collect surface water and lead it to the center of the tube. Thorough soaking occasionally will keep these grounds in good condition. It is a good plan to place them in flower beds, so that they will be watered with the beds.

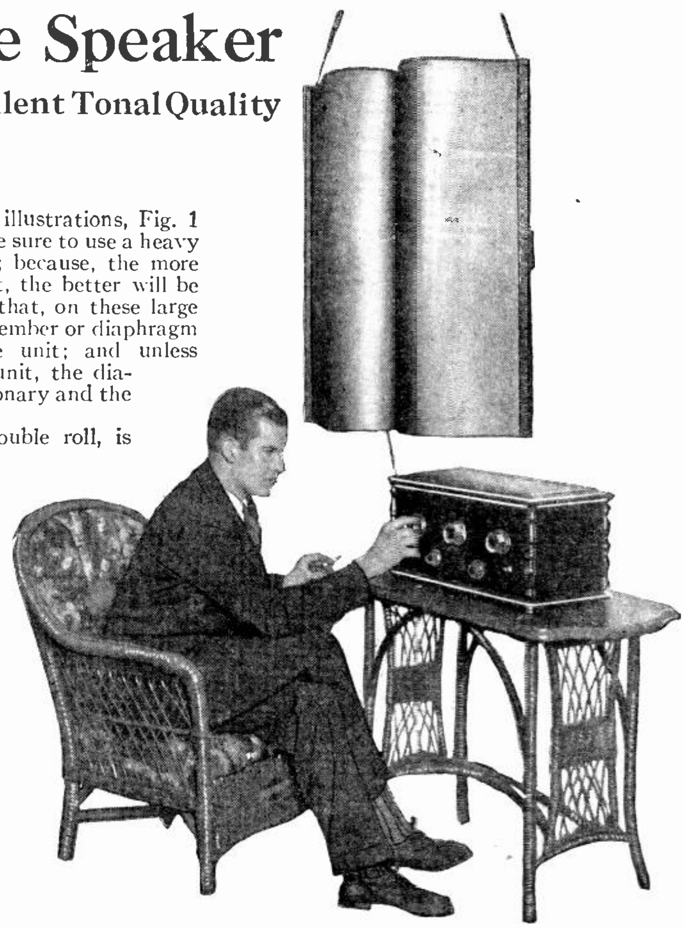


An excellent method is here shown for obtaining a good ground connection; which is a most important factor in this type of reception.

A Three-Foot Roll-Type Speaker

A Reproducer Simple of Construction, with Excellent Tonal Quality

By CLYDE J. FITCH



THE loud speaker offers one of the most interesting fields of experimentation open to the radio listener. Its evolution is toward better quality of reproduction. What is the final solution will be is difficult to predict. The large, three-foot-cone type of loud speaker has proven itself so excellent, as far as quality of reproduction is concerned, that by analogy why should not a large roll-type speaker prove superior to the smaller ones? (And the small ones are very good.) With this in mind, a large roll speaker was built, with the parts designed for a three-foot cone speaker. The roll speaker, shown in the accompanying illustrations, was found surprisingly simple to make. Only a few minutes were required to assemble it; it was then directly compared with a three-foot cone, using a resistance-coupled set. Whether the roll is superior to the cone, is difficult to determine. It is slightly higher in pitch than the cone and it certainly gives excellent reproduction. It is a matter of personal opinion which is the better speaker; many who heard the roll speaker prefer it to the cone, and vice versa. The type of set used with this speaker must also be taken into consideration when tests are being made.

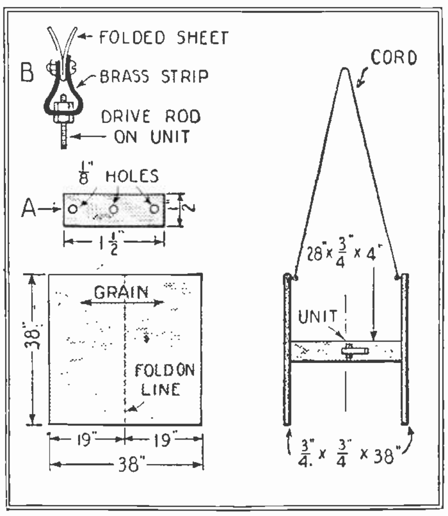


Fig. 1.
Details of construction for the roll-type speaker. At the upper left are data for preparing the metal strip that is attached to the diaphragm of the speaker.

In the cone the vibrations are applied at the apex and waves radiate outward; in the roll speaker the transition between vibratory and undulatory motion is more gradual, giving it a distinctive tone of its own, not found in other speakers.

Construction of Speaker

The construction of the speaker is so utterly simple that it requires little comment here. First a frame of three sticks was built as shown in the various illustrations, Fig. 1 giving the dimensions. Be sure to use a heavy hard wood, such as oak; because, the more weight added to the unit, the better will be the results. Remember that, on these large speakers, the vibrating member or diaphragm weighs as much as the unit; and unless weight is added to the unit, the diaphragm will remain stationary and the unit will vibrate.

The roll, or rather double roll, is made from one sheet of 38 x 38-inch speaker cone material. The sheet is folded once through the center, across the grain, as shown. (This material is usually supplied in rolls, with the grain running lengthwise with the roll.) Before folding, draw a line through the center with a straightedge. Now using the straightedge and a sharp pointed tool, go over this line, making an indentation in the paper. The sheet may now be folded along this line without fear of crushing.

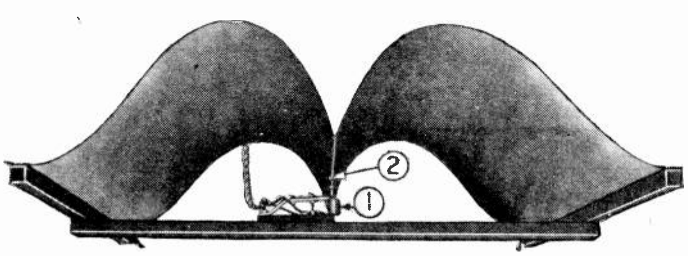
Next we require a thin piece of brass cut out and drilled as shown at A. This is fastened to the threaded drive-rod of the unit, bent up around the outside nut, and clamped upon the center of the folded edge of the sheet with a small nut and screw, as shown at B. Before clamping this piece to the sheet, mount the unit on the center of the wooden frame with wood screws.

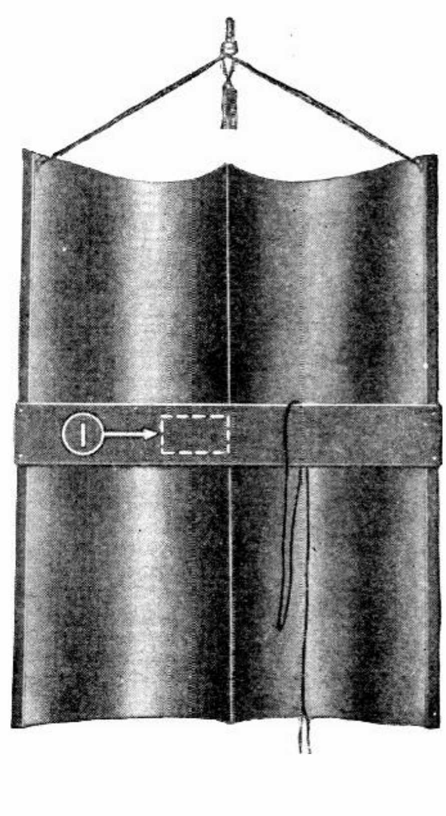
With the unit in place and the folded sheet attached to it, procure a few thumb tacks; bend the sheet over to the sides of the frame and securely attach it with the tacks. If desired, a gold braid may be placed along the sides to improve the appearance. The addition of a cord to hang the instrument to the picture moulding completes the assembly. Although called a three-foot roll, the speaker is in fact 38 inches long and 28 inches wide.

A loud speaker of this type lends itself admirably to decoration in a style harmonious with its surroundings. In contrast to the neutral tint of the diaphragm paper, braid trimmings may be used in brighter colors, agreeing with the other furnishings and the general scheme of the room in which it is hung.

In selecting the parts for this speaker be sure to procure a good cone unit, preferably a direct-drive one; in other words, one that has no mechanical reducing levers for reducing the motion applied to the cone. The one used in the writer's experiments was not a balanced unit, and could therefore be directly connected in the plate circuit of the output power tube of the set, without the use of an output transformer or choke coil and condenser system. A power tube may be used without fear of damaging the unit.

The theory of operation of the large roll speaker is somewhat similar to that of the cone speaker. In order to obtain faithful reproduction of the low tones, such as are produced by the bass viol, it is necessary to move a large volume of air. This requires a large, light, and strong diaphragm, the larger the better, up to a certain point where the lowest musical tones are reproduced. A sheet of paper may be large and of light weight; but it has no strength unless formed into a cone or roll, after which it serves as an excellent diaphragm.





On the left is the end view of the speaker, showing the manner in which the unit is mounted. No. 1 in both views is this unit and No. 2 is the point where the unit's drive rod is attached to the paper diaphragm. On the right, rear view of the speaker.

Photos by courtesy Engineers' Service Co.

Building a 36-Inch Cone Speaker

How to Construct a Large Cone Capable of Reproducing Notes of Very Low Frequency

By WARREN T. MITHOFF

THE writer is one whose radio budget, having suffered ravages from a severe case of superheterodyne construction, would not permit of such gross extravagance just at the time the urge to buy a factory-made 36-inch cone hit him. These big cones do cost real money, but they are worth every nickel of it, if we judge by results. The only alternative, then, was to build the much-coveted cone. Now there are on the market kits of parts for just this purpose; but the great ambition was to build out of such parts as the junk box afforded.

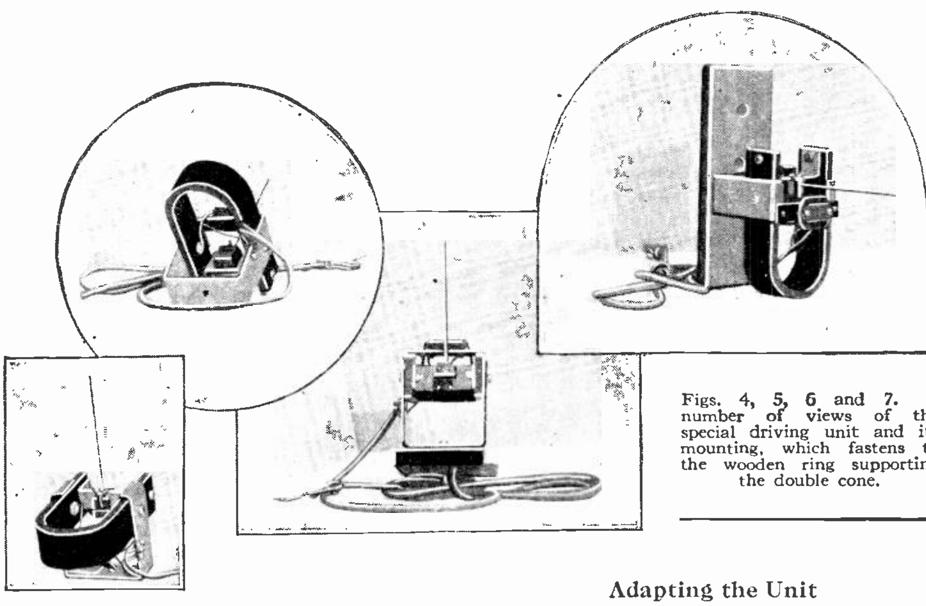
With this in mind work was started. After several months of experimenting an arrangement was found which stood the test; yet the cost was under ten dollars, even with the full market price put upon the junk-box parts.

The only requisites for success along this line are the materials, a little patience and care—and a good audio amplifier. The amplifier, of course, is important, as a cone speaker will show up distortion entirely passed over by the usual type of horn.

Selection of Parts

To start with, certain materials and parts are needed, first in importance being the driving unit. A Baldwin "Type C" is first rate; either the phonograph attachment or one of a pair of earphones. One is being used by the writer with great success, and this article is being prepared with the Baldwin unit in mind. Dimensions and instruction are given accordingly; although the same general procedure can be followed with any unit which has the balanced-armature type of construction. Units which have the thin iron diaphragm supported above the coils will not do for this cone, as they are inclined to rattle, and do not have sufficient power.

A large permanent horseshoe magnet is also needed, and can usually be obtained from one of the firms which make a business of scrapping worn-out automobiles and trucks. The magnet required is the kind found on truck magnetos, 3⅜ inches across the legs, 6 inches long, and made of ⅜ x 1⅝-inch steel. These dimensions are used in this article and the accompanying drawings, and if a magnet of different size is obtained, allowance must be made accordingly. Most of these magnets are already provided



Figs. 4, 5, 6 and 7. A number of views of the special driving unit and its mounting, which fastens to the wooden ring supporting the double cone.

with two drill holes on each leg, to pass ¼-inch machine screws.

The only other major item needed for the speaker is the paper from which to make the cone itself. The very best thing to use here is Alhambra "Low Frequency" paper; as its structure is such that it is not resonant to any particular frequency of its own, but reproduces all frequencies with good uniformity. Other papers can be used with greater or less success, depending on their nature. For example lampshade

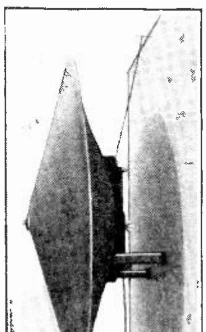


Fig. 2. This shows the manner in which the rear cone is joined to the wooden ring with sealing wax; also the manner of affixing legs, for use in hanging the cone on the wall.

parchment, which comes 36 inches wide, is highly satisfactory in actual practice, if not in theory; and it can be stained a rich brown with walnut-wood stain, and decorated with oil paints to suit the constructor's fancy. Some papers used for covers for catalogs and books can also be used, such as Castilian cover, heavy weight; a good printer can suggest something for the purpose. One trouble with the cover stocks is that generally the largest sheets obtainable are 23 x 33 inches, so they would have to be pieced out to make a 36-inch cone.

Some odds and ends are needed, of course, such as 6 inches of ⅛ x 1½-inch cold rolled steel; 12 inches of strip brass the same size; some No. 30 gauge sheet copper or brass, No. 30 gauge phosphor bronze, and ¼-inch round brass rod. Machine screws in four sizes are used: ¼-inch, No. 6-32, 4-36, and 2-56. Taps should be on hand for the 6-32, 4-36 and 2-56 sizes.

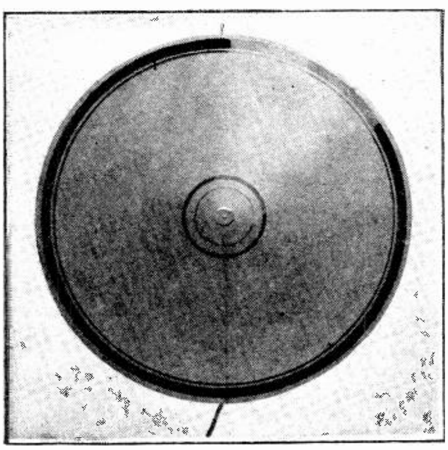


Fig. 1. From the front, the cone presents a very pleasing appearance; and if the constructor is handy with colors it can be made a thing of beauty.

Adapting the Unit

The first step is the dismantling of the Baldwin unit. The top of the hard-rubber case is unscrewed; the entire mechanism may then be removed, and the double speaker cord disconnected and laid aside for future, use. Before doing any more dismantling it is well to examine what is found inside the Baldwin case. There is a small coil of very fine wire, oval in shape, with an oblong slot through the center of it. Through this slot there is a small, flat, iron armature, one side of which is joined to the diaphragm with a fine brass wire, and the other held in place with a bent wire spring. Around the coil are "U" shaped pieces of flat steel, and to them is fastened the permanent magnet with machine screws. It is an excellent idea to pay careful attention to the manufacturer's method of assembling this unit, with regard to coil and magnet polarity. In other words, when the unit is re-assembled, this should be done in the same manner as originally, the inner and outer ends of the winding going to the same respective binding posts, and these terminals placed with the same respect to the north and south poles of the magnet. By marking the coil before removing it, no trouble should be experienced in re-assembling.

The diaphragm used in this unit is of mica instead of metal; through the center

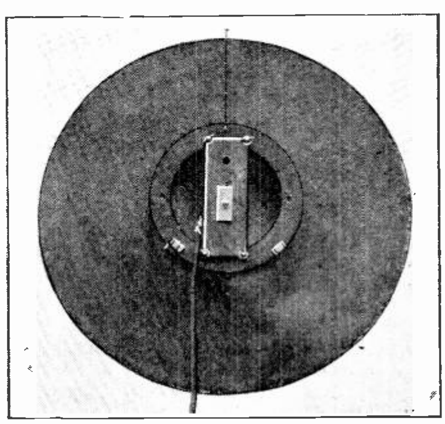
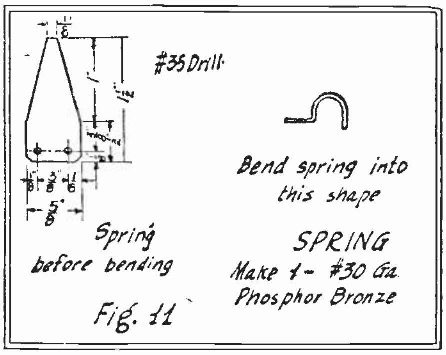


Fig. 3. Showing how the two cones are joined together with sealing wax or glue, and how the cross piece fits across the wooden ring.

of it projects the fine brass wire mentioned above, secured with a nut and a drop of solder. The mica should be cut or broken, and the wire clipped and unhooked from the projecting end of the armature. The circular magnet is next removed from the coil by taking out the two small screws which hold it in place. Then the tiny wires leading from the coil to the binding posts are unsoldered, care being used that they are not broken. The binding posts may be removed also. The coil, together with the two "U" shaped pieces of steel, is held with three rivets to a metal disc, on which the mica diaphragm originally rested. These rivets must be cut or filed off to permit the coil to be removed; the disc is then thrown away. The small wire spring holding the armature is removed, and the armature is taken out and laid aside.

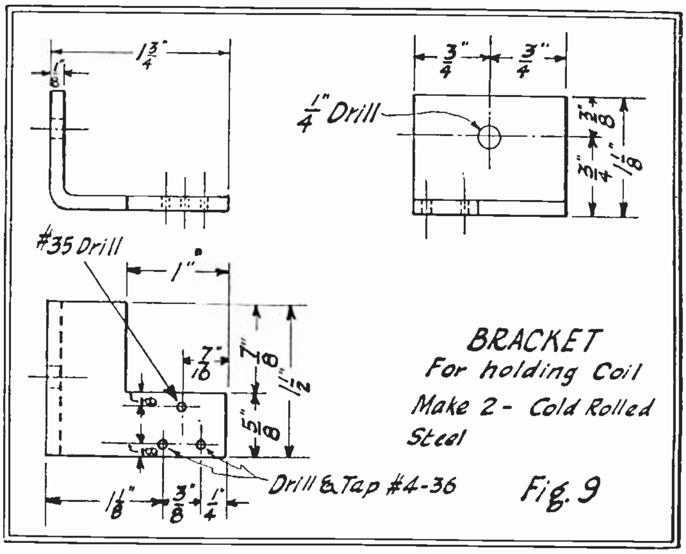
The coil is now to be mounted on the large horseshoe magnet; but, in order to do this, it is necessary to make two brackets of cold rolled steel, as shown in Fig. 9. These brackets are drilled and tapped as indicated, smoothed off with a file, and mounted with ¼-inch machine screws on the large magnet, so that there is an even separation between them. The coil, with the two "U" shaped pieces in place, is then put in position, and, if the holes are properly



Details of the armature-balancing spring.

spaced, it can be fastened with two No. 4-36 machine screws, as shown in Fig. 8. It will be noted that the two "U" shaped pieces are already tapped for these screws.

The two brackets should hold the coil level, and the "U" shaped pieces should fit tight against the slot in the center of the coil, both top and bottom. The lever, Fig. 10, and the spring, Fig. 11, are next made. These two, which are of phosphor bronze, are drilled as shown to pass No. 4-36 screws. The lever will be mounted on one side of the coil by means of these screws, fitting the holes tapped in the steel brackets; but, before it is put in place, it should be noted that in the slot in the center of the coil are two small pins projecting from one side. The armature has drill holes provided for these pins and, when put in position through the slot, the pins fit through the drill holes. The lever should be mounted on the side of the coil which has these pins. The spring is then mounted on the opposite side.



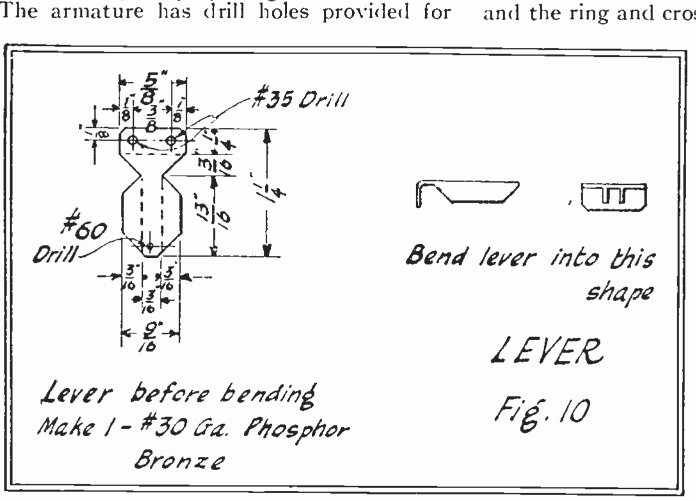
Details of the brackets, two of which are used for supporting the solenoid. These brackets form a part of the magnetic field.

The armature is put in place, and adjusted so that it will rock back and forth easily on the pins. A small hole is drilled in the end of the lever (Fig. 10) and a piece of No. 26 copper or brass wire run through this hole. A small hook is formed on the end of this wire, and caught through the hole in the part of the armature projecting from the slot. The spring on the other end of the armature is engaged, and the wire pulled up tight to balance the pressure exerted by the spring. The effect sought is so to balance the armature that it will remain stationary midway of the slot, so that any variations of current flowing through the coil will influence the armature magnetically and cause it to vibrate. After this has been achieved, the wire is secured to the lever with a drop of solder.

Binding posts should be provided for attaching the speaker cords, and it is best to use the one originally provided in the unit. These may be attached to suit the constructor's convenience, and the terminal wires soldered to them.

If the reader desires to test what he has done so far, he may at this point connect the unit alone to a set, with a good strong local station tuned in. If the unit is working properly, the armature will vibrate strongly with the signal received, giving a faint muffled sound of music or speech. If the finger is placed on one of the projecting ends of the armature these vibrations will be plainly felt; in fact it will be difficult or impossible to hold the armature still in the center of the slot. This is exactly the effect desired, as considerable power is needed to drive a 36-inch cone.

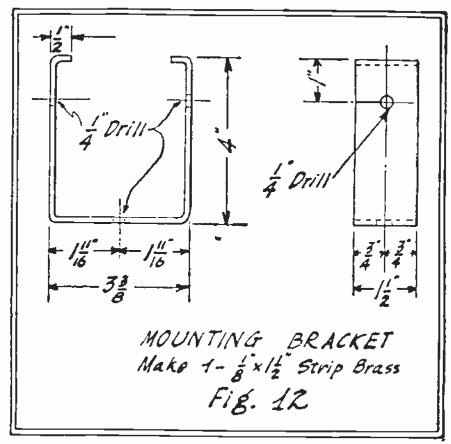
After the test has been made, and the unit disconnected, a straight, stiff piece of bus bar, 1/16-inch in diameter, is soldered securely to the lever, about three-quarters or two-thirds of the way back toward the bend, or fulcrum. This bus bar should be about 7 inches long, and should extend out at right angles, as shown in Fig. 8, in the illustrations. The mounting bracket, Fig. 12, and the ring and cross piece, Fig. 13, should now be prepared. The bracket is made of ⅛ x 1½-inch brass, and requires a piece about 12 inches long, bent shape and drilled as shown. The ring is cut with a jig saw, from ⅞-inch wood, either hard or soft, and has a diameter of 12 inches outside and 8 inches within. A piece of wood 3 inches wide and 12 inches long, should also be cut, planed, and drilled as indicated, to be used as a support for the entire assembly, being secured to the ring with ¼-inch machine screws and wing nuts.



The lever to which is attached the drive rod. One end of the lever is fastened to the frame of the unit, and the other end is attached to the balanced armature.

Constructing the Diaphragm

The next logical step is the making of the cone itself. Assuming that Alhambra paper is to be used, two sheets will be needed, 38 inches square. If the constructor has artistic tendencies, the cone may be decorated to suit his fancy with water colors, mixed and applied rather thick. It is best to do this decorating before making the cone. For the actual construction of the cone, one sheet of paper is laid flat on a table, rough side up; and, around a thumb tack in the



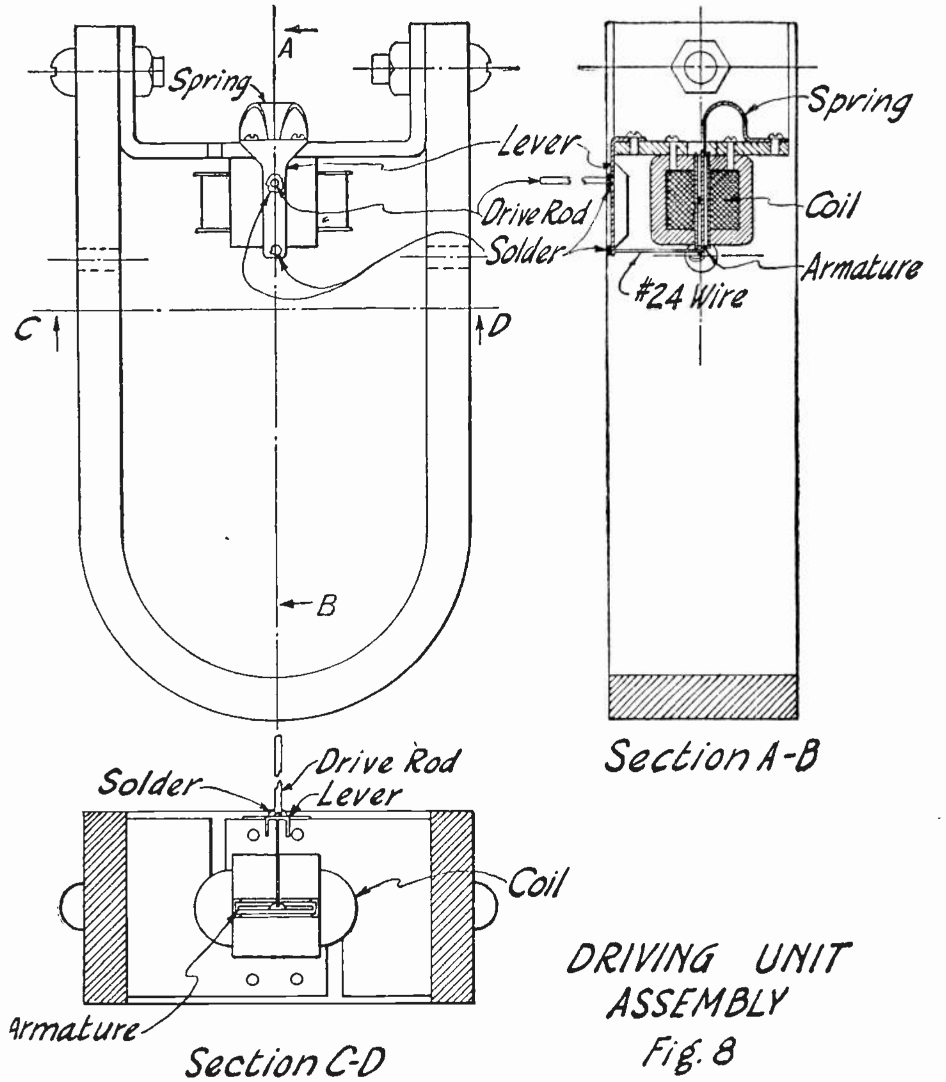
The brass bracket used for mounting the driving unit to the main support.

exact center of the sheet, a circle is drawn as large as possible, by means of a string and a soft pencil. This circle, allowing for any bent or torn edges on the paper, will be close to 38 inches in diameter when flat, but the shaping of the cone will reduce it to about 36 inches.

When the paper is bought, there will be found a note on the wrapper indicating which way the grain runs; and the sector cut out, to form the cone, must be cut with the grain, not against it. The sector to be removed comprises about 15 to 20 degrees, or from 5 to 6 inches along the outer circumference of the circle. After marking these lines, the circle may be cut out, and the sector also; the operation being performed with a sharp-pointed knife and a straight edge, to insure a perfectly straight cut.

Next a strip about 1½ inches wide and 19 inches long is cut, not necessarily from the same paper. The two edges of the segment are brought together, with the smooth surface of the paper on the inside or concave side of the cone, and the strip is glued to both edges so that it holds them firmly together. The glue which works best is one made by dissolving celluloid in amyl acetate, as this mixture is waterproof. Many fans are familiar with it, having used it in the construction of self-supporting coils. It will be well to try out the glue on some small pieces of paper before using it, to make sure that it will hold properly. A good celluloid-base glue can be obtained from the same source as the Alhambra paper, and is strongly recommended by the makers for this work. Regular glue should not be used, as it may cause the paper to buckle or warp, and may loosen in damp weather.

From the other sheet of paper, another circle is cut, with a diameter ¼-inch less than the first one. An inner circle, 11½ inches in diameter, is also cut out, as well as the same angular sector as on the first sheet. This cone may also be glued, with a 1½-inch strip holding the edges together. After the glue has set, this cone should be mounted on the wood ring as shown in Fig. 2. The 11½-inch circle cut from the paper should be centered exactly on the 12-inch ring, leaving about ¼-inch all around. The paper is fastened temporarily with three or four tacks near the inner edge. The most satisfactory method of making the permanent joint here is to use sealing wax. The stick of wax is heated in a flame, and the wax spread evenly along the inside of the cone, making a tight joint between the paper and the wood.



Details of the complete driving unit, as it is when assembled.

Mounting the Cone

The front cone is now set, with the apex down, into a dish pan or other large round pan to hold it in position. The other cone, with the wood ring affixed, is placed, ring uppermost, on the first one. If the circles have been accurately cut the front cone, which is lying in the dish pan, should extend about ⅛-inch beyond the other one, all around. It is on this ⅛-inch extension that the glueing is done. There are two methods available for fastening these two cones together. One is to use sealing wax, applying it carefully and sparingly, so that it does not run over on the front of the cone; and the other is to use the celluloid-base glue mentioned previously. If the glue is used, it must be applied quite liberally, to fill the crack or seam between the two edges. The sealing wax is a little easier to work with, as it hardens more quickly, and it seems to make no difference in the operation of the speaker. In using the wax, it must be applied very hot, so it will flow evenly, and in just sufficient amount to cover thoroughly every inch of the circumference, as seen in Fig. 3.

It is necessary now to provide some means of joining the actuating unit to the cone proper. This is done by means of the tip illustrated in Figs. 15, 16 and 17. The two small circles, Fig. 15, are cut out of

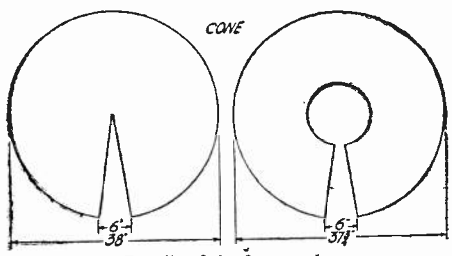
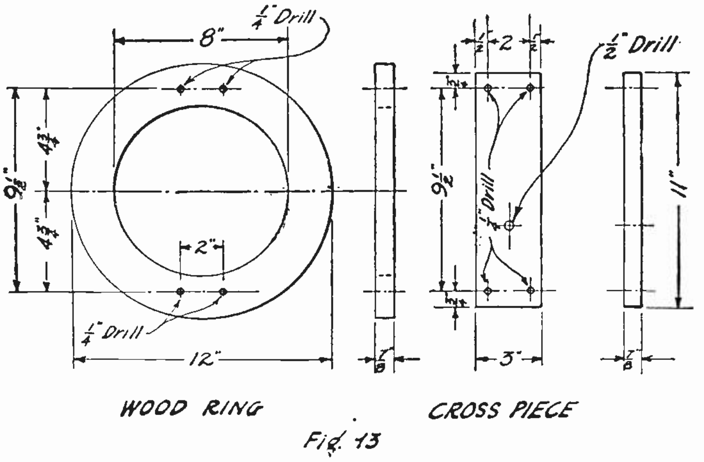


Fig. 14. Details of the front and rear cones.

thin sheet brass or copper, drilled as shown, and formed into the shape of a cone, being held in shape by means of solder sparingly applied to the seam. Excess solder must be removed with a file. Then the tip is made from ¼-inch brass rod, drilled through the center, or axially, with a No. 50 drill, slightly countersunk on one end, and drilled and tapped for a No. 2-56 machine screw through the side, as indicated. This tapped hole is for the set screw that holds the driving rod. This tip is then carefully soldered to the apex of one of the small metal cones, so that it fits in place straight, and so that the drill holes do not fill with solder.

This is rather a particular operation, and several attempts may be necessary before a good job is obtained. With reasonable care, however, it can be done successfully. This tip, with its metal cone, is mounted on the apex of the large paper cone, and the other metal cone placed inside. Before putting these in place, it is a good idea to spread a little rubber cement (or the celluloid-base glue may be used) both inside and outside, to join the tip securely to the paper. Further strength is obtained by passing No. 2-56 machine screws through the holes in the metal cones and through the paper, and tightening up the nuts on the inside. This makes a neat and serviceable job.

The bracket, Fig. 12, which was made out of strip brass, is used to hold the magnet and unit in place. The bracket is mounted on the magnet with ¼-inch machine screws, and the whole assembly laid in position on the cross piece (the wood strip which is fastened to the back of the wood ring), in such a way that the driving rod is exactly in line with the center point of the cross piece. This is of great importance, and care will be needed to see that there is no appreciable variation from the center. When this has been determined, a ½-inch hole is drilled in the cross piece, to line up with the ¼-inch hole in the back of the bracket. A

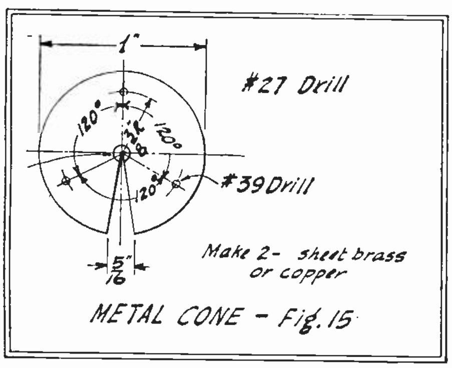


Details of the wooden supporting ring, and the cross-piece to which is attached the driving unit.

¼-inch machine screw is passed through these two holes, and a 1-inch washer slipped over the end of the screw. A suitable square washer can be made from the strip brass used on the bracket. A wing nut is used on the machine screw, as it can be loosened for adjustment without a wrench. It will be noted that the hole drilled in the wood crosspiece is ½-inch in size, while the bolt passing through it is only ¼-inch. This is to permit the entire driving mechanism assembly to be shifted slightly after the cone is put in place, in order to line up the driving rod exactly with the apex of the cone.

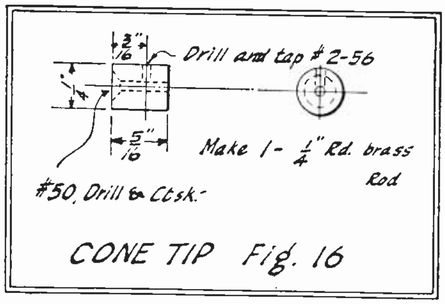
The crosspiece, with mechanism attached, is now fastened to the wooden ring with ¼-inch machine screws, also using wing nuts to permit easy access. At this stage the writer found it very convenient to construct a rough stand, to hold the cone proper while mounting and adjusting the mechanism. It is very difficult to hold a 36-inch cone with one hand and work with the other, tightening nuts, and fitting the driving rod into the tip of the cone. This stand consisted simply of a board, 3 feet long and 10 inches wide, laid flat on the floor, and two 3-foot uprights nailed on the edges at the center. Another strip was used to brace each upright. The cone was fastened to the uprights with wood screws, and was thereby held firmly in position, leaving both hands free for other work. It is strongly recommended that every constructor build such a stand.

The reader is cautioned at this point not to allow the driving rod to puncture the paper of the cone while trying to fit



The small metal cone or apex. Two of these are used, at the point where the drive-rod is attached to the cone.

the unit into the cone; also to make sure that it fits easily into place. If it does not, then some miscalculation has been made in laying out the various parts, and trying to force it into place may injure the mechanism. It is well to proceed slowly.



The cone tip, where adjustments of the drive rod are made, is soldered to one of the apexes, as shown in Fig. 17.

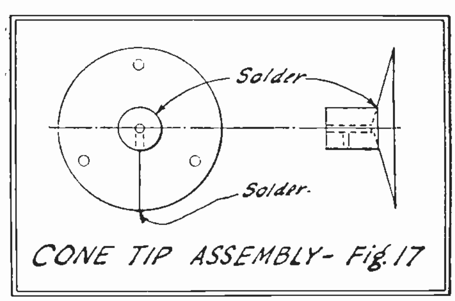
If everything fits properly, and all the nuts are tightened, the speaker may be connected to the set. It is best, first to tune in a powerful station clear and loud on the present speaker, and then connect the cone. The first sounds may be disappointing; if so, it is because the set screw on the tip of the cone has not been tightened. A No. 2-56 machine screw should be inserted here and tightened, thereby holding the driving rod securely in place. If the mechanism is properly adjusted, and exactly centered, a surprise will follow—a flood of golden melody such as seldom is heard from a receiving set. After making sure that everything is right, the surplus length of driving rod protruding from the tip is cut off, and the cone may be hung on the wall with picture wire; or perhaps the constructor who is ambitious with carpenter's tools will wish to build a permanent stand, of the three-legged variety, so that the speaker may stand on the floor near the set, or as far distant from it as he may choose. Before hanging the cone from the wall, two wooden strips are screwed to the edge of the wood ring near the bottom, and tipped with sponge rubber. The strips hold the cone away from the wall, while the rubber prevents vibrations being transmitted to it.

In case, however, that flood of melody does not come, there are several minor adjustments to be made that may coax it along. First, it would be well to loosen the set screw on the cone tip, and carefully pull out or push in on the driving rod. If that brings out the volume and richness of tone, then all is well, and the screw may be tightened. If not, the screw is loosened again, and the wing nut in the center of the cross-piece in the rear is unscrewed a little, and the entire mechanism shifted slightly, up, down, or sideways.

If this is unsuccessful, the unit should be removed from the cone, and examined for evidence of damage that may have occurred while fastening it in place. A bent drive-rod, or a lever sprung out of place, will cause trouble. The armature should be examined to make sure that it is centered in the slot and able to move freely. A slight adjustment of the spring will usually take care of this.

Another thing that may help is to put a .005-mf. fixed condenser across the speaker terminals. It was found desirable, on the writer's speaker, and was mounted inside the cone. Reversing the speaker cords may induce a change for the better in the tone quality. As a last resort, if results are disappointing (and it is extremely unlikely that they will be, if directions have been followed carefully) the set itself should be looked to. There must be no distortion here, as a cone speaker will reproduce the distortion faithfully where a horn might pass it over. This is not theory but fact. If a milliammeter is available, it should be connected in the "B—" lead to make sure that the proper grid bias is being used on the audio tubes, and that regeneration, if any, is not being pushed too far. This is not the place for a discussion of this subject; suffice it to say that there should be only the most minute variation of the milliammeter needle with the received signals. Anything more than that indicates distortion, which must be cured before a cone can do its best.

One further word about radio amplifiers. A 36-inch cone deserves the very best amplifier that the pocketbook will permit. Careful tests have been made with several different amplifiers, all of which gave fine results. One test was made with a well-known manufactured receiver, using 201A tubes throughout, and 90 volts of "B" battery, properly biased. Volume and quality were splendid, on both local and distant stations. Further tests included a different set, with transformer-coupled audio, using



Showing how the cone tip is soldered to one of the apexes.

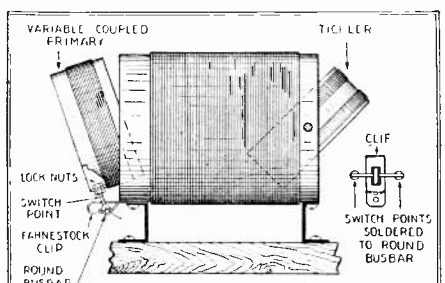
the 112 type of tube in the last stage, with 135 volts on the plate, and 9 volts negative grid bias. With this arrangement, greater volume was obtained, together with somewhat better quality, especially when full volume was used. Of course, if the larger power tubes, such as the 171 or 210, are available, they should be used.

Simple Variable Coupling Arrangement

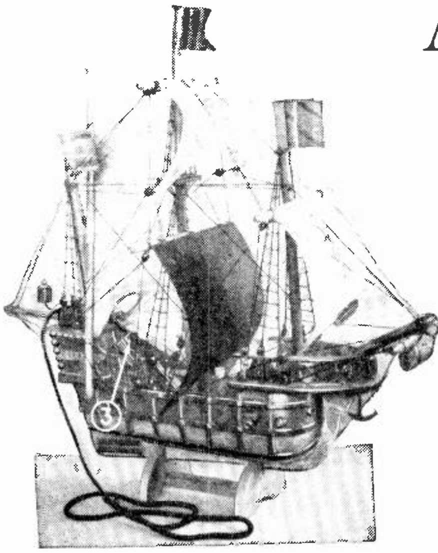
By J. L. ROCHESTER

IT IS OF considerable advantage to have some means whereby the coupling of the primary coil of a three-circuit tuner can be varied easily and effectively, and still be able to maintain any position in which it is placed.

A very good method for varying the primary coupling is shown in the accompanying illustration. The tuner itself is of the usual construction. At the end of the tube, upon which the secondary coil is wound, is fastened a common form of spring clip.



Through this clip is passed a piece of heavy round copper wire (No. 12) about one inch long; this section of wire acts as a hinge. The ends of the wire are soldered to two machine screws which, in turn, are fastened to the tube containing the primary coil, as shown. The spring clip exerts sufficient pressure on the section of wire, so that the primary coil, though it can be easily moved, will hold its position. The method of constructing the coil mounting is apparent from the sketch; it is simple, inexpensive and very easy of construction.



The loud-speaking ship completed.

A Ship-Model Loud Speaker

How a Decorative Loud Speaker Can Be Easily Made

By JAMES FRANCIS CLEMENGER

MANY ingenious attempts have been essayed by ambitious manufacturers, to make the very necessary loud speaker slightly more decorative than it has been in the past. Loud speakers vary in color, shape, and size within very wide limits, the general tendency being toward better reproduction even at the cost of an ungainly appearance.

The usual method of decorating a loud speaker is an attempt to hide its mechanical purpose, by disguising it as something which it most assuredly is not. Every one has seen these instruments built into flower stands, bird cages, fish bowls, and innumerable other peculiar housings; but it is rather hard to find a properly-designed speaker which is decorative without being simply an apologetically-disguised mechanism.

It occurred to the writer that it might be a good idea to combine the latest of fads in household ornaments with an efficient reproducing unit, to afford a most pleasing appearance with the highest degree of satisfactory reproduction. Ship models are undoubtedly the rage, so far as interior decorating goes. They are to be found in all sizes and types, from the tiniest silver galleons to huge models of ocean-going liners.

The great majority of the models found in modern homes are quite modest and unpretentious. They are used more for their significance and decorative value than because of their intrinsic worth. In fact, probably two-thirds of the models which are now gracing the mantelpieces of thousands of homes were built by the owners from parts furnished by the "model ship" factories which specialize in such materials.

The Musical Sail

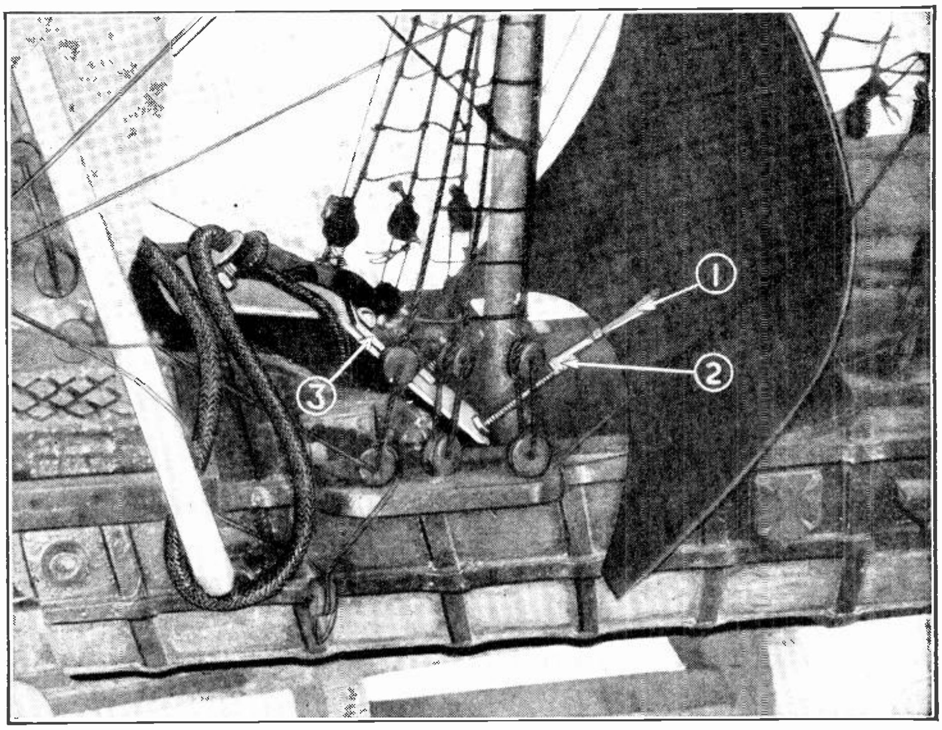
Obviously an ideal thing to do would be to incorporate a loud speaker in some way in the design of a model ship, doing away with the cone or horn, and replacing it with a handsome and graceful miniature vessel. Several ideas suggested themselves, but it soon became apparent that the only method which would answer was that involving the use of some sort of speaker unit, so connected to one of the sails that it would cause the sail to vibrate and set the air in motion.

place the largest sail with a duplicate made of the heavy diaphragm paper, and to cut out a section of the deck so that the loud-talker unit might rest in the hull of the ship. The unit used in this speaker was developed particularly for use in operating a 3-foot cone, so that it has abundant power to vibrate the sail and produce a considerable volume of sound.

In later designs of this same general type, it has been found advisable to raise the boom of the sail clear up to the "crow's nest," enlarging the sail in order to utilize as much sound-producing area as possible.

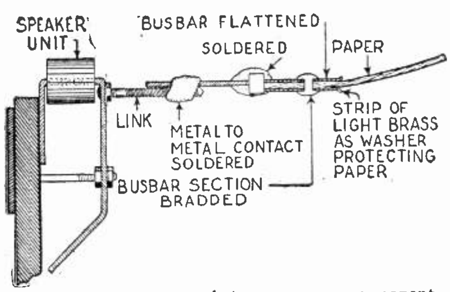
The reproduction is most excellent, and the volume quite sufficient for home use.

Only one difficulty will be encountered in



Showing a close-up of the unit as installed: 1, metal plate attaching driving-rod to sail; 2, link; 3, loud-speaker unit.

Photo courtesy of Miniature Ship Models, Inc., and Engineers' Service Co.



The arrangement used to assure a permanent connection between the loud-speaker unit and the sail-diaphragm is shown above.

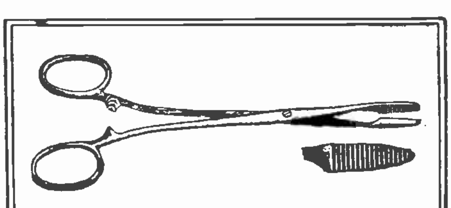
Utilizing the principle devised by Clyde J. Fitch, of driving a speaking surface along the length of the paper fibers, through the impulse of a special type of unit, the writer developed the sail speaker pictured here. As may be seen by consulting the illustrations, the driving pin of the loud speaker unit is clamped tight to the edge of the sail surface—which is made of any standard cone-speaker fabric—and the motion of the armature causes the entire sail area to vibrates strongly. In this particular case, as the model was entirely experimental, the only changes made in the ship were to re-

preparing this type of speaker from whatever materials may be at hand; that of connecting the pin of the unit to the edge of the sheet of paper. It was accomplished, as you will see in the illustrations, by attaching a small metal anchor plate, to which the link had been soldered firmly, to the lower edge of the sail.

The upper edge of the sail is to be thumbtacked or glued to the boom; but the lower edge and the sides must be permitted to ride free, so that the vibrations will not be "damped" or transmitted to other surfaces.

SURGEON'S FORCEPS HANDY TOOL FOR RADIO EXPERIMENTER

IT IS said that radio has contributed something to surgery, especially in making possible the care of the sick at sea under the direction of the surgeon on land. So it is fitting that surgery should contribute something to radio; in fact it can contribute to the radio set builder the very best tool he can have in his kit-box, the surgical instrument known as the Murphy-Pean hemostatic forceps. This is an instrument in



common use by surgeons for grasping bleeding vessels. It is inexpensive and readily obtained from the nearest surgical instrument dealer, or it may be ordered through any druggist. It is 6½ inches long, of light weight, rather flexible, but very strong. The blades are serrated, thus enabling it to grasp and hold tightly any small object, whether round, square or flat.

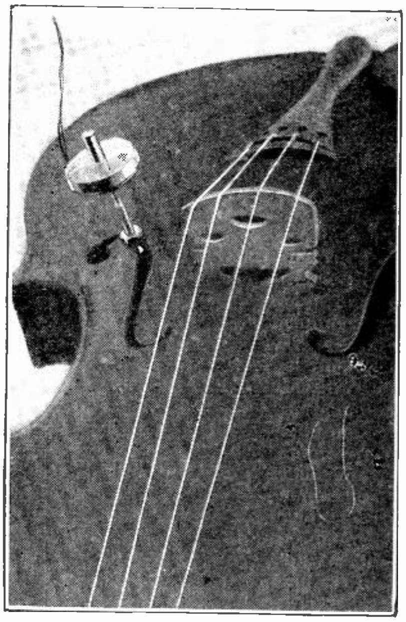
By H. B. Beeson, M. D.

The Giant-Tone Radio Violin

Radio Gives a Small Violin Foghorn Volume

By R. F. STARZL

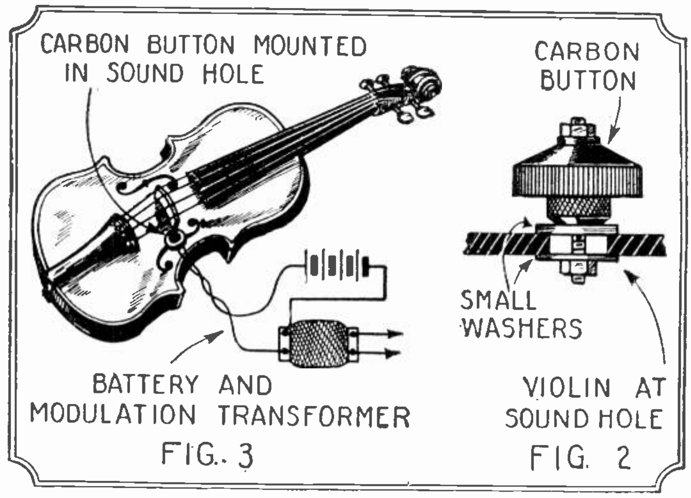
A DANCE orchestra leader, who also plays the violin, asked the writer recently if the violin music could be amplified electrically, so that it could be heard all over a large dance hall above the music of a piano and the loud wind instruments. He thought this would be a profitable novelty and would, as well, improve the quality of the dance music by making the director's instrument dominate all the others.



Showing detail of mounting in f-hole of violin, which does not mar instrument. With some stringed instruments it may be desirable to drill a small hole to accommodate the screw to which the microphone reed is soldered.

Fig. 2. Here is shown the method of mounting the microphone in one of the "f" holes of the violin. It would be possible to drill a hole in the body of the instrument, but there are few who wish to mar their violins for the sake of an experiment.

Fig. 3. In this sketch are shown the connections which are made from the microphone to the modulation transformer and the 6-volt battery. The output of the transformer goes to the audio-frequency amplifier, two circuits for such amplifiers being given on page 79. By using a microphone of this type, only the vibrations of the violin are picked up and amplified.



The first suggestion to present itself was to put on the orchestra stage a microphone hooked up to an amplifier in the usual way, with a horn speaker for the output; but when this was tried out the resulting bedlam was terrible. The louder instruments monopolized the microphone and the sound feed-back, due to the proximity of the speaker and the echoes of the hall, produced a fiendish howl.

Then it was decided to mount the microphone *directly on the violin.* The expensive studio microphone was returned to the local college from which it had been borrowed, and one of the small carbon buttons (which can be had for about a dollar) was purchased. (See Fig. 1.) At one end of this unit is a small screw for attachment to a microphone diaphragm. No diaphragm was used, however. Instead, a small brass screw was soldered to the reed where the diaphragm is supposed to go (see Fig. 2), and in this way the unit was mounted by means of a brass nut and small washer in one of the sound holes in the top of the violin (see Fig. 3). A more workmanlike job would be to drill a small hole, but in this case the owner did not want to deface his instrument; hence the makeshift.

It will be seen that the microphone will respond to the vibrations of the violin only. The weight of the button, or rather, its inertia, provides the mechanical reactance for the vibrating reed to work against. The carbon button should be mounted as near the edge of the violin as possible. Up near the bridge the amplitude of the vibrations is so great as to cause distortion. For that matter, almost any part of the violin vibrates sufficiently to give good volume when the carbon button is fastened to it.

Building Up An Impedance

The microphone was connected in series with a six-volt storage battery (which also operates the amplifier-tube filaments), and with the primary of a transformer which matches the low impedance of the microphone to the high impedance of the first amplifier tube. Modulation transformers for this purpose can be bought; or a good one can be made out of an ordinary telephone coil, which may usually be had for nothing at the local telephone exchange. The primary of the coil is used "as is." The secondary is brought up to the proper impedance by winding on about 2 or 3 ounces of No. 36 D.S.C. enameled wire (see Fig. 4). The outside end of the secondary (which is wound over the primary) is first uncovered and soldered to the end of the additional wire. The secondary is then covered with insulating tape or empire cloth, for considerable voltage difference will be developed between the two sections.

It would be impossible for anyone not equipped with a winding machine to lay the turns on nice and straight; but for this purpose it is neither necessary nor desirable to do so. A kind of a "jumble-bank-wound" effect is secured instead by winding as shown in the drawings. This is very easy to do. It reduces distributed capacity and simplifies insulation, because the potential be-

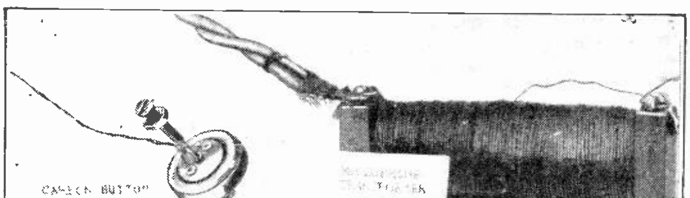


Fig. 1. The heart of the circuit. The carbon button employed came out of an old telephone transmitter. See Fig. 4 for directions for progressive winding of the crude but efficient microphone transformer.

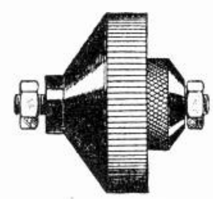
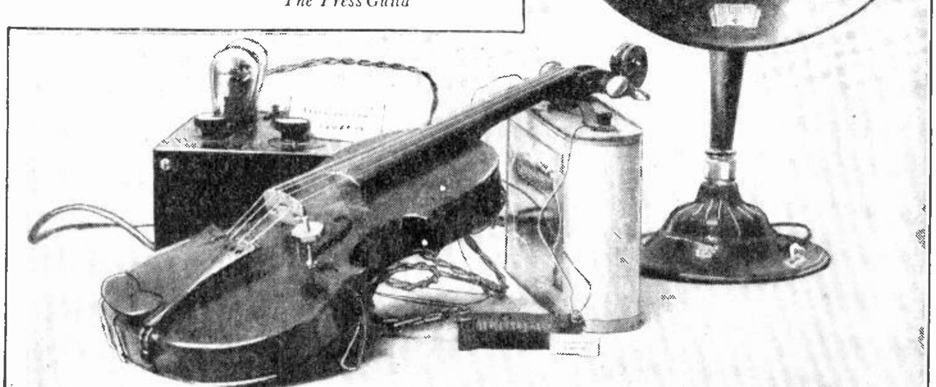


Illustration courtesy The Press Guild



The complete outfit for making a violin play with enormous volume. Above is shown a transmitter button of another type, which can be used instead of that shown.

tween adjacent turns is low, and the wires lie in a kind of honeycomb arrangement. This method of winding flattens the characteristic curve of the transformer, which improves tone quality. The homemade modulation transformer should be soaked in paraffin.

The secondary of the transformer is connected to the first tube of a two-tube amplifier, the circuit of which is shown in Fig. 5. A 201A-type tube and a semi-power tube were found sufficient for all purposes. A standard "B" power unit supplied the plate voltage. A concert-model loud-speaker unit was used in connection with a 6-foot collapsible horn built of light boards, which could be folded and packed on the running-board of a car. If extreme amplification is desired, the push-pull power-amplifier circuit shown in Fig. 6 can be used. Tubes V and V1 are the 201A-type, while V2 and V3 are semi-power tubes. Standard push-pull transformers are employed.

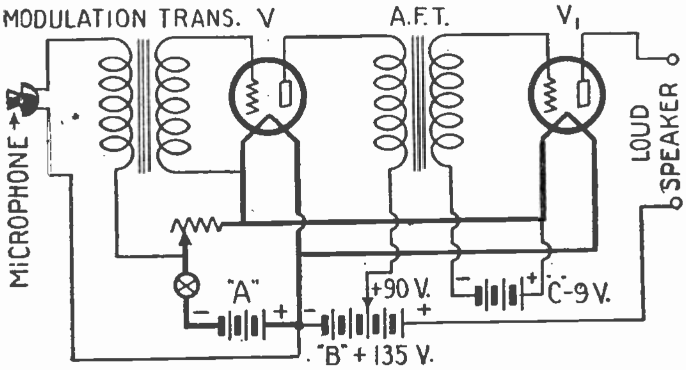


FIG. 5

Fig. 5. At the left is shown the audio-frequency amplifier which is used for amplifying the tones of a violin to "fog-horn" volume. The vacuum tubes, V and V1, are of the 201A type of amplifiers. As may be seen from the diagram, a "C" battery having a value of 9 volts, is used in the grid circuit of the second tube, V1. In the diagram shown below, Fig. 6, there is a stage of push-pull amplification, which insures great volume without distortion.

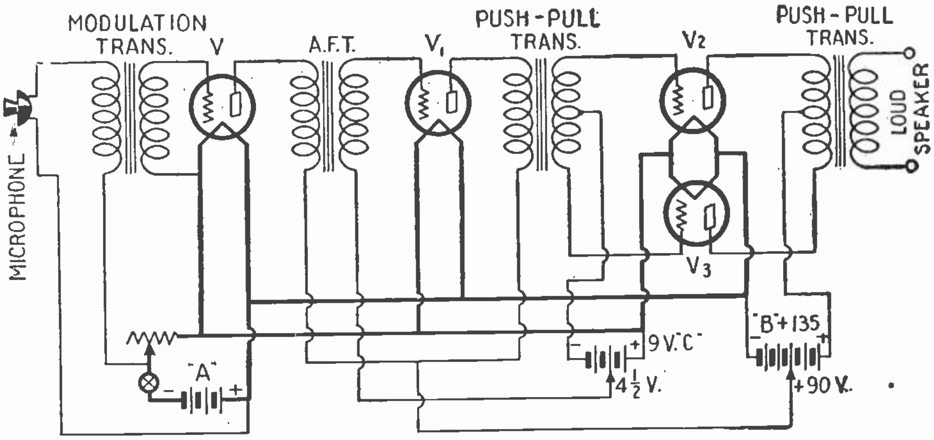


FIG. 6

A four-tube A.F. amplifier can be used if extremely great volume is desired, as for an outdoor audience. V and V1 are 201-A type tubes and V2 and V3 are semi-power tubes.

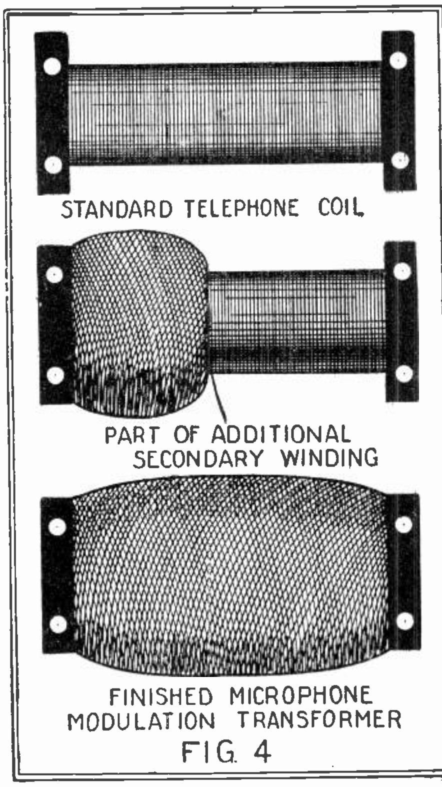


FIG. 4

The modulation transformer, details of which are shown above, can be easily made by the experimenter.

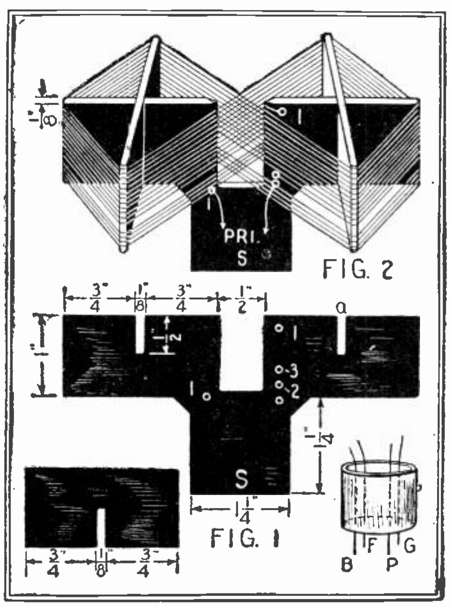
The performance of this violin amplifier is phenomenal. The violin alone can be made to supply as much volume as an entire orchestra, yet its characteristic timbre is preserved. In combination with four or five other instruments it makes an orchestra that cannot be equalled for snap and power by orchestras using more than twice as many musicians. The great amplification causes the violin, which often carries the melody, to dominate all other instruments, and to be heard above the shuffle and murmur of the dance hall.

Very probably the same method of amplification could be used on all stringed instruments.

An Interchangeable Plug-in Coil

By ROBERT N. AUBLE

THE coil illustrated in the accompanying sketches is not only easy to construct, but also very compact. The form upon which it is wound is sawed from a piece of bakelite, formica, or other suitable material. If several coils are to be constructed, several strips of material may be clamped together in a vise and all of them sawed at the same time. For each main supporting strip (S, Fig. 1) two cross strips should be cut. The depth of the slot in the cross strip and of the corresponding slot in the supporting strip should be one-half the vertical height, so that when the two are fitted together the joint at the top and bottom will be even. The center slot in the main supporting strip should be of such width that the wire will not touch the insulation when carried straight across. The projecting parts at the bottom should be of such width and length as to fit snugly into the shell of a discarded vacuum tube. Small holes for wire (indicated in Fig. 1) should be bored in the supporting strip. The four ends of the primary and secondary coils are threaded through these holes before they



are soldered into the prongs of the tube shell as shown at the lower right.

In the winding of a coil, the wire is first threaded through hole number 1, four or five inches being left for convenience in soldering in the tube shell. The wire is carried around one-half of the form in a clockwise direction; thence through the center slot, and counter-clockwise about the other half of the form. The other end of the primary coil should be brought out at the same side of the form as the first end, while the two ends of the secondary are to be carried to the opposite side. When completed, the two ends of the primary are soldered to the plate and "A+" terminals of the shell, and those of the secondary to the grid and "A—" terminals. After the wires have been soldered, the shell is filled with sealing wax to render the coil rigid.

The coil illustrated has seven double turns on the primary and 64 double turns on the secondary, and is suitable for use with a .00035-mf. condenser for the broadcast band of wavelengths. A form one-inch high accommodates 72 turns of No. 26 D.S.C. wire.

Some Suggested Aerial Installations

Details of Modern Construction Meeting Every Set Owner's Need and Pocketbook

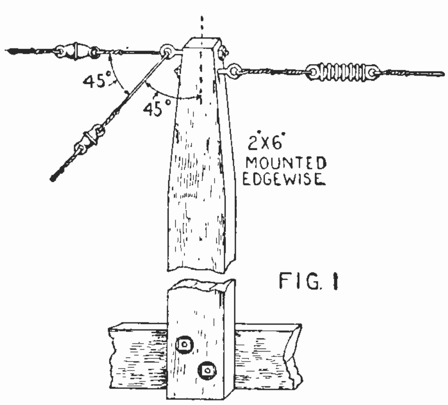
By A. BINNEWEG, Jr.

WHAT is more unsightly than a badly-bent aerial mast protruding from the roof of a respectable residence or apartment house? Yet, in every city, one may see scores of ill-constructed poor excuses for poles. Usually the cause is not the lack of proper tools or the selection of unsuitable material, but the improper *use* of material, and, in general, a lack of experience in setting up aerial supports. It is the purpose of this article to suggest proper methods of procedure in erecting some simple, commonly-used types of these, and to give other useful information.

Selecting the Location

The efficient performance of an antenna depends upon not only its construction, but also its location with respect to surrounding objects, such as trees, tin roofs, smoking chimneys and similar disturbing influences. Large, nearby trees may change the capacity of an antenna considerably when the wind blows, tin roofs often impair its "pick-up," and smoking chimneys invariably ruin its insulation. These effects should be borne in mind when one is choosing a site for an efficient installation. Keep the entire antenna as clear of surrounding objects as possible. Other factors remaining constant, it is no mystery that one can secure wonderful results with ordinary receivers in small, out-of-the-way country towns, where networks of all sorts of wiring and steel-framed structures are at a minimum.

Select the best site available, remembering that the completed aerial is to have one wire from 50 to 100 feet long, depending upon the set and the selectivity desired, and is to be erected as much in the open as circumstances permit. It is an infinitesimally small current, induced in the antenna by a passing wave, that governs reception; give this current a chance.

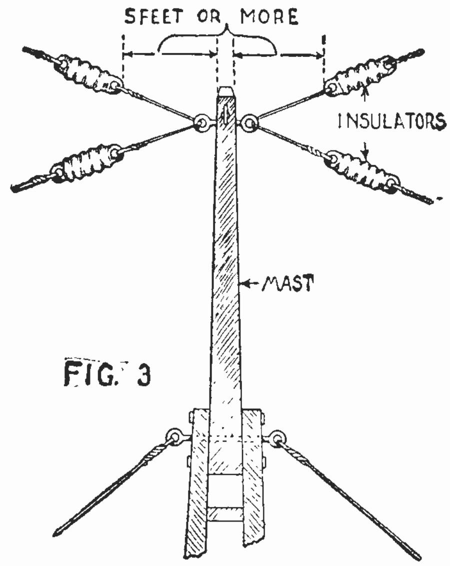


An excellent mast between 15 and 25 feet in height may be constructed from 2x6 lumber, mounted edgewise, as shown.

Severe cases of "fading" may often be traced to a swinging aerial which is too close to a tin roof or other similar conductor; the remedy is obvious. An aerial well away from surrounding objects rarely causes objectionable wave-changing, but a poorly-located lead-in near and parallel to a water pipe often does. All parts of the antenna should be securely fastened down; then, even though part of it must be placed in one of these positions, little trouble will result.

Preparing the Mast

One must next select a mast that will support the conducting wire above the ground or the roof, as the case may be. The majority of radio fans will be content with a pole of moderate proportions, such as a single mast from 10 to 25 feet long; others may desire tall masts and still others small poles that will raise the wire well above the roof. An aerial support to suit the individual fancy and pocketbook may be selected from those about to be described.



A neighborhood antenna mast can be made with advantage to all, by employing the above system for several aerials.

In cities it is often difficult to find room for a large mast, so the average used in these localities is about 15 feet high. A piece of lumber, having a length of from 15 to 25 feet, is diagramed in Fig. 1. The piece of lumber should be wider than its thickness and should be set up edgewise, as shown. An ordinary 2 x 6 plank will serve for this purpose. It will look better if some of the wood at the top is trimmed off, as shown in the sketch. One of this type may remain in place for years and still show no tendency to bend.

The proper method with a mast like this or any pole in which the strain at the top is horizontal, or nearly so, is to place at the rear two guy wires spaced about 45° apart, making the same angle with the horizontal. Guy wires, if improperly placed, will often do more harm than good; do not place them half-way down a single pole; they should be fastened at the same height as the aerial wire which, of course, should be at the top. Large galvanized screw-eyes may be used for fastening all wires to the pole; small holes should first be drilled and then the eyes may be readily screwed in without danger of splitting the wood.

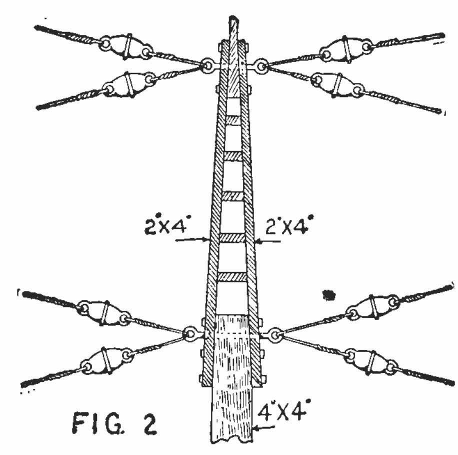
After all the wires have been attached and properly insulated, select suitable "anchors" for the guy wires. For this purpose screw-eyes may be driven into convenient wooden objects or pieces of 2 x 4 may be set in the ground at an angle. Those necessary for an ordinary aerial are easily constructed, but it may be well to put in good, permanent anchors. A piece of 2 x 4, set in a hole about 30 inches deep and properly cemented in place, is about the best and simplest anchor one can conveniently make. The screw-eye may be driven into the wood and the guy-wires attached.

Erecting the Mast

To raise the mast, lay it toward the guy anchors with its lower end in the proper position; run the guy wire through the screw-eyes in the anchors, and have some one pay out the guy wires while you hold the mast in its proper position and another helper hoists the pole by the aerial wire. If the mast is too heavy to raise by means of this wire, better use three guys, and then the extra guy wire can be used for this purpose. When the mast is vertical, the trouble is about all over and the guy wires should be drawn fairly taut. With the aid of a borrowed level, the mast may be made vertical by leveling first from one side, then from the other and gradually tightening up on the wires. One can usually judge the correct tensions to be applied.

Another mast that can be easily constructed and, with a little patience, made as high as 70 feet, is suggested by Fig. 2. The bottom section is a 4 x 4 which may be made as long as 26 feet; this should be securely set about 5 feet into the ground. The second section consists of two 2 x 4s which are bridged-in with short lengths of the same material and the third and top section is a round pole about 3 inches in diameter at the base and about 2 or 2½ inches at the top. Each joint is securely guyed with at least three guy wires. All holes are drilled and all wires properly insulated and put into place before the mast is raised. Do not forget to put in the rope with which the antenna is to be raised.

To raise this mast, set the first section securely in place, and guy it; then set the second section over the end of the first and place the lower bolt through the proper hole. This section may be pushed into place by having some assistants at its guy wires and pushing the section into place with a pole prepared of some rough lumber. With the guy wires tightened, this second section may be readily climbed. The third section may be pushed between two pieces of the second section and guided by means of its guys as before. When the last section is in position, the bolts are slipped into place, the nuts are tightened and the guy wires are secured.



This method of construction can be used in erecting masts up to 70 feet in height.

Probably the best method of connecting two pieces of pole is to use galvanized-iron bolts. Enough of the wood should be allowed to overlap so that a fairly strong joint will result. Washers should be used in conjunction with the bolts, so that the heads will not work into the lumber and thus loosen the joint. An ordinary pole will require an overlap of at least four feet, and for best results three bolts should be used. The two poles may be laid side by side and the holes for the bolts may be drilled through both at the same time, thus assuring that the bolts will fit properly.

Sometimes small poles may be secured to the side of the roof, and this may be done with bolts also. However, if the mast is well-guyed, it is usually not so important to fasten its foot very securely. All lumber used for the poles should be free of knots.

Radio poles are conspicuous and should be made to look well before they are erected. A couple of coats of good paint, grey for instance, certainly improve the appearance of a mast and will cause it to withstand the elements longer. Enameled wire for the antenna will prevent corrosion.

A Neighborhood Antenna Mast

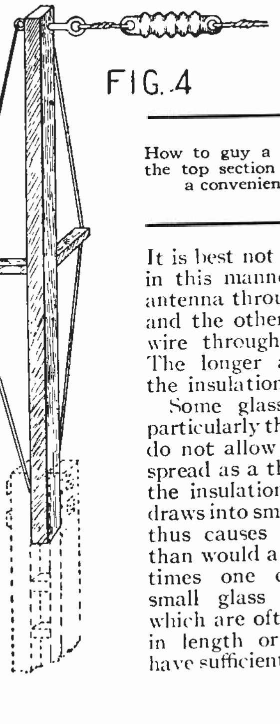
Occasionally one can erect an antenna mast in some convenient, centrally-located spot, and all the neighbors can be coaxed to help with the expenses. Several aerials may be attached to the pole, the insulators being about 5 feet out from it, and these aerials also support the pole. It is not advisable to have too many antennas attached to the same pole. Set the insulators a good distance from the pole and space the wires 45° apart or more. This will allow as many as eight wires, though fewer would be somewhat better. (See Fig. 3.)

Selection of Material

There are many kinds of antenna wire, but no one has proved that one is any better than another under average operating conditions. About the best is ordinary hard-drawn No. 12 enameled wire.

Screw-eyes should have the strength required of them and preferably be galvanized. There is some advantage in insulating the guy wires properly; however, do not make the mistake of using an excessive number of insulators; one for every 15 or 20 feet of wire is sufficient. Strain insulators of the usual type will do.

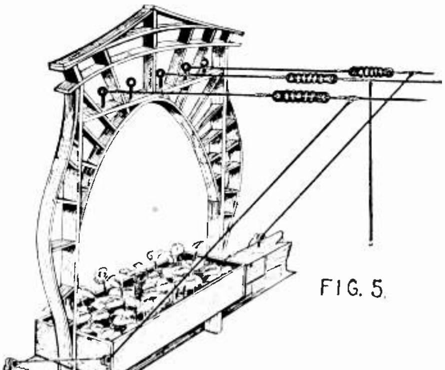
Ordinary porcelain insulators are quite porous and absorb considerable moisture, which impairs their insulating properties. Those of the glazed type should be used. Some strain insulators have small grooves for the wire, allowing the wire to start from one end, proceed along one side and through the opening and thence back again along the other side.



How to guy a short mast or the top section of a mast in a convenient manner.

It is best not to use them in this manner; loop the antenna through one hole and the other supporting wire through the other. The longer and thinner the insulation the better.

Some glass insulators, particularly those of pyrex, do not allow moisture to spread as a thin film over the insulation; the water draws into small drops and thus causes less leakage than would a film. Sometimes one can procure small glass towel bars, which are often 14 inches in length or longer and have sufficient strength for



A decorative support for a group of several aerials on an apartment roof.

ordinary conditions. These are cheap and have knobs at their ends to which the wires can be fastened. Wrap the wire around the ends of the bar about three times, then loop it around the end of the knob and splice it to the insulator lead.

Where it is necessary to use more than one wire for an aerial, in congested localities, do not insulate each wire separately, as this has the effect of placing the insulators in parallel and consequently lowering their efficiency. Insulate the wires coming from the spreaders and use the insulators at the point where they converge.

The lead-in should be insulated as thoroughly as the rest of the antenna; for an antenna, like a chain, is no better than its weakest link. Run the lead-in either from the center of the aerial or from one of its ends. The lead-in should go as directly to the set as possible; not wind around all the corners one can find. Instead of boring holes in the window-sill for the lead-in, purchase a flexible lead-in. This may be bent around and under the window and still allow the window to be closed tight.

Guy Wires

Small poles should be so constructed that an excessive number of guys is unnecessary. It is not so essential to insulate them if the aerial itself is well insulated; a few insulated guys will help, however, and will make the pole look better. Guy wire, as well as the other metallic parts used, should be galvanized. No. 14 iron wire will serve for the ordinary installation. Heavier wire is difficult to handle and often develops bad kinks, which are not readily removed. When the guys are tightened small kinks will be evident; but these straighten out in time, allowing the wire to sag somewhat. The slack should be taken up when this occurs.

If a rope is used for hoisting the antenna into place, use one that will not shrink greatly when it becomes wet. Some rope shrinks a great deal and this may be enough to bend the top section of a long pole. Ordinary clothes-line rope is suitable for the purpose.

It is often convenient to use guy-wires for either a short mast or the top section of a larger one. Small projecting pieces may be nailed securely in place, about half-way down on the pole, and wires attached at the top of the mast. These are stretched tightly over the ends of the pieces and are fastened at the bottom of the section. (See Fig. 4.) Heavy staples or screw-eyes will serve to hold these wires. There is usually more difficulty in arranging these wires than in properly installing a few ordinary guys, however.

Apartment House Installations

In some apartment houses, residents must content themselves with indoor antennas or go without their radio. Often one can convince the landlord that a neat aerial installation will actually improve the appearance of the building; all modern built-in installations certainly do. In one house the residents got together one Sunday, designed an aerial system that would be of benefit to all, presented their plans to the owner and received permission for its installation; each did some of the carpentry and helped to defray costs.

With a little care a very neat system of aerials may be arranged. An arrangement that may be used with little modification on any large apartment building is shown in Fig. 5. The wires should be spaced as far apart as possible to reduce interference between nearby receivers. For best results, a separate wire should be used for each receiver. The lead-in may be taken from either end or from the center of the wire. Wherever possible, it may be of advantage to take the first lead-in from one end of a wire, then the next from the opposite end of the next wire, and so on. Such aerial supports as are shown in Fig. 5 may be very artistically blended into the outlines of the building by arranging suitable embellishments, such as flower pots and the like.

There is an inward satisfaction in knowing that the exterior energy-collector for one's costly receiver is as well designed as the receiver itself, and that the best of results may be expected when one is bitten by the DX bug.

Plug-in-Mounting for Short-Wave Coils

By GEORGE HARVEY

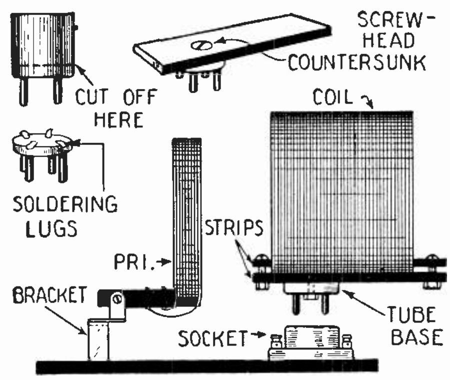
A VERY convenient and inexpensive set of mountings for short-wave coils can be made from a few UX-tube bases, a UX socket, and a few strips of bakelite.

The tube bases are cut off as illustrated and soldering lugs are soldered to the tops of the prongs.

Then a hole is drilled in the center of the tube base and it is bolted to the bakelite strip. Care must be taken that the head of the screw does not project above the surface of the strip, so that it will not come in contact with the coil.

This strip is drilled at the ends and the coil is bolted to it by another strip of the same length. (See illustration.)

The socket is mounted on one end of a wider strip and the primary on the other end.



Here is shown a method of making plug-in coils and mounting them in a tube socket.

The mounting for the primary is made out of a piece of ¼-inch bakelite, supported by a bracket which is made from a piece of sheet brass and a piece of brass tubing. The coil is bolted to it by another strip of the piece of bakelite.

Two pieces of heavy copper wire are fastened tightly into holes in the piece of bakelite. These are used as terminals for the primary.

If a sub-panel is used, the socket and the primary may be mounted directly on the sub-panel.

Permanent Installation of Radio Equipment

Loud-Speaker Outlets Make Radio Service Now Available In Every Room

By E. R. PFAFF†

RADIO is rapidly taking a more prominent part in the American home. It is no longer regarded as a toy, but is made instead a chief source of entertainment and enlightenment. Just as the necessity of having the family grouped around a receiver to "listen in" by means of head sets has been overcome by the general use of the loud speaker, so has the confinement of radio entertainment to one room been ended. The more enterprising radio fans have enlisted the aid of extension cords and portable jacks to enable them to carry a loud speaker to a porch or adjoining room. Many progressive and far-sighted contractors and architects, however, are establishing in new homes, apartments, hotels, hospitals and office structures practical, permanent installations which will furnish radio service to any room in the building.

The home that is wired for radio service in its principal rooms should be most pleasant for every member of the family, and especially the housewife, for the reason that she spends a greater portion of her time in the house. It is now possible for her to hear her favorite programs at all times, regardless of what part of the house she may be led to by her occupation.

The following description of some of the more practical applications will be found in sufficient detail to use for installation purposes.

Convenience of Volume Controls

The receptacle jack in the bedroom may or may not be equipped with a volume control. It is preferable, however, to have this; in case of sickness or confinement a loud speaker or headset may be used by the patient, and the volume easily and immediately adjusted for maximum comfort.

Any desired volume, from a barely audible signal to that suitable for a loud speaker, may be obtained by turning the volume knob. This does not noticeably affect the volume of any other speaker which may be operating simultaneously in another part of the house.

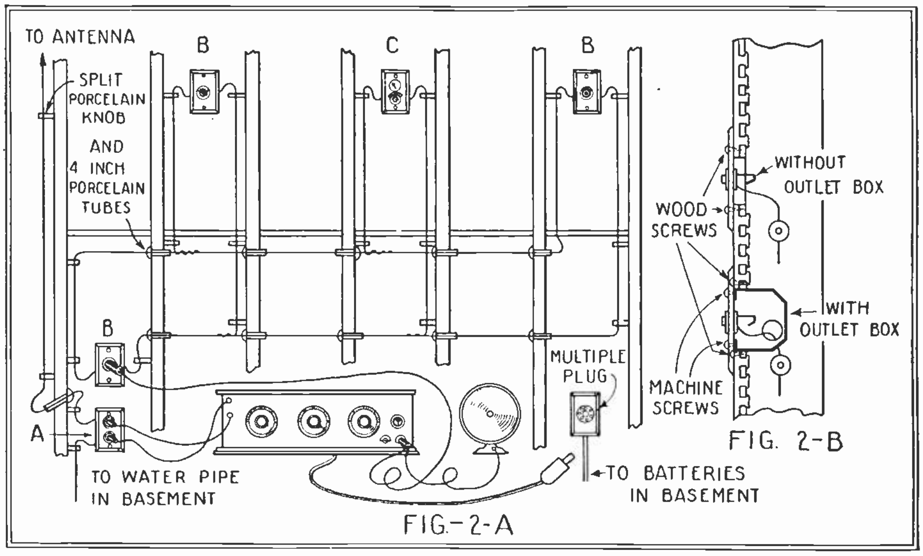
The "Radio-Equipped" house in Fig. 1 shows a volume-control receptacle jack on the porch also. In summer, when the living room is too warm for comfort, the speaker may be carried to the porch and plugged into the jack. It is desirable to use a volume-control receptacle jack here, so that the volume may be reduced to avoid disturbing the neighbors.

An antenna-and-ground outlet jack (shown in Fig. 1 near the receiver), will furnish a neat and convenient connection for concealed antenna and ground wires. The outlet jack should be placed near the antenna lead-in, although reasonable distances will have no appreciable effect upon the operation of the receiver. The porcelain tube in the outside wall, through which the lead-in wire is brought, should slant down and the lead-in wire be allowed to sag in order to prevent water from running down the wire through the tube and into the building. The aerial lead-in and ground wires may be run through porcelain tubes in the studding or joists. (Fig. 2A.)

Wiring Recommendations

Fig. 1 shows also the method of wiring the receptacle jacks in the various rooms, which is best done at the time the electricians are installing the lighting circuit. Any wiring contractor will be able to do this, as only a few simple rules need be followed The current carried by this circuit does not exceed 10 or 15 milliamperes. The receptacle jacks are mounted on the wall or baseboard, either with or without a standard wall box; the latter is not indispensable, but it is an effective protection against falling plaster and dirt. Fig. 2B illustrates both methods of mounting this equipment.

It is important that parallel wires be kept at least one foot apart. The method of wiring shown in Fig. 2A allows approximately 18 inches of space between wires, keeping capacity between leads at a minimum.

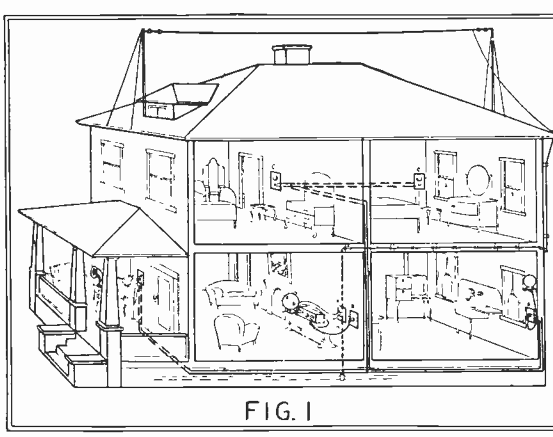


The method of running wires about 18 inches apart between walls to reduce capacity effects is indicated in Fig. 2A, at the left. Fig. 2B shows the methods of outlet mountings.

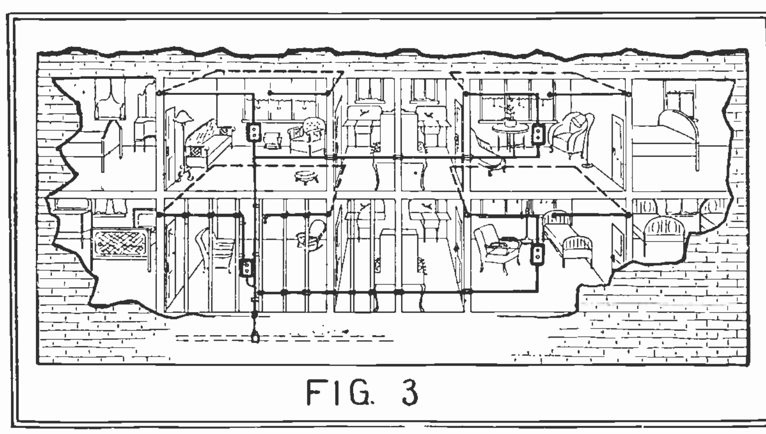
When wires are run from one floor to another they should be supported on split porcelain knobs, as shown in the drawing. Leads running in horizontal directions should pass through porcelain tubes, which are set in holes drilled in the joists or studding of the building.

The standard practice for open-circuit wiring should be followed as much as possible. The wire should be No. 18 to No. 14, rubber-and-cotton covered. Wires should be allowed to hang loose enough to permit convenient connection to the receptacle jacks. Fig. 2A is a detailed sketch to illustrate the method of running the wires.

In case a building is of fireproof construction, there is no space between the floors and



Above is shown how an entire house may be wired especially for radio, providing loud-speaker outlets in the principal rooms, and on the porch for summer comfort in reception.



An installation of aerial and ground, such as shown above, will end trouble in apartment houses, where each tenant desires his own. By using outlet jacks every apartment is provided with an individual antenna and ground.

†*Carter Radio Co.*

walls to run open-circuit wiring. It is impracticable to run the wires in metal conduit, as done with power wires, because of the choking effect of metal pipes. The electrostatic capacity between wires in the conduit is also responsible for a large portion of this absorption.

Some time ago an installation of this nature was made in a large Chicago apartment building; but, of course, the system would not operate. While an attempt to locate the trouble was being made, one of the wires connected to the jack terminals broke off and the jack terminal was accidentally grounded on the conduit. To the surprise of all, it was found possible to operate a loud speaker from this receptacle jack. The broken wire was taped, and the jack terminal permanently grounded on the conduit. This change was made in each room, thereby making the entire system operative.

The action of this circuit will be more readily understood when attention is called to the fact that the conduit acts as one plate of a fixed condenser and the dead-ended wire as the other plate, thus placing a capacity in series with the loud-speaker circuit. This method may be successfully used; but it is not recommended, since the open-circuit wiring is less expensive and produces better results.

Buried Wiring

There have been many installations where No. 14 rubber covered wire was encased in "loom" and buried in concrete floors and walls. When making an installation of this kind it is necessary to maintain the spacing specified for open-circuit wiring. The loom should be run between outlet boxes without a break. Several layers of tape wrapped on the end of the loom, inside the box, will prevent it from slipping out when the concrete is being poured.

Fiber conduit may be used instead of loom, affording better protection to the wires and permitting rigid construction similar to metal conduit. The conduit should be threaded at the ends and fastened to metal or fiber outlet boxes with metal nuts in the conventional manner. This material does not bend readily; so it will be necessary to use elbows or condulets when a turn is made. These may be made of either fiber or metal. It is rather unusual to run two separate lengths of conduit between two outlet boxes, but it is necessary in order to maintain the proper spacing between wires.

A radio-wired home would not be complete without some method of concealing unsightly batteries. Of course if a console cabinet is used, the batteries may be kept in it. When this is not the case, however, the batteries may be kept in the basement and connected to the set by means of a multiple plug (see Fig. 2A).

Apartment Service

During the past few years there have been numerous radio installations in apartments, hotels and hospitals. If a radio-equipped hotel or apartment has a private telephone switchboard, the radio receiver should be in the care of the switchboard operator

One receptacle is usually placed in each apartment or hotel room. When a tenant or guest, as the case may be, desires to hear a program, it is necessary only for him to plug in the jack. Of course, this does not allow individual selection; but in special cases it may be possible to phone the operator and make a request for a definite program.

A modification of this system, which is somewhat more expensive to install and operate but allows greater flexibility, was used in the Hudson View Gardens, a newly-constructed group of large apartment buildings in New York. Each apartment is provided with four receptacle jacks, each of which is connected to a different set in the operating room. Each tenant may thus choose one of four different simultaneous programs.

For Hospital Beds

There is also a great demand for radio service in hospitals. The same method of wiring as in apartment houses can be used, but receptacle jacks with volume controls should be furnished. A receptacle jack should be placed at the head of each bed to enable the patient to listen in, with a headset, without disturbing those around him. The headset may be equipped with soft-rubber ear cushions to make possible its use for a long period without discomfiture. In large institutions, where there are many rooms, it is recommended that a receiver be installed on each floor and that it be operated by the nurses.

Built-In Antenna

There is still another type of radio apartment to be considered.

It is often desirable to add special features to a building to contribute to the convenience of the tenants and add rental value to the apartments. Fig. 3 shows a method of installing concealed antennas, together with ground connections, each pair terminating in an outlet jack, thus providing a separate individual antenna for each apartment. The wiring should consist of No. 18 to No. 14 rubber-and-cotton-covered wire. The antenna may be concealed behind the picture moulding, or run through porcelain tubes in the wall. The "lead-in" should be supported on knobs between the walls and terminated at the jack. It is advisable to tape the free end of the antenna with friction tape, in order to prevent the copper wire from touching the wall. This is a very inexpensive installation and, in addition to the above mentioned advantages, keeps the roof free from unsightly make-shift antennas. It also completely eliminates damage to the roof and leaks occasioned by the erection of antenna supports and by undesirable walking on the roofs. An apartment owner will readily appreciate this feature.

In conclusion, it will be in order to give a few suggestions regarding the receiving set to be used with an elaborate system, such as described in the beginning of this article. It is obvious that the ordinary vacuum tube would be badly overloaded if it furnished power to a great number of speakers. It is generally known that this would impair the tone quality of the entire system. A simple remedy is to use a power tube in the last audio stage. Many sets are now available equipped and wired for such tubes, or can readily be adapted to their use. Another method is to use a separate power amplifier with a standard receiver. Of course, if a standard receiver is modified for use with a power tube, few changes are necessary.

Thus radio, which yesterday was considered a mere novelty, is today counted among the necessities by far-visioned builders and those who wish to add still greater convenience and pleasure to homes already built.

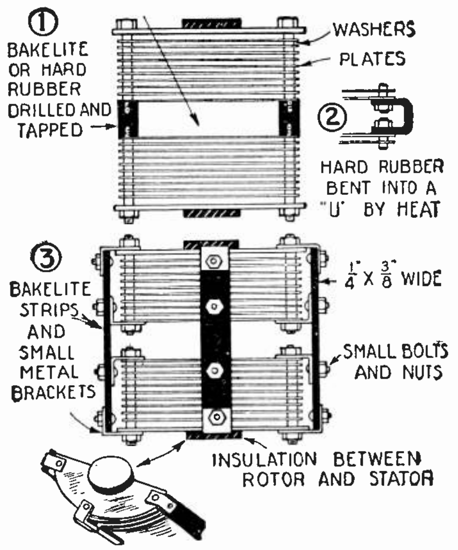
Making a Tandem Condenser

By J. E. HAYES

A variable condenser having 43 plates can be easily made into a tandem condenser, composed of two 17-plate sections. The condenser used for this purpose should be one of the type which is held together by three bolts, so that it can be taken apart. Remove these bolts, being careful not to bend the plates, and cut the long bolts in half with a hack-saw.

Before the condenser is taken apart, it is best to measure the exact distance between the two end plates, so that the bakelite strips can be cut to the exact length. This is necessary because the distance between the bearings of the rotor must be kept the same. In 17-plate condensers there will be 9 stator plates for each section. Since the rotors of a condenser in a R. F. receiver are connected to the "A—" lead, the rotor need not be separated.

Assemble the two end plates and place them on the table, at the same distance apart as they were originally. Measure the distance between the inner edges and make the separators this length. In Fig. 1 the separators are of bakelite rods, drilled and tapped to the size of the condenser bolts. The method of assembly is clearly shown in the diagram. One separator is used for each bolt, and for most condensers three will be required. This is a neat method but a little difficult.



A similar method is shown in Fig. 2. This will be found to be excellent if the insulator remains firm, but the construction is not as strong as that shown in Fig. 3. Here the two stators are supported by three bakelite strips, about 1/8-inch thick and 1/2-inch wide, and just as long as the condenser was originally. Four small metal brackets are bolted on each strip and then to the stators by means of the original bolts cut in half.

The five center plates of the rotor should be removed and cut down to washers. Replace these washers in the original positions and the rotor will be the same length as before. Thus the two rotors are one, electrically speaking.

Alleviation of Static

Helpful Hints to the Amateur and Broadcast Fan for Abating This Nuisance

By L. W. HATRY

PERHAPS this article should start with a cheerful statement, of the customary nature, regarding the vast amount of scientific effort expended in attempting to solve the baffling question: "Why can't static be eliminated?" Of course it should be pointed out that the earlier efforts were aimed at elimination, whereas the later ones have been devoted to the more practical attempts at alleviation; or, in other words, to a reduction of the static so that the desired reception can be obtained in spite of the interference. There is no reason to avoid the subject of "elimination," except that "it can't be done." This article will therefore be confined to practical methods for alleviation of the nuisance, and will avoid expensive and complicated schemes.

A Hint for "Hams"

A practical, yet simple, method which is sometimes unusually effective is shown in Fig. 1. Yes, it seems absurd; it is merely a tuned antenna circuit, yet few of the less difficult arrangements will better it. The average short-wave receiver has a fixed-tune primary or antenna circuit. Static is as bad with a tuned as with an untuned arrangement; but the signal is definitely improved by the use of tuning in the antenna circuit. However, the use of tuning is not the only trick; it is necessary to adjust for very loose coupling, which cuts the volume of the static much more than that of the signal.

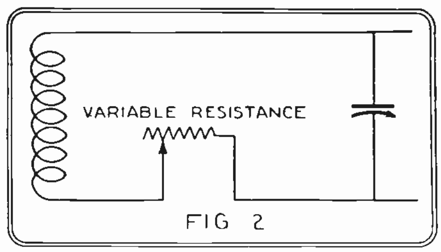
This loose coupling may seem excessive, but a special plea must be made to stress its importance. The sacrifice of signal strength reduces the static to an even greater degree.

It is practically impossible to reduce this looseness of coupling to definite figures. Coil fields differ so with dimensions and trivial changes, antenna resistance likewise; and the resultant of these two variables is a coupling, for the purpose of static alleviation, for which there is no hard and fast rule. The important thing is to loosen the coupling to such a point that resonating the antenna has no longer any particular effect upon oscillation and does not demand a consequent "increase" in the adjustment of its control. When your antenna coupling has reached that degree, you will begin to realize an alleviation of static.

Easier in Code Work

Let us resolve the problem to an understandable position. Static elimination sounds impractical; it is unreasonable to suppose that a thing so nearly in the exact nature of the received signal can be completely eliminated without completely eliminating the signal also. It may possibly be done, some time; but let us face the facts as we understand them. The thing to be done is to reduce the static, if it completely destroys signal intelligibility, to a degree that will permit signal reception. This is less difficult for radiotelegraphy than for radiotelephony. A constant and steady tone frequency is, at least theoretically, possible in radiotelegraphy; and it can be made sufficiently distinct from static, to permit differentiation and be read, by its tone alone.

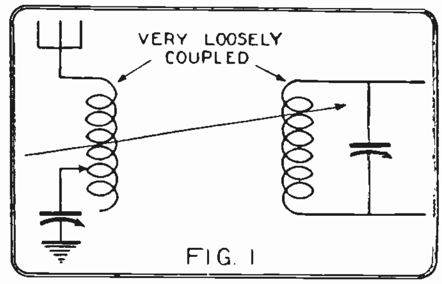
In fact, the adjustment for constant tone, and the use of tuned audio transformers, is mainly to accentuate the advantage of the tone in contrast to the notable lack of it in static discharges. The manifest advantage of telegraphy over telephony in this matter is great; it may be estimated safely that static of ten times the severity necessary to stop phone reception will not prevent successful telegraphic communication. We need a signal-to-static ratio that permits signal intelligibility, nothing more.



A variable resistance in series with the secondary of the tuner is a simple thing which often helps.

Use of Resistance in Secondary

To obtain this reduction in ratio, we may take advantage of a number of things. One has been mentioned, the tone-frequency of the received signal; another is the fact that the received signal has its radio-frequency resonance. This latter, however, is more or less useless because of the fact that static, being nearly without period, serves to shock (or impact) the secondary circuit into oscillation at its own frequency, which is of course that of the received signal. Loose coupling partly aggravates this; but, for all that, the signal itself, because it is a sustained frequency, fares better than the static.



A tuned antenna circuit, such as the one above, helps greatly to reduce static.

If the static comes through too well, it is because of the low resistance of the secondary circuit, and this may be overcome by a variable resistance, as shown in Fig. 2. It may seem foolish to add resistance to a circuit where it should be kept low, but it must be done. It is not too easy to prescribe the exact resistance required; it should be of a type permitting a complete cutout to leave the tuned circuit at its own minimum. One variable to 400 ohms is sufficient, and may be made practically non-inductive by winding in a special fashion. Any variable 400-ohm resistance will do if the tuning effect is recognized and compensated by the tuning condenser.

Filtering the A. F. End

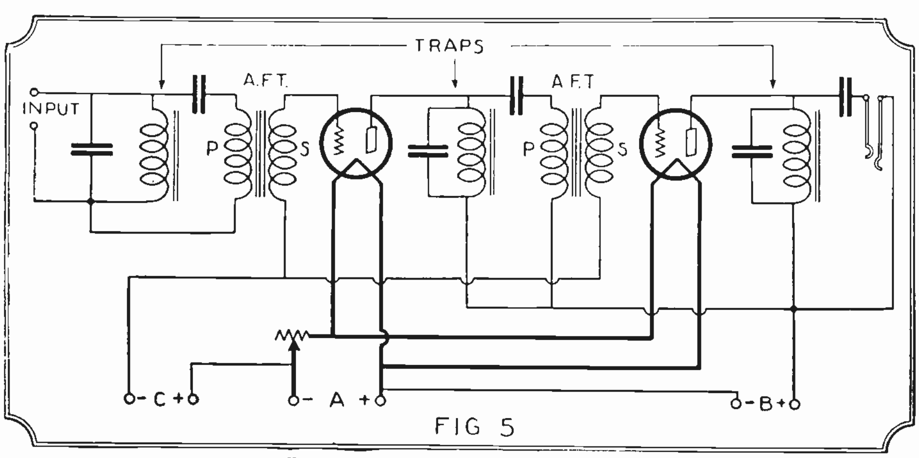
Every precaution has been taken with the set to preserve the signal in preference to the static, at the R. F. end; the same must be done at the A.F. end. A means of doing this is shown in Fig. 4, which shows a tuned choke or trap filter. With the constants specified, only the frequency to which the trap is tuned, about 500 cycles, gets satisfactorily past to the amplifying transformer. Others are shorted mainly through the trap and avoid the transformer. The odd and indifferent static discharges are thus reduced below their usual volume; while the average C.W. note may be adjusted properly for effectiveness.

Beyond this we cannot go, except to mutiply our traps by using more audio amplification and repeating the trap in each stage, as shown in Fig. 5. While this proves very effective for telegraphy, it becomes both cumbersome and expensive when carried out to any considerable extent. The "ham" who is after the most effective way to improve his receiver at minimum expense, however, will not neglect an opportunity to install traps of the type shown.

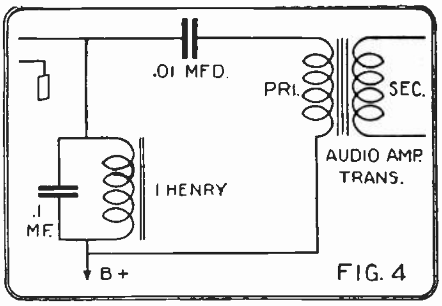
Details for a home-made inductance coil of the correct size are shown in Fig. 6; the coil is wound with 2300 turns of No. 33 enameled wire. The air gap is necessary to preserve the inductance at the proper value, one henry. The usual transformer iron is used in the core. Two of these, and two fixed condensers, will make a pair of first-class traps in a two-stage amplifier.

For the Broadcast Fan

Of course, it is obvious that the connections outlined already are useless to the broadcast fan. "Music," consisting entirely of 500-cycle effective reproduction, would be only noise. This washes from our slate one of the most effective means of bettering the signal-to-static ratio. Yet the fight must go on.



By incorporating traps in the A.F. amplifier, as well as the R.F., the static annoyance is greatly alleviated.



Static must be reduced in the A.F., as well as the R.F., amplifier. Here is one method.

There is the old, and well known, scheme of a crystal detector connected between antenna and ground, across the terminals that serve as input connections to the set, as shown in Fig. 7. What happens is merely a reduction of the peak discharges to prevent the exceedingly heavy crashes that now and then dull the sensitivity of the ear. This at times creates a very satisfactory illusion of bettering the signal-static ratio, but at others seems to have no particular effect. Briefly, its theory is that the "square-law" response of the detector in the antenna circuit wastes a lot of energy in the peak discharges, as it would if the resistance dropped in geometric progression; but the lower signal voltage is very little affected. In practice it seems that this happens.

There is much said in favor of the loop as a means of improving the ratio. The recommendation is generally to obtain increasing sensitivity in the receiver by the use of R.F. amplification directly on the waves which permit it; or of superheterdyne I.F. amplification for the shorter wavelengths. Practically, the gain through the use of the loop is not appreciable, for the increased sensitivity of the receiver seems to bring the static up to its usual level. There is no apparent discrimination between static and signal in the receiver itself.

Underground Antenna Effective

If the loop fails, there is one thing which does not, if one is in a situation to use the device, and that is the underground antenna. In some of the worst possible weather a good underground antenna will register no extraneous disturbance. It should be both long and well-insulated. One consisting of the ordinary rubber-covered wire can be used for a short time, but the covering will deteriorate and become very unsatisfactory.

A more thorough job is done by using a garden hose, with thick walls and good rubber, with the end sealed, as shown in Fig. 8. Such an installation will last a very long time. Permanent underground antennas may be installed in tile conduits, or in metal pipe, buried two feet to six inches under the surface of the earth. The ideal underground antenna system must be a radial one, since the antenna is directional lengthwise.

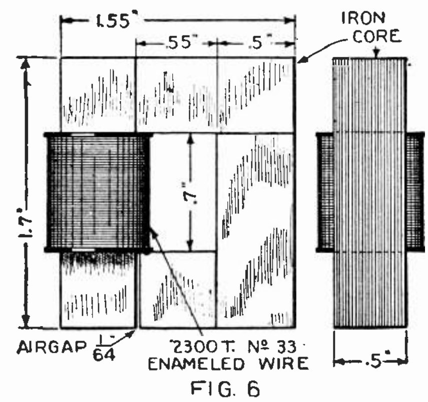
A single wire may be installed, with a right-angle turn, to permit of more general reception than is possible from one running in only one direction. Of course, the underground antenna does not pick up as well as the aerial, but this may be made up by amplification, very profitably. It is most uncanny to find very mild static, excellent signal strength and very pleasing reception in the midst of a thunder storm; yet it is possible with the underground antenna.

This system is impracticable, however, for many experimenting broadcast fans; and it is doubtful to what extent they can make use of it, particularly in the case of the large installations which are necessary for reception on the long wave-lengths.

Setting Static to "Buck" Itself

For the average fan, a number of things may be suggested as worthy of experiment. One static "eliminator," which is as nearly satisfactory as any, uses a transformer with a double-primary winding, connected to a double-detector system. The latter is coupled to a single antenna, so that one detector is tuned to the desired signal plus the static, and the other to the static without the signal. The primary windings of the double transformer are connected to oppose each other. The result is a reduction of the static, which comes in equally on each opposing primary, but no great effect upon the signal, which comes in only on one primary, and thus is put through to the amplifying tube or tubes to the desired volume. The general scheme is shown in Fig. 9.

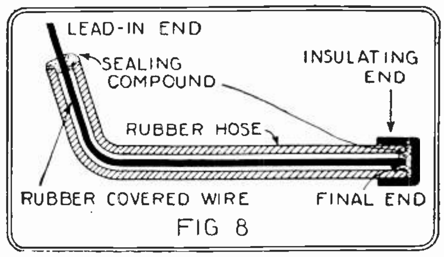
In general, this system has proved very unsatisfactory, because the direct current through the transformer windings results in too great magnetic inertia. The proper method of connecting the balancing transformer for the most satisfactory effect is shown in Fig. 9-A. It is unfortunate that a specially-wound transformer is necessary. There are many schemes of the same general nature, designed to balance equal and opposing, and consequently self-cancelling, statics; while permitting the signal to go in from one side unchecked. In the main, these are quite useful if one is not deterred by the expense.



Here are shown details for a home-made choke coil, that can be shunted with a condenser, as shown in Fig. 4, for a filter.

Effect of Long, Low Antenna

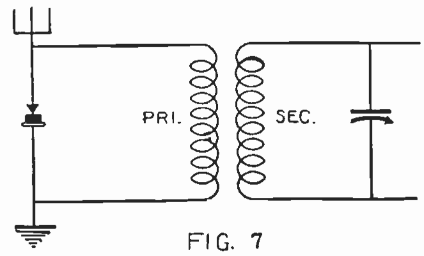
Other things often suggested are simple tricks, of varying degrees of value. A long, low antenna is often a very satisfactory reducer of interference and static; and a short high antenna is often said to be of similar merit, in comparison with a long one of the same height. From the writer's experience, he cannot agree with this latter assumption, except in the case of the set which (as the average one does) makes no allowance for different antennas, and must be fitted with one according to location, weather and other variables. The low antenna, however, with any set capable of taking full advantage of it, has invariably resulted in some improvement of the signal-to-static ratio. This is aside from the well-known Beverage antenna; being shorter than the latter, it is less directional. Briefly, double the former antenna length at about half the former height is a practical dimension; although even greater length is preferable if the height is reduced by half. The set used on such a long, low antenna should have an antenna circuit tapped to allow for coarse tuning, and a coarsely adjustable degree of coupling between the former and the tube circuits. This paragraph is intended to place emphasis on the merit which, in the writer's opinion, the longer and lower antenna has in these respects.



The use of an underground antenna (details shown above) prevents excessive static from drowning signals.

Use of Balanced Circuits

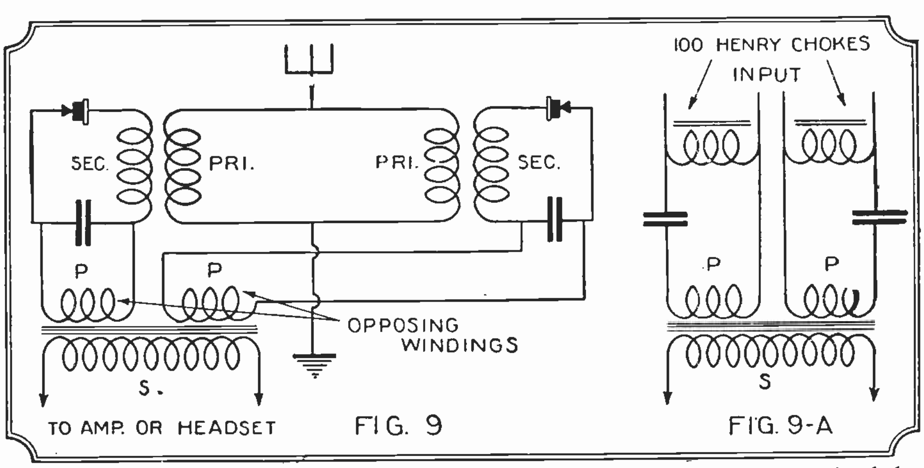
Other ideas for alleviation of static are based on similar principles to those explained above. In the Wheatstone bridge circuit (Fig. 10) a current from X to Y will not affect the indicator, I, if the two paths indicated by the resistance symbols are equal and proportionately divided. Although the radio circuits are less simple, the principle is the same. In Fig. 10-A we have a doubly-branched circuit with opposing emf.s passing through the two halves. If the paths provided are equal in impedance the two forces will cancel, and nothing will appear across the indicator, I, as before. Most anti-static schemes have employed this principle in various ways.



This use of a crystal will reduce the peak discharges and prevent the heaviest crashes in the phones.

One practical scheme of balancing suggested, that of Fig. 11, is obviously for a

(*Continued on page 88*)



By a "bucking" system, employing two crystal detectors, as shown above, static can be greatly reduced, due to the opposing windings of the inductances in the antenna circuit.

"On Short Waves"

Considerations and Data for the Design and Operation of a Short-Wave Transmitter

By J. BERNSLEY

BECAUSE short waves are short waves, there are numerous difficulties and precautions which the constructor must consider when he is building apparatus for either the reception or transmission of signals within this band. We hear so much from amateurs who have constructed short-wave apparatus and who complain that their transmitters do not oscillate properly; or that they cannot get the results they expect from their short-wave receivers.

Very few "ham" beginners seem to realize that they encounter in short-wave work conditions entirely different from those usually experienced in ordinary broadcast receiver work. Radio energy at the high frequencies used by amateurs is very difficult to handle, and it is most essential that only parts of correct value be employed in short-wave transmitters or receivers. We will point out a few of the most noteworthy differences between short- and broadcast-wave receivers, which will help drive this point home.

We know that in the conventional broadcast set the tuning coils may be wound with wire of practically any gauge and in almost any fashion. In the design of short-wave coils, however, the turns must be space-wound. Heavy-gauge wire will be found to be most practical, and as little supporting material as possible should be used. The grid condenser in the 200-600 meter set is almost invariably of .00025-mf. size. In a 20-200 meter set a .0001-mf. is all that is required. In broadcast work an aerial about 100 feet in length is usually recommended. When a short-wave set is connected to the same aerial, the best results are obtained if a .0001-mf. or .00025-mf. fixed condenser is inserted in series with the aerial lead.

Very high-frequency currents are rather capricious, this characteristic making it necessary for the amateur to exercise particular pains when building short-wave apparatus. In the old days we used any conglomeration of junk; but today a consistent range of 2,000 miles and more is possible only through the use of low-loss inductances and condensers and improved vacuum tubes.

Reducing Internal Capacity

In short-wave work, the conventional type of transmitting tube with its metal base and inside-wire connections suffers from what we term excessive "internal capacity," which plays havoc in a transmitter designed for operation below 100 meters. To offset this disadvantage the amateur, not so long ago, would remove the base from the tube and separate the four connections to reduce the capacity; thereby obtaining more stable tube operation and a dependable R.F. output. Yet the wires from the plate, grid, and filament

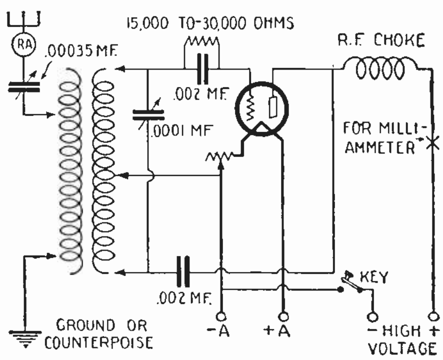


Fig. 2. The schematic circuit diagram of a short-wave transmitter employing a single tube. This is known as the Hartley circuit.

are all brought through the same end of the standard transmitting tube and, because of their proximity, an appreciable tube capacity exists even when the base is removed.

A tube we believe to be ideal for short-wave transmission, because of its construction, is shown in Fig. 1. Note how the leads are separated, each one being brought through a different part of the glass; grid-to-plate and grid-to-filament capacity are thus reduced to a minimum. (Of course, there is always some internal tube capacity, due to the juxtaposition of the elements). The characteristics of this tube are very favorable for short-wave work. No fixed plate voltage is required, the minimum required to produce an R.F. output being about 500 volts. The maximum plate voltage specified by the manufacturer is 3,000 volts. The filament consumption of the tube is 2.35 amperes at 10 volts. The plate current is usually between 40 and 50 milliamperes. Its R.F. output is about 30 watts under average conditions; although much more can be obtained when the tube is placed in an efficient oscillating circuit, with correct constants, and supplied with more than 2,000 volts on the plate.

Construction of a Transmitter

Of the numerous existing oscillator circuits, the Hartley is most commonly used among radio amateurs. The transmitting circuit shown in Fig. 2 is of this type, and employs an inductively-coupled antenna circuit, in compliance with present legal requirements. Its operating range is variable between 15 and approximately 75 meters. The antenna inductance consists of 8 turns of flat copper ribbon about 1/4 of an inch in width, each turn spaced about half an inch away from the preceding one. The first turn should form a circle about 3 1/2 inches in diameter. The primary inductance (grid inductance) has the same dimensions. The grid leak required, for stable operation, should have a value in the vicinity of 30,000 ohms. The grid condenser should be of the transmitter type, and of .002-mf. capacity.

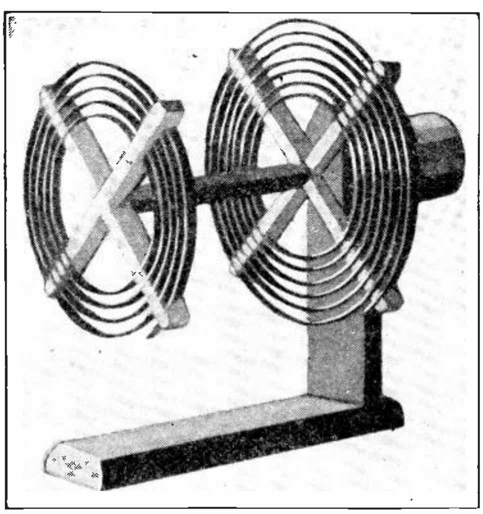


Fig. 3. An oscillating transformer, or antenna coupling inductance, designed for short-wave work. The coils are wound with heavy copper ribbon.
Photo courtesy Amateur Radio Specialty Co.

The condenser connected across the primary inductance is a .0001-mf. double-spaced instrument (14 plates total, double-spaced). The condenser connected in series with the antenna, to reduce the operating wave below the latter's fundamental, is .00035-mf. size.

If an ordinary 5- or 7 1/2-watt tube is employed in the transmitter, then approximately 500 volts will be sufficient for the plate. With the transmitting tube mentioned in the preceding paragraphs, however, a plate voltage of at least 1,000 volts will be required.

The construction of the R.F. choke coil is as follows: wind on a tube approximately 1 to 1 1/2 inches in diameter, and approximately 6 inches in length, 150 turns of No. 28 D.S.C. wire. Fasten the two ends of the winding to two terminals, which should be rigidly clamped or bolted to the form. The tube or form should be of either bakelite or hard rubber.

The plate voltage employed with this type of transmitter should preferably be D.C., so that a pure C.W. note may be obtained. If only A.C. is available, then employ some efficient means of rectification, such as a full-wave kenotron system or a bridge-system chemical rectifier, with a suitable transformer to step-up the 110-volt A.C. to the required or desired plate voltage. Straight or raw A.C. may be used, the transmitted note corresponding to the frequency of the current impressed on the plate.

The adjustment is extremely simple; the two variable condensers are simply turned until a resonance point is reached. This will be indicated by a sharp drop in the plate-milliammeter reading, and by a movement of increase in the radiation-ammeter reading. (The radiation ammeter should preferably be of the thermocouple type). If the wave emitted is higher than desired, simply rotate the condensers toward their minimum settings, or reduce the number of turns in the grid coil.

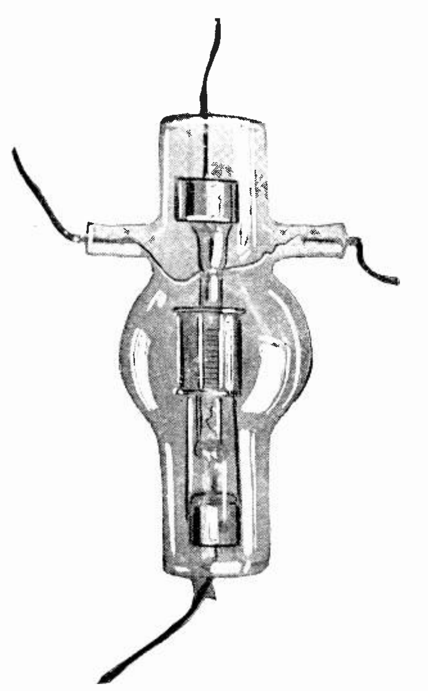


Fig. 1. A transmitting tube designed for short-wave work. The internal capacity of the tube is greatly reduced by the use, instead of the usual base, of widely-separated leads from the tube elements.
Photo courtesy of De Forest Radio Co.

Short-Wave-Oscillator Adjustment and Operation

Some Suggestions for Securing Maximum Efficiency from Short-Wave Transmitters Employing the Hartley Circuit

By A. BINNEWEG, Jr., 6BX, 6XAA

THE Hartley circuit, due to its simplicity and flexibility, can be readily adjusted to oscillate on practically any wavelength. This may seem strange to some, but on very short wavelengths, under certain conditions, it is sometimes difficult to *prevent* the circuit from oscillating. It is for these reasons and others that practically all amateurs have chosen the Hartley circuit for their transmitters. This circuit, but slightly modified for short-wave operation, is shown in Fig. 1.

In this diagram it will be noticed that no shunt condenser is used across any part of the primary inductance. A circuit, to be oscillatory, must have capacity, to be sure; but on short waves the distributed capacity of the inductance and connecting wires is sufficient. In fact, this capacity is so large that when operating at 5 meters we must use variable grid and plate stopping condensers to cut down the circuit capacity. By all means keep the leads on a short-wave transmitter short; more "effective" inductance may then be used, usually. If the leads are not short and well-spaced, the circuit may also oscillate at a second frequency (independent of that to which the set is normally tuned) determined by the distributed capacity and distributed inductance. This oscillation is not easily detected, but it requires useful power to maintain and therefore it constitutes a waste.

Wavelength Adjustment

The wavelength of the primary circuit is determined largely by the number of turns in the inductance between the plate and grid taps, and is not dependent on the number of turns in the grid coil (*i.e.*, the number of turns between the grid and filament clips), as generally thought. A large change in the setting of the filament clip affects the wave but little, whereas a small change of the plate clip affects the wave materially. The wavelength at which the transmitter is to be operated is experimentally determined by moving the plate clip toward or away from the grid clip. This wave should be near the fundamental of your antenna. The grid clip may also be varied if desired, but it has been found best to leave this in place and move only the plate clip. For every position of the plate clip there is a corresponding position of the filament tap for best operation.

There are, under certain conditions, two positions of the filament clip at which the circuit oscillates; one position is within one or two turns of the grid end of the inductance; the other is approximately halfway between grid and plate clips, but usually nearer the latter. With the filament clip in the first position, the tube oscillates with a very small plate current and may be readily thrown out of oscillation by bringing the hand near the inductance. This adjustment is fairly critical.

In the second position of the filament clip, the set will oscillate with four or five times the plate current secured at the other position; and the circuit oscillates with greater stability, the adjustment being less critical. Never disconnect the filament clip when adjusting the transmitter, as a dangerous tube flashover may occur. Between these two positions of the clip practically no current may flow in the plate circuit; beyond the second position a tremendous current may flow, although the tube may not be oscillating. The best position, then, is about midway between the other two clips and a turn or two nearer the plate tap; the exact position must be determined experimentally. If the plate current is too high move the filament clip toward the grid end. Often it is rather difficult to determine when a circuit is oscillating. One method is to obtain sparks from the plate coil, but this does not always work and touching any instrument to the inductance sometimes throws the set out of oscillation. With given inductance, etc., a circuit usually oscillates with a definite plate current; if, by previous experiment, it is found that the tube oscillates with a particular current, it will usually be oscillating when this current is obtained. Another method is to listen in a receiver, but perhaps the best method is to test with a wavemeter employing a flash-lamp indicator.

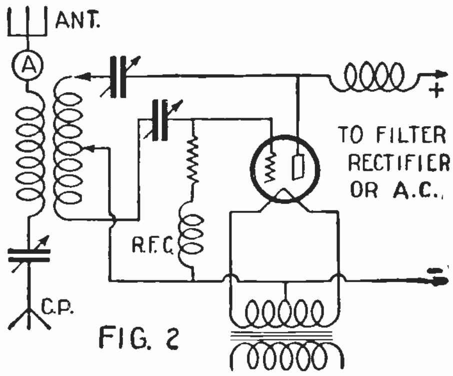
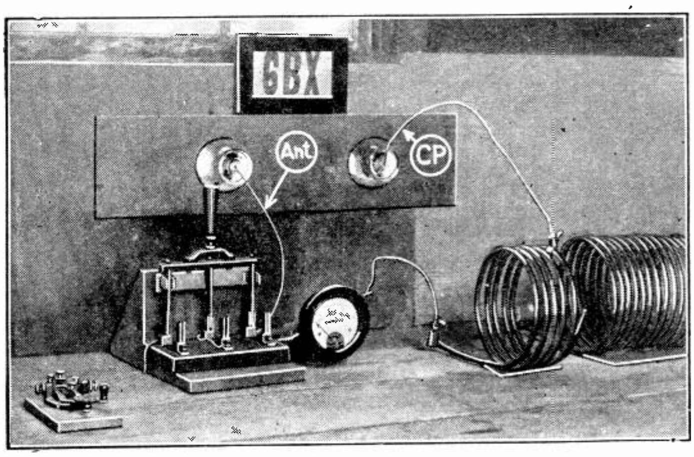


FIG. 2

For operation below 20 meters the grid-leak should be controlled as shown above.



A very efficient lead-in for the short-wave transmitter; its construction is described in the text.

Sizes of Condensers

The capacity of the plate-stopping condenser for the 20-50 meter range is not very critical. The set will oscillate quite readily with a very small capacity here; but the adjustment of the filament clip is changed considerably and its adjustment is then rather critical. For stable operation any good fixed condenser of .001- to .002-mf. will suffice. For the extremely short waves this condenser must be made variable, for reasons previously stated. A condenser of about 5 plates is usually the right value in this position. It should be double-spaced and care should be taken to see that it does not short-circuit; a short here short-circuits the plate current and something will inevitably burn out.

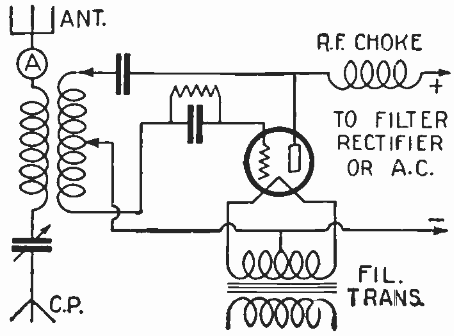


FIG. 1

The slightly-modified Hartley transmitting circuit.

The size of the grid condenser is not very critical, except that a small variable one is used for the short waves. A 5,000- or 7,500-ohm leak will suffice for most tubes. The DeForest "H" tube often requires 30,000 ohms and sometimes more than this. A high grid resistance always lowers the plate current somewhat. In the vicinity of 5 meters, the leak must be connected as shown in Fig. 2; for the capacity of the grid condenser is low and the distributed capacity of the leak may be so high that it may act as a condenser. A small R.F. choke coil of about 15 turns of thin wire may be space-wound on a piece of ¼-inch tube; this choke is placed in series with the leak to prevent R.F. currents from flowing through this circuit.

Temperature Effects

Since the amount of energy dissipated in the form of heat varies as the *square* of the current, it is always best, for highest efficiency, to provide the desired power at a high potential and low current, instead of at a low potential and a high current; however, the maximum safe potential that the tube will withstand should not be exceeded. Allowing some tubes to heat greatly lowers the resistance of the glass supports and a flash-over may result. Never adjust a short-wave oscillator when the plates are red-hot, for it will be found that the set will not oscillate stably until this condition is again obtained. Adjust while cool, and so that the plates do not become hot, for intermittent use. A circuit employing a hot tube has a slightly different wave from one employing a cold one If a steady signal is desired, watch this.

Sometimes the grid current becomes excessive and the set oscillates very unstably;

the remedy is to insert in series with the grid a small graphite rod of sufficient resistance to reduce this current to normal.

The size of the R.F. choke in the plate circuit has been found to have some effect on the stability of a transmitter. A large choke seems to provide steadier operation than a small one. For the upper bands, 250 turns on a 2-inch tube will serve; for the shorter waves, small Lorenz coils 1-inch in diameter must be used. Determine the size necessary and let it alone; changing chokes usually has some effect on the adjustments of the oscillator. If at any time the house lights grow brighter when the key is depressed, currents are finding their way into the power lines. All power leads should be provided with small chokes. Keep all chokes away from the primary; if they must be placed near the latter, set them so that their fields are at right angles.

Adjustment Procedure

The following procedure is suggested for adjusting the transmitter. First, select a primary of the proper size. This is determined by the wavelength to be used. For 40 meters, sixteen turns of space-wound, copper tubing make an excellent inductance; for 20 meters seven turns 4 inches in diameter will do; and three turns of No. 12 wire (here the exact number will depend upon circuit conditions) are sufficient for the 5-meter band. Securely solder the grid lead to the proper end, place the plate clip at the other and the filament tap halfway between. Lower the plate voltage, turn up the filament to its rated voltage, throw the power switch and press the key. If the set oscillates, determine the wave either by a wavemeter or by listening-in; if too high move the plate clip in, if too low move it out. Now adjust the filament clip for steady operation and proper input. If the set does not oscillate at first, though all connections are properly made, adjust the filament clip until it does; it should oscillate easily. With the primary in action on the proper wave and all adjustments made as previously described, bring up the antenna coil with the antenna and counterpoise attached.

Bringing up the secondary raises the wave of the oscillator to some extent and, if the coupling is made too tight, the set will oscillate very unsteadily, or not at all. A tremendous amount of power may be induced in the antenna circuit by very tight coupling and very fine adjustment of the primary, but an unsteady signal inevitably results, so that loose coupling is much better and less obtainable interference will reach the antenna. Under no circumstances should the two inductances be closer than two inches; having them farther apart is advisable, for a sharper wave results. It may be found necessary to readjust the filament taps slightly to bring the set to its original, steady condition. The circuits are then brought into resonance by varying the antenna series condenser.

The amount of antenna current has nothing to do with the output; to the novice this may seem strange, but to those acquainted with current nodes it sounds reasonable. The maximum antenna current, at the particular wave, does tell us that the circuits are in resonance, however, and usually that maximum output is being obtained. It is advisable to lower the antenna current slightly from the maximum value, so that small changes in secondary constants will have little effect on the oscillator. It is better, perhaps, to use looser coupling than to detune the antenna system, as any slight detuning then has little effect.

The antenna series condenser has no effect on the wave of the oscillator; it serves merely to adjust the frequency of the antenna circuit to that of the oscillator. The value of capacity necessary in this condenser is dependent upon the size of the antenna and the number of turns in its coupling coil. On the short waves a small receiving condenser will suffice for the low-power transmitters; this condenser may be double-spaced.

After the transmitter is operating properly, one may find that better output can be secured by "juggling" the coupling, the filament clip and the grid resistance. Lower grid excitation usually gives a better note and circuit conditions may be varied until a good note, comparatively low plate current and good output, is secured. The top of the antenna is the point of highest voltage and should be well-insulated.

Antenna Formula

A simple, rough rule to follow in selecting the length of the single-wire antenna and counterpoise is to divide the desired operating wavelength by 4, which gives the length for both the antenna and counterpoise in meters; this may be changed to its approximate value in feet by multiplying by 3 and adding 1/11 of the total.

A wire parallel to the ground, such as an ordinary counterpoise, has a higher natural wavelength than a vertical wire of the same length, such as the ordinary short-wave antenna. The counterpoise therefore, should be made somewhat shorter than the aerial, say one foot. With a secondary inductance of 4 turns and of the usual size, the 40-meter antenna should have a length of about 31 feet; the counterpoise, which may be run in any direction, as long as it is kept in the clear, may be made about 30 feet long. It is not important to have great height in a short-wave antenna; but it is extremely important to keep it in the clear so that the radiated wave may at least start off right. Height is not so important on the short waves; because the so-called "ground wave' is rapidly absorbed and the great distances are covered by that part of the radiated energy which is reflected down from an ionized layer above the surface of the earth and usually referred to as the "Heaviside" layer

Drilling the Insulators

A good lead-in may be made from a pair of pyrex bowls. These are drilled with the aid of a small three-cornered file which has been ground down to a point on a grindstone. The piece of file is set into an ordinary breast-drill and the glass is kept moistened with turpentine during the operation. Two holes are drilled in a piece of boxwood, large enough to allow the ends of the bowls to slip through to the glass rim, which holds them securely in place when the wood is fastened down. Other holes are drilled in the wall and the wood is screwed down, holding the bowls securely in place over the holes in the wall. The holes in the bowls should be drilled originally to take a No. 10 wire, so that any convenient size may be used later.

Fine antenna insulators may be made from glass towel bars, which are often 18 inches in length. Thick-walled glass tubing may be looped at its ends in a Bunsen flame, and insulators of this type may be made as long as the tubing.

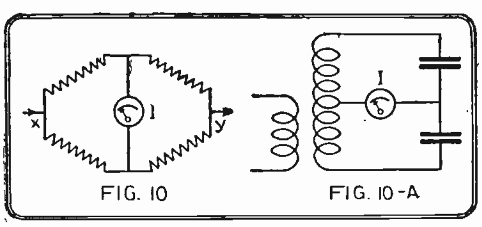
Power Supply

Dry cells may be used as plate supply for low-power, short-wave transmitters; but a rectifier and transformer arrangement is, of course, more economical in the long run. It is better to have separate transformers, one for the filament supply and one for the plate potential, for when any appreciable current is drawn from the lines there will be a drop in filament voltage when the key is depressed, and this is objectionable. An ordinary "B" socket unit may be successfully used on the lowest-power transmitter with gratifying results. The ordinary 5- and 7½-watt tubes should not be operated at voltage higher than 750, ordinarily, if one is to have cool tubes.

Alleviation of Static

(*Continued from page* 85)

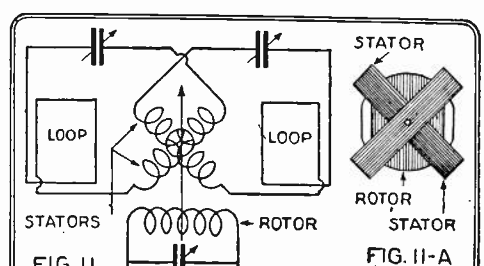
sensitive set with plenty of R.F. amplification, such as the superheterodyne. The two coils at right angles are prepared for coupling to a common rotor. Each of the stator coils connects to a loop and condenser to make a tuned circuit. One circuit is tuned to the signal plus the static, and the other to the static alone. On obtaining the right polarity of the two stator coils, the rotor coil will adjust for an intermediate coupling between the two former, resulting in equal but opposing induction from the static forces and only one unopposed induction from the signal. (See Fig. 11-A.) Thus the signal alone should get through; and while this does not work out exactly, it does approximate the desired result sufficiently to improve reception. Volume is lost, as in all attempts at static reduction.



Here is an application of the Wheatstone bridge theory to static alleviation.

The same idea, of course, may be applied to the use of two antennas. The larger antenna, with the greater static-collecting proclivities, is one that should be used for static alone. It may seem queer that it should not be used preferably for the signal-and-static pickup; but the fact remains that the latter method would not be so successful. In any event, all couplings should be adjusted for best performance.

This scheme, employing two condensers in the case of loop antennas, may be worked out very nicely by using a double-rotor condenser to result in simultaneous tuning. The tuning of the static loop should be slightly off that of the other; for all pickup. Once simplification of control enters into the field, the troubles with many of the static reducers are lessened. In using tandem ("Siamese") condensers, the tuning must not differ too much, since there results the unwelcome possibility of undesired station interference, which is always a live source of worry.



By variocoupler coils like those indicated above in a set using R.F. amplifiers static can be much reduced.

A Simple, Inexpensive "Ham" Installation

By JOSEPH BERNSLEY

THE particular transmitter and receiver which we are here describing have been designed from a standpoint of simplicity and low initial expense and upkeep. In most transmitters previously described, motor generator, "B" batteries, power units employing large step-up transformers and complicated rectifying systems were suggested as sources of plate supply. An inexpensive "B" power unit whose voltage output is approximately 400 (D.C.) supplies the "B" current to this transmitter. If the switch is turned off, all power to the transmitter is automatically shut off. The circuit employed is of the conventional Hartley type, and is designed primarily for telegraph work. The note emitted depends to a large extent on the purity of the current obtained from the "B" unit. If the filter system, consisting of the choke coil and condensers, is correctly designed, a fairly good quality of D.C. should be obtained; and a pure continuous wave note may then be expected.

The filter system employed in the construction of the "B" unit combined with this transmitter (diagramed in Fig. 2) is conventional in design and is used in practically all commercial types of "B" supply devices. A special power transformer is required for this power unit, since the voltage output of ordinary "B" transformers is not sufficient for transmission purposes, unless low-power work is desired and a small receiving tube is employed as the oscillator. A 210 or 310 (7½-watt) transmitting-type tube is suggested for use in this transmitter. This power will cover a consistent range of 200 or 300 miles under fair conditions, providing the transmitter is correctly adjusted.

The following are the parts necessary for the construction of the transmitter and the plate and filament voltage supply unit.

Transmitter

One short-wave, low-loss inductance;
One .00025-mf. variable condenser;
One .00015-mf. transmitting-type variable condenser, double spaced;
One radiation ammeter, thermocoupled type, preferably 0-1 scale;
Two .002-mf. transmitting-type fixed condensers;
One milliammeter, 0-100 scale;
One power rheostat;
One socket;
One 5,000-ohm transmitting grid leak;
One 7½-watt tube;
One R.F. choke;
One transmitting key.

Current Supply Unit

One special power transformer, consisting of two secondary windings for filament supply, and a secondary winding whose voltage output is in the neighborhood of 525 to 550 volts;
Two 30-henry choke coils;
One 4-mf. by-pass condenser;
One 6-mf. by-pass condenser;
One 2-mf. by-pass condenser;
One snap switch;
One full-wave rectifying tube, 213- or 313-type.

Constructional Details

The oscillation transformer may consist of two bakelite tubes, one 4 inches in diameter and the other 3½. The antenna winding is wound on the smaller tube and consists of approximately eight turns of No. 14 seven-strand antenna wire, space wound. The primary or grid winding is wound on the large tube, and consists of eight turns of the same wire with a tap taken off at every turn. This will permit satisfactory operation up to 40 meters in conjunction with the .00015-mf. variable condenser. If 80-meter or higher wavelength transmission is desired, either the size of the condenser or the number of turns of this coil should be increased. The oscillation transformer may be constructed in the present approved style; i. e., spiral pancake. The design and construction of an oscillation transformer of this type illustrated (Fig. 3) in the article entitled, "On Short Waves," on page 86.

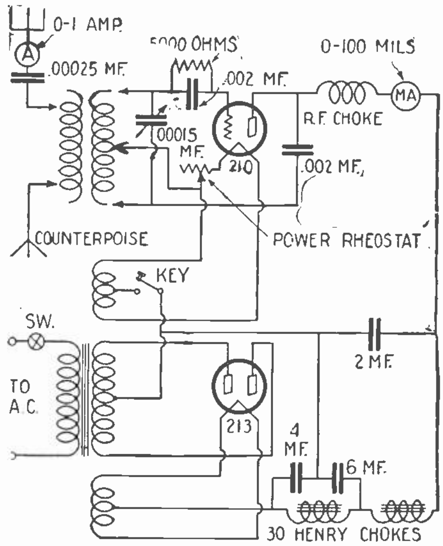


Fig. 2. The wiring diagram of a short-wave transmitter, with a wavelength range of approximately 20 to 100 meters. The plate supply is furnished by any effective "B" unit.

The radio-frequency choke coil consists simply of 200 turns of No. 28 or 30 D.S.C. wire wound on a tube one inch in diameter.

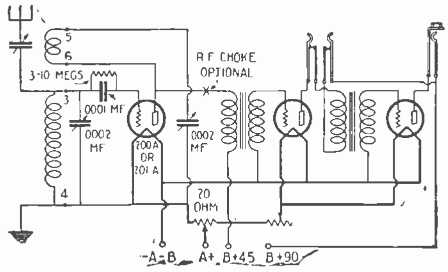


Fig. 1. The circuit diagram of a simple and effective short-wave receiver with two stages of audio. A jack is included so that only two tubes need be employed on loud signals.

Adjustment

The antenna and primary condensers should be rotated slowly until a resonant point is reached. This will be indicated by a deflection in the radiation ammeter, or by a sudden drop in the space-current reading, measured by the milliammeter. If, after the wavelength has been checked, the emitted wave is found to be too high, simply continue to rotate the two variable condensers towards minimum capacity until resonance and the proper wavelength are obtained. The two condensers are rotated towards maximum capacity if the wavelength emitted is too low. The transmitting key must, of course, be depressed during the adjustment process.

For short-wave operation it is suggested that a short antenna be employed, one not exceeding 60 or 75 feet, including the lead-in.

The Receiver

Any efficient type of short-wave receiver may be used. We recommend one that employs the plug-in type of coils so that the same set can be used for the reception of any signals between the wavelengths of 15 and 600 meters. A schematic wiring diagram of an efficient plug-in coil receiver is given in Fig. 1. Its design and construction are very simple, only one coil and two variable condensers being employed in the entire tuning circuit. The simplicity and neatness of the receiver are shown in the picture of the outfit, Fig. 3. A small midget balancing condenser is connected in series with the antenna and helps to reduce the tendency of the receiver to oscillate violently. It also minimizes other critical effects.

The grid winding consists of approximately 20 turns of No. 24 D.S.C. wire wound on a plug-in type form 2 inches in diameter. The plate coil also consists of approximately 20 turns of the same size wire, and is wound alongside of the grid winding. The two variable condensers employed should preferably be of the S.L.F. type, each having a capacity of .0002-mf.

When the construction of the transmitter and receiver is completed, the amateur is prepared for short-wave communication and traffic work. It is suggested that he prearrange schedules with other local amateurs for transmission practice until he becomes fairly adept at operating both transmitter and receiver.

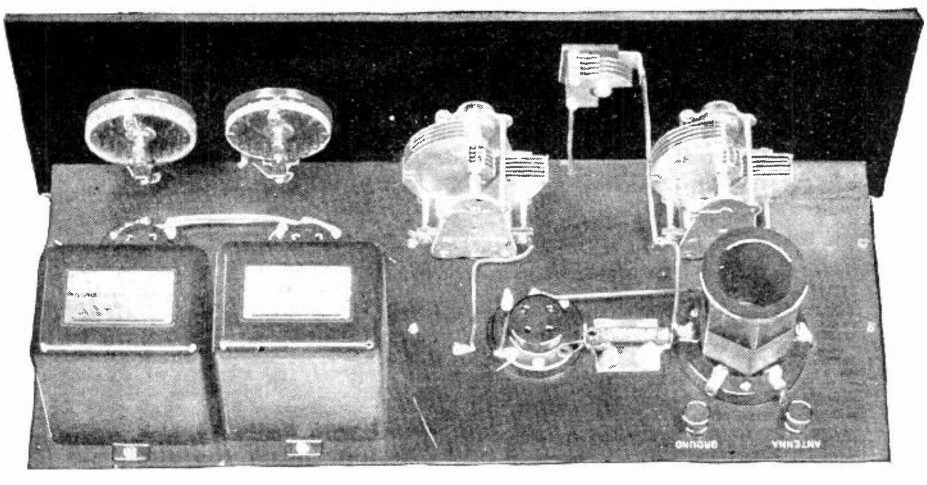


Fig 3. This view of a short-wave receiver, for which the circuit diagram is Fig. 1, illustrates the simplicity of the entire unit, the position of the various parts, and the symmetrical appearance obtained by care in designing the set.

A Complete 20-Meter Ham Installation

Constructional Data for Building Modern Short-Wave Transmitting and Receiving Equipment

By A. BINNEWEG, Jr.

THAT the short waves are the best is now an established fact; so why waste time and power on a long wavelength that sooner or later will be completely abandoned, at least by the DX-shooters, in favor of shorter waves? Amazing results with low-powered transmitters have been secured on 40 meters and very amazing results may be secured on 20 meters in daylight. For the experimenter and low powered DX-man, 20 meters offers wonderful possibilities for distant communication. Certain hours of the day favor transmission in certain directions, and by merely choosing the right time, there is practically no limit to the DX that may be attained. True it is, that real, consistent long-distance work usually cannot be accomplished by any low-powered transmitter, but the short waves offer greater possibilities. The dropping of a signal, now and then, into some distant land is all that the average fan desires and the following constructional data should prove of more than ordinary interest to those considering the construction of short wave transmitters and receivers.

The Receiver

The receiver, although originally designed for 20-meter reception, is of the interchangeable-coil type and hence may be readily adapted to receive on any wavelength below 100 meters. The famous circuit employed by Schnell in his wonderful DX work, with the navy in the Pacific, is shown in Fig. 1. It is important to have the throttling, or variable by-pass condenser, connected exactly as shown; good oscillation control is very important when dealing with long-distant C.W. reception. The leads in the receiver are as short as possible, consistent with other requirements, and are all well spaced. As much of the wiring as possible has been shifted to the amplifier, leaving coils well in the open. The filament leads are of heavy, paraffined house-wire and are kept away from surrounding apparatus by being run directly on the baseboard. All wiring is done with No. 12 D.C.C. wire and all joints are securely soldered with rosin-core solder so that corrosion cannot set in. The phones are attached directly to one post of the amplifier socket and to the head of another binding post soldered directly to the back of one of the battery screws. The posts for the coils are mounted on a small, very thin strip of insulating material and sufficient distance is left between them. The nearest object to the coils, the detector tube, is about 5 inches away. Heavy leads are run directly from the coil posts to the tube-socket. The grid-leak and condenser are mounted at the socket. The coils are all well in the open and are of the popular low-loss, space-wound construction.

The small porcelain switch seen in the picture is used to switch to different antennas; either a long antenna, a short one or none at all may be used; a very convenient feature. A long antenna should be used on the receiver wherever possible. Better results on distance work are always secured. The horizontal antenna is always a big advantage, too, so make the antenna long and part of it horizontal.

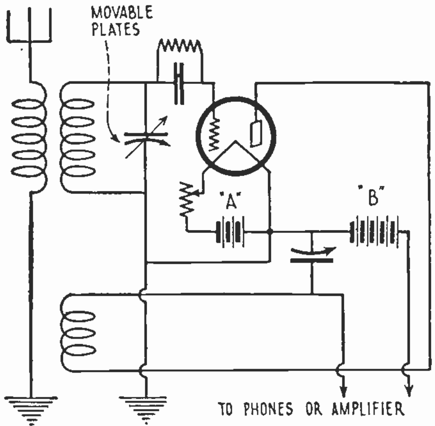


FIG. 1

The coils of this receiver for work on 20 meters are of the plug-in type, so that different wavebands may be heard with different coils.

The vernier shown on the secondary condenser, although not absolutely necessary, is quite a convenience in tuning-in long-distant stations. One should be used wherever possible.

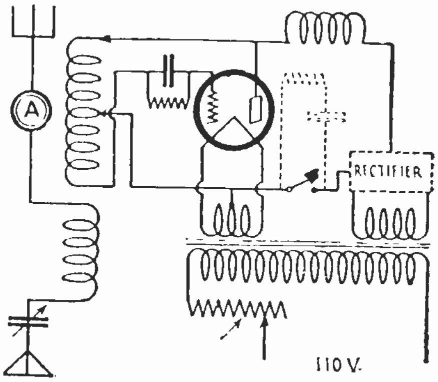


FIG. 2

The circuit diagram of a transmitter designed especially for operation on a wavelength of 20 meters.

The grid leak should be a variable one: the correct adjustment of the leak often gives better signal strength and always allows correct adjustment for oscillation.

Although any ordinary binding posts will serve, some very good screws may be secured from the old wooden-case type "B" batteries.

Detector tubes have a habit of making ringing noises in the receiver every time the table is jarred. This is especially noticeable on short wavelengths and is very objectionable. Either buy a "cushioned" socket or mount the one you have on a pile of small felt clippings and replace the heavy leads to the socket by small copper foil pieces for a short distance. This will prevent vibrations reaching the tube through the connecting wires. If you do not intend removing the tube from its socket it might be well to solder the leads directly to its base and do away with the socket entirely. This is by far the best procedure but is seldom done because changing tubes then becomes rather troublesome.

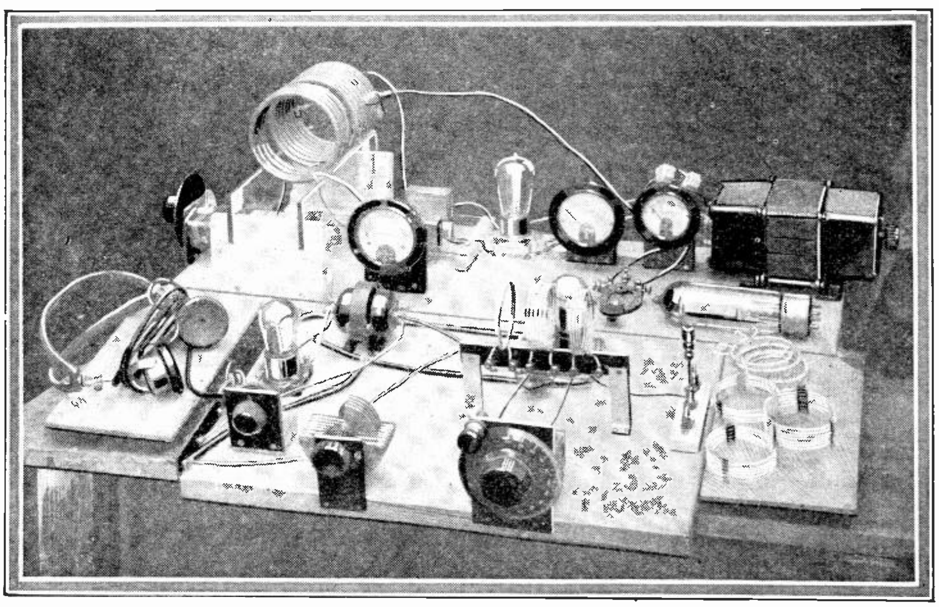
The Transmitter

The transmitter employs the coupled Hartley circuit, which will oscillate and put power into an antenna on practically any wavelength. It is, perhaps, the most popular circuit, in use by the amateur, for its simplicity and flexibility. The circuit is shown in Fig. 2.

The arrangement of parts is the most efficient that the writer has seen. All high-frequency parts are well insulated, the inductances are out in the open, the lead a e comparatively short; and yet the whole arrangement is pleasing to the eye. Normally the outfit is set to the left of the receiver and employs a separate antenna. Both the antenna and counterpoise are vertical and are connected directly to the ammeter and series condenser respectively. They should be each about 12 feet long, for operation on a wavelength of 20 meters.

The inductances are of heavy copper-tubing, space wound, and mounted on plate-glass supports as shown.

The R.F. chokes are small Lorenz coils, supported by heavier leads soldered to them, and placed so that their fields are at right angles to that of the main inductance.



Usually the receiver (in front) is placed at the right of the transmitter, which may be seen in the background of the illustration. Separate antennas are used.

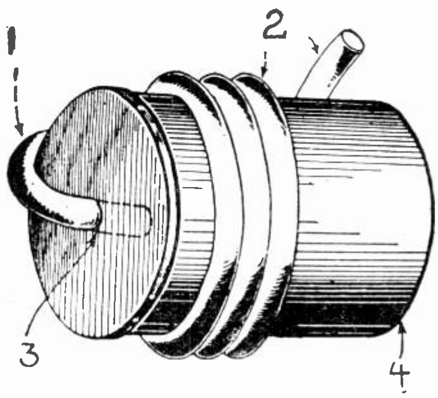


FIG. 4
Method of winding the inductances of copper tubing for the transmitter. See text for explanation of letters.

The grid leak is of the ordinary 5,000-ohm variety. The resistance of the leak has been found not critical.

Those acquainted with the Hartley circuit as employed on the longer wavelengths will notice that no shunt condenser is used across any part of the primary inductance. It has been found that the distributed capacity of ordinary inductances below 70 meters is sufficient to make the circuit oscillatory without it. In fact this distributed capacity is so high that around 5 meters the plate-stopping and grid condensers must be made variable to reduce the total circuit capacity sufficiently.

All the meters, as well as the condensers on the receiver, are mounted on small pieces of scrap insulating material screwed to small pieces of wood mounted on the baseboards.

The clips have small points in the jaws. The jaws should be widened out somewhat, so as to fit around the heavy tubing, and the points cut half-way off. Very good contact can then be made with the inductance.

The Coils

The coils are, perhaps, the most important parts of a short-wave receiver. Extreme care should be taken in their construction to see that they are made as good, electrically, as possible. The coils with the least losses are probably the single-layer, space-wound variety employed here. The coils are comparatively easy to make and are very good electrically. While you are at it make enough to cover the 20- and 40-meter bands at least. Some very good sizes to have lying about are 2, 3, 4, 5, 7, 9 and 11 turns. For the 80-meter band you will need coils larger than this but these sizes will serve you well on the shorter waves.

The tickler coils are wound "haywire", and tied together with twine. These coils take very little time to construct; it is a good idea to construct several, starting with a 2-turn size. The coils illustrated are the same diameter as the other coils; it might be better to make them slightly smaller in diameter although this makes little difference.

Condenser

The secondary condenser should be the best that you can buy. It should run smoothly, have 3 or 5 plates, as desired, be S.L.W. or S.L.F. and have very low losses.

The by-pass condenser may be any one at hand. The one pictured was originally a 23-plate, but has been reduced to a 10-plate by double-spacing the remaining plates. This may also be done for the secondary condenser if a good one is on hand, but it is usually better to buy one; it doesn't pay to fool with good condensers anyway.

The R.F. choke is composed of two small Lorenz coils, of about 50 turns each, connected in series. One coil of 100 turns would do just as well but such a long coil usually is difficult to handle, especially when the wire is small. They are wound on 7 nails, spaced equally around a one-inch circle, and the finished windings are tied together with heavy thread.

Oscillator Inductances

The oscillator inductances are made from some 5/16-inch copper tubing wound upon a four-inch form. Ordinarily the winding of such stiff tubing presents certain difficulties but these difficulties may be overcome by employing the method illustrated in Fig. 4. A hole (3) that will accommodate the tubing is made near the edge of a good, stiff tin-can (4) and the tube inserted for about an inch. This part of the can is then held firmly against the bench while the tubing is bent securely around the circumference (2) of the can. Gradually rotate the can as the tubing is wound on with each successive turn securely against the preceding one. Wind both coils in one operation and cut them apart later. When the required number of turns is wound on, slip the tubing off. You will find that the final inside diameter of the turns is slightly over 4 inches, due to the spring in the copper. The small piece (1) that was inserted in the hole in the can may be straightened out or cut off as desired. If the tubing is rolled up, as it usually is when purchased, it should be straightened out before winding; otherwise small bends in the final winding will be noticed. To make the coils space-wound, each turn should now be separated from its neighbor by about 1/8 to 3/16-inch. Start at one end and gently pull each turn out till it remains at the required distance. Quite a neat job may be done if reasonable care is taken. The completed coils will be found to be very good electrically and very rigid, an important item.

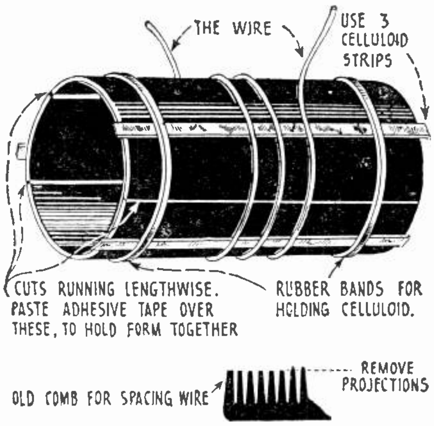


FIG. 3
The cardboard covers of old dry cells furnished these forms. The coils are doped with collodion to make them self-supporting.

The Rectifier

The rectifier is constructed of pure aluminum and lead plates cut to the proper size. It will be best to design the rectifier, originally, for higher powers so that it need not be

SYMBOL	Quantity	NAME OF PART	VALUE OF PART	REMARKS	MANUFACTURER ★	
				RECEIVER		
	1	Variable cond.	.000125 mf.	7 Plates	1	4,31,32
	1	" "	.00025 mf.	10 Plates	1	4,31,32
	1	Rheostat	30-ohms		2	4,8,32
	1	Socket		For detector	3	17
	1	"		UX Type	4	2,3,17
	1	A.F. Trans.	High Ratio		5	4,26,28,29,32
	1	Var. grid leak			6	16,33,34
	1	Grid condenser	.00025 mf.		7	18,35
	1	Switch		S. P. D. T.	8	4,19
	1	Dial		Vernier	9	20,36
		Wire	No.20	For coils	10	21
				TRANSMITTER		
	13 ft.	Copper tubing			22	23
	2	Fixed condenser	.02 mf.	Working voltage 6,000	11	37,38
	1	Socket			3	2,17
	1	Grid leak	5000-ohms		5	30
	1	Ammeter	0-1 amp.	Antenna	12	24,25
	1	Voltmeter	0-15v.	Filament	12	24,25
	1	Milliammeter	0-200 MA	Plate	12	24,25
	1	Power Trans.	550-1100v.		5	28,29
	1	Trans. key			13	27
	1	Variable cond.	.000125 mf.	7 Plate	1	31, 32
	1	Rheostat		For primary	14	
	2	Strips plate glass		2½" X ¼" X 12"	15	
	1	pc. window glass		6" X 6"	15	
		Wire	No.26	For chokes	10	21

NUMBERS IN LAST COLUMN REFER TO CODE NUMBERS BELOW.

1 Bremer-Tully Mfg. Co.	17 Airgap Products	33 North Amer. Bretwood Co.
2 Klosner Radio Corp.	18 Electrad, Inc.	34 Central Radio Labs.(Centralab)
3 Garod Corporation	19 Leslie F. Muter Co.	35 Sangamo Elec. Co.
4 Pacent Elec. Co., Inc.	20 Martin Copeland Co. (Marco)	36 Kurz-Kasch Co.
5 Radio Corp. of America	21 Acme Wire Co.	37 Tobe Deutschmann Co.
6 Durham & Co., Inc.	22 Radio Eng. Labs.	38 Dubilier Cond. & Radio Co.
7 N.Y. Coil Co.	23 J. Gross	39
8 H.H. Frost, Inc.	24 Weston Elec. Inst. Co.	40
9 National Co.,Inc.	25 Nagel Elec. Co.	41
10 Cornish Wire Co.	26 American Trans. Co. (Amertran)	42
11 Wireless Spec. Apparatus Co.	27 Bunnell & Co., Inc.	43
12 Jewell Elec. Inst. Co.	28 Acme Apparatus Co.	44
13 Manhattan Elec. Supply Co.	29 Thordarson Elec. Mfg. Co.	45
14 Allen-Bradley Co.	30 Crescent Radio Supply Co.	46
15 Pittsburgh Plate Glass Co.	31 A. D. Cardwell	47
16 Eagle Elec. Mfg. Co.	32 General Radio Co.	48

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

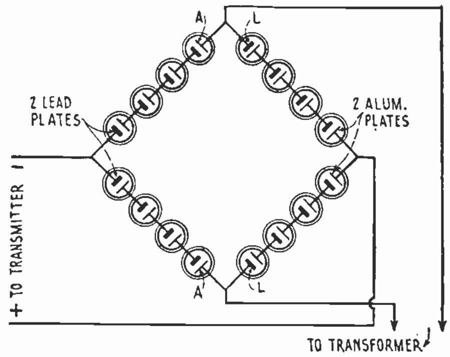


Fig. 5. Showing how the rectifier is connected. It is well to design this for a current around 150 milliamperes.

redesigned later. Three square inches of plate surface underneath the solution will serve for all ordinary purposes; that is, up to a plate current of 150 milliamperes. Allow one square inch for each additional 50 milliamperes. Many different chemicals are used for the electrolyte; but sodium phosphate is as good as any, and seems to be slightly better than ordinary "borax." A few drops of ammonia per jar will greatly strengthen the film that forms on the aluminum plate. For efficient rectification you need sufficient jars so that the voltage across any one is not excessive; thirty volts per jar is about the right value. That is, if your plate voltage is 300 volts you will need 10 jars on each side of the cycle. Connect them in the usual manner, a lead and aluminum plate in each jar, as shown in Fig. 5.

The rectifier is attached to large binding posts at the rear of the milliammeter and the primary rheostat is inserted in the 110-volt lead to the transformer (they are not shown in the illustration). If no rectifier is desired, for the time being, the set will operate fairly well on "raw" A.C.; although such procedure is ordinarily not recommended. The wavelength is so short that practically no interference will result. The range of the outfit using A.C. is very much less and, in general, the set should not be so operated.

Receiver Adjustment

After you have constructed the receiver and have made sure that your wiring is all right you are ready to bring it into operation on the proper wave. Perhaps the simplest method of doing this is to make use of a wavemeter, but few are available that cover this band. Usually the 40-meter band can be found without difficulty; there are so many stations working at this wave. The 9-turn coil will probably cover this. Select a tickler of say, 5 turns; set it into its proper place on the bakelite strip and move the condenser knobs. Set the secondary condenser at about the center of the dial and move the other condenser knob. If the set does not oscillate move the tickler coil up against the secondary and again proceed as before. Then try turning the tickler around; it is unnecessary to remove it from the posts, just twist it around through 180°. If the 5-turn coil doesn't seem to bring the set into oscillation, try a 7-turn.

Usually one has little trouble with the circuit, if connections are properly made, the filament voltage is correct and the plate voltage is sufficient. If the 7-turn works you may find that a 6-turn would perhaps be better. That is, you should be able to bring the receiver into and out of oscillation with a slight hiss by merely moving the throttling-condenser knob. The tickler should be placed at such a distance from the secondary that the set oscillates when the by-pass condenser is at half-scale; and this should be when your secondary condenser is tuned to the center of the particular wave-band.

We have our set on 40 meters and by a little experimentation we have become acquainted with all the tricks of the circuit. Now for 20 meters. This is the most difficult part if a wavemeter is unavailable. One method is to adjust a transmitter to operate at 40 meters; then by gradually reducing the turns in the secondary and tickler, to listen for a strong harmonic. Another way is to listen with the receiver for the harmonic of some friend's oscillating 40-meter receiver. All this, however, is like working in the dark; a wavemeter is such a simple, inexpensive and important addition that you should not be without one. When your receiver is properly adjusted on the 20-meter band you are ready to adjust your transmitter.

Transmitter Adjustment

Remove the secondary from the immediate vicinity and set the filament clip at the center of the primary inductance. Set the plate clip at the opposite end to the grid clip, bring the plate voltage to about one-half normal, raise the filament voltage to its proper values and depress the key. Usually little difficulty is experienced in making the set oscillate. Listen in the receiver when pressing the key; you should hear a fairly strong signal; a click doesn't mean anything. Adjust the filament clip until the set oscillates strongly. The correct position is about halfway between the grid and plate clips, but perhaps a turn or so nearer the latter.

If the plate current is excessive and the tube heats badly, readjust the filament clip. Moving it toward the grid end of the inductance will usually lower it greatly. If the wavelength is too high, as determined by wavemeter or by listening in the receiver, move the plate clip toward the grid end a turn at a time and again adjust the filament clip.

After the primary is in operation on the proper wave bring up the secondary. All kinds of strange things happen if you are not careful. Do not make the coupling too close—start at say 4-inch and move the counterpoise series condenser until you notice a small kick in the plate milliammeter or you get some radiation. Don't expect to blow the meter; you'll be lucky if you get any at first with a five-watter. All this time you have been listening in the receiver. Now try a little closer coupling, say 3 inches. This would be a fine place to leave the secondary; but you may find, while bringing it into resonance as before, that the oscillator will suddenly stop oscillating. The remedy is to reset the filament clip, or to adjust the series condenser so that the circuits are not exactly in resonance. The latter is good procedure anyhow, if you desire a steady note; a note that will not vary every time the antenna system "constants" vary slightly.

Experimentation

Some rather interesting things are noted at this wavelength. A distant station may be heard quite loudly at a certain time of day, then grow fainter and finally not be heard at all; this is especially noticeable at sunset. Sometimes this effect may be made use of in carrying out communication over great distances. If you notice, that in your particular location, stations from a certain distant locality come in particularly well at a certain time of day and certain wavelengths, you may be practically assured that signals from your own transmitter, if on the same wavelength and with equal power, will arrive at this locality with about equal intensity. The thing to do then is to change your wavelength so that this effect may be made use of.

Changing the wavelength of the transmitter is rather bad practice but, if you are the experimenting type of amateur, you will probably know how to do this and get away with it. With some experimentation you can readily determine the correct position of the plate clip for the particular wave. The filament clip must also be slightly readjusted and the primary and secondary circuits should be brought into resonance again. It may be well to attach small tags, with the proper wavelengths marked on them, to the inductances, so that this wave-changing business will not consume much time.

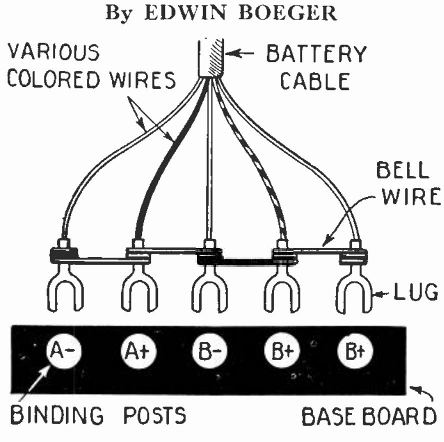
Perhaps after you have experimented with the 20-meter outfit for some time you may become curious enough to try your luck at 5 meters. At this wavelength, all the knowledge you may have gained through experimentation on 20 meters will be of value to you; any slight change in wiring, in capacity values, in fact any change that can be made, almost, will change the wavelength. The experiments that may be performed with reflectors and the like, are innumerable and the work may prove so intensely interesting (this business of measuring waves with a yardstick!), that you may wish that you were in the game for good.

A Quickly-Made Serviceable Cable Plug

By EDWIN BOEGER

ALL that is needed to make this "plug" is a piece of wire. There comes a time in every fan's life when he wants to disconnect his set from the batteries. If he does not have a cable plug—and the majority of sets are not so equipped—he must first disconnect the cable from the batteries and then from the set. If the wires are removed from the set first, they may touch each other and cause a short-circuit.

To disconnect the set quickly, the lugs on the cable must be attached in some way, so that all may be removed at the same time and yet not come in contact with one another. This can be done with a piece of bell-wire.



While the lugs are yet connected to the binding posts, twist the wire two or three times around a lug; then stretch the wire to the next lug and again twist two or three times, and so on, till all the lugs are connected to each other.

The bell-wire will keep the lugs apart and all lugs can be taken off at the same time by simply loosening or tightening the binding posts. The only precautions to be observed are to see that the wire is stretched tightly and that it is thoroughly insulated. It must, of course, be stiff enough to hold its shape when the leads are disconnected from the batteries.

Short-Wave Receivers

A Description of How These Interesting Sets Are Designed and Constructed

By L. W. HATRY

THE average concert fan does not clearly understand the reason why short-wave receiving sets are different from those to which he has been used. He can not understand why it is not possible to build a set to cover from 1 to 200 meters, if another can easily be built to tune from 200 to 600 meters, a greater wavelength range. It is hoped that this will help to reduce the mystery of the matter.

We have learned, in general, that the frequency range and how it is dealt with in tuning determine to a great extent how difficult it is going to be to handle the receiver. The result of this knowledge has been the designing of straight-line-frequency condensers, and others of different calibration, to distribute the allocation of stations along the scale more equally, according to frequency. One of the problems the amateur short-wave bug fights is this same, or very nearly same, one of frequency.

control the tuning of the secondary circuit. The antenna circuit is coupled to the set through a loose coupler with a very few turns, or else through a very small fixed condenser. Either way works very satisfactorily and, as usual with differing ways of doing the same thing, both have their supporters claiming that their own way is better than the other. Strictly speaking, that should not be; practically it is, since the user must fit conditions to his own satisfaction. The general idea of these two methods is shown in Figs. 1 and 2.

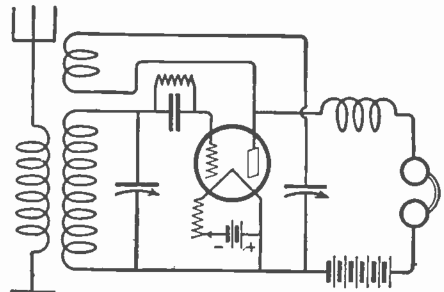


FIG. 1

The antenna is coupled to the receiver through a loose coupler in this circuit.

Why Plug-in Coils?

The subject of plug-in coils is wrapped up with a couple of explanations that will be better handled by starting further back than the coils themselves.

Half the difficulty of tuning is settled if the frequency range is not too great; and if its calibration curve is a straight line in relation to the scale used on the tuning dial. The broadcast frequency band is not quite a million cycles, or 1,000 kilocycles, wide. When the greater portion of this band is confined, as in the case of the semicircular-plate old-style condenser, to the lower portion of the tuning dial, the trouble in tuning thus caused can be overcome only with a dial which slows the condenser down at the low end and rotates it much faster at the higher; such as the converting dials now offered for sale. The reduction ratio starts off, say, at sixteen to one, and accelerates to two to one. Yet with a condenser of the straight-line type, a good vernier (reduction-gear type) dial of six-to-one ratio, or thereabouts, is satisfactory enough. In fact it is unsatisfactory to handle a reduction ratio much higher than that; so there is one more thing for the amateur short-wave man to keep in mind. He must have a frequency-range not much more than 1,000 kc. in extent.

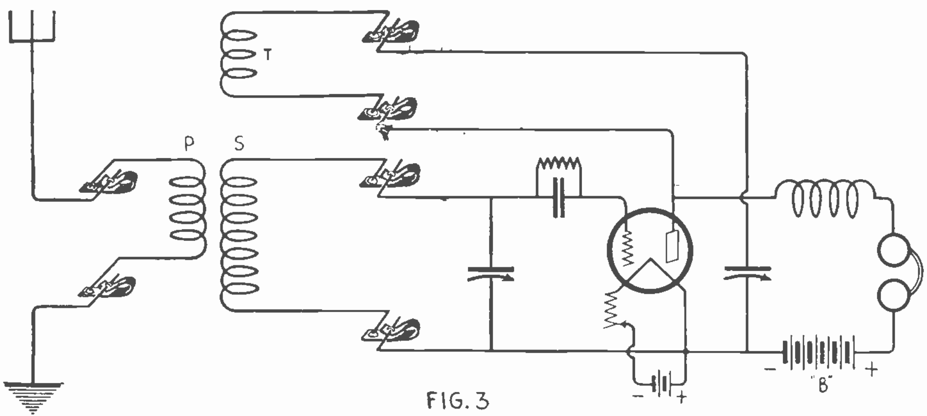


FIG. 3

Schematic diagram of the S. W. receiver illustrated. As shown, spring clips are used for connecting in the different sets of inductances.

Problems in Capacity

Now his problem becomes complicated. There are four amateur wavelength bands in which to listen for the licensed short-wave transmitters. On either side of these bands can be found as well, foreign amateurs, commercial transmissions and experimental transmissions. His set should be able to get all these things. The 75-85.6-meter amateur band includes a frequency range of slightly over 500 kc. The 37.5—42.8 meter band includes a frequency range of nearly 1,000 kc.; and the 18.75—21.4 meter band includes a frequency range of 2,000 kc., in round numbers. Then the 150—200-meter band is 500 kc. Three of the bands are quite satisfactorily covered if the variable condenser spreads over the 1,000 kc. band figured from.

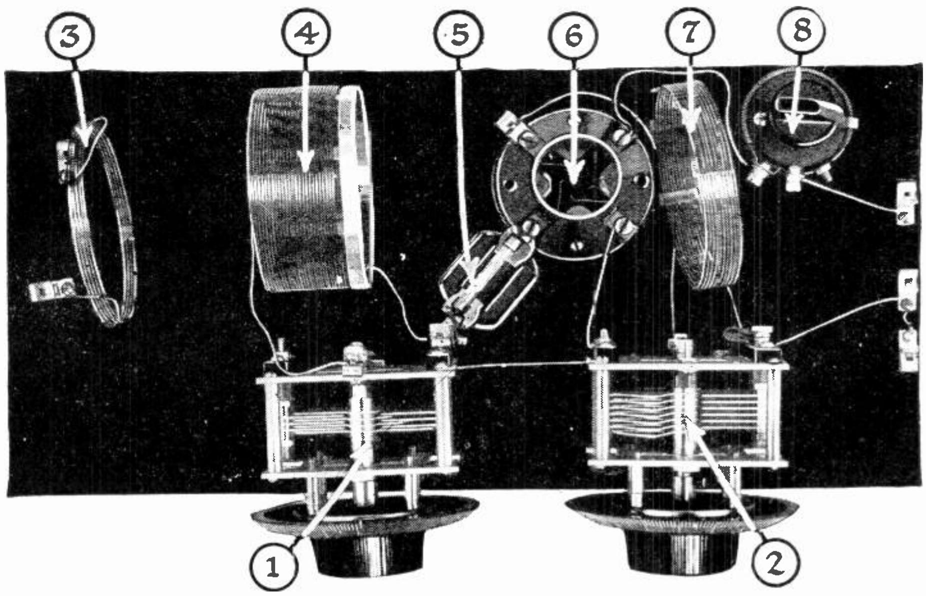
Then figuring from the 150—200-meter

First, multi-tube sets using R.F. amplification are marked from his list of possibilities. The only thing that is approximately feasible along this line is the superheterodyne; and the reason for this is obvious from its theory. The super-regenerative circuit appeals to many, but it has proved impractical for short-wave work. The only thing left, then, is the straight regenerative circuit, arranged in some way to permit convenient change of wavelength, with simplified control. R.F. amplification fails to amplify, so the short-wave enthusiast turns to audio amplification; and here he uses transformers the concert fan would abhor, transformers which distort. This for a very good reason.

Amplification At Any Price

The whistles that the BC fan detests are the means of communication on the short-wave lengths. This whistle can always be adjusted to the sound that suits the ear best. If an audio transformer is used which distorts along the frequency or frequencies that satisfy the ear, the received signal will get excessive amplification due to that same distortion. For this purpose the amplifier tubes are generally used with but 45 or 22 volts of "B" battery; because then the tube impedances fail to match the transformer in any worth-while fashion and the lower frequencies are nearly abandoned, making static and other odd noises remain at a satisfactory minimum.

Simplified control is generally obtained satisfactorily with two dials, one to control regeneration or oscillation and the other to



Layout of short-wave receiver: Nos. 1 and 2 are the variable condensers; 3, the primary coil; 4, the secondary; 5, grid leak and condenser; 6, tube socket; 7, tickler coil; and 8, rheostat.

band we get a necessary wavelength range of 1.33 to 1, a capacity range of practically 2:1; for the square root of the added capacity to a given inductance gives the added wave-length. Dropping down to what we ought to cover in the 40-meter region if we want to take care of foreigners, we need a capacity range only about 1.6 to 1 for 35 to 45 meters; and the frequency range is quite enormous, it's getting outside our 1000-kc. limit. Yet, there's no avoiding this. There is no difficulty in getting a two-to-one capacity range, since the average condenser minimum is in the order of .00001-mf. in the amateur size of condenser, and the circuit capacity is along the same order. (The circuit capacity includes the distributed capacity of the coil plus the tube and wiring capacity.) This gives us a minimum of .00002-mf., or 20-mmf., so that we see our maximum need not be more than double that. However, when we start to vary the condenser, the minimum of the condenser changes and the fixed minimum of the circuit capacity remains; so that our top capacity is necessarily, for the condenser, 40 less 10 or 30 micromikes (.00003 mf.). This is close figuring. If anything should go wrong in our wiring and calculations we would be way off. We must allow something. So, the maximum capacity of the variable condenser we need ought to be

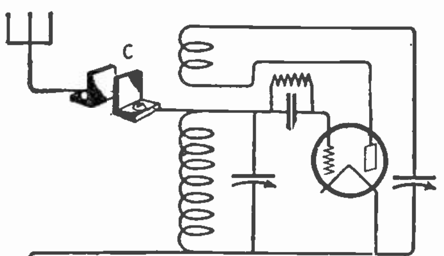


FIG. 2

The antenna is here coupled through a small condenser, C, to the receiver.

in the order of .00004-mf. for safety's sake. A condenser of this sort may be, satisfactorily, a baby midget variable, or else a three-plater of the usual dimensions.

Adapting a Common Condenser

To get a sufficiently low capacity, it is also possible to cut down a large condenser. Many variable condensers have their rotor plates bound together on the shaft with a nut only. It is easy in that case to loosen the nut, remove the useless plates and leave only those needed to get the right capacity. The stator plates need not be changed since only those plates interleaved will be effective. Of course, the stunt can be reversed and stator plates removed instead of rotor ones.

To get the right capacity calculate this way: count the number of rotor plates; notice whether or not they all interleave between two stator plates; if they do then each rotor plate has two active surfaces. A condenser of this sort has 16 active surfaces for .00025-mf. capacity (250-mf.). Dividing by sixteen to get the capacity of one active surface gives .0000156; and we only wanted .00003, so that a single rotor plate with two active surfaces did the trick nicely. (See Fig. 6). This condenser was rated with a minimum capacity of .000007-mf., which is unusually small, .00001 to .00002 being more often the case.

The general troubles of the amateur are perhaps more clear to your mind now than they were. It is obvious that a set designed with such a small tuning condenser will not do on the BC range of wave-lengths with the sizes of coils required. Often enough builders find a .00025-mf. maximum condenser too small; and that has nearly ten times the capacity of our one-plate condenser. The 200- to 500-meter wavelength range requires a capacity range of nine-to-one, where-

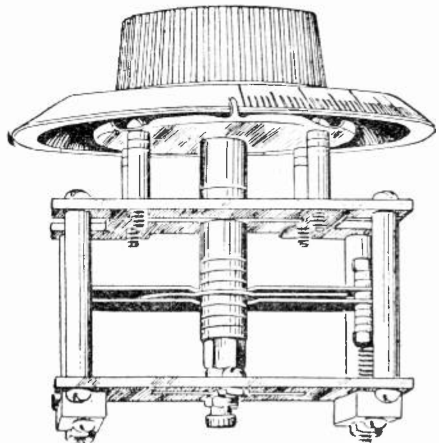


FIG. 6

A variable condenser of many plates can be easily converted to capacity suitable for S.W. work, as shown above.

as two-to-one is enough for the amateur short-wave receiver.

The illustration shows one baseboard, or "bread-board" set used by the writer in experimental work. The antenna coil was permanently fixed at 5 turns, well separated from a secondary with the number of turns necessary for the wavelength range used. The coils illustrated are rather difficult to make; however their dimensions for various wavelength bands are given. Spring-clip binding posts were used to connect in the coils. The tickler coil was allowed to be on the other side of the tube from the secondary. The secondary condenser is a variable one with plates shaped to give some sort of a frequency-spreading curve, similar to the "straight-lines" now so touted. Because the plates were shaped and small, several were necessary. The regeneration condenser, to the right, is an ordinary semicircular-plate affair.

In Fig. 3 is shown the circuit of this set. Since the coils hang by their leads it is possible to vary the coupling between them to any satisfactory point in the case that the tickler or antenna coil should have too many turns, rather than have to remove turns.

The primary coil (No. 3 in the illustration) consists of five turns of No. 22 enameled wire, space wound, 3½ inches in diameter. The other coils, the secondary (No. 4) and

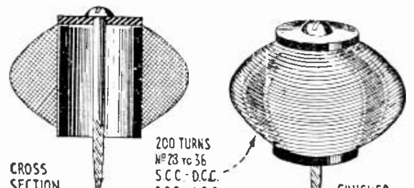


FIG. 4

A choke coil of special design is unnecessary. One may be made according to the above specifications.

tickler (No. 7) are wound similarly, with the same wire; but the number of turns is altered, as follows, for the three short-wave bands:

Bands Meters	Secondary Turns	Tickler Turns
75-85.6	21	8
37.5-42.8	12	6
18.75-21.4	7	4

The choke coil used is not very critical. The writer usually grabbed any coil handy for the purpose: some times it was a spider-web of 60 turns ordinarily used in the usual sort of receiver and other times it was the secondary of a loose R.F. transformer of the sort styled "neutroformer," or else a coil in some spare and otherwise unused form. The important point was a choke coil of some sort rather than merely a special form of coil for the purpose. A good choke coil for the job can be made according to Fig. 4.

If you possess a semi-circular plate condenser of the .00025-mf. size whose plates can be removed and you have a desire to to build a short-wave affair, it is only necessary to take the plates out, cut them down according to the general shape of Fig. 5 and reassemble the condenser with the original number of plates. If sufficient area is removed the maximum capacity of the new condenser will be on the general order of .00008-mf. to .0001-mf. and that is not particularly excessive after all for the shorter wavelengths. The new shape of the plates will give an approximately equal frequency separation over the scale and will make the tuning consequently smoother and easier. A heavy pair of tinsmith shears which can be purchased in an inferior but satisfactory grade at the ten cent store, can be used to cut the plates well enough. In cutting, small bites should be taken one at a time to avoid bending or curling the plates of the condenser.

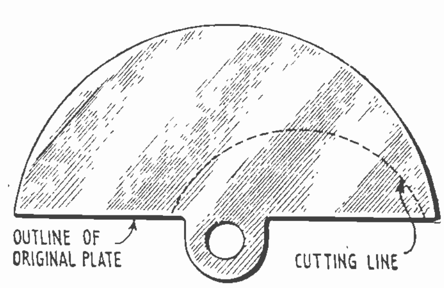


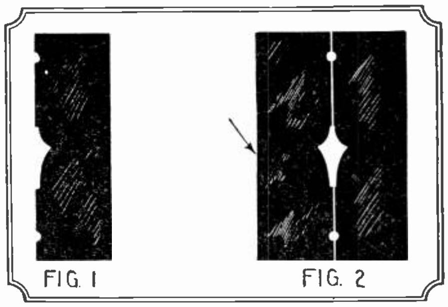
FIG. 5

If the experimenter wishes to retain the same number of plates in the condenser, this may be done by cutting down their size, as shown.

There is no merit in having the feed-back condenser one with specially shaped plates. With proper coupling between plate and grid circuits this method of regeneration control has practically no tuning effect. However, for the telegraph man, there is a value in having a large size of variable regeneration condenser. He is then able to dive deeply into oscillation to muffle interference and noises somewhat, and often to his entire satisfaction.

Device for Engraving Dial Indicators

NEAT dial indicators can be engraved on the panel of a home-made set by using the metal template illustrated. Two pieces cut from metal, as shown in Fig. 1, are placed together as in Fig. 2, and fastened to the panel with two furniture



Details of a metal template employed for engraving dial indicators on panels.

clamps. The holes are used merely to line up the template with a center-line pencil mark on the panel. By means of a scriber the design may be accurately engraved in the panel.

By Mile Simmonds

Short-Wave-Receiver Adjustment and Operation

Applying to All Arrangements, But Particularly to the "Schnell" Circuit

By A. BINNEWEG, Jr.

GRADUALLY, as short-wave knowledge increases and the value of these waves for DX becomes more apparent, more and more experimenters are adjusting their receivers so that they, too, may obtain the wonderful results that earlier experimenters have found to be so commonplace on the lower wavelengths. It is true that anyone who is thoroughly acquainted with the correct adjustment of an ordinary "three-circuit" regenerative receiver will experience little difficulty on the shorter waves, provided he has the patience to employ "cut-and-try" methods.

It is the purpose of this article to point out how some of the common difficulties, experienced by those new to the short waves, may be overcome and to offer suggestions for securing maximum efficiency from a time-tested circuit that has secured, and is securing, such wonderful results for amateurs all over the world. These suggestions will in general be applicable to most all short-wave receivers.

The reception of continuous-wave signals can only be obtained conveniently by employing a regenerative circuit; hence all short-wave receivers developed by the amateur are regenerative and are, almost without exception, built around the straight, three-circuit regenerative idea. Some broadcast listeners imagine that all regenerative receivers, no matter how they may be adjusted, always have that rather objectionable tendency to "howl." Any regenerative receiver that "howls," however, is not operating properly and is "on the air" as far as the rest of the neighborhood is concerned; suggestions will be given for proper adjustment.

Any such circuit, if properly operated on short-wave broadcast reception, is all right; it is the amplifying equal of one or two ordinary stages of radio-frequency amplification, due to the regenerative feature. It is surprising what good volume can be secured from an ordinary two- or three-tube set on distant stations when reception conditions in the broadcast band are unfavorable.

How to Avoid Blooping

One of the worst enemies of good distant reception, perhaps, is a regenerative receiver operated by an unskilled listener. This was brought out quite forcibly during the last International Tests. Perhaps a few words in this connection may be of advantage.

An oscillating receiver is simply a low-power transmitter, hence it may be well to describe how such a transmitter is adjusted for *maximum* output, so that none of these adjustments may accidentally be made. It is adjusted to oscillate as strongly as possible at the particular wavelength, after which the antenna coil is closely coupled to the secondary and tuned into resonance with it.

It is obvious that the reverse of the above should be followed if the set is to approach the non-radiation goal; that is, *loose coupling should be used, the set should not be allowed to oscillate and the antenna circuit should not be resonant with the secondary.* If loose coupling is used and no "dead-spots" are noted, the last of the above requirements is taken care of.

It should be noted, however, that "dead-spots" may also originate from nearby electric-light wiring, choke-coils, wave-

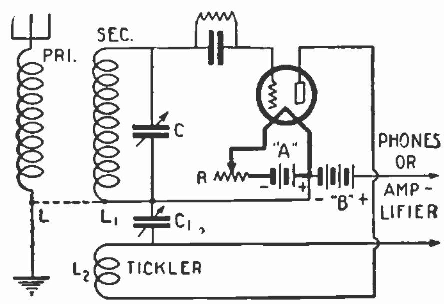


FIG. 1

The Schnell circuit, which employs a fixed tickler coil and a variable by-pass condenser.

meters, etc. *Any circuit in resonance with a sensitive receiver may be detected at a distance of several feet.*

"Dead-spots" on the receiver dial, due to resonance effects, are seldom encountered on the short-waves if a large antenna is used, which should be the case if greater volume and DX are desired. Loose-coupling reduces these effects. Probably the best and easiest method of eliminating them if found, is to change the wavelength of the antenna system. This may be done by changing its

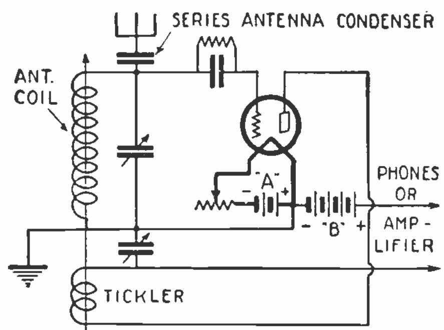


FIG. 2

A modification of the Schnell circuit wherein the primary inductance is eliminated through the use of a fixed series antenna condenser.

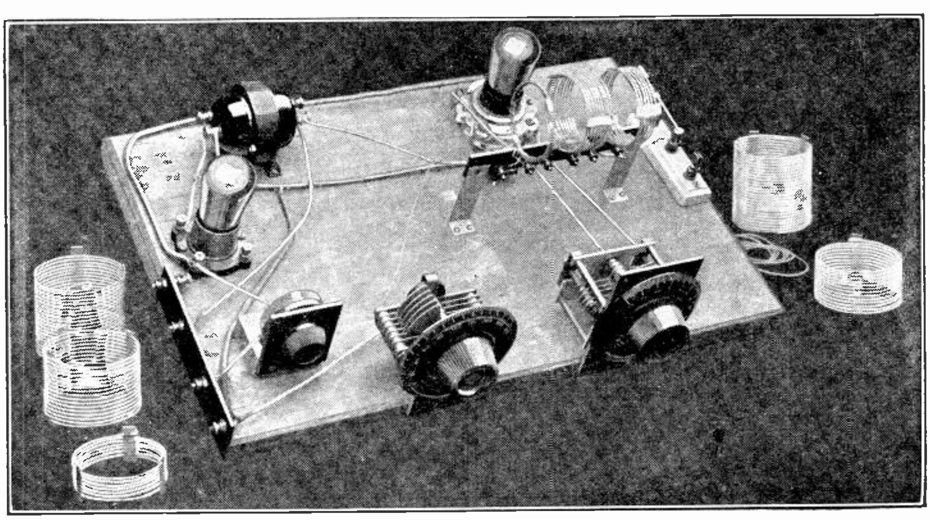
length or using a small series condenser. In the case of the amateur who employs the same antenna for both transmitting and receiving, this cannot be done, but a separate antenna for receiving always gives better results anyway.

The Schnell Circuit

The three-coil circuit employing the awkward, moving tickler coil has been almost entirely done away with of late and the "Schnell" circuit substituted. This circuit employs a variable by-pass condenser or throttling condenser, in conjunction with a fixed tickler coil for regeneration control. This circuit is shown in Fig. 1 and Fig. 2. Fig. 2 shows how the primary may be replaced by a small series condenser of the proper value. This capacity, if used, should be two small plates of brass or copper, to allow soldering, about ½-inch square, mounted on binding-posts about an inch apart. A wire soldered to one of the plates and passing through the hole in one of the screws serves as the variable capacity adjustment and the correct distance is about half an inch. This capacity must be readjusted and its setting is dependent upon the antenna used. (See Fig. 2 on page 94). For the experimenter this is sometimes objectionable. A primary coil of about 3 turns gives the same results, and practically all short-wave receivers employ one.

The process of assembling a receiver is not difficult but making it function on the proper wave is another matter. Perhaps it may be to advantage to outline this procedure in the following paragraphs.

The selection of the proper inductance for the particular waveband is perhaps the first consideration. This should not be an ordinary "variocoupler," "honeycomb," or any of the favorite coils ordinarily in use on the longer waves; but preferably a space-wound coil of say 2¾ or 3 inches in diameter and made of about No. 20 wire. Smaller wire may be used, perhaps, but No. 20 will serve and furnish the proper rigidity. The familiar "collodion-celluloid" space-wound coils, now very popular with short-wave enthusiasts, are excellent for this purpose and are quite readily constructed.



The short-wave receiver constructed by Mr. Binneweg. The Schnell circuit is employed. Note the double spacing between the plates of the low-capacity variable condensers.

The secondary-shunt variable condenser,

as usual, should be the best obtainable and ought to be of the S.L.F. type; a 7-plate serves well on the ranges down to about 60 meters; below this a 5-plate should be employed. Even with these comparatively small capacities tuning is often close; hence it is quite an advantage to have a good vernier attachment for best results.

Hand-capacity becomes especially noticeable at the higher frequencies; in this connection, it is often necessary to employ a 10-inch extension handle to overcome this effect, on a wavelength of 5 meters! The selection of properly-constructed condensers does away with this objection to some extent if the *rotor plates are connected to the filament side of the inductance* and not to the grid end; this point is often overlooked.

Adjustment for Lower Waves

As the number of turns in the secondary inductance is reduced, the wavelength of the receiver is reduced and less turns are necessary in the fixed tickler for proper regeneration. Perhaps the best procedure in adjusting for the lower waves is a gradual reduction from some wavelength at which the operation of the receiver is understood. Choose a certain size of inductance that will allow tuning-in on this particular, familiar wave-band; and gradually reduce the number of turns in the secondary, say 5 or 6 turns at a time. For each reduction in the inductance it will be necessary to readjust the tickler coil, that is, to reduce its number of turns somewhat.

If the set will not regenerate on the lower settings of the secondary condenser, the number of turns in the tickler coil is too high or they may be too close. Usually, however, the number of turns determines the range of regeneration control; and proper spacing improves matters by not allowing such violent regeneration or oscillations and promoting more critical control by the by-pass condenser. In general, the lower the wavelength, the less the turns necessary in the tickler and with a given tickler, the less the capacity necessary in this condenser. More turns may then be removed and the adjustments made again, until the desired wavelengths is reached.

But take it easy. If you are not well acquainted with short-wave peculiarities you may get lost, especially if a wavemeter is not available; but a rough check may be secured by listening for the amateur bands. A telegraph and telephone band exists around 80 meters, another at about 40 meters and yet another at 20 meters. Hence if one expects to operate his receiver at 65 meters say, and can tune-in code and amateur phone with a certain value of inductance, etc., 65 meters is not very far below, and so on. Yet another method is to construct a receiver exactly to specifications given, for coil sizes and the like. This is usually objectionable, however, and sometimes difficult to do. With a little experimentation, the operation of determining one's wavelength is not difficult.

The oscillation control, in this case a variable condenser, is perhaps the most important part of a short-wave receiver for maximum sensitivity and volume. If a cheap condenser must be used for this purpose, the best way to connect it so that hand-capacity effects are at a minimum is to connect the rotor plates to the "B" battery side, the stators being connected to the tickler.

If full-scale setting of the by-pass condenser is necessary for any setting of the secondary dial, and it is not desired to change the coils because of good oscillation control on the rest of the range, a small R.F. choke-coil may be inserted between the tickler and this condenser; this will allow regeneration with less capacity. This, by the way, is a very satisfactory method of comparing R.F. choke-coils, that is, their effectiveness at this frequency; the better choke-coils require less throttling-condenser capacity to allow regeneration. A fairly large choke in this position will allow regeneration with very few tickler turns indeed.

For a condenser to give good regeneration control on practically any wave-band, 10 or 12 plates will be necessary. Don't expect such a condenser to give good regeneration control over a wide wavelength range. At the lowest wavelength setting, a small change in wavelength sometimes requires a large change in this capacity; hence the position of the tickler, that is, its distance from the secondary, its number of turns, etc., should be properly adjusted at the wavelengths that are desired to be used, for best results, as described.

Regeneration Troubles

A difficulty that most everyone encounters when first dealing with a circuit of this type is caused by a refusal of the set to regenerate; especially is this noticed after a new tickler coil is inserted or some change made in the oscillation control. "B" battery voltage causes the greater part of these difficulties; be sure that the "B" voltage is correct and ample. The correct filament current is also important for correct oscillation control; after the set is once working properly the filament is turned down as low as possible consistent with proper control. While still experimenting with various tickler coils and the like, it is best to have the filament a little high rather than too low, of course. The tickler coil causes the rest of the difficulties; it is usually either too small or its field is in the wrong direction for proper feed-back; the correct direction is the same, no matter which way the secondary coil may be turned, end-for-end. The proper number of turns is determined by experiment.

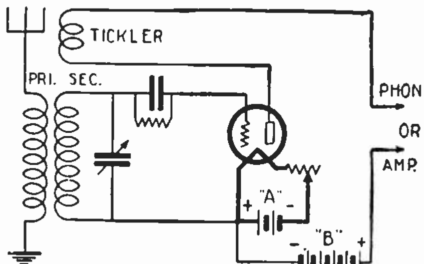


FIG. 3

A three-circuit tuner with a variable tickler coil, formerly employed for short-wave reception.

In this connection, it may be well to wind several coils differing by a turn or two; these are not so important; wind the turns in a "bunch" on a piece of tubing somewhat smaller in diameter than the secondary coils, remove and tie together with string. When determining the correct value, insert the particular coil, couple it closely to the secondary and vary the condenser settings. In doing this, move the secondary condenser about one-fourth full-scale setting at a time and for each of the settings slowly move the oscillation control from minimum to maximum; "slowly" because regeneration is often feeble. Ordinarily no loud oscillations are noticed. If this does not bring results, reverse the tickler coil and repeat the operation. It is unnecessary to remove the coil from its support, just twist it round. If still there are no results, try a coil with a different number of turns; this procedure may be troublesome if repeated very often, hence a gradual changing is best.

After the receiver is approximately on the correct wavelength that is expected to be used, it may be necessary to add to, or reduce the turns in the inductance slightly, so that tuning may be done at the correct position on the wavelength dial. A tickler coil of the correct value should be selected and properly spaced from the secondary so that the set may be made to regenerate at about the center of the by-pass condenser scale when it is properly tuned. Regeneration should not start with a click, but quietly and with a gentle "hiss." Since a click is a sudden beginning of regeneration, it may be readily seen that the most sensitive spot of the whole receiver, just at the point of regeneration is lost. This may usually be remedied by adjusting the distance of the fixed tickler from the secondary and sometimes by reducing the plate voltage. Close coupling of the antenna coil may also cause clicks or violent regeneration. Other causes are poor tubes, grid condensers and grid leaks, especially the variable ones.

Another very common difficulty is caused by very close coupling of the primary and secondary coils. This will not work on the short waves, usually. The usual high-resistance antenna closely coupled to the secondary prevents the tube from oscillating freely.

(*Continued on page 98*)

SYMBOL	Quantity	NAME OF PART	VALUE OF PART	REMARKS	MANUFACTURER ★	
	1	Var. Cond.		7 plates	1	7,10,18
	1	Var. Cond.		10-Plate Throttling	1	7,10,18
	1	Rheostat	30 ohm		2	9,11,17
	1	Socket		Detector - Pyrex	3	
	1	Socket		Amplifier	3	10,18,1
	1	A. F. Trans.		High Ratio	4	10,16,19
	1	Grid Leak		Variable	5	11,20,21
	1	Grid Cond.	.00025 mf.		6	15,11,8
	1	Switch	S.P.D.T.	Porcelain	8	12,13,14

NUMBERS IN LAST COLUMN REFER TO CODE NUMBERS BELOW.

1 Bremer-Tully Mfg. Co.	17 Carter Radio Co.	33
2 Kloener Radio Co.	18 Amsco Prod. Inc.	34
3 Garod Corp.	19 Samson Elec. Co.	35
4 Radio Corp. of America	20 Allen Bradley Co.	36
5 Durham & Co.	21 Central Radio Lab.	37
6 N. Y. Coil Co.	22	38
7 Hammarlund Mfg.	23	39
8 Leslie F. Muter Co.	24	40
9 H. H. Frost, Inc.	25	41
10 Pacent Elec. Co., Inc.	26	42
11 Electrad, Inc.	27	43
12 Barkelew Elec. Mfg. Co.	28	44
13 Westinghouse Elec. & Mfg. Co.	29	45
14 Circle F Mfg. Co.	30	46
15 Aerovox Wireless Corp.	31	47
16 All American Radio Corp.	32	48

APPROXIMATE COST OF PARTS $ 18.00

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

Wavemeter Calibration from Broadcast Harmonics

How to Utilize Standard-Frequency Transmissions for This Purpose

By A. BINNEWEG, Jr.

THE ever watchful Bureau of Standards has been checking up on broadcast frequencies and has found, over a long period of time, that there is practically no deviation in the frequencies of the carrier-waves radiated by the better-known broadcasting plants. There is no reason, then, why these stations cannot be used to calibrate wavemeters, the accuracy of which will depend only upon the care used in this work. The writer here describes a simple means of wavemeter calibration, using these reliable frequency standards, and yet requiring no apparatus not found in any radio listener's home.

For the experimenter, a simple wavemeter that will give fairly accurate wavelength checks is a great convenience. Even if greater accuracy may be desired than that given by a wavemeter of this type, such a wavemeter is often a necessity in locating dial-settings when tuning-in standard-wave signals and the like. An accuracy of 2% or better may be secured with a little care. Waiting for certain stations to sign off, is often troublesome; a simple wavemeter often saves much of this trouble.

The large number of broadcast stations on the air in almost every locality offers a very convenient means of wavemeter calibration. Not only may the main wave be used, but harmonics of the main wave may also be utilized for this purpose, provided certain precautions are taken to determine the correct harmonics.

Design of the Wavemeter

The circuit for such a wavemeter is shown in Fig. 1. The condenser should be .00035-mf. for ordinary use. The coils necessary to cover any range down to 15 meters with such a condenser are as follows:

(All coils 2 inches in diameter)

	Turns
260—560 meters	50
180—280 meters	33
90—230 meters	17
45—130 meters	9
15— 50 meters	3

The above values overlap, that is, wavelengths at the top settings with a smaller coil may also be obtained from the lower dial-settings with a larger coil, hence a continuous calibration may be had.

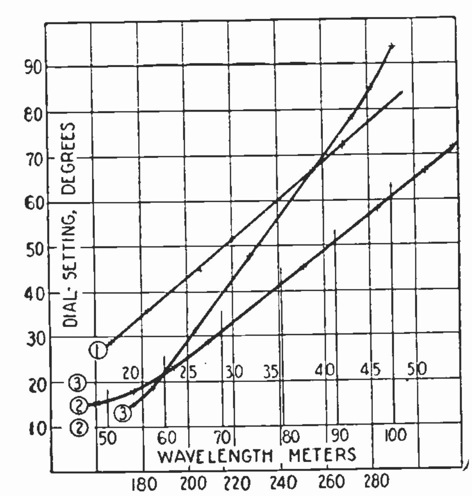


FIG. 2 - TYPICAL SLC CURVES

Some examples of a set of calibration curves for a wavemeter, using a different coil for each curve.

This is the simplest wavemeter that can be constructed. It requires a minimum of apparatus and is as simple as any to calibrate. The condenser should be mechanically rigid and should be mounted in a small case. The dial should be securely set in place and the condenser leads should be rigid and heavy. The leads may be brought out of the case at any convenient spot; it is quite an advantage to provide a honeycomb mounting, besides the binding posts, originally. This facilitates determining the correct number of turns for the coils, sometimes, and has other advantages.

The coils are wound with a fair-sized wire (any convenient size will do), on pieces of 2-inch bakelite tubing of the proper length. The wire should be securely held in place by some "dope," such as collodion; glue will not do, for it cracks off in a short time. When necessary, the coils may be wound in two layers.

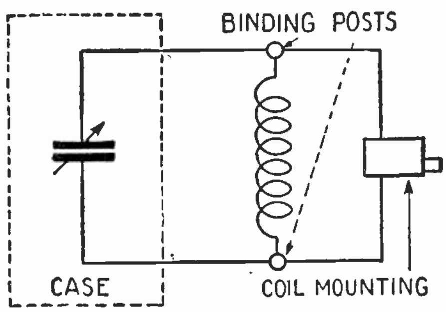


FIG. 1

With a .00035-mf. variable condenser in parallel with an inductance (which is interchangeable) an effective wavemeter can be made, as diagramed above.

There is some advantage in using the proper condenser in the wavemeter, hence an explanation of the curves shown in Fig. 3 will be of value.

Types of Condensers

Curve No. 1 represents the distribution of wavelengths on the wavemeter dial using an S.L.C. condenser. This "curve" is practically a straight line from 25 to 85 on the dial. An S.L.C. condenser offers an easy means of calibration between these two values, if wavelength vs. dial-setting is desired.

Curve No. 2 of the same figure shows the distribution of kilocycles on the dial of an S.L.C. condenser. It was plotted by calculating the corresponding kilocycles for each wavelength. Such a curve would be more difficult to determine; hence an S.L.C. condenser should not be used for kilocycles vs. dial-setting; there is much "cramping" at extreme dial-settings.

Curve No. 3 shows the distribution of wavelengths on an S.L.F. condenser in the receiver used, it is more difficult to determine than the straight line, also.

Curve 4 is a straight line showing how the kilocycles would be distributed on a theoretical S.L.F. condenser; and Curve 5, differing but slightly from a straight line, shows the actual kilocycle distribution on the condenser used.

The kilocycles were calculated from the relation: V=KW where V is the velocity (or 299,820 kilometers per sec.). K is the frequency in kilocycles, and W is the wavelength in meters. The frequencies may also be obtained from lists giving wavelengths, power, etc., of all stations.

Theoretically, the S.L.F. condenser is the one to use, since the stations are allotted wavelengths 10 kilocycles apart. The curves may then be plotted, using kilocycles vs. dial-settings, and opposite the kc. the corresponding wavelengths may be written for convenience. However, an S.L.W. condenser or an S.L.C. condenser may be used, as herein described.

At the present time it is customary to deal with wavelengths, hence it is all right to use an S.L.C. condenser; since it gives a straight-line relation between 25 and 85 on a 100-degree dial, as shown by the curves; ordinarily the experimenter has more of these condensers at his disposal.

Necessary Operations

The process of calibrating a wavemeter, using the click-method and a regenerative receiver is as follows:

The station is tuned-in, with the receiver just above the point of oscillation. A carrier "hump" will be noticed on each side of the correct setting; tune the receiver between the two. Then bring up the wavemeter and couple it rather loosely to the secondary of the receiver and vary the dial of the wavemeter until a click is heard in the 'phones of the receiver, or until it stops oscillating. It may then be necessary to move the wavemeter farther away, so that the indication will not be so broad. With a little experimentation, the correct position may be determined within half a degree. Lay off the dial-settings and wavelengths on a piece of graph paper, and plot each point from the two values; that is, the dial-setting and its corresponding wavelength. These wavelengths are known and are regularly published in RADIO NEWS.

After the broadcast waveband has been covered, the wavemeter range may be extended downward by listening for broadcast harmonics. A 50-turn, space-wound coil in the receiver covers the broadcast range quite well with a .00035-mf. condenser; to extend the range down to 90 meters use a 17-turn coil in the receiver. Such a coil allows tuning-in the short-wave broadcast stations at the top of the dial and these are used as starting points on the curves. Near-by stations, that is, stations within 20 miles, give many audible harmonics and harmonics of quite distant stations are often heard.

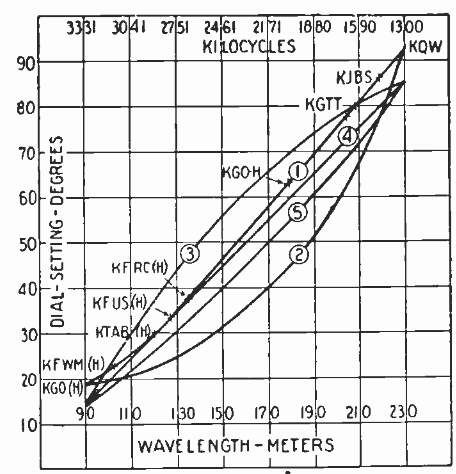


FIG 3

Experimental and theoretical calibration curves, obtained from condensers of different types in the wavemeter.

Prepare a table of the stations in the locality, tabulating the main waves and the harmonics; the 2nd harmonic being half the main wavelength; the 3rd one-third, etc. A table that was actually used for some of the curves is shown below. (*Use the new standard broadcast frequencies*).

Station	Main Wave	2nd. Harm.	3rd Harm.
KFWM	206.8	103.4	68.9
KJBS	220.4	110.2	73.5
KQW	230.6	115.3	76.9
KZM	239.9	120.0	80.0
KFRC	267.7	133.9	89.2
KGO	361.2	180.6	120.4
KPO	428.3	214.2	142.8
KLX	508.2	254.1	169.4

Using the stations at the top of the dial, note a few points; then draw a line on the calibration curve in the direction in which the final curve will probably go. Read, from this temporary curve, where one of the harmonics will come near 25 on the dial; and then adjust the receiver at this wavelength with the wavemeter. When the station is on, that gives this harmonic, it will probably be found very near the estimated position. Tune in and plot this point on the curve. Work back on the new curve drawn to this point and find other points in the same way. Sometimes a point is found that does not fit the curve; disregard it, it is probably wrong. Mistakes may easily be made; as will be seen from the table, some of the harmonics are quite close together. However, if a nearby station is used, one can be quite sure of the harmonic, and the other points will serve as checks.

In securing data for the curves, as may be readily seen from the curves here, it is unnecessary to take a large number of points; when using an S.L.C. condenser take two or three values at the higher settings of the wavemeter, one at the center and two or three at the lower settings; these determine the curve quite nicely.

Broadcast harmonics have been heard as low as 30 meters and have been tuned in and identified; but ordinarily 50 meters is the lower limit when this method is used. With this method there is usually less chance for error in selecting harmonics than with the "driver-receiver" method (in which the harmonics become complicated sometimes), and no extra equipment is necessary. This work may be greatly simplified by using two stages of audio amplification.

The short-wave stations are usually much easier to calibrate from; for the indication of the long-wave stations is sometimes quite broad. On nearby stations, the coupling should be reduced to a minimum; and in some regenerative receivers the tickler must be of the correct value.

The receiver dial itself may also be calibrated by using a curve; but different antennas and various adjustments of the receiver may change results.

For special ranges of the wavemeter, remember that to have a particular wavelength come in lower on the dial it is necessary to increase the inductance.

The wavemeter will be only as accurate as the calibration-curve; therefore use graph paper of sufficient size for the desired accuracy. The curves for the different ranges may be plotted on the same sheet for convenience; different "base-lines" for the different ranges will be necessary, as shown in Fig. 2.

Such a simple wavemeter is very convenient in determining the location of short-wave broadcast stations and, with calibrations for a few different coils, will have many uses; it will repay one many times over for the time spent in its construction. No owner of a modern receiver should be without one.

Short-Wave Receiver Adjustment

(Continued from page 96)

Use enough coupling to allow the proper regeneration and selectivity.

Tube Selection

The detector tube is of great importance if sensitivity, proper regeneration and a minimum of unnecessary noise, are desired. Some tubes regenerate with a hum, others with a click and still others with a gentle "hiss." The grid-leak may influence this to some extent; but in general only the third type of tube should be employed where quiet, sensitive reception is desired. A good tube with a socket that will not allow "ringing" (which is especially noticeable at the higher frequencies in sets subject to vibration) is certainly a big step toward proper receiver operation. Flexible leads, such as thin foil, near the socket terminals prevent vibrations reaching the tube through the wiring.

The grid-leak, besides being sometimes the cause of unnecessary noises, is often not of the proper value. A variable grid leak for securing the proper resistance is an advantage, especially where a variety of different wavelengths may be used. It has been found that the grid leak gives proper oscillation control under most circumstances. This is hardly noticeable on the higher wavelengths; but almost all short-wave circuits give better results if a proper value of resistance is employed. In general the proper resistance for short-wave receivers is higher; sometimes very much higher. The selection of the proper resistance is important where short-wave broadcast receiving is to be done. After the proper value for the particular waveband is known, a fixed leak may be used.

For efficiency, of course, all parts should be as low-loss as possible and the wiring be well-spaced. It is difficult to conceive how any cramped, panel-mounted short-wave receiver can compete with one neatly laid-out, all parts given the proper spacing and the amplifier placed off by itself.

Since the oscillation control is quite independent of the rest of the adjustments, this circuit may be easily calibrated. There is a great tendency to look very closely at the graduations on the wavelength dial as if the stations were actually hidden there; hence it is advantageous to use a pointer and a large scale which may be accurately calibrated in wavelengths.

All objects of any description should be kept away from the antenna, the coils, etc., for the increase in losses caused by such is high. All leads should be of fairly large plate circuits. Since a low-resistance circuit always tunes sharper, it is not necessary to employ such loose coupling to the antenna circuit in congested areas where there may be considerable interference. Satisfactory regeneration below the oscillation point of the tube is very desirable; hence keep the circuit resistances low. A good soldering-copper is perhaps the worst enemy of such resistance.

With the movable tickler coil that was formerly in general use (See Fig. 3), it was quite an advantage to split the secondary into two sections, the tickler coil being coupled to that portion which was not coupled to the antenna and which was set at right angles to the other secondary coil; in this way any motion of the tickler did not necessitate a readjustment of the other controls. With this circuit, this may also be of some advantage but the tickler-coil is a fixed one anyway and the regeneration control is quite independent.

Operation of the Receiver

The filament rheostat is set at the proper value. The secondary condenser is slowly turned while keeping the other condenser at the point of regeneration. Don't think for a minute that one setting of the oscillation control will serve for the whole condenser range; this mistake is often made; signal strength may be increased by as much as 100%; signals that would be inaudible may be easily brought in by proper handling. It is evident therefore, that the nearer the point of regeneration the greater the signal strength; not a little better, but a *very great deal* better—another reason for not tolerating the click as previously described. This critical adjustment of the oscillation control for greatest sensitivity is probably the greatest difference between this circuit and the ordinary movable tickler-coil variety. The short wavelengths employed have also something to do with this. When a station is picked up, change to the secondary vernier and vary both condensers until maximum signal-strength, good quality and volume are obtained. The adjustment for telegraph C. W. signals will not be as particular as adjustment for broadcasting. Little difficulty will be experienced with the latter if the oscillation control is set at the proper value and the vernier is used.

Many claim that their receivers work just as well with the dotted line in Fig. 1 (connecting the primary and secondary) omitted. One useful purpose of this is to reduce hand-capacity effects; but there are some disadvantages. With this lead connected as shown one hears a rather disagreeable hum when the set is not regenerating, and to some extent just at the point of regeneration. If the set were to be operated above this condition at all times this hum could not be heard; but when operating for maximum sensitivity this noise becomes monotonous if headphones are used for long periods. This is about the same proposition as listening with a headset to a receiver operated by an old-type "B" eliminator. Thus the slight advantage gained by the use of such a lead is more than offset.

The only change necessary to receive from 10 to about 125 meters, that is, over a limited band anywhere within these limits, would be in the size of the inductances.

Closer coupling of the antenna coil to the secondary necessitates a large increase in the by-pass capacity; oscillations are more troublesome but they cease when the antenna switch, as used by amateurs, is thrown. A loud hum in the receivers usually means that the secondary is disconnected.

When the "ground-lead" is connected the wavelength of the receiver increases slightly. Do not run this lead, if used at any time, to the grid-end of the secondary by mistake; little or nothing may be heard in this case. Small pieces of cardboard inserted between the coils will keep them in their proper places and prevent objectionable vibrations.

Much has been said about the importance of good antennas; hence a few words will suffice. Whenever possible a long antenna, part of which is horizontal, should be used; since it has been found that short radio-waves coming from a distance are *polarized*, that is, the vibrations in the wave-front are more or less confined to a plane; naturally more energy is induced in the antenna if it is in the plane of these vibrations.

Radio "Wrinkles" for the Constructor

Short Cuts and First Aids to the Experimenter

A Compact Triple Condenser

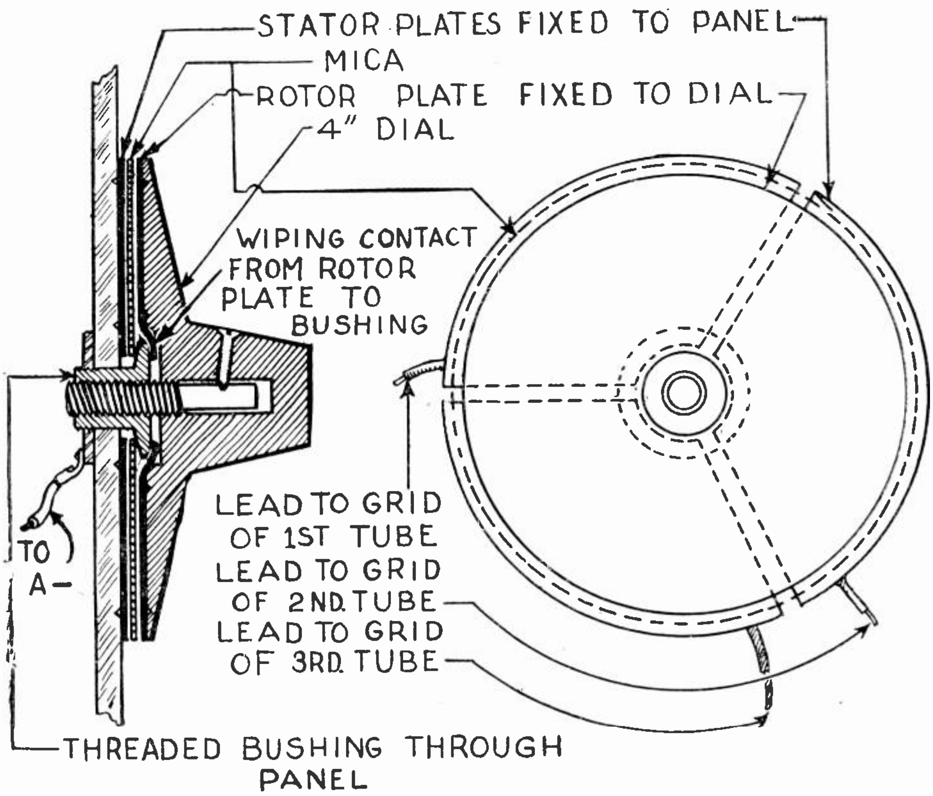
By Robert N. Auble

A VERY compact, and if the workmanship is careful, a very efficient triple condenser may be constructed as shown in the accompanying sketches, and will be suitable for use in tuned-radio-frequency sets, in which tuning is accomplished by changing simultaneously capacities in three or more separate circuits.

A disc of thin copper, or other suitable conductor, is fastened with collodion to a four-inch dial. The shaft of the condenser is a ¼-inch brass bolt, which is threaded into a bushing in the panel. Rotating the dial will move the plate nearer or farther from the panel. Fixed to the panel, and insulated from the rotor plate by a thin sheet of mica, or other dielectric, is a similar disc of copper, which has been cut into three sectors, as shown. The rotor or dial plate constitutes the "grounded" section of the condenser, while the three sectors of the stator disc constitute the "live" plates, each being connected to its respective grid. Capacities are changed in the three circuits simultaneously and in equal amounts, provided the common rotor plate is moved uniformly toward or away from the stator plates.

The idea of this device may be extended to include more than three condensers, since it is necessary only to add more sections to the panel.

Obviously the dial must run perfectly true in order to maintain parallelism of the plate. If the three condensers are not perfectly matched, however, three small vernier condensers, constructed on the same plan as the large condenser, may be fastened on the inside of the panel. A flat-head screw, countersunk into the panel before the stator plates are put on, will make a satisfactory vernier. The shaft of the condenser should have a thread of fine pitch, in order that the rate of change shall be small.



Here is an excellent triple variable condenser in one unit. A single circular metal plate, attached to the dial, functions as all three rotors. A similar plate, cut into three sections and these fastened to the set panel, forms the stators.

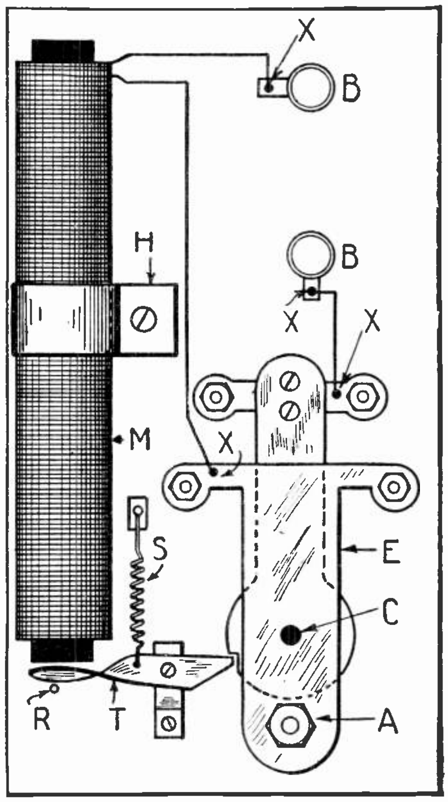
A Home-Made Circuit Breaker

By L. G. Campbell

MOST of us would use a circuit breaker instead of a fuse to protect our apparatus, whether receiving, transmitting, or other electrical equipment, if we could afford the initial expense. The advantages of a circuit breaker are many. Instead of inserting a new fuse we simply reset the circuit breaker. The fuse requires time to melt in opening the circuit; whereas the circuit breaker operates instantly, thus affording adequate protection to valuable tubes, etc. The circuit breaker is adjustable at will to the type of apparatus to be protected.

This home-made circuit breaker possesses the following desirable points:

It requires only common tools and a few screws; it is made in its entirety from a discarded Ford spark coil; adjustment can be made so that it will open the circuit with less than 1 ampere or with more than 10 amperes, according to the requirements; it can be inserted in line either way. This is important for batteries, etc., are protected whether they are *on charge or in service*, without reversing the circuit breaker; and you are assured protection all the time, for it is simple and absolute in action.



A top view of the circuit breaker; S is a spring from a tire-valve core; C and E are lower and upper contacts, meeting at C, and regulated by A. B are binding posts, x, soldered connections; and R is a check limiting the movement of the trip. Other parts are explained in the text.

The diagram indicates clearly all the necessary parts. The magnet M is obtained by opening the Ford coil box and removing it from its surrounding high-tension windings. The iron must be left inside. The two ends of the heavy-wire winding must be found, so that they may be connected as shown.

The base may be bakelite, or made of one side of the coil box if care has been taken not to split it.

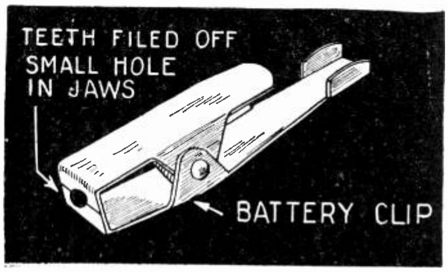
The vibrator parts are removed as all these are necessary. The vibrator contacts should be brightened up with a file, this to insure good contact connection. The lower vibrator spring is bent or otherwise adjusted so contacts are about ⅛-inch apart. The trip T is made of soft iron and holds the contacts together; as shown in the diagram the circuit is open. The magnet end of this trip is circular and somewhat larger than the end of the magnet core.

The circuit breaker when completed is ready for adjustment. The tension in the spring S, is made just enough to make the trip move easily and to take up any excess motion at its joint. For the adjustment for opening the circuit at various loads, the magnet is shifted in position; it must be noted that, the farther away the magnet is from the trip, the harder it will be for it to move the trip and thus the greater the load must be in order to open the circuit. The closer the magnet to the trip, the more delicate is the release.

Wire-Skinning Device

By Oliver Scheibell

IN using the popular rubber-covered stranded hook-up wire, considerable trouble was experienced in skinning the ends for connections until the following simple tool was devised. It consists of a large battery-connection clamp, the teeth of which are filed smooth. A small notch in the jaws, roughly the size of the skinned wire, is also made with a file. With this little tool you can do a neater job in a fraction of the time necessary to skin this type of wire with a knife, and there is no danger of cutting the fine strands of the wire.



By filing the teeth off a clip, and a small hole in the smooth jaws, an insulation remover can be easily made.

"A-and-B"-Battery Charger

By Arthur A. Siniscal

THE writer has in mind to describe a simple, inexpensive, easily-made chemical rectifier which will recharge both "A" and "B" batteries conveniently at home.

Having obtained four one-pint Mason jars, you will need eight electrodes for these cells, one pair for each. These electrodes consist of four aluminum and four lead plates, whose dimensions are each 1⅝ x 5 inches (Fig. 1). Four aluminum plates cut from an ordinary kitchen casserole are excellent for this purpose. A strip of sheet lead, 5 x 6½ inches, obtained at a plumber's shop and cut into four pieces of the same size, will serve for the other set of plates. Scrape all eight plates well with emery paper to bring out a clean surface.

The plates are suspended in the cells, in pairs, by means of wooden supports, the size of each of which is ¾ x ⅞ x 3 inches. Both plates and supports and the method of attaching them are sketched in Figs. 1 and 2. Two holes drilled in each plate will allow two small screws to attach it to its support, a 10-in. length of copper wire being firmly entwined between the screws and wood support for connection later. The supports should be boiled in a hot paraffin bath for an hour or so before final use. The four cells are then placed upon a base of wood (8 by 10 inches), arranging the plates in the manner shown in Fig. 4. Two hard rubber strips are fastened to the base, having binding posts with which external connections are made. The receptacle (S) is an ordinary porcelain lamp socket, placed where shown, and used for inserting the resistances (R), as a lamp, electric iron, etc.

For the electrolyte, first make a saturated solution of sodium bicarbonate (common baking-soda) in two quarts of distilled or rain water. Be sure you use distilled and not tap water, as the latter contains mineral compounds that interfere with the chemical action of the cell. When this solution is made, obtain 10 grams (one-third ounce) of ammonium phosphate (at any drug store) and dissolve this in a beaker of distilled water, adding the whole, when entirely dissolved, to the first solution. When the final mixture is completed, fill each cell with it to about an inch from the top and then connect your apparatus as indicated in Fig. 3.

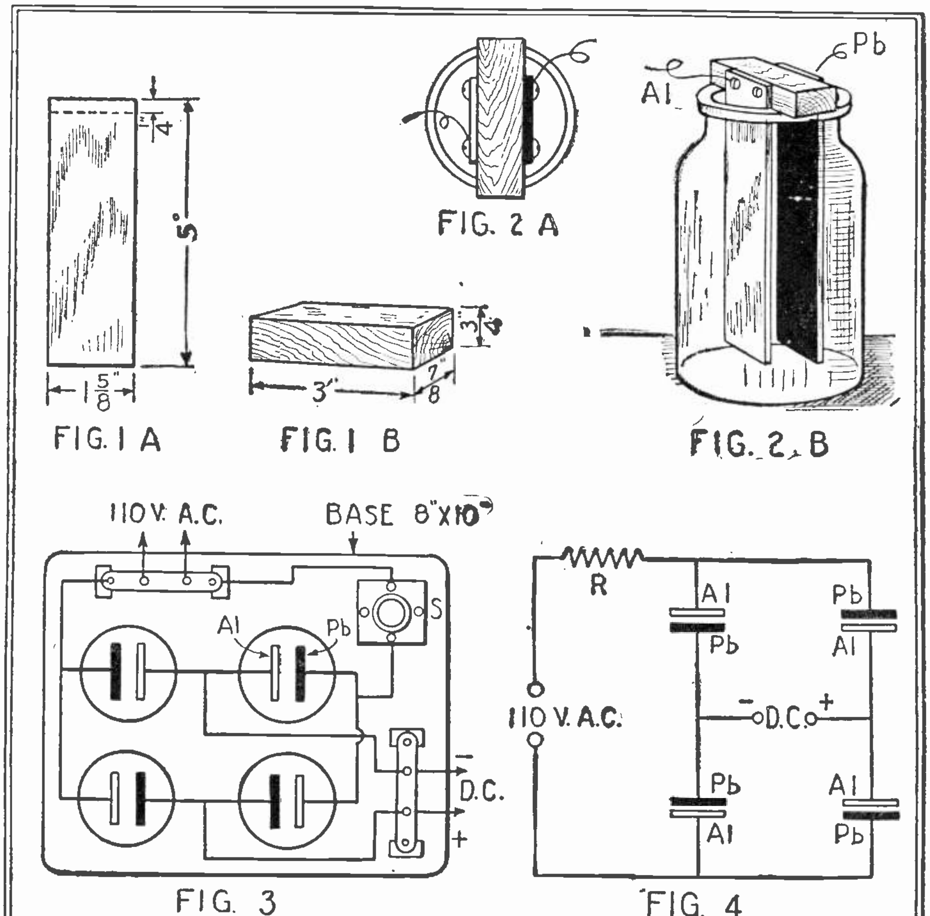
For those who do not readily understand the wiring diagram of Fig. 4, the complete view of the apparatus in Fig. 3 will help illustrate more clearly the method of connections. Thus an aluminum from one jar is connected with a lead from another jar to one side of the house current line. Then the other side of the line is connected to an aluminum and a lead plate from the other two jars, as in the first case, but in series with a resistance (R) placed at S. This leaves two aluminums and two leads free, the two lead plates connected together forming the negative (—) terminal of the charging side, while the two aluminum plates are likewise connected and form the positive (+) terminal of the D.C. side.

In time, if any of the salts separate out and collect at the bottom of the jars, care should be taken that the sediment does not rise high enough to short-circuit the plates.

The size of the resistance is dependent upon the battery to be charged. If an "A" battery is used, an electric-iron plug is screwed into the socket (S), Fig. 3. If none is handy, then the following idea may be of interest, also because of its economy. Extract a single fuse from the box in the cellar, and insert a plug from a light cord whose other end terminates in a plug screwed into the socket (S). Now, by going upstairs and switching on a half-dozen lights or so in the house, you can, besides charging your battery in the cellar, also peruse leisurely the evening paper in the parlor, on the same electric bill.

If a "B" battery is to be charged, simply insert a 75-watt bulb into the socket, S, and leave it so until the battery is fully charged, which is determined with a voltmeter, or hydrometer in the case of an acid battery. If you are fortunate enough to possess a step-down transformer whose secondary voltage is around 20 to 50 volts or so, you can connect the A.C. side of your rectifier directly to the secondary terminals, placing a 5-ampere fuse into the receptacle (S) for either battery.

In practice, just before using the charger for the first time in any case above stated, you must "form" the plates of the cells. This is done by directly short-circuiting the D.C. side with a thick wire and letting it stand thus for one-half hour or more with the current on. Of course, a low resistance, as an electric iron (if the house current is not stepped-down) must be connected to (S), or a fuse if a transformer is used. The plates are thoroughly "formed" when, on disconnecting this wire, a bulb placed in the socket at (S) burns very dimly, if at all. This test can also be applied at some other time during the use of the apparatus, if it is suspected of functioning improperly. Should the lamp thus tested burn brightly, the electrodes are not rectifying at all, and the trouble is usually found to be in the electrolyte, which will weaken in time. A fresh solution ordinarily removes the trouble, unless it happens to be in the external circuit. Other details, as the use of a switch control, are left to the will of the experimenter, but the apparatus is absolutely complete as hitherto described.



Constructional details and wiring diagram of the "A-and-B"-battery charger. The rectifier is of the electrolytic type, employing aluminum and lead plates. The amount of current delivered is dependent on the size of the lamp, or other form of resistance inserted into the socket S shown in Fig. 3. R in Fig. 4 represents the resistance placed in series with the circuit to control the current flow. This corresponds to S in Fig. 3.

Flushing Device for Ground Connection

By C. A. Oldroyd

FANS usually devote a great deal of effort and time to the erection of a good aerial, but unfortunately they are inclined to forget that a good ground is quite as essential for good reception as a well-insulated aerial. The size of a suitable ground plate depends to some extent upon the soil in which it is buried; with very dry soil a larger plate should be used than in moist soil. A plate two feet square will generally be satisfactory. With a flushing device you can moisten the soil above and below the ground plate to saturation point and obtain hundred per cent efficiency.

Fig. 1 shows a section through the trench in which the plate has been buried. Above

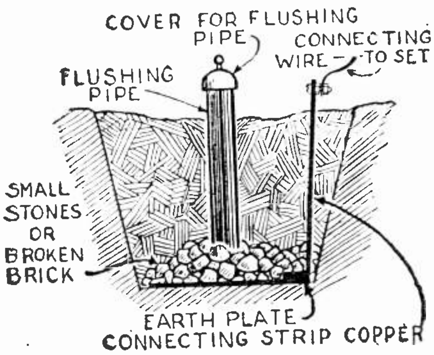


Fig. 1. Showing the details of a water-supply system for the ground connection. The flushing pipe carries water to the plate, to which the ground wire is soldered.

this small stones and broken bricks are placed for about four inches; on the stones rests the flushing pipe, which may have a diameter of from 1½ to 2 inches. The upper end of this pipe reaches well above the ground level; it is covered by a lid to prevent leaves, etc., falling into the pipe and clogging it.

Connection to the ground lead is made by a long copper strip or thick copper wire which has been riveted and soldered to the plate and projects about ten inches above the ground level.

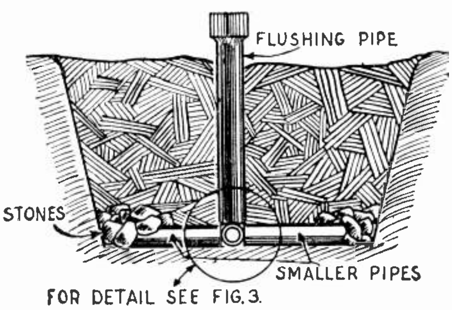


Fig. 1-A. Details of the flushing pipes located over the ground plate.

A Multiple Pipe System

A still more efficient solution is given in Fig. 1A. Here four smaller pipes join the central flushing pipe and lead just over the edge of the ground plate; their ends are bridged over with stones or bricks to prevent the openings being clogged by settling soil.

The diameter of the main pipe may be about three inches; the smaller pipes need have a diameter of only about two inches (Fig. 2). If a length of hose is used for this purpose, turning on the tap will fill the pipe in a few minutes.

Care must be taken to get a really sound joint between the upright main pipe and the four smaller ones. (See Fig. 3). The

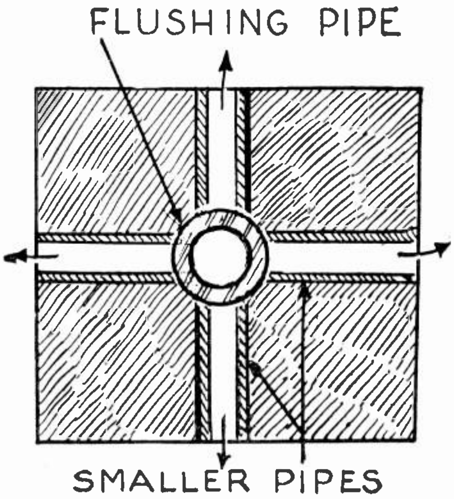


Fig. 2. Section of the pipes as seen from above.

four smaller pipes are placed under the main pipe, so that their ends reach about half an inch beyond the inside edge of the vertical one. The first joint is made with clay, about two inches thick. Over the clay, concrete is poured to make a really sound joint. The concrete binds well with the pipe surface and the whole flushing-pipe arrangement can be built above ground.

In sandy soil, where this device is invaluable, the sand may tend to filter through the crevices between the stones, and clog the pipe mouth. If, however, a piece of

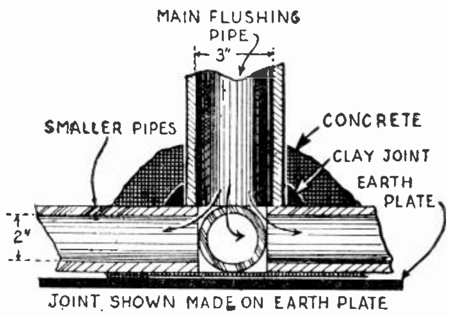


Fig. 3. Showing how the five pipes are joined to prevent leakage.

burlap is placed over the stones before the soil is filled in, the mouth of the pipe will be kept open.

A Trick With a Trickle Charger

By J. P. Kennedy

A TRICKLE charger of the type using lead and tantalum in a solution of dilute sulphuric acid, or aluminum and lead in a solution of borax or some similar salt, can be used to charge storage "B" batteries in the following manner. The rectifier jar is removed from its mounting and disconnected from its accompanying transformer. The polarity of the electrodes on the rectifier jar will be the same while charging "B" batteries as while charging the "A" battery. A lamp socket and a 60-watt lamp, plus a few feet of lamp cord with a standard plug attached, will complete the equipment.

One side of the lamp socket is connected to the negative electrode of the rectifier, the positive electrode is connected to the positive 48-volt side of a "B" battery block. The negative "B" battery line and the line from the side of the lamp socket opposite to the side already tapped are then connected to the 110-volt A.C. line as shown. When the lamp is inserted in its socket the "B" battery goes on charge. When the "B" battery is charged the rectifier jar may be returned to its regular position, where it will function as usual.

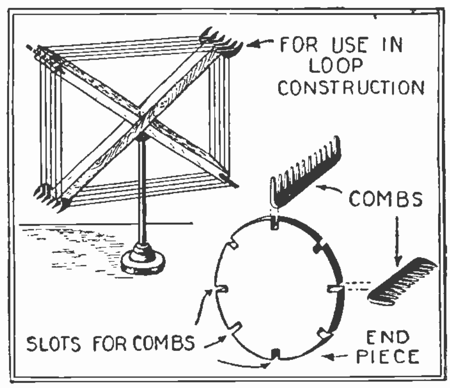
Coil Forms From Combs

By George S. Turner

A SUGGESTION how to make a very simple (and at the same time exceedingly efficient) coil form from ordinary combs, obtainable anywhere for a few cents, might be of interest. Combs, as we know, are usually made of either hard rubber or celluloid, and therefore have excellent dielectric qualities. The teeth come in a variety of sizes, either coarse or fine, and are so spaced that they allow various sizes of wire to be threaded in between them.

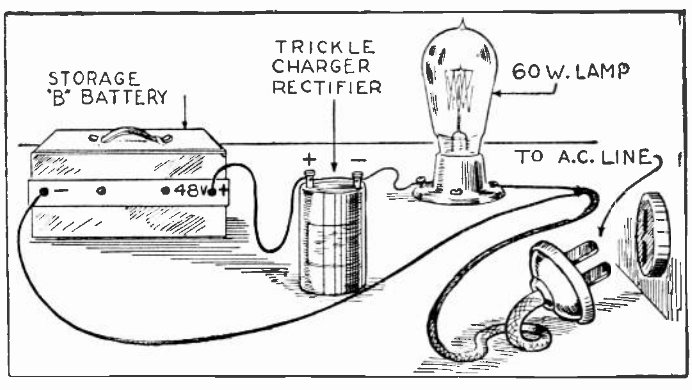
And, truly, the comb is close to being perfect according to specifications outlined by the Bureau of Standards, insofar as it permits spaced winding, optimum size wire for frequency intended, minimum of dielectric loss in the coil support, and, of equal importance, mechanical ruggedness.

The figures are self-explanatory. It remains only for the builder to adapt this idea to the particular type of coil desired, whether of the receiving or transmitting type.

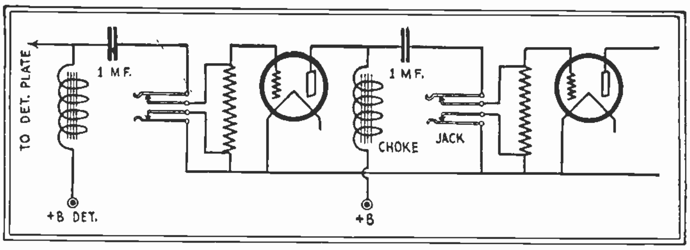


Above are suggested two uses to which rubber combs can be put. There are many other possibilities.

As a final word, the comb for use as a wire spacer and low-loss support is unbeatable for loop construction.



Showing how to use the tantalum-lead rectifier from a trickle charger for charging storage "B" batteries. A number of 48-volt units can be charged at one time by connecting them in parallel.



A very clever arrangement for an impedance-coupled audio amplifier. When the loud speaker is plugged into either of the jacks, the impedance and condenser of the preceding stage form an output filter.

Impedance Coupling Kink

By D. C. Duncan

IMPEDANCE- and resistance-coupled audio amplifiers are quite popular. The circuits used lend themselves admirably for speaker filter circuits without any additional apparatus. By connecting the jacks as shown in the illustration, the loud-speaker may be connected to the first, second, or third stage and the choke coil and condenser of the stage in which the speaker is connected forms the speaker filter circuit. You will note that with this arrangement the "B" battery current does not pass through the speaker.

Collapsible Loop Antenna

By H. R. Wallin

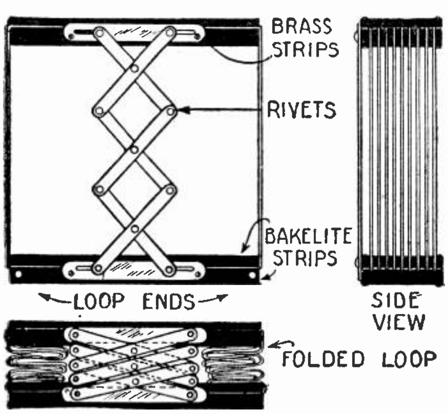
A VERY neat and efficient collapsible loop which, when not in use, folds out of sight in rear of cabinet is shown in the sketch.

The scissors arrangement is made of 1/32-inch sheet brass, 3/16-inch wide. As most loops are made for specific sets, no details as to length and height are given; the loop can be made to fit any requirements. A good size is about 18 to 20 inches in height when opened and 10 inches wide. The strips holding the loop wire are 10x2x¾-inches, split in two and fastened together by screws; the wire being held between the two strips. These strips can be made of wood varnished or polished to match the cabinet, of hard rubber or bakelite.

The sheet-brass strips at the two ends of the scissors arrangement are slotted for about half an inch, as shown.

The loop described makes a neat installation for the home set, as many people object to the loop of wire being in sight and collecting dust and dirt. If there is sufficient room in the cabinet, it can be placed on a bracket inside the set and the cover opened when it is to be used. It can also be made to fit a slot in the cover, so that when folded out of sight it is flush with the top of the cabinet. However, it is necessary to cut a hole in the cabinet to do this.

When folded the loop is very compact, as it takes less than two inches of space. The number of pieces used in the scissors arrangement depends on the height of the loop.



The design of a folding loop antenna, which can be simply constructed.

These are very easy to make and are held together by rivets, which should not be hammered down too tight; as when opening the arrangement, the strips turn about the rivets. The loop described is especially useful for portable sets as it takes up very little room.

Use for Burnt-Out A.F. Transformers

By Glen Decker

IN many radio junk boxes will be found burnt-out transformers; and a new use for them is here offered the experimenter who has saved them. As it is, almost always, the primary of these transformers which burns out, they can be utilized very satisfactorily by connecting a 100,000-ohm fixed resistance across the primary terminals and a .006- to .01-mf. condenser between the "grid" and "plate" terminals of the transformer.

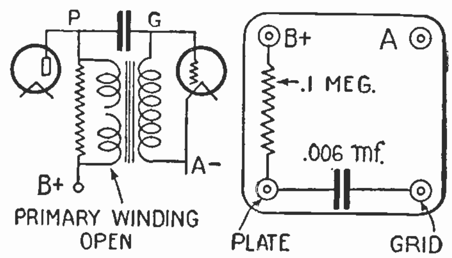


FIG. 2 FIG. 1

By connecting a 0-1-megohm resistance and a .006-mf. condenser as shown, an efficient impedance-coupling device can be made.

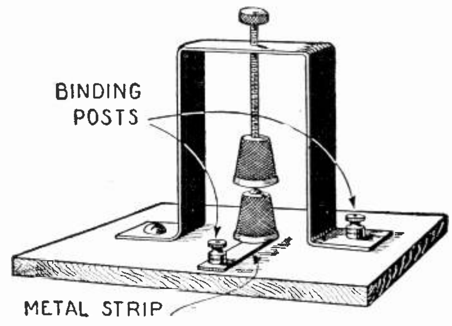
This connection effects resistance-capacity coupling with an impedance leak, and will be found to give very good tone quality, from even cheap and inefficient transformers, though these afford slightly less volume. It is a relatively simple matter to make clips of spring brass, which may be mounted directly on the binding posts of the transformer and which will hold the resistor and the coupling condenser.

Two Thimbles Form Condenser

By Donald F. Holaday.

SOMETIME in his career the inveterate experimenter generally finds himself, about 11 o'clock in the evening, without some very important "gadget" that is absolutely necessary to carry out the work on hand. Therefore, if you should encounter such a problem and happen to need a small-capacity variable condenser, here is one that can be made easily and quickly.

Two sewing thimbles (of the advertising variety, stamped from aluminum), are used. A hole is drilled through the top of one of them, to take a piece of threaded brass rod, which is fastened in place by two nuts. A hole is drilled also in the top of the second thimble. A bolt is passed through this and through a piece of insulating material, which forms the base of the instrument. A piece of brass is bent into a U-shaped bracket, as shown, and three holes drilled in it, one in the bend and the others in each end, for mounting purposes. A nut to take the threaded brass rod is then soldered over the hole in the top of the cross-piece. This hole and nut allow the raising and lowering of the upper thimble in respect to the lower one. A binding post can be fastened to the end of the threaded rod for use as a handle. All the insulation necessary between the two thimbles is a heavy coat of shellac on the lower one. This prevents a short-circuit in case the upper thimble is lowered too far and touches the bottom one.



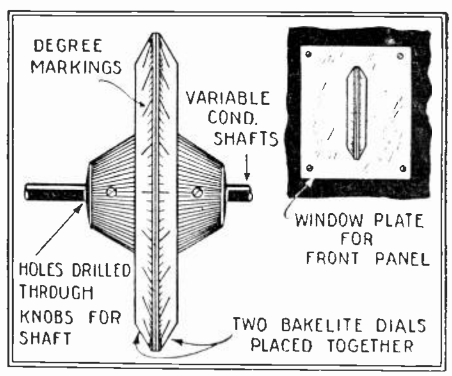
With two thimbles, a strip of thin brass and a few odds and ends, an excellent low-capacity variable condenser can be made.

In order to make connections to the two plates of this condenser, one wire is connected to one of the screws holding the square bracket, and another to the metal strip which is fastened beneath the edge of the thimble mounted on the base. This strip can be made of several thicknesses of tinfoil, brought out to a binding-post on the base.

An Easily-Made Drum-Type Dial

By H. R. Wallin

ONE of the new drum-type rotary dials, such as are used in the higher grade of radio sets today, can be easily made with two ordinary three- or four-inch bakelite dials. Holes are drilled through the knobs to fit the shafts as shown in the illustration and the two dials are glued together with the degree marks coinciding. A small window-



An excellent drum-type dial, made from two ordinary composition dials. The arrangement may be adapted to either single or double control. One dial must read in the opposite direction from the other.

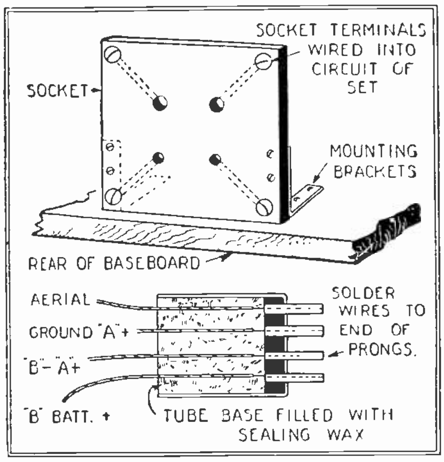
plate made of brass, with the opening made to fit the dials, is placed on the front of the panel as shown. Small brackets hold the shafts securely. The dial can be used on a single-control set operating several condensers in tandem, or two or three dials can be placed in the set.

(By using one dial for each condenser and by placing the two close together, but without glueing them, the two condensers may be turned with one hand simultaneously or each one individually.—*Editor.*)

A Plug-In Aerial and Battery Connector

By Lawrence Hercher

A VERY practical method of connecting battery wires to a radio set can be followed easily by any one, with very little expense and labor. It can be adapted to the needs of any particular set, by slight variation of the scheme. With this system of connection, when it is desired to move the table



A simple battery connector made from a tube base and a UX tube socket.

on which the set is placed, all that is necessary is to pull out the plug, and the table is free to be moved anywhere.

The parts needed are as follows: one UX-type socket, a discarded tube to fit same, a flexible lamp cord or battery cable for connection from the set to the batteries.

As the writer's set was built with the "B" battery inside the cabinet, only four leads were needed, viz: aerial, ground, "A+" and "A−"

Mount the socket in a vertical position at the rear, and in the center of the baseboard, with the top of the socket facing towards the back of the cabinet. This can be done by using small brackets made of stiff brass; their exact shape will depend upon the type of socket used, and will present no problem to the average builder. When firmly fastened in place, the socket is wired into the circuit, using one terminal for the antenna connection, the opposite terminal for ground, and the remaining two for "A+" and "A−," respectively. In case the circuit calls for a grounded "A" battery, the proper terminal can be grounded at the socket by using a strip of sheet copper connected across the ground and desired "A" battery terminal of the socket. This completes the work on the set itself.

Break all glass out of the tube to be used as a plug, and clean out cement and all interior of base, leaving only a shell with the four prongs intact. To each prong, on inside of base, solder the end of a length of the lamp cord, or battery cable, long enough to reach from the set to the battery, antenna, and ground lead-ins. This soldering is best done by drilling all solder out of the center of the prongs, pushing the bare end of the lamp wire through the prong from the inner side, and soldering at the tip of the prong, as it is done when the tube is made. After this is accomplished, the base is poured full of melted sealing wax around the wires, to give it a finished appearance. Then the loose ends of the wires are connected to their respective places on "A" battery, ground and aerial; remembering that the plug will push into the socket in only one position, necessitating care that the proper wires are connected to each place.

Before placing the set in its cabinet, a hole just large enough to admit the plug is cut in the back of the cabinet directly in line with the position the upright socket will assume. Then when the assembly is completed, the plug may be pushed into place from the rear, and all connections are instantly made.

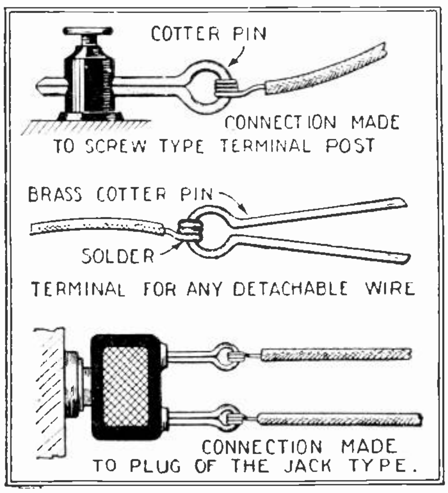
In case the "B" battery is not placed in the cabinet, it can be kept with the "A" battery, and one terminal, as specified in the circuit used, connected to its proper terminal on the "A" battery. Thus by connecting the "A−" to the ground and the "B−" to the "A+," only four wires are needed for connection to the set; as, for instance, aerial, ground, "A+" and "B+". All batteries may be kept on the porch or in the basement, preferably as close to the set as possible.

Brass Cotter Pins As Terminals

By G. A. Luers

THE radio owner or electrical worker, in need of a plug-in type of terminal for detachable parts of the wiring, will find in the means shown in the attached sketch a simple, positive and effective terminal.

Brass cotter pins, of the most appropriate size, are soldered to the ends of the wires. The ends of these terminals can be squeezed together with the fingers and inserted into any



A convenient use for cotter pins in radio construction is shown in the above illustrations, as excellent substitutes for wire terminals.

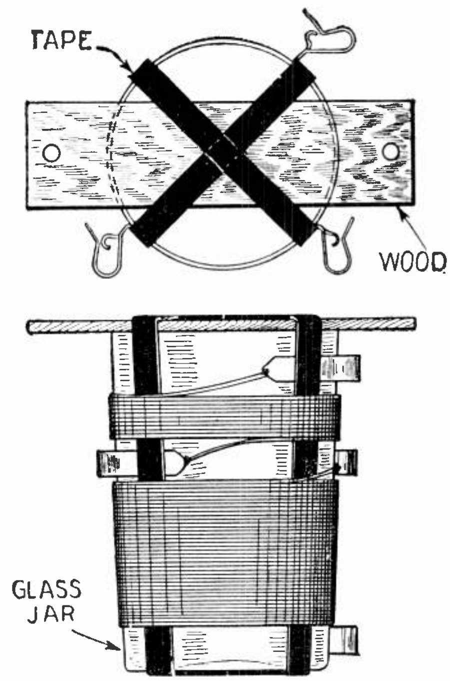
screw or plug-in type of connection. They will give good contact and offer a fair resistance to being pulled out. This resistance to removal will be increased if the ends of the cotter pin are spread outward.

A Cheap, Easily-Made Coil

By Philip Sussman

QUITE often in his experimenting a radio fan needs a coil that is easily-made, cheap, and efficient. The materials needed for this coil are: an ordinary drinking glass, some No. 24 D.S.C. wire, a roll of tape, four Fahnestock clips and a piece of thin wood, such as may be obtained from a cigar box.

The wood should be cut to 1¼x4½ inches and then placed across the middle of the open end of the tumbler. Double a piece of the tape and wrap it tightly across the glass and obliquely over the wood. Then double another piece of tape and place it over the glass and wood, so that it divides them into four equal parts. Bend the clips in the middle and round them a little so that they will fit against the curve of the glass. Slip the ends of the clip under the tape and to their ends solder the wire. The coil can then



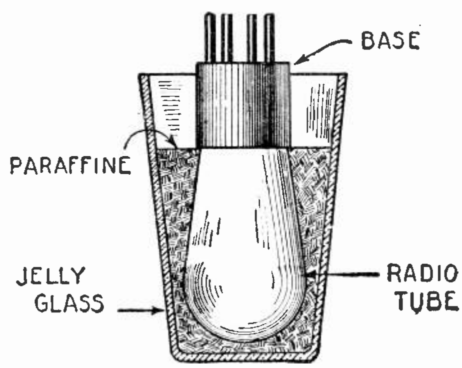
By winding a coil on a tumbler, on the top of which is a mounting board, losses may be greatly reduced.

be mounted by means of holes drilled in the wooden base. If the wire is wrapped tightly around the glass and tape, there will be no danger of its slipping off.

Quieting Noisy Tubes

By Howard R. Potter

COATING radio vacuum tubes with paraffin is an easy method of silencing microphonic noises and other disturbances to which some are subject. To shield tubes by this method it is necessary only to heat a little paraffin, bringing it to liquid state. Pour it immediately into a small jelly glass, filling the glass to a depth of about two inches.



A simple remedy for making noisy tubes less responsive to vibration.

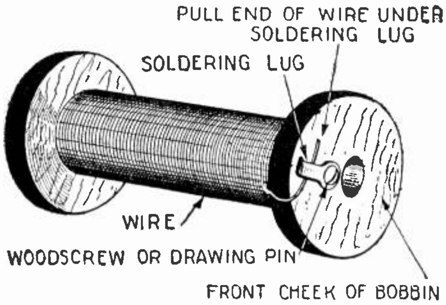
Hold the tube to be coated by the base and insert it upside down into the glass. The displacement will cause the paraffin to rise, thoroughly coating the surface of the glass. Care should be taken not to allow the paraffin to rise beyond the top of the base. Withdraw the tube and allow any drops to fall back into the glass. This coating will quickly harden, after which the tube should be dipped again. Should any of the paraffin get on the base, it may be scraped off with a knife.

Do not let the paraffin get too hot. It should be poured from the pan into the glass as soon as it reaches a liquid state, and allowed to stand in the glass a minute or so before dipping.

Clip for End of Wire

By C. A. Oldroyd

EVERY year, miles of new wire are wasted by fans when they secure the free end of a wire by a loop around the storage spool. At least two turns of wire are kinked and twisted in this fashion; and, before a new coil can be started, six to eight inches of damaged wire must be cut off.



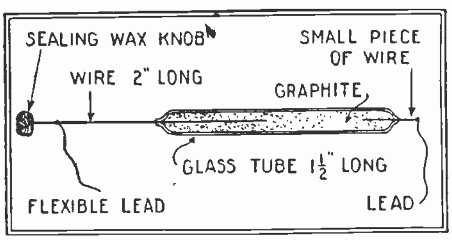
When it is necessary to store spools of wire, instead of twisting the wire in order to keep it on the spool, fasten a soldering lug on the spool's end and it will keep the wire in its proper place.

This waste can be avoided if the end of the wire is secured under a small spring clip fixed to the bobbin cheek, as shown. The wire is simply pulled under the clip in one motion.

The clip can be made from a short piece of stiff, thin brass strip; a soldering lug affords a simple solution. It is just the right size and already has a hole for the fixing screw. The tip of the lug is bent up slightly, to guide the wire under the clip. A short wood-screw can be used to fix the clip to the bobbin cheek. A large drawing pin often serves the purpose quite as well, particularly if the bobbin happens to be a small one.

A Simple Variable Grid Leak

PROCURE a thin piece of glass tubing 1½ inches in length and having an inside diameter of about 1/16 inch. Place a piece



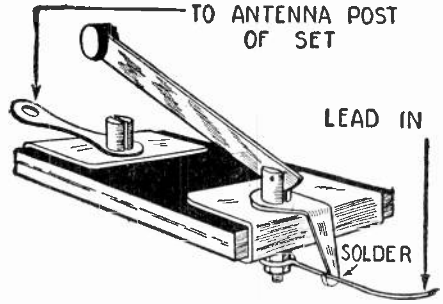
A variable grid leak, made from powdered graphite sealed into a glass tube.

of wire in one end as shown in the illustration and seal the end by heating the glass. Next fill the tube with graphite from a lead pencil. Now get a piece of wire about 2 inches long, that fits in the tube, and make a knob of sealing wax on one end of it. This is placed in the tube and the end of the tube sealed just enough so that the plunger can move freely. This makes a very good variable grid leak. It is connected in the circuit by means of two connections soldered to the small wires.—*By V. Sia (Shanghai, China)*

An Antenna-Changing Switch

By Edw. C. Delsing

IT is quite common to insert a fixed condenser in series with the antenna, to reduce spread over the dial of nearby broadcast stations and enable tuning-in other stations on that portion of the dial. In some instances this causes reduction of volume, but is absolutely necessary if other stations are to be properly heard. Then there are times when the interfering station is not broadcasting, or it is desired to listen to stations on



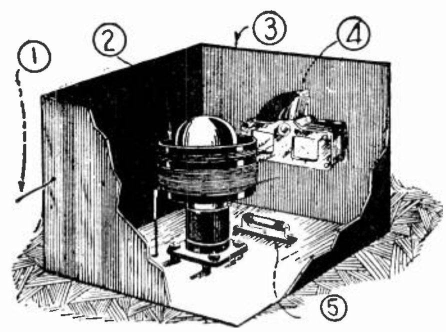
This wrinkle will be found an inexpensive and handy one for changing the electrical length of the aerial.

other portions of the dial where there is no interference, and a direct antenna connection is wanted to secure maximum volume. This wrinkle enables the set operator to throw in direct connection or utilize the condenser by simply throwing the switch shut or open. It is constructed from the working parts of a miniature single-throw switch (costing 15 cents) which are mounted on the condenser proper, discarding the base of the switch.

Coffee Cans for Shielding

By Frank A. D. LaMater

SHIELDING has proven so effective in the laboratory that now practically all good commercial sets are so constructed. Coffee cans make very excellent shielding for the



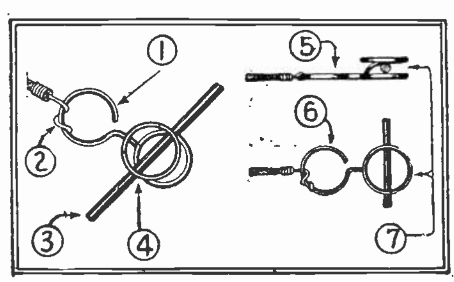
A coffee can or cracker tin, if large enough, will make a good shield for R.F.-amplifier and detector units. There should be plenty of space between the coil and the sides of the can.

radio experimenter's set. Cans large enough for the various stages can be easily obtained. By placing the coil around the tube as shown and with automatic filament controls much space is saved. However, with some condensers mounted at an angle you will find plenty of room for a filament rheostat. Be sure to make holes in the cans large enough so that they will not short-circuit wires and other live parts passing through them. The cans may be fastened to the base-board with wood screws and grounded and the lids placed on them.

Simple Tapping Clip

By C. A. Oldroyd

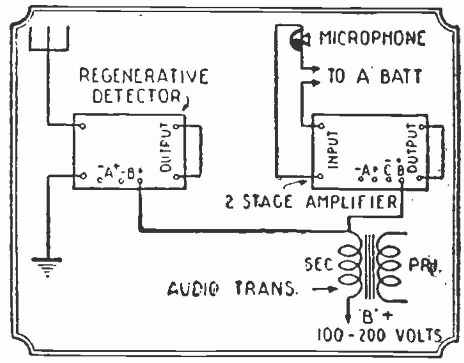
A VERY simple and useful tapping clip or connector, for tapping coil turns and busbar leads, can be readily made from a stiff



It is handy, in experiments, to have terminals on the leads, which can be quickly connected to different taps or connecting wires. A portion of a spring soldered to a lead, as indicated above, will prove satisfactory.

brass or steel wire spring having a diameter of from ¼ to ⅜ inch. Three or four turns are cut from the spring and one turn is bent outwards, away from the others. This forms a convenient handle, to which the end of the flexible connecting lead is soldered.

A dozen or more clips can be made in as many minutes if cut from the same spring. These clips will prove very handy for test work, since they grip both round wire and square busbar equally well.



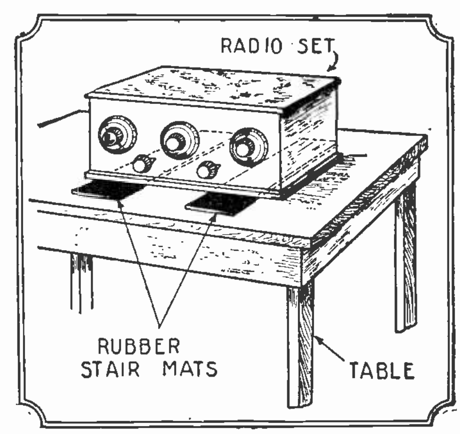
Showing how a regenerative receiver and two-stage A.F. amplifier can be converted into a radiophone transmitter.

A New Use For The Single-Circuit Receiver

By Frank Wilburn

A VERY simple radiophone transmitter, that operates well over a range of several miles, may be made out of the old three-tube regenerative set. All the additional parts required are a microphone and an audio transformer. They are connected as shown. Both the detector output and the amplifier output are short-circuited.

On speaking into the microphone the voice currents are amplified and the transformer, which acts as a constant current choke, modulates the output of the oscillating detector tube. The radiation can be increased considerably by replacing the detector grid leak with one of about 50,000 ohms. Although this is a low-powered transmitter, a license for operating it should be obtained from the radio inspector.



Microphone noises in a receiving set can be eliminated by placing the set on rubber mats, as shown.

A Non-Microphonic Set

By James A. Lynch

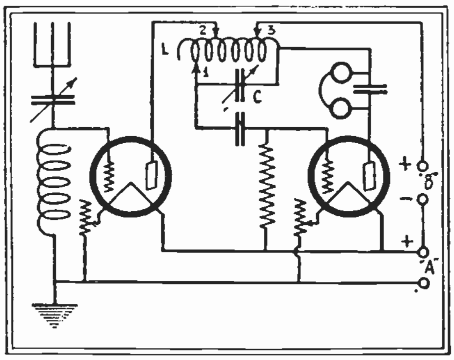
AN inexpensive way of reducing the microphonic tube noises in a radio set is clearly illustrated in the accompanying drawing. Two rubber stair mats, which may be obtained for about ten cents each (or for nothing at all if filched from the stairs, as were the writer's) are used. By placing these mats under the set, as shown, the microphonic noises are reduced to a minimum. The mats may be completely hidden from view by covering them with a tablecover.

Experimental Circuits

Recently Produced by Inventors Throughout the World

The Abélé Circuit

THE circuit shown here is held in high esteem among French amateurs. It was originaly designed by Mons. J. Abélé, an officer of the French Signal Corps, who developed it from the so-called "type-C" receiver used during the later months of the war.



This circuit, the Abélé, is worth trying. It has many good points.

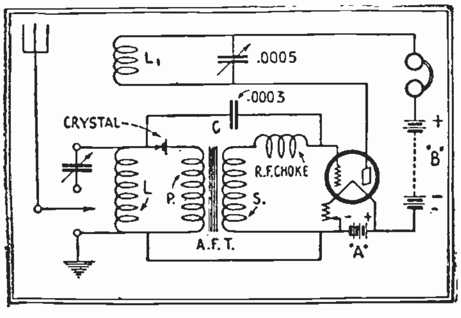
At first sight it appears to be very similar to an ordinary tuned-plate radio-frequency amplifier; but a closer examination brings out several features of distinction. Actually the circuit combines amplification due to the resonant properties of the tuned inter-tube circuit, LC, with amplification obtained by a direct back-coupling between the grid and the plate circuits of the second tube.

The plate circuit of the first tube includes only the portion of the tuned coil L between the adjustable tapping points 2, 3. This gives a step-up voltage effect, the coil acting as an auto-transformer. The grid connection to the second tube is taken from the outside tapping 1 at the farthest point from the plate terminal of the same tube.

As the output current from the detector plate passes through that part of the coil L branched by the tapping 3, there is a direct back-coupling between the plate and grid circuits of the detector tube, the strength of which is determined by the position of the tap 3.—*Popular Wireless.*

The Trinadyne Circuit

THERE comes from England the circuit shown in the accompanying diagram, which at first glance might appear to be a common type of reflex. Such is not the case. It will be noted that there is the usual tuned aerial circuit with a series antenna condenser and a crystal rectifier. This followed by a conventional one-stage transformer-coupled vacuum-tube amplifier.



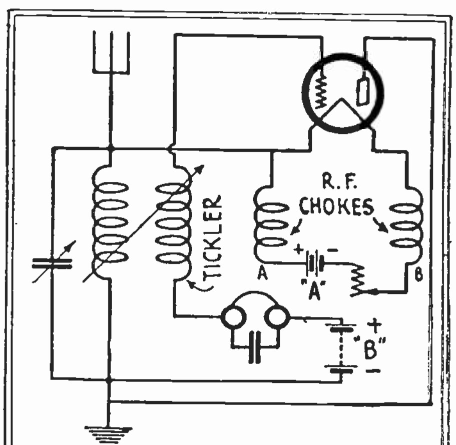
The Trinadyne is not a true reflex, but extra amplification is obtained.

Up to this point everything is quite normal; but regeneration is introduced by the addition of a tickler coil L1 in the plate circuit of the vacuum tube, which is coupled to the antenna inductance L. A portion of the radio-frequency current is impressed on the grid of the vacuum tube, finding ready passage through the fixed condenser C. It is amplified by the tube and fed back to L through L1. The R.F. choke prevents the passage of the radio-frequency currents through the secondary winding of the audio transformer, where they would meet ground potential.

The Filadyne Circuit

ONE is inclined to connect the grid of a tube to the input circuit, hardly ever to employ the plate as the input side, as is done at times; but who ever before thought of utilizing the filament?

An English amateur did this in an attempt to reduce the effects of the space charge within a tube and met with startling results. The circuit, with regeneration used, is shown; it will be noted that the aerial circuit connects directly to the filament, that the "B+" is connected to the grid and that the plate of the tube is at ground potential. An odd state of affairs, yet it works; and quite well at that, providing the two radio-frequency chokes A and B are employed. Without them the radio-frequency currents have a low-resistance path to ground. Each of these chokes consists of 250 turns of No. 24 DCC wire.

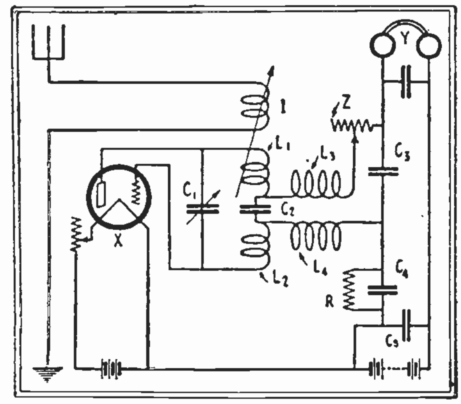


The Filadyne circuit—the input is to the filament, the plate is at ground potential and the "B" battery is in the grid circuit—but it works!

There is no saying what the specific action of the tube is under these rather curious circumstances, but it is not believed that the input voltage has any marked effect, if any, on the electron emission of the filament. Only certain types of tubes work well in this circuit.

Another "Super" Circuit

THIS invention, which is by Captain Claude Seymour, R. N., and James Clarence William Drabble, both of H.M. Signal School, R.M. Barracks, Portsmouth, England, applies particularly to great amplification of radio-frequency currents.



A single tube Super-regenerative circuit of considerable merit.

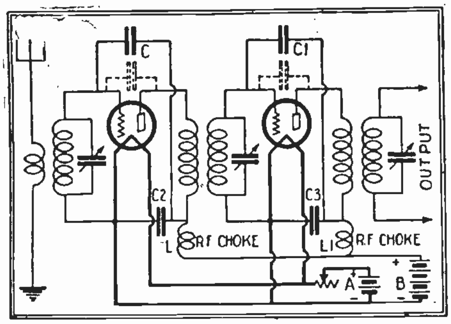
The receiving circuit shown in the illustration as variably coupled to the aerial coil 1 comprises a divided circuit L1, C1, L2, C2, tuned to the incoming signal. It is not essential that the tuned circuit should be coupled to an aerial circuit or that the coupling should be variable, as coil windings L1, L2, of the divided circuit itself may be used as a kind of loop aerial. (In such case the coils should preferably be of large diameter.)

The aerial circuit itself may be tuned or aperiodic, and may be grounded or not. Variable condenser C1 which is used for tuning the divided circuit L1-C1, L2-C2, may in some cases be omitted—as, for instance, for very high frequencies, in which case the internal capacity of the tube X provides sufficient capacity. In this case the tuning might be effected by varying the inductance of the coils L1 and L2. The condenser C2 is of large capacity compared with the condenser C1.

The condenser C2, coils L3, L4 and condenser C3, form a circuit tuned to a frequency lower than the frequency of the incoming signal. Subsequently in the specification this frequency is referred to as the "quenching" frequency. Connected to this circuit is a high resistance R, shunted by a condenser C4 and connected to a blocking condenser C5. In series with the "B" battery the headphones Y are connected. The "quenching" frequency of this circuit may be sub-audible, audible, or R.F., provided that this frequency is greater than that of I.C.W. transmission when this form of transmission is used. It is claimed that a circuit in accordance with this invention requires few adjustments of a non-critical nature to obtain great amplification. (British patent 253,192). —*Wireless World.*

Stabilizing Radio-Frequency Amplifiers

A VERY interesting system for the stabilization of R.F. amplifiers is described in U. S. patent No. 1,605,042, granted to Edward H. Lange, of New York City. By referring to the circuit diagram, it can be seen that the system is so arranged that any feed-back of energy from the plate to the grid of a tube will be out of phase with the original impulses and so will not combine with them to produce oscillation. This is accomplished by

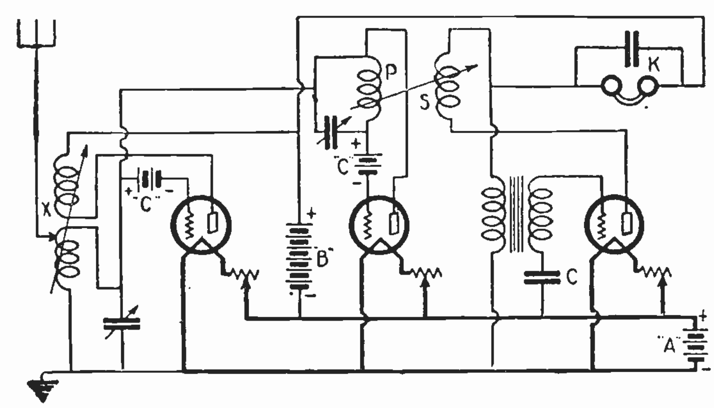


Another stabilized radio-frequency circuit employing "phase-shifting" condensers.

means of the small capacities C and C1. It will be noted that the radio-frequency currents are prevented from passing through the common battery circuit by the R.F. chokes L and L1, and are instead by-passed through condensers C2 and C3 to the filament legs of the tubes.

The "Retrosonic" Circuit

THIS is the joint production of John Wilcockson and Harold William Roberts, of Sheffield, who have recently been granted a British patent covering the principles of the circuit. The invention has for its object the provision of a circuit in which great amplification is claimed, the inventors stating



Here is a very unusual circuit to which the name "retrosonic" is given. The first tube employs the usual regenerative coupling. This is coupled to the grid and plate of a second tube which is devoid of the usual "B" voltage. The output of this tube feeds into an A.F. amplifier.

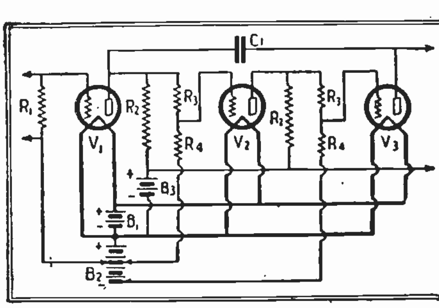
that a 3-tube set will give a volume equivalent to that of an ordinary receiver having five or six tubes. In the present invention, three tubes are provided, but the "B" potential is applied directly between the plate and grid of two of the tubes only. The set depends for its operation upon the application of a difference of potential between the plate and grid of the remaining tube by the employment of a radio-frequency coupling, comprising a primary coil located in a loop circuit fed from the aerial and a secondary coil deriving voltage from a "B" battery; the primary coil being also connected between the plate and grid of the tube, and the coupling having its coils balanced. It is found that this balance is obtained when the turns ratio of the coupling coils is 64 to 89.

The first tube acts as an ordinary back-coupled detector, and the signal impulses are also led at radio frequency directly from the aerial to the plate of the second tube, and to the grid of that tube through the primary coil of the R.F. coupling, across which a condenser is shunted. Audio currents are transferred to the secondary coil of the R.F. coupling and are led therefrom to the plate of the third tube and also to the grid of that tube across an iron-core transformer.

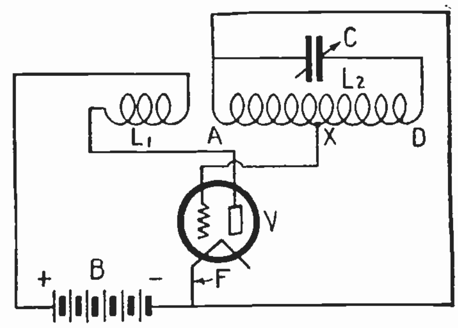
The following are the values of the components used; the secondary coil, X, forty-five turns; primary coil, P, of the R.F. coupling, sixty-four turns; secondary coil, S, eighty-nine turns; A.F. transformer, T, a ratio of about ten to one; fixed condenser, C, capacity .002-mf.; and loud speaker condenser, K, .005-mf. As in some other circuits of an unusual nature it will be noted that the "B" battery is placed directly across the phones. Great amplification and absolute stability are claimed.—*Wireless Trader.*

Resistance-Battery-Coupled A.F. Amplifier

A RESISTANCE-COUPLED amplifier obviating the use of coupling or blocking condensers is described by S. B. Smith in a recent British patent specification. It will be noticed that the amplifier shown in the illustration utilizes a potentiometer form of coupling to the grids of the various tubes; the positive potential which would otherwise be communicated to the grids from the plates of the preceding tubes being counteracted by an opposite negative potential from a high voltage "C" battery common to all grids. The amplifier can, therefore, be used for amplifying the effect of direct-current potentials applied between the grid and the filament of the first tube. The action of the amplifier can be easily understood by referring to the illustration. The input of the first tube V1 comprises a resistance R1, across which the potentials to be amplified are introduced. The lower end of the resistance R1, is taken to a tapping on the battery B2, in order to give the grid of the first tube a suitable negative bias. The plate circuit of the tube V1 contains a plate resistance R2, which is connected to the positive side of the "B" battery B3. The plate A of the tube V1 is coupled to the grid of the tube V2, through one section of a potentiometer comprising two resistances R3 and R4. The ohmic value of these resistances is considerably greater than that of the plate resistance R2. The other half of the potentiometer R4, is taken to a negative tapping on the "C" battery B2. This negative bias is suitably adjusted to more than counteract the positive potential which would otherwise be conveyed to the grid from the plate of the plate V1; the grid potential, of course, becoming negative with respect to the filament. The tube V2 is coupled to the tube V3, in a similar manner. In order to overcome any regenerative effect which may occur in the amplifier, thus giving rise to audio-frequency oscillation, a stabilizing condenser C1 may be connected between the plate of the tube V1, and the plate of the tube V3, acting, of course, in the manner of an ordinary neutralizing condenser.—*Wireless World.*



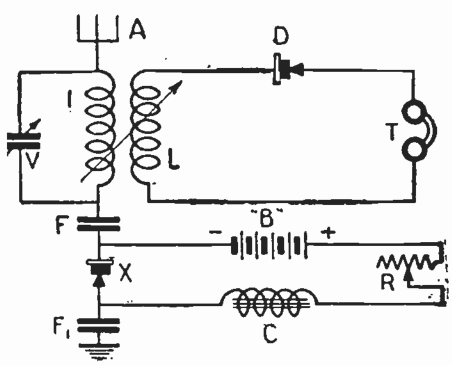
A resistance-battery-coupled A.F. amplifier wherein a common "C" or "bucking" battery (B2) is employed for maintaining the grids of all three tubes at a constant negative potential.



A wavemeter circuit that holds its calibration, even if the tube is changed.

Wavemeter Circuit

IT is essential that the constants of a wavemeter should not change in use. Some slight difficulty has been experienced with vacuum-tube wavemeters, owing to the necessity of substituting a new tube when the original one, with which the instrument was calibrated, burns out. Varying inter-electrode capacities of the tubes, for example, would seriously alter the maximum and minimum wavelengths to which the wavemeter will tune, thereby introducing inaccuracies over the whole of the range. Col. K. E. Edgeworth describes in his (British) patent a circuit which overcomes this difficulty. Here it will be seen that a tube V is provided with a tickler coil L1 and a "B" battery. This is coupled in the normal manner to a grid-circuit inductance L2, tuned by a variable condenser C. One end A of the inductance L2 is connected to the filament F of the tube; while instead of connecting the free end D directly to the grid of the tube, the actual grid connection is taken to a tapping point X along the inductance L2; so that only a portion of the turns of the inductance are actually in the grid circuit. Obviously, then, the tube capacity is in shunt only with a few of the turns; instead of all the turns, as would be the case with the normal arrangement. This means that any slight variation in tube capacity will not materially alter the wavelength of the circuit L2 C; since the capacity variation is in shunt with only a few of the turns. —*Wireless World.*



A standard crystal receiving circuit, employing a second crystal in a separate circuit as an amplifier.

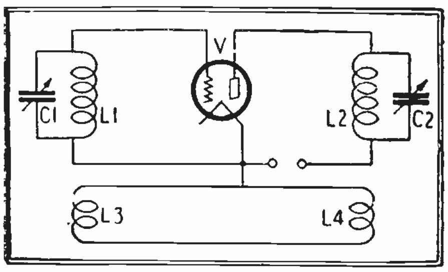
Crystal Amplification

SIDNEY CHARLES PEARCE and John Sidney Smith, both of Birmingham, have recently obtained a British patent upon an invention which appears in their joint name. The invention has for its object the improvement of apparatus wherein amplification can be effected with the aid of a crystal. The device comprises the employment in series with the aerial of a crystal contact and a condenser on each side of the crystal, and electromotive force being applied to opposite sides of the crystal by a battery in a circuit containing an inductance or choke coil.

Referring to the diagram, it will be seen that the amplifying circuit contains a battery B, a resistance, R, and a choke coil, C, all in series. The ends of this circuit are connected to the opposite sides of a crystal contact, X, arranged in series with the aerial, A. Also in series with the aerial is arranged a pair of fixed condensers, F and F1, the crystal contact and the amplifying circuit being located between the condensers. Aerial tuning is effected by the inductance, 1, and the variable condenser, V. A secondary circuit contains a coil, L, a crystal detector, D, and head phones, T.—*Wireless Trader.*

Neutralizing Electro-Magnetic and Capacitative Couplings

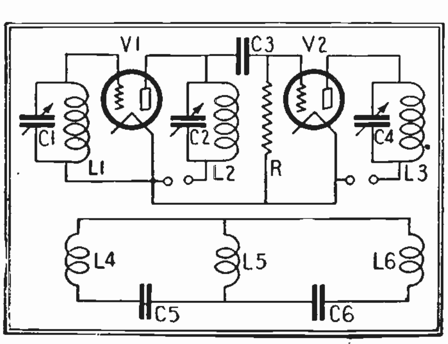
P. W. WILLANS and the Igranic Electric Co., Ltd., describe in their British patent No. 260,324 a method of neutralizing magnetic coupling existing between the input and output circuits of a vacuum-tube amplifier. Reference to the accompanying illustration shows a tube V provided with a tuned input circuit L1, C1, and a similar output circuit L2, C2. Normally, the position of the two inductances is such that



A method for neutralizing electromagnetic coupling by introducing a counter electromotive force in the input circuit. This is accomplished by coils L3 and L4.

there is an appreciable magnetic coupling between the two, sufficient to sustain the generation of oscillations. The effect of this coupling is neutralized by the inclusion of two auxiliary inductances L3 and L4. The inductance L3 is tightly coupled to the inductance L1 and the inductance L4 is similarly coupled to the inductance L2. The number of turns on the auxiliary inductances L3 and L4 is smaller than that of the main inductances L1 and L2. The inductances L3 and L4 are connected to form a closed circuit, and are arranged so that potentials transferred from the output to the input circuit tend to oppose any regenerative effect between the two circuits. A further feature of the invention is the grounding of the two inductances L3 and L4.

Another British patent, granted to the same patentees, describes a method of neutralizing capacitative coupling, which is brought about through inter-element capacity or stray capacity in the circuits The arrangement is shown in the accompanying illustration as applied to a two-stage radio-frequency amplifier. Two tubes V1 and V2

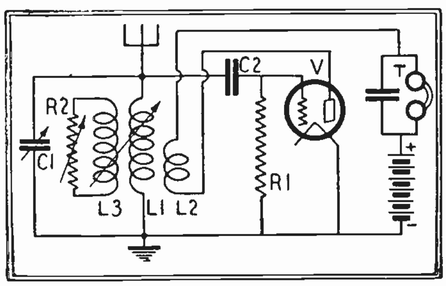


A circuit for neutralizing the capacitative coupling existing between two or more stages of radio-frequency amplification.

are connected through the usual tuned circuits, the input of the system being an inductance L1 tuned by a capacity C1. The plate circuit contains an inductance L2 tuned by a capacity C2. The plate end of the inductance L2 is coupled through a capacity C3 and a grid leak R to the input of the tube V2. An inductance L3 tuned by a condenser C4 is included in the plate circuit of the tube V2, and the three oscillatory circuits are tuned substantially to the same frequency. The stabilizing arrangement comprises three inductances L4, L5 and L6, which are respectively coupled to the inductances L1, L2 and L3. One side of the inductances L4, L5 and L6 is common, while the free ends of L4 and L5 are joined through a capacity C5, and the free ends of L5 and L6 are joined through another capacity C6. The direction of the windings of L4, L5 and L6 is so arranged, with respect to the inductances to which they are coupled, that the potentials induced by them into the main oscillatory circuits tend to oppose those which are introduced by regenerative effects.—*Wireless World.*

Resistance-Controlled Regeneration

N. H. Clough shows in a British patent a method of controlling regeneration by a variable resistance. The illustration shows an ordinary single-tube regenerative circuit in which the input circuit consists of an inductance L1, tuned by a condenser C1, tightly coupled to a tickler coil L2. The usual grid condenser and leak are shown at

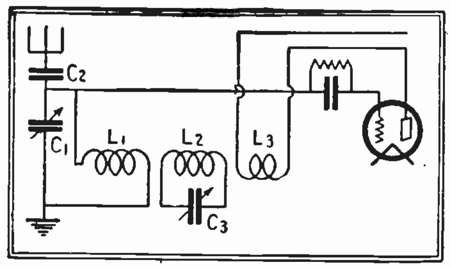


This is an orthodox regenerative circuit, except for the coil L3 and resistance R2. This acts as an absorption circuit and is effective in controlling regeneration.

C2-R1, and the phones at T. The coupling between L1 and L2 is sufficiently great to cause oscillations to be generated, the coupling, of course, being fixed. Variably coupled to the inductance L1 is another inductance L3 shunted by a variable resistance R2. This resistance-controlled circuit consists of one or more turns of resistance wire, or one or more turns of copper wire, shunted by a resistor.—*Wireless World.*

Selective Regenerative Circuit

A RATHER interesting form of selective receiving circuit is described by A. G. Benstead and Rotax (Motor Accessories), Limited. The invention really consists in coupling a tuned filter circuit or wavetrap to the aerial inductance and coupling the tickler coil into the wavetrap instead of into the normal antenna tuning circuit. Referring to the accompanying illustration, it will be seen that a tuned circuit L1 C1, which is connected to an aerial and ground system through a series condenser C2, forms the input circuit of the tube. Loosely coupled to the inductance L1, is another tuned circuit L2 C3, which forms the trap circuit. Regeneration is obtained by including an inductance L3, in the plate circuit of the tube, which is then coupled to the trap circuit L2



A simple regenerative hookup, employing a tuned absorption circuit L2-L3 as regeneration control.

C3. The regenerative effect is brought about, of course, by the fact that the circuit L2 C3 is coupled to the grid circuit of the tube through the ordinary antenna tuning circuit. It should be noted that the intermediate circuit L2 C3 is electrically disconnected from the other components of the circuit.

The arrangement provides a non-critical regeneration control.—*Wireless World.*

A Sensitive Vacuum-Tube Relay

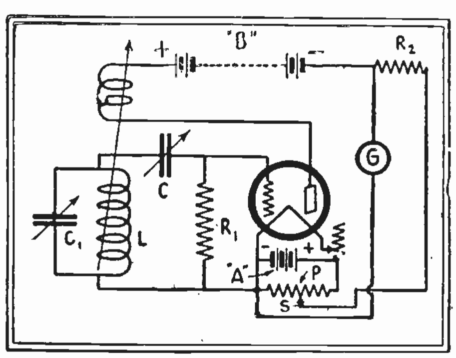
IN 1921 J. J. Dowling, of Dublin University, showed that the effect of a steady current passing through a galvanometer placed in the plate circuit of a vacuum tube could be cancelled out by connecting a second circuit through the same galvanometer, and passing a current from a separate battery through the latter in the opposite direction.

The circuit shown is an adaptation of this idea, but contains several new features, simplifying the arrangement and giving greater facility for easy control.

Instead of employing a separate battery in the shunt circuit to oppose the plate-circuit current through the galvanometer, a potentiometer P is connected across the "A" battery. By careful adjustment of the arm S, the current fed through resistance R2 to the galvanometer G in one direction can be approximately balanced against the plate current passing through the galvanometer in the opposite direction; so that only a very small galvanometer reading is obtained. After this approximate adjustment has been made, the galvanometer reading can be brought to absolute zero by fine adjustment of the variable grid condenser C.

This circuit, no doubt, has many possible applications, both for radio and other electrical purposes. Once the galvanometer is set at zero with the tube oscillating, the slightest variation in the capacity of the tuning condenser C1, or in inductance L, will displace the galvanometer needle several divisions. Again, if a variable grid leak be employed instead of the fixed grid leak R1, the slightest variation in its value will be recorded by galvanometer movements.

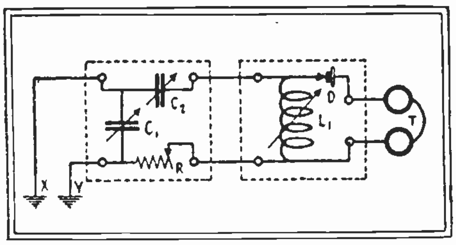
—*Wireless World.*



A very sensitive vacuum-tube relay based on the "opposed-currents" principle.

Double-Ground Reception

MANY aerial systems have been devised from time to time, and an interesting system employing two ground connections is described in the British patent No. 251,693 by G. A. Morris and B. C. Stevenson. The accompanying diagram shows the arrangement of the reception system, which consists essentially of two independent grounds X and Y, such, for example, as one made to a water pipe and the other to a buried plate. These are associated with an ordinary receiver, which is shown as a variable inductance L1 and a crystal detector D connected to a pair of headphones T in the normal manner. Connection from the grounds is not made direct to the set, but through an arrangement of variable condensers and a resistance.



A circuit used for double-ground reception. A vacuum-tube detector may be used in place of the crystal.

Thus, there are two variable condensers C1 and C2, the former being in parallel with the two grounds and the latter in series with one ground, while the variable resistor R is in series with the other ground. This and the remote side of the variable condenser C2 are connected to the ordinary aerial and ground terminals of the receiving set. The series condenser C2 may be between 0.00001- and 0.0003-mf., while the shunt condenser may be of the order of 0.001-mf., and the variable resistor may be about 20 ohms. In another modification of the invention radio-frequency chokes are shown connected across the two variable condensers C1 and C2.

—*Wireless World*

Resistors Improving Reproduction

By William H. Fine

A REALLY serious problem, which has but recently been brought forcibly to the attention of users of resistance-coupled amplification, is that presented by the continuous "putting," or "motor-boating" as it is more commonly termed, which manifests itself in varying degrees of intensity when "B" eliminators are connected to this type of amplifier.

These "plopping" sounds, which generally rise to such intensity as to drown out the incoming signals, are caused by low-frequency audio oscillations and present an almost unsurmountable stumbling block for the average layman.

The circuit and data here given are the result of extensive laboratory experiments, and not only solve the "motor-boating" problem, but set forth the use of variable resistors in a manner which tends to improve the high standard of resistance-coupled amplification.

In the plate circuits, R1 is a fixed resistor with a value of 750,000 ohms; R2 and R3 are of 500,000 ohms each.

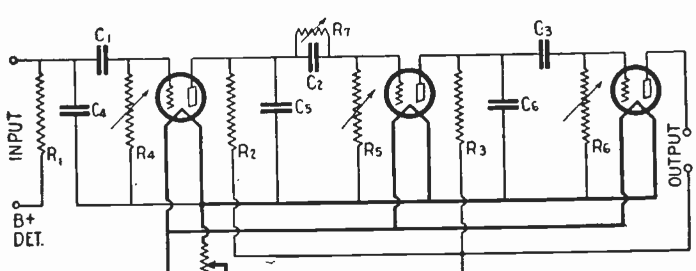
In the grid circuits, R4 is a resistor variable up to 500,000 ohms; R5, a resistor variable up to 250,000 ohms; and R6, a resistor variable up to 100,000 ohms. When a power tube was used in the last stage, a resistor variable up to 50,000 ohms gave maximum results.

As the resistance in the grid circuit of the last tube is that which actually governs the final tone quality of the receiver, only through the use of a high-dependable make of variable resistor can the proper value be determined to assure clear and undistorted reception.

The variable resistors may readily be mounted on the sub-base of the receiver. When the most efficient operating values have been once determined, further adjustment is unnecessary.

The isolating condensers, C1, C2, and C3, have a capacity of at least 1.0-mf. Condensers C4, C5 and C6 are of the small by-pass type and low in capacity, about .00025-mf. These by-pass condensers which keep the radio-frequency currents out of the resistors in the plate circuits have been found absolutely necessary for best results. It is better practice to connect these by-pass condensers to "A—," as they then by-pass the batteries as well as the resistors themselves.

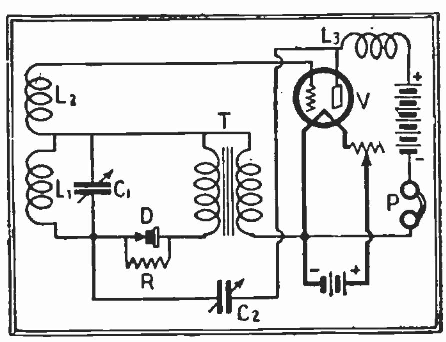
To eliminate all semblance of "putting" or "motor-boating," it is advisable also to shunt a variable resistor across the isolating condenser C2, coupling the first and second stages. This is shown as R7, and should be variable up to approximately 5 megohms



By the use of the bypass condensersC4, C5 and C6, the variable by-pass resistorR7 andvariable grid-leaks, it is possible to prevent "putting" or "motor boating" in a resistance-coupled A.F. amplifier, operated from a "B" unit.

Courtesy Central Radio Laboratories

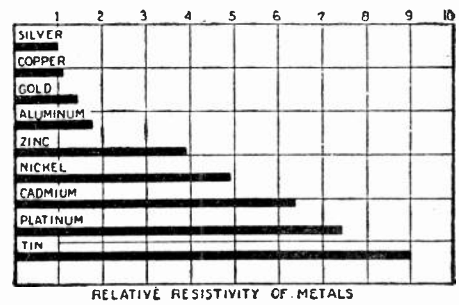
A Dual-Amplification Scheme



A new form of simple reflex circuit, employing a crystal detector for rectification. The tube amplifies at both radio and audio frequencies.

A RATHER peculiar form of dual amplification circuit is claimed by J. Sieger in a British patent. The circuit appears to be of the type in which incoming oscillations are rectified by a crystal, the audio-frequency potentials being passed on by a transformer to the grid circuit of a tube which further amplifies them. The tube is also used to introduce a regenerative effect into the tuned circuit, which is connected to the grid circuit of the tube. Thus, the invention should be quite clear from the accompanying diagram. Here it will be seen that an inductance L1, such as a loop aerial, is tuned by a condenser C1. Potentials across this tuned circuit are rectified by the crystal detector D, the rectified potentials being passed on by an A. F. transformer T to the grid circuit of the tube V, through another inductance L2, which is coupled to the loop aerial or inductance L1. The plate circuit of the tube contains a radio-frequency choke L3 and the usual "B" battery and headphones. A regeneration or throttle condenser C2 is included between the plate and one side of the inductance L1. The two inductances are connected respectively in the grid and plate circuits of the tube, capacity regeneration being obtained by means of the condenser C2. A further feature of the invention is the inclusion of a resistance R, which is connected across the detector D. The object of this resistance is to stabilize the set and prevent it from breaking into oscillation too readily when the crystal contact is altered or affected by vibration.—*Wireless World.*

Conductivity of Shielding Materials



A glance will show the comparative resistance, which means current loss, in equal-sized pieces of the various metals. The resistivity of pure iron is six times (disregarding the added effects of its magnetism), and that of commercial grades up to 60 times, that of copper.

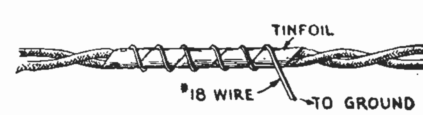
COPPER, because of its low resistivity, is a very efficient shielding material. It follows naturally that the better conductor will dissipate more easily, in the form of eddy-current losses, the undesired electromagnetic lines of force between certain portions of radio receivers. Experiments have shown that these fields will pass through sheet metal if it is of insufficient thickness.

The efficiency of perfect shielding has been shown by enclosing receivers in copper boxes and testing them in the vicinity of transmitting stations. It has been found that the smallest crack in the shielding is enough to ruin entirely the effect of the shielding material. Several years ago it was thought that copper screening would give enough shielding effect, and experiments have been made by the manufacturers of panels within which copper screening has been cast. Present-day broadcasting, however, demands something better than this; and the all-metal cabinet of appreciable thickness will be, we think, the ultimate solution.

Shielding Against Hum

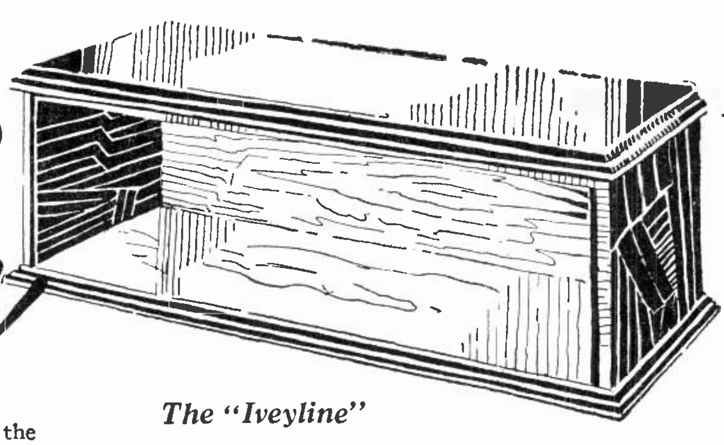
By Joseph S. Grant

A WAY to eliminate A.C. hum caused by nearby socket-power and other electrical devices, is to shield the troublesome wire with sheet tin- or leadfoil, such as comes with friction tape. Cut it into lengths, 2 inches wide, and wrap the wire with it; then wind over the foil a length of No. 18 bare wire, which is connected to the ground.



By preparing the A.C. leads to a set as shown a great deal of the hum is stopped.

$5 50 buys this famous cabinet!!



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7x24x10	6.25	7.50
7x26x10	6.75	8.00
7x28x10	7.00	8.50
7x30x10	7.25	8.75
7x18x12	7.00	8.00
7x21x12	7.50	8.50
7x24x12	7.75	9.00
7x26x12	8.25	9.50
7x28x12	8.50	10.00
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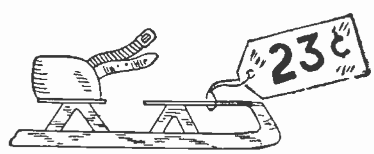
What is a COOKOO NUT?

Refrigerator

"This isn't so hot"



"A Cheap Skate"

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"Pointing out an error"

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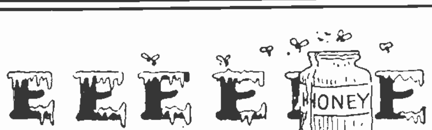
The best COOKOO NUT printed in FRENCH HUMOR gets a weekly prize of $5.00. For every other one accepted FRENCH HUMOR pays $1.00.

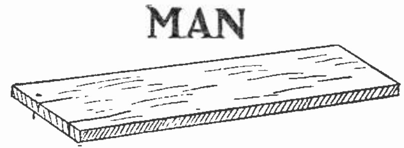


"Sweeties"

A Good Cry, Th ey

"After a good cry, they parted"

MAN



"Man Overboard"

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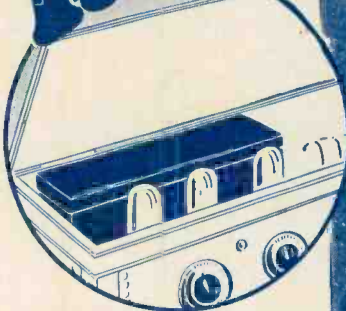

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Never before has there been a "B" eliminator at the price of the Cloverleaf which supplied enough current to operate the new high voltage power tubes. The Cloverleaf DOES. It supplies the 22-45-90-135 volt outputs for the radio frequency, detector and ordinary audio requirements of any set—then it provides 180 volts for the operation of the power tube. No buzz—no hum—no odor—no acids or liquids.

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The Cloverleaf "B" is only 3 inches wide, only 5¾ inches tall and only 9 inches long. Its "thin model" construction enables it to be placed inside most any radio cabinet. Or—if it must be out in full view, its handsome crystal maroon finished metal case presents a neat appearance.

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Don't confuse the Cloverleaf "B" with cheap electrolytic or chemical "B" eliminators. The Cloverleaf is the standard gas-tube rectifier type which uses either the Raytheon or QRS tubes. Moreover, the Cloverleaf "B" is not to be classed with similar type eliminators which use only one choke coil in the filter circuit, and which use short-lived single-paper filter condensers. The Cloverleaf has two oversize chokes, has the very finest high voltage, heavy duty filter condensers that money can buy, and the best grade of wire wound resistances that can be made. A better "B" cannot be built—and no "B" eliminator offers you so many advantages as the Cloverleaf—and think! Its better quality and better construction acclaim it the true "lifetime" eliminator.

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