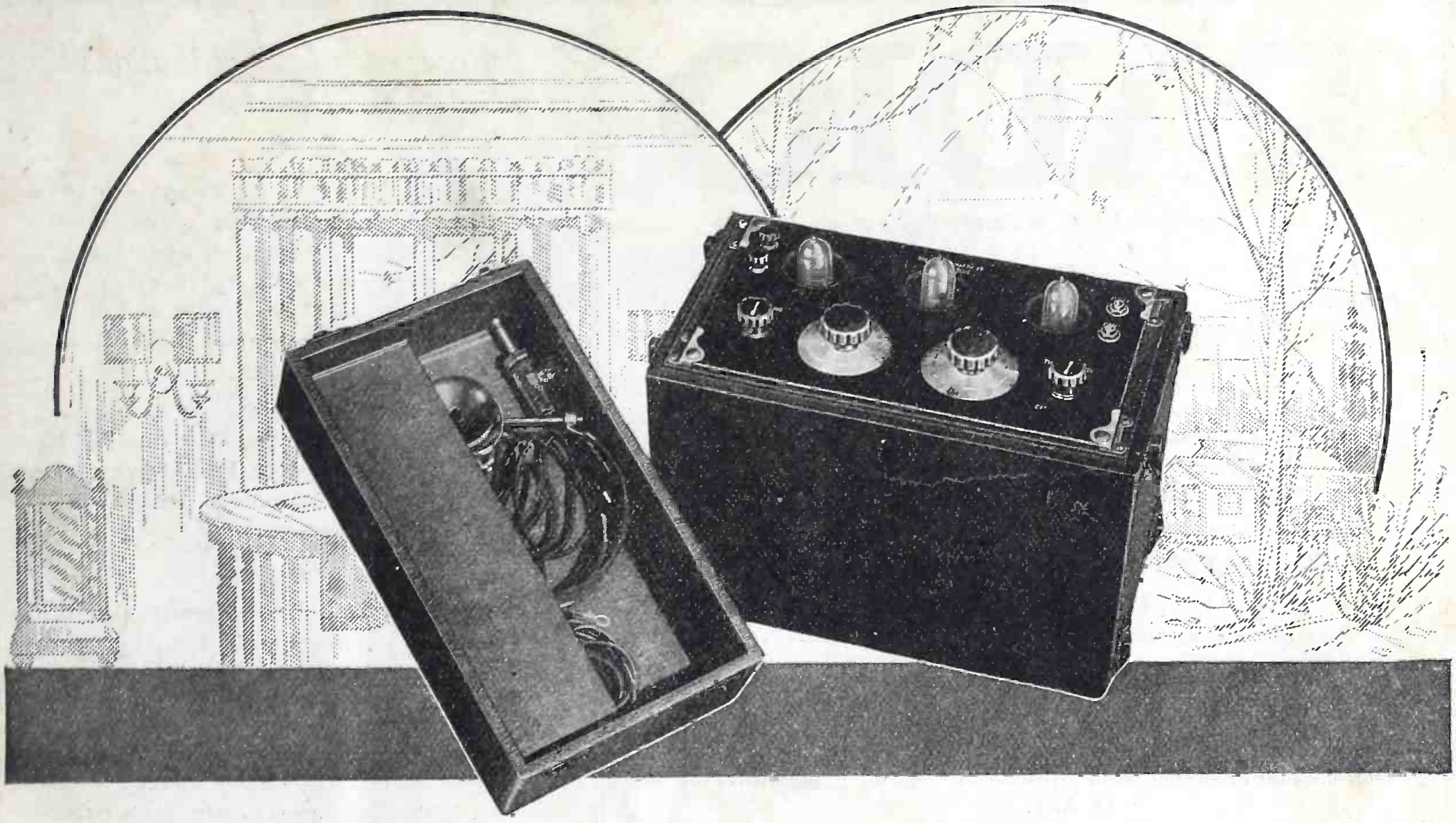

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Volume VI for MAY, 1924 *Number 5*

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Forecast of Contributions for June Issue

G. M. Best describes the construction of a transformer, rectifier and filter to supply rectified a.c. instead of *B* battery current for amplifier tubes. The outfit costs less than $20. His "Queries and Replies" department will be devoted to hook-ups of various standard new receivers.

Prof. C. M. Jansky, Jr., will continue his "Lectures on Radio Communication" with some exceedingly helpful information on the transmission of radio waves.

D. B. McGown describes the construction of a 100-meter C. W. transmitter. He also has an article on wood finishing.

Much space will be devoted to the superheterodyne. This will include additional suggestions in the construction of Mr. Best's set and a fine article on the theory by L. R. Felder.

The experimenter will be interested in S. G. McMeen's account of how to make three types of high-frequency generators.

Brainard Foote gives a few tips on handling panel construction, illustrated by a number of good pictures of tools and shop stunts.

Carl Dreher makes an interesting comparison of wire and radio telephony which clarifies the understanding of how each is accomplished.

Most seasonable for the summer months is an article on "Radio in The Automobile" by Paul Oard. He also has some more good construction hints, including one on eliminating the plug and jack.

The fiction feature is a mystery story entitled "The Invisible Wire" by Erald A. Schivo.

Philip N. Emigh tells how to solder aluminum.

Wallace Kelk discusses "Direction Finding for the Amateur."

Edward T. Jones has some good ideas on how amateurs can reduce interference from their transmitters.

Aaron Nadell tells how to learn the code.

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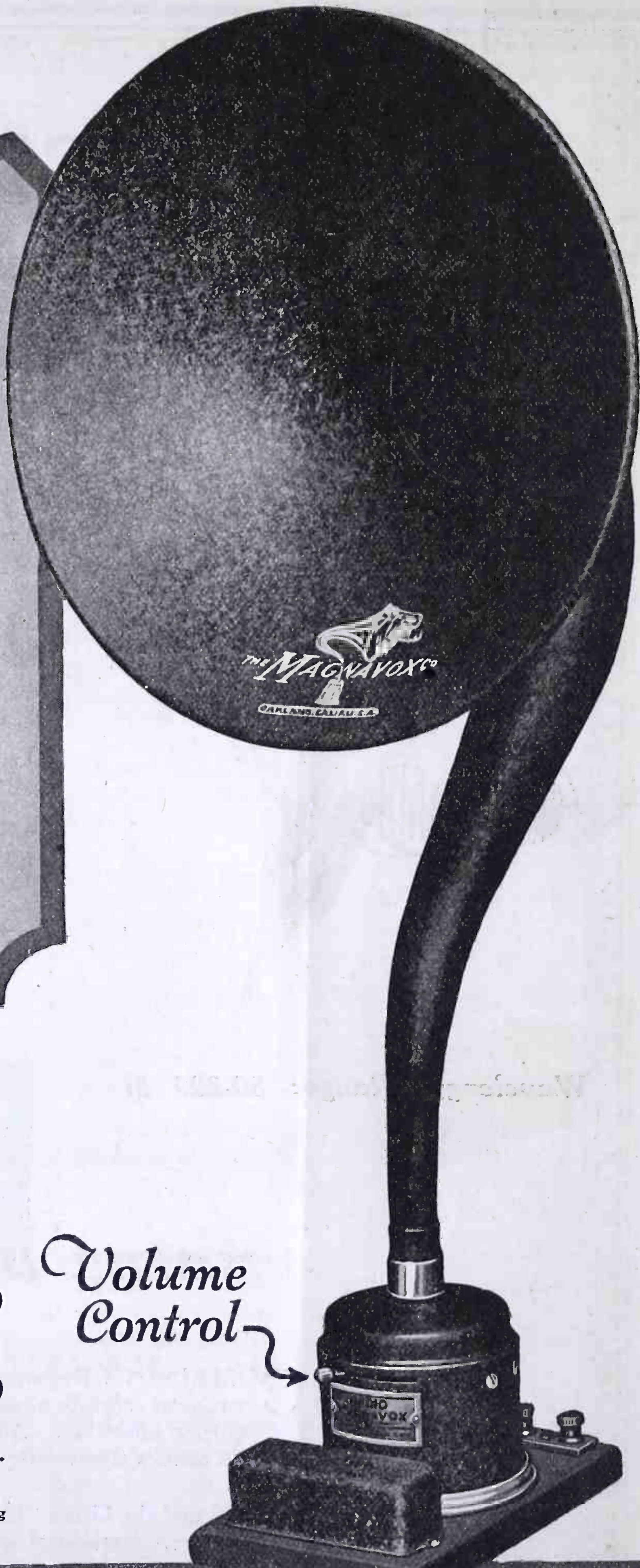

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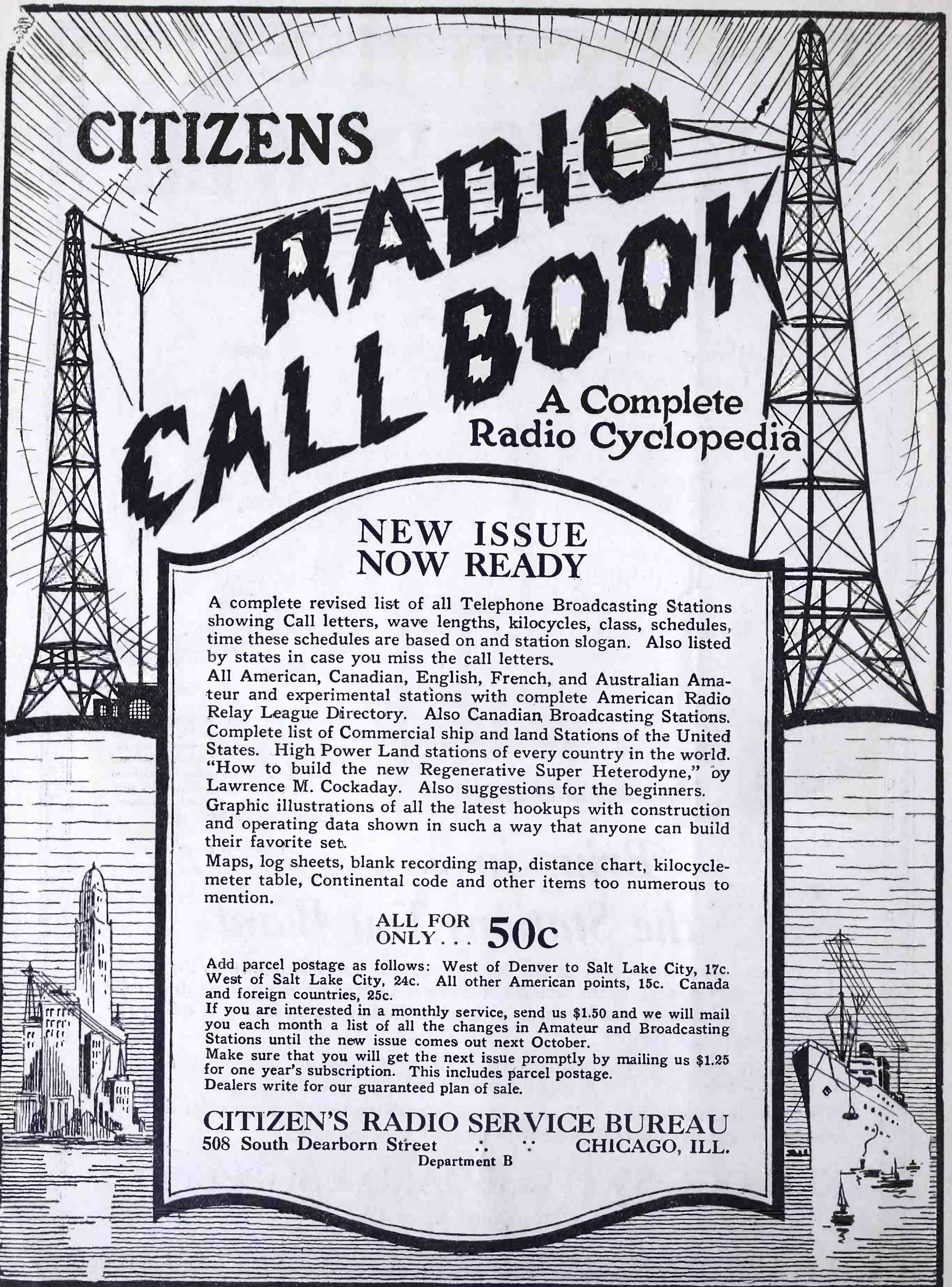
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Department B

Clear from the skies

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It is a fascination to see how far distant a station you can tune in, but still more fascinating to get it so clearly that you actually enjoy the concert.

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There are two things to remember about Exide Batteries: They give uniform current over a long period of discharge. This means not only clear reception but economy.

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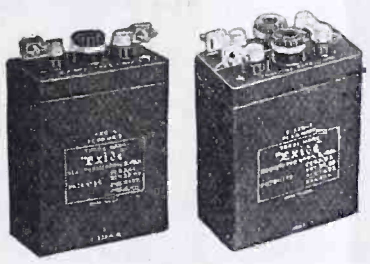
From the "midget" five-pound battery for low-voltage tubes to the larger battery for six volts, each Exide is powerful, rugged, silent, and so long-lasting that it makes for true economy.



For low-voltage tubes

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Exide "B" Battery

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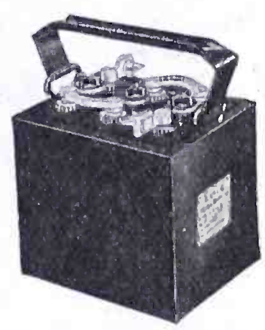

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Go to any radio dealer or Exide Service Station and ask for Exide A and B Batteries. If your dealer cannot supply you with free booklets describing the complete Exide line of radio batteries, write to us.

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May
1924

RADIO

Established 1917

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Volume 6
No. 5

Radiotorial Comment

OF threatened monopoly in broadcasting there has been much publicity in the daily press. Nor are these reports entirely imaginary. Radio is a technical development—a development based upon patents whose control is closely centralized. Those controlling the patents can control their use in broadcasting.

So far the control exercised has been beneficent, the iron hand in the velvet glove. Patent violations have been overlooked as long as the violators were giving service desired by the public in places where the owners of the patents were not prepared to give such service.

For instance, two years ago hundreds of little broadcasting stations were started all over the country. These "hay-wire" sets infringed on patents used in both radio and wire telephony. But still no attempt was made to enjoin them.

Most of the patents are owned by the American Tel. & Tel. Co. and the Western Electric Co., who have sold equipment to nearly fifty concerns operating stations all over the country. Licenses have also been granted to the Radio Corporation, the General Electric Co. and the Westinghouse Co., each of which has, or soon will have, three high-power stations in operation. These stations, nearly sixty in number, can serve every square mile of the United States. Furthermore, any of the other stations can secure a license at a reasonable cost.

From the foregoing it is quite evident that the telephone company has no intention of curtailing broadcasting. While naturally desirous of protecting its own patent rights, these have been placed at the disposal of all who desire to use them.

Furthermore, any vicious attempt to monopolize control can readily be curbed by legislation, as has been done in the case of other public utilities. For radio broadcasting has already reached the dignity of a public utility and as such should be regulated in the public interest. It is now well recognized that a regulated public utility is the best servant. The legislation now pending in Congress is framed to protect the public interest so that there need be no fear that broadcasting will not continue or that it will be monopolized to the detriment of the public.

INTERFERENCE to radio from electric power lines is a frequent and unnecessary source of vexation to radio fans all over the country. It is unnecessary because preventable and frequent because of ignorance or carelessness on the part of the power company. It may come from a leaky insulator, an improperly connected transformer, or from the charging of lightning arresters.

The source of the trouble can readily be located with a loop aerial and portable set in an automobile. Any lineman can find and cure the irritation in less than an hour.

As a means for alleviation it is suggested that anyone bothered by a persistent fifty or sixty-cycle hum should advise the local power company manager of the fact and request that an investigation be made. It is to the power company's interest to do this, not only because the trouble is usually an indication of power waste, but also because the company is anxious to maintain the good will of the public.

Under the head of inductive interference, this matter has been carefully investigated for many years by telephone and power company engineers. They have found that it may be mitigated or eliminated by the exercise of a little care, and, as a rule, appreciate attention being drawn to the trouble.

Other sources of inductive interferences are violet ray machines and even sewing machine motors. They can usually be cured by putting a small condenser across the terminals. The same remedy is frequently effective in stopping a receiver from re-radiating.

In this day of the widespread use of sensitive radio receivers there is no more excuse for such inductive interference than there is for an open automobile exhaust in a hospital zone of quiet. If a few of the sufferers will energetically take up the question with the offenders, point out the error of their ways and suggest what can be done to stop the nuisance, their radio will be far more enjoyable.

THE tremendous hold that radio has taken on the American public is indicated by Roger Babson's estimate that the sales for radio equipment during 1924 will total $350,000,000. On this basis radio shares with automobile electrical supplies the distinction of being the greatest single factor in the electrical supply business, each constituting about one-sixth of the estimated total of two billion dollars. All domestic electrical appliances, including washing machines, vacuum cleaners, ranges, electric irons, heaters and miscellaneous heating devices, make up but one-eighth of this total, electric lighting fixtures being estimated at a like amount. Even part of the one-ninth that is credited to wire and wiring supplies is used for radio aerials. Incandescent lamps, as well as motors and motor control, will be responsible for one-fifteenth each, and all other electrical applications together for one-sixth. Whereas the electrical industry doubles its sales once in five years, a truly remarkable record, radio is doubling its sales yearly. And radio is still in its infancy!

NOW that the war emergency is past, taxing Peter to pay Paul is no longer popular. To merely transfer the tax burden from automobiles and candy to mah jongg and radio is not the tax relief that the people expect from Congress. Such nuisance taxes should be abated before incurring the ridicule they deserve.

Best's 45,000 Cycle Super-Heterodyne*

By G. M. Best

The features of this set include its use of dry battery tubes and "C" batteries to minimize current consumption, the use of but two operating controls or station selectors, the doing away with loss-causing stabilizers, and the employment of 45,000 cycles as the intermediate frequency. Furthermore, it provides a simple and effective means for volume control. The directions for construction are unusually complete and thoroughly dependable.

THE super-heterodyne circuit is universally recognized as the closest approximation to perfection in radio receivers yet developed commercially. It has extreme selectivity and sensitiveness combined with simplicity of operation.

But, unlike many forms of detector and audio-frequency circuits which give stable operation and good quality of reproduction, the super-heterodyne requires careful attention to engineering details in the selection of parts and in the circuit layout. These features of design have been so perfected in the set here described that the amateur constructor can be assured of a most satisfactory receiver by following the instructions given. They are based upon several years of experimenting and on the construction of a number of sets that are giving at least as good results as any on the market.

While this set can be made without any greater understanding of the theory of the super-heterodyne than is briefly brought out in this constructional article, the reader is advised to study the theory so as to better understand the operation of the set. An article by L. R. Felder in June 1924 RADIO will give the facts in simple form.

Great sensitiveness, or range, of a receiver is dependent upon the use of radio-frequency amplification. At relatively long wavelengths this is comparatively simple, but at the short broadcast wavelengths there is a tendency to oscillate due to internal capacity and circuit coupling. To overcome this tendency most radio frequency circuits use a "stabilizer" which has very properly been called a "losser." Such a stabilizer takes either the form of a resistance in the tuning circuit, introducing a loss to overcome oscillation and thereby decreasing the signal strength as well as broadening the tuning, or a potentiometer to apply a positive voltage to the grid of the radio-frequency amplifier tubes. This not only increases the drain on the plate battery but also cuts down the gain from the tubes and results in distortion. The stabilizer not only introduces an extra unnecessary control but is a makeshift to compensate for errors in engineering design. Some of the popular descriptions of super-heterodyne circuits specify a stabilizer, with all its disadvantages, to compensate for errors in layout, in transformer design, or in the selection of the intermediate frequency. This loss in efficiency is then partially offset by the use of high mutual conductance tubes such as C-301A or UV-201A. In multi-tube sets the dry battery tube C-299 or UV-199 gives more than sufficient amplification when operated at full efficiency.

The super-heterodyne circuit overcomes the difficulties of radio-frequency amplification at broadcast wavelengths by heterodyning or transferring the voice modulation from the incoming carrier wave to a new carrier wave of a frequency at which the effect of inter-electrode and wiring capacities disappears. The proper selection of this intermediate frequency is important. A careful analysis shows 45,000 cycles to be the best frequency. If a frequency higher than 50,000 to 60,000 is selected, internal capacity effects will tend to shunt the energy being amplified, reducing the overall gain as well as introducing instability. If the intermediate frequency is below 40,000 cycles the two settings on the oscillator condenser scale will be too close together, especially at the lower wavelengths, and poor musical quality may result.

In the super-heterodyne all radio frequency amplification is obtained at a fixed frequency, irrespective of the incoming wavelength. This eliminates all controls on the radio frequency amplifiers and thus reduces the actual number of controls to two.

Maximum amplification, however, is obtained only when the intermediate frequency transformers are designed to operate at the selected frequency and whose in-put impedances match the out-put impedance of the tube. This design is incorporated in the transformers specified or can be duplicated by following the directions for winding as given in this article.

Another advantage of this set is that it employs dry battery tubes, C-299 or UV-199, thus being extremely economical in current consumption, the filament current being less than ½ ampere for the eight tubes. Due to the use of three *C* batteries the plate current drain on the *B* batteries is only 10 to 12 milliamperes.

Circuit Analysis

FIG. 3 shows the circuit. It is readily analyzed in four sections: (1) The local oscillator for generating the heterodyne frequency and the preliminary detector in which the incoming wave and the locally generated oscillations are mixed (tubes marked *OSC* and *1st Det.* with associated circuits); (2) three stages of 45,000 cycle intermediate frequency amplification (tubes IF_1, IF_2, IF_3 and associated transformers T_1, T_2, T_3, T_4; (3) the final detector (marked *2nd Det.*); and (4) two stages of audio frequency amplification (tubes AF_1 and AF_2 and associated transformers T_5, T_6).

The three stages of intermediate frequency amplification require four 45,000 cycle transformers, the last stage, T_4, being of the tuned type. T_1, T_2 and T_3 are iron core transformers, whereas, T_4, with air core, has its secondary circuit tuned to 45,000 cycles by the fixed condenser, C_7, of .00025 mfd. capacity. The value of this condenser must be fairly accurate so that the frequency of transformer

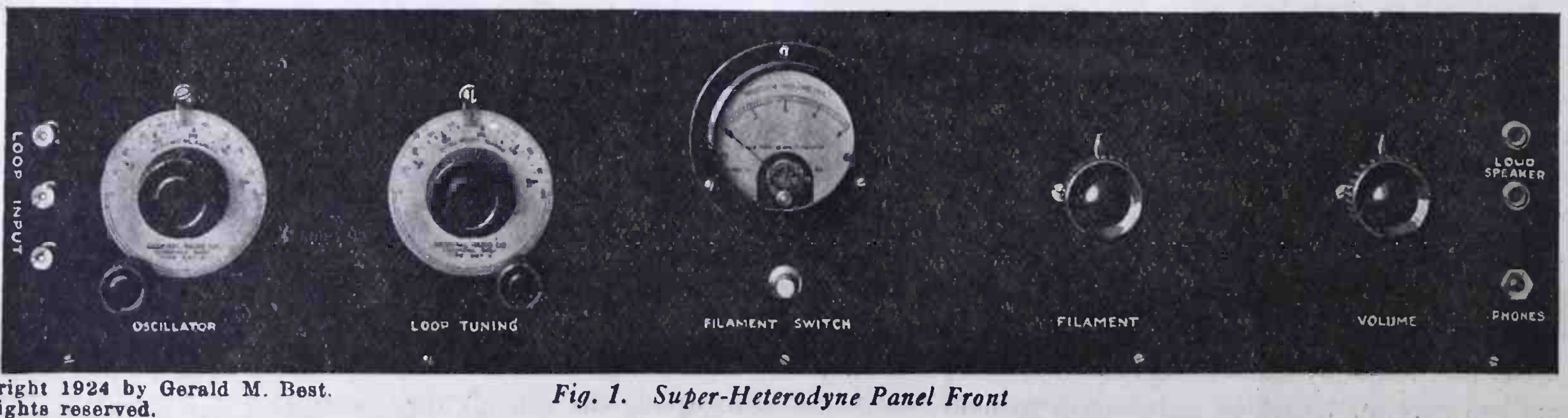

Fig. 1. Super-Heterodyne Panel Front

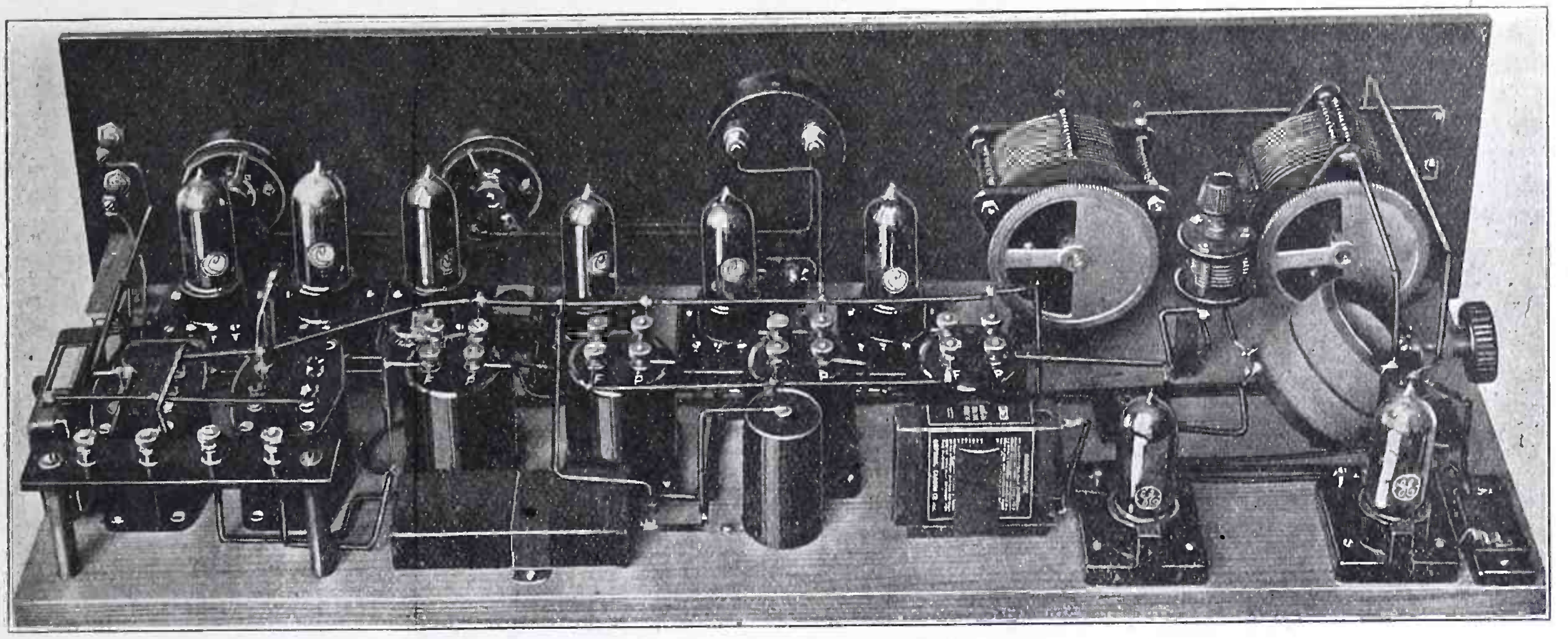

Fig 2. Rear View of Completed Set

T_4 will closely approximate 45,000 cycles, the frequency at which transformers T_1, T_2, T_3 are designed to operate with maximum gain.

Two stages of audio frequency amplification, transformers T_5 and T_6 are connected in accordance with standard practice.

Instead of the conventional grid-condenser-grid-leak method, detection in the preliminary detector is obtained by biasing the grid to operate at the bend in the plate current-grid voltage characteristic. This negative voltage of 4½ is fed through the loop and not only reduces the plate current almost to zero, but by increasing the impedance of the tube increases the selectivity of the loop circuit.

The final detector tube uses the customary grid condenser C_8 and grid leak for obtaining detector action. Note particularly that this grid condenser has a capacity of .0005 mfd. due to the comparatively low frequency of 45,000 cycles at which it operates. The value of the grid leak, although not critical, should be between 2 and 3 megohms.

L_1, L_2, L_3 is the oscillator coil system, Remler Type 620 being used in the sets made by the author. For those desiring to construct their own coils the following dimensions are given: Oscillator coil 70 turns of No. 26 D. C. C. wire in two sections of 35 turns each, wound on a 2¼-in. tube. Grid coil, 20 turns of No. 26 D. C. C. wire wound on a 1⅝-in. tube and arranged to rotate within the oscillator coil in a manner similar to the rotor in a 180-degree vario-coupler. Pigtail leads should be used for the rotor connections.

C_1 and C_2 are variable air condensers for tuning the loop and the heterodyne oscillator respectively.

By-pass condensers for radio frequency currents play a very important part in the successful operation of this circuit. C_4 by-passes radio frequency current across the 4½ volt *C* battery on the 1st detector tube. C_5 by-passes the radio frequency currents in the oscillator and three intermediate frequency circuits across the 1½ volt *C* battery. C_6 forms a direct filament return for the high frequency current in the plate circuit of the oscillator tube.

These last two condensers are extremely important as they confine the radio frequency currents from the local oscillator within its own circuit and prevent their flow through batteries or other parts of the circuit where their presence would tend to cause instability.

Condenser C_9 shunted across the primary of the first audio frequency transformer by-passes the 45,000 cycle current in the plate circuit of the final detector. Its value is very important and should be .0025 mfd. If its value is too low it will offer a high impedance to the 45,000 cycle currents; if too high it will distort the audio frequency currents.

Condenser C_{10} is not critical in value but should be at least 1 mfd. It by-passes the alternating current component in the plate circuit of all tubes supplied by the 45 volt section of the *B* battery.

A plate voltage of 45 is used on all tubes except the two audio frequency amplifiers. On these tubes 90 volts is used.

Note that the negative terminal of the *B* battery is common to the negative terminal of the *A* battery instead of to the positive *A* battery terminal as is general practice in most radio circuits. This eliminates the danger of filament burnout by the *B* battery in the case of an accidental short in the variable condensers, the by-pass condensers or other parts of the circuit.

The rheostat R_1, 6 ohms resistance, regulates the voltage supply to the filaments of all the tubes. This voltage is indicated by a voltmeter, the use of which is recommended to insure maximum life of the tubes.

The rheostat R_2, 6 ohms resistance, is connected into the filament of the first detector and the three inter-

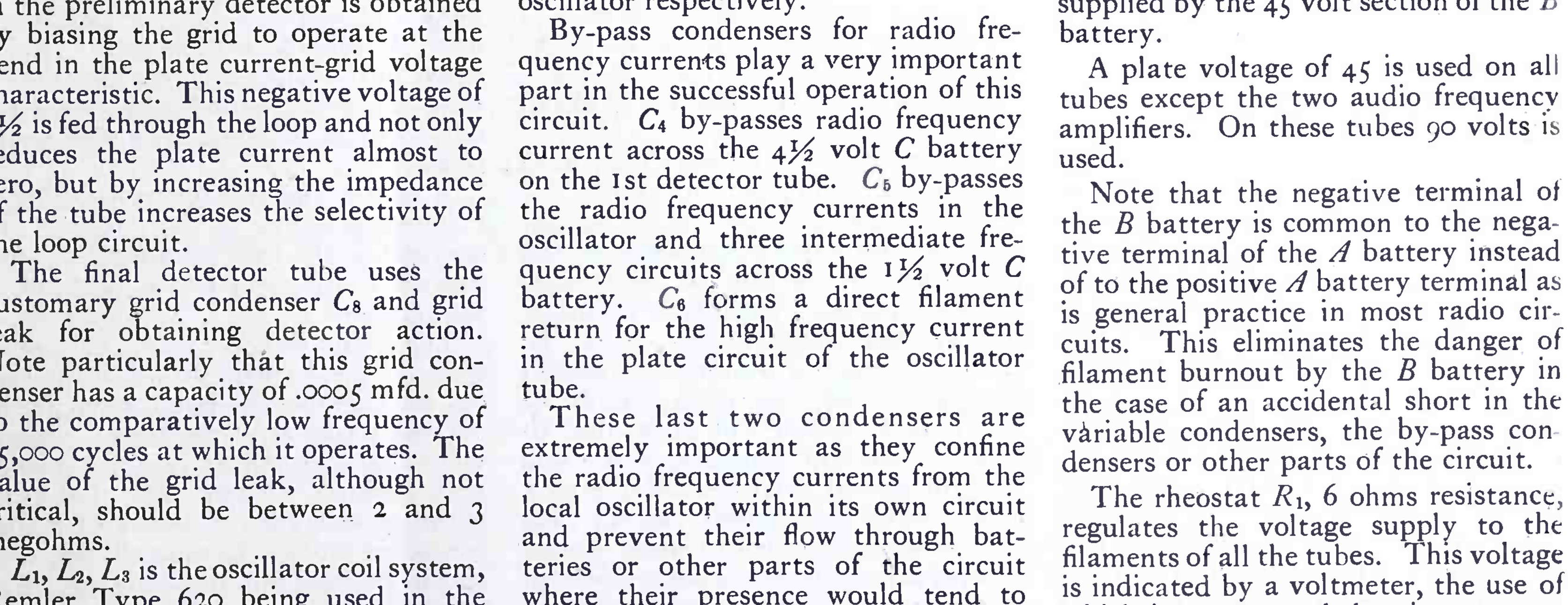

Fig. 3. Circuit Diagram for 8-Tube Super-Heterodyne

mediate amplifiers and serves as a volume control.

It will be noted that no shielding is shown in the illustration of either the panel or the apparatus. Some shielding may be necessary if the receiver is close to a high power broadcast station. The best material is either sheet copper or tin plate of sufficient thickness to stay in place when tacked to the interior of the cabinet. If the tuning appears broad for the local station it would be well to place a metal partition between the oscillator tube and the intermediate frequency amplifier. This shield should extend from the back of the panel to the rear of the baseboard. In extreme cases it may also be necessary to shield the back of the panel.

The loop circuit differs from the conventional type in that a center tap is employed. This is an application of the Armstrong circuit, by which a sufficient amount of energy is fed back from the first detector to the loop circuit, through a small condenser C_3 ranging in value from 1 to 20 micro microfarads, so that the loop resistance is considerably lowered, thereby increasing the selectivity and signal strength. One side of the loop goes to the grid of the 1st detector, and the other side is connected to the plate through the feedback condenser, while the center tap is connected to the filament.

Selection of Parts

In selecting the parts used in building this set consideration was given; first, to parts that would combine to perform most efficiently; second, to parts having the lowest price consistent with good quality; and third, to parts of standard manufacture that are well known and readily available at radio stores.

The accompanying table lists the parts used and recommended by the writer with prices in effect at the time this article was written.

Substitution may be necessary, but the reader is advised to adhere to the above suggestions to prevent unknown factors entering into the construction of the set. This is particularly true of the vacuum tubes, which should be either C-299 or UV-199.

If any of the parts in the list are not obtainable or if parts of similar design are on hand substitutions can be made.

SUGGESTED LIST OF PARTS

Number Required	Manufacturer Type Number	Article	Circuit Designation	List Price Each	List Price Total
3	Remler Type 600	Intermediate Frequency Transformers	T_1, T_2, T_3	$6.00	$18.00
1	Remler Type 610	Tuned circuit transformer	T_4	5.00	5.00
1	Remler Type 620	Coupling Unit	L_1, L_2, L_3	3.00	3.00
8	Remler Type 399	Sockets	Sockets for Tubes	.75	6.00
2	(See text)	AF Transformers	T_5, T_6	4.50	9.00
2	General Radio 247A	Condensers	C_1, C_2	5.00	10.00
1	Chelten	Midget Condenser	C_3	1.00	1.00
1	Jewell or Weston	Voltmeter	0-5V. Voltmeter	7.50	7.50
1	Cutler-Hammer	Radio Switch	Filament switch	.60	.60
2	Federal 18	Rheostats	R_2, R_1	1.10	2.20
1	Frost No. 133 or Federal	Open Circuit Jack	Phone Jack	.60	.60
1	Federal No. 133	1 mf. Fixed Condenser	C_{10}	1.50	1.50
1	Dubilier No. 600	.006 mf. Fixed Condenser	C_6	.75	.75
1	Dubilier No. 601	.0005 mf. Grid Condenser with Grid Leak Mounting	C_8	.45	.45
1	Dubilier No. 601	.00025 mf. Fixed Condenser	C_7	.35	.35
3	Dubilier No. 601	.0025 mf. Fixed Condenser	C_4, C_5, C_9	.40	1.20
1	Radiotron 2-3 megohm Grid Leak	Grid Leak	2 Megohms	.35	.35
2	Union	Phone Tip Jacks	For loud speaker	.25	.50
7	Any standard type	Binding Posts	For loop and battery terminals	.05	.35
1	Eveready 950	C Battery	1½ V.	.20	.20
2	Eveready 751	C Battery	1st—4½V., 2nd—4½V.	.40	.80
1		Bakelite Panel 26"x6"x3/16"	Fig. 5	3.50	3.50
30 ft.		30 ft. No. 16 or 14 tinned copper wire		.45	.45
20 ft.		Spaghetti tubing		1.40	1.40
	Material for details of special mountings, Figs. 7, 8, 9 and 10			.....	1.00
	Material for Loop—Wood frame and bakelite winding supports		(approx.)	1.50	.....
	110 ft. No. 18 or 20 Standard Lamp Cord			2.75	4.25
					$70.95

The panel drillings shown in Fig. 5 and the baseboard layout, Fig. 6, only apply to the exact list of parts given.

The list of parts calls for a Jewell voltmeter and the drilling shown in Fig. 5 is for this instrument, although a Weston is shown in the picture. Any standard voltmeter with range of 0 to 5 volts may be used. Its current consumption should not exceed 10 milliamperes at 3 volts. Beware of cheap voltmeters.

General Radio condensers have been recommended for the two station selectors C_1 and C_2. One of the advantages of the super-heterodyne is the permanent calibration of these condenser settings. To insure accuracy the bearing construction must be excellent, pig-tail connection should be made from the rotor plates to eliminate possibility of noise due to loose or friction contacts, and some form of geared drive (at least 4 to 1 ratio) to facilitate close tuning. Do not use condensers with vernier plates. The capacity of these condensers should be about .0005 mfd. (approximately 21 plates).

Remler intermediate frequency transformers are used in the writer's set. Laboratory measurements show these transformers to have a smooth and uniform frequency characteristic between 40,000 and 50,000 cycles. The impedance values throughout this range of frequency are uniform and of the proper value for use with C-299 or UV-199 tubes. The iron core construction limits the stray field and permits of close spacing, without shielding (which always introduces a loss) and without circuit instability due to linking of the stray fields between transformers. Air core transformers cannot be used in this set without appreciable changes in the entire layout.

A Remler tuned stage transformer is recommended as it is designed to operate with the intermediate frequency transformer and is uniform in appearance.

The Stromberg-Carlson audio-frequency transformers shown in the layout are compact in design, have a convenient terminal arrangement, a good voice characteristic and correct impedance values. There are, however, many good standard makes of audio-frequency transformers available, such as the Federal No. 65, Kellogg 3½:1, General Radio, or Amertran. For voice quality do not use a transformer with a turn ratio greater than 3½ to 1.

The various fixed by-pass condensers should be of standard manufacture to insure capacity values closely agreeing with their rated values.

A picture of the loop is shown in

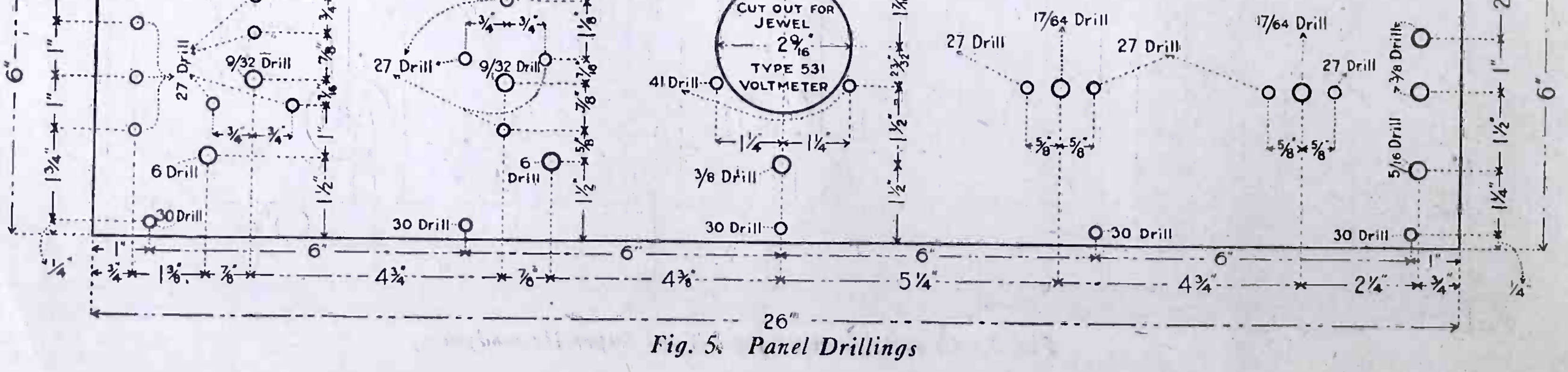

Fig. 5. Panel Drillings

Fig. 4, and all dimensions are given in Fig. 11. It is not necessary that the exact form of loop shown be used as long as the general dimensions and spacing between turns and the number of turns are complied with. In the

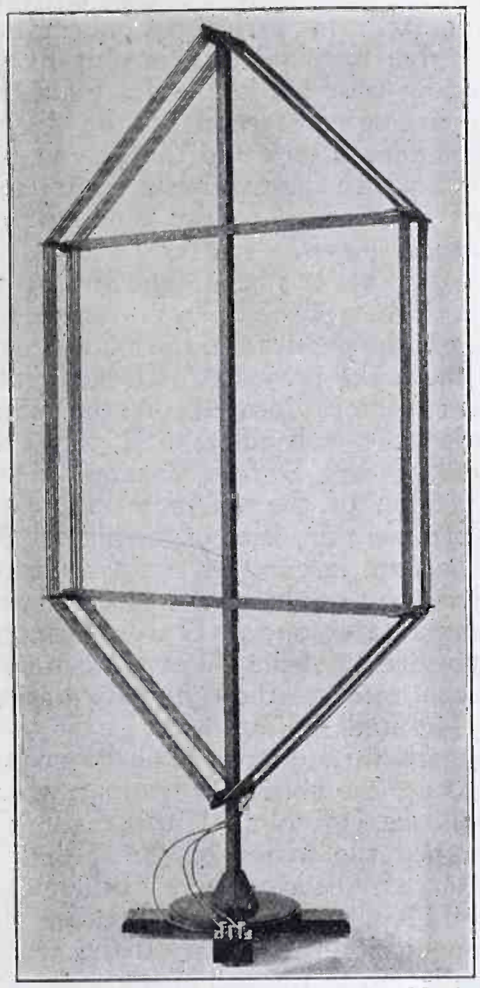

Fig. 4. Three-Tap Loop

operation of the set it is necessary to change the direction of the loop for the reception of different stations. For this reason it will be convenient, although not absolutely necessary, to have a swivel base. The loop is wound with a total of 12 turns of single strand No. 18 silk covered lamp cord.

$400 in Cash Prizes for Improvements in Best's 45,000 Cycle Super-Heterodyne

Because of their confidence in the results that may be secured with this hook-up, the publishers of RADIO will devote regular space for the next six months or more to an account of experimenter's experiences with it. Although we believe it to be the most practical set of instructions for the home construction of a super-heterodyne yet published, we recognize it is susceptible of modifications which may improve it.

Consequently, it has been decided to offer a series of monthly prizes for the best suggestions received from readers who have constructed a set in accordance with the directions here given, or as subsequently modified. These prizes will amount to $50 monthly during a six months' period and will consist of a first prize of $25, a second prize of $15 and a third prize of $10 to be awarded each month. Finally, there will be awarded three additional prizes of $60, $40 and $20 respectively for the best ideas received during the entire six months' period. This makes a total of $400 in prizes.

Entries for the first award must be in the editor's hands prior to June 1, 1924, and for each succeeding award prior to the first of each month thereafter. The meritorious suggestions will be given careful laboratory tests, upon which the awards will be based.

Contestants are requested to submit manuscripts written on one side of the sheet and with all photographs, diagrams and sketches on separate sheets,—the drawings to be in ink. Submit no description of a design that has not been actually tried out in practice. Manuscripts will not be returned. Prizes will be paid on the date of the publication of the issue announcing the awards. Address all communications to the Editor of RADIO, 433 Pacific Bldg., San Francisco.

The Assembly

FIRST decide on the parts to be used, making changes in the panel and baseboard layouts to provide for any substitutions. Study Figs. 1, 2, 3, 5 and 6 carefully. Figs. 1 and 2 will give an excellent idea of what is to be accomplished in the mounting and wiring of the set and how it will look when completed. In the actual construction, the base board and panel assembly can be started in two separate units.

After the panel is drilled two variable condensers C_1 and C_2, voltmeter, filament switch, two 6-ohm rheostats, jacks and the binding posts may all be mounted. All of the wiring between instruments on the panel may next be run.

The tube sockets, transformers and other apparatus are next mounted on the baseboard in accordance with the layout in Fig. 6. Follow these dimensions closely, because this set has been built in the most compact manner possible without internal shielding; arrangements of the apparatus other than shown may result in instability of the entire circuit. Most of the apparatus is screwed direct to the baseboard.

However, a few special fittings were found necessary for mounting the battery terminals (Fig. 7), condenser

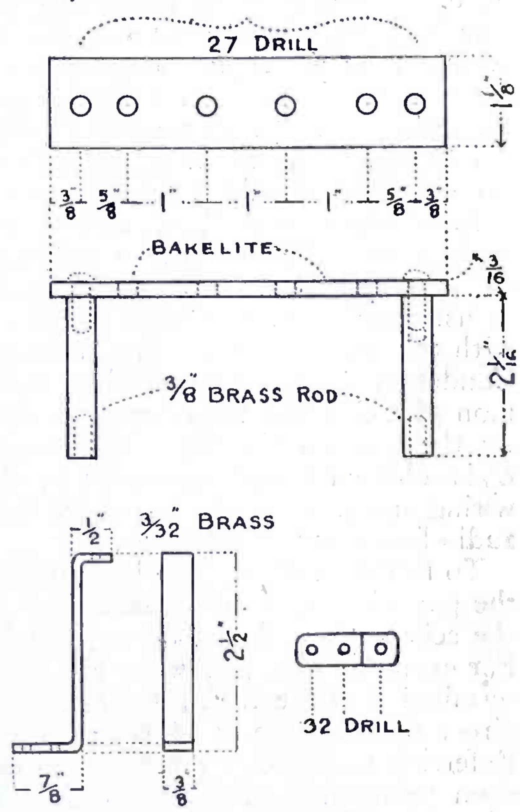

Fig. 7. Special Mounting for Battery Terminals

C_{10} (Fig. 8) and two of the C batteries and the Chelten midget condenser C_3 (Fig. 9).

It was also found desirable to mount the sockets for the final detector tube

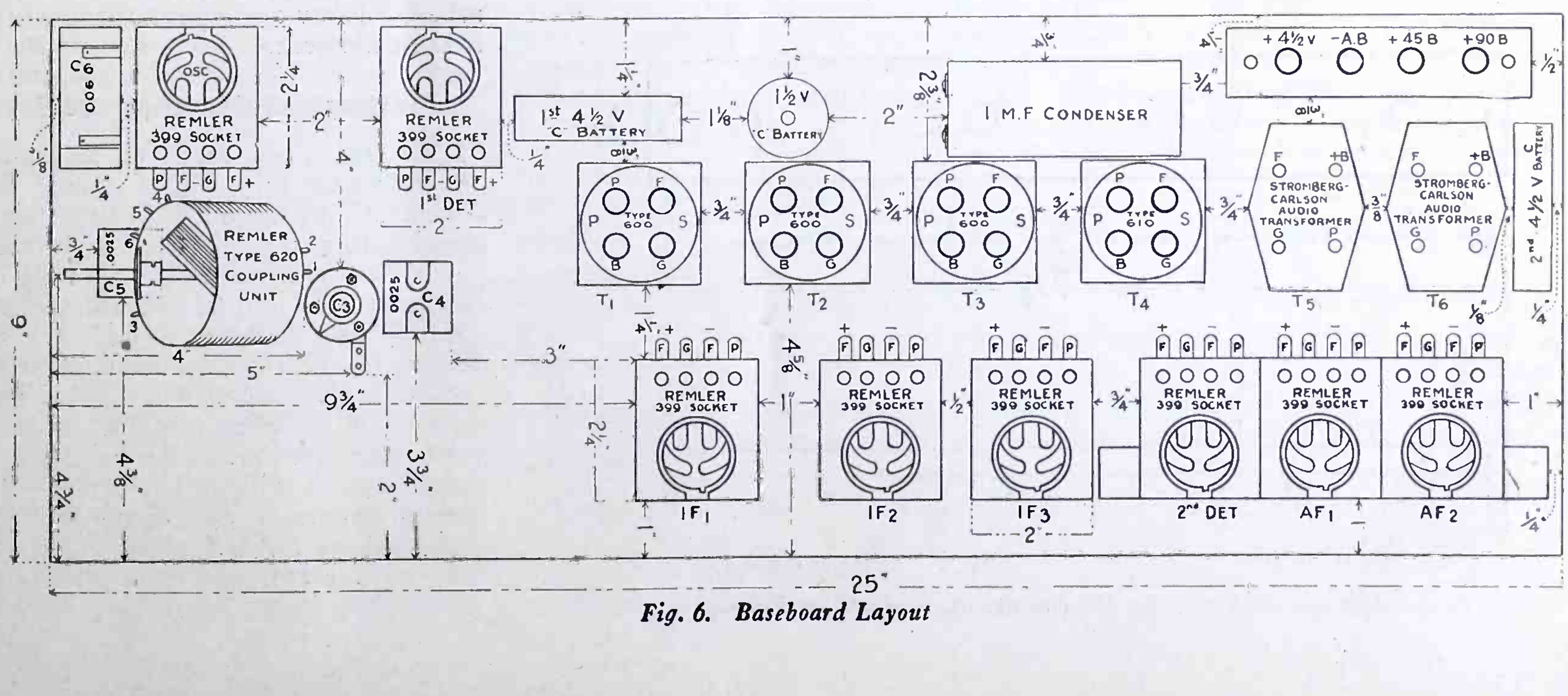

Fig. 6. Baseboard Layout

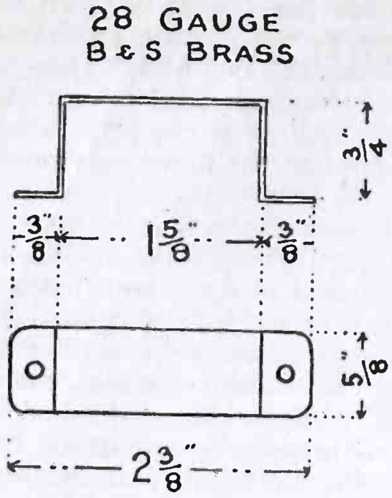

Fig. 8. Mounting for C_{10}

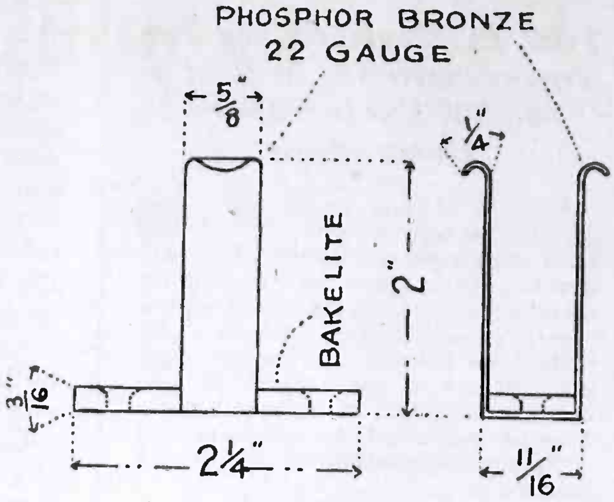

Fig. 9. Mounting for Midget Condenser and "C" Battery

and the two audio-frequency amplifiers on a small strip of bakelite, supported at the ends by sponge rubber (see Fig. 10). This eliminates microphonic tube noises and any tendency for the circuit to howl at an audio-frequency when a loud speaker is used. All of the leads running from these three sockets should be flexible wire.

Fixed condensers C_4, C_5 and C_6 are screwed to the baseboard. Condenser C_7 is mounted on the tuned stage transformer with the clips provided with the transformer for that purpose. Condenser C_8 has one terminal common with C_7 and is therefore supported by the transformer clips. Condenser C_9 is soldered to and supported by the wiring and rests on the top of the first audio-frequency transformer.

To facilitate wiring, the lettering on the parts in Fig. 6 agrees with that in the schematic wiring diagram, Fig. 4. For example, Fig. 4 shows a lead from terminal *P* of the I. F. transformer T_3 direct to the plate *P* of tube $I.\ F._2$. Referring to Fig. 6, a wire is run direct from terminal *P* of T_3 to terminal *P* of socket IF_2.

Except for the flexible leads mentioned above use No. 14 or 16 tinned copper wire formed to shape and protected with spaghetti tubing. All connections should be carefully soldered or the binding posts thoroughly tightened with a pair of pliers, in case the apparatus is not provided with lugs.

The wiring of the instruments on the baseboard may be done in any convenient order. However it would be preferable to wire the filament circuit first, with the exception of the connections that run to the instruments on the panel. Then wire the complete oscillator circuit and the first detector circuit, omitting wires running to terminals on the panel. Proceed next with the entire intermediate frequency amplifier circuit, final detector and the audio-frequency amplifier unit, in the sequence mentioned. When the baseboard wiring is completed the bakelite panel can be screwed to the front edge of the board and the wiring between the instruments on the panel and those on the baseboard completed.

Preparing the Set for Operation

WITH all wiring completed it is advisable to finally check your work with the wiring diagram. Do not insert the tubes until the following instructions have been carried out:

Connect the loop to the three binding posts on the left end of the panel. The center tap of the loop must be connected to the center binding post. One of the outside loop terminals should be connected to the top binding post and the other to the lower binding post. These two connections may be reversed without affecting the operation of the set.

The *B* battery unit should consist of two 767 Eveready 45 volt batteries connected in series. Connect the negative terminal of this unit to the binding post marked $-AB$ Fig. 6, the positive 90 volt terminal to the binding post marked $90B$ and the 45 volt terminal where the two batteries are connected in series to the binding post marked $+45B$.

After this has been done and before the *A* battery has been connected, plug in the phones and the loud speaker in the jacks provided. Close the filament switch, located on the panel under the voltmeter, and turn the rheostat up a few degrees. Any deflection of the voltmeter indicates an error in the wiring of the filament or *B* battery circuit. If such an error exists the trouble must be located and eliminated at once. If the voltmeter is not deflected the *A* battery can next be connected to the terminals marked $+4\frac{1}{2}A$ and $-AB$, Fig. 6.

Again turn on the filament switch and note the voltmeter reading, which should be 4½ volts. If this reading is obtained the wiring of the *A* and *B* battery circuit is correct. If the meter should fail to read it is because the filament circuit is open. If the needle is deflected to the end of the scale, the *B* battery voltage is shorted through the filament circuit.

The tubes can now be inserted. First see that the filament rheostat is turned to the off position and that the volume control rheostat on the right hand end of the panel is turned clear to the right; also that the filament circuit switch is open and that the terminals of all the tubes and the contacts in the sockets are clean. Close the filament switch and turn the filament rheostat until the voltmeter indicates a filament potential of exactly 3 volts. This value should never be exceeded, as doing so will shorten the life of the tubes and may cause permanent injury to their filaments.

Adjusting and Operating the Set

THE set is now ready for an actual operating test. This should be done at a time when it is known that a broadcasting station of medium or high power is operating within a range of 100 miles. In normal operation there are only two variables to adjust, condensers C_1 and C_2. Volume control R_2 cannot be classified as a variable. The rotor of the coupling unit and value of condenser C_3 require initial adjustment but, once set, will probably not need further attention. Set condenser C_3 at the position for minimum capacity; that is, so stator and rotor plates are

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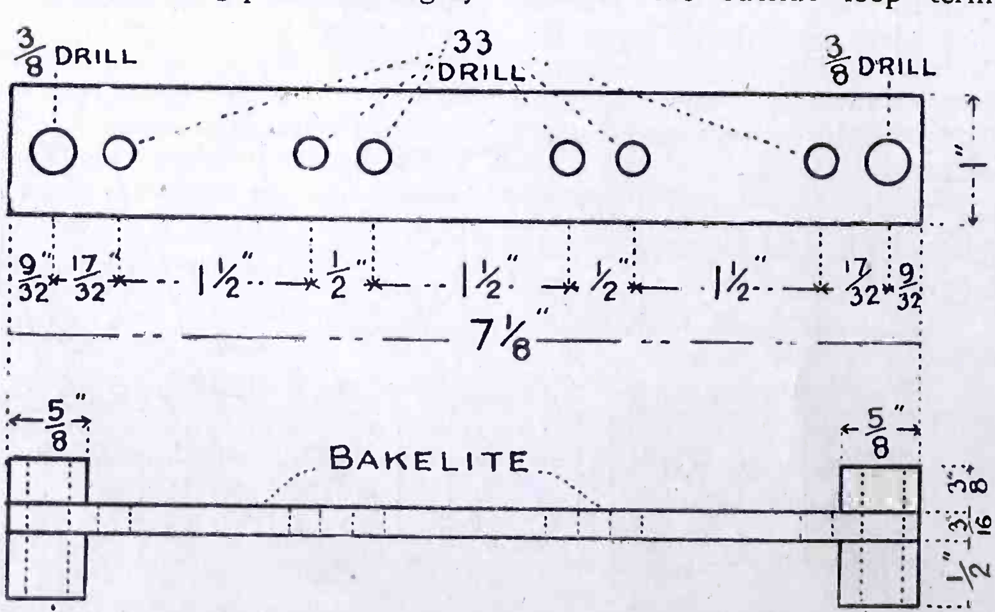

Fig. 10. Mounting for Detector and A. F. Amplifier Tubes

Lectures on Radio Communication

By Prof. C. M. Jansky, Jr.

This, the first of a series of lectures by Prof. Jansky, simply and clearly explains the meaning of the terms used in defining direct and alternating current. It also treats somewhat of the properties of these currents in various kinds of circuits. The next installment will tell how electromagnetic or radio waves are transmitted.

Introduction

A STUDY of radio communication circuits involves the use of electrical quantities, such as current, voltage, charge, and, in addition, the use of certain electrical devices, such as batteries, generators, inductance coils, resistances and condensers. An understanding of these electrical terms and devices is necessary if one is to have an understanding of the theory of radio communication and the operation of radio circuits.

We cannot understand the how and why of tuning and adjusting radio circuits unless we know what an electric current is, what a condenser is and what an inductance coil is. These lectures assume no knowledge of electricity on the part of the reader. At the risk of boring some who already know something of electricity, I must, therefore, begin at the beginning. I shall try to make these articles as simple and as non-technical as possible. This means that from time to time I may have to make statements which the reader will have to take on faith, and I may have to include formulas which these articles do not prove. The non-technical nature of this treatment precludes the possibility of mathematical proofs. If the first article appears to be far removed from radio communication, please bear in mind these limitations and I promise that we will turn our attention to radio circuits and their uses very shortly.

Theory of Electricity

SCIENTISTS now tell us that all matter is composed of electricity. Thus, if we analyze an atom of copper and an atom of zinc we find that each atom has a central nucleus which we say is electrically positive. Around this positive nucleus is grouped a large number of little particles called electrons. The electrons are negative charges of electricity. The mass of an electron is 1/1800 that of an atom of hydrogen. The nature of the positive nucleus of a copper atom is different from that of a zinc atom. The electrons on an atom of copper, however, are identical with those on an atom of zinc. It is, therefore, the nature of the positive nucleus which determines the nature of the atom.

If we connect a copper wire to some source of electrical energy, such as a dry cell, and, if we insert in the line an ammeter or a device for indicating electric current flow we find that we have an electic current in the circuit. We will call the zinc of our dry cell —, the carbon terminal +. The *electric current* actually consists of a stream of electrons moving around the circuit in the direction indicated in Fig. 2. An electric current is therefore a stream of electrons passing from atom to atom.

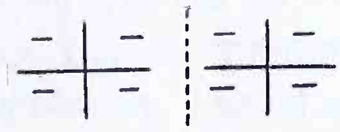

Fig. 1. Representation of Electrons Surrounding Positive Nucleus.

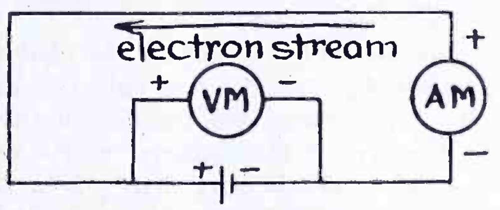

Fig. 2. Direction of Electron Flow in Battery Circuit.

The ammeter is a device for measuring the amount of current flow. The unit of current flow is the ampere.

Electric currents were used and studied long before it was known that an electric current is a stream of electrons. By convention we therefore think of the current flowing out of the carbon, or +, side of the dry cell around through the circuit and back to the zinc or — side. So, in speaking of the direction of current flow we will use the convention. The battery is a current-producing device, so that the side from which current is supposed to come is called +. The meter measures current and is so marked that current flows in the + terminal and out the —.

The battery's tendency to produce current may be called electrical pressure. The magnitude of electrical pressure may be measured by a device called a voltmeter which is connected across the battery with the + side of the voltmeter connected to the + side of the battery. Electrical pressure is measured in volts.

The Direct Current Circuit

THE amount of current which we get in an electric circuit containing a battery depends upon a property of the circuit called resistance. Graphically an electric circuit may be represented as in Fig. 3. In a resistance, electricity is changed to heat. The unit of resistance is the ohm. The amount of current in the circuit in Fig. 3 depends upon the voltage of the battery and the value of the resistance.

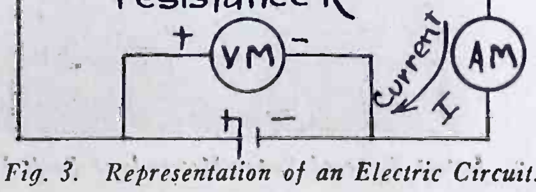

Fig. 3. Representation of an Electric Circuit.

$$\text{Current in amperes} = \frac{\text{voltage of battery in volts}}{\text{resistance of circuit in ohms}}$$

Summary

(1). *Electric current,* a stream of electricity measured in amperes.

(2). *Electric pressure,* E.M.F., or voltage, a measure of the tendency to produce electric current. (Pressure is measured in volts).

(3). *Resistance*—that property of a wire which retards the flow of current and which converts electrical energy into heat—a small wire has more resistance than a large one. (Some wires, as iron, have more resistance than others, like copper or aluminum. Substances which do not carry electric currents are called insulators.)

(4). *An ammeter,* a device for measuring electric current flow in amperes.

(5). *A voltmeter*—a device for measuring electrical pressure in volts.

(6). *A battery,* or generator, a device for producing electric current.

Electrostatics

WE must now turn our attention to other electrical quantities and other electrical devices.

If we allow an electric current to flow in a wire we can think of a given number of electrons as flowing past that point, or we can think of a given amount of electric charge as passing that point. This amount of charge is measured in *coulombs. A coulomb is the amount of charge which passes a given point in a wire in one second if the current flow is one ampere.*

In a normal condition there are enough negative electrons in an atom of matter to neutralize the + effect of the positive nucleus. Let us assume that it takes 4 electrons to neutralize the positive nucleus of a given atom. (Actually, the number is much greater.) The two atoms in Fig. 4 are then electrically neutral and will neither repel nor attract each other. Let us assume now that we fasten two additional electrons to each atom as in Fig. 5.

Fig. 4. Electrically Neutral Atoms.

Fig. 5. Electrically Negative Atoms

There is then an excess of electrons on each atom and they are both negatively charged. The two atoms now repel each other. Like charges repel one another.

If we take away two electrons from our original atoms (Fig. 6) then there is an excess of + charge and the atoms

Fig. 6. Electrically Positive Atoms

act positively charged. They still repel each other. Like charges repel one another.

A positively charged and a negatively charged atom, however, will attract each other. The law is:

(1) Like charges repel.
(2) Unlike charges attract.

Condensers

If a dry cell or other source of voltage is connected to two plates placed near each other as in Fig. 7 there will be a — charge on one plate and a +

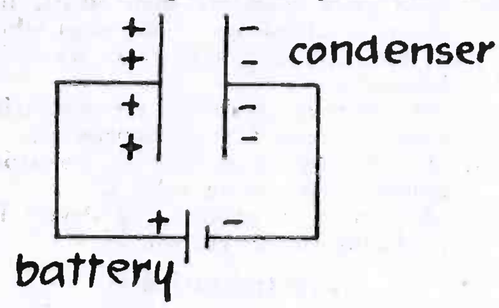

Fig. 7. Condenser Circuit.

charge on the other. As the plates are close together the + and — charges attract each other. The charges will remain on the plates even if the battery is disconnected. Such a device is called a condenser. The amount of charge depends upon the value of the applied pressure, the area of the plates of the condenser, the distance between the plates and the material between them. Some condensers have many plates arranged as in Fig. 8. The amount of charge ob-

Fig. 8. Multi-Plate Condenser.

tained upon the plates of a condenser for a given voltage applied is called its capacity or capacitance. The relationship is:

Charge on plates in coulombs	=	Capacitance of condenser in farads	×	Voltage applied in volts
Q	=	*C*	×	*E*

A condenser is said to have one farad capacitance when a pressure of one volt produces a charge of one coulomb on the plates. In radio tuning condensers, the capacity is varied by rotating one set of plates in or out of the other set. Mica, paraffine paper, and sometimes glass are used between the plates of the condensers to prevent arcing between plates at high voltage and to increase the capacitance.

Inductance

If we close a switch on a circuit containing a resistance and a coil of wire (Fig. 9) we find that the current

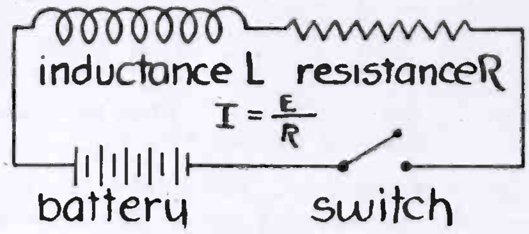

Fig. 9. Direct Current Inductive Circuit

does not immediately rise to the value determined by Ohm's Law, current $= \frac{\text{voltage,}}{\text{resistance}}$ but rises slowly to that value. This is due to the choking effect of the coil which is called inductance. The larger the number of turns and the greater the diameter of the coil the greater this choking effect. The use of an iron core in the coil also increases the choking effect.

If we have a current of electricity in a coil of wire and attempt to change the value of this current we find that there is a voltage developed or induced in the coil which opposes this change. The unit of inductance is defined in terms of this effect and is called a *henry*. *If when the current is changing at the rate of one ampere per second, the voltage induced which tends to oppose that change is 1 volt, then the inductance is one henry.*

The accompanying table contains a summary of the electrical quantities we have discussed.

ELECTRICAL QUANTITIES

Electrical Quantity	Name of Fundamental Unit	Subdivision and Multiples: 1,000,000 x Fundamental	1,000 x Fundamental	.001 x Fundamental	.000001 x Fundamental	Abbreviations
Current	Ampere	......	......	Milli-ampere	Micro-ampere	I
Pressure	Volt	......	Kilo-volt	Milli-volt	Micro-volt	E
Charge	Coulomb	......	......	......	......	Q
Resistance	Ohm	Meg-ohm	......	......	Micro-ohm	R
Capacitance	Farad	......	......	......	Micro-farad also Micro-micro farad	C
Inductance	Henry	......	......	Milli-henry	Micro-henry	L

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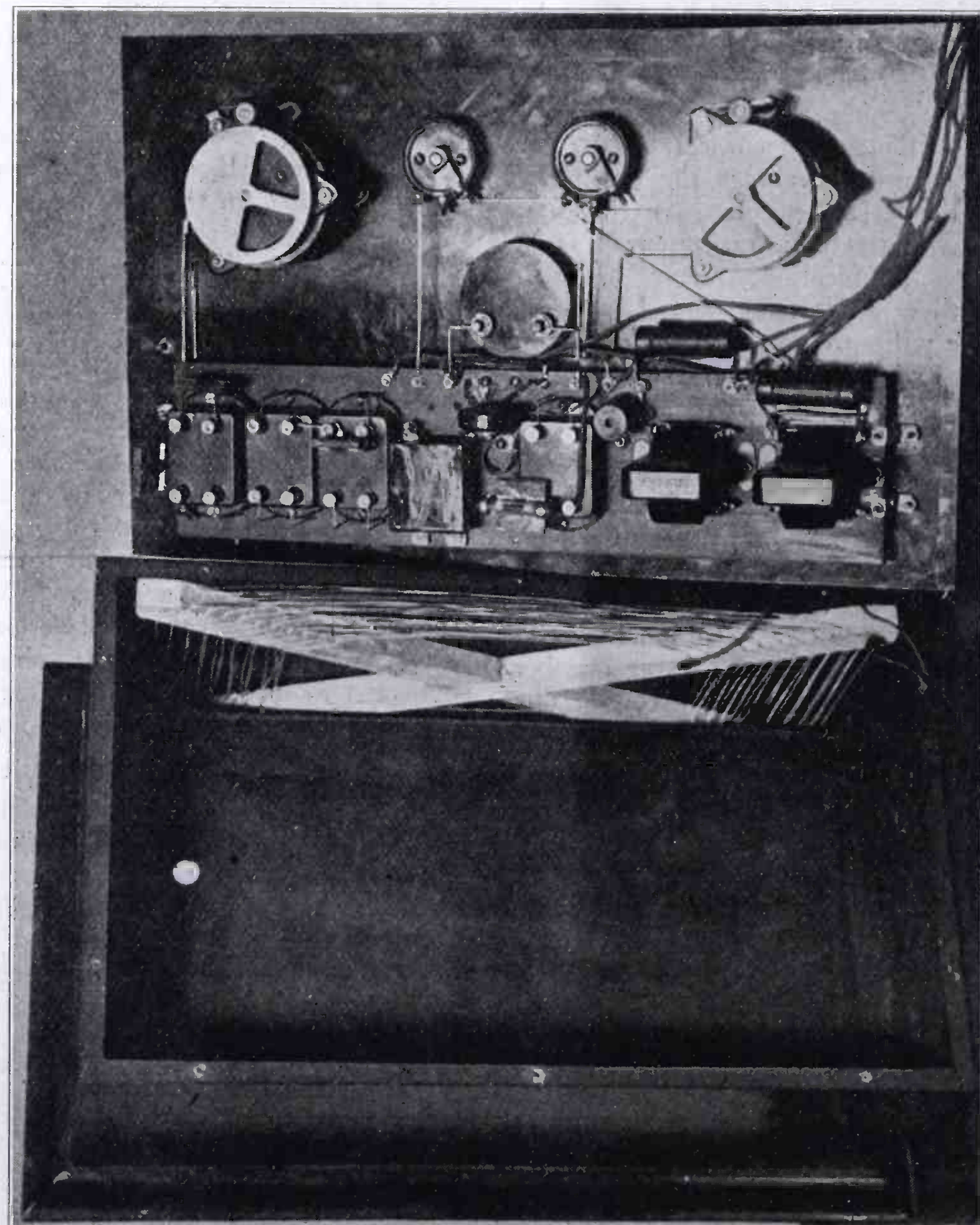

Latest Type of Super-Heterodyne Built by Major E. H. Armstrong and Harry Houck
Wide World Photo.

An Easily-Made Variometer

By A. H. Vance

These directions are intended for the guidance of the constructor having a limited pocketbook and desirous of a variometer occupying a small space. It can be made by any boy who is handy with tools.

A COMPACT and effective variometer to fit into a space 6x5x1 can be easily made with a few simple tools and materials. The tools required are a scroll saw, pocket knife, small hammer, dividers, soldering iron, small round file, hand drill, and three drills—¼ in., 15/64 in., and 1/16 in. These tools can be purchased with the money saved by the construction of one variometer.

The materials needed for the stator are: two pieces of wood 5¾ in. long, 2½ in. wide and ⅝ in. thick. Four strips of wood 5¾ in. long and ¼ in. square are also needed. These are used to brace the stator form and also to support the rotor. All wood pieces should have the edges planed true, and should be finished to the exact dimensions given.

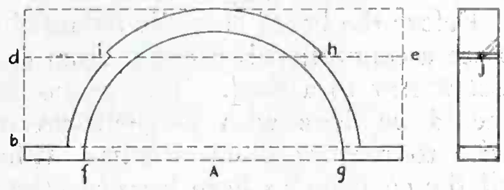

Fig 1.

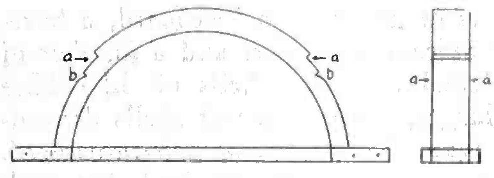

Fig 2.

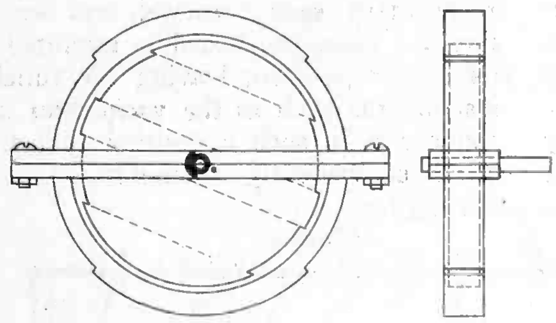
Fig 4.

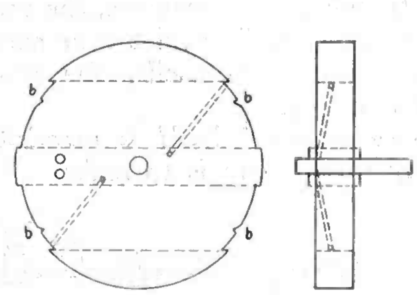

Fig 3.

The details of the stator are shown in Figs. 1 and 2. Referring to Fig. 1, measure ¼ in. from the edge and draw the line *bc* parallel with edge. Measure 1½ in. from the edge and draw the line *de* parallel with the first line. Now set the dividers to 2⅛ in. radius, and with the point *A* as a center describe the semicircle *fg*. Set the dividers to 2⅜ in. radius, and, with the point *A* as a center, describe the short segments shown between the lines *bc* and *de*. Set the dividers to 2½ in. radius and draw the segment as shown at *hi*. With the scroll saw cut out the block as shown by the full lines. Repeat the process with the other large block.

Two of the small strips may now be tacked with small brads and glued to each stator block, as shown in Fig. 2. The edges of the block marked *a* should be rounded slightly to make the wires fit the form better. It is advisable to drill a small hole in each stator block as shown at *j*, Fig. 1, to start the winding. Any difficulty in getting the wire to lie flat on the form may be obviated if the following directions are carefully followed. Take the semi-circular block which was cut from the stator block, and put it in the place from which it was sawed. This provides a perfectly flat surface for winding. This block may be easily removed when the winding is completed. After winding on about twelve turns as shown, it will be found that the turns of wire tend to pile up on each other. A small notch should now be cut on the edge in such a manner that the thirteenth turn can be wound on in a straight line. This notch is shown at *b*, Fig. 2. Its exact location cannot be given, as it depends on the size of wire used. The original variometer was designed for No. 20 wire, but No. 22 was used successfully.

Care must be used in order to have the windings run in a continuous direc-

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Major E. H. Armstrong at His Newest Type of Super-Heterodyne
Wide World Photo.

A Quick Change Circuit Board

By R. F. Stares

This is a time saver for the hook-up experimenter. By its use the most involved circuits can be put together in no time.

A QUICK change circuit board can be made up of a few radio instruments mounted on a baseboard, a bakelite switchboard panel and a number of exploded cartridge shells of 32 calibre or larger, the number of shells depending upon the amount of apparatus used. One shell will be required for each terminal of the instruments used to experiment with. For instance, the vacuum tube socket will require four shells, the variometer two shells, the transformer four, etc.

The switchboard itself is practically the only thing there is to make. The rest of the work simply involves the soldering of a few connections and the mounting of the instruments on a baseboard. Reference to the sketch will show that the switchboard itself is formed by a bakelite panel, the size of which will depend upon the number of radio instruments used. This is given four legs, which can be made of bent brass strips, so that it will stand horizontally over the board carrying the instruments. Holes are drilled in the bakelite board of such size that a forced fit will be made for the shells, which are put in from the underside as far as they will go, the flange on them preventing them from going all the way through. Before the shells are put in it will be well to clean them in a solution of one part of nitric acid and one part of sulphuric, for the purpose of removing all foreign matter that would tend to result in poor electrical connection. When the shells are taken out of the solution they should be carefully rinsed in clean water to remove all traces of the acid which would bring about corrosion. The closed ends of the shells are then filed down to expose a good soldering area.

Before the board is finally mounted in place a connection is brought from each instrument to a shell. This connecting should be done with spaghetti-covered wire to prevent short circuits. When all the connections have been completed small paper stickers are used to carefully mark each terminal and set of shells. Then the board is mounted in its proper position, leaving the tunable instruments such as the variometer and condensers in such a position that they can be conveniently manipulated.

Before the instrument is ready for service it will be necessary to make a few dozen small connectors which are used to establish contact between the instruments. These connectors are made with good flexible wire, having small spring clips attached to their ends as illustrated. It will be noticed that these clips are of such dimensions that two or three of them can be slipped into a single shell. To complete the device for operation, about one pound of mercury should be purchased and two or three drops placed in each shell, so that when the connectors are placed in the shell an exceptionally good electrical contact will be produced.

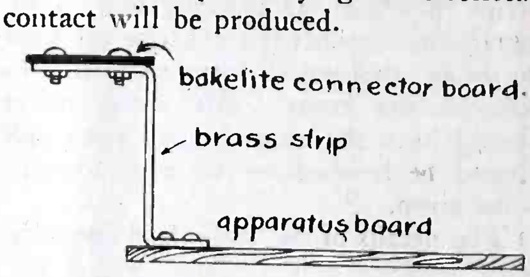


Fig. 3. Alternative Mounting

There are other ways in which the board may be mounted, and the writer has shown another one in Fig. 3, where the switch panel takes its place at the back of the instrument board.

For the true circuit experimenter there is nothing that will serve as well for new circuit work as this, especially if there is a surplus of shells or connecting jacks that will accommodate more apparatus, which can be put on the board as the occasion arises.

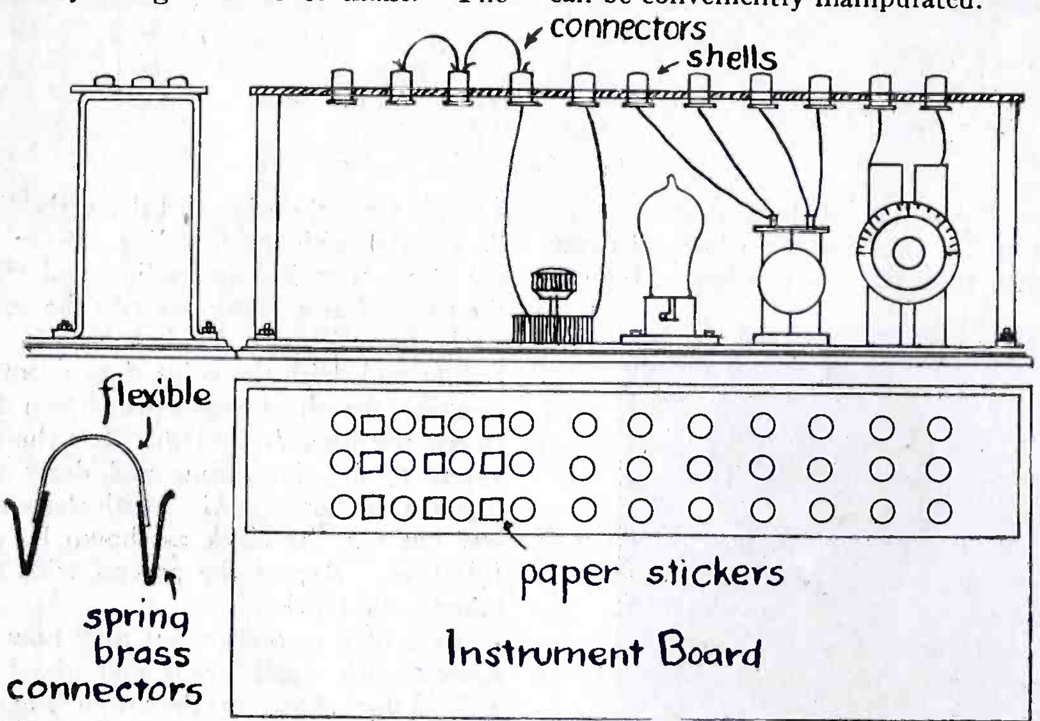
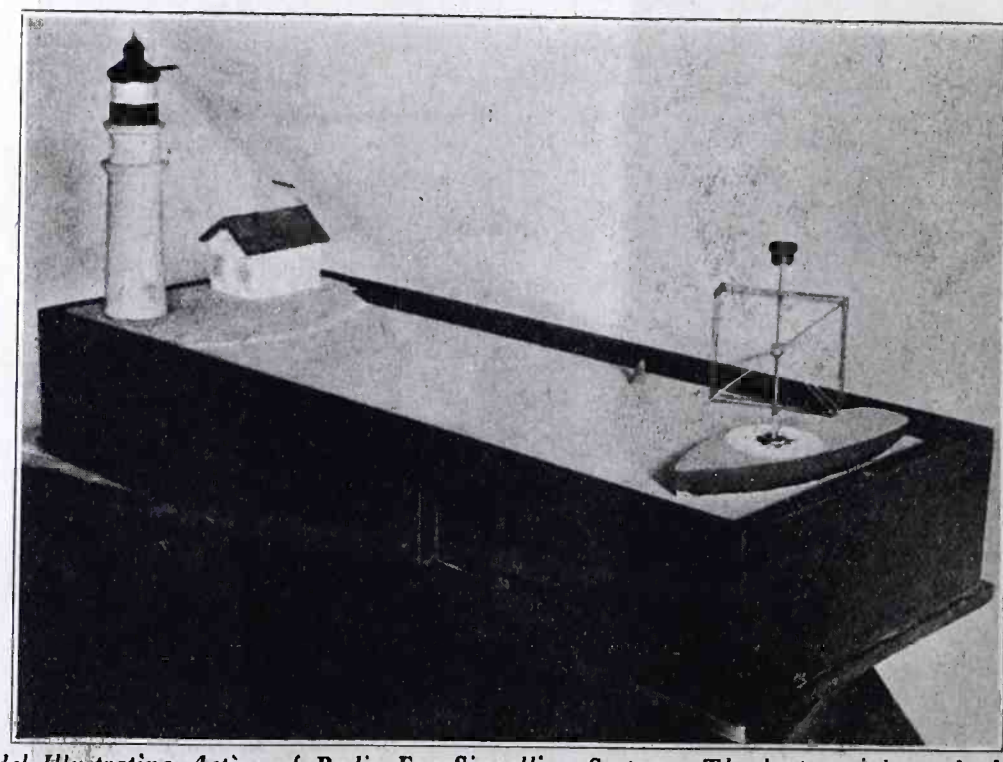


Fig. 2. Connectors

Fig. 1. Instrument Board

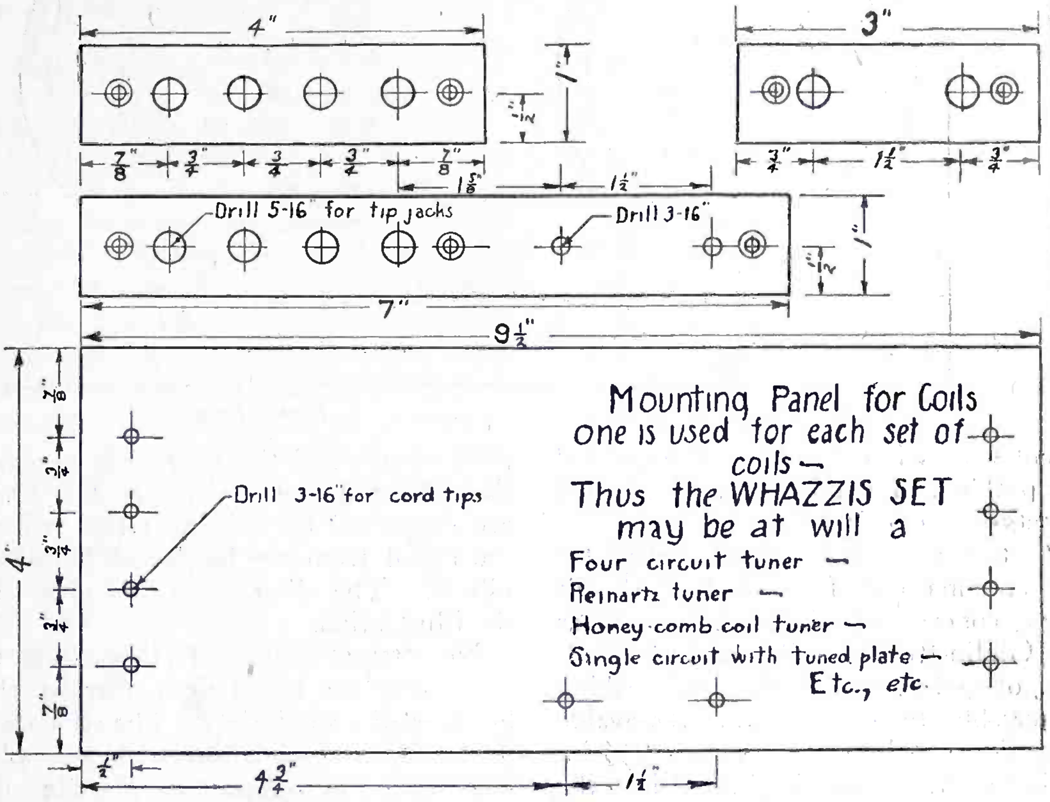


Model Illustrating Action of Radio Fog Signalling System. The loop aerial on the boat is turned until the signal comes in loudest from the radio station on shore. This bearing and a similar bearing on another known station is plotted on a map. The intersection of the two lines shows the ship's location. This model was designed by A. W. Tupper of the U. S. Lighthouse Service. Eight such fog signal stations are in operation, five are being built and twenty more are in contemplation. Wide World Photo.

The Whazzis Set

By Keith La Bar

Here is a clever idea for building an efficient receiver readily adaptable to all wavelengths and various hookups. In this respect it is attractive and convenient.



Coil Mounting Panel.

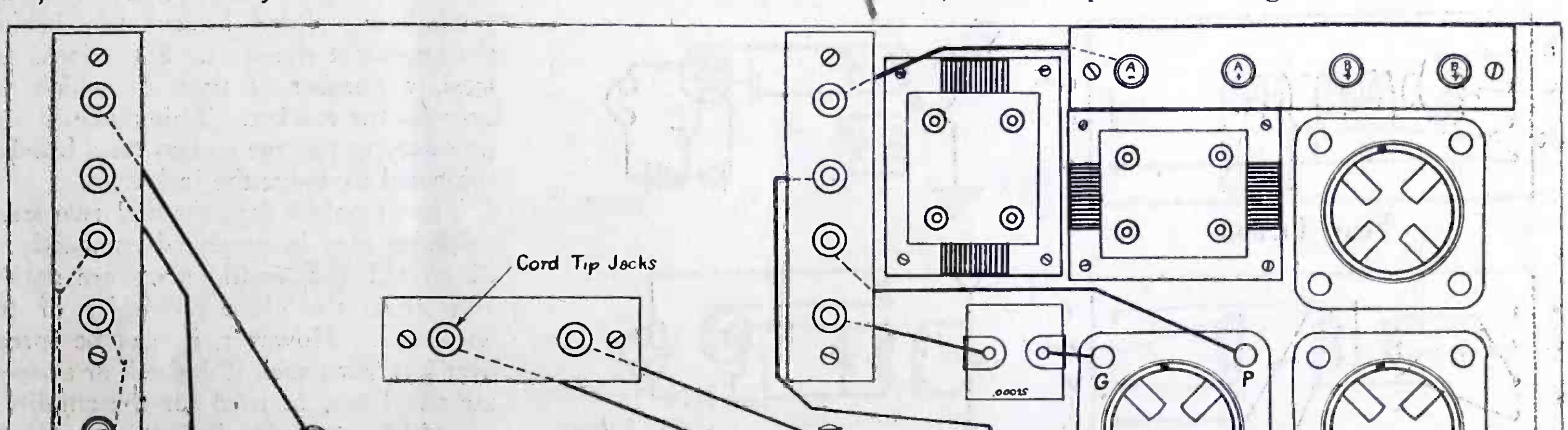
THE radio experimenter now seems to need a different set for every purpose and perhaps a set or two that has no purpose except to yield up a dial, or condenser, or binding post when such parts are needed. First, he must have a broadcast receiver to convince the family that the purchase of numerous articles pertaining to radio is as necessary as buying a new tire for the flivver. Next comes the tuner for shorter waves from 80 to 250 meters. This cannot be combined efficiently with a broadcast tuner without tapping the coils and thereby sacrificing some of the efficiency and many of those distant stations. This short wave tuner must oscillate easily in order to receive C.W. code; unlike the broadcast tuner, which must regenerate strongly but not oscillate. And thus the experimenter convinces himself that he must have two sets.

Then, what radio shack would be complete without a honeycomb coil tuner? After listening to some of the broadcasting or some of the ragged sending and worse tone of some of the amateur stations it is restful to listen to the high powered stations on the higher wavelengths where the struggle for existence is not so great. And so another set is added to the hope list of the experimenter, bringing the total up to three. If more than one kind of set is used for the shorter waves the total may reach five or more. How, then, can we have them all and not go broke?

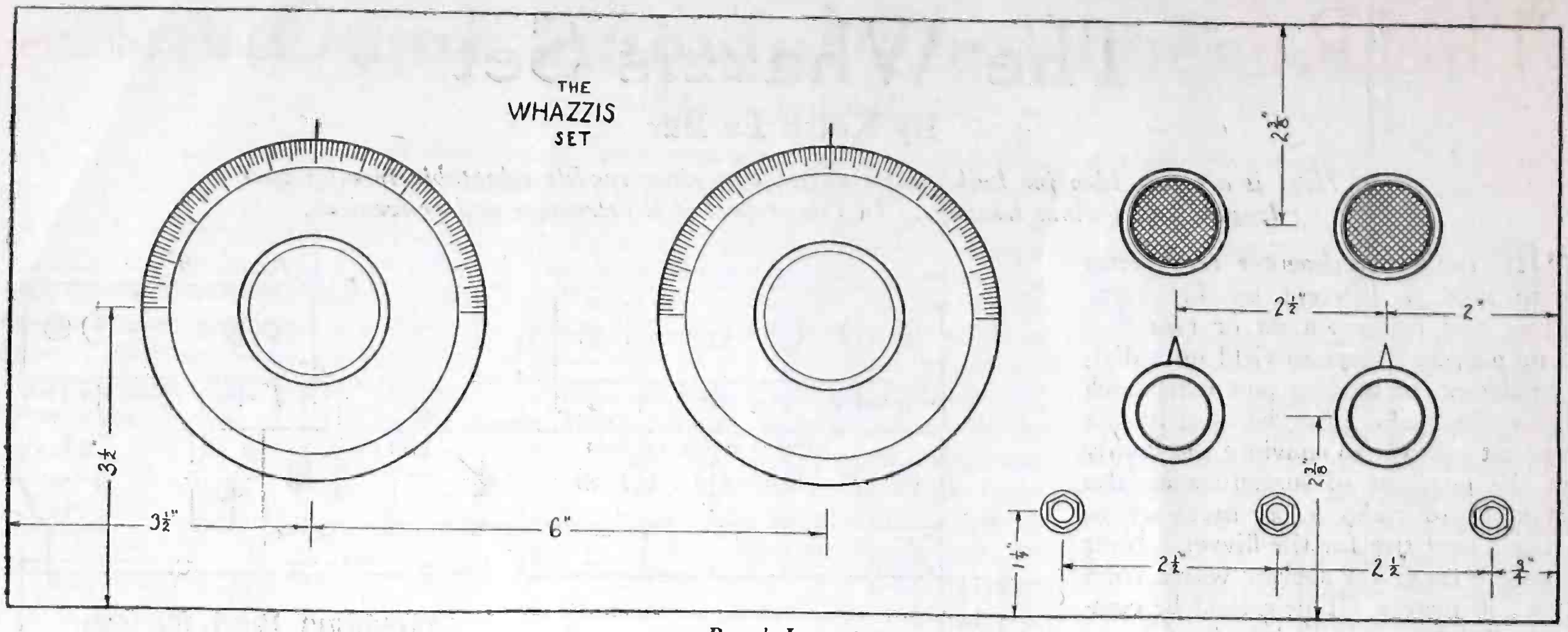
The answer is—combine all these sets in one. This saves trouble, conserves space, and is less costly. The usual result of an effort in this direction is a set mounted on a panel about the size of the side of a trunk and about as unwieldy. Marvelous are some of the switching arrangements employed, comprising in some cases the use of eight pole triple throw switches and the like. A lone signal coming into all this maze would get lost and die of weariness before getting to the grid of the detector tube. These sets, while great stuff to exhibit to visitors, cannot help but be slightly inefficient.

Therefore the Whazzis set, which may be used for any circuit utilizing two variable condensers. This is no small number, as any book of circuits will show. Among them are the four circuit tuner, the Reinartz tuner, the honeycomb coil tuner, the single circuit tuner with tuned plate regeneration, sets using a loop with capacity coupled feedback, and others.

The only thing that is different in these sets is the coils, their relation to each other, and the circuit. Therefore put the coils on a separate removable panel allowing the substitution of dif-



Plan of Main Panel.



Panel Layout.

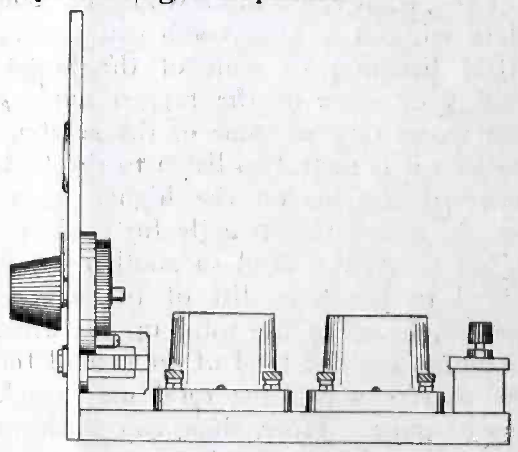
ferent coils wired in different ways and the problem of making a large number of sets into one is solved.

As taps are not necessary, except for the antenna coil for the four circuit tuner, concentrated inductances such as the Giblin-Remler coils, banked windings, or spiderweb coils are used, making it possible to use for the removable mounting panel one only 4 in. x 9½ in. This mounting panel is plugged into the set by means of cord tips on the panel and cord tip jacks on the set.

Ten jacks are used, mounted four at each end of the panel and two at one side. Two are for the aerial and ground, two for one variable condenser, two for the other condenser, two for the plate circuit and the remaining two for the grid and negative filament. They are supported on bakelite strips, which are raised from the baseboard by metal pillars. The dimensions are given in the illustration.

No attempt is made in this article to give complete instructions toward the building of a specific set. The set shown in the illustrations is merely an example, built to be as compact as possible and show the general design.

A 7 in. x 18 in. panel was used. With four inch dials, a very pleasing arrangement may be made, and if care is taken to symmetrically arrange the parts, such as by having the distance from the left edge of the panel to the edge of the dial, the right edge of the panel to edge of the knob on the amplifier rheostat, and the edge of the second dial to the knob on the detector rheostat made equal, it will present a more balanced appearance, that home-made look will vanish, and friends will ask the dealer's name and address with an idea of purchasing a duplicate.



Mounting for Amplifier Tubes

One rheostat is used for the detector and one for the two amplifier tubes, the tubes being placed immediately behind the respective rheostats. Short jacks are used, a number of types of which are now on the market. This makes it unnecessary to put the sockets on a bakelite sub-panel to dodge the jacks.

The complete detector and two stage amplifier may be arranged compactly as illustrated and no ill effects are noticeable from the close proximity of the apparatus. However, it may be spread over a larger panel, if desired, or a separate panel may be used for the amplifier, in which case the last stage may be push-pull with corresponding betterment of results.

If you see, after starting, that the set is going to be a knock-out, judiciously invest in a little engraving for the front panel. Like face powder, it is a useless expenditure, but does a lot of good.

The cord-tips are secured in the mounting panel by drilling a hole very slightly smaller than their diameter and

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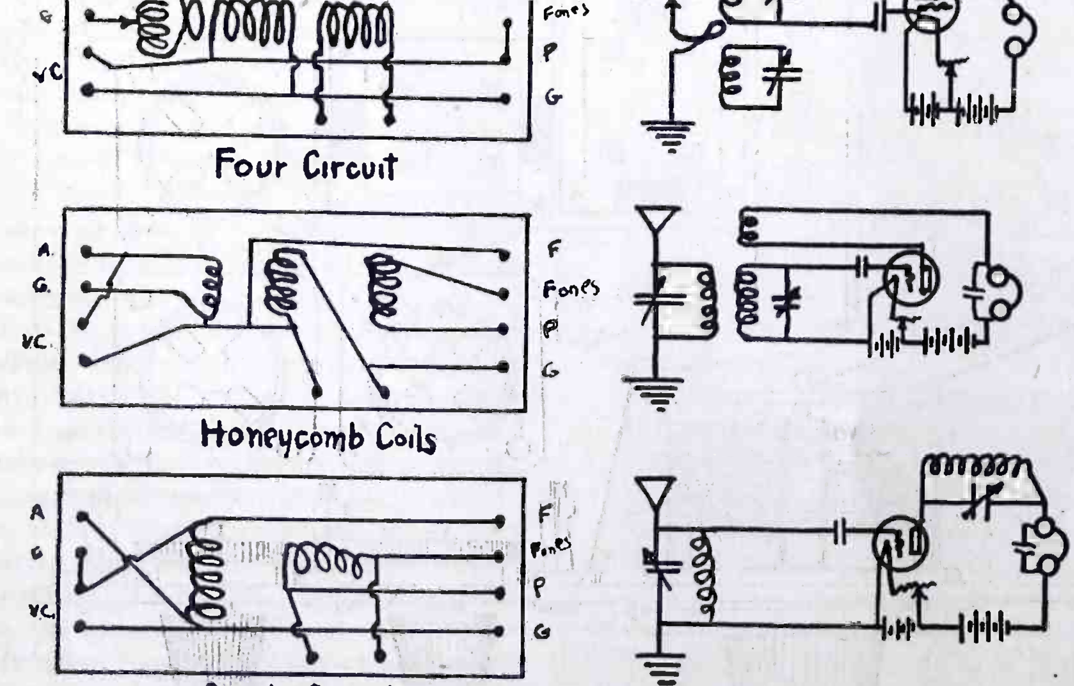


Arrangements for Various Hook-ups.

The Reason for Matching Impedances

By Samuel C. Miller

Here is a simple explanation of why the input impedance of a transformer or phone should equal the output impedance of the vacuum tube. In view of the more intelligent design of a receiving set thus made possible, it is to be hoped that transformer manufacturers will include this information in their specifications.

THE constants given on the data sheets accompanying a new tube are the amplification factor, the plate impedance and the mutual conductance. To the average radio fan the seemingly more important one is the amplification factor because it is believed that this constant alone determines the value of the tube as an amplifier. The impression seems to be that if the amplification factor is high then the actual amplification of a transformer-coupled tube will be high in proportion.

But this is not correct because the plate impedance plays just as important a part in the operation of a tube as does the amplification factor and both factors must be taken into account when considering the value of the tube as an amplifier. It is not difficult to manufacture a tube that will have an amplification constant of 50 to 100 instead of 6 to 8 as in the standard tubes; but in the high amplification factor tube the plate impedance will also be very high, somewhere around 200,000 to 500,000 ohms. This high plate impedance makes the tube practically useless when connected in circuit with an audio-frequency transformer. Let us connect a generator *G*, designed to be coupled to the standard tube which has a plate impedance of 20,000 ohms.

The maximum output that a tube is capable of supplying is obtained only when it is connected to a circuit of equal impedance. The reason for this can be more readily seen when the tube is considered as a generator feeding the transformer. Let us connect a generator *G*, Fig. 1, to various values of external resistance, R_1. The generator has an internal resistance *R* of 20 ohms and generates a constant voltage, *E*, of 100 volts. The current that *G* will supply to R_1 depends on the total resistance in the circuit, which is the sum of *R* and R_1. When an external resistance of 1 ohm is connected across the generator, the total resistance $R + R_1$ is $20 + 1 = 21$ ohms. With 100 volts generated, the current *I* flowing in the circuit is $100/21 = 4.76$ amperes. The power in watts supplied to R_1 is found by the formula $W = I^2 R$ or $4.76^2 \times 1 = 22.6$ watts. The total power generated by the generator is $4.76^2 \times 21 = 474.6$ of which $4.76^2 \times 20 = 452$ watts is lost in the resistance *R* of the generator.

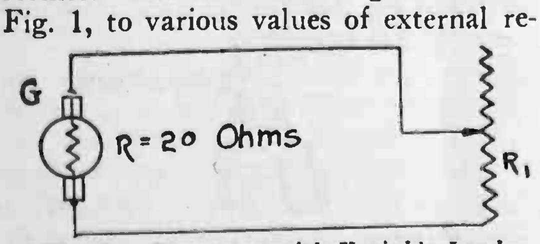


Fig. 1. Generator with Variable Load

Substituting for the resistance of 1 ohm in the above example different values for R_1, a table is obtained which gives for every value of R_1 the total power generated, the power supplied to R_1, and the power consumed within the generator. It is to be noticed that, when the external resistance R_1 is 20 ohms or equal to the resistance *R* of the generator, the power supplied to R_1 is greatest. While the efficiency is not greatest at this value we are more concerned with output than efficiency in a tube circuit. This example clearly indicates the importance of matching resistances, or impedances, to obtain the maximum output.

TABLE I

R_1 in Ohms	Total Watts Generated	Power Output to R_1	Power consumed in generator
1	474.6	22.6	452
5	384	74	310
10	333	117	234
20	250	125	125
30	200	120	80
45	153	106	47
80	100	80	20

A tube when connected to a circuit may be used either as a device to impress on its output load a maximum voltage, or as a device which supplies the circuit with the maximum amount of power it is capable of delivering. In the first case, it is used as a voltage amplifier and in the second case as a power amplifier. In Fig. 2, where tube *1* is used as a voltage amplifier, it is desired that it impress a maxiumum voltage on the transformer which steps up and impresses a higher voltage e_1 on the grid of tube *2*. In Fig. 3, the tube is connected to a pair of phones, the object being to supply the maximum amount of power for conversion into sound waves of maximum intensity.

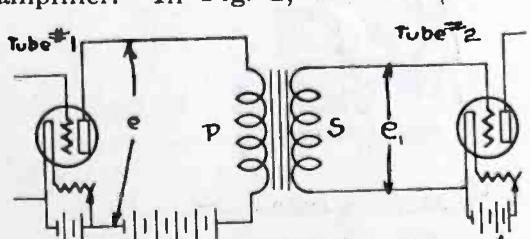


Fig. 2. Voltage Amplifier Circuit

With a standard power transformer such as is used for house lighting, bell ringing, etc., all that is required is a step up or step down in voltage at the highest possible efficiency for 60 cycles. But when dealing with transformers for radio-telephony, where the frequency varies from 60 cycles to 5000 cycles for high quality transmission, the problem becomes more complex because it is desired to amplify all this band of frequencies with equal intensity. If any of these frequencies are amplified by the transformer with a difference in intensity in relation to any other frequency, distortion will occur unless the same relative difference in frequency intensity exists when the sounds are put into the microphone at the broadcasting station. This means that if two instruments such as the violin and bass viol are playing a duet, the transformer may amplify the low bass viol notes a great deal less than the high violin notes and thus produce an effect different from that actually being played.

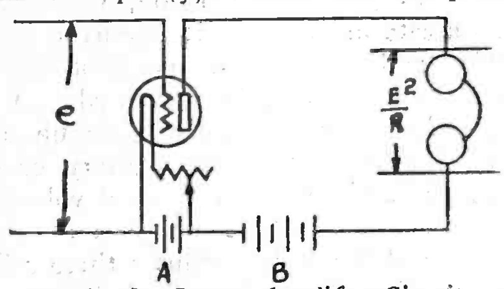


Fig. 3. Power Amplifier Circuit

To analyze the operation of a tube coupled to an audio-frequency transformer and its circuit, it is necessary to present an equivalent circuit. This is shown in Fig. 4 and represents the circuit of Fig. 2.

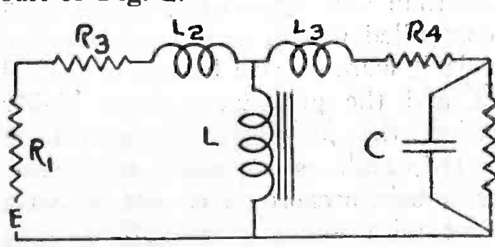


Fig. 4. Equivalent to Voltage Amplifier Circuit

E is the voltage generated by tube *1* and R_1 is the internal plate impedance of the tube. *L* is the mutual inductance of the transformer and is equal to the primary inductance due to the coupling being pratically unity. R_3 is the primary ohmic resistance of the primary and R_4 the ohmic resistance of the secondary. L_2 and L_3 are the leakage inductance of the primary and secondary. *R* is the load corresponding to the input of tube *2* and is practically infinite resistance. *C* is the distributed capacity of the secondary of the transformer and, when converted back across R_1, becomes

Continued on page 62

Revealing the Mystery of the "C" Battery

By Jacques Avon

In view of the importance of the "C" battery as a means for minimizing distortion in amplifier circuits and reducing "B" battery current consumption, these suggestions should prove of interest and value. The article clearly shows the purpose and application of this device.

WHILE *C* batteries are employed to prevent distortion, they can also create distortion. It is only by an understanding of their operation that such distortion may be prevented.

A *C* battery is usually made up of several cells of flashlight battery connected in series so that the total voltage of the battery will be the sum of the voltages of the cells. Thus a three cell battery gives 4.5 volts. Such batteries are placed in a circuit so that their negative poles are connected with the grid and consequently their function is to place a negative charge of electricity upon the grid. The positive pole of the *C* battery finds its way to the filament and the negative pole of the *B* battery. This method of connecting can easily be remembered by keeping in mind that it is connected just the reverse of the *B* battery. The positive pole of the *B* battery is always connected to the plate while the negative pole of the *C* battery is always connected to the grid. It is to be remembered that this arrangement is not to be employed with detector tubes, but only with amplifiers.

The object is to place enough negative potential upon the grid so that its maximum positive point will still remain below zero. Since a negative grid cannot draw a current, no distortion will be produced.

A *C* battery of the wrong voltage, either too high or too low, will be worse than nothing. The voltage must be controlled within rather narrow limits. If it were carried beyond a critical point and the grid were made highly negative, the plate current would be distorted, and, as a result, badly distorted music, because we cannot distort a current with sound superimposed upon it without at the same time distorting the sound. Indeed if we insist upon carrying the negative potential of the grid to a point where it is abnormally high, we shall cut off the plate current entirely. We should choose a *C* battery of such voltage that when the grid is at its most positive point it will still have an appreciable negative potential. This will prevent the plate current from being distorted and also keep the music sweet and melodious. A potentiometer shunted across the *C* battery so that its potential could be varied from practically zero to full value is one extreme means of getting the correct voltage. It will be found that the voltage should be somewhere between 3 and 9.

The amount of *C* battery on the first stage is not nearly as critical as that on the second stage. This is easy to understand if we know that the voltage of the incoming radio wave is weaker and therefore can be more readily accommodated to the straight part of the characteristic curve. Since the voltage is boosted in each stage of amplification, in the second stage it has been built up to a higher point and the radio user will therefore find it harder to reach just the proper *C* battery potential.

Although the *C* battery is usually employed as shown in Fig. 1, experience

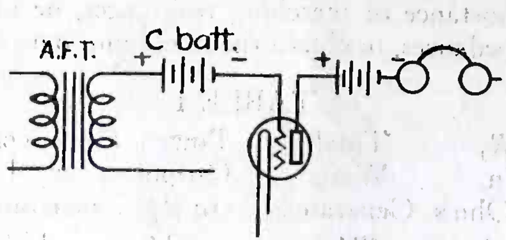


Fig. 1. Usual C Battery Circuit

has proven that it is more practical to place it as shown in Fig. 2 where it may be used without adding a length to the grid lead, which, owing to its susceptibility to stray currents, it is best to keep as short as possible. A long grid lead is an invitation to stray currents and when they are induced in it a feed-back condition is brought about which usually results in audio-frequency regeneration and the consequent distortion. It is wise therefore to place the *C* battery between the filament and the secondary of the amplifying transformer. When in this position the impedance of the secondary winding acts in such a manner as to ward off any stray potentials that may reach the grid and bring about trouble.

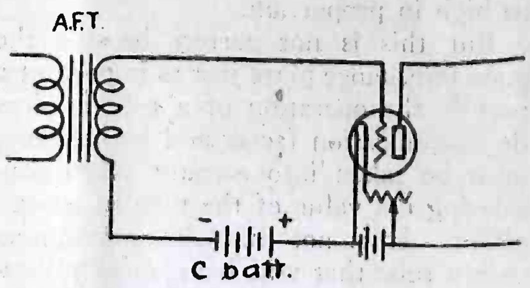
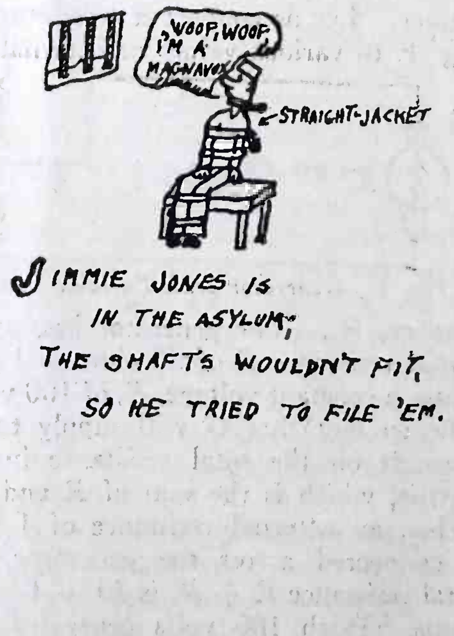
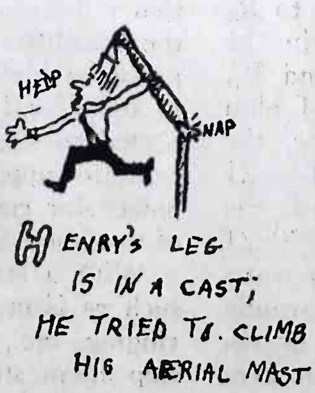


Fig. 2. Improved C Battery Circuit

It is always well to keep the *C* battery fresh, for when extreme chemical action sets in, which is usually denoted by swelling and the formation of blisters, the battery is apt to become noisy through a certain amount of current fluctuation to which the grid is somewhat sensitive, especially at the first stage. However, but a trifle of current is drawn from a *C* battery and it can be used for a long time before it will be necessary to replace it.





-SULLIVAN-

"Out of the swirling mists a gray, vague shadowy shape swooped down on him with a weird banshee wail."

McGuffy's Flying Antenna

By Paul Oard

This account of the sad experiences of a youthful radio experimenter in pioneer days has in it a strange ring of truth. At least they might have happened. And in the telling there is much good humor.

"SON," said McGuffy senior, removing his pipe from his mouth and eyeing his offspring thoughtfully, "the time has arrived when you and I must have an understanding. I am a long suffering son of Erin, and far be it from me to interfere with your lawful pursuit of scientific knowledge, but this business of blowing your dad out of the bathtub and into the parlor where your mother is entertaining her lady friends, hardly comes under science. I gave up trying to make a farmer out of you ever since the day you rigged up a wireless on the hay wagon and stuck a pitchfork into me when you received an S O S from the Norwegian ship that lost her 'rodder' off Eureka, but there is a limit to my long suffering patience. I would be willing to be patient with you, if my being patient didn't promise to make a patient of me. Your ma says that Mrs. Hannigan hasn't recovered from the shock yet, and that the neighbors had to use physical force in restraining Hannigan from coming over here and challenging me to a duel. I am having enough trouble with you without taking on the husband of some lady who objects to my forced appearance clad in a suit of the Adam period."

So saying, McGuffy senior settled back in his chair, puffed viciously at his pipe and eyed his son, Thomas McGuffy, with a determined look. The occasion of his outburst followed the day after that historic event, wirelessly speaking, when young McGuffy's Poulsen arc transmitter, the first to be built in amateur circles in so far as I am aware, in the United States, had exploded violently, just as McGuffy senior was taking his bath after a dusty trip to his ranch. McGuffy had failed to provide poppet valves in the arc chamber, and a leak in the electrode channel had permitted air to mingle with the hydrogen gas in which the arc burned. When McGuffy struck his arc, the gaseous mixture had exploded violently, wrecking the arc housing. Part of the housing blew into the bathroom, striking McGuffy senior amidships, and had toppled him out of the bathtub into the parlor where Mrs. McGuffy was receiving three lady callers. Another part of the arc housing struck the McGuffy cat, causing it to jump into a pan of homemade tomato catsup set out to cool, a catastrophe that spoiled the catsup and sent the feline caterwauling around the house to collide with the agitated ladies as they hurriedly emerged in retreat from the parlor.

The result of the council of war between McGuffy and his father resulted in a compromise upon the part of both parties. McGuffy senior withdrew his parental ban upon all things wireless to a point that would allow his son to experiment in wireless as long as he confined his activities to reception only. But no more transmitting. In vain young McGuffy attempted to convince his father that there were transmitters *and* transmitters, and that a spark transmitter could not possibly explode. Nothing doing, said McGuffy senior. Young McGuffy, having started at the top of the ladder, rather than the bottom, in that he had built an arc transmitter when all other amateurs were still engaged in heated arguments over the relative merits of zinc and copper in the construction of fixed gaps, and whether flanges on the gap really increased radiation, and whether helixes were of im-

Continued on page 66

Tuned Radio Frequency with Neutralized Capacity Coupling

By A. L. Munzig

This is not merely an article on assembly. Detailed directions are given for constructing the tuned radio-frequency transformers and neutralizing condensers. In conjunction with other articles in this issue little trouble should be experienced in making a satisfactory receiver of this type.

THE tendency of the usual tuned radio-frequency circuit to oscillate at resonance is due to the capacity coupling inherent in all vacuum tubes. This capacity which exists between grid and plate, grid and filament and plate and filament can be corrected by the circuit shown in Fig. 1. It uses four A tubes and one soft detector tube. Two jacks are shown. One for plugging in the head phones and one for a loud speaker.

The necessary parts are listed below. Most of them can be found around the experimenters' shop.

2 Panels 3 in. by 3 in. by 3/16 in. (for tube sockets).
1 Panel 7 in. by 24 in. by 3/16 in.
1 Panel 6 in. by 4 in. by 3/16 in.
1 Panel 6 in. by 4½ in by 3/16 in.
1 Sub-base 7 in. by 23 in. by ¾ in.
5 Tube sockets.
1 25-ohm rheostat able to stand 1 amp.
1 6-ohm rheostat.
1 6-ohm rheostat.
3 23-plate variable condensers.
3 Bakelite tubes 2⅞ in. dia. by 3 in. long.
½ lb. No. 24 DCC wire.
2 Audio-frequency transformers — one low ratio and one high.
1 Double circuit jack.
1 Single circuit jack.
3 4-in. dials.
1 C-H push switch.
1 Plug.
1 .0005 Micadon.
1 .002 Micadon.
7 inches of ¼-in. copper tubing.

The tuned radio-frequency transformers are constructed as follows: On each of the bakelite tubes 12 turns of No. 24 DCC wire are wound exactly in the center of the tubes. Give this winding a coat of collodion to hold it in place. Then wind 55 turns of the same size wire over the 12 turns, starting 11/16th in. in on tube. Give this winding a coat of collodion also. Lead all ends of wire to binding posts and soldering lugs. Mount all three on the back of 23-plate variable condensers. This can be done by bending sheet brass strips to conform with the mountings on the rear of condensers.

The miniature variable condensers used in neutralizing the capacity of the tubes can be constructed as follows: Cut a piece of copper or brass tubing ¼ in. in diameter, 3 in. long. On one end solder a large lug. Insert in the tube a length of flexible lamp cord, leaving about 3 in. extending out. On the end of this solder a small lug. This is shown in Fig. 2. Two of these condensers are necessary. These are shown as *NC* in Fig. 1.

Referring to the rear view picture it will be seen that the two audio-frequency amplifying tubes and detector tube are mounted on the 6 in. by 4 in. panel. The 6 in. by 4½ in. panel mounts the two audio-frequency transformers and the battery connections. The two radio-frequency amplifying tube sockets are mounted on the 3 in. by 3 in. panels. All of these panels are fastened to the

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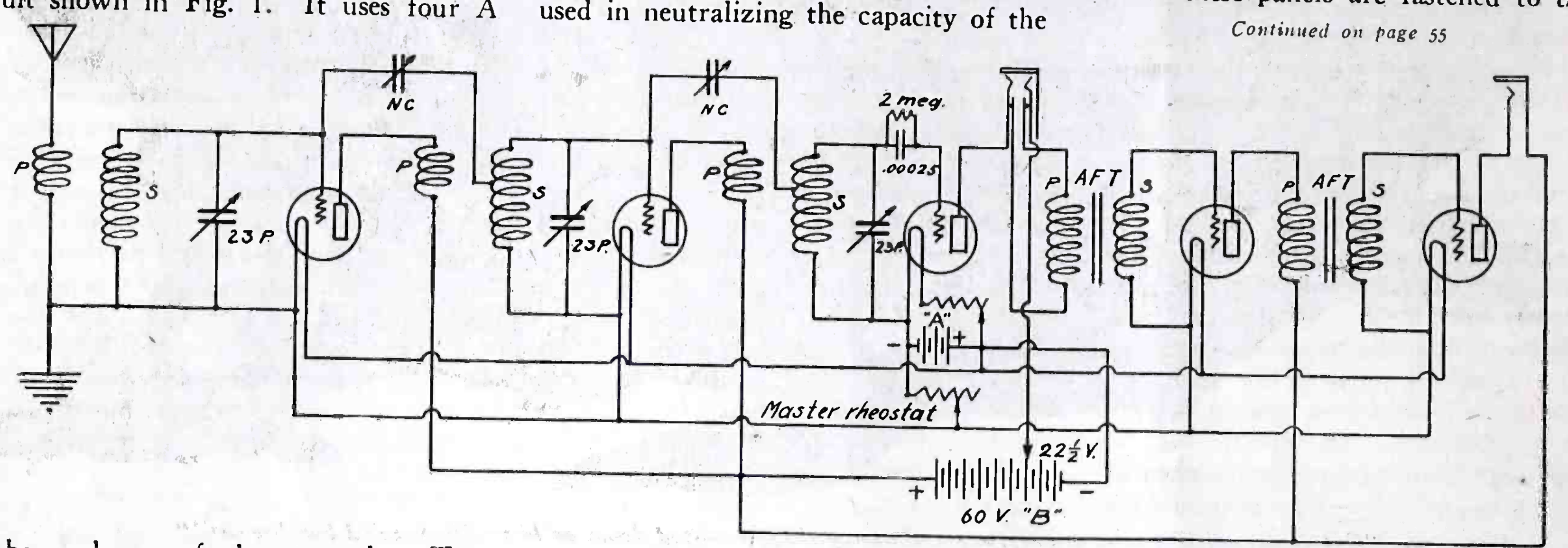


Fig. 1. Circuit Diagram

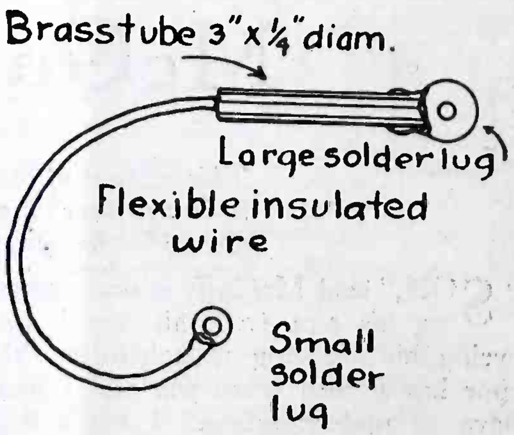
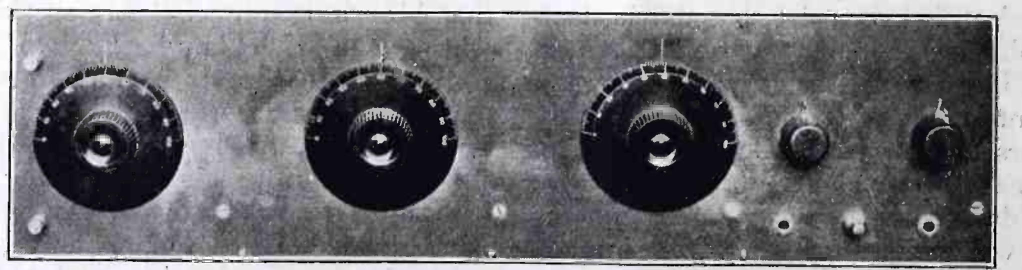
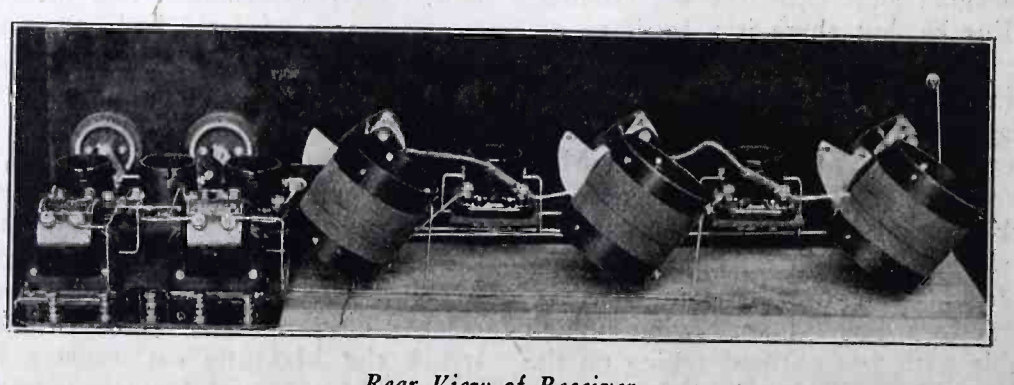


Fig. 2. Construction of Neutralizing Condenser



Front View of Receiver



Rear View of Receiver

The Neutrodyne Circuit

By L. R. Felder

This article presents in simple language a complete explanation of the theory of the neutrodyne circuit. With these principles in mind a builder or operator can proceed intelligently.

ONE of the most recently developed circuits which has justifiably created a big sensation is the Neutrodyne as developed by Prof. L. A. Hazeltine. This development is without doubt a distinct improvement in the art of radio reception in that it completely overcomes one of the most annoying causes of failure in tuned radio-frequency amplification, namely it eliminates the tendency of tuned amplifiers to oscillate. In order to thoroughly appreciate and understand what the neutrodyne accomplishes it is necessary to examine the conditions which led to its development.

One of the principal sources of trouble in radio-frequency circuits is the existence of small stray or distributed capacity between different parts of the circuits. Such small capacities are especially harmful at the low wavelengths or high frequencies. For at the high frequencies the reactance of this small stray capacity becomes very small and so passes high-frequency currents when it is not intended that current should pass.

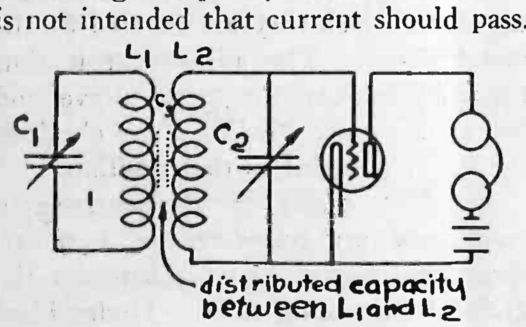


Fig. 1. Capacity Effect Between Inductively Coupled Coils

Thus suppose we have, as in Fig. 1, two radio-frequency circuits which are magnetically coupled to each other by the coils L_1 and L_2. Energy then passes from circuit *1* to circuit *2* by way of magnetic induction. But since both coils are conductors and are separated by an insulating medium they constitute a small condenser, or, in other words, there is distributed capacity between them. This distributed capacity behaves like any other condenser and will therefore let radio-frequency currents flow through it. Thus high-frequency currents would flow from circuit *1* to circuit *2* by way of the small stray capacity rather than by way of the transformer coils and induction, thus defeating the purpose of the transformer. Also these capacity currents, called parasitic currents, represent a loss of energy, and are therefore an undesirable feature of any circuit. Not only does this small stray capacity introduce harmful effects by by-passing from their legitimate paths currents to which the circuits are tuned, but it also creates trouble by introducing into the circuits undesirable, extraneous currents to which the circuits are not tuned.

Consider again Fig. 1 which represents two radio-frequency circuits inductively coupled, the secondary of which feeds the grid of a detector tube, and suppose C_3 represents the small distributed capacity existing between the two coils. Let us furthermore assume that the circuits represent primary and secondary of a receiver which is supposed to receive over a band of wavelengths from 200 to 600 meters. In the first place we would have present the harmful effects described above, namely at the low wavelengths around 200 meters the distributed capacity will by-pass some of the received current, preventing the coupling coils from performing their proper function. In the second place when reception is taking place at the higher wavelengths interference from low wave signals will be introduced by the distributed capacity. For any low wave signal which may get into the primary circuit in any way, as for example via the aerial, will be transmitted to the secondary through the capacity which exists between primary and secondary, and thus will get on the grid of the detector tube and produce an interfering signal. This occurs irrespective of the tuning of the circuits, since capacity parasitic currents do not depend on the tuning of circuits but simply flow through the capacity coupling.

When we consider the vacuum tube we are again confronted with very small capacities which influence the action of the tube considerably. Thus the plate and grid together form the two plates of a tiny condenser. In the average tube this capacity is of the order of 3 to 5 micro-microfarads. This is, of course, very minute but is capable of doing untold harm if not properly controlled.

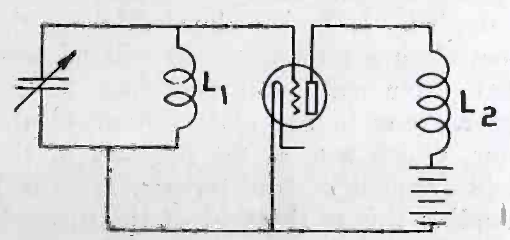


Fig. 2. Conventional Amplifier Circuit

Fig. 2 represents a conventional type of circuit frequently employed in radio reception, as for example one stage of a transformer coupled r.f. amplifier with one tuned circuit. L_2 is not coupled to L_1 and it might therefore be thought that such an amplifier would be stable. However this is not necessarily the case as will be seen when we simplify this circuit as in Fig. 3 where we have inserted C_p in place of the tube. C_p represents the capacity between plate and grid. This small capacity is in reality a coupling condenser, for one plate is in the grid or input circuit while the other is in the plate or output circuit. As a result, even if there is zero coupling between coils L_1 and L_2, it will be seen that there is capacity coupling through C_p between the output and input. Any current flowing in the plate circuit of the tube will therefore feed back into the input circuit thus rendering the circuit unstable. This explains the reason for regeneration in circuits where there is no apparent feed-back coupling between input and output. The higher the frequency the greater is this capacitive feed-back, for the reactance of the small coupling condenser decreases and makes feed-back all the easier. It is for this

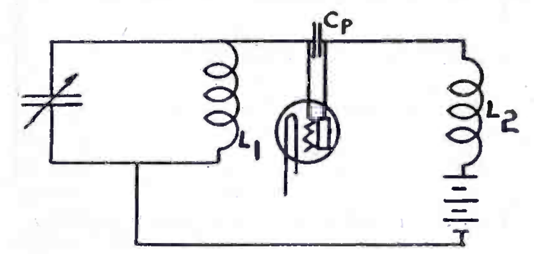


Fig. 3. Tube Capacity Effect in Circuit of Fig. 2.

reason that radio-frequency amplification at the low waves—600 meters and under—was very unsuccessful for a long time, for the capacity coupling and feed-back was so great that circuits were rendered unstable at the slightest provocation and would oscillate, thus ruining any amplification.

A number of methods have been advanced for mitigating this undesirable capacity effect, as for example, the well known device of a stabilizer potentiometer. This does not eliminate the regenerating effect of the tube capacity, but simply introduces such losses into the grid circuit that the amount of regeneration is reduced. One of the solutions to this problem of stable radio-frequency amplification was the development of the super-heterodyne receiver, which will be taken up in the next paper. Another solution is the neutrodyne circuit as advanced by Prof. L. A. Hazeltine.

The principle on which the neutrodyne system is based is that of neutralizing the effect of one voltage by an equal and opposite voltage, and in this particular case, of neutralizing the capacity feed-back of the tube by an equal and opposite capacity feed-back introduced externally, so, that the two feed-backs neutralize each other.

To understand the principle let us consider the simple case of two magnetically coupled circuits which is more easily understood, see Fig. 4. Here we

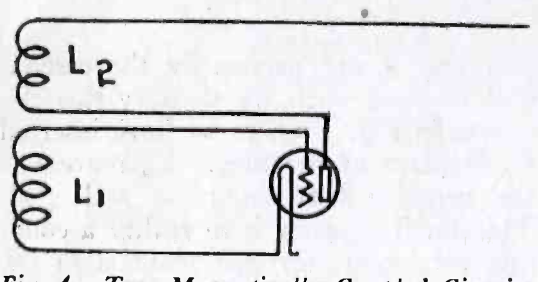


Fig. 4. Two Magnetically Coupled Circuits.

have inductive coupling and coil L_2 induces in coil L_1 a voltage which has a certain value and phase. Suppose that we are able to couple another coil L_3 to coil L_1, and the direction of the coupling is such that the voltage induced in L_1 by L_3 is equal and opposite to the voltage induced in L_1 by L_2. Then these two voltages neutralize and balance each other in L_1, and no effect is produced by either, Fig. 5.

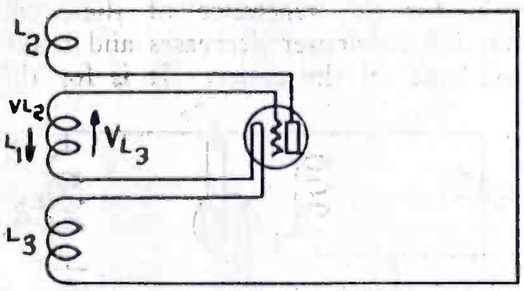


Fig. 5. Neutralized Inductive Coupling

It is this principle which is applied in neutralizing the feed-back effect of tube capacity. But since the feed-back now is capacitive it is necessary to employ a condenser to balance it. Furthermore, in order to obtain a voltage of opposite phase to an existing voltage it is necessary to employ two opposing coils as explained in the preceding paragraph. The neutrodyne method then is as follows:

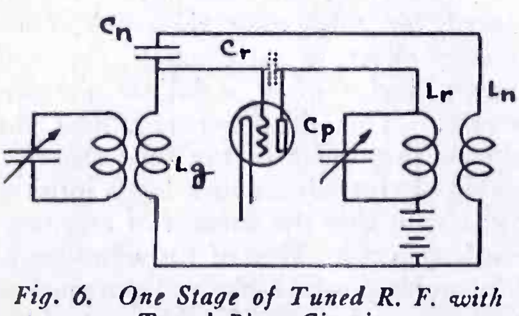


Fig. 6. One Stage of Tuned R. F. with Tuned Plate Circuit.

Fig. 6 represents one stage of a multistage radio-frequency amplifier in which the plate circuit is the tuned circuit. The dotted capacity C_r represents the small but disturbing capacity which always exists between the plate and grid of the tube. L_g, L_r and L_n represent inductance coils, of which L_n is the neutralizing inductance. C_n is a small fixed capacity external to the tube which is used as the neutralizing condenser. Assume for the moment that the neutralizing inductance L_n and the neutralizing capacity C_n are not present. When the amplified currents flow through the tuned plate circuit L_r C_p a regenerative action is set up through the medium of the tube capacity C_r and a feed-back current flows from plate circuit through the capacity coupling C_r and through L_g. This feed-back current flowing through L_g sets up a voltage across it which is applied to the grid and thus reamplified by the tube, in this way producing the well-known regenerative effect as explained in the first article of this series. To neutralize this effect the coil L_n is coupled to L_r so that the voltage induced in it is opposite in phase to that in coil L_r. This is obtained by using reverse coupling to that normally employed. In addition the external neutralizing capacity is adjustable so that the current through it may be controlled. By adjusting the neutralizing condenser C_r, the current through it due to the reversed voltage of L_n may be brought to such a value that it sets up a voltage in L_g equal to that set up by the feed-back current through C_r. But since these voltages are opposite in phase, due to the reversed coupling of L_r and L_n, they just neutralize each other and the regenerative effect is thus destroyed. The exact value of this neutralizing condenser may be calculated mathematically from a knowledge of the tube capacity C_r and the number of turns in L_r and L_n.

In coupling from the plate circuit of Fig. 6 to a succeeding tube another coil is needed. If L_n is utilized solely as the neutralizing inductance it will be seen that three coils will therefore be required, one in the plate circuit of the tube, which acts as the primary of the radio-frequency transformer, a coil coupling this to the grid of the succeeding tube, *i.e.* the secondary of the radio-frequency transformer, and thirdly a neutralizing coil. Such an arrangement is obviously cumbersone. As a result in commercial neutrodyne receivers the neutralizing inductance acts also as the secondary of the radio-frequency interstage transformer.

Thus the neutralizing coil and the plate inductance must be designed to behave efficiently as a radio-frequency transformer, and hence the ratio of the number of turns in each coil is limited. If the coils have the same number of turns, then the neutralizing condenser must equal the capacity of the tube, C_r. In practice this capacity is determined by trial and when the exact suitable value is found the capacity is fixed and sealed.

It will be apparent that the neutralizing condenser is extremely small, of the order of a few micro-microfarads. In order to secure such small capacities which are adjustable a small metal sleeve about 2 in. long, or less, slides over the ends of two insulated wires. The capacity between the ends of these two wires is extremely small and varies with the extent to which they are covered by the metal sleeve. The adjustment is thus made by moving the metal sleeve and when the proper conditions are obtained the sleeve is sealed in that position.

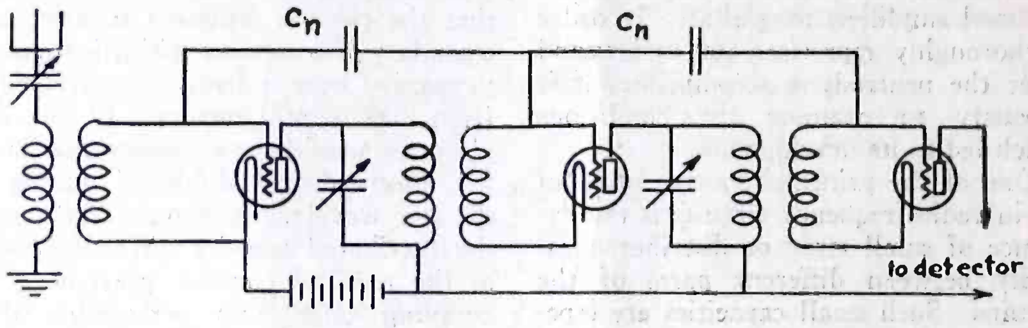


Fig. 7. Condenser Connections in Multi-Stage Neutrodyne.

Fig. 7 illustrates how the neutralizing condensers are connected in a multistage neutrodyne, namely, between the grids of succeeding tubes. Under ideal conditions the neutralizing condenser should be constant at all wavelengths. Actually, however, on account of leakage in the radio-frequency transformers this is not the case. But over a narrow band of wavelengths a fixed value of the neutralizing condenser is satisfactory. But even in cases where the neutralizing capacity is not exactly of the right value it effects a reduction in the feed-back coupling through the tube capacity and avoids oscillations due to regeneration. The neutrodyne circuit has thus made tuned radio-frequency amplification at very low wavelengths a possibility without the usual uncertainty and instability which heretofore accompanied it.

The use of a *C* battery for maintaining the grid of a vacuum tube at a negative potential not only increases its efficiency as an amplifier, giving increased volume and improved quality, but also makes a saving in the consumption of current from the *B* battery. This saving may reduce the *B* battery current to about a third of the amount normally used and thus make the *B* battery last three times as long.

A Reflex Receiver for Beginners

Part III

By Charles F. Filstead, 6CU

This, the concluding article in a series of three, describes a reflexed tube unit to be used with a crystal detector unit. The first part appeared in the March and the second in the April number.

THE single-tube unit, here described, when connected to the crystal receiving set described in Part I, will form a single-tube reflex set. A one-tube reflex set is equal to one stage of radio-frequency amplification, a crystal detector, and one stage of audio-frequency amplification. If desired, the amplifier which was described in Part II can be added to this reflex set, giving an additional stage of audio-frequency amplification.

Due to one of the tubes being reflexed, the set is almost equal to a standard four-tube receiving set. On local signals, a 2 or 3 ft. loop gives fine audibility, and it has the added advantage of being almost free both from static and interference from other stations. Using a loop antenna connected across the aerial and ground binding posts of the crystal set, and connecting the ground in addition, long-distance stations can be brought in, although much weaker than when an aerial is used. Another way to get away from local interference, and still bring in the long-distance stuff is to disconnect the lead-in from the aerial binding post, and connect the ground wire where the aerial lead usually goes. When these other stunts are used the tuning of the set will be changed, of course.

A list of the parts used in the construction of this single-tube unit are given below:

Panel of 1/8-in. bakelite, 6x10 in.
Terminal panel of 1/8-in. bakelite, 1x5 in.
Sub-base of 1/2-in. wood, 6x10 in.
Audio-frequency amplifying transformer.
Vacuum-tube socket mounted on sponge-rubber.
30-ohm filament rheostat.
Two 3-in. dials—for the potentiometer and the rheostat (same make as used on the crystal set).
Eleven binding posts.
Two, 0.002 microfarad, fixed mica condensers.
Potentiometer of 200 to 400 ohms resistance.
Erla radio-frequency amplifying transformer.
Panel bezel for viewing tube.

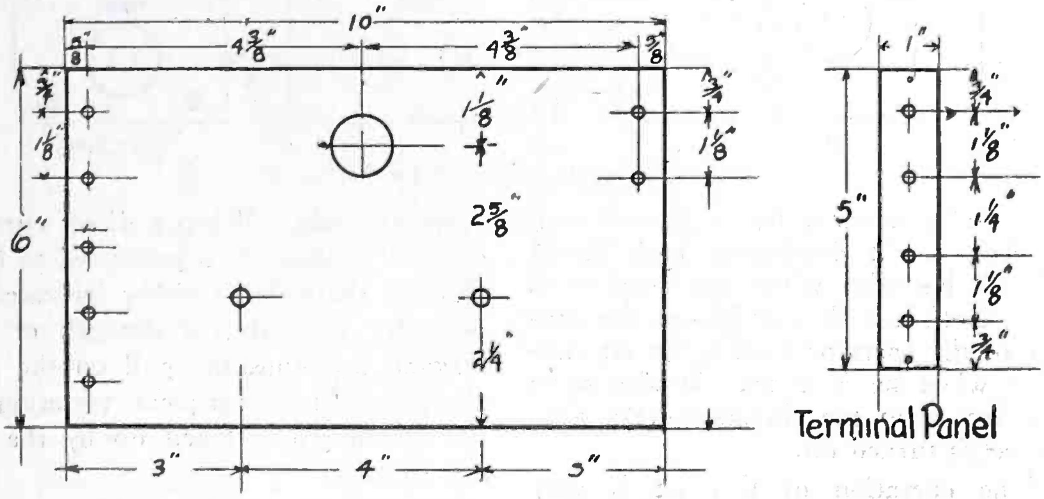


Fig. 1. Drilling Layout for Panels.

The large bakelite panel should be drilled as shown in Fig. 1. The sub-base is attached to it at the back by small wood screws put through the three holes in the bottom of the panel. The location of the other holes in the panel will vary somewhat with the make of parts used in the set. The tube socket is mounted on the sub-base directly behind the center of the panel so that it will be in line with the bezel in the panel. Facing the front of the panel, the audio-frequency amplifying transformer should be placed on the left of the tube socket, and the radio-frequency transformer on the right of it. The potentiometer is fastened to the panel directly in front of the audio-frequency transformer, and the rheostat is fastened to the panel in front of the radio-frequency transformer.

The terminal panel is drilled as shown in Fig. 1. Four binding posts are mounted on it and are for the *A* and *B* battery leads to the set. This terminal panel with its binding posts is mounted on the rear of the sub-base directly behind the tube socket. To keep the binding posts from touching the wood sub-base, the terminal panel is raised 1/2-in. off the base by a small block of wood under each end, and fastened by two 1-in. wood screws.

The apparatus is wired up according to the diagram given in Fig. 2, taking care that all leads are as short and direct as possible, and that spaghetti tubing is used over the wire wherever there is a chance of two wires touching. Standard bus-bar wire should be used and right-angle bends made in it. To keep the dials from rubbing on the panel, thin metal or leather washers should be slipped over both the rheostat and potentiometer shafts before the dials are put on. As in previous installments, no dimensions will be given for the construction of the cabinet, as a number of articles have already appeared on that subject. If the builder so desires, he can take the three parts of this combination set, as already described, and build one cabinet to hold all three panels, thereby cutting down the labor and expense of three separate cabinets.

The tube used in this single-tube unit should be of the same type as that used in the one-stage amplifier described in Part II. The same batteries can be used to run both tubes, as is shown in the diagram in Fig. 3, which gives the hook-up for all three parts of the set. If the builder did not make the one-stage amplifier, that part of the set can be omitted, and the receivers connected to the two binding posts on the single-tube unit marked *X* and *X*. If a 199 or 299 is used, an adapter must be purchased, as that type of tube does not fit a standard socket.

To protect the tubes from burn-outs when experimenting, a 10 watt, 110 volt tungsten lamp should be placed in the negative lead of the plate battery, as shown in Fig. 3. This lamp not only serves to protect the tubes, but also, by

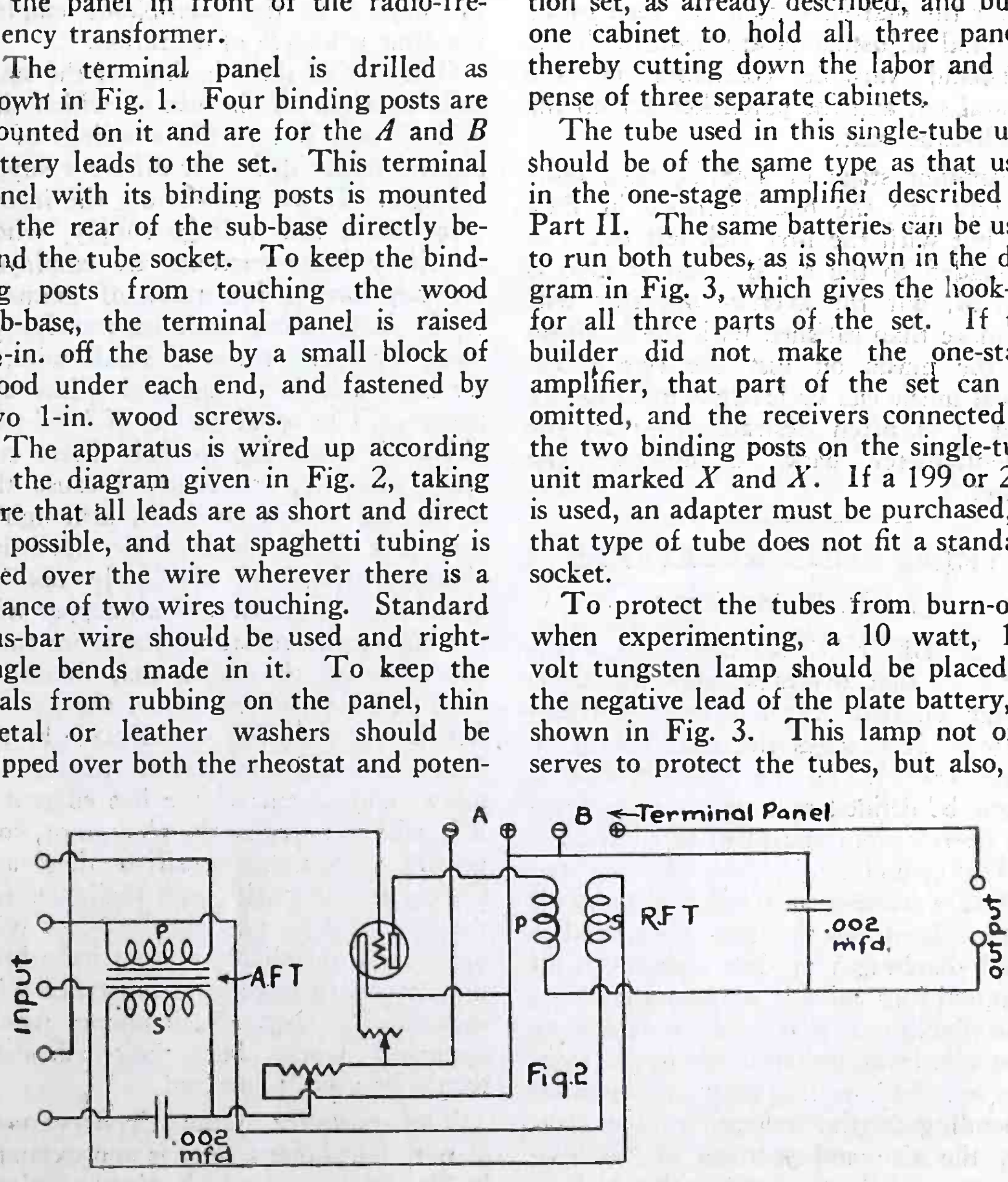


Fig. 2. Wiring Diagram for Reflexed Tube.

lighting up, it gives warning when the *B* battery is short-circuited.

A double-pole, single-throw knife switch is also shown connected to the batteries in Fig. 3. This switch is not

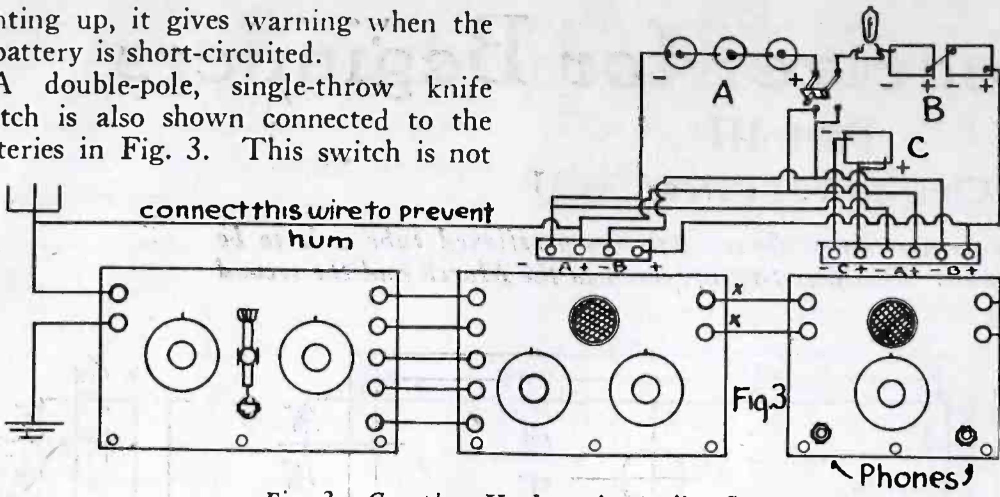


Fig. 3. Complete Hook-up for Reflex Set.

absolutely necessary but it is very convenient, for it disconnects both the *A* and *B* batteries when the receiver is turned off, and thereby lessens the danger of the operator leaving the set running when he is away. It also saves turning down the rheostats every time the set is turned off.

The operation of this set is very simple, and even a beginner will find little trouble in learning to tune it. First, the rheostats are turned up until the tubes are lighted sufficiently bright, then, with the potentiometer set in the middle of its resistance coil, the crystal detector is adjusted to a sensitive spot, and tuning is done with the right-hand variable condenser on the crystal set. After the desired station has been tuned in, final adjustments are made with the left-hand variable condenser on the crystal set, and the potentiometer on the single-tube unit.

Another stage of amplification, built exactly like the one described in Part II, but with the first jack left out, can be added to the set if more volume is desired, but the average operator will be more than satisfied with the loudness of the music on just the two tubes. Local music can be brought in so loudly that it is often desirable to turn the potentiometer back to decrease the sound.

TELEPHONE RECEIVERS

By D. B. McGowN

A TELEPHONE receiver is a device that makes audible the alternating current supplied from a transmitter. It changes electrical energy to sound energy. In the broadest sense it might be defined as a motor transforming energy from one form to another.

The common telephone receiver consists of a horse-shoe magnet, with small coils wound on the two ends, and a small diaphragm of thin sheet iron, all mounted in a suitably arranged housing. The diaphragm is constantly in a state of strain, being pulled down to the magnets but not touching them, the amount depending on the strength of the magnet, the size and stiffness of the diaphragm, and the tightness with which its edges are held. When a direct current of small magnitude is permitted to flow through the coils, it either increases or decreases the effective strength of the magnet, and thus the pull on the diaphragm. The consequent vibration of the diaphragm is taken up by the air as sound.

As the magnet is thoroughly saturated with magnetism, a very slight current in the coils is applied almost entirely to moving the diaphragm. Thus the use of a permanent magnet which absorbs little or no magnetism from the coils enables small current variations to be made audible.

The "watch-case" type of receiver as adapted to the head-phone employs the same principle of operation.

The size of the windings of the small coils depends on the use to which they will be put, just as the windings of an electric motor differ for different supply voltages. If we wish to use the instrument on a low voltage supply, where relatively large currents are employed, we may have a few turns of comparatively large wire, and, conversely, we must use many turns of small wire, if we have a high voltage and a low amperage. The usual rating of head-telephones is according to their direct current resistance, apparently because this is the easiest way to do it, although it tells but little about their operating characteristics, and absolutely nothing about their sensitivity. With copper wire the higher the resistance the more turns there are on the coils, and, therefore, with a fixed current value, the greater will be the resulting sound made by the diaphragm. In electrical terms, the more "ampere turns" the less current it will take to energize the phones, or, conversely, the more sensitive they are. Owing to the small space available, and the difficulty of winding the small wire used, some unreliable makers have been understood to have used resistance wire instead of copper. Such phones would doubtless work, but their efficiency would be greatly lowered.

The resistance of the telephones used in wire telephone service is approximately 80 ohms, d.c., which gives an alternating current impedance of about 300 ohms, on 800 cycles. The receivers used in radio work average 1,000 ohms resistance, d.c., and an alternating current impedance of from 10,000 to 15,000 ohms, depending on the characteristics of the phones. It would be advantageous to rate phones in their impedance, but generally the user has no idea of the constants of the circuits of his apparatus, and therefore, even if the impedance of the phones were known, it would mean but little to him.

As receivers contain permanent magnets, care should be taken that they are not jarred, as every jar decreases the strength of the magnets. Even in spite of good care, it will be found that telephones gradually lose their magnetism, and when this occurs they give weaker and weaker signals. In such a case the remedy is to return the phones to the manufacturer and have them re-magnetized, which usually places the phones in a condition nearly equal to new.

The diaphragms should be examined from time to time, and if they show signs of bending, or rusting, they should be replaced at once.

One of the commonest causes of trouble in telephone receivers is in the flexible connecting cords. These cords are made of thin copper tinsel wound on threads, and are liable to damage, through corrosion, or even continued bending. Many unknown and unexplainable noises in a receiving set can be located and eliminated by the use of new cords. A simple test for poor cords is to connect the phones across a new single dry cell. There should be a loud click when the terminals are touched, and a similar one when they the withdrawn. If the cord is worked back and forth, with the current on, a rubbing or scraping noise will be heard if the cord is defective, and it should be replaced. Usually it does not pay to try to repair cords, for if they are bad in one spot they would not be much better elsewhere and would only last a short time. Often poor cords can be located by working them back and forth while in use without bothering to connect them to a battery.

Loud-speaking telephones are specially made telephone receivers, so constructed that they will handle relatively large amounts of power, without injury or distortion. Although basically they are similar to the more common types, their larger power handling ability requires that they be more ruggedly built, and that many changes of design be made.

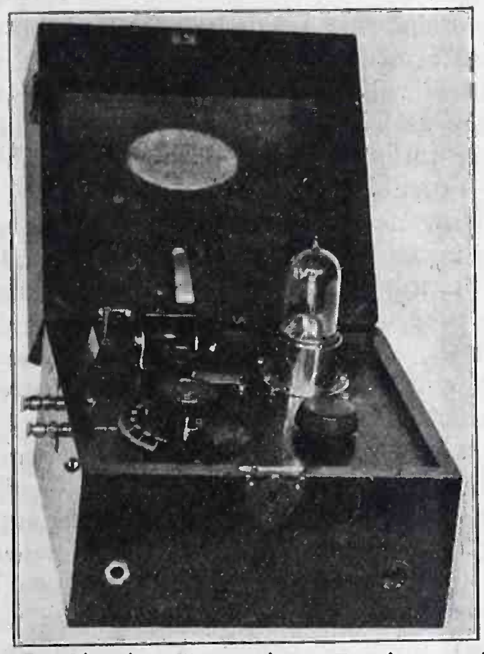
The proper resistance, or ampere turns ratio of phones, must be carefully considered, as well as the shape of the magnetic circuit, the air-gap between the pole-pieces and the diaphragm, etc., all of which must be given consideration, and sometimes worked out empirically.

Combination Radio Set

By F. W. Morse, Jr., 6ATZ

This is a remarkably simple and effective set that is capable of performing nearly all of the functions to which a vacuum tube may be applied. Nor is it merely a laboratory instrument but a thoroughly practical short-range transmitter and receiver.

MANY times does the amateur wish for a general utility set that will answer the purpose of a heterodyne, wavemeter, receiver, or low-power portable transmitter. The set to be described is not a complex multi-tube outfit but a simple affair using a dry cell tube and a loop. It covers the amateur's wavelength band from 170 to 230 meters. It may be thought that an instrument of this type, to satisfy the amateur's needs, is far beyond the limits of his pocketbook. But, on the contrary, the parts to be used can be found in any "Ham's" scrap box.



Combination Transmitter, Receiver and Wavemeter

Before going into construction detail I will briefly outline its capabilities. As a heterodyne, it will check a transmitter's wave or calibrate a receiver with a fair degree of accuracy. The receiving range of the set varies with conditions. Distances up to 300 miles have been covered during the "dark hours". Local work up to 5 or 10 miles can be handled with the set, as a transmitter.

Below is a list of parts which will be needed in the construction of the outfit:

- 1 Loop (specially constructed).
- 1 Variable Condenser .00025, 11 or 13 plate.
- 1 Grid Condenser .00025 mica variety.
- 1 Socket.
- 1 Rheostat, vernier not necessary.
- 1 Dial.
- 1 Panel, size optional.
- 1 S.P.S.T. Knife Switch.
- 10 Binding Posts.
- 1 Tube WD-11-WD-12 (hard).
- 1 Dry Cell (A Battery).
- 1 Tapped 45-Volt Battery.
- Phones.
- 1 .001 Phone Condenser.

The loop is composed of two coils, an outer and an inner. The outer coil is in the grid-filament circuit and is

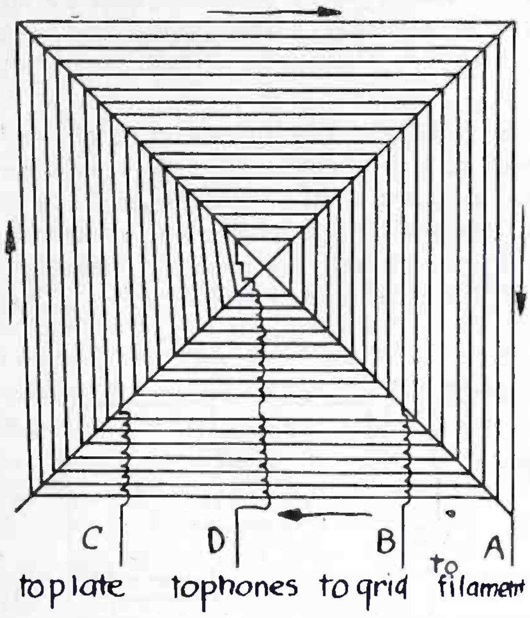


Fig. 1. Loop Construction

tuned by the variable condenser. The inner coil is the plate feed-back and has a fixed coupling. The cross members of the frame are 36 in. long. The base and support can be any size and shape. The writer used a 7 in. x 7 in. base with a 16-in. support. Beginning ¼ in. from the outside, wind 7 turns of No. 18 enamelled wire, spaced ½ in. apart, in the direction indicated in Fig. 1. Continue on the next cross member and wind 11 turns in the same direction and the same spacing. Solder on each end of the two coils a 3-ft. length of rubber-covered flexible wire which will be used as leads to the set.

The variable condenser may be of any make and design, but avoid using one where plates are very closely spaced. The grid condenser must have a mica dielectric, or the applied voltage will injure it. The socket should be of a good quality with firm contacts. The remaining apparatus may be of any type.

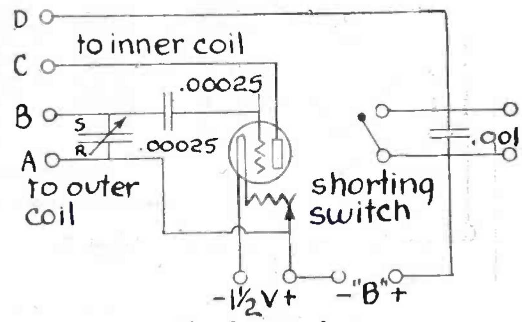


Fig. 2. Hook-up

Glancing at Fig. 2 you will recognize the single-circuit hook-up, but with a few modifications. In place of the primary coil and tickler coil of the single-circuit we substitute the loop with its two independent coils. An S.P.S.T. switch is placed across the phone leads, to short the phones when the high voltage is applied for transmitting. No particular layout will be given, as the size

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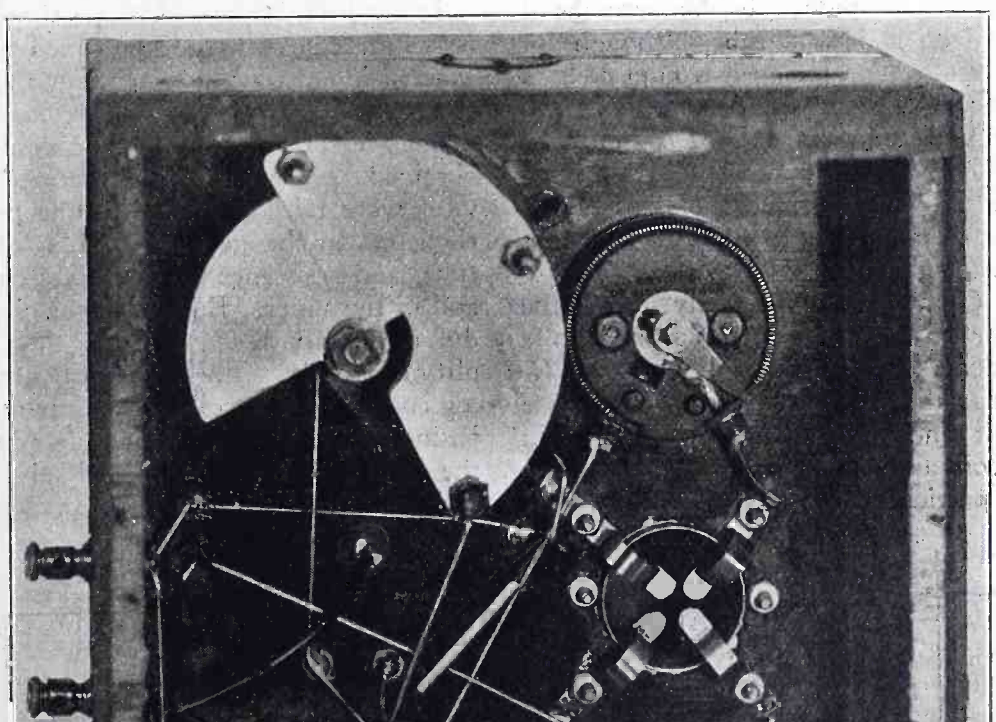


Rear View of Set

Efficient Radio Frequency Amplification

By George C. Jones

Here is an account of an interesting method of slightly under-neutralizing tube capacity so as to allow sufficient regeneration to give increased amplification. The set constructed by the author works admirably. His results can be duplicated by the careful experimenter.

NO! it's not a Reinartz, though it looks and tunes like one. It has an untuned aerial and capacity feedback. Regeneration is minimized by using a small condenser—15 micro-microfarads for C_1 in Fig. 1.

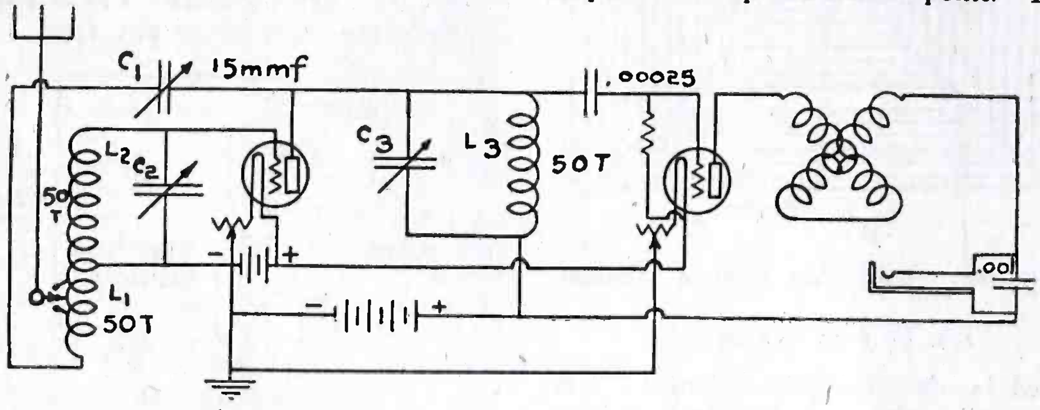


Fig. 1. One Stage R. F. Amplification with Detector.

Taking out all but nine blades of a Midget vernier if the tube is a 201A, and five if it be a 199, leaves a condenser of about the right size, if the coils L_1 and L_2 are of about an equal number of turns.

The coils L_1 and L_2 are wound in the same direction. They, like L_3, should consist of 50 turns each for broadcast reception or 25 turns each for amateurs. They may be spiderwebs, honeycombs or wound on a 3½-in. tube, although for best results I prefer open wound coils of some sort, as they seem to be more efficient and tune sharper. L_1 should be tapped every ten turns. L_3 is shunted by a 23-plate variable condenser and serves to tune the plate circuit to resonance.

If C_1 were taken entirely out of the tickler circuit and the set tuned to a broadcast station we could advance C_8 to near the resonant point of the plate circuit and thus create a resistance in the coil and condenser combination, to that particular frequency. The resultant voltage at the upper end of the coil will then be impressed on the condenser C_4 attached to the detector grid. The nearer we tune this circuit to resonance, the greater will be the radio frequency amplification up to a certain point. This is the point where the voltage of the plate circuit causes too much regenerative feedback though the capacity of the tube and the system is set into oscillation thereby. The internal capacity of a 201A tube is approximately 6 m.mfd. and it will spill over much quicker under the same conditions than a 199 which has much smaller internal capacity.

It has been known for some time that if the plate circuit could be tuned to the exact point of resonance without the circuit spilling over into oscillations that much greater r.f. amplification could be obtained. Many "anti-oscillation" devices were tried. These include potentiometers to change the grid bias of the tube, and resistances in the plate circuit and in the tuner. But while the circuits did not oscillate, neither did they amplify efficiently. The use of a neutralizing condenser and coil to generate an opposing feed-back to grid does away with the oscillations but in a completely neutralized circuit there can be no regeneration and the natural resistance of the different parts of the system cuts down the signal strength. On the other hand, if a little regeneration could be introduced, under control of the operator, without unduly complicating the tuning or destroying the present hard-won stability we could get a little more distance.

The present circuit was evolved after much hard thinking and soft soldering so that with one stage of r.f. I have done as well as with two stages in the best of the others that I have tried. By adding transformer coupled stages after the first neutralized circuit I have reached as many as five r.f. stages without adding more tuning controls or having trouble with oscillations.

Now as to the theory of the thing. If the condenser C_1 is twice the capacity of the tube and is set at one-half setting the tube will be neutralized, if the two coils L_1 and L_2 are about the same size, but will take place to a small degree no matter which way the condenser C_1 is moved from this central setting. When the condenser under these conditions is set at zero the feedback through the tube causes regeneration and when at 100 the feedback takes place through the condenser and the tickler C_1 and L_1. The tuning of coil L_2 to the desired wave-length with C_2 changes this neutralization point of C_1 to a certain extent but not enough to hurt as we can get regeneration either up or down. So why worry?

If only one or two stages of radio frequency is used with this system a variometer can be used in the plate circuit of the detector with an appreciable gain in efficiency and will cause no trouble in the first tube which is neutralized. This stunt will be of special value to the "hams" who try this method, as C.W. comes in "to beat the band" by the use of the variometer without reradiating or interfering with the stabilized "sentinel" in the first socket.

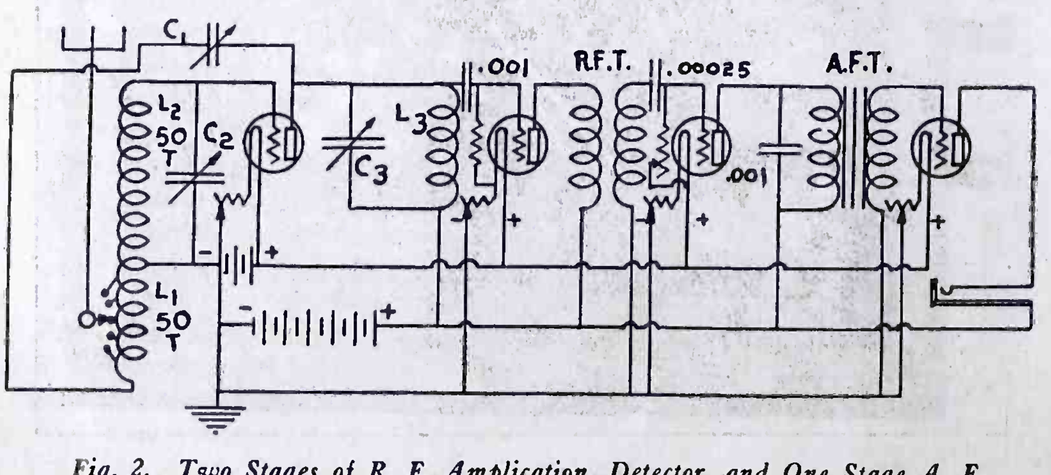


Fig. 2. Two Stages of R. F. Amplication Detector, and One Stage A. F.

Automatic train control by radio will be installed on at least one division of forty-nine first-class roads of the country by 1925, it was announced at the opening session of the fourteenth annual convention of the Association of Railway Electrical Engineers. Radio holds possibilities of inter-communication between moving trains and fixed points for personal wire or phone service.

A Super-Selective Receiving Set

By L. H. La Montagne

Here is another circuit to be tried out by the hook-up enthusiast. It involves several novel ideas which are well worth trying. Sufficient details are given to enable the experienced constructor to duplicate the results secured by the author.

WITH so many different types of receiving circuits in use and with everyone boosting for the particular type that he is using, the average constructor is sometimes at a loss as to just what type to construct. The receiver described below has a number of advantages, especially for one that hasn't a large amount of money to invest, but still desires a selective receiver. Its chief advantages may be enumerated as follows:

1. Very selective on all wavelengths.
2. Requires a single control for wavelength, with vernier.
3. One or two rheostats for all tubes.
4. No grid condensers or leaks to bother with.
5. Good volume with a fair range, depending upon location.
6. Requires a minimum of parts.
7. Simple in construction.

With the above advantages, there also should be listed the following disadvantages:

1. With a certain wiring of the set, it is sometimes difficult to clear up the "mush", and reproduce clearly.
2. Quality poor unless especially good audio-frequency transformers are used.
3. Since the circuit is a good oscillator, considerable disturbance is created in nearby receivers.

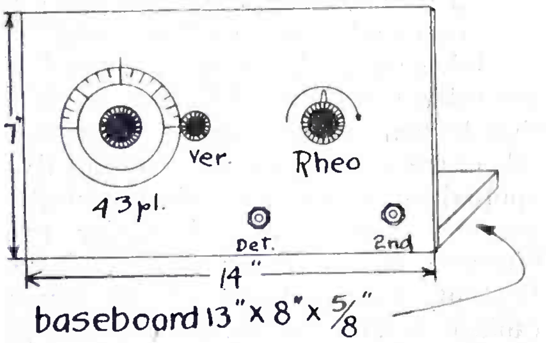
Before taking up the actual construction, the circuit will be recognized as a Colpitts transmitter with a single control for varying the wavelength. In the transmitting circuit, the modulator tube varies the amount of current flowing into the oscillator circuit, but in the receiver using the Colpitts circuit this action is reversed.

The high degree of selectivity comes from the fact that an oscillating circuit will reject all wavelengths but the one to which it is tuned, thus preventing a large amount of interference between stations on nearly the same wavelength. It is possible to tune out nearby stations, and listen to distant ones, even though there is only a few meters difference in their wavelengths.

It also seems that a certain amount of super-regeneration takes place, as the tube used as the detector has a certain amount of a varying frequency applied to its grid from the oscillator, at the wavelength being received. This fact is borne out by the fact that with two tubes local concerts have a very good intensity without audio-frequency amplification. With two tubes having 90 volts on their plates it is possible to receive local music with enough intensity to operate an ordinary loud speaker. However, the set must be carefully constructed, and the tubes chosen from a number of tests, as some tubes give very poor results in this circuit. It is best to be able to pick the tubes from a number.

All leads should be as short as possible, and all apparatus of the highest quality. Do not use a cheap 43-plate condenser as leakage will occur and cut down the intensity of the signals. Don't attempt to use above a 3-1 audio-frequency transformer, or you may have some very weird noises, often taken for music by those not onto the stuff. It would be better to use a push-pull circuit for the last step of audio-frequency, as this will materially improve the quality. "A" tubes should be used. The circuit refuses to function with the WD-11 or 12 tubes. You can have three guesses as to just why, but it is a fact.

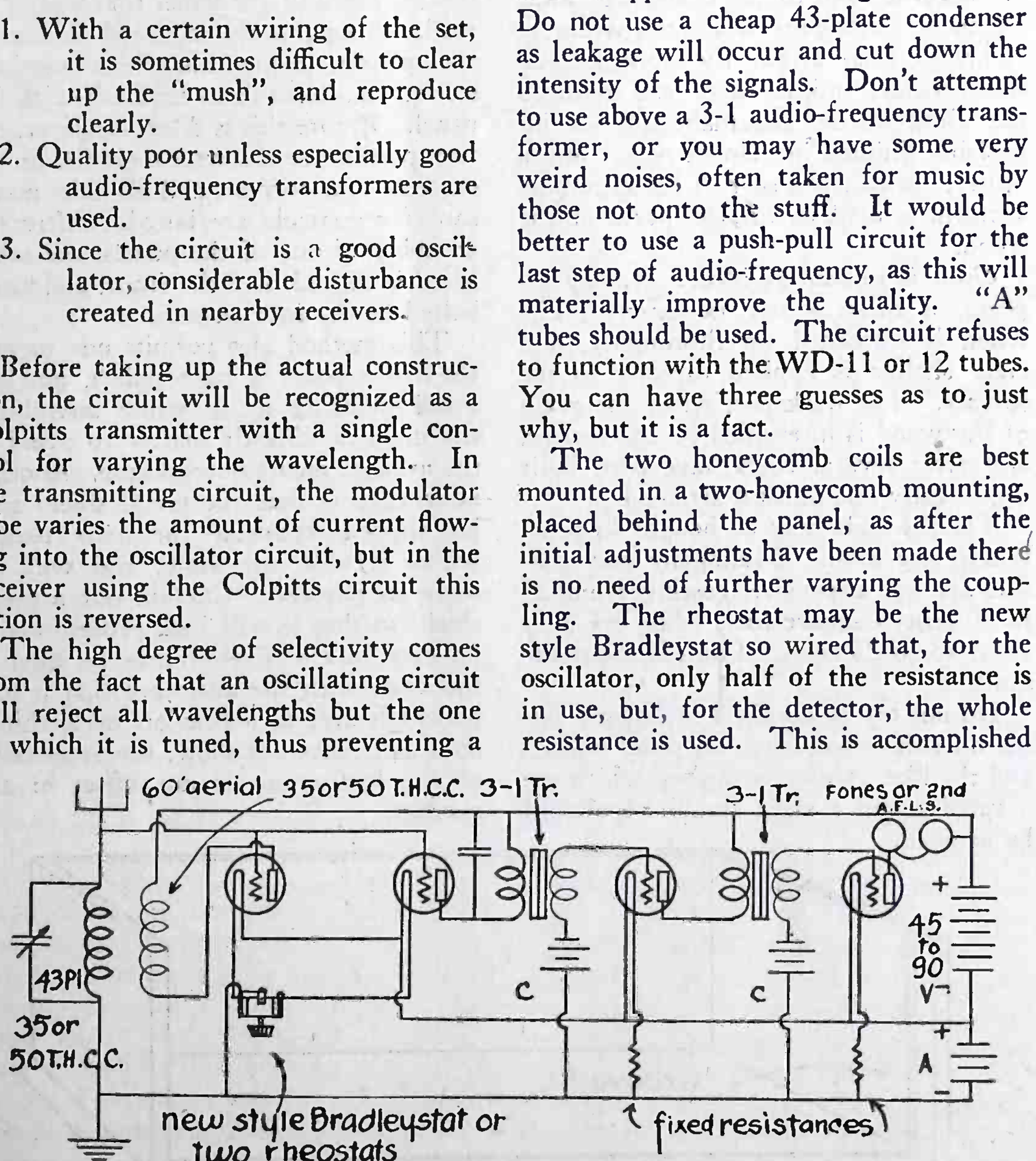
The two honeycomb coils are best mounted in a two-honeycomb mounting, placed behind the panel, as after the initial adjustments have been made there is no need of further varying the coupling. The rheostat may be the new style Bradleystat so wired that, for the oscillator, only half of the resistance is in use, but, for the detector, the whole resistance is used. This is accomplished by connecting the center terminal to the negative (see diagram) of the battery, and the left terminal of the rheostat going to the oscillator, and the right to the detector. It will be seen that the detector tube burns at a much lower briliancy than the oscillator. If it is desired, two separate rheostats may be used for these two tubes, and another for the audio-frequency, though a fixed resistance will answer just as well for the latter. Two jacks are used—one for the first two tubes, and one using all four tubes.



Suggested Panel Layout

The actual dimensions of the panel and cabinet will depend upon the builder, as some may desire to make a portable set with all the batteries inside of the cabinet. A suggested panel layout is given.

Now, suppose that we have wired up the circuit and carefully checked the wiring, we are now ready for the final adjustments of the circuit. Connect up the *A* battery and test the filament circuit to each socket. If these are found to be all right, connect up the *B* battery, attach the aerial and ground and put the first two tubes in place, and plug in the phones in the proper jack. Bring the two tubes up to about normal brilliancy on the oscillator. Now slowly turn the 43-plate condenser, listening for the familiar C. W. squeal, as with a regenerative set. If no squeals are heard, and the circuit seems to be dead, reverse the leads to the tickler coil, after going over all the circuit to be sure that it is all right. When the circuit is oscillating properly a distinct click will be heard if any part of the aerial is touched. Sometimes signals are heard from local stations without the first tube oscillating, but the sensitivity is destroyed, and no selectivity is possible. Vary the coupling of the feed-back coil until maximum volume is obtained and the signals are still clear. The tubes should be interchanged to see which ones will function best in any particular part of the circuit.



Circuit Diagram for Super-Selective Receiver

Continued on page 64

Construction of Radio Cabinets

By Paul Oard

A brief summary as to the choice and finish of woods is here presented. Included are a number of unusually good kinks on panel mounting.

FEW radio enthusiasts do justice to the construction of the cabinet that houses the completed assembly panel. Cabinet woodworking is a fine art in itself. Only those who have had intimate contact with the processes used in making up a cabinet from the rough sawed stock to the final point where the finishing coat of varnish is applied can fully appreciate the necessity for a full understanding of the processes that are involved.

The wood generally used is either oak, mahogany, walnut or gum. There are several grades of oak. So-called "quarter sawed" oak, which is cut in a certain way with respect to the grain, is most commonly used in cabinet work.

Mahogany is the "precious" wood of the cabinet makers. The best grade is that known as "west coast" mahogany. There are a number of other woods that approximate mahogany when correctly finished, such as Spanish Cedar and Geneseri, but which are of softer body. Walnut, in the hands of an expert cabinet maker, resembles mahogany so closely that one not versed in woods is unable to distinguish between the two. Likewise, mahogany may be finished to resemble walnut, depending upon the stain and finish used. Gum (eucalyptus) is used to some extent, and is capable of a very high finish. It differs from the first three woods in that it is "close pored" while they are "open pored." This means that the first three named are, in their native state, full of minute pits or depressions while the latter is, when planed, perfectly smooth. The first three, are in most jobs, artificially treated to overcome this factor.

Of these four woods oak is by far the easiest to handle. Oak reaches the cabinet maker in a rough sawed state. When cut to dimensions for a particular cabinet, it is run through a machine planer. The wood now looks perfectly smooth, but if it is held to the light, it will be seen to be "ripply," marks left by the planer blades. The wood is carefully sandpapered, first with coarse and then fine grades. It is still far from smooth, according to the cabinet maker's idea. A hand scraper, which is a steel blade, fastened to a convenient handle, is used to scrape the surface of the wood to a finish that is as near smooth as it is possible to get. Sometimes a hand plane is used to accomplish the same purpose. The wood is now ready for treatment for varnishing and finishing.

The same treatment applies to all cabinet woods. But now that the wood has been brought to this stage, the methods of handling vary considerably for the different varieties.

In oak, it is customary to finish in the so-called "fumed" finish, which is as a rule a nut brown color. Oak in the natural state is almost white in color. It is now stained with either an aniline dye, or one of the so-called "logwood" stains, either one of which penetrates the wood quickly, to dry in a few minutes. If the job is to be a "closed pore" affair, the pores of the wood are gone over with a special filling compound. This is eliminated if an "open pore" finish is desired. Several coats of shellac are next applied. Each coat of shellac, after thoroughly dry, is rubbed smooth with fine sandpaper or steel wool, before the next coat is put on. After several coats have been put on, the job is done, although sometimes another coat of clear varnish is applied over the shellac coats. The final coat is rubbed down as were the others, and the cabinet is next polished with a good oil polish.

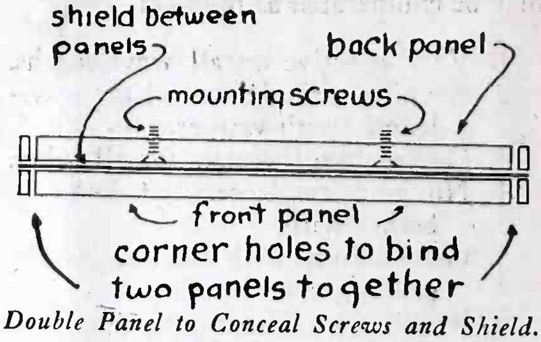
Mahogany is finished in a red or brown color, and in some instances, black. Walnut is finished in a light or deep brown, dependent somewhat upon the natural color of the wood. In some instances, mahogany is almost white in color, and to attain the conventional finish color, aniline dyes are resorted to. Both walnut and mahogany are invariably finished in "closed pore," and a "filler," which is a sort of thick gummy varnish, is used to fill the pores of the wood.

Gum is seldom stained. Having no pores, a filler is not necessary. The wood is smoothed up thoroughly, and clear shellac is applied directly to the surface. The dark portion of the grain of the wood is intensified by the shellac, and after several coats have been built up, a really fine finish is attained.

These woods may be bought in practically any town. Mahogany and walnut are not expensive, costing from 25 to 50 cents a square foot, while oak runs from 15 to 25 cents. Gum is about the same.

Do not try to obtain a mahogany finish on soft woods such as pine, poplar, and the like. Color varnishes, which are a varnish and a stain combined, should be avoided.

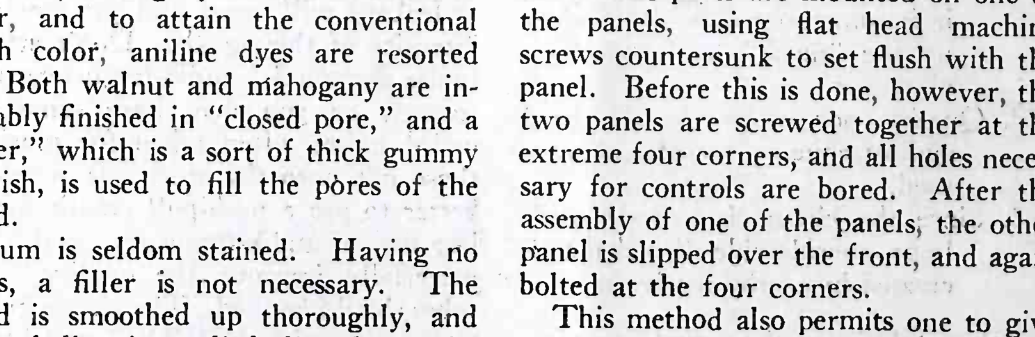
The most practical method of mounting a bakelite panel is to cut a groove in the cabinet a short distance from the face, so that the panel may be inserted into this groove. This permits the panel to be removed instantly for inspection, and does away with the necessity of removing a number of screws in order to take the panel out. Neither is it necessary that the panel be an exact fit, as the slots allow a certain amount of leeway for under or oversize panels.



Double Panel to Conceal Screws and Shield.

To eliminate unsightly screws on the front of the panel, where the various units are supported by the main panel, use two sheets of bakelite, each of half the thickness of the panel that would be used. All parts are mounted on one of the panels, using flat head machine screws countersunk to set flush with the panel. Before this is done, however, the two panels are screwed together at the extreme four corners, and all holes necessary for controls are bored. After the assembly of one of the panels, the other panel is slipped over the front, and again bolted at the four corners.

This method also permits one to give the front panel a high polish, and yet avoid marking it up while assembling the units, a difficult matter to avoid in the average amateur workshop. Another advantage is that the metal shield may be slipped between the two panels, where it will not show, and will yet serve its purpose. Cutting out a metal shield so that it will look professional is no easy task, Tinfoil may be used in this case, with the assurance that it will be as effective as a heavier metal shield, and, as it does not show, the appearance of the instrument is not offset in any manner.



Groove for Mounting Panel

What Is Music?

By Arthur S. Garbett

Due to the potential power of radio broadcasting as a developer of a broader appreciation of good music, it seems fitting that some space be devoted in these columns toward bringing about a better understanding of music. In a most interesting manner the author tells how the tonal and rhythmic sense may be cultivated and how the listener may learn to discriminate the good from the poor in music.

FROM the standpoint of the listener, the most interesting thing that radio broadcasting has to offer is music. Sermons, speeches, plays, not to mention howls, are all very well, but they are dessert after the meat; and the meat is music. Radio enthusiasts are not necessarily musical to begin with, but they may easily become so. In fact, they almost inevitably will if they listen long enough.

The writer once had to listen to hundreds of miscellaneous phonograph records and discourse upon their merits to a stenographer. She was an average American girl with lots of snap, good to look at and even better to dance with. She neither liked nor disliked music except when it "made good" with her, and her preference was for jazz. After about a year, however, she blossomed into a music-lover. She jumped from jazz to grand opera in the most unexpected way. The writer likes to believe that this was due to the words of wisdom that fell from his lips in a constant stream. But, much more probably, she reached the saturation point in jazz and went on to better things simply because jazz began to bore her with its constantly repeated formulae of melodies and chords, and its rigid, inflexible rhythm (however much the melody of a jazz number may be "ragged," the fundamental rhythm is a tom-tom beat which never varies).

Anyway, the lady took the jump, and it was worth taking. "The man who likes bad stuff can come to detest it," says Percy Scholes, an English music critic, "but the man who has learned to like good stuff has become a lover of it for ever and ever."

Perhaps the words of wisdom helped her a little, however. Certainly many listeners-in, puzzled by the strange capacity of music to make us weep pleasurably, to reduce us to pensive calm after our nerves have been on the ragged edge all day, to uplift us to a state of exhilarated ecstasy akin to intoxication but without the headache, or to make us dance irresponsibly as children, may reasonably ask what music is, and how it achieves its astonishing results.

There are many stock answers to this question of what is music. There is the poetic one: "Music is a concourse of sweet sounds." There is the musician's technical answer: "Music consists of melody, harmony and rhythm," true but inadequate. There is the answer, more scientific, of the acoustician, the sound-specialist, who defines sound but leaves the art of music alone: "Sound is produced by the motion of the air. This motion is communicated to it by the vibration of some material body. If the vibrations are irregular the sound produced is called *noise;* if they are regular, the sound produced is called *musical.*"

Scientifically speaking, then, music is a form of vibratory motion transmitted through the air. It is also a pattern of musical sounds extended over a period of time. We may add that in order to give these sound-patterns the quality of art, they must be presented in such a way as to give an impression of unity, variety and proportion. As Plato said, a work of art has a beginning, a middle, and an end.

This reference to vibratory motion should be of interest to radio enthusiasts. It reminds us that we, the people, are ourselves complete radio outfits equipped for both transmission and receiving, but particularly receiving. We have special sense-organs responsive to electro-magnetic vibrations of light and heat. Our eyes accept and differentiate between light rays having a periodicity ranging from 430 trillions to 740 trillions per second. Our entire body is susceptible to heat waves vibrating at from 20 to 300 trillions per second. We are wireless receivers in communication with that great broadcaster, the sun.

In addition, and more interesting from our present viewpoint, we have ears capable of reciving air waves vibrating from about 40 to 10,000 per second. We have, in fact, five separate "receivers" or sense-organs which convey information to the brain by means of presumably electrically responsive nerve-lines.

Before returning to music, let us consider our five senses. Without them we could not live for more than a few hours. We could not eat. If somebody held a beefsteak before us we could neither see it nor smell it. If he told us it was there we could not hear him. If it were placed between our teeth we could neither taste nor feel it.

Should we be unconscious altogether? A difficult question which the writer can not answer, but one worth pondering. It seems, however, that one faculty might remain—the power of movement. We have a sixth sense: the motor-sense, the power to move ourselves from place to place, the power which differentiates us, for example, from trees which have life, and which eat, sleep and reproduce, but cannot step away from their roots. This motor-sense involves also a sense of balance. We are able, by some extraordinary miracle, to stand up on our two feet without falling upon our noses. We are able to sit down without rolling off the chair. We are able, after patient struggle in babyhood, to find the way to our mouths with a fork instead of poking our eyes out. This motor-power of balance and control of movement is slower to develop than our five senses, but come it does, and it has played a vital part in man's evolution. By means of it we can walk the earth, swim in the waters and—at last—fly in the air!

Quite so; but what has this to do with music?

Everything. We said above that music is a pattern of sounds extended over a period of time. It has two properties, therefore: that of sound, and that of motion or rhythm.

We have receivers for the sound in our ears; we have receivers for the rhythm is our motor-sense, our sense of rhythm and balance. This last faculty is so marked that it is easier to move in time to strongly-accented music than to sit still.

We are now in a position to consider music in terms of behavior, as the physicists consider the phenomena of radio. How do these receivers—our ears and our motor-faculties—act under the influence of music? They are the channels through which music enters our brain, our consciousness. What happens to the music after it gets there?

Big questions again: too big to answer at length in the space available, but not too big humbly to consider. We can at least learn a little of how these amazing receivers of ours respond to the stimulus of music.

To begin with there is the fact that no two people hear alike. Just as in seeing, one pair of eyes may differ from another pair to the extent that glasses are necessary, or one eye of a pair may differ from the other so that the glasses must be of unequal strength, so, too, our two ears differ from other folks' ears and maybe from each other. This is an important fact which has a tremendous bearing upon our individual appreciation of music, if only for the following reason.

The difference between the tone-quality of one instrument of music and

Continued on page 78

LETTERS TO THE EDITOR

Amyl Acetate and Celluloid

Sir: The amateur radio builder often reads a warning against the use of certain coverings for coils and is advised that "amyl acetate and celluloid" makes the best coil cement.

How many know how to prepare it? Amyl acetate can be obtained from any drug store at 10 or 15 cents per ounce. The best celluloid can be obtained from old kodak films by removing the emulsion with hot water in which a small amount of concentrated lye has been dissolved.

After the film has been thoroughly cleaned, rinsed and dried, place about 6 postcard size films in a 4-oz bottle and fill with amyl acetate. Agitate occasionally and within 48 hours it is ready for use.

Please test this to your satisfaction and then give it to the "boys" through the columns of your excellent paper for future use.

Atchison, Kansas. O. C. MILLER.

THE OPERATOR'S SIDE

Sir: After reading an article in the March issue of RADIO by Mr. Jose Valasco, may I give an operator's side of the discussion?

Two facts are quite evident. 1. Mr. Valasco has never been a commercial operator—that is within the past two years—while the traffic has been its "heaviest." 2. Mr. Valasco has had few, if any, dealings with the modern steamship companies. I will try to discuss the points as he brought them before us.

1. As to the transmitters being on every wavelength between 300 and 600 meters. The set is tuned when the operator comes on board. He is not allowed to tune the set in any way, except to change the wavelength to where the markings are and to tune the open circuit in order to bring it into resonance with the primary. This takes some time, especially if the transmitter is across the room from the key.

2. I have never heard a station call for twenty minutes in the ten years I have been connected with radio, and if a ship calls several more times than customary it is only in order that the shore station may adjust his receiver "sharply" so that he can receive through the local QRM.

3. "Waves as broad as the Golden Gate." In order that the receiving station may find a frequency where the QRM is less, it is often necessary to tune the transmitter quite broadly. However, I think that you will find that few, if any, operators are violating the law in regard to "decrement."

While an operator has his "position" at stake, due to the fact that the O.M. will stand for no delays, can't you see that he has to take advantage of every liberty that the law allows him? It's just like the old story of the hare running for his life and the hound for his dinner—we have our jobs to lose, you only your amusement.

When the steamship companies are too "tight" to place tube receivers on all of their ships, try and get them to place C. W. transmitters on board.

The fact that one uses a superheterodyne means nothing. An improperly designed superheterodyne, or one in the hands of a novice, can tune as broadly as the famous single-circuit set.

I agree perfectly with you about the "Hams." If any reply is made to this I never miss an issue of RADIO.

At Sea. A COMMERCIAL OPERATOR.

Studies by the U. S. Bureau of Standards show that amplification due to regeneration decreases with increase of signal strength and that the effect of regeneration is not strictly equivalent to a negative resistance for different values of current in the circuit.

PRIZE OFFERED FOR BEST SOLUTION OF BROADCASTING PROBLEM

Five hundred dollars in gold is the cash prize announced by the American Radio Association for the best answer to the question "Who is to pay for broadcasting?" according to an announcement made today by Alfred M. Caddell, secretary of the American Radio Association, with headquarters at 50 Union Square, New York City.

The terms of the contest require that all answers shall have been placed in the mail, addressed to the American Radio Association, on or before July 20, 1924. The contest is open to any resident of the United States without regard to sex or affiliation with the radio industry. Contestants are requested not to exceed fifteen hundred words in their statement of any one plan, which should be typewritten and double spaced. In addition to the plan itself a brief summary should also be included. In the possible event of the same plan being received from two different sources, the board of judges will be requested to award the prize to the first one received according to the postmark on the envelope.

The American Radio Association, through which this prize is being offered, is a co-operative Association of individuals, clubs, institutions, civic and religious bodies—in short, all who constitute the radio public, and has been formed to meet the pressing need of public representation. Its activities will be both centralized and decentralized in order to meet national and local problems.

It aims to co-ordinate, develop and protect public interest in all matters pertaining to radio:

(a) By establishing a clearing house for suggestions emanating from the public, which will benefit the public and industry alike.

(b) By initiating and actively supporting legislation which will safeguard the rights of amateurs and listeners-in.

(c) By working for the elimination of interference caused by:
  (1) Governmental, commercial and other stations.
  (2) Radiating receivers.

(d) By encouraging and utilizing suggestions that will stabilize broadcasting, and effecting improvements in programs.

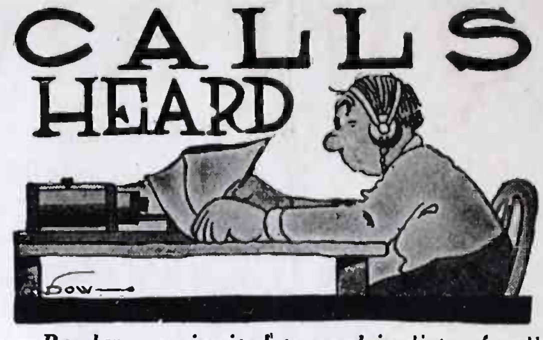
(e) By furnishing such events and meetings, both local and national, as will tend to increase the popular support of radio and further its use in the field of news, music, education, science, religion, civics and similar beneficial avenues.

(f) By cooperating with and assisting industry and the government toward the attainment of the foregoing objects.

Anyone interested in radio may become a member of the Association by making application to the office of the Secretary, 50 Union Square, New York City.

Before discarding a *B* battery whose voltage is too low use a sharp knife to cut the pasteboard battery box on three of the bottom edges and open the bottom like the cover of a book. If any of the cells seem badly corroded solder a wire to the bottoms of the two adjacent cells and thus short out the defective cells. Seal the bottom again and the remaining cells will give service for some time, giving less than the rated voltage of the battery.

A radio canvass of the "wet" and "dry" sentiment conducted by WJAZ at Chicago showed 34,185 "wets" and 12,483 drys." Votes were received from every state, West Virginia being the only one with a majority of "drys." More than half the total was received from Illinois.



Readers are invited to send in lists of calls heard from stations distant 250 miles or more from their own station.

By 9TR, 2517 Capitol Ave., Des Moines, Iowa.

1agb, 1agh, 1ail, 1all, 1avx, 1axq, 1bbh, 1bez, 1btr, 1cab, 1ccx, 1fb, 1nt, 2aec, 2baw, 2bg, 2bqu, 2brd, 2bt, 2cfb, 2cla, 2coh, 2dx, 2fs, 2hm, 2le, 3adu, 3arp, 3bdo, 3buv, 3hi, 3jx, 3lr, 3oq, 3uu, 4af, 4by, 4ft, 4gu, 4it, 4jr, 4pf, 4si, 4ta, 5adh, 5aim, 5air, 5ajd, 5akn, 5alv, 5anb, 5bx, 5eh, 5ft, 5gj, 5jl, 5kc, 5kr, 5ot, 5pz, 5vv, 5xd, za, 6aao, 6aca, 6acv, 6acx, 6aol, 6auu, 6bbc, 6bm, 6buh, 6cek, 6cgw, 6ckr, 6fp, 6ja, 6lu, 6mh, 6pe, 6pl, 7aci, 7af, 7co (fone vy qsa) 7fg, 7fs, 7hw, 7tq, 8aeq, 8afn, 8agx, 8ah, 8apz, 8asq, 8atp, 8avt, 8bbm, 8bbt, 8bfe, 8bgq, 8bk, 8bnj, 8bpl, 8bvr, 8bvu, 8bwc, 8bxd, 8byi, 8cag, 8cbw, 8cjp, 8cnz, 8cpk, 8cpm, 8cqv, 8ctp, 8cud, 8cux, 8cvm, 8cxi, 8cyi, 8cyn, 8czz, 8daa, 8dae, 8daw, 8dbm, 8dcq, 8dgl, 8deb, 8die, 8djp, 8dkb, 8dla, 8dlt, 8dp, 8dxb, 8fu, 8hk, 8ij, 8jj, 8kj, 8nb, 8pl, 8rv, 8wa, 8wp, 8yd, 8yn, 8zk.

Can: 2am, 2be, 3aeb, 3bb, 3cx, 3hi, 3nf, 3ni.

Anybody ever hear our sigs? Pse qsl if you have.

By 9UC ex 9BWF at College
Temporary QRA-5 Waldron, W. Lafayette, Ind.

6ao, 6bm, 6cc, 6ci, 6cl, 6cq, 6dd, 6ea, 6eb, 6el, 6eo, 6fm, 6fp, 6ip, 6ja, 6jz, 6ka, 6kb, 6kj, 6kq, 6le, 6lv, 6lu, 6mh, 6mg, 6ms, 6mt, 6nb, 6oe, 6od, 6ol, 6pe, 6pi, 6qi, 6qs, 6ra, 6rn, 6tp, 6tu, 6uo, 6uw, 6uy, 6ux, 6vd, 6vf, 6vm, 6aaj, 6aao, 6abd, 6abk, 6acv, 6acz, 6abd, 6adq, 6aeg, 6afq, 6age, 6agk, 6aiu, 6aja, 6ajh, 6ajd, 6ahg, 6akq, 6akw, 6akz, 6alg, 6alv, 6amg, 6ani, 6aol, 6aox, 6apc, 6ape, 6aqf, 6arf, 6arv, 6asq, 6auu, 6avj, 6avr, 6avz, 6awm, 6awq, 6awt, 6awx, 6bbc, 6bbw, 6bcl, 6beg, 6bic, 6bij, 6bhb, 6bjj, 6bgc, 6bgg, 6bkc, 6blw, 6bnb, 6bny, 6bon, 6bpm, 6bqb, 6bqe, 6bqr, 6bra, 6bri, 6brf, 6brn, 6bui, 6bum, 6bvd, 6bvg, 6bvl, 6bvz, 6bwe, 6bwp, 6caq, 6caw, 6cay, 6cbg, 6cbi, 6cbk, 6cbv, 6cbw, 6ccd, 6ccu, 6ccy, 6cdg, 6cdt, 6cef, 6ceg, 6cej, 6cek, 6cfm, 6cfs, 6cfy, 6cgd, 6cgg, 6cgi, 6cgw, 6chi, 6cib, 6cie, 6cih, 6cip, 6cix, 6cjb, 6cjh, 6cjv, 6cka, 6ckr, 6cku, 6cmr, 6cms, 6cmu, 6cmw, 6cng, 6cnh, 6cnl, 6cnm, 6cor, 6cpa, 6cqs, 6cum, 6bih-hi, 6xad, 6zh, 6zah, 6zar, 6zat, 6zbf, 6zbj, 6zbu, 7bh, 7bj, 7ci, 7co, 7ea, 7ej, 7du, 7dz, 7el, 7em, 7fd, 7fq, 7fr, 7gr, 7hu, 7hw, 7io, 7it, 7jy, 7jz, 7lb, 7lh, 7lu, 7ly, 7mp, 7no, 7nr, 7nt, 7ob, 7om, 7ot, 7qc, 7qd, 7qu, 7rc, 7rp, 7ry, 7sh, 7sy, 7td, 7to, 7tq, 7tt, 7wp, 7ws, 7zu, 7zw, 7aao, 7abb, 7abv, 7adf, 7adi, 7adr, 7ads, 7aek, 7ael, 7aer, 7afo, 7afu, 7aft, 7aez, 7aif, 7ahq, 7ajd, 7ajq, 7ajt, 7aka, 7akh, 7alk, 7arf, 7xaa, 7xaf.

Canada: 1ar, 1bq, 2be, 2bn, 2cg, 4ea, 4fn, 4io, 5cn, 5ch, 5ct, 5ef, 5go.

Other dists. too numerous. Both U. S. and Canada.

Hawaii: 6bdt.

Cuba: 2ww.

English 2od.

Send Us Ur Crd. We'll answ. it.

By 7SY and 7PD, 345 Mill St., Eugene, Ore.

1ol, 2bg, 2rk, 3mb, 3zl, 3bva, 4dy, 4gu, 4hs, 4io, 4pb, 4rr, 4xc, 5az, 5bo, 5cv, 5ez, 5ft, 5fx, 5gj, 5ht, 5jw, 5lr, 5na, 5pv, 5qx, 5rv, 5ts, 5xd, 5xah, 5ya, 5za, 5zb, 5aaw, 5ahd, 5air, 5ajb, 5akf, 5amb, 6bui, 7mn, 8fm, 8qk, 8vq, 8vy, 8acy, 8aih, 8apt, 8atc, 8bfm, 8bmb, 8bnh, 8bxx, 8cgj, 8cpk, 8cud, 8dat, 8dts, 9an, 9bx, 9em, 9er, 9lq, 9mc, 9ss, 9tm, 9xg, 9zt, 9aar, 9aau, 9acq, 9aep, 9agl, 9agy, 9aim, 9aks, 9aku, 9apf, 9amp, 9ase, 9atn, 9avg, 9avm, 9avn, 9awp, 9awv, 9axx, 9azg, 9bak, 9bal, 9bex, 9bez, 9bhi, 9bjk, 9bjn, 9bly, 9bof, 9bpu, 9bri, 9brk, 9bto, 9buh, 9bze, 9caa, 9ccs, 9cdv, 9ceh, 9cga, 9chc, 9ckd, 9cld, 9cnv, 9cvv, 9cwj, 9daw, 9day, 9dbf, 9dcp, 9dej, 9dkb, 9dkx, 9dpp, 9dpx, 9dqu, 9drw, 9dun, 9dwn, 9dxy, 9dyi, 9dyr, 9eak, 9ebb, 9edb, 9egu, 9eht, 9eky, 9xax, 9yam, 5mi, 5qy, 5rg, 5tj, kdef. I would appreciate reports on my c. w. all cards answered.

By 9BZH, Webb City, Mo.

1ajp, 1ana, 1ary, 1aw, 1bck, 1bes, 1bkg, 1bom, (1cmp), 1cpn, 1fd, (1fs), 1gr, 1my, 1rp, 1yb, 1ji, 2azy, 2bbn, 2bse, 2bqz, 2bqu, 2ccd, 2cee, (2cpa), (2cph), 2cqz, 2rb, 2wo, 2rk, (icw), 2abu, 3adr, 3agr, 3atb, 3bmn, 3bee, 3buy, 3chg, 3cgm, 3cgn, 3hs, 3ys, 4ai, 4bg, 4dg, 4ea, 4eb, 4ft, 4gz, 4hr, 4io, 4jc, 4jk, 4jy, 4kl, (4me), 4pb, 4pk, 4qz, (5aac), 5ac, (5abu), (adw), (5ado), (5afg), (5ajb), (5ajg), (5ajt), (5akn), (5amh), (5amk), (5bx), (5ahr), (5aic), (5aiu), (5er), (5me), (5na), (5nn), (5ov), 5pa, 5tm, (5ts), 5vm, (5ua), (5rg), (5rh), 5sh, (5sk), (5sp), (5az), 5zav, 6aao, 6alk, 6arf, 6arw, 6bbc, (6bur), 6bnu, 6brf, 6bql, 6buh, 6bum, 6blu, 6ceu, 6cgd, 6chr, 6cmr, 6pe, 6pl, 6nx, 6uo, 7co, 7fr, 7hu, 7hq, 7lu, 7lr, 7to, 7sc, 7nf, 7zi, (8bkm), 8buh, 8ded, (8dka), (8ahq), (8dkj), (8fc), (8ckv), (8rv), (8oa), (8zag), (8zc), (8zy), (8yx).

Spark: 1bcf, 2bqz, 2ctd, 3ody, 4fg, 4hs, 4mu, (5acq), 5ud, 8eb, 8tj, (9acb), (9bag), (9dil), (9ees).

Can.: 2bn, 3bp, 3nf, (3ni), 3oh, 3xi, (4co), 4eh, 4hh, 5go.

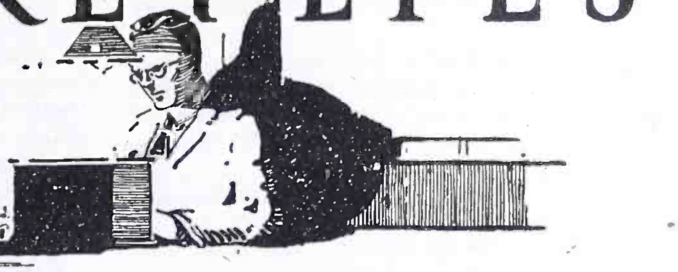
P. R. 401 Mex Bx W np.

Continued on page 44

QUERIES & REPLIES ON C.W. PRACTICE

BY

Gerald M. Best
TECHNICAL ADVISOR



Questions submitted for answer in this department should be typewritten or in ink, written on one side of the paper. All answers of general interest will be published. Readers are invited to use this service without charge, except that 25c per question should be forwarded when personal answer by mail is wanted.

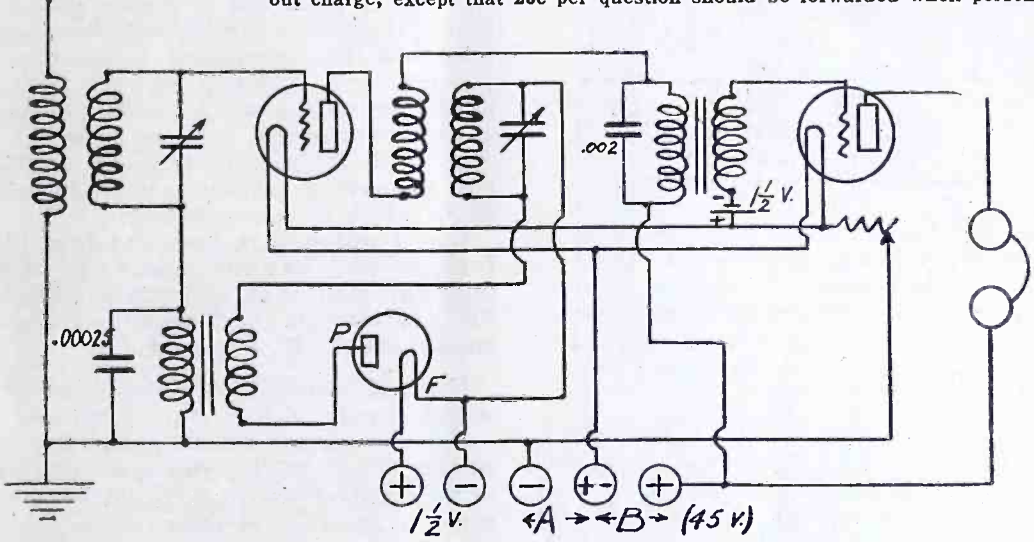


Fig. 1. Harkness Circuit

Kindly publish the Harkness circuit. —F. M., El Paso, Texas.

The Harkness circuit, which is a form of reflex circuit, is shown in Fig. 1. The detecting element is a Fleming valve or its equivalent, although a crystal detector, or a three-element vacuum tube will do as well. If a vacuum tube of the standard types is used, a grid condenser of .00025 M. F. and a grid leak of 2 megohms bridged across the condenser will be necessary in the detector tube grid circuit.

Is it possible to use a Harkness coil and 23-plate condenser in a crystal set to exclude the use of taps? Will more than one coil or condenser be of any help? —J. W. C., Los Angeles, Calif.

The use of a coupler, such as is prescribed for the Harkness circuit, is not recommended for a crystal set. If you wish to use a vacuum tube in connection with the crystal, Fig. 1 will show how the so-called Harkness coils are connected.

Please publish a two or three-tube Super-Regenerator circuit.—E. M. A., Los Angeles, Calif.

This circuit is shown in Fig. 2. It is advisable to use C-301A or UV-201A tubes, as the plate voltage is much higher than dry cell tubes will safely handle. The coupling coils shown in the grid circuit of the first tube can be easily made from a common variocoupler, with the stator in the grid circuit, and the rotor in the plate circuit. Only 15 turns of the stator should be used, however, as the inductance of the loop is too great to allow the customary 50 turns which the stator usually has, to be in the circuit.

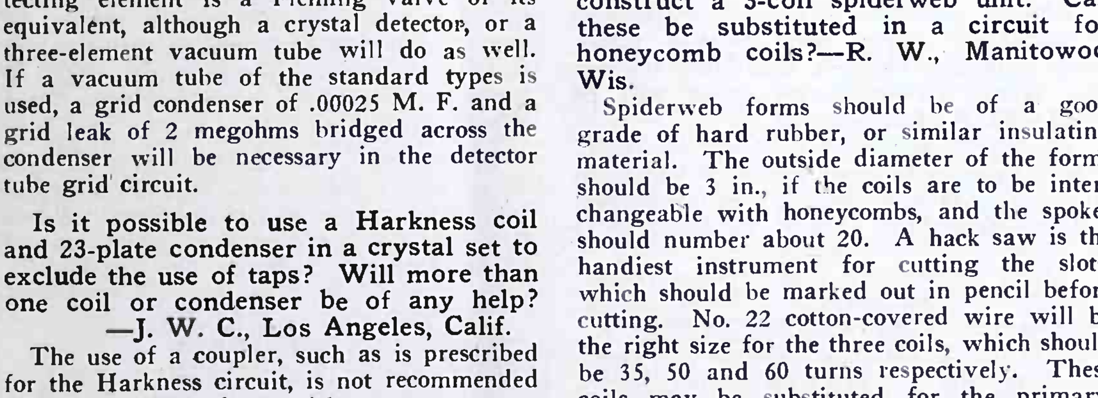


Fig. 2. Three-Tube Super-Regenerative Circuit

Kindly publish information on how to construct a 3-coil spiderweb unit. Can these be substituted in a circuit for honeycomb coils?—R. W., Manitowoc, Wis.

Spiderweb forms should be of a good grade of hard rubber, or similar insulating material. The outside diameter of the forms should be 3 in., if the coils are to be interchangeable with honeycombs, and the spokes should number about 20. A hack saw is the handiest instrument for cutting the slots, which should be marked out in pencil before cutting. No. 22 cotton-covered wire will be the right size for the three coils, which should be 35, 50 and 60 turns respectively. These coils may be substituted for the primary, secondary and tickler in an ordinary honeycomb coil set with good results.

Please publish a circuit for a 5-watt telephone transmitter.—H. K., Anaheim, Calif.

A good low-powered telephone and C. W. telegraph transmitter was shown in April RADIO, page 36, Fig. 4. If you desire only one 5-watt tube, one of the tubes shown in the diagram may be omitted without changing the constants of any of the other pieces of apparatus shown in the diagram.

Is a "C" battery any advantage in a Tuska No. 225-A receiver? If so, how should it be connected? How is a Genie Induction Filter connected to the receiving set? Is there any device on the market which will eliminate interference from a nearby 110-volt d.c. lighting plant?—W. L. W., Conetoe, N. C.

A *C* battery is a necessity in any receiver employing audio-frequency amplifiers. The negative side of the battery should be connected to the grid, and the positive side to the filament through the secondary of the audio-frequency transformer. For 90 volts plate, the battery should be 4½ volts. The Genie filter has three terminals. The binding post marked *A* goes to the antenna direct. The center binding post, marked *set,* should be connected to the antenna binding post on the radio set, and the post marked *G* should be connected to the ground binding post of the receiver, the latter post being grounded in the usual manner. It is sometimes impossible to cut out all the high frequency interference received from power lines, but the filter will no doubt be of assistance. It would be a good plan to inspect the lighting plant, and see if there is not an unusual sparking of the commutator. Two microfarad telephone condensers bridged across the commutator will probably greatly aid in eliminating such interference, at its source.

Please publish the circuit of the "Simplest Super," described in November RADIO. Some of the connections were omitted in the diagram accompanying the article.—C. L. D., Corona, Calif.

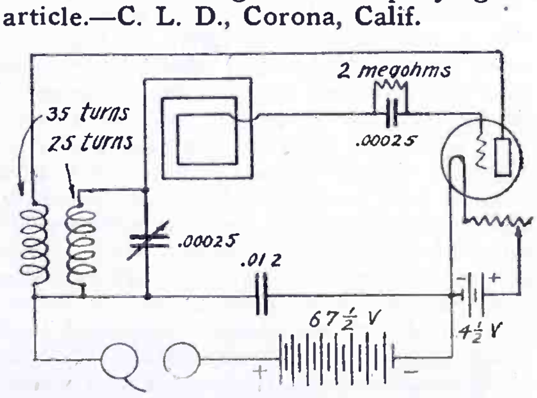


Fig. 3. Simplified Super-Regenerative Circuit

The corrected circuit is shown in Fig. 3. The filament rheostat and battery were omitted.

Please advise through your columns if my 3-tube Reflex circuit is O.K.—R. R. H., Oakland, Calif.

Your circuit diagram is correct except that you should have a fixed condenser of .001 M. F. across the secondary of the first audio-frequency transformer to by-pass the radio-frequency.

How are the resistances shown in the grid circuit of the second tube in the Radiola 4 manufactured? Please publish the circuit of the Radiola Regenoflex. —D. K. P., Ceres, Calif.

These resistances are ordinary grid leaks, varying in value from 0.10 megohm to 0.50 megohm. Several manufacturers sell grid leaks of any value from 0.10 to 10 megohms, so you should have no difficulty in building the potentiometer. A Bradleyleak makes a good volume control when bridged across the secondary of an audio-frequency transformer. The circuit of the Radiola Regenoflex is not yet available.

I have a one-tube set consisting of a variocoupler, 23-plate condenser, grid leak and phone condenser, and a DeForest vacuum tube. I also have a crystal set with loose coupler and air condenser. How can I best combine the two sets to get the most possible out of the apparatus?—G. W. C., Alameda, Cal.

You have nearly enough material for a good reflex circuit. Fig. 4 shows the proper connections for a one-tube reflex, with a crystal detector. A good make of radio-frequency transformer should be used between the tube and the crystal, and an audio-frequency transformer with a ratio of not more than 3½ to 1 should be used between the crystal and the tube. A *C* battery of 1½ volts in the grid circuit of the tube is necessary to preserve the quality of the output. The battery may be an ordinary flashlight cell, such as the Eveready No. 950.

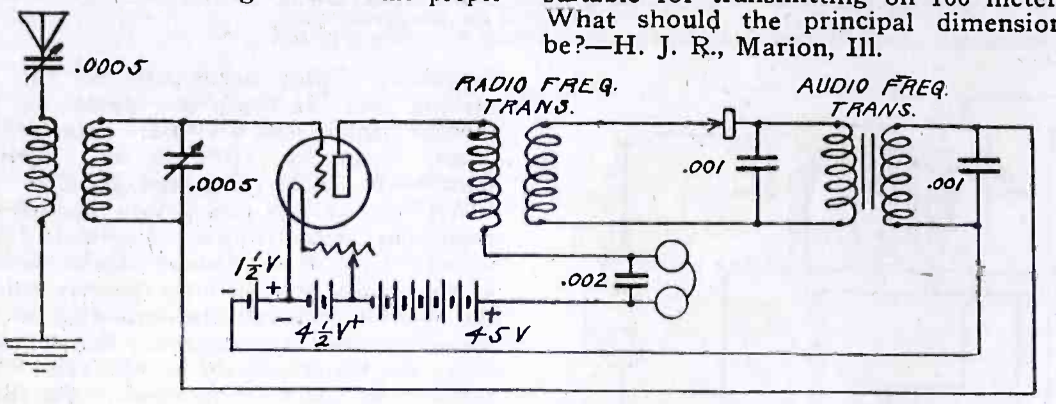


Fig. 4. One-Tube Reflex Circuit

Please publish a good 5-watt C. W. transmitter circuit, for both microphone and key. Also data on how to build a transformer for a 110-volt 60-cycle primary, 1000-volt, 10-volt secondary, with taps on the high voltage winding for 300 and 600 volts.—A. I., Canisteo, N. Y.

A good transmitting circuit is shown in Fig. 5, page 36, April RADIO. We will assume that you can obtain good soft iron for core material, and that the cross section of the core will be 1x2 in., the core pieces being 1 in. wide, and built up to a height of 2 in. The core should be square in shape, with a window 4x4 in. For the primary winding, which is on one leg of the core, wind on 412 turns of No. 20 cotton-covered wire. After placing a layer of insulating cloth over the primary, wind 37½ turns of No. 14 cotton-covered wire for the filament secondary, with a tap at the 18¾th turn. On the other leg of the core wind 3740 turns of No. 30 cotton-covered or enameled wire, with taps at the 1122nd and 2244th turns, for 300 and 600 volts respectively.

Please publish the circuit diagram of the set described by D. B. McGown in March RADIO, with one stage of radio-frequency amplification added.—T. E. R., jr., Columbus, Ohio.

An almost identical circuit, with tuned radio-frequency amplification, is shown in Fig. 1, page 35, April RADIO. You may use the plate variometer of the single tube set as the variometer in the radio-frequency stage, thereby obviating the necessity of adding a radio-frequency transformer. Three stages of audio-frequency amplification are shown in the circuit diagram.

Please show how to add jacks to the Neutrodyne circuit shown in Fig. 3, page 37, February RADIO, so that one or more amplifiers may be used as desired. —J. W., Cincinnati, Ohio.

The use of jacks in radio-frequency amplifiers is not advisable. There is a sufficient amount of capacity between springs in the jacks to short-circuit the radio-frequency currents, and the efficiency of the amplifier would be greatly impaired. About the only possible way to cut one amplifier out would be by means of an anti-capacity key with many contacts, and in a Neutrodyne circuit this might introduce complications of an undesirable nature. It would be better to make the leads in the radio-frequency part of the circuit as short as possible, and omit all keys, jacks or other switches that would tend to short-circuit the energy.

I would like to construct an antenna suitable for transmitting on 100 meters. What should the principal dimensions be?—H. J. R., Marion, Ill.

The entire over-all length of the antenna, including the lead-in and ground or counterpoise lead, should not be over 100 ft., and 10 or 20 ft. less if possible. A good size for such an antenna would be a 6 or 8-wire cage, placed as nearly perpendicular as possible, and about 70 ft. long, including the lead-in. A single mast very close to the room containing the apparatus, and about 75 ft. high will give you ideal conditions for very short-wave transmission.

Kindly publish a C. W. telegraph transmitter, using two 50-watt tubes, with chemical rectifier and filter system. An Acme power transformer will be used.—M. S., Chicago, Ill.

The circuit you want is shown in Fig. 5. The inductance in the filter circuit should be at least 6 henries, and if the capacitance bridged across the filter is increased to 10 mfd., on each side, an absolutely quiet supply of d.c. is assured, but, of course, the filter will be quite expensive. A minimum of 4 mfd. will be necessary to give good results.

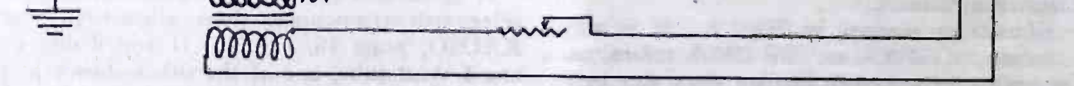


Fig. 5. C. W. Transmitter Circuit

How long should a "C" battery last when used in an ordinary audio-frequency amplifier?—E. C. K., Summitville, N. Y.

If the *C* battery is a flashlight cell, which is customary, you should change the battery every six months. The battery should last its normal shelf life, as there is no drain on the battery, its purpose being to supply a negative potential to the grids of the vacuum tubes.

Is any special filter required for a synchronous rectifier, for use in C. W. transmission? What is the advantage of a synchronous rectifier over the chemical type? Will not the same filter work on both rectifiers?—D. S. M., Huntington, W. Va.

A conventional filter, sometimes styled the "brute-force" filter, consisting of an inductance of 6 henries or more in the positive side of the d.c. supply, and at least 4 mfd. or more if your pocketbook will permit, shunted across the d.c. line on each side of the inductance, will serve very well for either a synchronous rectifier or a chemical rectifier. Due to sparking of the commutator in most synchronous rectifiers, however, more shunt capacity in the filter will be required than with the chemical rectifier, if an absoluely quiet d.c. supply is desired. A synchronous rectifier does not require the array of liquids which a chemical rectifier employs, and consequently is much less of a mess around the house. A properly cared for synchronous rectifier will last considerably longer than the chemical type, although perhaps more expensive in initial cost. A recent development in chemical rectifiers, however, appears to do away with the disadvantages of the borax type of rectifier, so it is rather difficult to decide which is most economical.

Can I purchase a fuse and fuse block for my "B" battery circuit, so that I will not burn out apparatus when the "B" battery is accidentally short-circuited?—A. L. B., Portland, Ore.

If the *B* battery is 45 volts or over, you would require a fuse that would not arc easily, and yet one which would blow at .1 ampere or less. Such a fuse is not obtainable in the standard sizes and would have to be made up specially at some considerable expense. A good protection for the *B* battery is a 25-watt Mazda lamp placed in the positive lead of the battery. If the circuit is accidentally shorted the lamp will act as an automatic regulator of the current, the maximum being only a few milliamperes. A 2-mfd. telephone condenser should be connected between the receiving set side of the lamp and the negative side of the *B* battery to prevent howling, which would surely occur with such a high resistance in the *B* battery circuit.

Please give me the data for an iron core, untuned radio-frequency transformer suitable for a two-stage amplifier, to cover the wavelength range from 300 to 500 meters.—J. McD., Saugus, Calif.

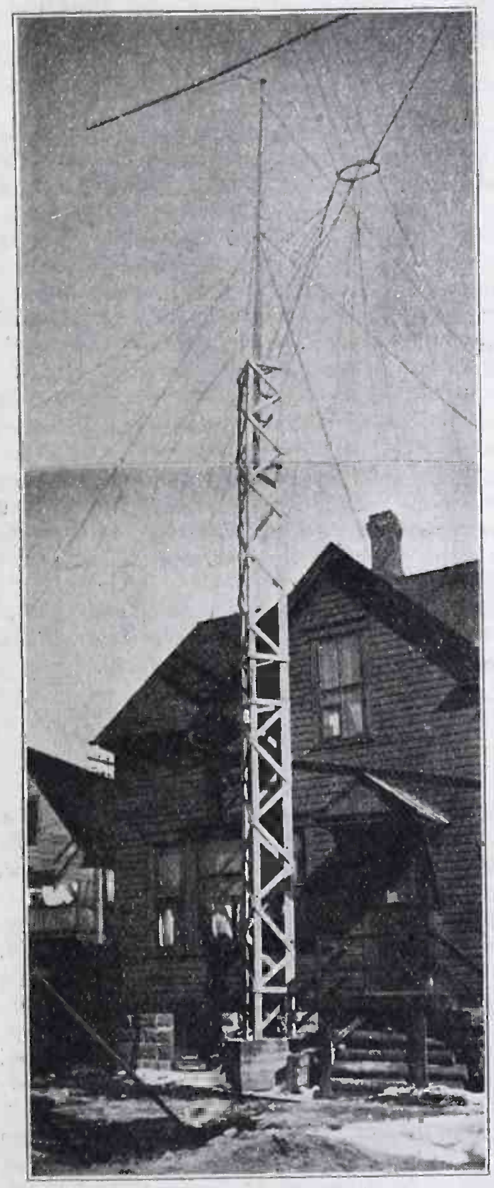
Construct a spool from good seasoned hardwood, with the following dimensions: Outside diameter, 2 in.; width, 1 in.; diameter of slots, ⅛ in.; number of slots, 2; diameter of hub, ¾ in. Drill a hole ¼ in. in diameter through the center of the spool, and make up a core ¼ in. x 1 in. of fine iron wires tied in a bundle. Place the core in the hole through the center of the spool, and wind the primary and secondary coils in the slots. The primary winding should consist of 110 turns of No. 36 S. S. wire, wound in a haphazard fashion, in order to avoid as much distributed capacity as possible. The secondary should consist of 140 turns of No. 36 S. S. wire, wound in the other slot. Care should be taken to connect the outside primary winding and the outside secondary winding to the *B* battery and filament, respectively. Do not shellac the wire in place, in the slots, as shellac will impair the efficiency of the coil.

WITH THE AMATEUR OPERATORS

STATION 9ELV

This station is operated and owned by Al Hennig and Jess Blauert at 498 13th Ave., Milwaukee, Wis. It has been in operation since November, 1923, and has worked all districts of U. S. and all of Canada except the 1st.

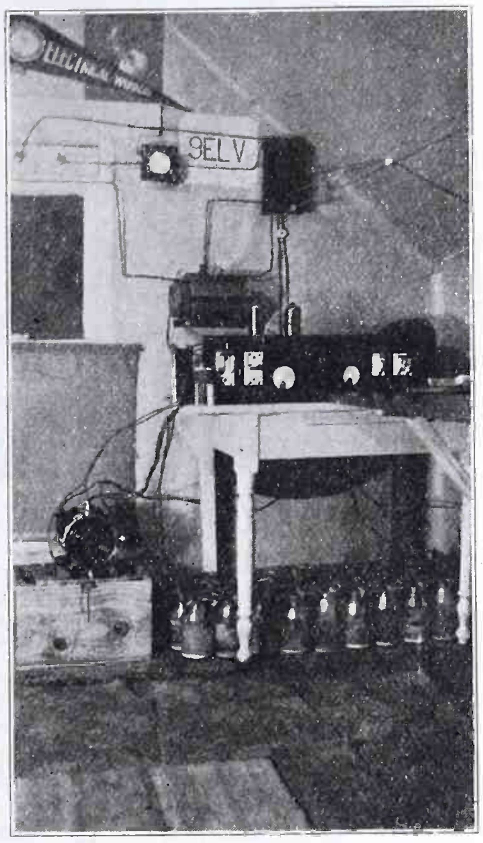
The station is in an attic room just below the lead-in. For receiving there is used a three-circuit tuner with two steps of a.f. and a single circuit and two step. The transmitting keys are on the right of each receiver. A four-pole double-throw Federal switch mounted in the table controls either set, shutting off both *A* and *B* batteries. 110 volts *B* battery is used on the plates. To the right of the receiving table is the battery charger and storage batteries. Only 1 step of amplification is used on the single-circuit tuner when listening to 6's, as they come in too loud on



Mast at 9ELV

two steps. (Notice 6XAD, 6PL, 6CGW, 6CBI, 6CMR.) The three-circuit cuts out the QRM much better.

The transmitter is to the left of the receivers and is built for efficiency and neatness. A 40-qt. jar chemical rectifier using ammonium phosphate and lake water is shown under the table. It will rectify up to 1500 volts. To the left of this is the sink rectifier which handles up to 3000 volts. It does not spark and the note is very good for a "sink." This is filtered by two 3-henry chokes and a small glass plate condenser. The switches on the panel control as follows: First switch changes from chemical to "sink," second reverses the output of the sink, third cuts off plate supply to chemical rectifier, fourth starts sink motor. The transmitter and receiving switch is operated by a rope and pulley arrangement making leads short. A 600-watt 3000-volt Acme plate transformer is on the right end of the table. A 150-watt



Transmitter at 9ELV

Acme filament transformer is in back of the tubes. The radiation meter is shown connected in the aerial lead. Three porcelain wall insulators are used in the lead-ins.

The circuit is the reversed feed-back. The radiation using one 50-watt tube is 5 amps at 1500 volts and 200 mills. At 2000 volts 250 mills. the antennae current goes up to 6.7.

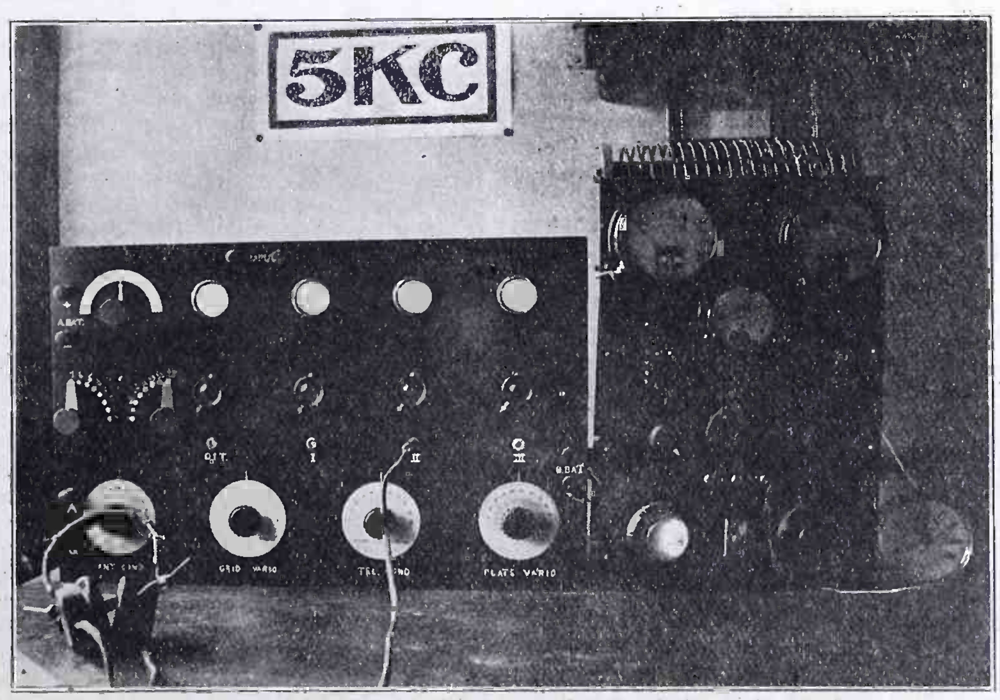
The aerial is of the inverted L type 6 wires, 55 ft. long and 65 ft. high, sloping down to 55 ft. at the lead-in. A triangular structure made of fir supports one end of the aerial. A 20-ft. pole is at the lead-in end on top of a two-story building. The triangular mast idea was copied from 9ZG ex-9APW of St. Paul. The mast is 36 ft. high with a 33-ft. pole stuck on top and a large concrete base holds the works. The lead-in spreader is 10 ft. in width and the open end spreader 22 ft., making a near fan.

To date, only one 50-watt tube has been used. Forty-four states have been worked. The station is ready to QSO with the west coast. Any information regarding the station or apparatus will be gladly furnished.

WORKING EVERY DISTRICT IN ONE NIGHT

After suffering from power trouble for a month, V. L. Rosso, owner and operator of radio station 5KC, managed to get the 20-watter in operation with a CQ on February 22nd, at 11:15 P.M.

5ALM at Houston, Texas, was first to answer. Then came 5MT calling, but was soon lost in the QRM. 8KJ was worked at 11:30. Then came 9ASR rolling in all over the room, a QRA was gotten and found him to be in St. Louis, Mo. Work was carried on with him until midnight. By this time QRM had decreased somewhat. Another CQ was sent out and was immediately answered by 5ADW—a message was received from him for 5AGV. At 12:35 8CNO was heard calling 5KC, but he was soon lost in the QRM. 8BCH was next worked while using phone. His voice was clear and distinct. A direct phone communication was held for ten minutes. 9CGN was heard calling, but was lost in the QRM of some 5th district station. 9BCC was next to answer a CQ. Then came 1BSZ. Answering a CQ, he said QSA FB, and a message was given him for 2RK. 8BAU was next worked at 3:40 A.M., and a duplicate message of 2RK was given him. 8BSF was next to pound in after a CQ, but was lost in the QRM. 7ABB was next raised. 6BIJ was next to answer a CQ. He came in like local stuff asking for a correct QSD. This was given him at 4:15 A.M. and then we bid each other farewell for the night. At 4:55 1ALL answered a CQ, but QRM made accurate work impossible. At 5:05 8BCF was heard again calling, but was lost in the QRM as in the first time. 2CGB was next to answer a CQ. A message was given him, but didn't know whether he received it or not as he faded in the QRM. 3HH was next heard answering a CQ, but was soon lost in the QRM. 9CPM and 9BGK were next worked. A 4 station was next and last to get and a CQ winged its way through the ether to be answered by some 4 station, but to my surprise there came 8DIG, 8ANB and 9DBJ calling. 9DBJ was worked and another CQ was sent out, as it was now daybreak and the time was growing short. 4BW was heard to answer, but local QRM made



Receiver and Transmitter at 5KC

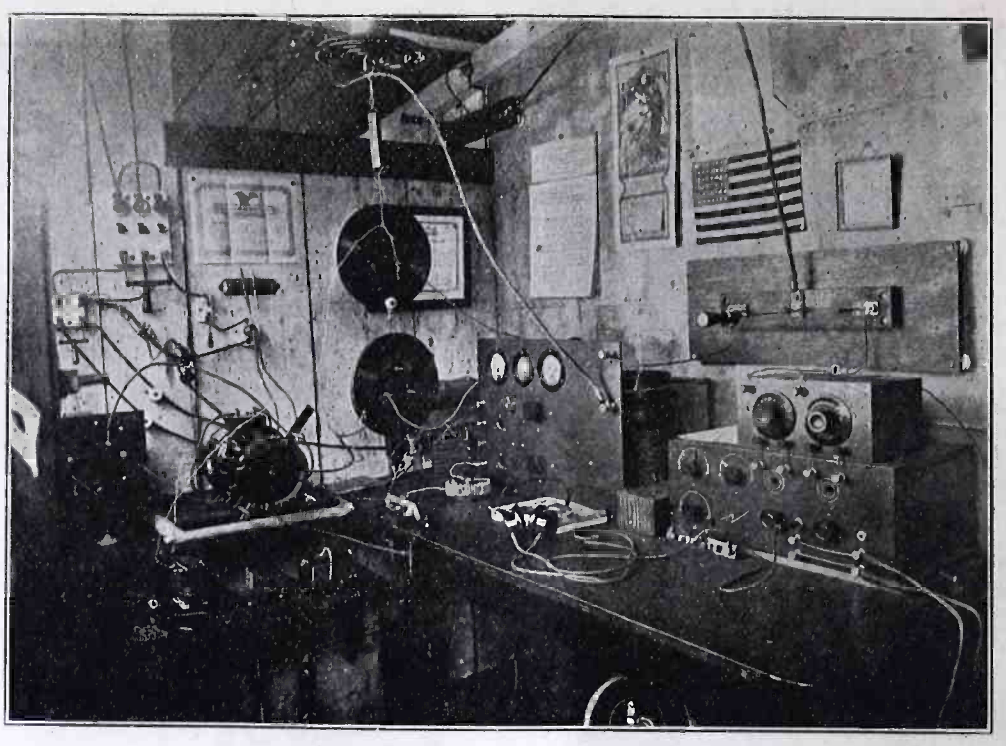
accurate work impossible. This marked the end of a perfect night. 138 stations were heard and 24 of them were worked.

Washington's birthday will always be remembered by Mr. Rosso, due to the splendid work accomplished with his station that night.

The receiver to the left of the picture is one of the conventional short-wave regenerative type, used with a three-stage audio-frequency amplifier. Only one stage is used for amateur signals.

To the right is the 20-watt C. W. transmitter. Four 5-watt tubes connected to a Hartley oscillating circuit are combined into a good-looking panel set that works. The inductance is 20 turns of No. 6 copper wire, 7 in. in diameter, and a .001 microfarad variable condenser is connected across the entire inductance to aid in tuning. The plate supply for the set is rectified by a bridge type chemical rectifier using 32 pint jars filled with a saturated solution of boorax. Two 1-microfarad filtering condensers are bridged across the plate supply. It smooths it out to a considerable extent.

The antenna is a five-wire T 50 ft. long and 60 and 67 ft. high. This set puts from 4 to 4.2 amps. into the antenna, and has been heard at one time and another in every state in the Union, Canada, Mexico, Central America, Yukon, Alaska, Cuba, Porto Rico, Hawaii and off the coast of Australia.



Radio Station 6EB

RADIO STATION 6EB

This station at Los Angeles, Calif., is owned and operated by Lyndon F. Seefred. It consists of one 50-watt Radiotron. The plate voltage is 1500 volts, 200 milliamperes, supplied by a 600-watt 1000-3000-volt "Acme" transformer, bought unmounted and mounted by the writer. The filament is generally at 11 volts, supplied by a homemade filament lighting transformer, having No. 12 D.C.C. wire on the primary and 27 strands of No. 22 D.C.C wire, equal to No. 8, for the secondary. The secondary was wrapped with empire tape before wound on and the core was insulated well under the two windings to prevent arcing to the ground which causes burned-out filament transformers, since one side of the high voltage is connected to the center tap. The secondary is tapped to give from approximately 5 to 13 volts, which will come in handy for larger tubes on account of the heavy wire. A couple of one mfd. condensers are bridged across the filament terminals and the center tap. A 50-250-watt size R.C.A. rheostat is used to reduce the filament voltage accurately. An 0-15 voltmeter, 0-500 milliampere meter, 0-8 thermo-couple radio-frequency meter take care of the filament voltage, plate current, and radiation, respectively. The variable grid and grid coil condensers are of the "Wireless Shop" double spaced specials. A 5000-ohm R.C.A. grid leak is shunted around the grid condenser. The grid coil has 13 turns of bell wire, while the antenna and plate coil has 19 turns of No. 12 weatherproof wire, tapped every turn.

The reversed feed-back circuit is employed and the writer finds that the grid coil works just as well 1½ inches from the other coil as it does inside same. Just add more wire, adjust the condenser, and you will get as much radiation. These two coils may be wound on one tube, but it is best to use two separate coils when more than 1000 volts are used.

The two phonograph records appear to be "musical choke coils" to make the tone sound "jazzy," but they are nothing but two records put together with 350 turns of No. 28 D.C.C. wire in each for radio-frequency chokes. These increased the radiation quite a bit as well as smoothing out the tone. The radiation was 5 T.C. amperes. A "Federal" audio choke was also used. Despite the fact that more filter was not used, many reported the tone as being d.c. A small home-made shunt by-pass condenser is across the high voltage in the circuit. The "Advance" synchronous rectifier is used to change the 1500 volts a.c. to d.c. Also an "Advance" magnetic charging unit is used for charging the *A* battery and it has given the writer excellent service. The contacts have not been adjusted for over seven months. A 60-ampere key can be seen on the table.

For receiving, a home-made single-circuit tuner with one stage of amplification fills the ticket. It tuned rather broad, but certainly dragged in the C. W. DX.

The hook shown in the upper right-hand corner of the picture has fooled many a visitor. They were asked what they thought of the "hook-up" on the wall. After looking much puzzled for some time they were finally told that it was nothing but a "hook" up on the wall.

Above the phonograph records can be seen two large change-over switches for connecting the antenna and counterpoise to either station 6EA or 6EB. This has puzzled many DX amateurs, who have written and asked if both calls were one station or two, and also what relation one was to the other. They are brothers. There are two separate stations under one antenna, which is probably better for experimental purposes. 6CFM, a C. W. station next door, is given the first choice of hours for operation each night and the remainder divided between the other two above-mentioned stations. Cards for 6CFM may be sent in care of these stations.

The antenna consists of two poles, 45 and 52 ft. high, respectively, 16 ft. spreaders, four wires, 7 strands of No. 22 copper in each, with rounders at the corners, 100 ft. total length, L type, and four-wire cage lead-in made of 6 in. embroidery hoops.

The counterpoise is 60 ft. long, 10 ft. high, 9 wires, 7 strands of No. 22 copper wire in each, 14 and 23 ft. wide, respectively.

As the station is located in the center of the city, one block from the business section, surrounded by broadcasting stations of high power, and the antenna rather low, it has done *fairly* good work for transmitting and receiving. Its signals have been copied in every district, along the coast of Canada, Alaska, Hawaii, Mexico, and by ships several thousand miles in the Pacific ocean. A test with 1FD at Norwich, Conn., was carried out with success. The dates were March 14, 15, 16, 1923. 6EB was copied by 1TS, Bristol, Conn., on the 15th and by 1FD on the 16th. 1FD was copied here before the tests. Some of the best cards received were from the third district as follows: "6EB—your C. W. like local eastern station hr om—3BLF, Richmond, Va."; "6EB—ur C. W. vy F. B. hr. Surprised me—3BWT, Washington, D. C."; "6EB—ur C. W. logged 5:12 A.M. Vy qsa, wave 200. Sum punch om. Ur sigs don't stop at Phila.—3CAN, Philadelphia, Pa"; "6EB—ur sigs hrd 5:35 A.M. vy qsa. Sounded like 3ZO-3AOX, Waynesboro, Pa."; "6EB—What circuit you use? Sure lbs. in—3BHV, Washington, D. C.". During the Australian tests this station was copied better towards the east, being heard at 3NF, Westhampton, Va., while daylite there. During these tests, which were in May, the 50-watt tube was run at normal, being 1000 volts, 150 mils., 10 volts filament, and 3 T.C. amps radiation.

Every district except the third and a total of 413 stations were copied here last winter. Sent printed cards to many of them.

DX LIST AT 6XAD-6ZW

(From February 29th to March 31st)

Stations Worked—1ban, 2atf, 2rk, c4cp, c4fu, 5dw, 5qx, 5kp, 5alv, 7ax, 7fq, 7abh, 7aek, 8wo, 8cko, 8jy, 8bnh, 8jb, 8amr, 9aec, 9day, 9ccz, 9btt, 9dp, 9mf, 9lb.

Stations Reporting 6XAD-6ZW—1ahi, 1py, 2brb, 2bbn, 2ayp, F. Hoffman, Brooklyn, N. Y., 2bxd, 2zb, L. Kennedy, Endicott, N. Y., 2csq, 3xaq, 3te, U. S. Navy Club, Norfolk, Va., 3ds, 5to, 5amf, 5xv, 8bmx, 8bxv, 8ags, 8dkl, C. Hamarm, Cleveland, O., 8bni, 8btn, 8acy, 9efu, 9efy, 9agl, 9bgk, 9dqh, D. Standford, Chicago, Ill., c3uj.

William Shiel—4ak, New Zealand—reports 6XAD "very loud." J. E. Strachan, of Rangiora, New Zealand, reports likewise. F. Hoffman hears 6XAD at Brooklyn, N. Y., on a bed spring as an aerial and an indoor aerial as a ground—"QSA." English 6LJ reports 6XAD as "very readable."

I have been on the air even less during the past month than I was in February, and henceforward shall be on but seldom. I would advise, however, that there has been an entire change of wavelengths at 6XAD-6ZW. I herewith list the transmitters as they are now "set"—to remain so until autumn:

The 500-watt Western Electric is on 178 meters, radiating 7.6 amperes. The 250-watt G. E. is on 216 meters. The 100-watt Western Electric is on 192 meters. During the summer I am going to instal a water-cooled McCullough 5-kw. tube, for experimental *short* wave effort in the autumn.

REPORT OF MACLURCAN'S TESTS

Charles Maclurcan, Australia 2CM, and John Davis, the Australian amateurs who sailed from Sydney, New South Wales, on February 28th, arrived in San Francisco on March 21st and left for the return trip on March 26th. As announced in the April RADIO, they were unable to transmit while en route because of a breakdown of their motor generator set, but this defect was corrected at San Francisco and their signals may be heard during the return trip.

Charles Maclurcan

The object of their trip primarily is to determine the range of various C. W. transmitters, especially the two transmitters at 2CM, one consisting of three 5-watt tubes with 7.8 watts input, and the other of two 50-watt tubes of 87 watts input, this station being at Stratfield, New South Wales.

During the trip, they used a three-tube set consisting of one stage of radio-frequency, detector, and one stage of audio-frequency, listening for a special thirty-letter code transmitted each day. The full details regarding reception and confirmation thereof will not be available for six or seven months, but the preliminary results showed that the smaller set was copied continuously up to 4800 miles from Sydney and the larger set for a distance of 5300 miles. Reception of the latter probably could have been continued satisfactorily at San Francisco were it not for the tremendous amount of interference from amateurs. This interference became noticeable while still 4000 miles from the United States.

It is of interest to note that KGO, the General Electric Co. station at Oakland, California, was heard the second day after leaving New Zealand, a distance of 6300 miles. On March 5th it was used to entertain the passengers by means of a loud speaker.

Mr. Maclurcan believes it is possible to establish communication between America and Australia with the present amateur power equipment if this can be done on a wavelength away from the usual amateur interference. He reported remarkable instances of fading at certain latitudes, for instance finding transmission from New Zealand louder at 4000 miles away than at 2000 miles away.

During the return trip the smaller set in Australia will transmit on a wavelength of 240 meters and the larger set on 100 meters.

9ZT WINS HOOVER CUP

The highest honor in amateur radio, recognition as the best all-around amateur station, home designed and contructed, as determined by the award of the Hoover Cup, has been paid this year to Donald C. Wallace, owner and operator of 9ZT at Minneapolis, Minn. The cup was awarded on the basis of the report of a special committee of judges appointed by Charles Stewart, vice-president of the American Radio Relay League. The transmitter was one 250-watt tube in a Hartley circuit.

NEWS OF THE AMATEUR OPERATORS

Call 6ANY has been assigned to Harold M. Okano, Box 98, Hilo, Hawaii, who is operating 20 watts C. W.

2AEY is owned and operated by Raymond Groebe, 338 El Mora Ave., Elizabeth, N. J., who is using 15 watts C. W. and will acknowledge all cards.

The short waves around 100 meters are becoming very popular. Many amateurs have been busy during the last few weeks building short-wave receivers and a few have constructed transmitters that will radiate on 100 meters. Interference on the short waves is almost nil, and DX records are being established almost every night. The demand for a band of waves in the short-wave region for amateur use is growing every day. It is hoped that when the new legislation is finally put through, a good wide band of short waves will be made available to the amateur.

1XW is probably the loudest east coast amateur heard in the 6th and 7th districts.

7BJ, in Vancouver, Washington, has been heard on 100 meters. Sturley reports many new DX records. He uses a modified form of the Meisner circuit and gets excellent results. The development of this circuit has been done by himself.

7CO, of Glendive, Montana, is still one of the busiest stations on the air. He handled a record number of messages during the last month.

Many of the European amateurs are establishing new DX records. British G 2KF of London, England, has been copied by 7ZU at Polytechnic, Montana. G 2KF is owned by Mr. J. A. Partridge and used only a small amount of power on 100 meters. The receiver used at 7ZU in picking up the British signals is a 10-tube superheterodyne built especially for short waves.

A great deal of interest is being shown in the coming Pan-American tests, which will be run off some time this Spring. It is surprising to know how many amateur stations there are in the South American countries. Argentina and Brazil seem to be the leading countries in amateur radio. If a good relay station could be found in Panama regular traffic could be handled between the United States and South American countries.

Mrs. Mary O. Houston, well-known amateur formerly operating under 6BAZ and later assigned the call 6MI, died March 24th after a long illness. Mrs. Houston was the first licensed girl amateur in San Diego and one of the first to be actively interested in the transmitting game on the Pacific coast. She was a staunch adherer to the Pacific Plan in the early days and a very active member of Sunset Radio Club, and San Diego Radio Club, and A. R. R. L. Her illness prevented her putting in a C. W. set which she had contemplated and longed for. The amateurs of the west coast will be grieved at this loss.

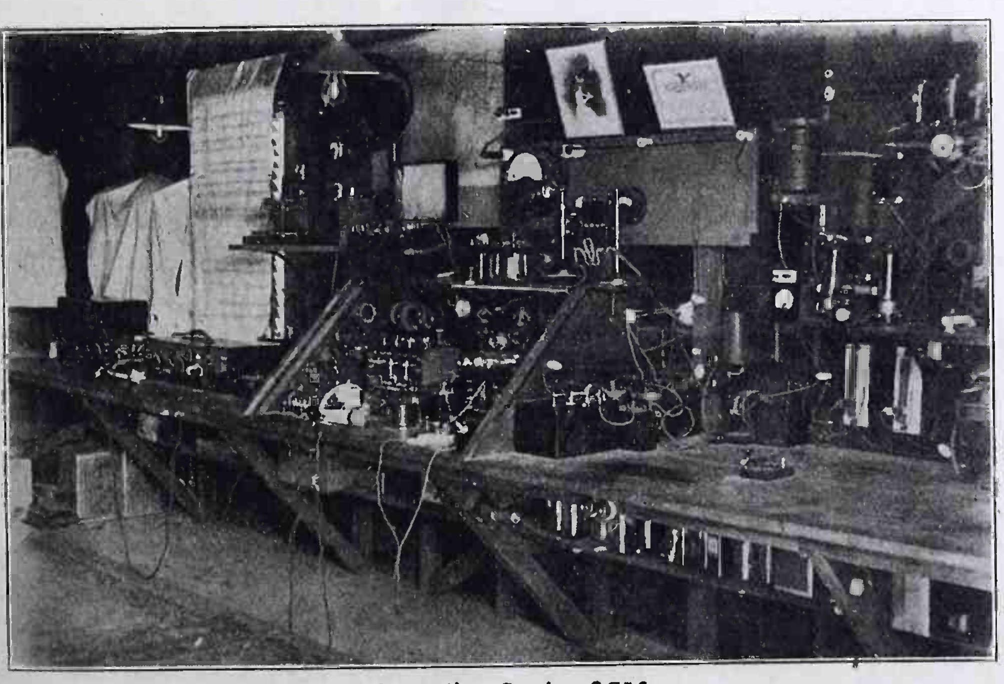
6COS at 728 Crocker St., Los Angeles, Calif., is owned and operated by William T. Seeley, Jr. This station is a 5-watt C. W. transmitter. Will be on the air in a short time.

The QRA of 9CEF is Herbert Settle, 462 E. Burkhart St., Moberly, Missouri, who will appreciate a QSL on his 10-watt C. W. and phone sigs.

An outlaw station in the South is using the call letters of 5BI, J. L. Scott, Lewisville, Ark. This station is a strong C. W.

6AWZ—A. Roy McGregor, 749 Farringdon, Burlingame, Calif. Pse qsl sigs; all crds answered.

Station 6CDP has moved to 955 Shattuck Ave., Berkeley, Calif. Cards would be appreciated fm hams on sigs of my 5 watts spk-coil C. W. or 5 watts rec ac. Tnx.



Australian Station 2CM

NEW RADIO CATALOGS

Catalog No. 11 from the Chelsea Radio Co. of Chelsea, Mass., illustrates and describes their complete line of receiving sets and parts.

Bulletin A-104 from the Connecticut Telephone and Electric Co. of Meriden, Conn., shows their triple range condenser which can be used in place of a 11, 23 or 43-plate variable by a simple shift of terminal connections.

THE LOOP ANTENNA

By R. H. LANGLEY, *General Electric Co.*

The loop antenna is an interesting device. It is quite different in its method of operation from the outdoor antenna. The outdoor antenna is in effect nothing more nor less than a condenser. It is a very large condenser, to be sure, so far as its physical dimensions are concerned, but electrically it is a relatively small condenser. The loop, on the other hand, is an inductance. This fundamental difference between the two is the reason why it is necessary to use different methods of tuning in the two cases.

Let us examine this special form of inductance, which we call a loop, and see why it serves as a pick-up device for radio signals and how it should be made to be effective.

There is a very close parallel between the ordinary direct-current generator or dynamo and the loop antenna exposed to passing radio waves. In the dynamo a number of coils corresponding to the loop antenna are rotated in a powerful magnetic field. The purpose of rotating them is in order that they may move with respect to the field and thus have a voltage generated in them. The amount of this voltage depends, of course, upon the strength of the field and the speed at which the wires are swept through it.

In the radio case, the coil stands still, but the field moves swiftly past the coil, thus accomplishing the same result. The speed at which the field moves cannot of course be varied and is always the speed of light, that is, 186,000 miles per second.

Let us see now what form of loop would have the greatest voltage generated in it by a passing radio wave. Let us think of this radio wave as very much like great smooth waves on the ocean, which, of course, also move forward with a very definite velocity. The turns of wire on our loop antenna are necessarily in series with each other, that is to say, they form a continuous winding. If the maximum voltage is to be generated in any one turn of the loop, then the voltage generated in the two sides of this turn should be in opposite direction so that they may add to and not oppose each other. If the voltage generated in both sides of the loop were in the upward direction at any one instance, then these two voltages would cancel each other; but if the voltage on one side of the turn was up and on the other side of the turn it was down, then they would add, and if the loop were connected to a receiver, a current would flow around the turns of the loop. This, of course, is exactly what we wish to have happen.

In order to have the voltage generated on one side of the loop in the opposite direction to that generated on the other side of the loop, the loop would have to be one-half a wavelength long, that is to say, it would have to be long enough in the horizontal direction so that one side was in the crest of the wave when the other side was in the trough of the wave. Since the distance between the crests of the wave is the wavelength itself, then the distance from the crest to the trough is one-half the wavelength.

The higher the sides of the loop are, that is, the longer the vertical wires are, the greater will be the voltage generated, and, of course, the voltage generated in each turn is added to the voltage generated in all the other turns.

But a loop one-half a wavelength long is quite out of the question. It would be as long as a steamship and almost as difficult to handle. The loops which we are using every day are of quite reasonable dimensions. They are only a few thousandths of a wavelength long. How do they function? In order to answer this question let us ask ourselves how we would build a coil of wire in order that absolutely no voltage should be generated in it by the passing wave. The only way in which this could be accomplished would be so to build the coil that the same voltage would be generated in both sides of it and that the voltages generated in the two sides would be opposed to each other. This would give a complete cancellation and no voltage at all at the terminals of the loop or coil. It is obvious that the only way in which this could be done would be by so arranging the loop that it had no length. That is to say, arrange it so that the two sides are exactly in the same position in space. This would mean that the horizontal wires across the top and bottom of the loop would cease to exist and the loop would become nothing but a wire laced up and down between pegs on the plane surface of a board.

If there is any distance at all between the two sides of the loop, then there will be some difference, not in the amount of voltage generated in the two sides, but in the time at which this voltage is generated, and there will consequently be some voltage at the terminals of the loop, since complete cancellation of voltages cannot occur.

If the loop is rotated so that its horizontal wires are at right angles to the direction in which the signal is coming, then the loop has no length so far as those signals are concerned. The passing wave strikes both sides of each turn in the loop at exactly the same instant and the voltages generated are therefore equal and opposed and there is no terminal voltage. This is the fact which gives the loop antenna its very useful directional property. It is to be noted, however, that if the loop is turned ever so slightly from this zero position then the voltages no longer cancel and there is a voltage at the terminal. This means that the zero position of the loop is very sharp, but the maximum position is broad.

In applying the loop antenna to an actual radio receiver, it is necessary that provision be made to tune it to resonance with the desired signal. This is accomplished by means of a variable air condenser, and, since this condenser has a very definite maximum capacity, the amount of inductance which the loop can have is also limited. This maximum inductance with the maximum capacity of the variable condenser, must give resonance to the longest wave to be received. The specification for the best loop antenna, therefore, is that it shall have just as many turns as possible, each turn being just as long as possible and just as high as possible, and still have no more than the required maximum inductance. The higher the loop is the greater will be the voltage generated in each side of each turn, and the longer it is the greater will be the difference in time at which these voltages are generated in the two sides of the loop, and, consequently, the greater will be the voltage at the terminals, but it must not have an inductance value greater than that required for tuning.

IMPROVING THE SELECTIVITY OF A SINGE-CIRCUIT RECEIVER

By J. O. WATKINS

The regenerative single-circuit receiver, by means of proper constants, can be made fully as selective as the non-regenerative coupled circuit. This, with its advantage of but two controls for the two-handed operator, and, as a bringer-in of distant signals, is likely to maintain its popularity.

For each wavelength on a given antenna there is a certain value of series capacity which gives maximum sensitivity combined with maximum selectivity. The writer has found that this best value changes but little throughout the band from 200 to 600 meters and that consequently all tuning can be accomplished with a variable inductance such as a variometer.

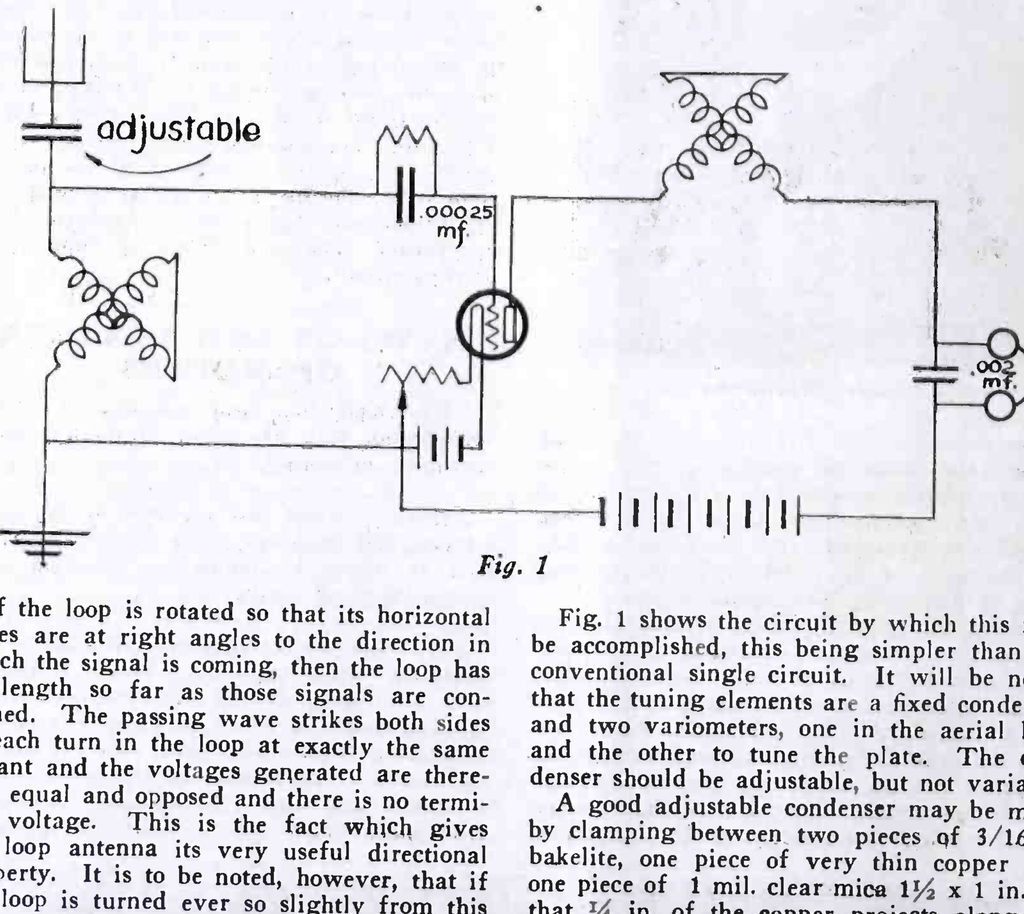


Fig. 1

Fig. 1 shows the circuit by which this may be accomplished, this being simpler than the conventional single circuit. It will be noted that the tuning elements are a fixed condenser and two variometers, one in the aerial lead and the other to tune the plate. The condenser should be adjustable, but not variable.

A good adjustable condenser may be made by clamping between two pieces of 3/16-in. bakelite, one piece of very thin copper and one piece of 1 mil. clear mica 1½ x 1 in., so that ¼ in. of the copper projects along the long dimension. After drilling a hole near each end insert a piece of the thin copper ¾ by 1½ in. endwise on the side of the mica opposite the other piece of copper. After screws have been put through the drilled holes it will be found that by loosening the screws the small piece of copper can be moved in or out to vary the capacity. When the right capacity is found the screws may be tightened.

The two variometers should be separated as far as possible and should be mounted at right angles to reduce inductive effects. The tuning variometer shaft should be connected to ground at dial end and the plate variometer shaft should be placed toward the plate battery to minimize body capacity effects.

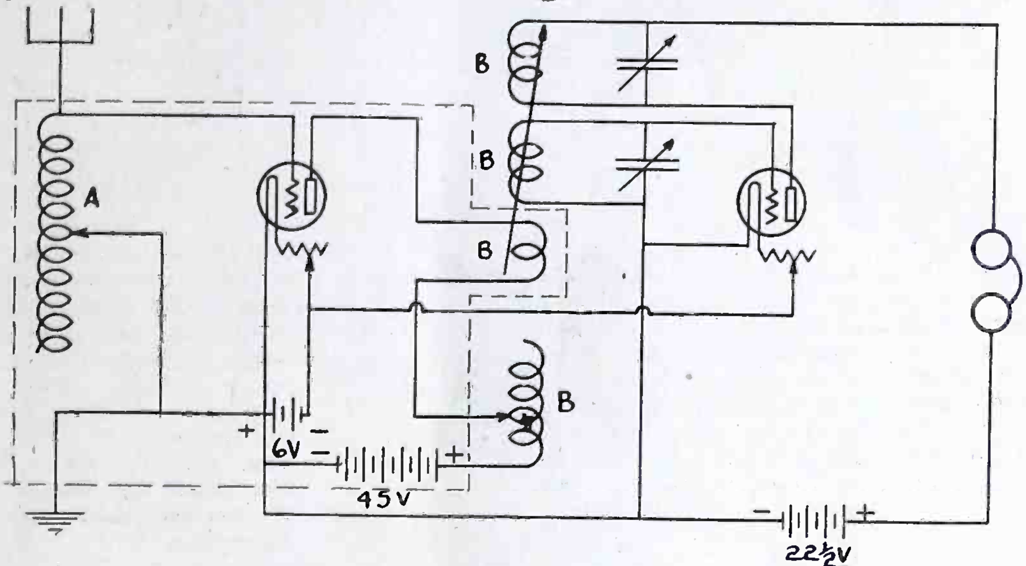
While tuning to 360 meters on a number of antennas of different size the writer has found then an inductance value of 400 microhenries and a series capacity of .0001 mfd. is about right. The antenna should be short and high to give the best results.

INTERFERENCE ELIMINATING CIRCUIT

By F. L. ULRICH

The circuit here described not only gives excellent results as to distance and volume but also is so selective that a nearby high-power station can be eliminated so as to get a distant one. The essential features and arrangement are shown in the diagram.

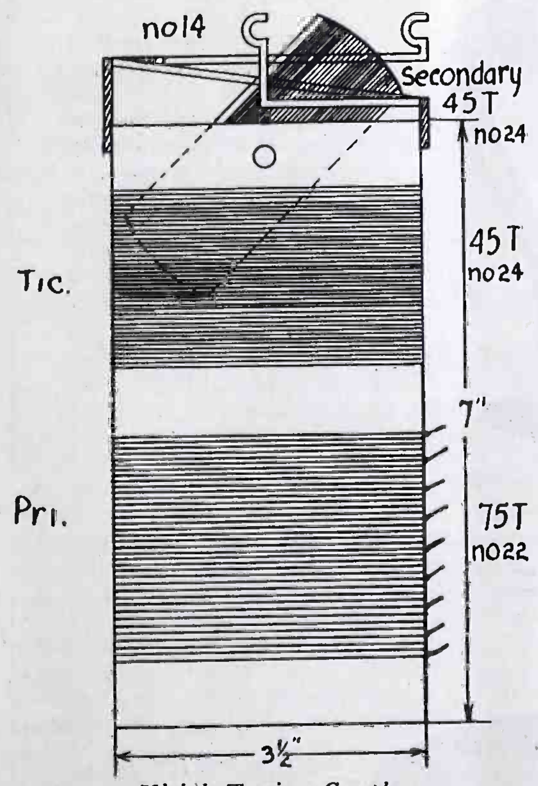
The resistance *A* should be adjusted for the tube that is being used. It carries all stray currents to the ground. The signals of various frequencies pass through the filter tube and thence to the primary of the receiver. But little adjustment is necessary to exclude undesired signals. The receiver involves no new points and any number of amplifiers may be added to increase volume.



Ulrich Interference Eliminator

A is a variable resistance of from 5000 to 12000 ohms. A carbon potentiometer will serve the purpose.

B is the tuning coupler and tickler. It consists of a cardboard or bakelite tube 3½ in. in diameter and 7 in. long, inside of which is fitted a wooden rotor which can turn without rubbing the sides of the tube.



Ulrich Tuning Coupler

The rotor turns on a 3/16-in. brass tube 5½ in. long, through which the rotor leads are run. On the rotor are wound 45 turns of No. 24 C.C. copper wire to make the secondary winding. The tickler winding is 45 turns of the same wire wound on the tube 1½ in. from the edge. The primary consists of 75 turns of No. 22 C.C. copper winding started 1 in. from the tickler and 1½ turns of No. 14 soft copper wire supported at the extreme end of the tube and coupled to the secondary rotor. The primary may be tapped to give better tuning.

Two .00025 mfd. 23-plate variable condensers are used, one shunting the tickler and the other the secondary. The rest of the apparatus, such as sockets, rheostats and vacuum tubes, can be purchased at any radio store.

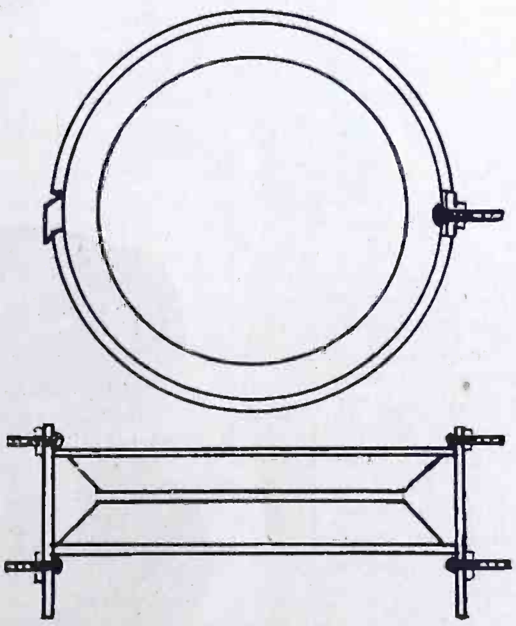
WGY, KGW, KDPM and WDAP have been heard through local interference at San Diego, Calif. The author will be glad to answer any questions sent him, care U. S. S. *Somers* (301), San Diego, Calif.

MAKING A TRANSMITTER CONDENSER

By FRANK BOWMAN

A good low loss condenser that is efficient and is very easy to build ought to be much in demand at this time when all the rage is to "get down." The ones in use at 6BUH do the trick and only cost 30c each!

Purchase from a fifteen-cent store a couple of aluminum pie plates. Bend the rim up with a pair of pliers between slits cut about 1 in. apart so that the center of the part bent up will be diametrically opposite another similar pair of cuts on the other side of the plate. Bend only the part that is parallel with the bottom, not the dished part, as that would spoil the alignment of the bottom. About ½ in. from the edge is right. Treat both pans the same.



Aluminum Plate Condenser Assembly

Then get a strip of hard rubber (or your favorite insulating material) about 1 in. wide, ⅛ in. thick, and 4½ in. long. Drill a hole in the rubber to take an 8/32 machine screw ½ in. from the end, then another 2¼ in. from the first, both in the center of the strip. Make two alike. Also drill similar holes in the aluminum in the center of the small part that was bent up. Then bolt the hard rubber strips on to the plates with 8/32 machine screws 1 in. in length, leaving a space of about ⅛ in. between plates. Your condenser is finished.

The capacity is fixed, but can be changed by making the holes in the rubber a little large and changing the spacing of the plates by the play this will give. Several can be operated in multiple by bolting directly together and connecting with copper ribbon. For series, connect direct to the end plates only. They will carry upwards of 10 amps. without any heating on waves below 200 meters.

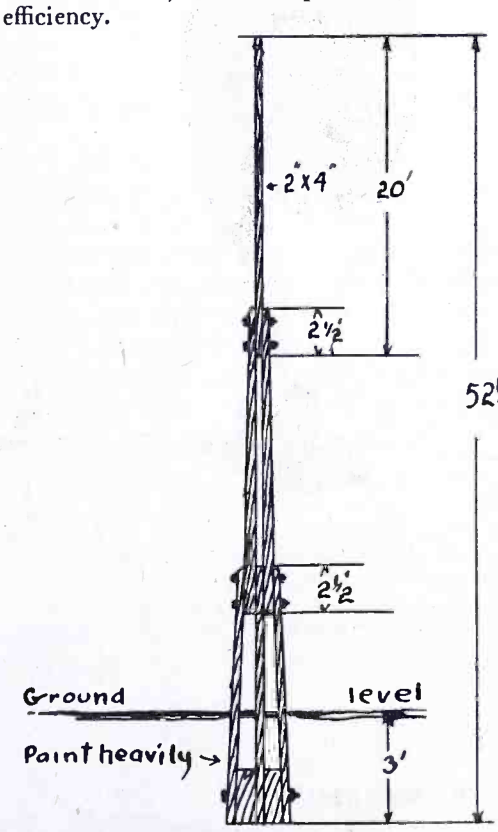
This condenser has nothing in the field but AIR. The leakage paths through the hard rubber supports are 2½ in. long and there are no sharp edges for corona losses when very high voltages are used.

The ends of the rubber strips that project can be used for feet or holes drilled in them for mounting. The machine screws also serve as binding posts.

A CHEAP BUT EFFICIENT ANTENNA MAST

By H. W. ALLEN

Many "hams," especially those living in the larger cities, have long felt the need of an antenna mast that would be both cheap and efficient. Such a mast can be made to combine the addition feature of height, strength, and ease of construction, with a few common tools, small expense and over-all efficiency.



Antenna Mast

Here is the list of necessary parts:

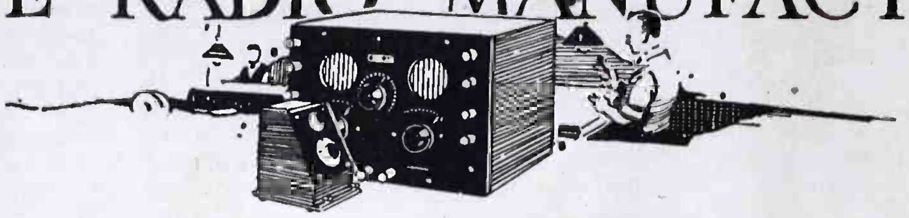
Six 2x4's (pine) 20 ft. long.
Two ⅜-in. bolts 8 in. long.
Two ⅜-in. bolts 12 in. long.
One ⅜-in. bolt 12 in. long (to go underground); paint heavily.
Ten washers to fit bolts.

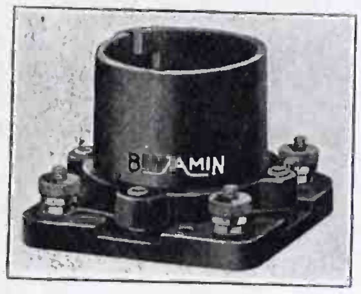
The accompanying drawing is self-explanatory. Besides most of you will want to use your own ideas.

A mast of this type has been in use at my station for two years and has withstood some very heavy storms, being braced by only three wires and the antenna.

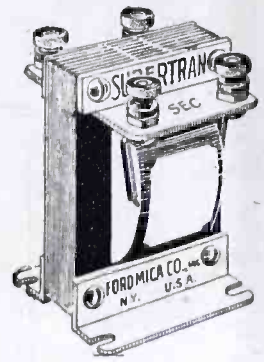
If properly painted with preservative this mast will last indefinitely.

FROM THE RADIO MANUFACTURERS





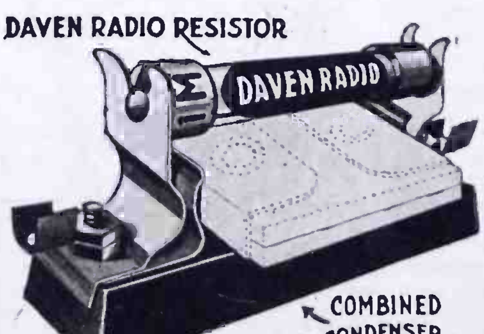
The Benjamin Cle-Ra-Tone vacuum tube socket is intended to minimize tube noises due to vibration. The tube-holding element floats on springs which act as shock-absorbers. This not only eliminates the noise effect of jars but also protects the tube in a portable set.



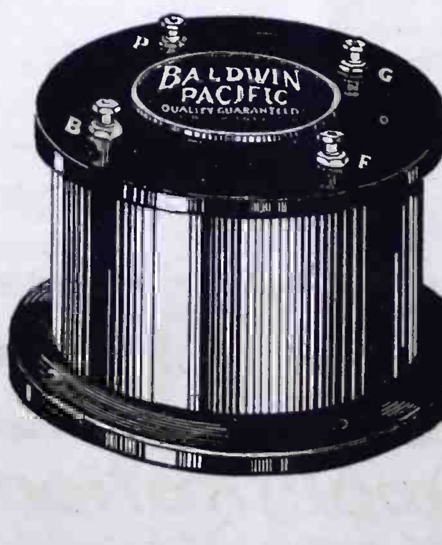
The F.M.C. Supertran is an audio-frequency amplifying transformer that is claimed to reproduce all tone frequencies without distortion. This is due to special design of the turns ratio, inductance, capacity and core laminations. It has a d.c. resistance of 1090 ohms and primary open circuit impedance of 500,000 ohms at 500 cycles.

The new R3 Magnavox radio reproducer is operated on the electro-dynamic principle, taking .6 amperes at 6 volts. By means of an electrical modulator perfect control of volume is secured, the current consumption dropping to .1 ampere. This instrument is extremely sensitive to faint signals. It is most attractive in appearance and conveniently arranged for attachment.

The K.E. loud speaker is a new radio reproducer for which is claimed a full mellow tone that is unusually loud and clear. It employs an adjustable diaphragm to control the volume and eliminate distortion and operates without a battery.



The Daven resistor and condenser mounting is designed as a combined unit for convenience in trying out various fixed grid condensers and leaks. One set of clips holds a standard mica condenser and the other a 50,000-ohm Daven resistor unit.



Pacific S-H (Super-Heterodyne) Transformers are the result of extensive research work, scientific design and finest materials to provide for the many advantages that are to be had by the owner of a Super-Heterodyne set. Distance, selectivity and simplicity are claimed for this transformer.

HOW MANY STATIONS DO YOU GET ?

and do you hear them "LOUD and CLEAR"

WHEN the fellow from next door comes in and wants to tell you about his set, and shows you a list of stations that look like a Chinese newspaper, what have you got to show? Can you sit down and tune them in so that they sound as if they were in the next room? That's what thousands of radio owners can do who have learned how to get loud and clear messages from the far away stations by the Acme method.

The importance of amplification

In order to hear clearly and distinctly, you must be sure that you are using amplifying transformers that amplify the sound without distorting it. Amplification is the key to radio—it increases the tiny sound waves that reach your set and makes them loud enough for you to hear and enjoy.

But it is not enough to amplify the sound, you must be sure that in amplifying it you do not blur it and make muffled, unintelligible sounds out of messages that should be clear and distinct. That is the danger of distortion.

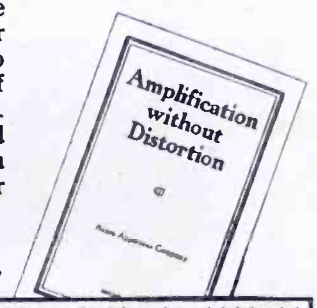
The Acme A-2 Transformer (shown above) and Acme R-2, R-3 and R-4 Radio Frequency Transformers sell for $5 each at radio and electrical stores. Your dealer will be glad to help you.

How to get amplification without distortion

The Acme engineers have perfected two instruments that give you maximum amplification without distortion. The Acme R-2 (also R-3 and R-4) Radio Frequency Transformer builds up the radio energy before it reaches your detector. This increases your range. The Acme A-2 Audio Amplifying Transformer gives you greater volume of sound. It builds up the audio energy that leaves your detector and gives it to you "loud and clear." If you want to get the most out of your set, be sure to use Acme Transformers.

How to get the best results

In order to get the best results, send for "Amplification Without Distortion"— an instructive and helpful book which not only explains exactly how to get the best results by proper amplification, but also contains a number of reliable wiring diagrams. It will help you build a set. Send the coupon with 10 cents for your copy.



ACME APPARATUS COMPANY, Dept. 64, CAMBRIDGE, MASS.

ACME
for amplification

ACME APPARATUS COMPANY,
Dept. 64, Cambridge, Mass., U. S. A.

Gentlemen: I am enclosing 10 cents (U. S. stamps or coin) for a copy of your book, "Amplification without distortion," containing complete instructions and diagrams for making my set "Reflex."

Name ....

Street ....

City .... State ....

CALLS HEARD

Continued from page 34

At 7ZU, Polytechnic, Mont.

1aw, 1bk, 1cab, 1cac, 1ce, 1cua, 1co, 1fs, 1ka, 1qw, 1xn, 1yb, 2agb, 2afp, 2al, 2azy, 2bbu, 2bgi, 2bq, 2by, 2byw, 2cqu, 2fn, 2fq, 2gk, 2hh, 2in, 2nm, 2od, 2pd, 2rf, 2rg, 2rj, 2rw, 2sbu, 2sz, 2ts, 2wc, 3ab, 3atb, 3au, 3bmn, 3bnu, 3buy, 3cc, 3cwx, 3em, 3ir, 3lg, 3lm, 3oi, 3om, 3rg, 3sc, 3yo, 4am, 4ba, 4ce, (4cs), 4ft, 4hs, 4is, 4kw, 4lj, 4lp, 4oa, 4og, 4oh, 4pt, 4sq, 4xe, 5aac, 5abo, 5adi, 5ahr, 5aeu, (5ahd), 5aiu, (5aji), (5amj), 5amu, 5anr, 5bu, 5bx, 5by, 5cm, 5cv, 5ek, 5er, (5gg), (5gj), 5iq, 5kp, 5nk, (5nw), 5lp, 5pa, 5ql, (5ax), 5qy, 5rg, 5sd, 5ua, 5uo, 5wm, 5xd, (5zav), 5zbd, 6aao, 6aay, 6acz, 6age, (6aja), 6ajf, 6ak, 6alq, 6ang, 6ape, 6arf, 6aru, 6auu, 6avv, 6awt, 6bbc, 6bcl, 6bjf, 6bih, 6blf, 6bnf, 6brf, 6bug, 6bur, 6bui, 6bvg, 6bzs, 6cbw, 6cde, 6cgd, 6cgw, 6ch, 6cih, 6cjj, 6ckp, 6ckr, 6ckv, 6cng, 6crv, 6eu, (6fw), 6gw, 6hc, 6jt, (6lv), 6cmr, 6nx, 6osa, 6pg, 6su, 6ux, 6vf, 6zbd, 6zbu, 6zh, 7abb, 7abs, 7adr, 7af, 7afu, 7ahc, (7aho), 7ahs, 7aif, 7aek, 7aem, (7adj), 7ajv, 7aky, 7ald, 7bx, 7bz, (7cf), (7co), 7dt, 7cd, 7em, 7er, 7fq, 7gi, 7gr, (7hi), (7hw), 7io, 7je, 7ng, 7ob, 7od, 7om, 7ot, 7pj, 7qa, 7qc, (7qd), 7qoi, 7qu, 7ra, 7ry, 7sf, (7sh), 7sy, 7to, 7tq, 7tt, 7tx, 7ut, 7wt, 8aab, 8acy, 8ada, 8ak, 8anb, 8apt, 8ata, 8atc, 8azg, 8bce, 8bda, 8bf, 8bgz, 8bmm, 8boy, 8bsf, 8bvt, 8bwj, 8bxw, 8bzc, 8cci, 8cdi, 8cfy, 8cgu, 8chy, (8cku), 8clc, 8com, 8cqj, 8csk, 8ct, 8cw, 8cwp, 8cwu, 8cxo, 8cyu, 8cy, 8cza, 8czy, 8dae, 8dai, 8dbm, 8ddc, 8dgp, 8dh, 8dhq, 8diz, 8djf, (8dks), 8dof, 8dso, 8dxu, 8dys, 8eb, 8fc, 8fk, 8gw, 8gza, 8hn, 8jso, 8lt, 8ly, 8ph, 8qk, 8qw, 8rj, 8rv, 8tq, 8uf, 8vm, 8vt, 8wo, 8wx, (8zc), 8zz, (9aau), 9aaw, 9abc, 9aci, (9ack), 9aec, 9af, 9afw, 9ahg, 9aii, 9ajv, 9amz, 9anf, 9anj, 9any, 9aou, 9aow, 9ape, 9aqv, 9atc, 9avg, 9awf, 9awl, 9awv, 9ayl, 8ba, (9bab), 9bav, 9bez, 9bdu, (9bkf), 9bgg, 9bji, 9blt, 9bly, 9bnh, 9bof, 9boz, 9bpn, 9bpq, 9bqg, 9bqj, 9bri, 9bsi, 9bst, 9bsz, 9btu, 9btx, 9bzi, 9caa, 9ccm, 9ccn, 9cco, 9ccv, 9cea, 9cfx, 9cga, 9cgn, 9cgq, 9chc, 9cic, 9cih, 9cjf, 9cjy, 9cka, 9ckp, 9clq, 9cme, 9cnn, 9co, 9cox, 9cqa, 9cra, 9cvc, 9cxp, 9cze, 9czg, 9day, 9dc, 9dcc, 9dec, 9dgy, 9djp, 9dk, 9dkb, (9dkg), 9dkq, 9dow, 9dpx, 9dsl, (9dun), 9dxu, 9dyr, 9dzo, (9eea), 9ees, 9efq, 9eky, 9ell, (9elv), 9fm, 9hg, 9mc, 9mf, 9qse, 9ry, 9ss, 9vz, 9xar, 9yy, 9zl, 9zt.

Can.: 2ng, 3bq, 3je, 3ws, (4aw), (4ax), 4co, 4iw, 5ct, 9bx.

Gt. Britain: 2kf.

B. C.: Kdka, kgo, wgal.

By Melbourne Renken, Cole Camp, Mo.

1gh, 1ij, 1aw, 1iy, 1fm, 1alj, 1ci, 1aol, 1awy, 1xz, 1azm, 1agh, 1bho, 1ci, 1oj, 2awl, 2cor, 2cnc, 2bbn, 2bqh (daylite), 2be, 2blm, 2bm, 2awf, 2ana, 2wc, 2wr, 2cxz, 3hh, 3btl, 3cdn, 3bb, 3lg, 3aij, 3atb, 3br, 3lr, 3aaz, 3jx, 3bwt, 3adp, 3blp, 3mo, 3ti, 3ckl, 3kp, 3ph (daylite), 3can, 3yh, 3cbk, 3bgz, 3cez, 3wf, 3aor, 3ckl, 3wf, 4mi, 4rh, 4mu, 4ku, 4hu, 4dv, 5jr, 4pf, 4og, 4ir, 4je, 4jk, 4kb, 4su, 4qy, 4eh, 4gh, 5vm, 5amu, 5air, 5pp, 5xa, 5tj, 5aao, 5alv, 5aom, 5aac, 5fx, 5afh, 5ahd, 5qj, 5rq, 5zas, 5za, 5arm, 5qj, 5ql, 5na, 5ac, 5agh, 5sg, 5ml, 5aaw, 5anf, 5mz, 5qg, 5xv, 5alm, 5ib, 5kc, 5tj, 5akn, 5ajj, 5qw, 5alm, 5ua, 5ql, 5afq, 5ut, many more, 6bbc, 6cmr, 6rn, 6ba, 6ajh, 6cnq, 6cih, 6bwp, 6cmu, 6cnw, 6ak, 6cbj, 6bh, 6brf, 6bgo, 6ti, 6bpm, 6tv, 6uw, 6zu, 6pe, 6gl, 6cka, 6bm, 6bqa, 6zv, 6aao, 6mg, 6cjv, 6but, 6ckg, 6aku, 6bnf, 6akz, 6bqb, 6cas, 6cl, 6amw, 6bnt, 6adh, 6aqm, 7co, 7qd, 7to, 7rn, 7om, 7tq, 7adf, 7adj, 7io, 7fq, 7co (daylite).

Too mani nines and eights.

Fone: 5qd, 4hs, 8cmg, 8kg, 9diz, 5amf.

Cuba: 2ww, Pure dc, Pa? Qra? 8xbh? Qra? Qrh?

Can: 5cg, 3bm, 3ir, 3cmn, 3uv, 3hi, 3ws, 3av.

By 5KC, Plaquemine, La.

1rr, 1sw, 1xz, 1acb, (1all), 1asu, 1aww, 1bgq, 1bom, (1boq), (1bsz), 1cbj, 1cpi, 2bt, (2rk), 2awa, 2azy, 2bqq, 2bwp, (2cgb), (3hh), 3hi, 3hs, 3nf, 2pz, 3ws, 3xi, 3btl, (3cjn), 3cjr, 3ctn, (4bw), 4hh, 4hn, (4io,) (4jr), (4og), 4su, (5ag), (5jt), (5mq), (6mt), (5mz), (5nk), (5qj), (5ua), (5xa), (5yw), (5abw), (5adw), (5afs), (5ajg), (5aju), (5alk), (5alm), 6gt, 6of, 6xh, 6acv, 6ajf, 6ajh, 6awq, 6bez, (6bij), 6buy, (6cgw), 6cmr, 6cnl, 7fq, 7fs, 7ft, 7ih, 7to, 7zu, (7abb), 7xaf, (8bk), (8dj), (8kj), (8ack), (8aig), (8alm), (8anb), (8bau), (8bcf), (8bch), (8bmb), (8boj), (8cno), (8ddc), (8dig), (9ap), (9dr), (9er), (9wu), (9adi), (9alz), (9aqv), (9asr), (9ato), (9bcc), (9bdh), spark, (9bff), (9bgk), (9bhw), (9bij), (9bio), (9bps), (9bqj), (9brk), (9brs), (9cgn), (9cpm), (9cwq), (9dbj), (9dbw), (9dwa).

Canadian: 3je, (3nf), 4co.

Mexican: (bx).

By 4EZ, Jacksonville, Fla.

1ar, 1ii, 1hx, 1zt, 1agh, 1all, 1ayt, 1bes, 1bwj, 1bsz, 1cde, 1cmp, 1cmx, 2nz, Cuban 2by, 2xq, 2awf, 2ayp, (2azy), 2brb, (2cgb), 2cjx Spk, (2cxy), 3fj Spk, 3fs, 3go, 3hh, 3hs, 3me, 3mo, (3oi), 3ph, 3qt Spk, 3ti, 3tr, 3xi, 3aou, 3apv, 3arp, 3atb, (3bmn), 3buv, 3cdn, 3cel, 3cjn, 3ckl, (4ch), (4dp), (4eb), (4fg), (4ft), (4fz), (4og), (4qw), (5lr), 5qd, 5ql, 5qy, (5qz), 5sd, 5ua, 5zg, 5aac, 5abd, 5ads, (5afs), 5aiu, 5alz, 5amh, 5zas, 6bbc, 8jj, 8kc, 8pl, (8vq), 8ada, 8aig, 8alm, (8bwc), 8cci, 8cvx, (8cwp), 8ddc, 8dkb, 9er, 9ss, 9abf, 9aps, 9agv, 9azp, 9bdz, 9bhi, 9bhk, 9bie, 9bly, 9bps, (9ccm), 9ccv, 9cdo, 9cly, (9ctr), 9cvo, 9dbf, 9dmj, (9dtc), (9dwa), 9ehy, 9elv.

At 2BBN, 518 9th St., Carlstadt, N. J.

4aa, (4bl), (4oh), (4pk), 5aaw, 5abn, 5ags, 5ajb, (5dm), (5kq), (5lr), (5xau), 5zav, (6bbw), 6bcl, 6bic, 6buy, 6bvg, 6cbg, 6cmr, 6gt, 6nb, 6nx, 6ru, 6tu, (6tv), 6xad, 6zw, 7aci, 7co, 7hg, 7zu, (9aad), 9aci, (9ahz), (9agy), (9asw), (9bis), (9bps), (9bss), (9bty), (9byc), (9clz), (9cvo), (9dbf), (9dcs), (9dr), 9dsl, (9dwe), (9dvn), 9dzv, 9elz, 9ji, (9ux).

Cuban: (2ww).

Continued on page 46

SUPER HETERODYNE

DISTANCE
SELECTIVITY
SIMPLICITY

PACIFIC S-H
(SUPER-HETERODYNE)
TRANSFORMERS

WITH these perfected transformers, you can know always that you are getting the very best results from your receiving set that it is capable of giving.

ASK YOUR DEALER

PACIFIC S-H Transformers are but an example of the *better* radio products sold under the Baldwin-Pacific trade name and gladly shown you by *better* radio dealers. Every article is of proved superiority. Exacting tests have proved it the best of its kind, bar none! And prices are low compared to the remarkable quality.

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PACIFIC S-H Super Heterodyne Amplifying Transformer (3 required), each $6.50

No. 10
PACIFIC S-H Super Heterodyne Transformer Standard for input or output, each $6.50

FREE
Super Heterodyne Hook-Up Print Packed with each transformer.

Order from your regular dealer or advise us his name and we will arrange to supply you.

A complete knock-down SUPER SET ready soon.

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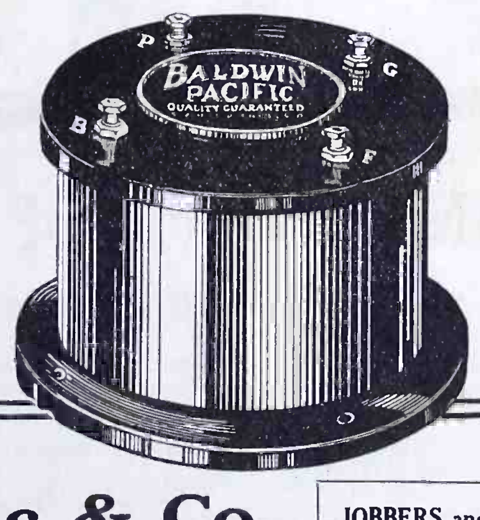

W·H·A·

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Right policy, attractive prices and guaranteed quality apply to this line. Strong publicity to follow — trade paper, show cards, etc. Order now for prompt delivery.

Continued from page 44

By 6CDP, 955 Shattuck Ave., Berkeley, Calif.

3lg, 3mb, 4io, 5aam, 5adb, 5aic, 5cv, 5ef, 5ft, 5lr, 5na, 5qd. 5yw, 6aaj, 6aao, 6aak, 6acl, 6adh, 6aqd, 6agk, 6ahp, 6alo, 6alq, 6bad, 6bih, 6bko, 6blh, 6beq, 6bqa, 6cdj, 6cdu, 6cgk, 6cgw, 6cih, 6cis, 6cix, 6ckv, 6cmf, 6ak, 6bk, 6jz, 6kt, 6nb, 6of, 6oz, 6qb, 6qh, 6zbj, 7adg, 7ads, 7akk, 7ald, 7bj, 7em, 7ez, 7fa, 7fr, 7fs, 7go, 7gr, 7hg, 7io, 7kv, 7nf, 7ob, 7ot, 7pz, 7qc, 7qd, 7rd, 7to, 7tt, 7om, 7on, 7zw, 8xw, 8zk, 9ax, 9ak, 9co, 9dr, 9er, 9hm, 9lz, 9ss, 9ahz, 9amt, 9ape, 9atn, 9avn, 9avs, 9axx, 9bdz, 9bed, 9bqj, 9bth, 9bze, 9caa, 9cdv, 9ceh, 9ckc, 9daj, 9daw, 9dro, 9dsl, 9dsw, 9dyr, 9eky.

Can. C. W. 5cn, 5ct. Hrd on 1 tube Reinartz, Wl qsl checks on abv es wd appreciate repts on mi 5 watts c. w.

By 8BKY, Albert Silcox, 1325 So. Pittsburgh Street, Connellsville, Pa.

5za, 6aao, 6aha, 6ajh, 6auu, 6awq, 6bcl, 6bcu, 6cdj, 6cgw, 6ckr, 6cmu, 6cz, 6fp, 6gg, 6gi, 6mh, 6od, 6pl, 6xbc, 6zz, 7eo (also hrd 7co on 100 meter harmonic), 7lu, 7zu.

Can.: 9bp.
British: 2kf, 2nm, 2od, 2sz, 5nn.
French: 8ab, 8bf.
Dutch: Pa9, pc11. Wl qsl on request.
Pse qsl My 1-202 C. W. (40 watts input).

At 6BQA, 855 Birch St., Los Angeles.

2by, 3tb, 4bz, c4cs, c4oo, 4eq, 4ft, 4ik, 4io, 4mw, 4my, 5bg, 5eh, 5if, 5xd, 5nw, 5jl, 5rv, 5uo, 5adb, 5ado, 5ajb, 5za, 5zb, 5zav, 7bj, 7el, 7fs, 7fd, (7gq), 7gp, 7ih, 7lh, (7akh), 7ln, 7ob, 7vn, 7abb, 8bf, 8abm, 8vq, 8yn, c9bp, 9fm, 9ss, 9aau, 9ado, 9aep, 9amb, 9avu, 9afy, 9dbf, 9bed, 9bis, 9dkq, 9caa, 9cee, 9cgk, (9dyi), 9czn, 9dle, 9cca, 9clv. Ani one hring my sigs, pse qsl.

By 5ANC, 223 So. 3rd St., Enid, Okla.

(1afe), 1apj, 1ana, (1are), 1arp, (1aur), 1aww, 1bbo, (1bcr), 1boq, 1bgg, 1bes, (1bkq), (1bvr), 1bwj, 1ckp, (1cit), (1opi), 1er, (1fs), (1sn), (1ts), (1zl), (2blp), (2brb), (2bsc), (2cdw), (2cnh), (2cpa), (2cxb), (2dx), (2ku), (3aaq), (3ab), (3adb), (3apv), (3bdr), (3bwj), (3ccf), (3ccu), (3ccx), (3chh), (3ckj), (3hs), (3qt), (3qv), (3ll), (3vd), (3vw), 4af, 4ai, 4bq, 4db, 4dx, 4eb, 4er, 4ft, 4fs, (4hs), 4jk, (4ku), (4mi), (4pk), (6akz), 6aoc, (6auu), (6bkq), (6bkx), (6blw), (6bmp), (6bqk), (6bql), (6bsg), 6bur, 6buy, 6cgw, (6gi), (6zbk), (7abb), 7aci, 7adr, 7co, 7fd, (7hg), 7ob, 7qd, 7sf, (7to), 7wm, 7zb, 7zu, 7zv, 7yl.

Can. C. W.: 1ar, 1bq, 2bn, (2je), 3aa, 3co, (3db), (3gg), (3ia), (3kq), (3ml), (3ni), (3xi), (3xn), (3zt), (4aw), (4ea), 5go, (5he), 9bp, (9cf).
Mexico C. W.: Aj, (bx), cp, (ng), qra?.
We alway qsl.

By 9AVG, Eureka, Kansas

1aj, 1ajt, 1amu, 1aol, 1ari, 1aqm, 1ar, 1aw, 1ayt, (1bbo), 1bcg, 1bkq, (1bnl), 1bqd, 1bwj, 1ci, (1cjc), 1ckp, 1cmp, 1cpn, 1er, (1oa), 1fd, (1fn), (1fs), 1hx, 1ii, 1jf, (1jv), 1kw, 1mo, 1my, (10a), (1sw), 1yb, 1yk, 1xm, (1xaq), (1xz), (2aay), 2aco, (2adu), 2agb, 2afp, (2ate), 2awf, (2atz), 2axf, 2be, (2bqu), 2brb, 2bsl, (2bxw), 2ccd, (2cee), 2cg, 2cfp, 2cji, 2cnh, (2cnk), 2cph, 2cqz, (2csl), 2cva, 2cvc, 2cx, (2cxd), (2czy), 2do, 2fp, 2fq, 2ku, 2oq, 2rk, (2ts), 2wb, 2xat, 2za, 3ab, (3abw), (3adv), 3ajd, (3aek), (3aqr), 3as, 3bdo, 3bnu, 3bpw, 3bss, 3bwt, (3cez), 3fk, 3gl, 3hs, 3jl, 3jj, 3jy, 3mb, (3mf), 3nc, 3ni, 3ov, 3ph, 3pz, 3ru, 3su, 3tf, (3tr), 3wb, 3wf, 3wg, 3ws, 3yp, 3zo, 3zs, (4ai), 4ay, 4by, (4co), 4cr, 4cw, (4db), (4dy), 4eb, 4er, (4fa), 4fs, (4fz), 4ft, (4hw), (4gu), 4io, 4it, 4jg, (4jk), 4jr, 4kc, 4lg, 4ll, 4lq, 4me, (4na), (4mr), 4nv, 4oi, 4ou, 4pd, (4pk), 4rf, 4sh, 4za, 6aan, (6aao), 6abw, 6acm, 6acw, (6afz), 6age, 6ahu, (6ajf), 6ajj, 6ajr, (6akw), 6alg, 6alh, 6alo, 6alk, 6alv, 6amg, 6ani, 6aoc, (6aos), 6aou, 6aoi, 6ape, (6aru), 6asa, 6atc, (6atz), 6aup, 6auy, 6ava, 6avj, 6avm, 6avv, 6avw, 6awt, 6bah, 6bgl, (6blr), 6bbh, 6bbw, 6bcl, 6bcs, (6bdt), 6bdw, 6beg, 6bfl, 6bh, 6bic, 6bih, 6biq, 6bis, 6bjc, 6bjj, 6bku, 6blg, 6blh, 6bm, 6bmu, 6boh, 6bon, 6bpz, (6bqk), 6bri, 6bsg, 6bsh, 6bua, 6bub, 6buo, 6buy, 6bvz, 6bwe, 6byc, 6cb, 6cbu, 6cbw, 6cc, 6cci, 6cco, 6ccy, 6cdg, 6cek, 6cej, 6cfz, 6cgd, 6cgs, 6cgw, 6chu, 6cie, 6cjb, 6cjl, 6cjv, 6ckp, 6ckr, 6cmd, 6cmr, (6cmu), 6cnh, 6cti, 6cu, 6etu, (6fp), 6fy, 6gx, 6hc, (6ip), 6jd, 6ka, 6lu, 6lv, 6mh, (6nb), 6nx, 6od, 6oi, 6pl, 6qi, 6rb, 6rn, 6su, 6tu, 6tv, 6ux, (6xad), 6yb, 6zah, 6zam, 6zat, 6zq, 6zx, (6zz), 7abb, 7aci, 7adr, 7ads, (7af), 7afs, 7ald, (7afu), 7ajt, 7aoy, 7bj, 7cf, 7co, 7cq, 7di, 7ed, (7fs), 7ge, 7hc, 7it, 7iw, 7iy, 7je, 7me, (7mp), 7no, (7nr), 7ob, 7ot, 7rd, 7sc, (7sf), 7st, 7vc, 7vn, 7xaf, 7xba, (7zd), 7zf, 7zr, 7zu, 7zz.

Canadians: 1ar, 1dj, 2bg, 2be, 2cg, 3aa, (3ad), 3adn, 3aln, 3ba, 3bg, 3bq, (3fc), 3he, (3js), (3jv), 3kg, (3kq), 3mv, 3oh, 3om, 3ov, 3sp, 3ty, 3vi, 3wg, (3xi), 3zl, 4cn, 4cw, (4dy), (4ea), (4er), (4fv), 4hh, 5cn, 9al, 9bx.
New Zealand: ?? 4aa.
Mexican: bx-qra?

At 7IW, Eugene, Oregon

1bwj, 1xam, 1bcr, 2rk, 2ar, 2bkl, 2agf, 2wr, 3ch, 3xi, 3gg, 3ccx, 3yo, 3ot, 4rr, 4xc, 4my, 4ba, 5lv, 5pw, 5lr, 5bf, 5qd, 5ak, 5sn, 5ajj, 5zav, 5ph, 5tj, (5aic), 5mi, 5rg, 5agn, 5dm, 5qh, 5nf, 5vm, 5ql, 5xat, 5ts, (5qy), 5agv, 5lp, 6ccr, 6ceu, 7mn, 8bkn, 8yd, 8cck, 8bk, (8bdv), 8zk, 8vy, 8yd, 8ada, 8cxw, 8qhq, 8azd, 8dla, 8pl, 8ak, 8rn, 8jy, 8bkn, 8ks, 8bcu, 8atp, 8dcy, 8bf, 8cxm, 9bre, 9bzi, (9cga), 9ake, ape, 9aep, rc, 9eky, 9dqu, 9xbe, 9dej, 9awu, 9bfp, 9abe, 9hze, (9ss), 9bez, (9daw), 9cpd, 9dyz, 9dai, 9btl, 9dxy, 9cdv, 9dxu, 9dpp, (9cpz), 9eak, 9czg, 9bfi, 9bre, 9vk, (9cwj), 9btk, 9cka, 9clq, 9beu, (9bis), 9cht, 9yau, 9ddp, 9cxp, 9cju, 9ahz, 9ayj, 9eht, 9xa, 9ess, 9aht, 9aoj, 9aep, 9ckc, 9alp, 9aot, 9ahh, 9ato, 9apf, 9asn, 9bbv, 9bmj, 9dmj, 9ckm, 9er, 9amz, 9clh, 9eea, (9blb), 9ato, 9dkb, 9cx, (9bgc), 9bxa, 9dxu, 9zy, 9ccm, 9dr, 9bly, 9ry, 9azg, (kdef).

Continued on page 48

Continued from page 46

By 8CMY Elyria, Ohio

6aao, 6acm, 6ad, 6afq, 6ahf, 6ahp, 6aja, 6ajh, 6ajj, 6akz, 6ani, 6aoi, 6aol, 6aos, 6ape, 6arb, 6arp, 6asx, 6aup, 6auu, 6avr, 6avv, 6awq, 6awt, 6awx, 6bbc, 6bbw, 6bcl, 6beg, 6beo, 6bh, 6bhk, 6bio, 6bih, 6bjj, 6bkb, 6blg, 6bm, 6bmn, 6bnt, 6bpz, 6brf, 6bsg, 6bum, 6buo, 6bur, 6bvh, 6cbw, 6cdg, 6cej, 6cek, 6cgw, 6chc, 6chu, 6cjv, 6cka, 6ckr, 6cmm, 6cmr, 6cmu, 6cng, 6cnh, 6cwv, 6dd, 6en, 6eo, 6fh, 6fp, 6gr, 6hc, 6jd, 6lv, 6mh, 6pl, 6uo, 6wt, 6uw, 6ux, 6wv, 6xad, 6zah, 6zar, 6zba, 6zbn, 6zbu, 6ze, 6zh, 6zr, 6zt, 6zy, 7abb, 7acm, 7adf, 7adh, 7adi, 7adr, 7ael, 7af, 7afo, 7ahv, 7aim, 7ajd, 7akk, 7bbo, 7co, 7cok, 7em, 7fq, 7fr, 7gm, 7lo, 7li, 7lr, 7lum 7na, 7ob. 7oy, 7qj, 7qt, 7qu, 7ry, 7sc, 7sf, 7sh, 7tq, 7ve, 7wm, 7zar, 7zd, 7zu, 9amb, 9apf, 9auw, 9avu, 9azg, 9bji, 9bto, 9bun, 9caa, 9cde, 9cjy, 9ddf, 9dte,

Will qsl, crd. to all who request. Use 15 watts at 8cmy, pse. qrk?

By 5AHD, B. H. HUFF, Altus, Okla.

1aac, 1jv, 1my, 2pv, 2xan, 3adb, 3awf, 3bdi, 3bj, 3hh, 3lg, 3ys, 4bz, 4eh, 4jr, 4xc, 6aaq, 6adh, 6adt, 6ajh, 6aft, 6amw, 6asq, 6avr, 6awc, 6bcl, 6bdt, 6bfp, 6bh, 6ajj, 6bon, 6bpm, 6bqb, 6bui, 6bur, 6cjv, 6cka, 6cmu, 6cng, 6cnh, 6fp, 6nb, 6of, 6tv, 6xh, 6xad, 7acz, 7afo, 7ajd, 7ajt, 7fq, 7fr, 7hw, 7kr, 7kz, 7mc, 7ot, 7zu, 8acy, 8ago, 8aij, 8aji, 8bmb, 8bnn, 8byi, 8byn, 8bzd, 8chy, 8cke, 8ctp, 8cxu, 8czc, 8dgj, 8dgo, 8dgp, 8die, 8dmc, 8rj, 8xan, 8zk, 9acx, 9aep, 9amb, 9apd, 9aqc, 9arj, 9avn, 9ayp, 9azg, 9azn, 9bcw, 9bhx, 9blw, 9bpm, 9buh, 9bun, 9bvv, 9bwv, 9bzh, 9caa, 9cim, 9cjy, 9ckp, 9cld, 9cmk, 9dap, 9dhr, 9dkx, 9dng, 9dpx, 9dte, 9dyy, 8eam, 9edo, 9eea, 9ehy, 9eld, 9qw, 9xw, 9xax. Can 3xi, 4ea. Mexico bx.

By 8DKI, Nick Geracimos, 12 Hertzel St., Warren, Pa.

9arr, 9alc, 9ahz, 9ach, 9atn, 9aci, 9alx, 9aio, 9ash, 9ajw, 9att, (9azg), 9agz, 9apf, 9boe, 9bwo, (9bru), 9bab, (9bqj), 9bhx, 9bbr, 9ckh, 9clz, 9chc, 9cui, (9crk), 9caa, 9egz, (9eky), 9djz, 9dbf, 9dpp, 9dyy, 9dly, 9doe, 9dmj, (9dft), 7afo, 7aek, 7ly, 7lw, 7sf, 7em, 7cd, 6avr, 6ard, 6aja, 6amw, 6ahp, 6abk, 6aol, 6bqb, 6bnt, 6cdg, 6ckr, 6cnc, 6cee, 6zba, 6zt, 6ql, 5ajb, 5alm, 5alw, 5alv, 5aiu, 5alz, 5qd, 5ep, 5ek, 5lg, 5ka, 5jl, 5kc, 5kv, (5qy), (5mi), 5jb, 5nt, 5fa, (5xa), 5zax, 5zb, 5xaq. Canadians: 4cb and 4aw. All crds. qsl'd at once if requested. qrk de 5 watts hr, pse.

By 9DQH, Minneapolis, Minn.

1yb, (1acb), 1ajx, 1bef, (1bom), 1bsq, 1xam, 2el, (2gk), (2bqb), 3ab, (3oe), 3mb, 3mo, 3jx, 3wv, 3xi, 3hh, 3adb. 3avu, 3bdi, (3brf), (3bvl), (3ahp), (3ccu), 4af, (4db), (4gz), 4my, 4sh, 5be, 5be, 5hh, 5in, 5ov, (5qy), (5ro), 5ry, (5aiu), 5aiy, 5ajb, 5akf, 5alk. (5alv), (5anf), 5amh, 5amu, 5amw, 6dd, 6by, 6gt, (6ip), 6rn, 6aao, 6adt, 6ahp, 6akw, 6alv, 6alk, 6atq, (6bcl), 6bfb, 6bij, 6bqb, 6cbb, (6cdg), 6ceu, 6cfm, 6cjl, 6cgs, 6cix, 6cmu, 6cnl, 6xad, (7co), 7fd, (7fq), 7fs, 7ft, (7hw), 7qd, 7qu, 7we, 7yl, 7abb, 7adp, 7adr, 7ail, 7ajd, 7akh, (8cp), 8hv, 8tt, 8uv, (8abm), 8ach, (8aex), (8apn), 8apt, (8anb), (8atz), 8awk, (8bau), 8bcf, (8bcu), 8bjv, (8bnh), (8bog), 8bqi, 8bsq, 8bvu, 8bwj, 8cci, (8cdz), (8cwp), 8czz, 8dcy, (8zab). Any of the above may have crds if they wish, appreciate qsl's on my 5 watt cw.

By 6ADB, Turlock, California

1my, 1yb, 1bbo, 1bdi, 1bkq, 1xah, 2be, 2fs, 2xn, 2aed, 3lg, 3yo, 4by, 4bz, Can. 4cr, Can. 4cw, 4er, Can. 4fn, 4hs, 4jk, 4oa, 4pk, 4we, 5as, 5be, Can. 5bf, 5cs, (Can. 5ct), 5cv, 5dm, 5ef, 5fc, 5he, 5hg, 5hk, 5jc, 5na, 5oq, 5qd, 5qt, 5sg, 5xa, 5za, 5zh, 5aat, 5aaw, 5abn, 5ado-fone, 5ahr, 5aic, 5air, 5ajq, 5ajt, 5alm, 5alx, 5aml, 5ams, 5amw, 5anc, 5zav, 6's too numerous, (7av), 7co, (7ft), (7gr), 7io, (7lh), (7no), 7nt, 7ob, 7ot, 7pz, 7qd, 7rd, 7ry, 7to, 7tq, 7tt, 7ut, (7wo), 7wp, (7wq), 7xb, 7zl, 7zu, 7acx, 7adg, (7adm), 7ads, 7ahz, 7ajd, 7ajt, 7ajy, (7akh), 7xbc, 8aa, 8dj, 8er, 8fm, 8fs, 8ue-icw, 8aih, 8alx, 8anb, 8apt, 8atc, 8bce, 8bmb, 8bzy, 8ckn, 8ckv, 8cva, 8czy, 8diz, 8dkb, 8xbi, 9fm, 9dge, 9ddp, 9drk, 9cfi, 9vm, 9ctr, 9dun, 9apf, 9czg, 9eky, 9aim, 9aou, 9bze, 9any, 9dwn, 9ehw, 9aps, 9chc, 9bez, 9bvv, 9bth, 9asn. 9aqk, 9aey, 9dhg, 9bof, 9dki, 9ape, 9lz, 9cly, 9bp, 9cjc, 9ccv, 9ell, 9zy, 9cpp, 9bdj, 9doe, 9brs, 9dlm, 9ry, 9eiq, 9dyy, 9dcr, 9cxp, 9asd, 9bed, 9dyr, 9rc, 9cyb, 9bnu, 9dfq, 9dkq, 9bqq, 9dxy, 9mf, 9cfy, 9bhi, 9ami, 9aci, 9cjy, 9efh, 9dts, 9czu, 9qr, 9eq, 9an, 9ctr, 9dti, 9aau, 9cde, 9bhd, 9ceh, 9awf, 9ce, 9djb, 9dft, 9azg, 9ake, 9dxu, 9zg, 9ath, 9bhk, (9dte), 9cga, 9cgn, 9dum, 9bqj, 9cmk, 9ecn, Can. 9dev, 9aus, 9aue, 9ctd, 9bis, 9avs, 9czm, 9avt. I also heard someone calling cq on February 16, if this person will pse. qsl. I will send him a card. hi.

By Kenneth C. Kinney, 2040 Berryman St., Berkeley, Calif.

4db, 4hi, 4io, 5ado, 5adv, 5aiu, 5amu, 5ek, 5ga, 5he, 5jl, 5lr, 5pw, 5ql, 5tj, 5um, 5vm, 5xa, 5xd, 5za, 5zav 6adh, 6aru, 6atq, 6blh, 6bnf, 6bno, 6cbu, 6ceu, 6cjl, 6cki, 6fm, 6pe, 7abb, 7abh, 7afu, 7ahs, 7aiy, 7ajd, 7ald, 7co, 7cr, 7di, 7eb, 7em, 7eo, 7fq, 7ft, 7gi, 7gw, 7it, 7ln, 7lp, 7lu, 7no, 7nt, 7ot, 7pj, 7qd, 7qj, 7rd, 7tq, 7xaf, 7xh, 7zl, 7zo, 7zu, 7zz, 8aa, 8art, 8bch, 8bcp, 8bda, 8bzc, 8chy, 8dcz, 8yn, 8zz, 9aaq, 9ahz, 9ajv, 9ake, 9anx, 9aon, 8awv, 9aza, 9bab, 9bak, 9bcb, 9bcg, 9beu, 9bhd, 9bjk, 9bly, 9bof, 9boz, 9bri, 9bvo, 9bzi, 9cga, 9cgu, 9che, 9cht, 9cim, 9cio, 9ckq, 9cmu, 9ctc, 9cwj, 9dwn, 9eam, 9edb, 9edd, 9ei, 9vm, 9yam, 9yy, 9zt, 9xax. Can. 4ab, 4cb, 4co, 4cw, 4dq, 4fz, 5af, 5bf, 5ef, 5go, 9bx.

Continued on page 88

BEST'S SUPER-HETERODYNE

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not interspaced. Its final adjustment follows later.

Set the rotor coil of the coupling unit half way between the maximum and minimum coupling positions.

To locate a broadcasting station with the tuning controls set the loop condenser, which is the one at the extreme left end of the panel, to the 5-degree position, then slowly turn the oscillator condenser from zero to 15 degrees. If no signal is intercepted change the loop condenser setting to 10 degrees and again slowly turn the oscillator condenser from 0 to 20 degrees. This process should be continued until a station is intercepted, changing the setting of the loop condenser about 5 degrees each time and slowly turning the oscillator condenser from a point at least 10 degrees below the loop setting to 10 degrees above the loop setting. When tuning distant stations the same procedure applies, only it will be necessary to make loop settings every two degrees or even every degree if the signal strength of the station to be received is weak.

When a station is picked up it will be noted that it can be received at two settings of the oscillator condenser, the lowest one on the dial being the adjustment of the oscillator that gives a frequency 45,000 cycles higher than the frequency of the incoming wave. The setting highest on the dial is for the frequency of the oscillator that is 45,000 cycles below the frequency of the incoming wave. Signals should be received with about the same intensity at either of these settings, but sometimes under conditions of interference from other broadcasting stations or spark transmitters it will often be found that one gives better results and less interference than the other.

If the station received is within a radius of four or five hundred miles the amplification obtained in the intermediate frequency amplifier will prob-

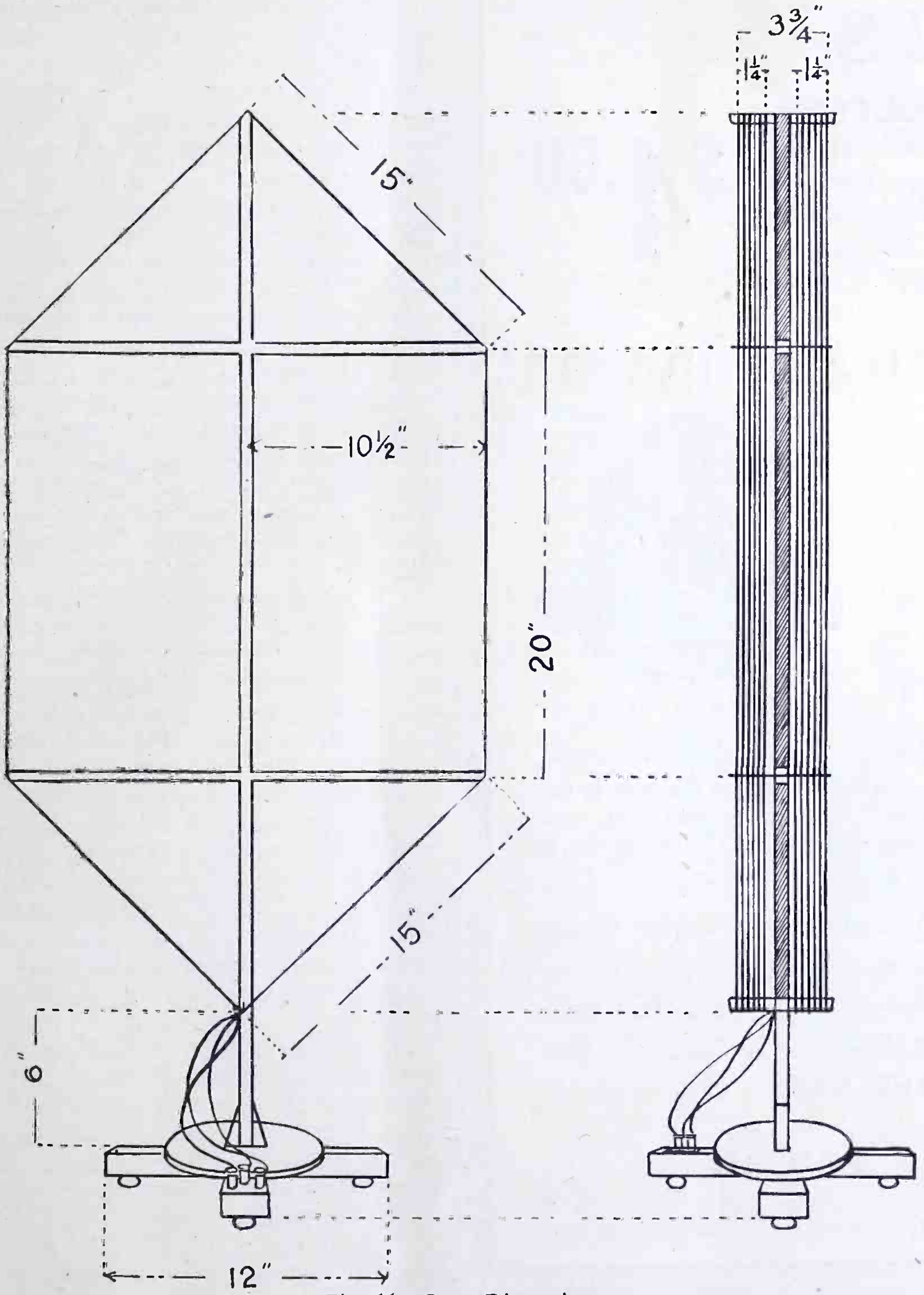

Fig. 11. Loop Dimensions

ably be so great that the audio-frequency amplifier tubes will be overloaded. This undesirable condition can be corrected by turning the volume control rheostat to the left until the volume is sufficiently reduced and distortion eliminated.

After one station has been received it will be fairly easy to pick up additional stations. Each time a station is tuned in its location on both the loop condenser and the oscillator condenser should be noted. This is important not only for tuning in the same station at another time but to facilitate the location of stations whose wavelengths are known to be slightly above or below the station for which settings were recorded.

When a station at least 1,000 miles distant has been tuned in the rotor of the coupling unit should be adjusted to as near the minimum coupling position as is possible without causing a decrease in signal strength. Once this adjustment has been made the rotor may be locked in place with the set screw provided for that purpose and need never be changed again throughout the life of the oscillator tube. When a new oscillator tube is inserted in the socket it will be well to readjust the setting of the rotor.

The adjustment of condenser C_3 should be made while a station of low wavelength, between 300 and 350 meters if possible and located at a distance of several hundred miles, is being received. Under these conditions increasing the capacity of the condenser will cause a considerable increase in signal strength. This capacity may be increased as far as possible without causing the first detector tube to oscillate or cause distortion of the received signal. When this adjustment is once made it can remain fixed for the reception of all stations on any wavelength.

If, after carefully following these instructions for tuning the circuit, no signals can be received and at a time when it is known that a local broadcasting station is operating, a test should be made to determine whether or not the oscillator tube is oscillating. A good method of doing this is to touch the grid terminal of the oscillator tube socket. If the tube is oscillating a click will be heard in the phones when the finger touches the terminal and again when it is withdrawn. If it is not oscillating a click will only be heard when the terminal is touched and not when the finger is withdrawn. Failure of the tube to oscillate may be due to incorrect wiring of the oscillator circuit; tube terminals may not be making contact with the socket prongs; or to the use of an old tube that is inoperative. Remedies for such conditions are obvious.

The range of reception depends largely upon the power of the broadcasting station. When the operator has become familiar with the tuning of this set little difficulty will be experienced in receiving 500 watt stations up to a distance of 2,000 miles. Under favorable atmospheric conditions the set is capable of reception across the continent.

If an audio-frequency amplifier of at least two stages is available, tubes AF_1 and AF_2 with transformers T_5 and T_6 may readily be omitted. This will also eliminate the 90 volt B battery terminal. The terminals from the final detector, shunted by condenser C_9, should then be connected direct to a phone jack or other output terminal.

One intermediate frequency stage may be omitted with corresponding loss in amplification by eliminating transformer T_3 and tube IF_3. This would result, without the audio-frequency amplifier, in a 5 tube set of remarkable capabilities.

NEW SPECIAL LICENSES

4XC B. W. Benning, 190 North Whiteford Ave., Atlanta, Ga.
3ZD Ernest R. Bateman, 1507 Edmondson Ave., Baltimore, Md.
1ZR Edith E. Rotch, 157 Bay State Road, Boston, Mass.
1ZL Carlton A. Weidenhammer, 33 Washington, Place, Bridgeport, Conn.
1ZT George E. Nothnagle, 176 Waldemore Ave., Bridgeport, Conn.
9YAU Carthage College, Carthage, Ill.
9XBD W. E. Schweitzer, 4264 Hazel Ave., Chicago, Ill.
8XBR Union Trust Co., 925 Euclid Ave., Cleveland, Ohio
8XBT College of the City of Detroit, Detroit, Mich.
8XBU Michigan Agricultural College, East Lansing, Mich.
1ZM Fullerton D. Webster, 12 Hampshire St., Everett, Mass.
1ZU Ralph S. Davis, 11 Upland Road, Everett, Mass.
1ZO Everett H. Gibbs, 11 Virginia Ave., Framingham, Mass.
6ZBZ Ray A. Hancock, R. D. 3, box 37, Fullerton, Calif.
9XBG Edmund T. Flewelling, 836 South St. Johns Ave., Highland Park, Ill.
8XBQ Clyde E. Darr, 137 Hill Ave., Highland Park, Mich.
9XBE Ott Radio (Inc.), La Crosse, Wis.
6XBO Los Angeles County Forestry Department, Los Angeles, Calif.
6XBP Nicholas E. Brown, 2000 West Seventy-fifth St., Los Angeles, Calif.
5XAV Edgar A. Sahm, 702 San Antonio St., New Braunfels, Tex.
6ZBV Walter P. Bell, 5205 Cole St., Oakland, Calif.
6ZBX Hyman W. Fink, 1708 West Twenty-third St., Los Angeles, Calif.
6ZBY George S. Morris, 6234 Hayes Ave., Los Angeles, Calif.
2XBA Russell S. Ohl, 2315 Andrews Ave., New York, N. Y.
6ZBW Leslie B. Magoon, Jr., 1967 Courtland Ave., Oakland, Calif.
6ZCA William A. Hammond, 3020 Champion St., Oakland, Calif.
4XR John E. Hodge, 128 East Forty-ninth St., Savannah, Ga.
1ZN Malcom A. Gordon, 1156 Washington St., South Braintree, Mass.
4XQ E. Richard Hall, 2801 Central Ave., St. Petersburg, Fla.
8XBS University of City of Toledo, Toledo, Ohio.

EASILY MADE VARIOMETER

Continued from page 17

tion across the stator when the two halves are assembled. The windings must not oppose each other.

The details of the rotor are shown in Fig. 3. A piece of wood 4 in. square and ½ in. thick is required. Set the dividers to a 2-in. radius and describe the circle. Draw a line through the center. Measure ¼ in. on each side of this line and draw two lines parallel to the center line as shown by the dotted lines. Measure 1½ in. from the center line and draw the two dotted lines as shown, also parallel with the center line. Cut the edge of the rotor away between the lines, as shown, to a depth equal to the diameter of the wire to be used. Drill two small holes diagonally from the edge to the narrow space left in between the windings and close to the center of the rotor. Drill two small holes through the center space as shown at *b*. When the winding on each side is completed the two ends are passed through these holes and soldered together. The winding is started by putting the end through the diagonal hole and leaving an end extend out a short distance. The same trouble may be had with the rotor as was had with the stator to get the wire to lie flat on the surface of the block. It can be remedied in the same manner. It will be found necessary to fasten all windings to the form with celluloid cement. The wires can be pressed flat while the cement is drying and they will remain in that position when dry.

After the cement has dried on the rotor, drill a 15/64-in. hole through the center. This hole must be drilled at exact right angles to the wood so that the rotor will run true. The shaft is made of a 3-inch piece of ¼-in. brass tubing, with a notch cut in the side as shown for one of the wires to pass through from the winding. One of the wires to the winding is soldered to the brass shaft and the other is soldered to a flexible wire and brought out through the center of the shaft. Brass washers should be placed on the shaft on each side of the rotor to prevent the rotor moving endwise and the windings touching each other. Notches should be filed in the small sticks which brace the stator at the proper place to form bearings for the rotor shaft, and in such a manner that the rotor will turn freely between the two halves of the stator.

The complete assembly is shown in Fig. 4, without windings. A stop is also shown soldered to the end of the shaft. This stop is used to prevent the rotor turning more than one half turn. The two halves of the stator are shown fastened together with a small brass stove bolt at each end. The method of mounting in the set will depend on the ideas of the individual maker.

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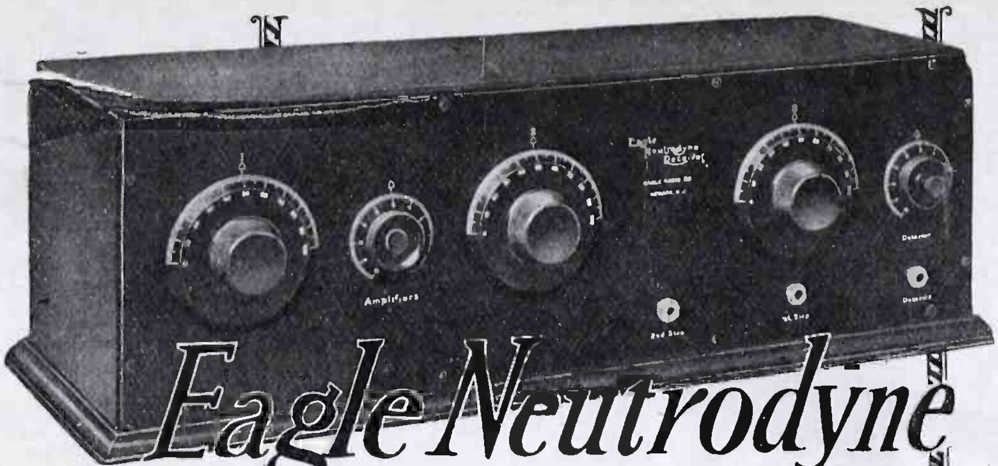
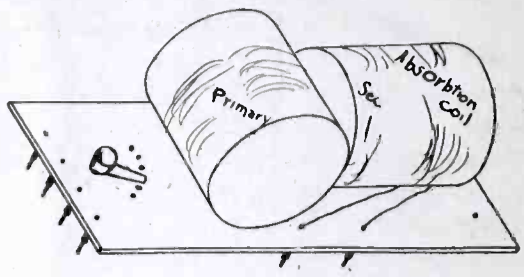


THE WHAZZIS SET

Continued from page 20

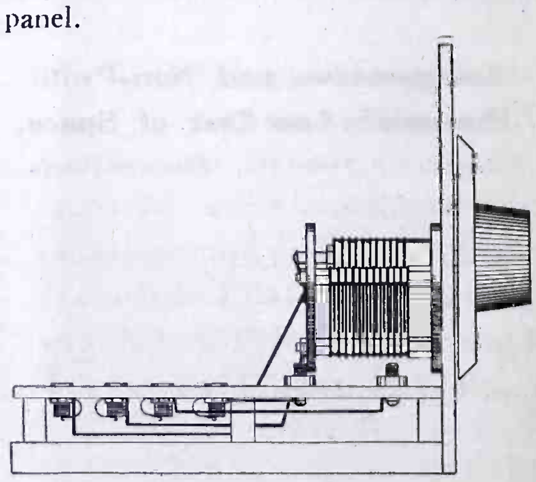
then driving them in with a hammer, leaving them to project on the top about 1-16 in. for soldering the leads. With 1/8 in. mounting panel, the average cord-tip is long enough to engage the jacks. Drill the holes for the jacks larger than necessary. Then, if one of the cord-tips in the mounting panel is off center, the jack will move a little and the cord-tip will not be bent.

The binding posts for the aerial and ground are mounted on the same strip as the left four jacks. Use good binding posts, or the aerial will come off at odd moments and make necessary a half hour search for open circuits.



Four-Circuit Tuner on Mounting Panel

As to mounting the coils on the mounting panel. A spiderweb for a Reinartz may be mounted flat. Coils wound on tubes may be mounted by standing them on edge, running a strip of bakelite through and bolting it at the ends to the panel. Simplified Reinartz and other tapless arrangements should be used, being more efficient and less bother. One can construct a whole new set of coils for different wave-lengths cheaper than buying switches. The only exception is the primary coil for the four circuit tuner. A small switch for this may be mounted in one corner of the panel.



Condenser Mounting.

The size of the mounting panel and practically the whole design can be varied to suit the builder's taste. It is a good set to build gradually, for one may buy the condensers and have a small crystal set, later put them on a panel and have a one tube set, and then may enlarge as desired.

Being possible to compare the relative advantages of two types of coils, or two hook-ups under the same conditions and on the same distant station, one may acquire a better knowledge of the circuits now in use and the relative merits of two coils wound with different size wire and so on.

Use the best quality of everything in your set. Then, when it is built, you will not wonder, when reception is poor, if you had used that better condenser the salesman showed you in place of the just-as-good now in use, whether you would not get more stations. Everyone knows the answer. Variable condenser shafts will not wear and chatter, contacts on rheostats will not wear and cause the tube to flicker, that socket will not split, etc., if the apparatus is of good quality.

NEUTRALIZED TUNED RADIO FREQUENCY

Continued from page 24

main panel by small brackets made from sheet brass, with the exception of the 6 in. by 4½ in. panel which is held away from the baseboard by small feet also made of sheet brass.

Each transformer should be mounted at an angle of 60 degrees so as not to allow the magnetic field of force of the respective transformers to interact. This is very important—otherwise interaction will result in the tendency to oscillate and neutralization will be difficult to obtain.

Various methods have been given for neutralizing the capacity coupling by reversing the phase of the voltage generated by the transformer. The correct connections are given in Fig. 1 and should be followed closely. Connect each lead from the transformers *exactly as given in diagram*. This gives the correct phase voltage and we can then proceed with the adjustment of both neutralizing condensers. The sliding flexible wire should be first pulled clear out. Adjust each dial so that the resonant point on each dial causes oscillations. This will be found by a slight rushing noise. Better yet is to tune in some strong station and get his carrier wave—which will cause lots of squealing. Now adjust each condenser by sliding the flexible wire into the copper tube. Make only slight adjustments on each one until the oscillations entirely stop and the stations come in clear without distortion. This may seem like a lot of work but in reality the right point is easily found. After this point is found it will not be necessary to touch the condensers again—that is not unless other tubes are substituted.

The front view of the receiver gives an idea of the panel layout. The average person familiar with tools will not experience any trouble in laying out his own panel.

Use standard bus bar and conceal all the wiring possible. Note that the rear view picture shows most of the wiring concealed by running underneath.

RADIO COMMUNICATION

Continued from page 16

The Alternating Current Circuit

THE flow of direct current in an electric circuit is limited by resistance. A steady direct current will not be retarded by the inductance of a coil of wire but it will be limited by its resistance. (Fig. 9.)

If a condenser be inserted in the circuit (Fig. 10) no current will pass through it.

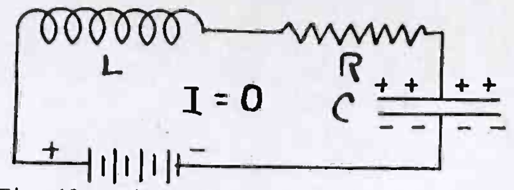


Fig. 10. Direct Current Circuit with Inductance and Capacitance in Series.

(a) A pure inductance offers no reactance to direct current.
(b) A condenser offers infinite reactance to direct current.

We now must consider an electric current which is not of constant magnitude but one which flows first in one direction and then in the other. Such a current may be called an alternating current and a good example is the ordinary current which is used so much for house lighting. A graph of the current in a direct current circuit carrying 2 amperes would look something like Fig. 11. The graph of a 60 cycle alternating current, however, would look like Fig. 12.

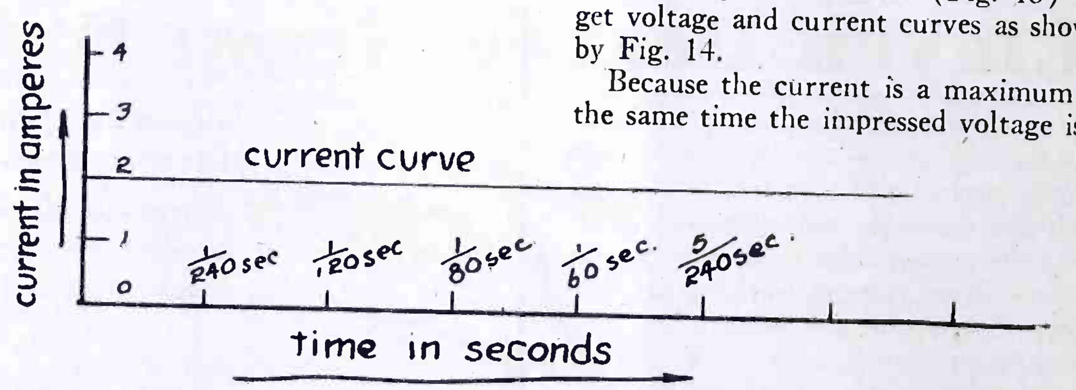


Fig. 11. Graph of Direct Current.

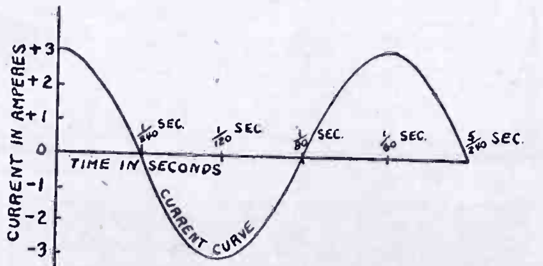


Fig. 12. Graph of Alternating Current.

It will be noticed that while the current has a value of +3 amperes at time 0, it has a value of 0 at time 1/240 sec. later and a value of —3 amperes at time = 1/120 sec. At time 1/60 sec. the current will be +3 amperes again. The time between one peak and the next one in the same direction in seconds is called the period T of the current and the number of periods per second is called the frequency f of the current. In the case under consideration, the period is 1/60 sec. while the frequency is 60 cycles per second.

Practically all power circuits use alternating currents of 60 cycles. Some use a frequency of 25 cycles for power, but an electric lamp lighted by 25 cycles will flicker. We should thoroughly understand the nature of an alternating current as alternating currents produce radio or electromagnetic waves. The frequencies used for radio purposes, however, are much higher than those used for power purposes. Radio frequencies run from 12,500 cycles to about 6,000,000 cycles.

Alternating currents are produced by alternating voltages. Alternating voltages may be produced by generators called alternators and by other means. Radio frequency alternating voltages are now usually produced by electron tube oscillators.

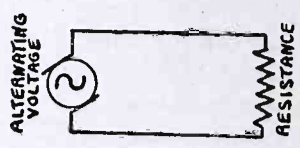


Fig. 13. A. C. Voltage Applied to Resistance.

If we have an alternating voltage applied to a pure resistance (Fig. 13) we get voltage and current curves as shown by Fig. 14.

Because the current is a maximum at the same time the impressed voltage is a maximum we say that the current is in phase with the impressed voltage.

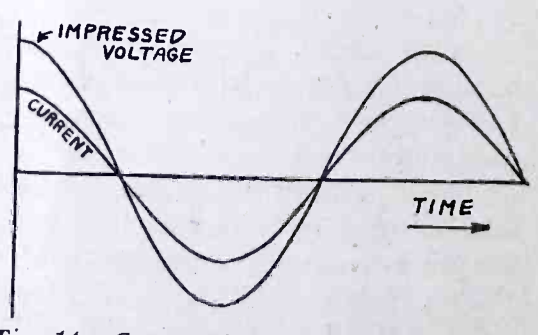


Fig. 14. Curves of A. C. Voltage and Current in Resistance Circuit.

If we now insert an inductance, which has no resistance, in the circuit (Fig. 15) and plot the current and voltage as

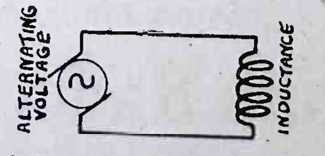


Fig. 15. A.C. Voltage Applied to Inductance.

Licensed under Armstrong U.S. Patent No. 1,113,149 a function of time we have curves as shown in Fig. 16.

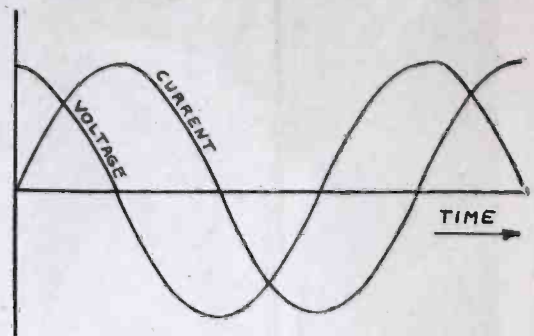


Fig. 16. Curves of A. C. Voltage and Current in Inductive Circuit

It will be seen that the current in this circuit does not reach a maximum until ¼ period after the impressed voltage is a maximum. The reason for this is that the opposition of the coil is dependent upon the charging condition of the current. We therefore say that current in a pure inductance lags ¼ period or 90° behind the applied voltage. If I is the peak value of current (Fig. 15) and E the peak value of the applied voltage then in place of Ohm's law we have

$$I = \frac{E}{2 \times 3.1416 \times f \times L \text{ henries}}$$

The quantity $2\pi fL$ is called the reactance of the coil and is indicated by the letter $X_L = 2\pi fL$.

An alternating current voltmeter and ammeter would not measure the peak value of E and I but what are known as the root mean square values. These are .707 times the peak values. The equations hold for either values.

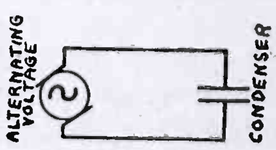


Fig. 17. A. C. Voltage Applied to Capacitance.

If a circuit contains both inductance and resistance (Fig. 17) the current is not

$$I = \frac{E}{R + X_L}$$

but

$$I = \frac{E}{\sqrt{R^2 + X_L^2}}$$

If, in place of the inductance in Fig. 15, we place a condenser (Fig. 17) and plot current and voltage curves we have curves like Fig. 18.

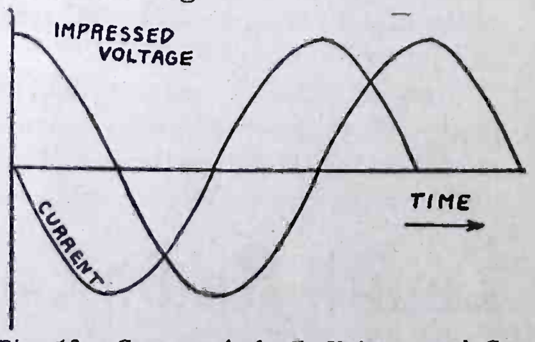


Fig. 18. Curves of A. C. Voltage and Current in Capacitive Circuit

It will be noticed that now the current curve leads the voltage curve by ¼ period or 90° while, with the inductance, the current was ¼ period behind the voltage. The current may be found from the equation

$$I = E \times 2 \times \pi f \times C \text{ in farads,}$$

$\frac{1}{2 \pi f C}$ is called X_C,

the capacitive reactance, and $I = \frac{E}{X_C}$

Because in an inductance the current leads the applied voltage and in a condenser lags the effect of a condenser in

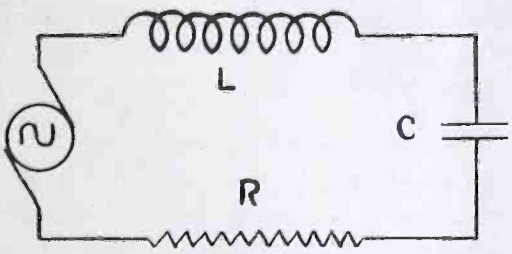


Fig. 19. A. C. Voltage Applied to Inductance, Capacitance and Resistance in Series

a circuit is to offset the effect of an inductance. Thus for Fig. 19 the current is given by

$$I = \frac{E}{\sqrt{R^2 + (X_L - X_C)^2}}$$

in which

R = resistance in ohms
X_L = inductive reactance in ohms

$$= 2 \times \pi \times fL$$

X_c = capacitive reactance in ohms

$$= \frac{1}{2 \times \pi \times fC}$$

$\sqrt{R^2 + (X_L - X_C)^2}$ = impedance = Z

$I = \frac{E}{Z}$ is the law used for a circuit containing R, L, and C.

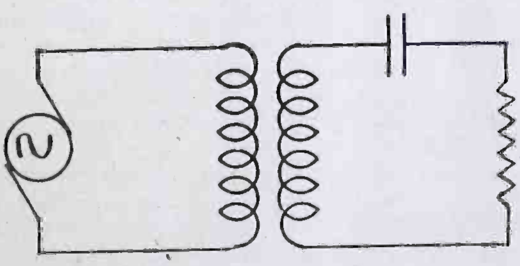


Fig. 20. Inductive Coupling

It is not necessary to have the alternating voltage generator directly in the circuit. It may be coupled to it by means of another coil as in Fig. 20. The value of E to be used in the equation would then depend upon the coupling between the circuits and other factors. Let us look for a minute at the equation for current

$$I = \frac{E}{\sqrt{(\text{Resistance})^2 + \left(\text{inductive reactance} - \text{capacitive reactance}\right)^2}}$$

If it should happen that the inductive reactance X^L = the capacity reactance X_c then

$$I = \frac{E}{\sqrt{R^2 + (o)^2}} = \frac{E}{R}$$

This is the condition for resonance and the condition for maximum current. When you adjust the condenser in the aerial circuit of a receiving set or when you adjust the condenser in the secondary circuit (if you have a coupled receiver) you are adjusting the circuit to resonance by making the capacitive reactance equal to the inductive reactance.

Now when

$$X_L = X_C,\ 2\pi f L = \frac{1}{2\pi f C}$$

$$\text{or } f^2 = \frac{1}{4\pi^2 L C}$$

$$\text{or } f = \frac{1}{2\pi\sqrt{LC}}$$

Therefore resonance results when the applied frequency

$$\text{or } f = \frac{1}{2\pi\sqrt{L_{\text{henries}}\, C_{\text{farads}}}}$$

(Continued in May RADIO)

AMERICAN LISTENER RECEIVES FRENCH BROADCAST

The first radio concert heard in America transmitted from the Eiffel Tower, Paris, France, was intercepted March 29th by Bert Moulton, Chatham, Mass. Moulton is employed at the Radio Corporation of America coastal station at Chatham, Mass., besides operating his own experimental station. The powerful station on the Eiffel Tower, with the call letters "SFR," operated by Compagnie Francaise De Radiophone, used a wavelength of 1780 meters, and broadcast a special program intended for American listeners between 5:00 P.M. and 7:00 P.M., E.S.T.

A carefully calibrated receiver employing four tubes was used, and Moulton listened to the French broadcast program for over an hour. He heard instrumental and vocal selections at 6:10 P.M. and held them until 7:15 P.M.

It was the first time regular concert from France was received in America. Station SFR used 2000 watts, which is twice as much power as American broadcast stations use, and it is also significant that the wavelength used was much higher than the average broadcasting wavelength. Static and the fact that little previous notice of the test was given to American listeners was responsible for the small American audience.

Upon complaint of the Dubilier Condenser and Radio Corporation, the U. S. District Court for Southern New York has issued an injunction restraining the Micadyne Radio Corporation from making and selling counterfeits of Micadon fixed condensers and from using the deceptive name Micadyne.

MATCHING IMPEDANCES

Continued from page 21

higher in value, depending on the ratio of turns.

When dealing with a wide band of frequencies which are all to be amplified with equal intensity, as in the circuit described above, there are two main points to be taken into consideration. First, L (primary inductance) should be high so that its impedance will be higher than the internal plate impedance R_1 of the tube in order to prevent the lower frequencies from being eliminated. increase in amplification at the lower frequencies and in some cases, where the primary impedance becomes practically negligible to R_1, the lower frequencies are eliminated entirely. In a good transformer the primary impedance is made high by using iron of high permeability and copper wire of a fine gauge such as No. 40.

On the other hand, the distributed capacity C, which limits the higher frequencies by by-passing them, can only be reduced by proper design in the winding of the transformer.

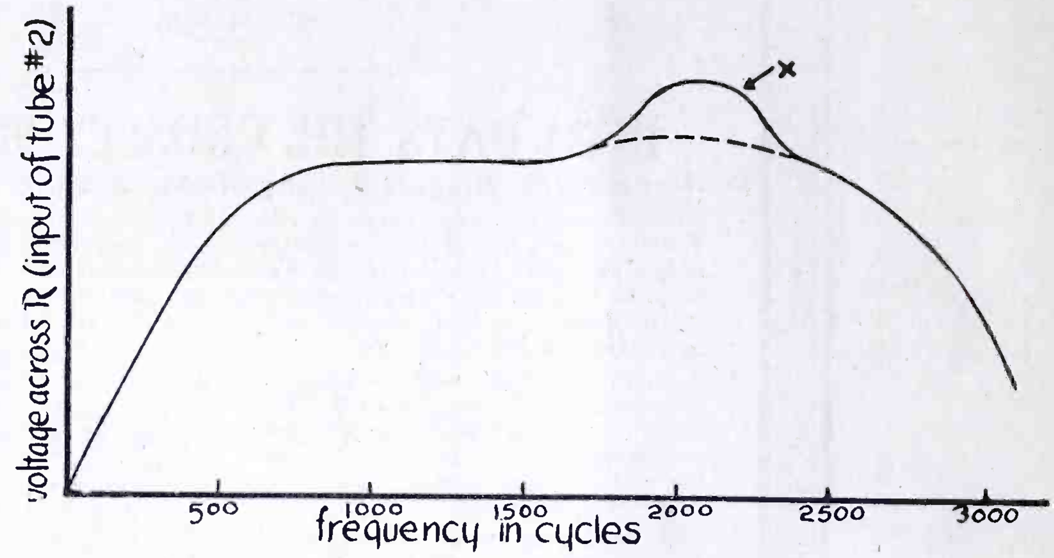


Fig. 5. Curve of Transformer Performance

This impedance should be about three times R_1. And, second, the distributed capacity C should be kept low to prevent the higher frequencies from being by-passed.

When the primary impedance is higher than R_1, the greater part of the voltage E generated by the tube is impressed across L. This relation should be obtained even on the lower frequencies. If R_1 is greater than the primary impedance, then most of the generated voltage E is across R_1 and the voltage across L is lower than it is at the higher frequencies. This will give a smaller

A curve showing the performance of a transformer is shown in Fig. 5, where across R (input of table 2). It is to be noticed that at zero frequency the voltage across R is zero. As the frequency is increased the voltage increases until a point is reached where the line becomes merely horizontal. It is at this saturation point that the primary impedance becomes larger than the internal plate impedance of the tube, with the result that the maximum voltage is across R and continues so at all the higher frequencies. This steady state remains until the effect of the distributed capacity

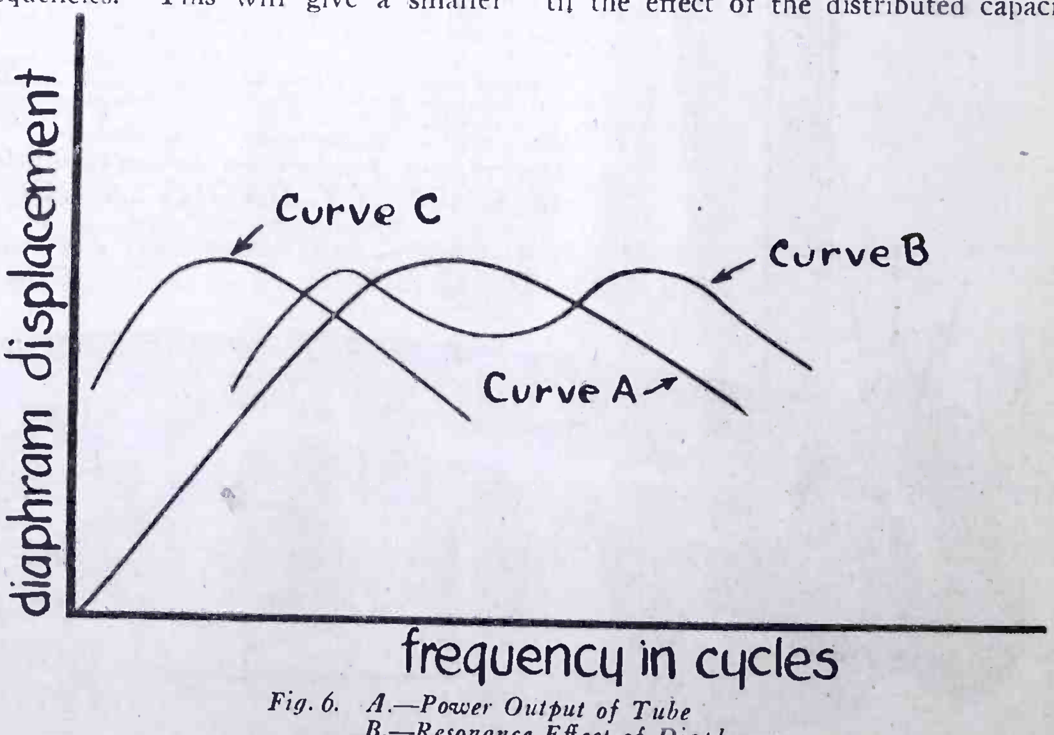


Fig. 6. A.—Power Output of Tube
B.—Resonance Effect of Diaphragm
C.—Effect of Horn Resonant Characteristics

C becomes apparent at the higher frequencies. The result is that the voltage begins to drop with increase of frequency. The peculiar hump marked *X* is due to a resonance circuit formed by the leakage inductance L_2 and L_2 and distributed capacity *C*. It is interesting to note that the broadness of this resonant hump depends on the ohmic resistance of the primary and secondary windings. The higher the resistance of these windings the less noticeable will be this resonance effect as shown by the dotted line in the curve.

When a tube is connected to a loud speaker, the circuit is similar to the example of the generator coupled to a resistance of equal value for maximum output. To get the maximum vibration of the diaphragm, a maximum amount of power must be delivered, which means that the impedance of the loud speaker should be equal to the plate impedance of the tube. But as the loud speaker impedance varies with frequency, the power output of the tube would also vary, with a maximum at that point where the plate impedance equals the loud speaker impedance. However, this is not actually the case when the loud speaker is operating, because both the diaphragm resonance and the shape and size of horn are also considerations in its performance. In Fig. 6 the curve *A* is that of the power output of the tube into the loud speaker, curve *B* is the resonance effect of the diaphragm and curve *C* is the effect of the resonant characteristics of the horn, which mainly compensate for the lower frequencies lost by the low impedance of the loud speaker. The resultant curve is as in

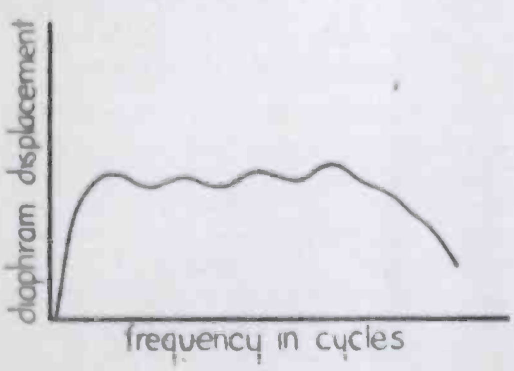


Fig. 7. Resultant of Curves in Fig. 6

Fig. 7 where the amplitude is nearly of the same value for all frequencies except for the very low and very high frequencies, where the amplitude begins to drop off to a great extent. The reason for distortion in the great number of the loud speakers is due to the horn not being properly designed. The result is usually a tinny effect because of the loss of the lower frequencies which should have been compensated for and accentuated by a properly designed horn.

SUPER-SELECTIVE SET

Continued from page 31

Sometimes a small grid condenser across the primary of the audio-frequency transformer will help. The aerial in use should be under 60 ft. in length or the operation will be unsatisfactory in most cases.

Here are some of the pecularities of the circuit to be kept in mind when adjusting it. The higher the *B* battery voltage, the greater the selectivity, due to the greater strength of the local oscillations; and the lower the *B* battery voltage, the better the quality of the signals. Sometimes it will be found difficult to clear up the signals, in which case the coupling of the honeycomb coils should be very carefully adjusted. Also, sometimes widely varying wavelengths may require a slight change in the coupling of these coils to obtain maximum volume, but this does not require placing the coils on the front of the panel. Remember to place the fixed plates of the 43-plate condenser in the ground side, in order to cut down capacity effects as much as possible.

There are many experiments to be performed with this circuit. One of the chief objections to its use is that it radiates so much energy that it will cause considerable interference if operated in a congested radio district. The obvious remedy is to add some sort of radio-frequency to the circuit, but, so far, no really successful method has been hit upon. The circuits used so far gives much clearer signals, due to a filtering action, but the volume is decreased somewhat.

U. S. CIVIL SERVICE EXAMINATION FOR JUNIOR RADIO ENGINEER

The United States Civil Service Commission announces competitive examination for junior engineer (radio) on May 7. It is to fill vacancies in various branches of the government service, at an entrance salary of $1,860 a year. Applicants must have been graduated with a degree in engineering, preferably in radio engineering, from a college of recognized standing; or must be senior students in such course and furnish within three months from the date of the examination proof of actual graduation. Applicants who have completed two full years of the engineering course may substitute for each of the additional years one year of experience in radio engineering. Competitors will be rated on general physics and chemistry, pure and applied mathematics, practical questions on radio engineering, and education, training and experience. Full information and application blanks may be obtained from the United States Civil Service Commission, Washington, D. C., or the secretary of the board of U. S. civil-service examiners at the post office or customhouse in any city.

McGUFFY'S FLYING ANTENNA

Continued from page 23

portance, had placed himself somewhat in the position of a balloonist, who having ascended to a considerable height, was unable to find the valve rope. He was up in the air, with no immediate prospects of coming down. Inasmuch as my story of the flying antenna has something to do with balloons, this is a good comparison.

In sketching the further progress of young McGuffy, with reference to the flying antenna, I have traced back over material that I have already recorded in a former story. This, however, but to emphasize factors entering into this tale. McGuffy, as I have already pointed out, was saturated with that commodity of which all American amateurs possess a good share—optimism. Of this commodity, McGuffy possessed an unusually large share. The beaten path of wireless experimentation was not for him. He cut corners and jumped fences, always reasoning that what he didn't know, he would find out. Therefore you may expect him to show the same reckless (and therefore wreckful) disregard of the conventions in his receiving experiments as he had shown in transmitter construction. Although parental decree had smothered further inventive efforts along transmitter experimentation, his efforts had not been without profit, for he was now a made man in amateur wireless circles. His fame spread not only around his own city, but the Poulsen operator had sent the story over the ether lanes to Poulsen stations in other Pacific Coast cities, and from these operators that story trickled out to other amateurs, and McGuffy's correspondence grew over night.

Possibly the notoriety that McGuffy attained has something to do with his flying antenna. We are all human, and we all like adulation, in varying forms, and McGuffy was no exception to this rule. He resolved from now on to stay off the beaten roads of wireless experimentation, and to explore regions as yet untrod. The De Forest audion was just now coming into prominence, following the Fleming valve, but it was still regarded with a lively suspicion upon the part of most wireless amateurs. Because of his financial condition, McGuffy was not ripe for the audion, or else another chapter might have been written in the annals of the invention of one to whom the radio world of today owes an ill-paid debt—Dr. Lee De Forest. He was, therefore to turn his attention to another then important branch of radio reception—the receiving aerial.

At this time, the low receiving antenna of today was unknown. Just as a good amateur must have at least a 2 or 3 k. w. transmitter to amount to anything in

Continued on page 68

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elect wireless circles, so must his aerial mast rear its slender length into the air. When McGuffy first entered the wireless game, even before he acquired a crystal detector, and a 75 ohm phone, he had put up an aerial mast quite close to 100 ft. in height. This mast had been a source of consternation to all neighbors within his block, due to its violent contortions during high winds, when it wriggled and quivered along its length in alarming fashion. After a rain, when the guy rope became saturated, and then dried out, with corresponding shrinkage, the mast would assume the form of the letter S. At night, the multiplicity of guy wires sang weird songs in the breeze, as though the banshees of McGuffy senior's mother country were assembled in concert. But height, in those days of crystal detectors, was necessary. And so McGuffy decided to go higher—higher than any other amateur in the country—higher than any professional wireless engineer of those days had dared. Visions of reception from China, Japan, Africa, Mars and Jupiter arose in his mind and drove him on.

McGuffy set to work to construct a *balloon* aerial. This was not an expensive undertaking, as it might seem, for Mrs. McGuffy donated a number of bed sheets that in her opinion as a careful housekeeper had outlived their usefulness. From these sheets McGuffy secured enough good material to make up the gores of a balloon around 6 ft. in diameter. The fabric he "doped" with a mixture of shellac which he obtained out of his slender resources.

Of course you will grasp McGuffy's idea. Here was a medium that would raise his receiving aerial to any desired height. He pictured the jealousy of brother amateurs. Visions of himself acclaimed as a second Marconi arose before him.

Again let me emphasize McGuffy's optimism, and the conviction that what he did not know could be found out. This is the fundamental base from which all good amateurs attack their problems, and which has done much to give them their present excellent status. McGuffy knew little about balloons, little about the gas which formed the lifting medium. Long back, he had found out that a balloon filled with air only would not rise—that gas was necessary. As to the gas, he entertained no disturbing doubts. Gas was gas, and that was that. He had no means of obtaining hydrogen gas, coal gas was too troublesome to generate—and the McGuffy kitchen was operated on a wood burning basis, so that the city gas mains were not available. So when McGuffy's balloon was finished, he calmly appropriated the carbide gas generator from the McGuffy automobile, which was one of those affairs not yet arrived at the refinement of an electrical lighting generator or battery. With this and a good sized can of calcium carbide, he retired to the basement of the McGuffy residence.

Acetylene gas is heavier than air. It won't float itself much less a balloon. But gas was gas to McGuffy. The generator was soon pumping a steady flow of gas into the balloon. The fabric puffed out steadily. When it was about half inflated, McGuffy ran out of carbide. He blamed the failure of the balloon to show any rising tendencies to a lack of gas. A further supply of carbide was out of the question, his slender resources having been exhausted in purchasing shellac for doping the balloon fabric. Then a flash of inspiration came to him—he would inflate the balloon with hot air instead. He secured a kerosene lamp from one of the basement shelves, lit it, opened up the balloon neck, and set the lamp under it.

Now, you will say, this was an utterly fool thing to do. I admit it. I can only excuse McGuffy upon the grounds that his thoughts were as high in the air as he intended his balloon to go. Normally, he would have thought of an explosion. But to this day, older and wiser heads still light matches to examine the gasoline supply in the automobile, as daily press dispatches indicate from time to time.

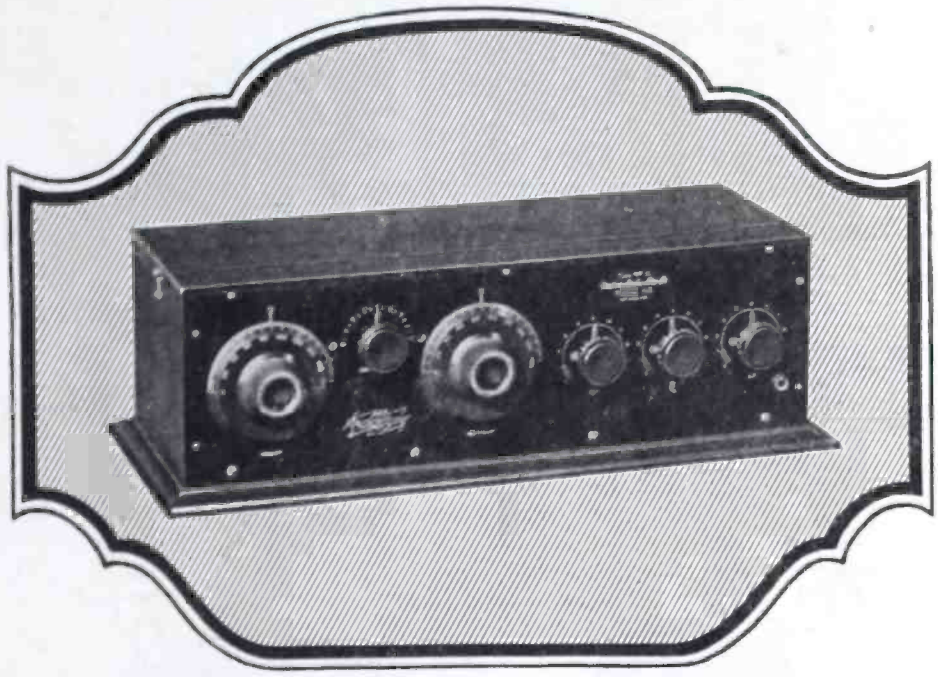
McGuffy's idea was to first try out the hot air idea, and if it supplied sufficient lifting power, to then build a fire cage under the balloon to insure a continuous supply of hot air. Just now, all he wanted the balloon to do, was to rise.

The balloon did rise. It rose swiftly, and tried to take the McGuffy house with it.

With the neck of the balloon open, enough air went in as the gas went out, to form as deadly a mixture as did the combination of hydrogen gas and air in the arc transmitter. It possessed all the potential possibilities of an army mule, a Kansas cyclone and a charge of dynamite. The McGuffy home rocked to its foundations. McGuffy was picked up as though he were a feather, and hurled across the basement.

As McGuffy departed from where he was standing to where he was going, he encountered a shelf loaded with some of the same batch of catsup that the McGuffy cat had catapulted into. Not from that particular pan, of course, for the McGuffys' possessed some ideas regarding catsup flavored with cat, but some of the same batch. McGuffy came to a stop pretty well covered with tomato catsup. He was cut a little by broken glass, though not badly.

The fire department turned out. The police department turned out. The emergency hospital ambulance turned out. McGuffy hurried from the basement by his frantic mother and excited officers, and carried through a horrified



crowd to the ambulance, was rushed to the emergency. Here three medicos and four nurses, tenderly separated McGuffy from the tomato catsup, at first supposed to be his life blood. Out from his stunned condition under the hands of the mystified doctors, McGuffy finally came back to earth.

Presumably this should end McGuffy's flying antenna, but not so. The McGuffy aerial has not flown yet, only tried to do so. Of course he achieved notoriety from this episode. The newspapers were full of it. Another council of war was held in the McGuffy home. But there was no need for McGuffy senior to issue a decree forbidding further constructional efforts along this line. Young McGuffy was sick of balloons. He had enough of them to last him for a year of static.

McGuffy now turned his attention to *kite* aerials. From the remnants of his wrecked balloon, and leftovers of the sheets used in its construction, he obtained enough material to build a Malay kite, some eight feet in length and width. The construction of this kite and consequent trial flights was attended by no untoward episodes. McGuffy senior, although he watched his young hopeful with anxious eye, could find no cause for complaint. McGuffy spent many evenings out in vacant fields on the outskirts of the city with his kite coasting overhead several hundred feet, while his straight tube tuner and crystal detector picked up stations afar and near. Ships four thousand miles out on the Pacific, a few on the Atlantic were also heard. In more than one instance, he was able to give officials of the United Wireless Company positions of ships which had passed beyond the operating range of their coastal stations.

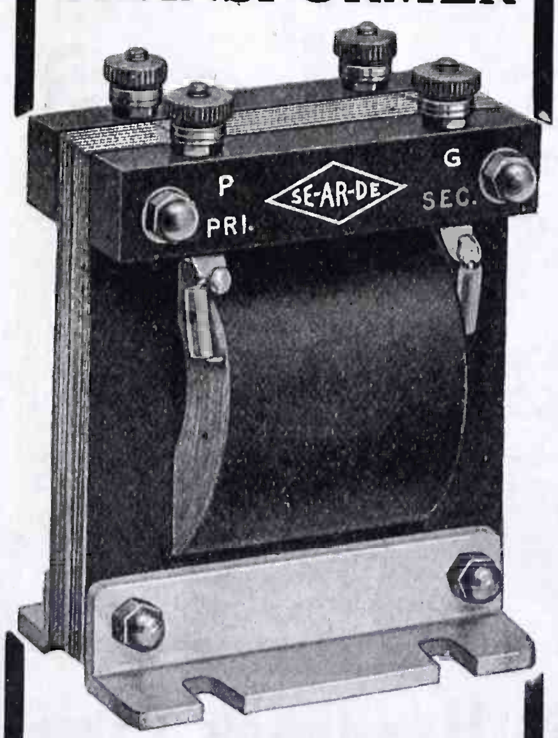
One fine Sunday afternoon, with a brisk wind blowing, the kite wire, kinked from endless reeling in and out, snapped when the kite was about four hundred feet in the air, and with just enough weight to hold it steady, headed toward the city with McGuffy racing along trying to grasp the trailing end. The kite blew into a street where one of the trolley car systems made a turn, and catching on one of the supporting connections which held the trolley wire, came to a stop with just enough wire dangling from the trolley line to touch the ground.

Car traffic was tied up for an hour. McGuffy was knocked silly in attempting to loosen his kite aerial. To insulate himself from the ground, he climbed up on the wooden guard that had been placed around a young and green shade tree near the track. With a rake borrowed from a nearby house, he pulled the wire over to where he could grasp it, in an attempt to loosen it from the trolley cable, while an interested crowd gathered and offered much useless advice. The hand which he was holding on to the tree guard was brushed against the green leaves, and McGuffy promptly let go with a yell as 1200 volts of direct current stung him. The shock was not serious on account of the high resistance offered, but it was finally necessary to call out the car company's linemen to loosen the kite which tugged away overhead.

Again it would seem that McGuffy's experiments with the flying antenna were fated to come to an untimely end. McGuffy senior, with visions of a lawsuit with the car company, decreed no further kite flying. But McGuffy was now becoming famous. His latest exploit make good copy for the local press, and a lengthy item found its way onto the press wires, to be distributed about the land. The United Wireless Company, impressed with his long distance work, communicated with him, asking that an attempt be made to pick up the S. S. *Persia,* just then leaving Honolulu, en route for the Orient, and due to pass out of range of communication with P H, the San Francisco station at Hillcrest within the next few days. Officials had already wirelessed the *Persia* operators to broadcast their position report nightly after passing out of range, in the hope that McGuffy might pick it up.

In view of this request, McGuffy senior consented to allow young McGuffy to fly his kite on the McGuffy ranch, where there were no trolley cars, nor power lines to interfere. He also drove a shrewd bargain with his son, to the effect that he must operate the farm tractor during the day time, a dusty job during the windy season, and one that McGuffy never did have any love for. However, McGuffy shouldered this task with little reluctance in this instance, since it afforded him an excellent opportunity to test his kite reception, and, if he were successful in holding communication with the *Persia,* much desirable publicity, for McGuffy had by this time begun to cherish the idea of becoming a full fledged juice jerker with the United Company.

The McGuffy ranch was situated in that world famous farming section of California, the Delta country, the so-called "Holland of America." Here, rich swamp lands lying below the level of the San Joaquin and Sacramento rivers, had been reclaimed by modern methods, which dyked the lands with strong embankments or levees, pumped the water out by means of powerful steam, gasoline and electric pumps, and converted the former swamp lands into some of the richest farming country in the world. This land stretches flat and level across thousands upon thousands of acres, with water lying from two to three feet below the surface. From a wireless standpoint, it afforded some in-



teresting possibilities in wireless reception.

McGuffy was soon established on the ranch. The wind held good during the night, and after communication range had been lost by PH, he picked up the low musical note of the 5 kw blower gap of the *Persia* clearly, following her to within one day off Yokohama. The press made much of the affair.

AT various points along the San Joaquin and Sacramento rivers and interthreading sloughs and canals, lived a group of beings who had earned the title of "river pirates." Living in arks and houseboats, they eked out a precarious existence in trapping and fishing. Many of them made a practice of robbing the delta farms, stripping the pumps of their brass and bronze fittings, or stealing anything else that could be disposed of at junk yards that did not ask embarrassing questions.

"Rat" Grison was one of this tribe. He was as often on the wrong side of the law as on the right, from time to time making successful hauls, ofttimes suspicioned, but as yet, not caught. He had but recently towed his houseboat to an anchorage near the McGuffy ranch, and had been keeping an interested eye on the big pump situated at the head of a drainage canal on the ranch.

On one corner of the McGuffy ranch was a slight hill. Here, in the early days, before the rush of gold brought the white man into the country, the Indians of the surrounding country, coming to the river to fish and trap, had buried many of their dead. Many of these mounds have been dug into by vandals or by exploration parties from schools and museums, and the mound on the McGuffy ranch had been thus plundered. Broken skulls and leg bones, vertebrae and bones of all description littered the mound. The McGuffys had respected the mound, but of late a party of boys had raided it again, digging up a number of skeletons in their hunt for the pitiful collections of beads and arrowheads that were buried with their owners.

The night that McGuffy went out to fly his kite for the last time before returning to town, Rat Grison fortified himself well with villianous booze, and went out to clean up the McGuffy ranch of its mechanical equipment. His efforts were well rewarded at the pump house, and he made three trips between it and a point near his houseboat, where he prepared a hiding place for his loot. With each trip he took a deep swig at the large bottle which he carried with him, so that by the time he was through with the pumping plant and ready to descend upon the McGuffy tractor, which was out in the field hitched to a gang plow, he was navigating with all canvas spread to the wind and a heavy list to starboard. A light tule fog was arising. Arriving at the tractor, he stripped it of carburetor, magneto and a number of other fittings, placing them in a sack which he had brought for the purpose.

A half mile away, McGuffy was preparing to reel in his kite, the fog warning him that the wind was dropping, and that it would be but a short while before the kite would come down of its own accord. He was elated, for he had picked up the *Persia* as she threaded her way through the Inland Sea of Japan, en route to Manila.

Rat Grison, now soused to a point where his sense of direction was completely fuddled, headed drunkenly along a course that would carry him squarely over the crest of the Indian mound. As I have already pointed out, Rat had but recently selected the McGuffy ranch locality for his headquarters, and of Indian mounds he knew but little. But I might add, Rat possessed a first class bump of superstition, and his respect for spooks was large. Rat in various drinking episodes had seen many spooks—red, green, pink, and other shades.

As Rat approached the mound, McGuffy was also coming up to the mound, over which his kite was flying, walking up on the kite wire, holding the kite reel in his hands, with his wireless receiver slung over his shoulders. The haze was now swirling around him in eddying gusts. A dim moon shed but little light, though probably enough for him to have spied Rat, had not a clump of willow trees been between him and that individual. The wind was away from McGuffy, so that he did not hear the slight clink of metal in Rat's sack.

Rat stumbled up onto the mound, and fell headlong into a yawning pit that had been dug at some time by mound raiders, to rise and look a grinning skull on the edge of the embankment squarely in its cavernous eyes. A good many people in sound mind would have been unnerved at such an occurrence, but Rat was more than unnerved. He had arrived at the particular point in his boozing which might have been called his "spook stage." He tried to yell, but the yell froze in his throat. Turning around in a desperate attempt to scramble up the sides of the pit, his cheek brushed against another skull, his hands outflung grasped the vertebrae and leg bones of some Poor Lo, and losing his balance, he toppled back into the pit again, amid a shower of rattling bones. Around Rat drifted the fog, eddying in gusts fitfully.

Overhead, one of the kite bridles snapped, and the kite frame released from the "bow" which a Malay kite must have in order to fly without a tail, snapped back. The kite at once began to "pin-wheel," swooping down a hundred feet or so, only to loop in a wide swing, to again drop in another pinwheel. Each spin brought it nearer the surface of the mound. Rat Grison, groveling in the bottom of the pit in an agony of besotted fear, heard a rushing sound overhead. Out of the swirling mists a vague gray shadowy shape swooped down upon him with a weird banshee wail. His imagination, now stimulated to a point where it overcome his frozen muscles, released his tongue in one shrill yelp of bloodcurdling volume.

"Swish, swish, swir-r-r-r, swish, swish, swir-r-r-r" sang the kite as it swooped down again. McGuffy had stopped a second to take a kink out of the line, and the kite was not being pulled toward him. Rat, with another scream of mortal fright, gave up his mad attempt to scramble out of the pit, and groveled at the bottom, digging into the loose soil with frantic hands. Then the kite made one more swoop, struck the edge of the pit, shattered into a dozen pieces along its frame, and the fabric, wet and dripping from the fog, enfolded over Rat Grison. To his maddened imagination, clawlike arms enfolded him, the damp clammy cheek of the Spook of all Spooks caressed him.

As the terrified yells, mounting in ever ascending volume, arose from the pit, McGuffy following the wire which lay on the ground as a guide, came up on the run, the hair on his scalp prickling uncomfortably. Over at the ranch house, the yells of Rat had by this time penetrated dimly, and McGuffy senior, hitching up his pants as he jumped from the edge of the bed where he was preparing to disrobe, grabbed a shotgun near the door and sprinted out into the night, followed by two farmhands also in a state of disrobement.

McGuffy junior had worn a pair of white corduroys and a white sweater that night. He had now reached the edge of the pit, and turned his flashlight into the pit, where under the folds of the kite fabric, Rat Grison was attempting to clear himself of its embrace. Looking up for a fleeting instant as McGuffy pulled away the fabric, at the white clad form in the now heavy haze, he uttered another terrified squawk, and rising to his knees, babbled incoherently. McGuffy senior and the farmhands arrived at this point, and under the united efforts of the four, Rat was pulled out of the pit, where his relief at finding his captors human was extreme. Under the stimulus of his fright, his brain was now beginning to clear rapidly. McGuffy senior, looking about him, spied the sack of tractor parts. Among them was a new carburetor that he had just brought down to replace an unsatisfactory one. Rat was marched ahead of the men, who escorted him back to the ranch house, where he confessed to his misdeeds without much urging. McGuffy was not inclined to punish Rat further. Now thoroughly sober, he was released upon his promise to restore all stolen articles the following morning, which he did, be it said to his credit. To make this a thoroughly consistent tale, I suppose it should be recorded that Rat reformed and became a respectable citizen, but as to this, I am not in a position to vouch.

"Well, son," said McGuffy senior as he thoughtfully pulled off a heavy brogan, and shook out the soil that he had gathered in his rush across the field, "there may be something in this wireless business after all. I'm almost ready to forgive you for blowing me out of the bathtub into the parlor with your arc transmitter, and I believe if your ma could have seen that thief when we pulled him out of the mound, that she would also. Well, it's an ill wind that blows nobody good."

"Yeah, particularly when there's a kite in it," responded McGuffy junior, "and——"

But at this point, a heavy snore from McGuffy senior interrupted him, and McGuffy junior, reflecting that it resembled very much the musical note of the blower gap on the S. S. *Persia,* some 5000 miles away in the Inland Sea of Japan, blew out the light and turned in.

COMBINATION RADIO SET

Continued from page 29

and type of the parts will govern the arrangement and size of the outfit. The author's set, however, has been put in a case 7x7x3½, which is smaller than the average portable 1-tube receiver.

The connections to the loop are made by four binding posts at one end of the panel, while battery connections are at the other with four more posts. This arrangement will keep the batteries as far away from the loop as possible.

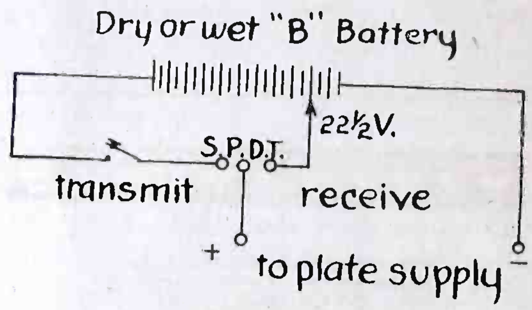


Fig. 3. Battery Connections

Solder all connections and have at least ½ in. clearance between crossed and parallel wires. Covering your wiring with cambric spaghetti tubing is good policy, as a high voltage will be used when transmitting. Follow the diagram closely, noting polarities and connections, both battery and loop, and no trouble will be experienced in making the outfit "perk".

Assuming that all connections have been made correctly, plug in the phones and turn the rheostat until the oscillating

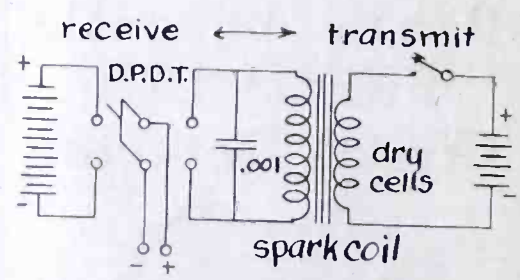


Fig. 4. Switch Connections

click is heard. While operating the set as a receiver or heterodyne use as low a plate voltage as possible so as not to "bloop" your neighbor. After the test for oscillation, the phones can be disconnected and the shorting switch thrown in. The set is now ready to be used as a heterodyne. The coupling between the loop and the secondary of the receiver may be very loose; in fact, a 3-ft. coupling has been used by the writer with good results. A suggestion: try this arrangement on a neutrodyne receiver.

For calibrating the set as a wavemeter, use the phones and bring a buzzer-excited wavemeter to resonance with it, taking direct reading from the meter. To check a transmitter wave use the outfit as a receiver. In calibrating a receiver bring both sets to the oscillation point, then use the resonance click method, taking the reading from the calibrated set. For local reception through interference the directional effect of the loop increases the selectivity.

Transmission up to 10 miles has been successful accomplished with the loop outfit, using a WD-12 dry cell tube with 120 volts on the plate. Figs. 3 and 4 will give you an idea for the switching arrangement, for transmission and reception.

As just the working data have been given, it is up to the amateur to change and improve it, for it has possibilities. The author would appreciate any suggestions or criticisms in regard to the outfit.

WHAT IS MUSIC?

Continued from page 33

another is the difference between the number and variety of the overtones. Overtones, or "upper partials" as they are sometimes called, are as it were "extra sounds" given off from a vibrating string or column of air in addition to the fundamental tone. When a big bell clangs you hear more than one sound; you hear the fundamental plus the overtones quite plainly so that the bell-note sounds more like a chord than a single note—as indeed it is. And so, though you may not realize it, when a bow is drawn over a violin string you hear the fundamental plus the overtones, the latter because of their ratio to the fundamental tone, giving the instrument its characteristic, "edgy" *timbre*. And so with other musical instruments.

Defective ear-drums will fail to respond to these "overtones," so that some of the more delicate of them are lost. That will instantly change one's perception of the quality of the sound. A violin may easily take on a flute-like quality, for instance, if certain of the upper partials or overtones are missing. The "edginess" is lost and the sound becomes "woolly," as musicians say.

This will interest radio fans: Defective or cheap head-phones with poor diaphragms will produce the same unsatisfactory result. So will a poor diaphragm on a phonographic instrument. In radio, the head-phones have to convert electric impulses into sound-waves for the ear, and, if the diaphragm is poor, the music will lose in quality as well as in volume, owing to the loss of overtones.

The human ear, like the radio receiver, varies in receptive power. One can, says Dr. Woods Hutchinson, lose 30 per cent of his hearing without being conscious of the loss in ordinary conversation. One can lose even fifty per cent and be scarcely more than "a little hard of hearing." But if your hearing is only slightly below normal, some of those delicate overtones will be lost, and the voice or instrument to which you are listening will not sound precisely the same to you as it does to one whose hearing is perfect.

Suppose the ear-drums of the listener-in have lost some of their receptive power, so that the voice or musical instrument he is listening to has lost some of its characteristic quality. Will it be surprising if this affects his musical appreciation—his pronounced "likes" and "dislikes" in music? Yet any number of people are slightly deaf without knowing it. Every time you catch a cold your hearing is affected. Many a flu-infected music critic has "panned" some unhappy soloist for a poverty of tone which existed only in the critic's slightly diminished auditory-perception. Many elderly people have declared plaintively and with sincerity that the singers of today are not as good as they once were. Perhaps a visit to an ear specialist would tell them why.

A deaf musician whose hearing has slowly deteriorated from normal will tell you that as his hearing faded, violin-tone sounded first "dull," lacking in "bite" and resonance, then became raspy and unpleasant, and finally was lost until even the full orchestra was hardly audible a few feet away. That is the end of his tonal experience in music. No ears, no music.

But it was not the end of his sense of rhythm, his "motor faculties" and sense of time.

Some years ago a talking machine and dance records were sent to a deaf and dumb asylum. The inmates could not hear a note, but they danced in perfect time and in obvious enjoyment.

How? They danced in their stockinged feet and felt the vibrations of the music from the bare but vibrant floor.

Once again, we repeat, music has two ingredients: sound and rhythm. The two are interdependent but can be considered separately, and for each we have separate sense-faculties: hearing and motor-responsiveness.

That the motor-responsiveness is separate from auditory responsiveness is easily proved. You can beat time in the air with your hand, making no sound, and people watching you will respond even to the point of dancing. Helen Keller, both deaf and blind, can "feel" rhythm literally with her finger-tips applied to a vibrating surface and frequently enjoys music this way.

Not only does music awaken motor-responsiveness, but it does so with such force as to compel us to motion. An untutored savage will leap to the rhythm of a tom-tom without a second thought. At first, perhaps, he will leap wildly, but gradually his steps will unconsciously co-ordinate with the musical rhythm until he "keeps step," as we say. Gradually, also, he will tend to make the familiar stereotyped gestures possible to human anatomy, and will, in a word, "dance." We are all untutored savages in this respect, and can no more avoid dancing to music than we can avoid listening to it.

Just as the capacity for hearing differs in individuals to a marked extent, affecting one's enjoyment of music proportionately, so also does the capacity for motor-responsiveness. Any flapper can tell you that men range in their dancing capacities from elephantine clumsiness to sheik-like grace. Any music teacher can assure you that there are music students constitutionally unable to keep time who yet may have a correct ear; and *vice versa* there are those with exquisite time-sense who may be almost "tone-deaf."

Singers who devote themselves too exclusively to tone-production often have good voices, correct intonation, but keep wretched time (a very common fault); similarly piano students often keep excellent time but hit wrong notes regardless and apparently unconsciously.

Take the hearing capacity and motor-responsiveness together, and you have the key to the so-called "understanding" of music. Any normal person can enormously develop either faculty, but on the whole there is a tendency to develop one faculty more than the other. People like what they can do best; if they have good ears for music and listen well they are keenly critical of music from that aspect. If their rhythm-sense is stronger they develop along that line in their preferences.

A man with keen musical hearing responds readily to rich, sensuous tonal masses of harmony such as you get in the "Sextette from Lucia." He soon learns to notice "barbershop" chords. He appreciates the full, luscious tones such as Caruso had or as Mischa Elman can produce from a violin. Conversely a note that is off-pitch or "sour" jars him terribly. He may readily find the path to discriminating musical appreciation through his ears.

Similarly, a man with keen rhythmic sense may be comparatively indifferent to wrong notes. He may begin by liking jazz because of its strong rhythmic pulse; yet in the end the very rigidity of this unvarying tom-tom beat may drive him forward to the next stage—to the now-hurrying, now-slowing, poised rhythm known as *tempo rubato* without which a Chopin valse would be a nightmare. He prefers such artists as Kreisler and Galli-Curci, both of whom have exquisitely-developed rhythmic feeling. (If you are interested, put on a Galli-Curci record and beat time to it; her bird-like flights of perfectly-balanced rhythm will be a revelation to you. "Les Filles de Cadiz—Maids of Cadiz" is a good example.) Lastly, his sense of rhythm may carry him to a point where he appreciates musical "form," the architecture, rhythmic structure, the very heart of music.

Even the really great musicians show these tendencies. Brahms, in his piano-playing, often hit wrong notes with superb disdain, but never failed to build up a mighty tonal structure; Schumann, on the other hand, was a dreamy, ineffective conductor of chorus or orchestra, showing that though (obviously from his music) he did not lack rhythmic sense, he did lack proper co-ordination so that he was more absorbed in the sounds he evoked than in their rhythmic accentuation. He loved to sit at the keyboard and, with the sustaining-pedal down, dream strange harmonies into reality. Curiously, he went deaf toward the end of his career.

The ideal muisc-lover, of course, has both tonal sense and rhythmic sense finely developed. But any normal listener-in can cultivate both if he chooses; it is mainly a question of being aware of both. All you have to do is to keep on listening-in and noticing things until, like the little lady who took the writer's dictation, you come to the saturation point with low-brow music and, of your own volition, move up to the high-brow. Nobody can force you to do it; nobody can prevent you from doing it.

So far, music has been considered purely on a "motor-sensory" basis, as the psychologists say. We have yet to consider what happens when music, entering the consciousness through the ears and the motor-faculties, goes on into the brain offering us new and strangely moving experiences of aesthetic loveliness. But that must wait for another month. At present it is enough to know that there are two gateways to the world of music—and both wide open.

Ban on Radio Sets in China

The purchase or operation by Chinese citizens of radio sets has been prohibited by order of the Ministry of Communications, according to the Chinese Economic Bulletin of December 26, 1923. The order states that such sale or installation is against the country's law, and offenders will be severely punished. Foreigners living in Chinese territory come under this order, and steps are being taken to prevent the sale of radio apparatus or its installation by Chinese living in the foreign settlements.

NEW ZEALAND NOTES

By L. S. LANE

Radio is not booming in this country, but it shows a steady growth, much advancement being made during the past few months. There are now seven broadcasting stations licensed to use 500 watts, 14 amateur and experimental stations using 50 watts, (the maximum allowed), 1 20-watt, and 2 15-watt transmitters, besides a host of low-powered amateur stations of 5 watts and under. Receiving sets are being installed everywhere.

The advent of good broadcasting stations in Australia has done a great deal towards the increased interest in broadcast reception. Two Australian stations are received here regularly, both giving programs that compare favorably with those given by the Class B on the Pacific Coast. In the near future the largest broadcast station "South of the Line" will be using its maximum power of approximately 6,000 watts. This should be received nightly in New Zealand on a good crystal set, the distance being from 1,000 to 1,400 miles, depending on the situation of the receiver.

The experimenters communicate nightly with Australia, maintaining two-way working on powers below 5 watts. A peculiar feature of experimenting here is the fact that the greatest distances (receiving) are generally accomplished on a single tube, or detector and audio amplification, the amateurs using radio-frequency not being able to beat those who don't. Perhaps it is due to poor design.

The question of payment for broadcasting is an absorbing topic. At present the stations are maintained by the various dealers in co-operation. They are trying for an increase in the license fee, a portion of which going to subsidize the transmitting stations.

American broadcasting stations are received here regularly. It is only necessary for a station to be "on the air" after 11 P.M., Pacific Standard time, for it to be received here, KPO, ?KFI, KHJ and KGO coming in quite loud, the latter often being received and amplified so that a loud speaker can be used. That is not too bad for a distance of 6,000 miles, what?

American amateur stations are also received whenever static permits, 6XAD being the one that seems the easiest to get. 9XN was heard here recently talking by phone to WNP. This seems to be the record distance for reception here. It was done on a detector and "one-step."

GEOLOGISTS DETERMINE BEST GROUNDS

It is not recorded that the Jove of olden days, in hurling his thunderbolts, called in a geologist to find the places where his shafts would strike most effectively, but the modern Jove, who has harnessed the force of the thunderbolt to powerful motors, brilliant lights, and other electric devices, wants to know where and how he can make the best ground connections for his electric currents and his lightning arresters. Tests made in the city of Chicago by the United States Bureau of Standards and the Commonwealth Edison Co. showed that the electric resistance of the ground connections was very much higher at some places than at others. When these places of high resistance were plotted on a map it was found that they were in tracts having sandy soil and sub-soil through which the rain passed down to a low-ground-water level. As a ground connection, which is generally made by driving an iron pipe into the ground, must reach a moist place in order to be most effective, the pipes had to be driven deeper than usual in these sandy places. In order, therefore, to show the places in which the pipes should be longer it became necessary to outline on a map all these sandy areas. In a great city, however, much of the land is covered with buildings and pavements, which conceal the soil, and the task of locating the sandy areas involves considerable labor. Here is where the modern Jove called in the geologist.

During the closing stages of the Great Ice Age the front of the great Lake Michigan glacier was melted back slowly northward along the lake basin. The waters were ponded between the retreating ice front and the great crescentic ridge of glacial debris that was left at the lower end of the lake basin (a ridge called by geologists the Valparaiso terminal moraine) thus forming a temporary lake known to geologists as glacial Lake Chicago. The waters of this lake rose to a height of about 60 feet above the present level of Lake Michigan, spreading over the plain on which Chicago now stands. Then they broke across the moraine and eroded the sag that is now traversed by the Sanitary Drainage Canal and Des Plaines River and that leads to Illinois River. Along the shores of this glacial lake and beneath its waters at their successively lowered stages, immense deposits of sand and gravel were laid down, largely in the form of beach ridges and sand bars.

Some years ago the Geological Survey of the Department of the Interior, in an investigation of the geology of this area, made a careful study of the ground in and around the city and mapped the ancient shore lines of Lake Chicago, the abandoned beach ridges and other deposits. These maps furnished the solution of the problem of the public utilities company, which turned to the Geological Survey's Chicago folio for aid in plotting the areas in which it may be necessary to use ground pipes that are 50 per cent longer than those generally used in other parts of the city. The company thus not only easily solved their own problem, but afforded another instructive example of the unforeseen utilization of the results of scientific research undertaken with no immediate commercial or industrial end in view.

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RADIO OFFICIAL DENIES TUBE HOLD-UP

When asked whether there was any foundation to the rumors that the Radio Corporation of America had withheld the sale of vacuum tubes and thus restrained the sale of competitive apparatus, E. E. Bucher, manager of sales department, said: "Rumors to the effect that we have been holding back on our tube sales are absolutely false and I wish to deny that this is the case. Only 10 to 15% of our total monthly tube production is required for our merchandise, the remainder going to purchasers using sets and parts manufactured by others.

"There are general facts in the vacuum tube situation which we are glad to give, and which, no doubt, will tend to curb any feeling that the Radio Corporation of America is not giving this subject the close attention that it deserves.

(1) "We maintained a day-by-day inventory of from 450,000 to 600,000 tubes of five different types, up to January 1st of this year, and steps were taken many weeks past with the endeavor to build this inventory to still larger figures.

(2) "768,816 Radiotrons were delivered to the trade in January, this year, 825,936 in February, and March deliveries will exceed 900,000.

(3) "*70% of our monthly production schedule is composed of Radiotrons UV*-200 *and* 201-A.

(4) "Stocks of dry battery tubes have been in excess of the trade demands from May, 1923, to date, and current production is keeping apace of the demand.

(5) "Current production on the storage battery types of tubes is actually in excess of new orders booked for these particular types, but present production schedules should produce an excess by the first week in April.

"There is no desire on the part of the Radio Corporation to do anything other than produce tubes in sufficient quantities to meet every possible requirement of the trade. We are in the business to *sell* and not to *withhold*. However, the circumstances under which the manufacturer works in meeting the requirements of the market must be given due consideration.

"Briefly, the industry is too young to enable either the dealer or the distributor to place orders with the manufacturer sufficiently in advance to meet the fluctuating demands for the specific types of tubes. As the factories, on the other hand, must prepare their production and procure new material from 90 to 120 days in advance of actual deliveries, it becomes necessary for us to endeavor to predict at least four months in advance what the trade requirements may possibly be. To this end the Radio Corporation maintains a staff of expert statisticians whose time and energies are devoted solely to a study of this situation, frequent conferences are held with the manufacturers and production schedules are re-vamped to meet the fluctuating demands of the market.

"During the latter part of November, 1923, a largely increased demand for the storage battery types of tubes became evident, but no prior notification of this possible increase was given to the Radio Corporation by the trade channels. Major steps were then taken in our factories to increase production on that type such as the building of additional plant facilities, the installation of new machinery, the training of additional personnel, etc., etc. Between the first week of December and February, production on the storage battery types of tubes was actually doubled and still further increases are obtained week by week.

"Production schedules have been laid down in the factories for the remainder of this year, which it is confidently believed will be largely in excess of the trade requirements, for it is the avowed policy of this Company to keep its production ahead of the demand.

"A temporary tube shortage may develop in any particular locality, not by reason of insufficient factory production, but because of the difficulties of obtaining uniform distribution. The Radio Corporation sells its tubes to distributors; from that point on it has no control over distribution to the dealers. We are aware, however, that distributors are making every effort to serve dealers in all localities, but the actual quantities distributed in any particular territory are also governed by the amount of dealers' orders, dealers' credits, inability of some dealers to sense the public demand sufficiently in advance to enable them to serve customers promptly, and numerous other factors, all of which have bearing on the situation.

"As further evidence of our desire to meet all possible trade demands, it is important to point out that only 10% to 15% of our total tube production is required for our own merchandise and all that we need is more concise advance notification of what the trade wants, thus enabling us to prevent shortages."

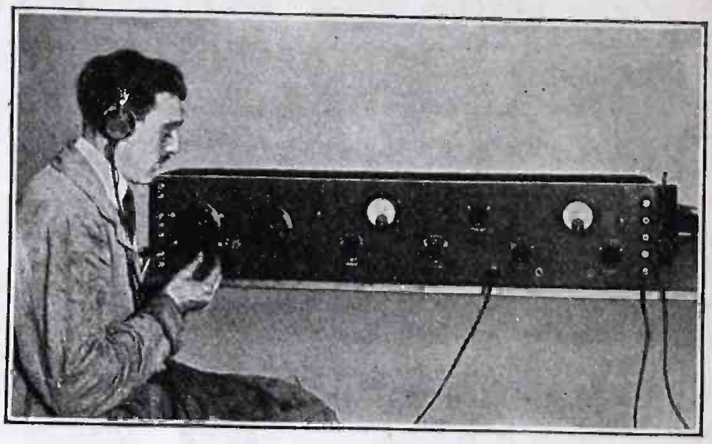
Broadcasting in Norway to be Private Enterprise

Control of broadcasting by private limited companies under Government supervision is the subject of a proposal from the Norwegian Director of State Telegraphs to be submitted shortly to the Government for approval. The director states that no single company is being considered with the object of giving it a concession, but that all will be given an opportunity to participate by offering half of the share capital for public subscription.

Brazilian Radio Association Formed

Under the auspices of the Instituto de Engenharia de S. Paulo there has been organized the "Sociedade Radio de S. Paulo." Its principal purpose is the broadcasting of information, etc., by wireless telephone. It is planned to install a transmitting station with sufficient power to be heard from 500 to 1000 miles.

For expensive, delicate parts—what panel will you use?



THE picture shows the front of a Super Heterodyne hook-up. This set has a normal range of 3,000 miles. When a radio fan builds this set he must use the best radio parts he can buy. And he needs a panel that will help those parts operate most efficiently.

A weak battery, a burned-out tube—any defective part—merely reduces the range of a set instantly. A cheap radio panel can hinder the effectiveness of the best instruments made.

Radio fans all over the country construct their sets around Celoron Standard Radio Panels. One of them, Mr. Phil Davies, of Grand Rapids, Michigan, writes about his Celoron panel:

> "I bought a Celoron Panel, first, because of the low loss of high frequency currents and its high dielectric capacity; second, because of its strength and durability; third, because of its beautiful finish; fourth, because of its convenient size."

Radio set manufacturers who use Celoron panels in their cabinets help fans get greater volume and clearer reception. Manufacturers of radio parts who mount their instruments on Celoron bases give insulation those parts need. In Celoron they have a bakelite product that is one of the best insulating materials known. Its dielectric strength has been proved time and again. The U. S. Signal Corps and U. S. Navy approve it heartily.

Radio manufacturers can buy Celoron in sheets, tubes, rods, and special forms.

Celoron Radio Panels were the first to be cut in standard sizes and wrapped in individual packages. They come in the following standard sizes finished in black, mahogany or oak:

1—	6 x	7 x	1/8
2—	7 x	9 x	1/8
3—	7 x	12 x	1/8
4—	7 x	14 x	3/16
5—	7 x	18 x	3/16
6—	7 x	21 x	3/16
7—	7 x	24 x	3/16
8—	12 x	18 x	3/16
9—	7 x	26 x	3/16

Special sizes cut to order from sheet stock.

Leading radio parts makers have already found that Celoron is an ideal material to use for cabinets, switch bases, and other radio and wireless equipment.

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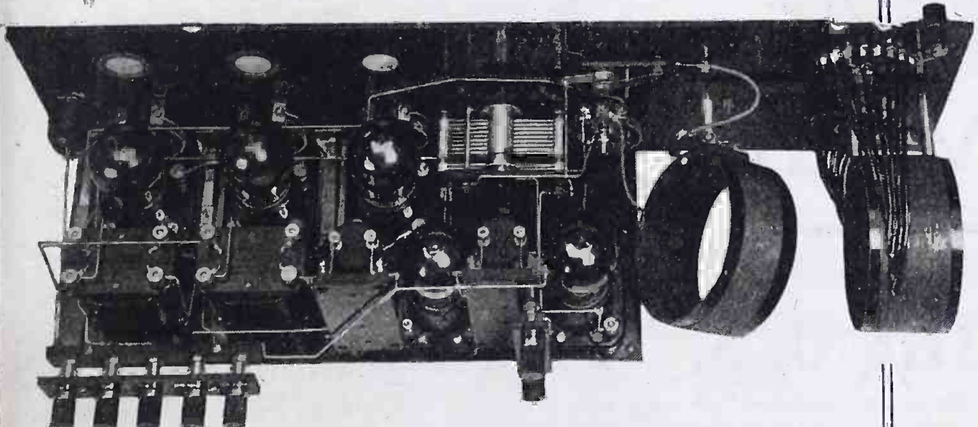

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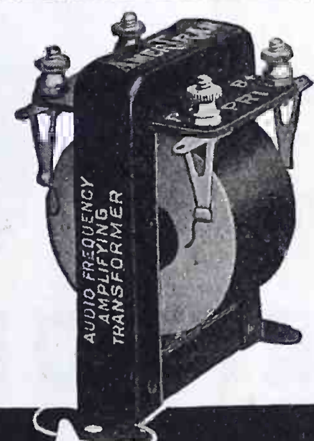

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CALLS HEARD

Continued from page 48

By 6BEZ, 407 Hillside Court, Piedmont, Calif. (Near S. F.)

1boa, (1er), 1kc, (2xna), 3bgj, 3mb, 3qv, 3yo, 4ba, 4db, 4iz, 4fs, 5aaq, 5aaw, 5agh, 5ajt, 5bq, 5ce, 5dm, 5dw, 5eh, 5ia, 5jb, 5mi, 5nw, 5ou, 5ov, 5ph, 5va, 5xd, 5zav, 8ada, 8ajh, 8alf, (8ced), 8cmy, 8crv, (8cvm), 8dce, 8dcy, 8dkb, 8fm, 8qm, 8rn, 8xbh, 9aav, 9abf, 9aem, 9agb, 9agl, 9agy, 9ahq, 9ahz, 9aim, 9aju, 9amf, 9ape, 9aqc, 9aqs, 9asw, 9avn, 9awf, 9ayx, 9bab, 9bav, 9bbs, 9bcb, 9bcf, 9bfb, 9bgv, 9biz, 9bly, (bmx), 9bob, 9bpv, 9btl, 9bvn, 9bxq, 9bze, 9ccm, 9ccw, 9cea, 9cee, (9ceh), (9chc), 9cin, (9clz), 9cme, 9co, 9cpc, 9caw, 9cvv, (9cxp), 9cyn, 9czg, (9czu), 9daj, 9dbh, 9ddp, (9dhk), 9djb, 9dsl, 9dxu, 9dyn, (9dyr), 9edb, 9eea, (9efh), 9eht, 9eiq, 9eq, 9dr, 9fm, 9hm, 9hn, 9hw, (9mf), 9ry, 9tm, 9wu, 9xba, 9xbd, 9yau, 9yy, WWV

Can: 3hh, 3ni, (3pz), 4cb, 4dq, 4hh, 9al, 9bx.

Mex.: bx.

Work done on 150 meters. Crds. answered promptly es, wud appreciate ani reports on mi 10 watts.

By 6CIX-6ABO, 317 N. Friends Av., Whittier, Calif.

1bcr, 1cpn, 1xak, 1xek, 1kc, 1xw, 2csl, 2bg, 2bn, 3bji, 3ckj, 3aa, 3bj, 3mb, (3mo), 3ni, 4og, 4cr, 4em, 4eq, 4hs, 4io, (4ll), 4mb, 4xc, 4xe, 4xp, 4xq, 5aat, 5aaw, 5adb, 5agl, 5aic, 5aiu, 5ajj, 5alv, 5ami, 5amo, 5apn, 5xab, 5zav, 5ak, 5az, 5cn, 5dw, 5eh, 5ek, 5ft, 5fu, 5la, 5lp, 5lr, 5nw, 5qh, 5ql, 5qy, 5rg, 5tj, 5va, 5vm, 5xa, (5xd), 5xj, 5xv, (6acl), (6adb), (6afe), 5xp, (6ams), (6apc), 6blh, 6cbu, (6cip), 6cjl, (6dt), (6ei), 6zt, 7acm, 7adf, 7adi, 7adm, 7ads, 7aea, 7afk, 7aiv, 7ajd, 7ald, 7co, 7eo, (7ey), 7fq, 7fr, 7fs, 7gq, 7gw, 7ij, 7io, 7iw, 7ju, 7ke, 7kr, 7lh, 7ln, 7ms, 7ob, (7om), (7ot), 7qc, (7qd), 7rq, (7sh), 7sy, 7td, 7we, 7zl, 7zu, 8ada, 8ado, 8apt, 8ala, 8ctp, 8cyz, 8dgp, 8xbh, 8xbp, 8aa, 8es, 8pl, 8nd, 8ry, 8xb, 9aep, 8agb, 8afz, 9amb, 9ami, 9amy, 9any, 9aqc, 9arj, 9avm, 9avn, 9azg, 9bal, 9bav, 9bdf, 9bdj, 9beo, 9beu, 9bez, 9bly, 9bmx, 9brk, 9brx, 9bsg, 9bun, (9bvv), 9caa, (9caj), 9cch, 9ccm, 9ccs, 9ccu, 9cdv, 9cen, 9cfk, 9ciq, 9cjk, 9cjl, 9cju, 9cka, 9clq, 9cly, 9cto, 9cvo, 9dai, 9day, 9dbh, 9dcp, 9dej, 9djx, (9dkx), 9dgu, 9dhg, 9dhs, 9dpx, 9dqr, 9dro, 9dte, 9dum, (9dun), 9dxr, 9dzm, 9eae, (9eak), 9ebt, 9eep, (9eht), 9eky, 9elz, 9erk, 9xax, 9xbe, 9aa, 9bw, 9dk, 9dn, 9dy, 9em, 9eq, 9hm, 9lb, 9mc, 9rc, 9ry, 9sh, (9ss), 9sv, 9xw, (fone), wgy, kdka, kfz, kdef.

Mex.: bx. Can.: 3os. Pse. qsl if u hr me. All crds. ansd.

By 5AJB, Oklahoma City, Okla.

(1and), 1ajp), (1are), (1arp), 1axn, (1bcr), 1bgc, (1bom), (1bsz), 1cmp, 1fh, 1fs, 1kc, (1sk), 1sw), 2atf, (2atz), (2azy), 2bgo. 2brb, (2cph), 2cxw, (2le), (2wr), 3adh, (3adv), (3cez), (3ckl), 3cl, 3je, 3lg, (3me), (3mo), (3qv), 4ba, (4dv), 4ez, 4hh, (4io), (4my), (4oa), (4sh), (5adh), (5ajh), (5ajq), (5ajt), (5alm), (5amg), (5anw), (5aom), (5xaq), (5dc), (5eg), (5ez), (5rg), (5ua), (6aao), (6adh), (6adt), (6aea), (6agk), (6apc), (aqd), (6atz), (6avr), (6avv), (6awe), (6bbw), (6bij), (6blq), (blw), (6cbg), (6cdc), (6cmu), (6gt), (6nb), (6qb), (6ql), (6vw), (7abb),(7akk), (7ald), (7fd), (7gr), (7hw), (7ly), (7io), (7to), (7zu), 7ws, (8aaj), (8ada), (8aip), (8alw), (8anm), (8bdr), (8bge), (8bjv), (8bkn), (8bnk), (8bqi), (8bue), (8bvy), (8bwb), (8bwr), (8bzr), (8cci), (8cdc), (8chy), (8cpk), (8cur), (8cwp), (8cwr), (8cxu), (czy), (8dae), (8dbn), (8dhq), (8dia), (8dp), (8rn), (8sr), (uy), (9ach), (9aef), (9agb), (9agl), (9aic), (9amf), (9aqk), (9avg), (9axx), (9axr), (9bgh), (9bgk), (9blb), (9bon), (9bre), (9brx), (9btm), (9bvj), (9bwq), (9bwv), (9caa), (9cdb), (9chk), (9chn), (9cji), (cjk), (9cka), (9cwx), (9czw), (9dbf), (9dct), (dkd), (9dle), (dlr), (9dly), (9dsl), (9dtc), (9eeg), (9egu?), (9eky), (9elb), (9ell), (9rc), (9vm), (9xbe), (9yau).

Can.: lar, lbq, (2bn), (3xi), (3yv), (3ws), (4fz), 4cb.

Note: Can. 9's who hr mi sigs. pse. qsl crd. inx.

By 6AVR-6ZBF, Cecil Yates, Fullerton, Calif. R. F. D. No. 3

1kc, 1sw, 1aap, 1are, 1aur, 1bom, (1bsz), 1cmp, 2gk, (2rk), 2tp, 2ts, 2wr, 2blp, 2bxd, (2cee), 2crp, 2csr, 2cuz, (2xna), (3ab), (3hg), (3hh), 3hs, (3lg), 3oi, 3qv, 3abw, 3adb, 3aqr, 3ats, 3bgj, 3blu, 3ccx, 4ba, 4bz, 4cs, 4db, 4fs, 4ft, 4gz, 4hs, 4io, (4my), 4oa, 4qy, (4sh), (4xc), 5be, 5ct, 5cv, 5jb, (5kw), 5li, 5mi, 5na, 5nw, (5qh), (5ql), 5rb, 5rh, 5rm, 5tj, (5uk), 5aaq, 5acq, 5adb, 5aeu, 5agh, 5agv, 5aic, 5aij, 5air, (5ajq), 5alv, 5amo, 5anc, 5xd, 5xab, (6fp), 7ak, 7ca, 7ej, 7er, 7em, 7gq, 7gr, (7io), 7ks, 7mn, 7no, 7qc, 7qd, 7rd, (7sy), (7tq), (7vm), 7vn, 7adf, 7aip, 7ajv. 7ajy, 7akh, 7aki, 7ald, (7zu), 8bk, 8dp, (8es), 8jj, 8jy, 8kc, 8mz, 8pl, 8tt, 8vn, 8vq, 8vy, 8wx, 8abm, 8acn, 8aih, 8ajh, 8amm, 8apt, 8ard, 8atp, 8axk, 8azz, 8bda, 8bjv, 8bkd, 8bmb, (8bnh), 8bwb, 8byn, 8ccd, 8chy, 8cjd, 8cko, 8cpk, (8crv), 8cry, 8ctp, 8cux, 8cwp, 8dae, 8dak, (8dbm), 8ddc, 8dgp, 8dkb, 8dkq, 8xbp, (8zk), 9cp, (9ei), (9mc), (9mm), (9rc, (9st), 9aau, 9abv, 9afy, 9agb, (9aju), (9amb), 9aou, 9apf, 9apy, 9asn, 9ato, 9avg, 9avs, 9bcx, (9bed), 9beu, 9bez, 9bfp, 9bhy, 9brk, 9bsp, (9bun), (9bva), 9bvn, 9bvv, (9bxt), (9byc), 9bzt, 9ccm, 9ccv, 9cea, 9ceh, 9cei, 9cfx, (9cga), 9chc, 9cjc, 9ckj, (9cmk), 9ctv, 9cvo, 9czg, (9day), (9dbf), (9dcr), (9dcw), 9ddp, 9dfh, (9dkb), 9dkq, 9dlb, 9dmj, 9dpr, 9dqu, 9dro, 9drx, 9dsv, (9dte), (dun), 9dvg, 9dwb, 9dxy, 9dyr, 9dyz, (9eak), 9efh, 9eiq, (9eky), 9elb, 9eld, 9elj, 9zay.

Canadians: 3bq, 3pz, (4cb), 4cn, 4cr, (4dq), 4ea, (4fv), (5bq), (5ch), 9bx.

By 6BBQ, Frank F. Macik, 194 S. El Molino Ave., Pasadena, Calif.

3br, 4je, 5by, 5lp, 5mt, 5nq, 5rg, 5sg, 5agz, 5ado, 5ahd, 5ajj, 5aiu, 5ano, 7fm, (7fs), 7pj, (7qu), 7tq, 7age, 7ajd, (7akh), 7afk, (7alk), 8vy, 8ack, 8acy, 8ard, 8ate, 8atc, 8cno, 9vm, 9aps, 9aue, 9avn, 9avw, 9azg, 9bqq, 9bth, 9bcg, 9caa, 9cga, 9cic, 9cmj, 9cmk, 9cht, 9cwj, 9dbf, 9dmj, 9dkq, 9dnr.

By Leonard Oswald, 1646 W. 101st St., Chicago, Ill.

1amq, 1asu, 1bge, 2baw, 2cwp, 2ek, 3arp, 3bm, 3cel, 3ek, 4af, 4jr, 5afq, 5aiu, 5ajb, 5alv, 5amh, 5djl, 5dq, 5fu, 5fz, 5jl, 5ka, 5ql. 5qy, 5sd, 5sk, 6arf, 7co, 8ak, 8ako, 8atc, 8bce, 8bf, 8bfe, 8bfh, 8bnh, 8br, 8btm, 8caa, 8cdl, 8chy, 8cmu, 8cwu, 8cta, 8dah, 8dal, 8ddt, 8dfo, 8gx, 8gz, 8dhq, 8ii, 8kg, 8rv, 8tt, 8wy, 8wz, 9adp, 9amu, 9art, 9att, 9azg, 9bbh, 9bis, 9blw, 9bmu, 9bye, 9caa, 9ccf, 9cea, 9cfi, 9cgv, 9cpd, 9ctg, 9cvf, 9cxt, 9dcw, 9dfs, 9dgv, 9dhq, 9dia, 9dnt, 9dre, 9dro, 9edq, 9efh, 9ela, 9eld, 9es, 9hk, 9le, 9vm.

By 6DD ,379 Mill St., Grass Valley, Calif.

1bpj, 1bw, 1cml, 1nr, 2bvy, 2dhr, 3aqr, 3bw, 4aab, 4ab, 4bf, 4xc, 5air, 5aiv, 5az, 5amo, (5hg), 5hk, 5lp, (5lr), 5my, (5mz), 5na, (5qy), 5rg, 5sg, 5tq, 6ceu, (7zu), 8abm, 8acy, 8anm, 8bf, 8cnz, (8cva), 8dae, (8eb), 8jy, 8vm, 8vy, 9ack, (9acx), 9aku, 9and, 9aol, (9atn), 9ayu, 9axg, 9bdz, (9bfp), 9biv, 9bly, (9bmd), 9bqj, (9btt), 9bwq, (9bwv), 9bzq, (9caa), 9cjc, (9cjy),)9ccs), 9cvs, 9dbf, (9dch), 9dhr, (9dyi), 9eak, (9eam), 9efh, 9eiq, 9elb, 9mc, 9ql, 9rc, 9ss, 9tv, 9xax. Fone:(9bwv).

Canadian.: 3gk, 4er, 4fv, (5ef), 5ak. Anyone hearing my cw pse. qsl. All cards answered.

By 9MC, A. H. Cain, Roodhouse, Illinois

(1aap), (1all), (1akz), (1avq), (1azr), (1bef), (1bie), (1biz), (1bsz), (1bwj), (1cab), (1cbh), (1fh), (1rv), (1xm), (1xz), (1yb), (2aay), (2ate), (2atf), (2bjx), (2bms), (2cee), (2cgj), (2cjb), (2cka), (2cpa), (2cpz), (2crq), (2crw), (2cuz), (2cvs), (2cxy), (2ei), (2gk), (2le), (2qf), (2rb), (2rk), (2ts), (3adv), (3apc), (3ava), (3bco), (3bdu), (3bgz), (3blu), (3bnu), (3bqp), (3ccx), (3cdk), (3cdu), (3hg), (3hh), (3ko), (3mf), (3oe), (3sh), (3ta), (3ts), (3wf), (3wx), (3zm), (4af), (4bg), (4bq), (4cl), (4db), (4ez), (4gz), (4hs), (4jr), (4lj), (4oa), (4og), (4pk), (4qw), (4sb), (6aao), (6acv), (6adh), (6adt), (6age),(ahp),(6akw),(6ald),(6alg),(6alk),6aos),(6aqd), (6avv), (6avr), (6awt), (6bbc),(6bic),(6bi),(6bij),(6bjj), (8blg). (6blq), (6blw), (6bnt), (6bny), (6bou), (6bpm), (6bqb), (6bql), (6bwd), (6cbw), (6cdg), (6cdn), (6cfm), (6cjv), (6cmi), (6cmr), (6cnc), (6cng), (6cnl), (6ea), (6jj), (6lv), (6qj), (6rn), (6tn), (6uw), (6vc), (6xad), (6zar), (6zp), (7abb), (7akz), (7co), (7fd), (7fq), (7hq), (7ih), (7iq), (7ly), (7no), (7qc), (7sf), (7vn).

Can.: (2ei), (3ia), (3je), (3ph), (3pz), (3rg), (4fv), (4fz), (5go).

Cuban (2by). Also ship in Gulf (kd5).

By 6CBW, Beverly Laugenour, R. D. 2, Bx22, Woodland, Calif.

1cmp, (3ab), (3abw), 3mb, 4co, 5adb, 5aic, 5dw, 5lr, 5xaw, (5xd), 5za, 5zav, 6aja, 6bnf, (6bui), 6cbu, 6pe, (7adr), 7adf, 7ack, 7aft, 7age, (7aha), 7aia, (7aiv), 7ajd, 7aju, 7ajy, (7akh), (7cw), 7di, (7el), (7fq), (7fs), 7fy, (7gq), (7iw), 7qu, (7rd), (7sh), (7sy), 7un, 7ws, (8aip), 9ab, 9abc, 9aci, 9aep, 9afm, 9aim, 9apf, 9atn, 9azg, 9bof, 9bou, 9bpt, 9bpy, 9bre, 9bun, (9bun), (9caa), 9cpu, 9cr, 9ctg, 9cwo, 9czm, 9dfh, 9dum, 9dyn, 9eak, (9efh), (9mc).

Can.: 4dq, (5ak), 5bf, 5bw, (5ef).

By 5AJJ, 3704 Oaklawn Ave., Dallas, Texas

1awe, (1bsz), 1cit, (1er), (1cmp), 1cmx, 1fs, 1kc, 1yb, 1xu, qra (?), (2bgi), (2bqh), 2wc, 2wr, 2xna, qra (?), 2za, 3chh, 3dt, 3ds, 3hg, 3qv, 3zz, 3ccu, 3zo, (4ab), 4af, 4cs, 4db, 4eq, 4er, 4gh, 4it, 4jr, 4oi, (4pk), 4sb, 4tj, 5's too numerous, 6aao, 6abk, 6adh, (6age), 6bic, 6bk, 6bij, 6bwd, 6cge, 6cmr, 6cay, (6ux), 6vd, 6zcd qra (?), 6zt, (6zbu), (7afn), (7akk), (7alk), (7em), (7ks), 7mc, (7vn), 7zu, 8aii, (8bde), 8bhj, (8cap), 8cei, (8ced), 8crv, 8cci, (8cgj), 8cmu, (8dhs), 8fu, 8ob, (8vn), (8yn), 8vt, 8tt, 8xan, (8zc), (8zw), nines too numerous. Mexico: bx. Cuban: (2ww). Hawaii: 6ceu. Porto Rico: 4oi, 4je. Canada: (3bg), 3kg, 3ud, 4co, 4fz, (5ef). Wl appreciate repts. on my sigs.

By 9DBF, 804 Ridge Terrace, Evanston, Illinois.

(6aao), 6abk, 6acu, 6ade, (6afa), 6ahc, 6ahp, 6akm, 6an, 6anq, 6aoa, 6aol, (6aqd), 6atz, 6auj, (6avr), 6awk, 6bbc, 6bcl, 6bik, 6bkl, 6buh, 6buv, 6bwd, 6cbd, (6cdc), 6cdg, 6cgw, 6chj, 6cmu, (6cnl), 6cqa, 6gt, 6kb, 6nb, 6qo, 6tv, 6xad, 6xl, 7ade, 7adf, 7adi, 7ajd, 7co, (7ei), 7kr, 7hw, 7qc, 7qf, 7sh, (7we), 7zk.

By 7AJT, Basin, Wyoming

CW: 1bsz, (?1cw), 2afp, 3bz, 3rg, (both qsa), 4jr, (vy qsa often), 5ado, 5aga, (5aiu), 5ajj, 5amu, 5azu, (5ef), 5lr, 5rg, 5qd, 5qq, 5ql, 6acv, (6adt), 6afa, 6awq, 6bbw, 6blm, 6bri, 6cmi, 6cmu, 6ckr, 6ei, 6fm, 6gr, 6oz, 6qp, (6zbu), 6zh, 7aby, 7ads, 7ael, (7afk), 7afo, 7ahs, 7ajq, 7alk, 7akz, 7ayd, 7cr, 7di, 7fq, 7fs, 7gi, 7gv, (7gw), 7ju, 7kv, (7lh), 7no, 7om, 7ot, 7ry, 7rn, (7qc), (7qd), 7zi, 8atc, 8bby, 8bci, 8bfh, 8cko, 8clc, 8cmy, 8cnw, 8dae, 8ded, 8dhq, 8dio, 8dgx, 8hn, 8hv, 8jy, 8kj, 8wp, 9's too numerous.

Can.: 3rg, 4co, 4eo, 4uv.

ICW: 1uj, 5cn, 5qd, (7el), 8ga, 9aim, 9cip, (?icw), (9aec).

Fone: 5akf, 5qd, 6fm, 7co, 7qo, 9azg, 9cfi.

Dalite CW: 5agn, (7co), 9agl, 9amp, 9bhi, 9bqy, 9bvm, 9bxt, 9cyn, 9cyx, 9dej, 9dlf, 9dnd, 9eak, 9egu, 9ekf, 9eky, 9hk.

Wud app vy rpts. on mi 10 watts. Wl QSL abv if requested.

At 6AOO, 1604 7th St., San Diego, Calif.

2brb, 4cr (?), 4xc, 5aic, 5aiu, 5ajj, 5ajt, 5alm, 5be, 5dc, 5ek, 5jl, 5ps, 5rv, 5su, 5uk, 5vm, 5xd, 5xv, 5yd, 5zav, 5zh, 7abs, 7ajd, 7em, 7fr, 7hw, 7ij, 7io, 7zg, 8atc, 8cko, 8xe, 9ab, 9abc, 9aau, 9apf, 9avn, 9bsi, 9cjc, 9cjy, 9cwj, 9ocw, 9ddf, 9dn, 9dro, 9dun, 9dyr, 9ee, 9cga, 9mc, 9ss, 9zcd.

Fone: 9xw—110 meters.

By Ernest E. Harper, 7GR, Station A, Vancouver, Washington

1asu, 1bcr, 1iv, 1kc, 2od, 3bj, 3rg, 4io, 4xc, 4xe, 5aaq, 5abw, 5ahd, (5aic), 5aij, (5ajb), 5ajt, 5apm, 5az, 5be, 5cv, 5dm, 5dj, 5fg, 5gm, 5id, 5lr, (5nn), 5ov, 5qd, 5ql, 5ts, 5vm, 5xr, 5xv, 8aig, 8ah, (8alf), 8anm, 8apt, 8atc, 8bgq, 8bkn, 8cko, 8chy, 8ctw, 8dae, 8ddj, 8dgo, 8pl, 8rj, 8ycp, 9aau, 9aem, (9aep), 9afm, 9akc, (9agl), 9aqk, 9aqv, 9ama, 9amm, (9amp), (9amw), (9and), 9bab, 9bav, 9bbv, 9bex, 9bdj, 9bff, 9bpn, 9brx, (9bze), 9ccv, 9ccs, 9cde, 9cdv, 9cfz, 9cfk, 9cga, 9cjm, 9ckm, 9cnb, 9cjy, 9cpd, 9cpz, 9cxp, 9cyn, 9dbh, 9dpp, 9dec, 9dhs, 9dcs, 9doe, 9dyr, 9dhg, 9dr, 9dka, (9dyi), 9dga, 9dkb, 9elz, (9eak), (9hm), 9rc, 9ry, 9tm, (9xbe), 9yau.

Pse. notice new QRA. All crds. answered. 5 watts R. A. C., C. W. here.

Continued on page 92

Continued from page 90

By 6ABK, 689-62nd St., Oakland, Calif.

1fs, (1ka), 1bcr, 1cmp, 1sw, 1xam, 1xw, 2ag, (2gk), 2agb, (2awf), 2cla' (3gc), 3gg, 3ws, 3aec, 3adb, (3bgj), 4db, 4hs, 4io, 4ik, 4xc, 5be, 5ce, 5dw, 5dm, 5eh, 5nn, 5rv, 5ef, (5ph), (5tj), 5uk, 5ts, 5aaw, 5adb, 5aic, 5aib, (5alr), (5ajt), 5azg, 5xv, 5zav, 8gx, 8nb, 8abm, 8ada, 8bvy, 8cvm, 8czy, (8cyi), (8cxm), (8die), 8dkd, 9er, 9vk, 9uh, 9wu, 9yy, 9ux, 9hw, 9ry, 9dn, (9acx), (9ape), (9aus), (9ado), (9amf), (apf), (9avg), (9agl), (9ato), 9amb, 9aqv, 9aue, 9aqc, 9agb, (9btl), (9bez), (9bmx), (9bis), (9bvn), (9abf), (9bpv), (9bqj), (9byo), 9boa, 9bab, 9bqq, 9beu, 9cld, 9chn, (9cxp), (9chc), (9ceh), 9ccv, 9cpu, (9dbh), (9dyt), (9dyr), (9dkb), (9dyz), (9ddp), (9dun), 9cnb, 9dai, 9dvh, 9bdz, 9djb, 9dct, 9eld, 9eky, 9edb, 9egw, 9elb, (9eak), (9eea), (9eht), (9yau), 9xax, 9ccs.
Can.: (4dq), (5cn).

By 6CLB, 5643 Shafter Ave., Oakland, Calif.

1aur, 4gz, 4my, 5bz, 5cv, 5eh, 5gm, 5lg, 5mi, 5na, 5nw, 5ov, 5ph, 5rv, 5tj, 5vo, (5adb), 5aiu, 5ajb, 5akn, 5xd, 5xaw, 5za, 5zav, 7ak, 7bj, 7cr, (7em), 7fa, 7fd, 7fr, 7fs, 7ft, 7gi, (7gq), 7hc, 7ho, 7io, (7iw), 7kr, 7kv, 7nt, 7ob, 7pf, 7pz, 7qd, 7qv, 7ra, 7ry, 7sh, (7to), 7vn, 7wa, 7acf, 7aci, 7acx, 7adg, 7ads, 7ael, 7afo, 7ahn, 7aim, 7aiv, 7akh, (7akk), 7xaf, 7zu, (7zw), 8abm, 8awj, 9afm, 9ahz, 9amb, 9apf, 9avt, 9ayj, 9azg, 9bcb, 9bfp, 9bhq, 9bly, 9bmx, 9bof, 9bpv, 9bre, 9brs, 9bso, 9bsp, 9bto, 9bun, 9bxq, 9byc, 9bzi, 9caa, 9cga, (9chc), 9cht, 9cim, 9cjc, 9czm, 9cdw, 9dfh, 9dkq, (9dxk), 9dxn, 9dxu, 9dyr, 9eak, 9efh, 9eld, 9yau. Can. : 4dq, 9bx. Would appreciate reports on my 10 watter.

By Earl Barnett, 3024-44th St., Sacramento, Calif. Radio 6CDC

4ai, 4cs, 4ik, (4my), 4pk, (4xc), (5aiv), 5cv, 5ft, 5lr, 5na, 5ql, 5rv, 5rg, 5rf, 5tj, 5xd, (5zav), 5zb, (6ceu), (7ael), (7afu), (7ajq), (7ajv), (7ali), (7av), (7ax), (7co), (7cr), (7fq), (7fs), (7ft), (gi), (7gr), (7no), (7sh), (7sz), (7zb), (8alm), 8agp, 8bfh, 8dae, 8er, 8hv, 8jy, 8vq, 8vy, 8yx, 9aau, 9abc, 9aev, 9ahz, 9aif, 9aii, 9aim, 9ami, (9amp), 9apf, 9aqc, 9atn, 9ava, 9avn, 9axx, (9beu), 9bed, (9bzq), (9caa), 9ccs, 9ceh, 9cic, (9cjy), 9cka, 9ckj, (9cld), 9cmk, 9ctg, cvo, 9cyw, (9daw), (9dbf), 9dfh, 9dhg, 9dkq, 9dly, 9dmj, 9dmz, 9dpr, 9dro, (9dsw), 9dwn, 9dyr, 9eak, 9ekt, 9eky, 9mc, (9ql), 9qz, 9rc, 9ry.
Can.: 4cb, 4dq, (5ak), 5cq.

By 6BSJ, 414 Church St., Salinas, Calif.

1bdg, 1yb, 2cju, 3gg, 3lg, 3ir. 3oi, 4az, 4eq, 4er, 4ft, 4ik, 4za, 5aar, 5ak, 5abw, 5adb, 5ado, 5aib, 5aic, 5agh, 5ajt, 5alr, 5amu, 5ct, 5dc, 5ek, 5gj, 5jb, 5jl, 5lr, 5mi, 5ml, 5mo, 5na, 5ra, 5ro, 5rv, 5sd, 5vm, 5xd, vm, 5zai, Qra?, 5zav, 8ack, 8aih, 8alx, 8arv, 8atc, 8axt, 8bbf, 8brm, 8byf, 8bzy, 8cfq, 8cmu, 8cmy, 8cpd, 8cwr, 8czz, 8dbm, 8djd, 8er, 8fc, 8fm, 8fu, 8jy, 8rn, 8nz, 8yn, 6's es 7's too numerous, 9agb, 9aim, 9ake, 9ami, 9aol, 9aom, 9aor, 9avn, 9awh, 9aza, 9bab, 9bal, 9bav, 9bcx, 9bec, 9bed, 9bez, 9bfi, 9bfp, 9big, 9bis, 9bk, 9bom, 9boo, 9bqv, 9brk, 9bsp, 9bth, 9btm, 9bmx, 9byc, 9caa, 9cez, 9cjc, 9cjm, 9cjt, 9cka, 9cow, 9cpu, 9cr, 9crr, 9ctl, 9cvs, 9cwj, 9czq, 9ddp, 9dgi, 9dgv, 9dhw, 9dll, 9doc, 9dro, 9dsw, 9dte, 9dtj, 9dui, 9dun, 9dvw, 9dwn, 9dxu, 9dxy, 9dzf, 9eak, 9ecv, 9edb, 9eky, 9fm, 9gz, 9ih, 9mf, 9qr, 9yam,
Can.: 4aw, 4co, 4dq, 5ak, 5ct, 5bw, 9bks(?).
ICW: 5vo, 9dky, 9rc.
Fone: 9drb, 9xm.

By 6ARB, C. E. Duncan, 3029 Acton St., Berkeley, Calif.

1fd, 1jv, (1sw), 1yw, 1xw, 1xz, 1aer, (1avj), 1bbu, (1boa), 1xak, 1xas, 2bg, 2bj, 2gk, 2ayv, (2brb), 2xab, (2xna), (3bb), 3mb, 3me, 3te, 3yo, 3zl, 3ckj, 4by, 4bz, 4cn, 4hi, (4io), 4ll, 4oa, 4yo, (4xc), 4xe, (5ac), 5dw, 5nn, 5ny, 5ph, 5ql, (5qy), (5tj), 5xd, 5aar, 5aaw, 5aiu, 5amb, (6ceu), (7bj), (8pl), (8ada), 8alf, 8arv, (8boe), 8ckv, (8crv), 8ctp, 8xbh, 8xbq, 8xbp, 9mc, 9rc, 9vm, (9yy), (9aau), 9ais, (9amb), 9ape, 9aqc, (9azg), 9bab, 9bed, (9cgu), 9chc, 9cjc, 9clz, (9cmk), 9cxp, (9dai), 9ddp, 9dfq, 9dkb, 9dro, (9eea), (9eky), (9eld), (9xax).
Canadian: 3bq, (3ni), 4cb, (4cr), 4dq, 4hh, (5hk), 9al, and (pm) (?)
All districts worked in one morning using a 50 watter, 250 watter now, glad to qsl, to any of above.

At 5QP, 410 Reynolds Street, Gadsden, Alabama.

CW. 1afe, 2by, 3bha, 3mo, 4ai, 4fz, 4io, 4it, 4jr, 4ll, (4mi), 4my, 4og, 5agj, 5aiu, 5bp, 5cm, 5ek, 5he, 5jb, 5kq, 5lr, (5mi), 5mo, 5py, 5qf, 5ql, 5qy, 5ro, 5ut, (5vc), (5vv), 5za, 5zav, 6gu, 6fp, 8ago, (8alw), (8anb), 8apn, 8apt, (8atc), 8bmh, 8bx, 8com, 8cvb, 8dcx, 8dx, 8jj, 8nb, 8zw, 9aau, 9aex, 9aps, 9arr, (9aru), 9atc, 9bhi, 9bof, (9bcb), (9bcx), (9cvo), 9chn, 9dl, 9daj, 9dhk, 9dhn, 9dnu, 9dwx, (9dyy), 9eky, 9fn, 9gp, 9mx. Spk: 8ve, 8xe. ICW: 8vq. Fone: 9cfn. Pse qsl crd if u hr my 15 watt ACCW. All crds answered.

By 6BBW, 234 No. Painter Ave., Whittier, Calif.

(1are), 1aur, 1bcr, 1bgq, (1bvl), 1fs, 1jv, 1xak, 2atz, 2axf, (2bbn), 2el, (2wr), 2xna, 3bgj, (3me), (3qv), 3xn, 4ba, 4db, 4dv, 4fs, 4iz, 4rr, 4xr, 4xw, 5aaq, (5aaw), (5abn), 5ags, 5ahd, (5ajb), 5ajt, 5amo, 5dm, (5jb), 5na, (5nw), (5ph), 5rc, 5rv, 5ut, (5xau), 5xaw, 5xd, 5zav, (6atz), (6bou), (6bqb), (6clb), (6cmi), 7adg, (7afo), (7akh), (7ald), 7fr, (7gr), 8aip, 8apt, 8azg, 8bkn, 8bvy, 8bwb, 8cwr, 8cxm, 8dhq, 8fm, 8kc, (8vy), 8xs, (9abf), (9acx), 9agl, (9ato), (9aus), 9ayj, (9bab), 9bdj, 9bhy, (9bis), 9brk, 9bsp, (9bvn), (9bwp), 9bxa, 9bze, (9cfx), 9cmk, (9cpu), 9cyb, (9dap), (9dbh), 9dds, 9dpx, (9dr), 9efh, 9ehq, (9elz), (9eq), 9ry, (9yau).
Canadian: 1aa, 4cn, 4cr, 4hh.
Mexican: (bx).
Wl qsl crds to above if requested. All repts on mi sigs appreciated es qsl'd.

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9—Six testing machines
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