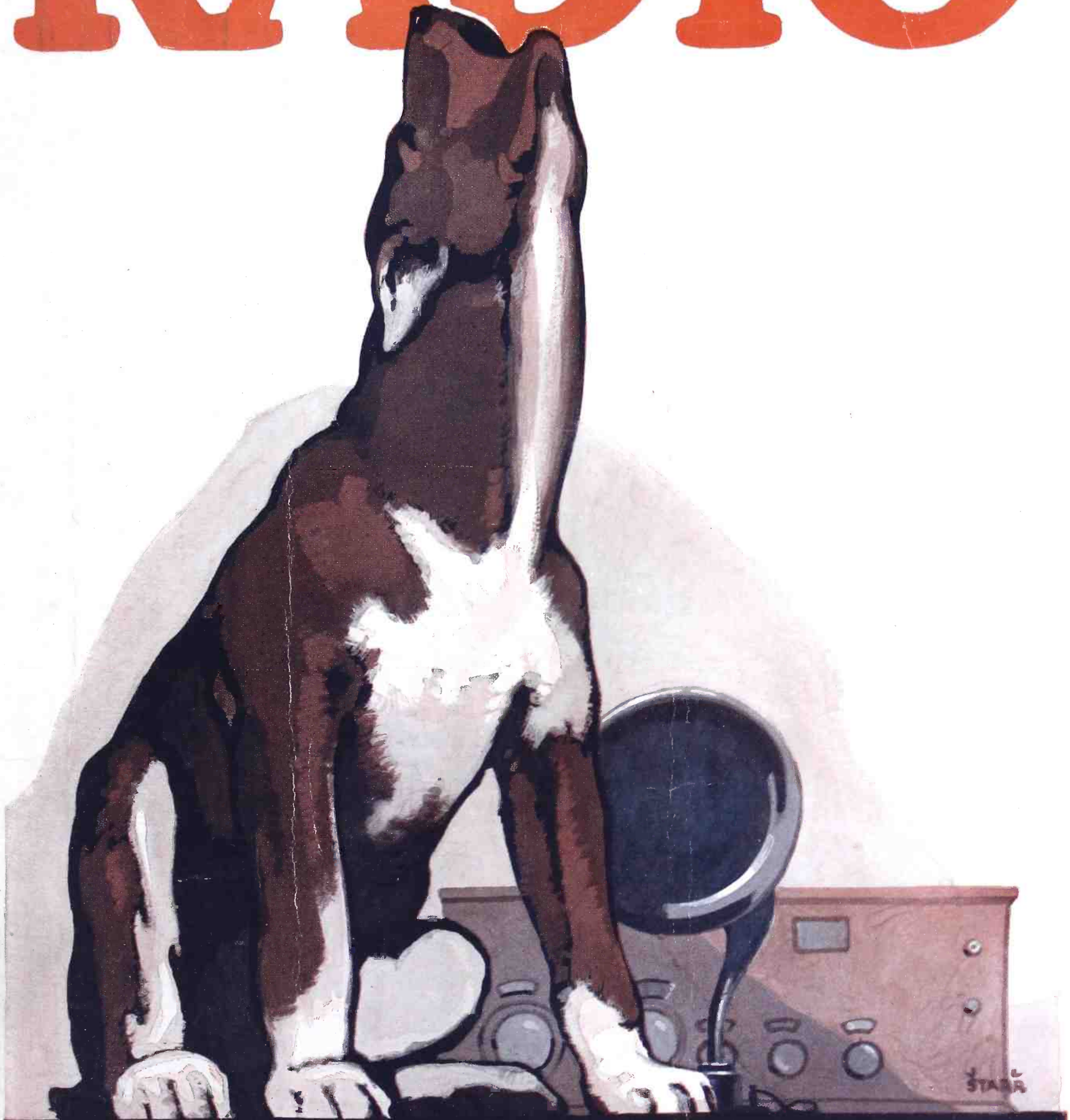
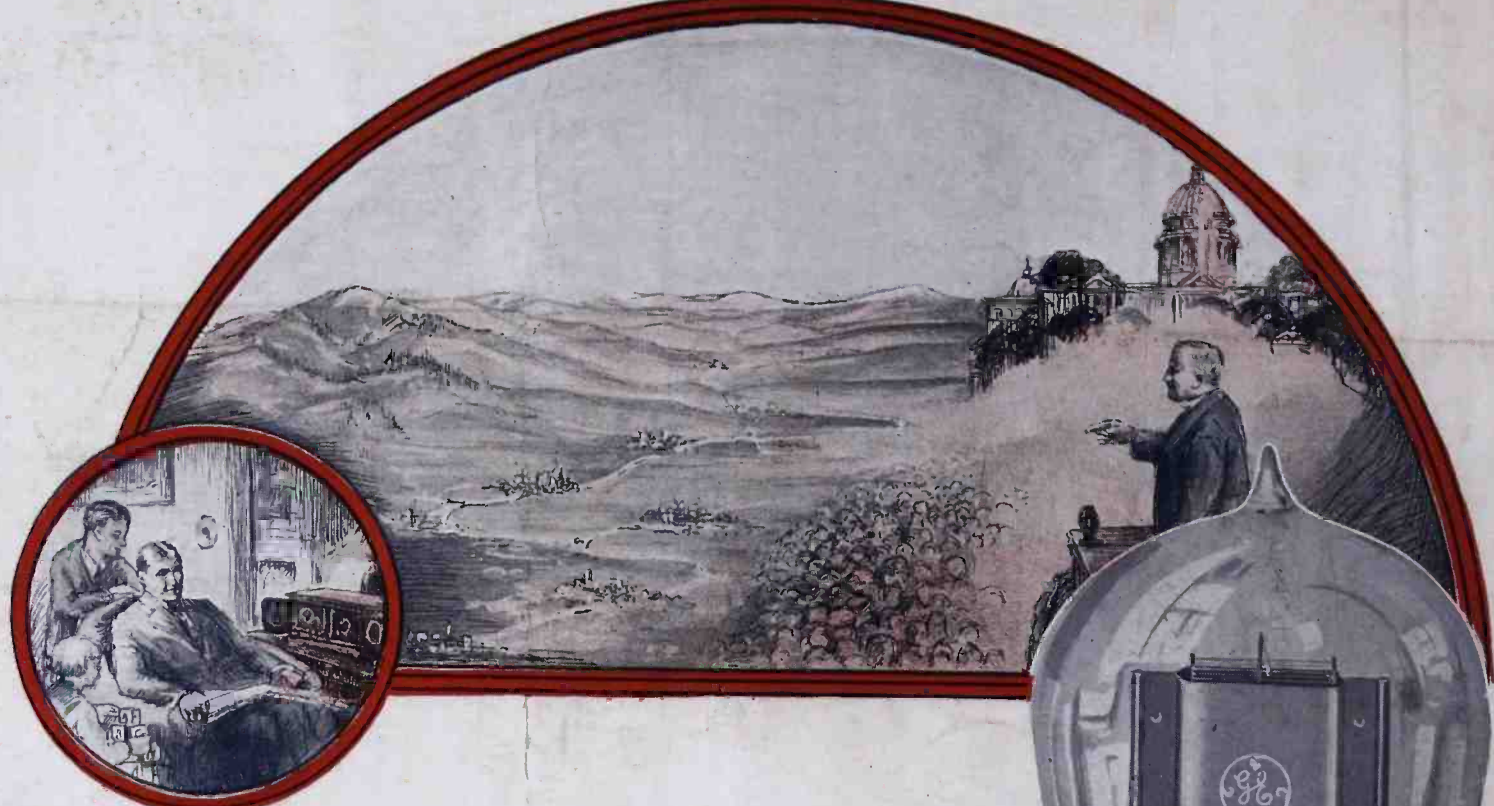
SEPTEMBER 1923 25 Cents

RADIO



IN THIS ISSUE:

Designing a "DX" Receiver -- The Beverage Antenna
Wavemeter Construction -- A 200 Watt Transmitter



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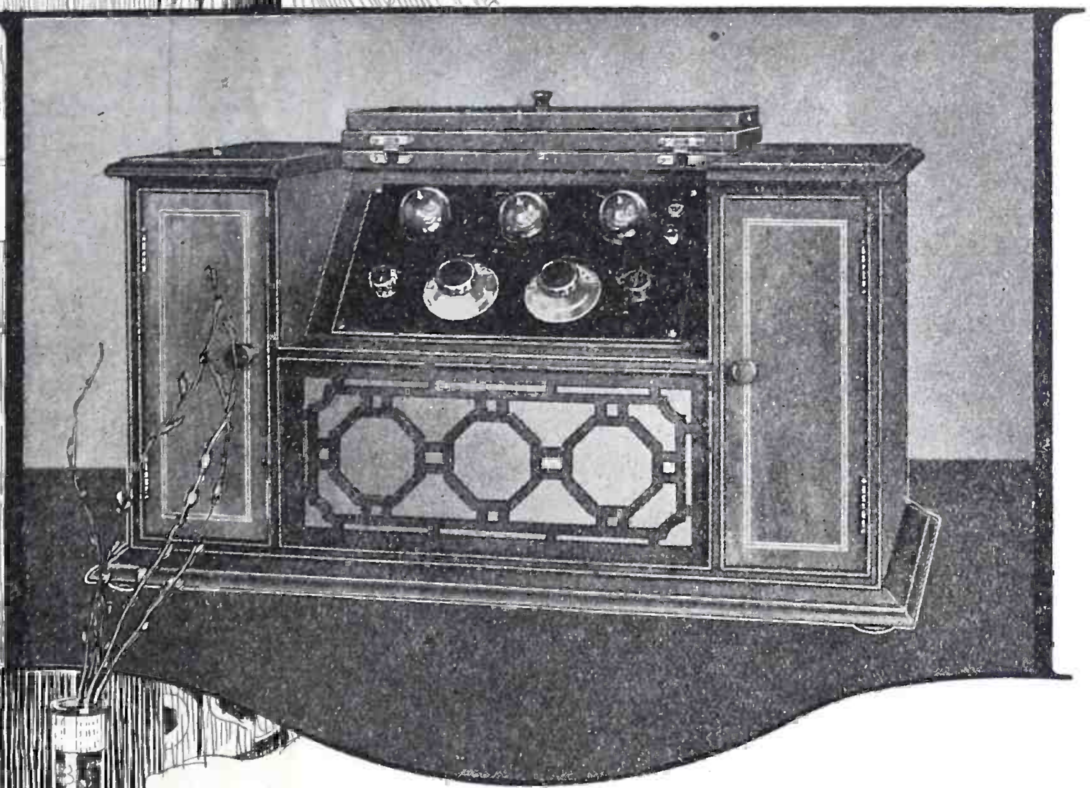

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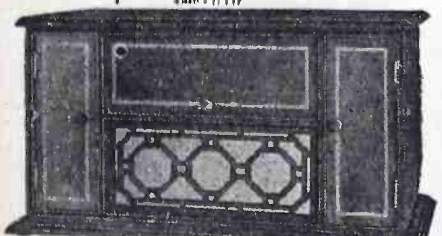

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All Kennedy radio receiving sets are regenerative—licensed under Armstrong U. S. patent No. 1,113,149.

RADIO

Established 1917 as Pacific Radio News

Volume V *for* SEPTEMBER, 1923 *Number 9*

CONTENTS *for* SEPTEMBER, 1923

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Entered as second-class matter at the Post Office at San Francisco, Calif., under the Act of March 3, 1879.

Forecast of Contributions for October Issue

Lloyd Jacquet, 2OZ, has a real article on "The Four-Circuit Tuner," which in itself is well worth the price of the October number.

The transmitting amateur will be interested in and helped by Dr. A. E. Banks' account of a "Puncture-Proof C. W. Power Condenser of High Capacity." Of like interest is L. R. Felder's suggestions for measuring transformer losses with a thermometer and watch.

D. B. McGown continues his series on the design of radio apparatus with careful guidance in the design of a tube transmitter. He also starts a new series on Radio Shop Practice, which, together with an article on the same subject by Raymond Francis Yates, will materially assist the amateur builder.

Edward T. Jones tells how to make a universal receiving set which uses either single or triple-circuit control at the will of the operator.

Jesse Marsten, in an article on "The Design and Function of Inductance Coils," starts a new series on modern radio apparatus, each of which will give a complete treatment of one of the essential parts of a receiver and transmitter.

In an "Efficient Groundless Receiver" Frederick J. Rumford tells of some interesting tests of reception without a ground and gives the hook-up that worked best.

Victor A. Ulrich tells how he greatly increases the volume from a single-circuit set by merely putting a variometer across the antenna and ground lead. Paul Oard also gives some valuable hints for improving the single circuit.

Commercial operators, actual and prospective, will be interested in B. W. Fordham's account of "Radio the Conjuror." It has the true flavor of salt water.

Carl Penther has devised a clever master control switch whose published details and assembly will enable anyone to secure automatic filament control.

Samuel G. McMeen's contribution to October RADIO is "Improving Amplification," especially by the use of the "push-pull" circuit.

The above, together with a number of articles which were crowded out of the September number due to lack of space, and the usual departments and news, will give a well-balanced issue containing material of value to every one interested in radio.


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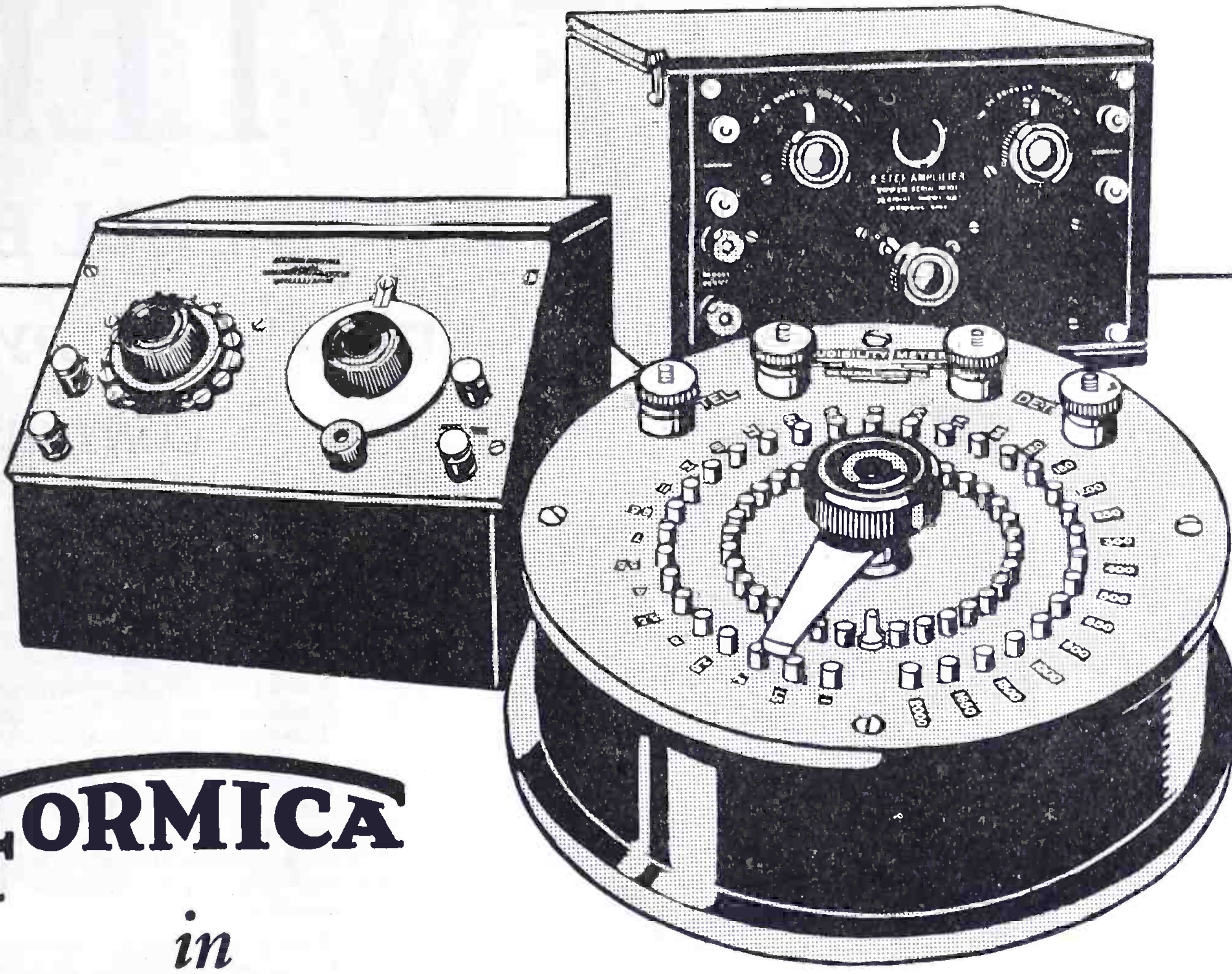

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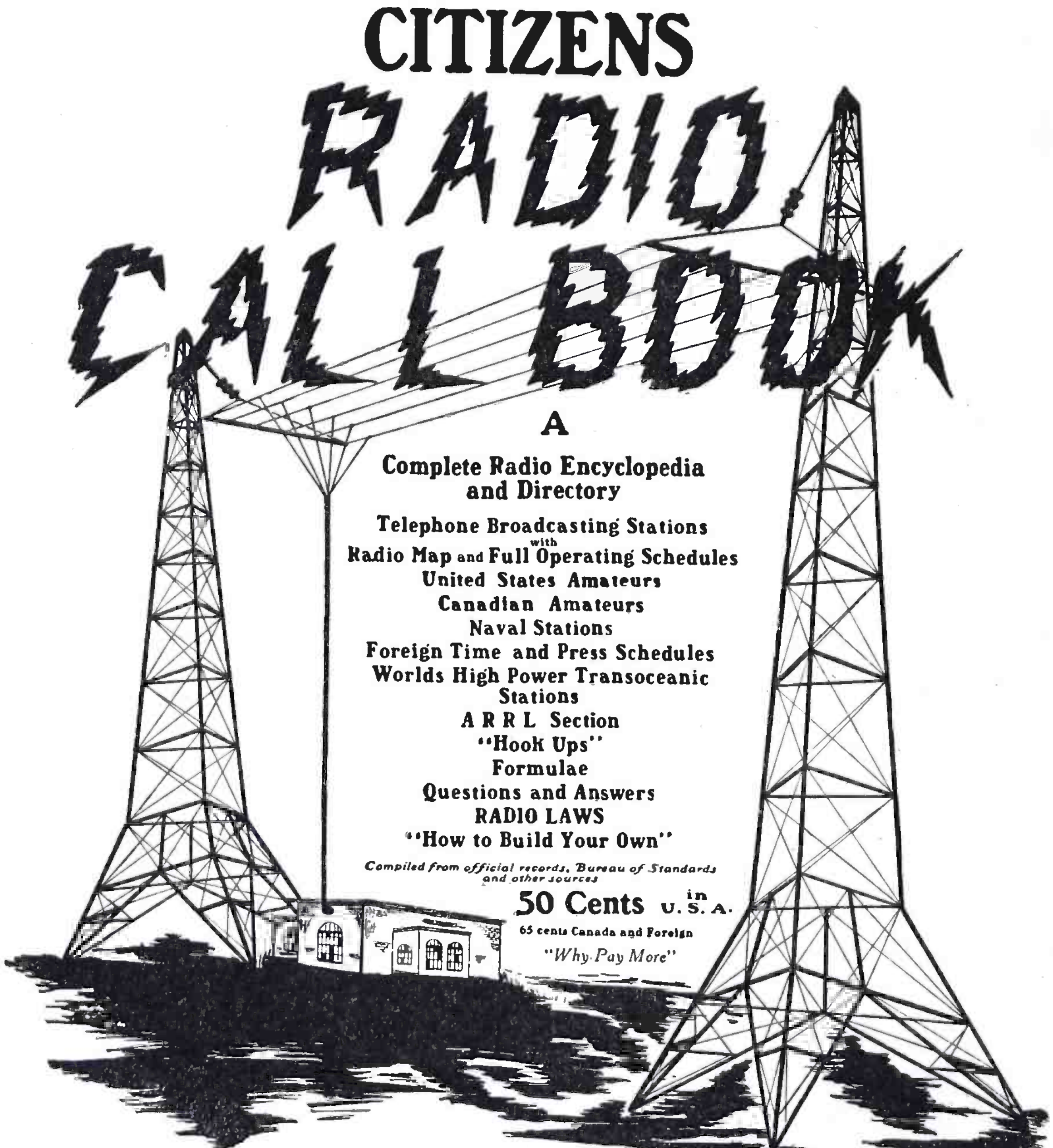

CONTENTS

The Nine Amateur Districts, Special Amateur and Experimental Stations. All practical wireless circuits. Schematic diagrams of these and a glossary or description of the working of the circuits. There are also full page graphic illustrations and photographs of the Flewelling circuit, the Reinartz and Armstrong double regenerative circuits.

A complete list of all Telephone Broadcasting Stations with their full operating schedules. These are also listed alphabetically by States. A complete 4 page American Radio Relay League section, containing a letter to the Citizen-Radio, by Mr. Kenneth B. Warner. A double page A. R. R. L. divisional map. A page giving the personnel of the Executive and Operation Divisions throughout the country.

A complete list of all Canadian Amateurs and Canadian Telephone Broadcasting Stations with their schedules.

A double page Radiophone Map of the United States, with all stations marked on the map, drawn to scale.

A double page map of the world, with all high powered stations marked. A Complete Schedule over 24 hours' time (Greenwich) of all high power stations, time they send, system they employ, wave length and character of the matter they send.

A Complete Federal Market Broadcasting schedule, by state, town and information on matter they broadcast.

International Continental Code and Conventional "Q" Signals.

Trap Circuits.

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The Circuit section contains both Receiving and Transmitting diagrams. The Transmitting end of this covers the best of the Amateur hook-ups on short wave transmission, C. W., I.C.W., and Voice.

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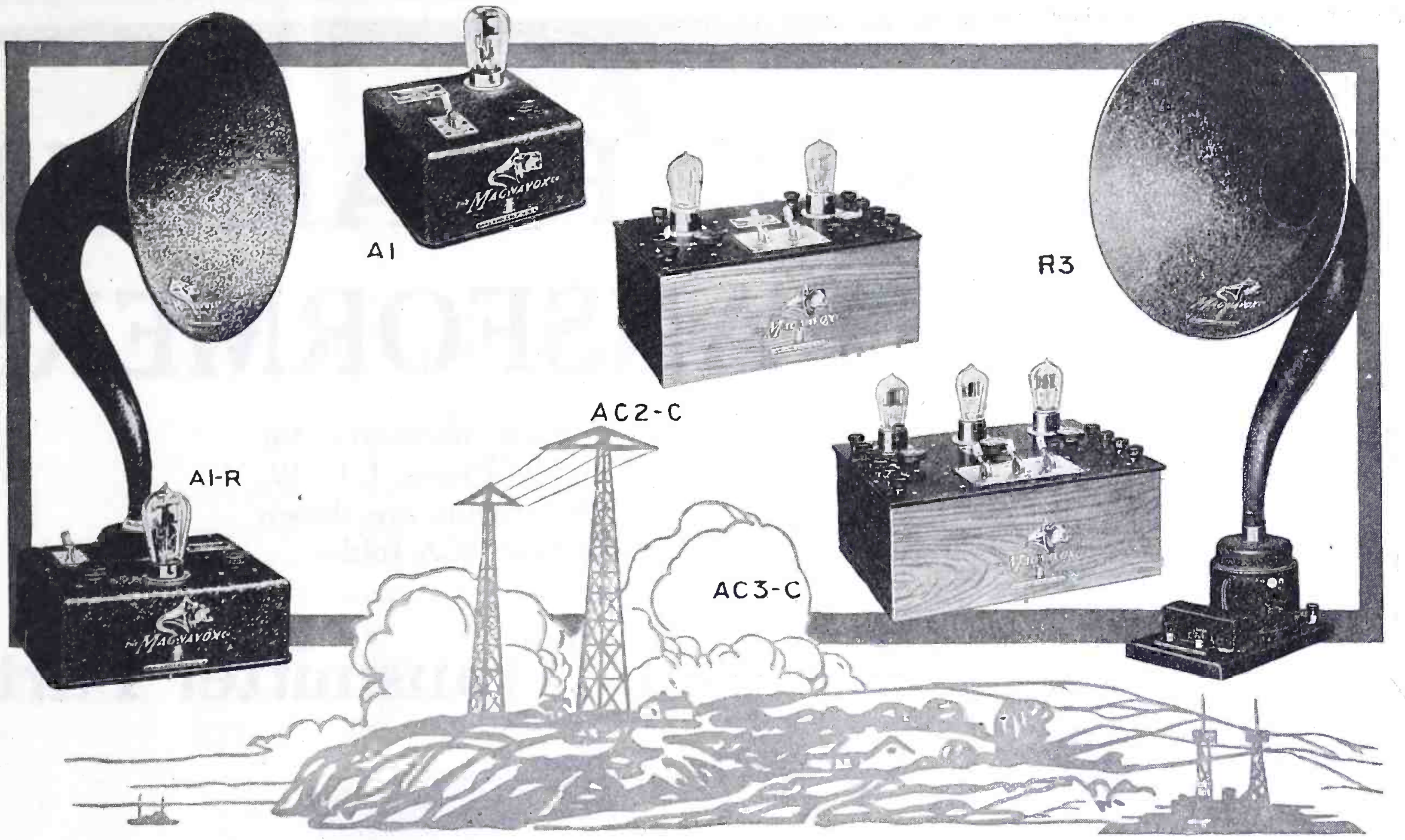

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THE new Magnavox models here shown extend and supplement the already famous Magnavox line of Reproducers and Power Amplifiers. There is a Magnavox for every receiving set.

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Magnavox Reproducers and Amplifiers

Sept. 1923

RADIO

Established 1917

Vol. 5, No. 9

Radiotorial Comment

AN interesting comment on the changes that radio has caused in the habits of the American people may be gleaned from the report of the Rate Research Committee of the National Electric Light Association. This committee ascribes to radio listening an increased use of electric current for lighting the home. They find that not only does Mr. Average Householder stay at home to hear the radio, but also that he stays up later than was his wont. This report may give additional incentive for power company experiments on broadcasting concerts over their lines by "wired wireless."

THE suit brought against radio station WOR at Newark, N. J., by the American Society of Composers, Authors and Publishers for broadcasting copyrighted music brings to a head and possible judicial decision a question that has been agitating the broadcast world for many months. This is the first gun in a campaign whereby the Society plans to compel each of the broadcasters to pay a large annual license fee for the privilege of broadcasting music whose title is vested in the Society. This includes nearly ninety per cent of the popular music of the day.

Most of the broadcasters contend that as they are not broadcasting for direct profit they are not infringing upon the copyright. They believe that the requested fees are exorbitant and add an impossible burden to the present high cost of putting out programs. Furthermore they know that broadcasting is the most effective means yet found for quickly popularizing new music and they feel that they might better be paid rather than charged for the service they are rendering the Society's members.

Foreseeing a probable delay in deciding the question and realizing the tremendous power of broadcasting, a number of stations have organized the National Association of Broadcasters. This association will assist in the proposed revision of the copyright law and encourage constructive legislation helpful to broadcasting. It has established a music bureau in charge of a competent musical critic who has already passed upon hundreds of musical compositions whose copyright title is vested in the Association. From this source the broadcasters are assured a continuous supply of copyrighted popular music of superior quality without payment of license or legal embarrassment.

This is neither the time nor place for us to air our views as to which side may be right in the controversy. Suffice it to say that our sympathies are with the broadcasters' association. They seem to have taken a sensible stand in fighting fire with fire.

WHEN the Einstein theory states that the ether is no longer a tenable hypothesis for explaining the nature and action of electromagnetic waves, and consequently of radio, it is like taking away a crutch from our halting imagination. The controversy is still raging too fiercely between eminent scientists for any mere layman to say which side is in the right, but the preponderance of recent evidence would seem to favor the Einstein camp. Therefore it is of interest and value to the inquiring amateur to know what relativity substitutes for the discredited ether.

For the ether has been discredited by the theory of relativity. Not that the theory has definitely and finally disproved the existence of the ether, but merely that Einstein finds the ether unnecessary to explain many things which heretofore could be explained only by its aid. And the Einstein explanations are perhaps more logical and more acceptable than the ether explanations. So, while the crutch may still be kept around the house in some obscure corner, the patient—and he indeed must be patient who would understand this theory—can get along all right without using the crutch.

Perhaps one of the simplest expositions of this complex subject has been given by Charles P. Steinmetz, who is an ardent advocate of relativity. He points out that the radio wave is not a wave *motion* in a material medium but is a periodic alternation of an electromagnetic energy field which travels through space at a speed of 186,000 miles per second. He makes clear the fact that the picture of a wireless wave as resembling a water wave is erroneous in that electromagnetic energy may alternate in intensity and direction without the necessity of the movement of matter or anything resembling it.

This conception of a field of energy is very like the field of force whereby Faraday originally explained the action of a magnet on an iron bar. It holds fast to the wave theory of light and radiation. It eliminates the necessity of accepting the contradictions involved in the ether theory and in its place gives a logical explanation of the forces of nature.

The general acceptance of this theory will require the revision of almost all the books and treatises on radio. It does not alter in any way the practical operation of a radio set. But to the thoughtful student it gives an understanding of many hitherto inexplicable natural phenomena. For this reason it is worth careful study and consideration. If there is sufficient demand on the part of our readers for a simple explanation of the entire theory and its deductions the editor will undertake the task in a future issue.

Navy Experiments on Static Reduction

By S. R. Winters

These experiments suggest a possible means whereby amateurs may likewise reduce static interference. Facts of general interest about the Navy monitor control system are also given.

RADIO Central of the Office of Communications, United States Navy Department, claims to have devised a system whereby static is reduced to a minimum. This is accomplished by the combination of a loop and a one-wire aerial, together with a barrage receiver.

On the roof of the Navy Department building is an 8-ft. loop from which extends a 75-ft. one-wire aerial. This aerial and loop are connected to a radio-telegraph barrage receiving set immediately below the loop. Leads are carried 300 ft. from this receiver to a jack-box in the telegraph operators' room where the messages are transcribed.

It is found that by an adjustment of the loop and short aerial the opposing forces of the two tend to neutralize static. The loop antennae on the roof may be controlled by means of a shaft extending therefrom to the operators' room, thus taking advantage of the marked directional characteristics of this form of antenna.

Static interference may be still further reduced by the new clarophone, the queer instrument looking like an airplane motor in the rear of the picture. This is a large cylinder with eight projecting tubes through which the *sound* of the signals is carried to four phones in the interior, where the sounds are filtered or clarified and then amplified. This is the invention of Wm. J. Scott, electrician U.S.N.

In one corner of the room are also three 2-ft. loops connected to receiving circuits so as to pick up the signals being transmitted, thus enabling each transmitting operator to determine whether his signals are audible. In other words, the radio operator checks up his own traffic with respect to the clearness of the signals he is transmitting for reception at some distant receiving station.

The control station is supervised by J. J. Delany, chief gunner radio, U.S.N., who is assisted by a crew of eight radio-telegraph operators working in eight-hour shifts. By means of remote-control, radio communications are transmitted from Annapolis or Greenbury Point, Maryland; Arlington or Radio, Virginia, and Sayville, Long Island, New York. Radio communications are both transmitted and received from Lyons, France; Balboa, Panama Canal Zone; San Juan, Porto Rico; San Diego and San Francisco, California. Additional broadcasting services are rendered for the benefit of vessels cruising in the waters in proximity to Turkey and London, as well as to a fleet of ships in the Atlantic ocean.

There are ten receiving instruments in the control station number, six for reception of trans-oceanic wireless signals and four for the reception of radio messages from coastal stations within the United States. Signals have been heard from Cairo, Egypt, and ships near Constantinople.

Radio Central of the Office of Communications, U.S.N. at Washington, D. C., Showing the New Clarophone in the Rear

AN EASY METHOD FOR MEASURING POWER

By CHARLES F. FILSTEAD

An inexpensive substitute for the wattmeter necessary for indicating the power consumed by an electrical device is found in the watthour meter installed by the power company in every electrically equipped home. The only essential is that it be of the type which has a rotating disc exposed to view.

Such a meter may be calibrated with a watch and a known load by noting how many seconds it takes the disc to make one revolution, as indicated by the black mark on its edge. Make sure that all current consuming devices in the house are shut off and that the disc is stationary. Then turn on a single lamp of known wattage and make three tests of the time required for the disc to revolve once, averaging the readings.

Now turn off the lamp, connect the device whose current consumption is desired to be known, and note the number of seconds required for the disc to make one revolution, averaging several readings.

Let S_1 be the average number of seconds required for one revolution of the disc, W_1 the lamp rating in watts, S the number of seconds required for one complete revolution of the disc with the unknown instrument connected in, and W the watts consumed by the instrument. W is found by the inverse proportion, $S : S_1 = W_1 : W$, and simplified: $W = \frac{W_1 S_1}{S}$ = watts consumed by the unknown load. While this method is a little longer than when using a standard wattmeter, it, at least, is *considerably* cheaper.

As an example, what is the power consumption of a rectifier which causes one revolution of the disc in 8 seconds when a 40-watt lamp causes one revolution in 41 seconds? Substituting in the formula we have $W = 40 \times 41/8 = 205$ watts.

Designing a Long Distance Receiver

By E. M. Sargent

After briefly analyzing the importance of coil design, the author presents a hook-up for a set which is at once selective and sensitive. Directions are given for winding an efficient basket weave coil.

THE design of a good long distance receiving set for use on short wavelengths is one of the most difficult problems with which the radio engineer is confronted. A good receiving set should be capable of receiving signals clearly over long distances, should be extremely selective so as to eliminate local signals when those from a distance are being received, and should be fairly simple to operate. There are many different types of long distance receivers, some employing honeycomb coils, some variometers, some variocouplers, and others employing various combinations of these instruments. It is not the purpose of this article to analyze any of these sets, but rather by proper design to construct one that will come as near the ideal set as possible.

The coils in a receiving set are one of the most important parts. Upon the coil design may depend the success or failure of the whole set. The coils should be as large as possible in order to give the set a wide wavelength range. At the same time they must not be so large that they will have a natural wavelength of their own inside of the wavelength range of the set. They should be wound with large enough wire to keep the resistance low. The available space which the coil may occupy is usually limited, and therefore the size of the wire must be kept small enough so that the proper number of turns can be put in this space.

The natural wavelength of any coil is determined by the inductance and the distributed capacity of the coil. The object is usually to have a high inductance. Therefore, the distributed capacity must be very low in order to keep down the natural wavelength. This capacity depends on the size of the wire, diameter of the coil, the closeness of the turns, and the length of the coil. Increasing the first three factors tends to increase the coil capacity. Increasing the number of turns decreases it to a very slight degree.

Fig. 1 shows the wiring diagram for the set. The hook-up is of the two-circuit type and is regenerative. In this circuit the primary coil should have a very low resistance. It is a distinct advantage and makes for sharp tuning and loud signals to use a low resistance and inductance in this place, and use as large a series condensers as possible.

The secondary coil must have a high inductance—the higher the better. The vacuum tube is a "voltage operated" device. The grid voltage depends directly on value of the secondary inductance, and also on the current flowing through the primary. The current flowing in the secondary is a matter of lesser importance, and the resistance of this coil does not play such an important part. The coupling between the primary and secondary should be loose enough so that only the desired signal will be transferred from one circuit to the other. The value of this coupling is not at all critical, and therefore the coupling need not be variable.

Regeneration is accomplished by means of a plate variometer. This variometer is preferably of the wooden rather than the moulded type, and should be of a good grade. When regeneration is accomplished with a plate variometer instead of a tickler coil, the tube oscillations can be controlled without appreciably affecting the tuning of the set. When the tickler coil is used, variation of the tickler coupling changes the secondary inductance so that it is necessary to re-adjust the secondary condenser every time the tickler is moved. This complicates the tuning considerably. A plate variometer does away with this sort of trouble.

Sensitive regenerative sets are often affected by what is called "body capacity." When the hand is on the condenser dial the set will have one wavelength. When the hand is withdrawn from the set there will be a slight change in the wavelength. This is a great annoyance when tuning in a long distance signal. Body capacity effects are sometimes eliminated by what is known as "shielding." A more efficient method is to design the circuit right in the first place so that shielding will not be necessary.

After testing nearly every known form of coil, the writer has found that "basket-weave" coils give the best all-around results in a receiving set. Fig. 2 shows the form on which the coils are wound. For the set described in this article, use the dimensions shown in this sketch. The bakelite tube is divided around the circumference into 22 equal divisions. Eleven of these divisions are then cut out with a hacksaw. The edges of the eleven pins that remain should be trimmed with a file so that the wire will not catch when it is being

Continued on page 46

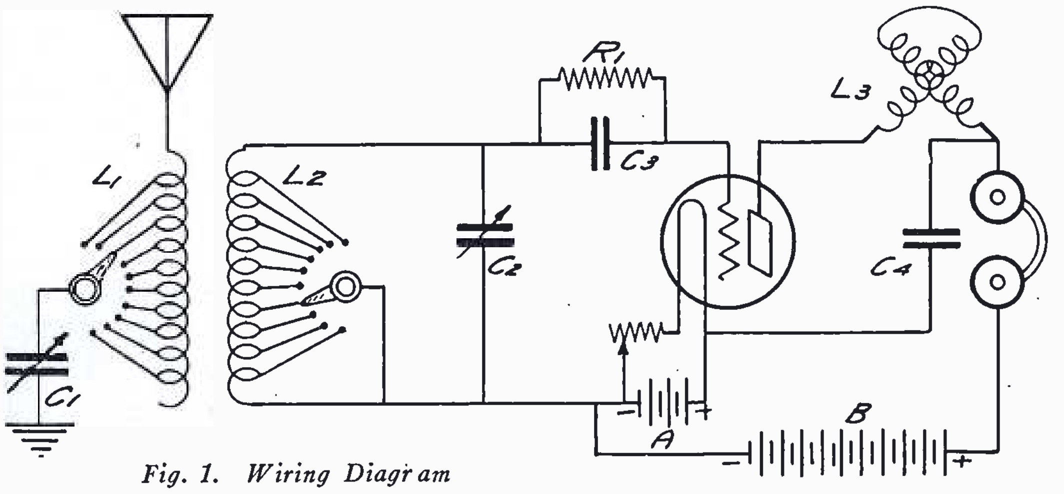


Fig. 1. Wiring Diagram

C_1—43 Plate Variable Condenser.
C_2—23 Plate Vernier Condenser
C_3—.00025 No. 600 Dubilier Condenser.
C_4—.001 Molded Fixt Condenser.
R_1—1 megohm Grid Leak.
L_1—Primary Coil—½ lb. No. 18DCC wire.
L_2—Secondary Coil—¼ lb. No. 28DCC wire.
L_3—Wooden Variometer, CYMO preferred.
1—Bakelite tube, 4¼" diam., 7½" long.
2—Tap Switches.
8—Switch Points.
1—Rheostat.
1—Socket.
1—C-300 Detector.
1—Formica Panel 3/16"x7"x20¾".

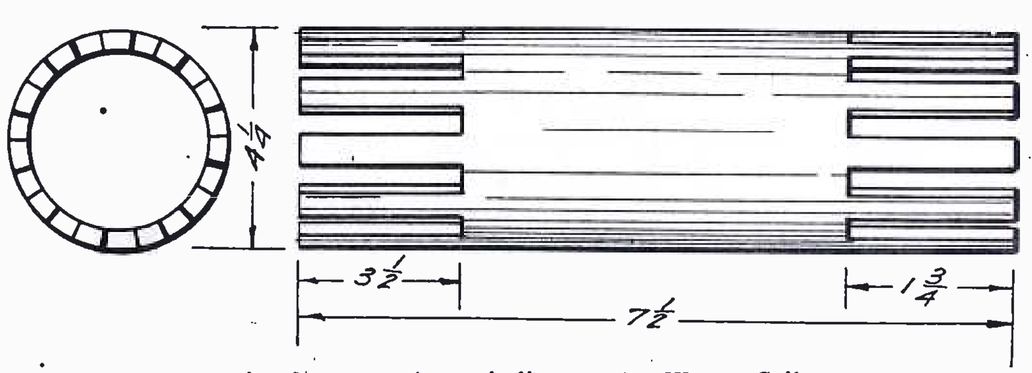


Fig. 2. Form for Winding Basket-Weave Coil

Music from the Parlor Table

By L. W. Van Slyck

While 'tis well known that with two stages each of radio and audio-frequency good dx reception can be secured with a loop, yet the author's account of what he is doing is interesting and suggestive. His hook-up and placement of parts is the result of experience from which others may well profit.

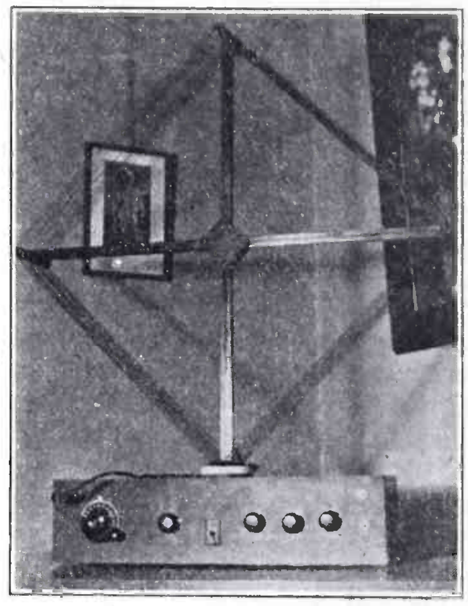
IT was the purpose, in building this receiver, to design an instrument in which signals would be loud enough for 'phone reception, which would be portable to a certain extent, and, most of all, an instrument which would furnish real music with little distortion. Results prove that expectations of the writer were exceeded in every way.

Fig. 1 shows the wiring and placement of the instruments. It is depicted in this manner because it is extremely important that the instruments be arranged in a certain order if best results are to be obtained. With the arrangement as shown, it is impossible to make the set howl in the manner so familiar to many owners of regenerative receivers. Capacity effects are not noticeable, except when the potentiometer is cut out of the circuit to such an extent as to bring the set on the verge of oscillation. This, however, is seldom necessary.

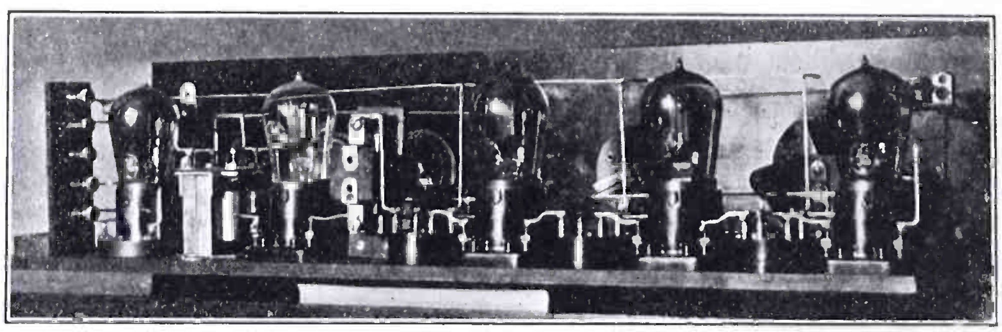
By placing the loop on top of the box, selectivity is greatly increased, probably due to the regenerative action between the wiring inside the cabinet and the loop wires. This, however, does not cause distortion in any way. It was also found that the filaments of the third amplifier tube and the detector tube could be burned at a considerably lower temperature than when the loop was isolated from the receiver proper, which again would indicate that regenerative action was brought into play when the loop was placed on top of the cabinet. Lowering the filament temperature and then advancing the potentiometer brings in the signals with the same strength, but as the resistance of the potentiometer approached zero, distortion creeps in. Considerable experimenting has been done to determine the correct placement of the instruments, and the writer wishes to again emphasize the importance of closely following the layout of Fig. 1. This receiver was wired six times before howling and distortion were finally eliminated.

Concerning distance, it is possible on any average winter night at Ironwood, Mich., to pick up such stations as Los Angeles, San Francisco, Havana, New York, etc., with sufficient intensity for enjoyment using the head phones. These results were obtained for the last two months using a 2-ft. loop. Using a small variocoupler for a loop antenna, and completely removing the loop from the box, Fort Worth has been copied on several occasions with satisfactory intensity. Stations within 500 miles can be depended upon practically any night except during a thunderstorm. There were stations in this vicinity using an outside antenna which, during some of these nights, were practically out of commission because the music was

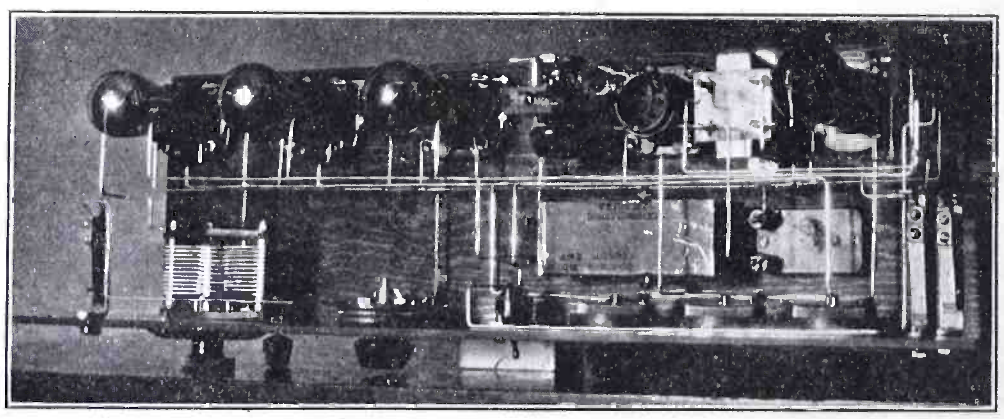
Continued on page 46



Complete Receiving Set with Loop on Parlor Table



Rear View of Set



Looking Down on Set

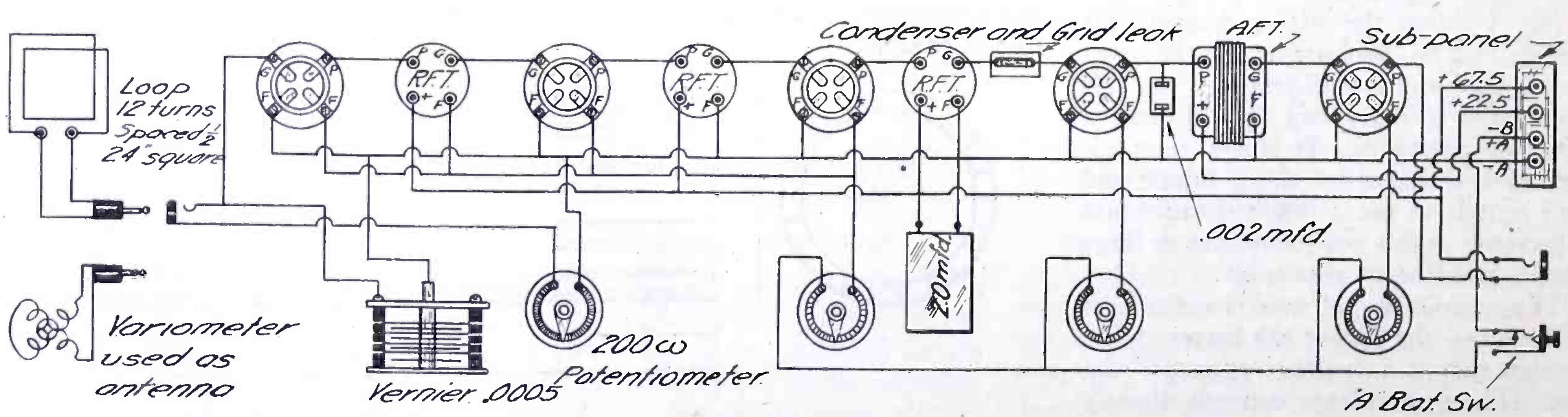


Fig. 1. The Hook-Up

A Two-Rotor Selective Receiver

By Samuel G. McMeen

Here is described a clever stunt for varying the coupling and thus the selectivity of a set. By following the text and diagrams it should be possible for any handy person to make an eminently satisfactory set for either broadcast or amateur wave reception.

IN the usual type of regenerative receiver there are adjustments for everything except the separation between the primary and secondary windings. Occasionally the curious experimenter has the desire to vary this separation, while retaining all the other advantages of that useful type of apparatus. In so desiring, the experimenter has sound logic behind him, for there is some advantage in being able to change the closeness of coupling and in turn the degree in which the set is selective. The closer the spacing between primary and secondary windings the greater is the influence of the former on the latter and the more the antenna is able to affect the tube. But this reacts against the ability to prevent the hearing of unwanted stations, which is all that is meant by the term "selectivity."

We address ourselves in this article to that type of receiver of the regenerative class in which there are three windings—a primary, a secondary and a tertiary or tickler. It is by means of the latter, set in close inductive relation to the secondary, that the regeneration is accomplished. The close inductive relation is accomplished by putting the tickler coil inside the secondary, and in a way so that it can rotate there. Because it is able to rotate, it is able to experience all shades of mutual inductance from maximum to minimum. The plan is so good a one for this purpose that it is a pity not to borrow it bodily for the desirable end of varying the mutual inductance between the primary and secondary windings for the purpose of varying, in turn, the selectivity.

So let us do so, and put another rotor in the arrangement, as shown in Fig. 1. In the practical working out of the device by the author the base of operations was made a 4-in. diameter tube, 6 in. long. In each end of this tube is fitted a rotor which clears the inside of the tube rather narrowly. For the reason that the plan shown in Fig. 1, and here described first, contemplates broadcast receiving only—or at least principally—the windings of these rotors are not tapped, but are of the usual type with but two ends brought out. Of course no tapping would be needed in the case of the tickler rotor in any case.

The stator winding on the tube is on No. 18 wire, and is of one layer of 80 turns, thus occupying 4 in. length of the tube. The shafts of the rotors are placed fairly close to the ends of the secondary winding, so as to have the coupling close at the maximum. The rotors have fifty turns of wire on each, the size depending on the width of the core, but No. 26 wire will do on most cores, one imagines. The writer used cores 1¼-in. wide, with a 3/16-in. spacing at the middle of the winding for the shaft.

The primary circuit includes only the rotor and a 23-plate condenser in series. The secondary circuit terminals are led to the grid and filament. The grid lead passes through a grid condenser of .00025 microfarads capacity, shunted by a 2-megohms leak. All the varieties of tubes may be accommodated if a variable grid leak is used, adjustable between the values ½ to 2 megohms. However, the 2 megohm fixed leak will serve in all but the very exceptional cases of stubborn tubes, and these are usually not new ones, one supposes.

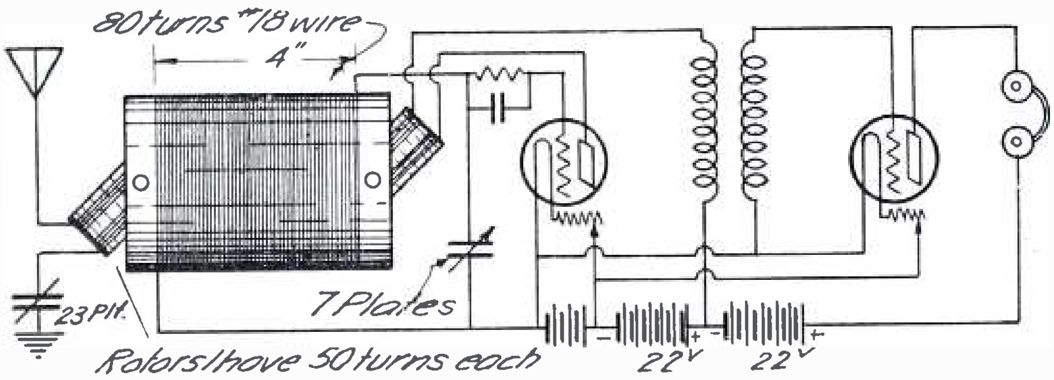


Fig. 1. Broadcast Receiver with Rotor-Primary

The condenser in the secondary circuit is a small one, preferably of but 7 plates, and it is bridged across the two terminals of the secondary coil. The use of so small a condenser makes the tuning more comfortable because of the wider band on the dial within which the desired wavelength may be picked up.

The arrangement of Fig. 1 includes one stage of audio-frequency amplification, and for that reason the plate circuit of the first tube contains the tickler or tertiary coil in series with the primary winding of the audio-frequency transformer. If the worker prefers to omit the amplifier stage and to be satisfied with the detector alone, then the telephones will go where the primary winding of the transformer appears in the figure. The telephone location, in other words, will be as shown in Fig 2, though other parts of that figure picture a different arrangement of coils.

The use of two 22-volt *B* batteries is required to get the best results, and the connections are so taken that the detector voltage is lower than that of the amplifier. The exact voltages required by the respective tubes will best be known from the statements of the tube makers, but will usually be considerably lower for the detector than the amplifier tube.

The use of a transmitting tube in the amplifier stage, as a substitute for a regular receiving amplifying tube, will give considerably louder reception, though it is not so well adapted, perhaps, to long distance working where the limits of the set are almost reached. By such use of a power tube, the arrangement here described will very amply actuate a loud speaker. This is a distinct advantage over the use of two or three stages of audio-frequency amplification for the purpose, because each stage of such amplification brings in its own degree of distortion, and even at two stages that distortion is noticeable and annoying. With the one stage it is hardly noticeable, if at all.

What has just been said about the gain by the use of a power tube shall not be construed to mean that an ordinary amplifier will not operate a loud speaker when used with this arrangement. It will, and very well. What we mean is that there is a gain in loudness by the use of the power tube.

In operation the primary rotor is set so as to have its plane at right angles to the axis of the tube—that is, with its turns parallel to those of the secondary—and if no interference is experienced it may be left so. But if interference *is* heard, then the rotor is to be turned toward a position with its turns at right angles to those of the secondary winding, and at some point the interference will be least.

The adjustability of the relation is complete, for at one critical point near or at the right-angle position all reception ceases, as at that position mutual inductance between primary and secondary coils is zero. It is in this particular that the ability to rotate rather than to slide the primary coil displays its virtue.

The only practical limitation of the set shown in Fig. 1 is its lack of responsiveness to wavelengths very far from the broadcasting range. As shown, its range is probably from 325 to 700 meters, and this is too high to enable one to hear the amateurs. This limitation can be removed by equipping both the primary and secondary windings with taps as shown in Fig. 2.

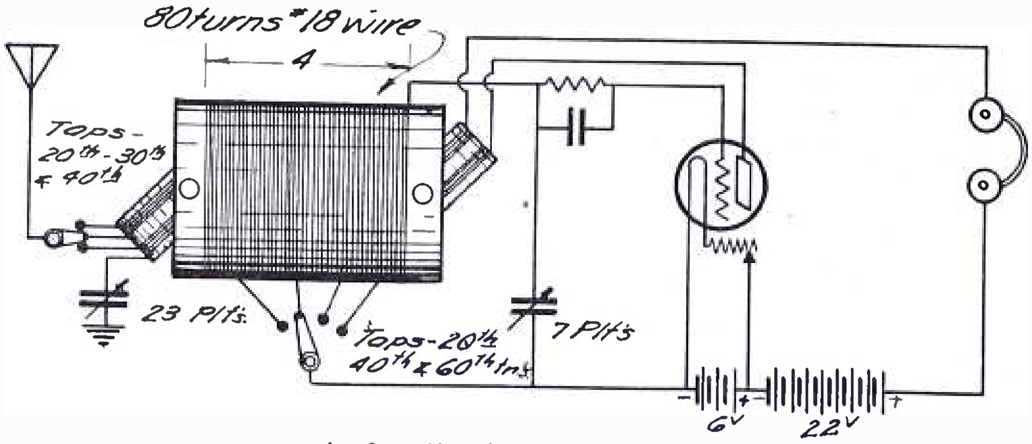


Fig. 2. 150 to 700 Meter Receiver

The taps on the secondary are simple enough. The coil being stationary, the taps may be brought out in the usual way. Even here, however, there is room for novelty, and the use of escutcheon pins in bakelite strips as terminal blocks will be found to add materially to the workmanlike arrangement of the parts. Such a terminal block is useful also on the rear end of the tapped-rotor shaft, to receive the four wires from the rotor and connect them to four tinsel cords leading to the switch. Tinsel cordage has greater flexibility than electric light cordage.

The circuit of Fig. 2 may be extended to include a stage of audio-frequency amplification if desired and in that case the connections for that tube will be the same as those shown following the detector tube in Fig. 1.

In the circuit of Fig. 1, wherein the whole secondary winding is used at all times, it is immaterial which end of that winding is carried to the grid. But in the case of the tapped type as shown in Fig. 2, there is the requirement that the grid terminal of the secondary coil be that from the end nearest to the primary rotor. This is for the reason that otherwise there would be, for all settings of the switch using less than the whole winding, excess space between the rotor and the secondary, this space being filled with useless and indeed harmful turns of the secondary. Therefore make sure that in this case the connections are as shown in the sketch.

The rotor leads to the switch can be readily brought out through the rear end of the shaft if the latter be made of tubing pierced at the side for the entrance of the leads into its bore. As the primary rotor that is so tapped requires but infrequent setting, and never turns more than a half-revolution, these leads do not absolutely have to be finished with flexible cordage, but may continue to the switch in the same size as the winding.

The set can be assembled quite compactly by placing the coil-tube horizontally, above the condensers, attaching the tube to the panel by means of small wooden blocks flat on the panel side and hollowed to fit the tube on the other. If a lathe is available such blocks can be hollowed readily by means of a wooden cylinder faced with garnet paper, the joint in the paper covering being cut on an angle.

For the panel the material most widely used is bakelite, but it is not unlawful to use hard rubber, and that substance has points to commend it for such a purpose. It takes a matt surface as readily as does bakelite, and is easier to drill without raising a burr around the larger holes. There is no tendency to flake off at the back of drilled holes. And it costs less than bakelite, while its insulating qualities are of the highest order.

For the cabinet one may use solid mahogany or other hard wood, but veneered panels of any of the hard woods may be had from dealers, with two advantages. One is low cost and the other is freedom from tendency to warp. The edges of such panels display the inner soft wood, so it it necessary to veneer them, but this can be done with more ease than the novice would suppose. If you attempt it, leave the slips of veneer a little wider than the thickness of the wood under treatment, and dress the edges down with a small plane when dry.

HOW I BECAME A SUCCESS

By A. CRYSTAL SET

LET me say at the outset that all books on "How to be Successful" are the bunk. This statement is made from personal experience. One can be a bank president by beginning as an office boy, working twenty hours a day, and *acting* honest. One may be President by splitting rails, studying law at nights, and *being* honest. But one cannot keep on being successful and *stay* honest. And that is no prophet's pipe dream.

Take my own case, for instance. When I was a little crystal set, my father said to me:

"Ta-dit—I want you to be successful. I want you to expand, and improve and develop yourself. I want you to be able to say that you have heard Europe, to move in the best society, to come in contact with stations of power and range. You must be somebody."

That was a big order for a little crystal set. My chest swelled with pride. My father was a big outfit in his day. He was all golden oak and sturdy knobs. His carborundum was of fine old stock, hard but sensitive to outside impressions. My mother, one of the Perikon sisters, was of finer caliber. She had come in contact with more of the world than had my father, and was more polished. Her brother Silicon was one of the most polished persons I think I have ever met.

So—they expected big things of me. I resolved that I would be a credit to my family—that the world would one day hear from me. The task, however, was monumental. There were not many openings in those days for a little crystal set. Business men, financier promoters—all refused to take me seriously, although one stock broker gambled heavily in my future, only to go broke when the public took him at his word and bought him out.

When I was twenty years of age, I was taken in a research laboratory and made much of. Those were long hard days. There were clinics in which I was dissected. Various professors tried their hands at trying to remodel me. I was put through paces that would have broken down a less rigorous constitution. Once, I recall Dr. de Forest visited the laboratory and I was shown to him as the most promising exhibit there.

"Yes—I know him," said Dr. de Forest. "I am his father."

I choked with indignation and would have burst into static comments and protestations had not my handler menaced me with a screwdriver. Later I heard that Dr. de Forest had claimed parentage of another child—little Audion, with whom I was to work in later years in reflex activities all over the world. At the time, however, I was so cut up over the matter that I refused to perk for several days, and I was sent away on a sea trip to the tropics.

I spent considerable time on the water after that. When the war broke out, I saw service overseas. I went over with a load of standard equipment—the finest junk that Congress could buy. I found that a fancy panel, however, does not make an efficient set. In my homespun coil and shabby box, I was smuggled to the front, there to lie for days in the trenches doing my bit for America, while the more decorative members of my detachment occupied shelves of honor and did nothing. I do not think I was ever mentioned in dispatches to Washington, and yet my buddy and I know

Continued on page 56

Loop Versus Bloop

By David P. Gibbons

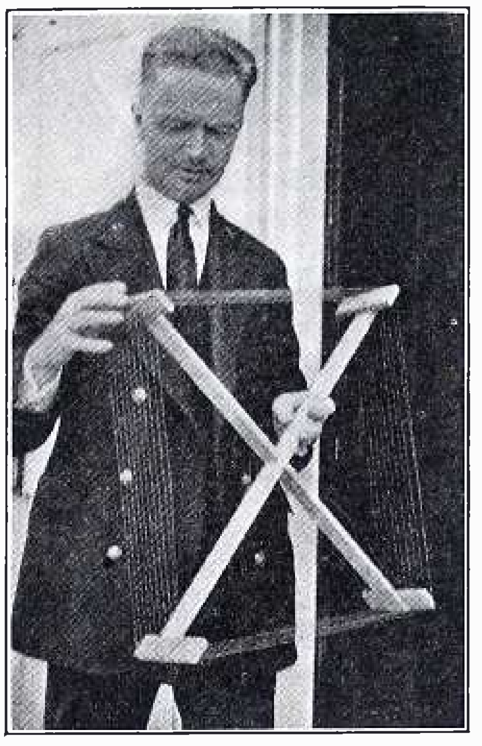
After a spirited and humorous defense of the single circuit the author tells how to make a loop aerial that will cut down the radiation from a so-called "Gibbons" hook-up. He also tells how to make a cheap grid leak.

TWO thousand years ago Aesop said "You can fool all the people some of the time," and today you hardly escape the large and rapidly-increasing tribe of enthusiastic followers of the suggestion of that early Grecian scenario writer. Especially in radio. The oil field runs a poor second to the radio field in the production of a prolific crop of experts, technicians, consultors and advisors whose pearls of wisdom are so generously cast before the readers of current radio literature and whose chief equipment for their self-appointed positions would seem to be simply and solely a monumental ignorance of the subject and a cast-iron nerve. You generally find the two qualifications hand in hand, or perhaps it would be more metaphorically correct to say that the cast-iron nerve is usually discovered superimposed on the monument of ignorance.

A shining example of this educational quackery is the present concerted and seemingly inspired onslaught on the humble but efficient little old single circuit regenerative receptor. The hard-working flivver of the ether has been accused of most of the high crimes and misdemeanors on the etheric calendar, but like its auto counterpart, it seems to thrive and multiply with opposition and to grow in favor with every additional user.

This attitude of opposition to any particular style, type, size or character of receiver is peculiarly childish and short-sighted. All present-day receivers are still a long way from perfection, and only a spirit of intelligent and helpful cooperation will materially increase our progress towards that desired goal. Intelligent criticism, however, demands thorough knowledge of the subject, both theoretical and practical, and right there is where nine-tenths of the "experts" are conspicuously A.W.O.L.

Take Barney Google, fr' instance! and let's say that Barney was your next-door neighbor and the owner of a chicken-coop, F.O.B. Detroit, instead of his beloved Sparkplug. Suppose now that you were the proud possessor of a much more imposing model of gaswagon —perhaps a Beerless Quartet or a Fierce-Sparrow Triple Six—and that you have occasionally been moved to annoyance by friend Barney's scooting past you on the highway at a rattling pace. Do you then—you, who are of course a respectable, law-abiding citizen —become overwhelmed with an atavistic impulse to slay your annoyer, and do you right away proceed to "obey that impulse?" Do you, in the dark of the moon, cautiously surround the nightly resting place of Barney's pet, and with a large, hard hammer concealed in your flask pocket, deliberately set about knocking his faithful Henrietta for a row of greasy drip-pans? Of course you don't! Not unless you are a real naughty little boy indeed and have been missing your bedtime stories recently!



Birdseye view of author with completed structure, the final cost of which reaches the staggering total of 8.0025 cents. The fraction represents the overhead.

Isn't it obvious that the friendly rivalry and good-natured tolerance which obtains among car owners of high and low degree should be practised to an even greater extent among the owners of various types of radio receivers, were the possibilities for improvement and refinement are so much more in evidence?

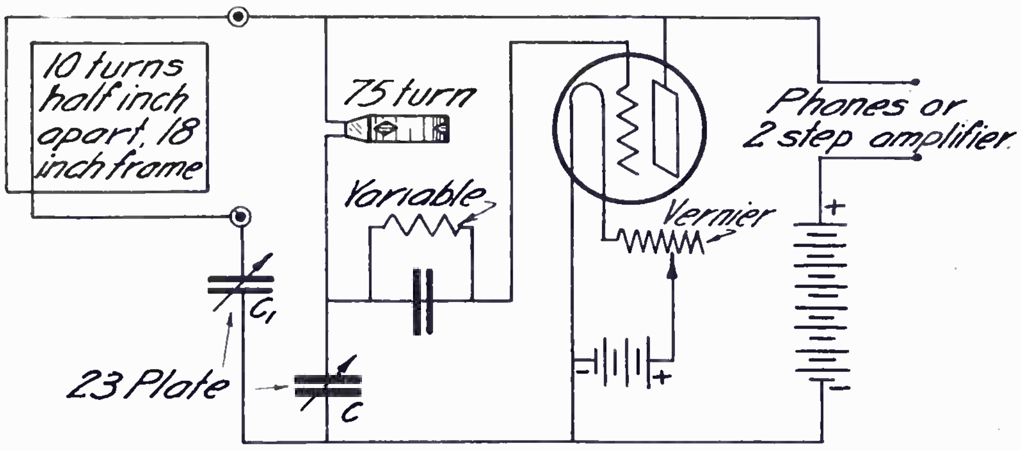
One of the most frequent charges against the single circuit sets is that they cause interference to the neighbors, with the implication that they are the only offenders in this respect. That the single circuit set does in fact cause trouble to nearby listeners when operated by the inexperienced or thoughtless is unfortunately only too true, but that it is the only or chief offender is decidedly untrue. Any type of tuner (whether employing one, two, or three circuits) in which the detector tube circuit is coupled, either inductively or conductively, to the aerial circuit, will act as a miniature transmitting station when the detector tube is caused to oscillate, and it is just as easy—to say the least—to produce this oscillating condition in a three circuit tuner as in a single circuit one.

Receiving sets which employ loop aerials, however, are in a class by themselves in this regard. Like Caesar's wife, they are above suspicion, and when to this advantage is added the fact of increased selectivity and an almost complete absence of all interference, the loop aerial seems the logical solution to most of the present causes of faulty reception. Of course there is the drawback of decreased volume, but the increased clarity about compensates for this, and if volume is desired, adding another amplifier presents no serious difficulty.

A concert which is punctuated throughout by fifty-seven varieties of "bloops" and "whoops" can hardly be described as pleasant entertainment, but by the use of the loop the "bloop" is duped. Besides you get the virtuous satisfaction of knowing that your set, at all events, cannot possibly be guilty of further "blooping."

A year ago in these columns the writer published a modified Colpitts transmitting circuit adopted for receiving, and employing a single honeycomb coil and a single variable condenser, under the title of "An All-Wave Receiver for Short-Length Pocketbooks." A few weeks later the *Literary Digest* reprinted the article in full with its usual courteous acknowledgment as to the origin of the article. Since then, in many guises and disguises and under varied names and labels, the circuit has bobbed up in practically every periodical devoted in whole or part to radio. Judging, then, from the very large number of letters received after its first appearance and the subsequent publicity it has been accorded, this circuit must be in daily use by quite a large group of radiofans, and it is in the interest of those and such others as may care to try out this anti-bloop version of the same, that the writer wishes to describe a very simple loop which has given remarkable results with this set.

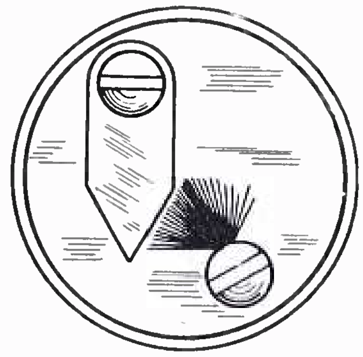
From raw material to finished product the total financial outlay involved shouldn't exceed about nine cents, American money, and anybody with sufficient mechanical ability to push a handsaw back and forth a few times is quite eligible as construction engineer. Wherever there is a new house being built (and where isn't there?) is a good place to procure your stock of lumber, and around 5 p.m. is the best hour, as all the workmen are busy knocking off for the day. Pick out and pick up a couple of pieces of nice, clean, discarded lath (half inch by inch and a quarter if you can find some) a little over six feet in all, and worth about five cents at a generous estimate. When you get them home saw off two pieces about 26 inches long, and cut a notch in the center of each so that when laid across each other at right angles the notches fit into place and hold the two pieces rigidly at right angles. This *can* be done without using logarithms (or glue). Then cut four pieces, each five inches long, and make ten deep sawmarks on the edge of each, spacing the marks half an inch apart. Fasten these with a couple of woodscrews apiece to the ends of the crossed pieces and at right angles to them, and your heavy labors are completed. In spite of the advice of one of those "experts" to the contrary, it really doesn't make the smallest particle of difference what kind of woodscrews you use in putting a loop together!



This non-blooping arrangement is Not an old Edison hook-up!

Next, wind around the frame ten turns of whatever kind of small-gauge wire you have handy, keeping the turns drawn taut in the sawcuts, and finishing on the same leg you started on. You can use your own judgment and ingenuity in arranging it most conveniently for connecting to your set, but the writer found that a little screw-hook in the center of one of the five-inch pieces and another in the upper woodwork of a window frame answered the purpose at a minimum of effort.

The diagram explains the method of connection. Condenser C_1 is essential and should be a 23-plate or larger, as a good deal of the rough tuning must be done with it. A two-step amplifier is practically a necessity when using a loop, although local stations come in fairly well on one step. Tuning with an outfit of this description is much more critical than when an aerial and ground are used, and it requires correspondingly more patience and skill to get the best results. A good reliable grid leak is very desirable in this connection, and one that has given the writer long and constant satisfaction can be very easily constructed in a few minutes. If you have an old Remler or similar pencil-mark leak, remove one of the screws between which the pencil marks are drawn.



Ground plan of a grid leak which is continuously variable from zero in one direction to infinity in the other.

Then cut a small strip of thin metal of some kind, short enough to not quite reach across, and make a hole near one end large enough to insert a screw. Replace the screw carrying the little strip of metal and make it tight enough to hold firmly and still allow the strip to be moved in an arc of a circle across the face of the leak. The pencil markings are then confined to the vicinity of the opposite screw-head and the resistance of the leak varied between all possible values by a slight movement of the strip. The point of the strip can be bent upwards to facilitate adjustment.

For those located at a distance from a broadcasting station the aerial is far more efficient, but for those living in congested centers within short range of a transmitter, particularly those living in apartment houses, who are the worst sufferers from the "bloops," a more general adoption of the loop aerial would contribute enormously to the enjoyment of good radio programs which are now being nightly ruined by the iniquitous, ubiquitous blooper.

If you have any of the new types of "peanut" tubes, and want to substitute them for the larger ones of old type, they can usually be operated very satisfactorily by putting them in series, with a single rheostat to control them. Three or even four of the WD-11 or WD-12 can be operated across a 6-volt battery.

HANDY HINTS ON RADIO

By D. B. McGowN

Fine wire and litz should always be soldered with rosin or rosin core solder. Acid or paste will corrode through in almost no time.

Having trouble in getting your receiving set to oscillate? Just connect a 0.006 mfd. condenser across the detector output and it will act differently. The radio-frequency has to have some kind of a path to flow across, as it can't flow through the output transformer or the head-set.

How high is the resistance of that water-pipe ground you are using? Probably you don't know. Try a substitute. Take from 50 to 100 ft. of rubber-covered wire, and cover one end with tape; connect the other end to the set, in place of the ground. Now stretch this wire out, under the antenna if possible, but stretch it out, anyway. Results are surprising, aren't they? Remember a counterpoise will work as well on a receiving set as a transmitter.

If your detector tube squeals when the tickler is brought up past the point of oscillation, try changing grid leaks. Probably one of half the value will solve the trouble. Use a leak of such value that the tube just stops squealing. Sometimes if you lower the filament current a trifle you will get the same effect.

Landlord won't let you bore holes in the wall for a lead-in? Too bad, but you can't blame him. Never mind. Just cover a part of one of the windows on both sides with a piece of tinfoil a foot square, on each side, and connect the aerial to the outside, and the lead to the set to the inside coating, and you'll have as good a lead-in as you could want, and probably better insulated. This acts as a series condenser, but will not seriously affect your tuning.

If your soldering iron won't work on large wire, try a flame. A torch is best, but even a candle will do in a pinch.

Strange noise in your set? Look at that *B* battery, before you get excited about it. Take a high resistance, like a 5000-ohm grid leak, and put in series with the head-set, and connect across the battery. Ten chances to one here is where the noise is. Throw the old battery out, if it is, and get a new one.

Having trouble with your portable set, while the auto is running? The primary breaker of the ignition system is probably the cause. Take an iron core choke, and a 1 mfd. condenser, and connect across it, and see if this doesn't remedy it. If this doesn't work, push the machine over the nearest bank. If the first method doesn't remedy the trouble, the second usually will, although it is desirable to get out of the "bus" before you try the shoving act.

Notes on the Beverage Antenna

By K. Kennethe

This article is intended for the amateur interested in better point-to-point communication such as relaying messages. Due to its directional characteristics and efficiency many relay workers have already adopted it with marked success.

THE Beverage or wave antenna, one of the comparatively recent achievements of radio engineers, is probably the most efficient type of antenna for reception purposes evolved to date, and because of certain marked properties which operate to materially reduce interference, the system holds more than ordinary interest.

Theoretically, the current induced in a wire suspended in space will travel along that conductor at a velocity equal to that of light, namely, 300,000,000 meters per second, this velocity being a constant determined by the capacity and inductance per unit length of conductor. In practice, however, a wire must be suspended in proximity to the earth, hence, the capacity increases in greater ratio than the inductance decreases and the velocity of currents along a conductor near the earth becomes less than the velocity of light, this being more strictly true of currents of low frequencies, though currents of frequencies in the order of 1500 kilocycles or more travel along a conductor in proximity to the earth at frequencies closely approaching that of light.

An electro-magnetic wave moving along a conductor suspended above the earth is capable of inducing in that conductor two currents, one of which moves along the conductor with the radio wave and builds to a maximum at one end of the conductor, and the other which travels in a direction opposite to that taken by the radio wave becomes practically zero as it approaches the other end of the conductor. If the end of the conductor at which the current is a maximum is grounded through a suitable coupling transformer, the current induced in the conductor by the radio wave is capable of operating through the coupling device and reception apparatus to produce a signal. Such a system may be represented schematically by the heavy lines in Fig. 1.

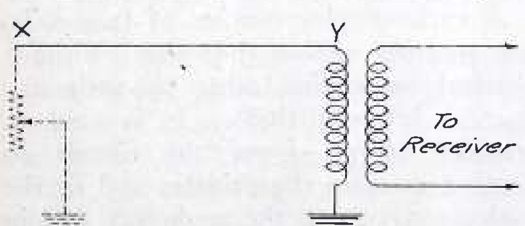


Fig. 1. Elementary Form of Wave Antenna Giving Maximum Response for Waves Moving from X to Y

Heretofore we have considered currents induced in a conductor by waves moving in the direction X to Y (referring to Fig. 1), but it is evident that waves moving in the direction Y to X will induce currents in the conductor which will build up to a maximum at the X end of the conductor. These currents will be reflected back from the open end of the conductor to the coupling transformer where they will tend to act through the receiving apparatus to produce signals. These signals, however, will not be of the intensity of those produced by waves moving from X to Y, as the horizontal plane intensity curve in Fig. 2, Detail A, indicates. This

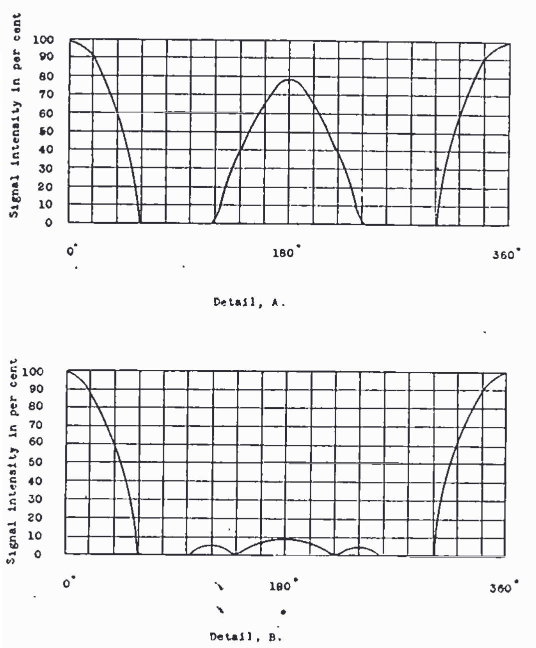


Fig. 2. Horizontal Plane Intensity Curves for Simple Wave Antenna, With and Without Damping Resistance

curve also shows the bi-directional properties which this system would possess.

By preventing the reflection of currents from the open end of the conductor, the system can be made to respond only to waves which originate in the direction toward which the open end of the conductor is pointing. This can be accomplished by grounding the open end of the conductor through a non-inductive resistance equal to the surge impedance of the conductor, this resistance being indicated by the dotted lines in Fig. 1. Theoretically, the surge impedance of a conductor is equal to $Z = \sqrt{L/C}$, L and C being the inductance and capacity per unit length. In practice it is not usually feasible to calculate this value and the damping resistance is made variable within certain limits so that it can be adjusted until the best response is secured from the system.

When the correct adjustment of damping resistance is secured the wave antenna functions aperiodically over a comparatively great range of frequencies; a marked contrast to other antennae systems which require adjustment to resonance with the frequency of the waves being intercepted for the attainment of maximum results.

Since the damping resistance prevents the reflection of currents induced in the antenna by waves moving toward the end in which the damping resistance is placed, the system is uni-directional; the horizontal plane intensity curve in Fig. 2, Detail B, indicating the marked directional properties of which this system is capable.

The system just described (of which the diagram in Fig. 1 is representative) is the elementary form of wave antenna, and will prove very practical and efficient as an experimental or permanent installation, but the adjustment of the damping resistance is a serious disadvantage, since it must be located some distance from the receiving apparatus. This disadvantage is eliminated, however, in more advanced types of wave antennae which employ two parallel conductors, and locate the damping resistance at the same end of the antenna as the receiving apparatus is located.

The schematic arrangement of one type of two-wire wave antenna is shown in Fig. 3. The system consists of two

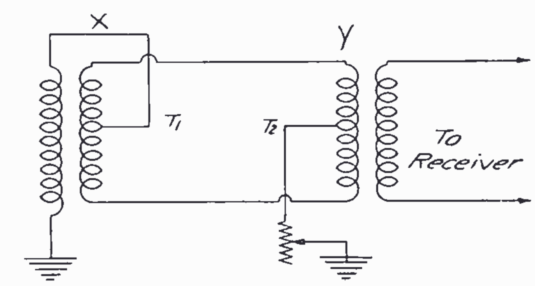


Fig. 3. Feed-back Transformer Type of Wave Antenna

parallel conductors connected at one end Y to a coupling transformer T_2, the primary of which is tapped at the mid-point and grounded through the damping resistance. At the other end of the conductors X is a feed-back transformer T_1, the primary of which is very closely coupled to the secondary. Waves moving along the conductors in a direction Y to X induce currents in each conductor that are in phase and which travel along the conductors to the transformer T_1 where they pass through the primary and secondary and to ground, but in passing through the secondary of the transformer they induce currents in the primary which circulates through the system of conductors in much the same manner as energy is transmitted over a power line. These currents as they pass through the coupling transformer

T_2 induce currents in the secondary which, operating through the receiver, produce signals. Currents induced in the conductors by waves moving from X to Y travel along the conductors in phase and, passing through the two halves of the primary of the coupling transformer, neutralize each other and induce no current in the secondary of the coupling transformer, thereby producing no effect in the receiving apparatus.

This system, like the one-wire wave antenna, is uni-directional, but it should be noted that the directional properties are the reverse of the simpler antenna. Because of certain losses which become more apparent at the very high frequencies of short wavelengths, this circuit cannot be recommended for short-wave reception.

Another two-wire wave antenna system is shown in Fig. 4. Electrically,

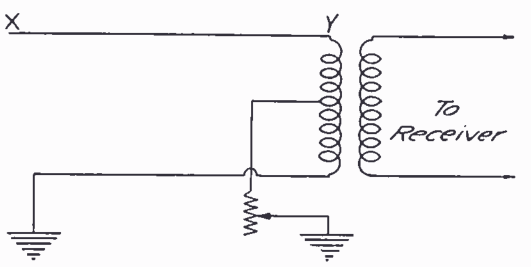


Fig. 4. Feed-back Wave Antenna Without Transformer

this circuit is similar to that of Fig. 3, but the feed-back transformer has been omitted, one of the conductors at the X-end being grounded, and the other left open. Waves moving along the conductors toward the Y-end induce currents in each conductor which are in phase and equal until reflection occurs; the reflected waves being 180 degrees out of phase, hence when they reach the coupling transformer they are capable of reacting through it to produce a signal in the receiving apparatus. This circuit, because of its simplicity and efficiency at high frequencies, is recommended for short-wave reception.

By inserting a variable condenser and an inductance in series with the damping resistance, better tuning can often be effected, since many times it is of advantage to make the damping reactance slightly capacitive or inductive to eliminate back-wave effects or interference.

Only the major points in the design of the wave antenna can be considered in these notes, these being the determination of the effective dimensions of the antenna, and a determination of the surge impedance. Of the effective dimensions the first to be considered must be length. For practical work, the length of the wave antenna, whether one or two wire, may be made equal to the wavelength of the signals which are to be received. As previously mentioned, the wave antenna will function over a wide band of frequencies, but in practical work there is usually but one wavelength employed and this can be made the determining factor of the length of the antenna. The length can, however, be varied within certain limits, though it should never be equal to less than one-half the wavelength to be received, nor greater than twice the wavelength. It should be remembered, in this connection, that with the longer antennae the directional properties are more pronounced and the antenna must be constructed to point either directly at or away from the transmitting station whose signals are to be intercepted, while with the shorter antennae a variation of as much as 20 degrees may be had without greatly affecting the intensity of the received signal. Generally speaking, signals received on short antennae are not of the intensity of those received on the longer structures.

The proximity of the wave antenna to the earth has a marked influence on its efficiency, the velocity of the currents along the conductor being greatly decreased when it is brought very close to the earth. It is, therefore, necessary to elevate the antenna some distance above ground, and for antennae to be used for intercepting waves of frequencies in the order of 1000 kilocycles or more, this height may be from 5 to 10 per cent the length of the antenna. Greater elevations add little to the efficiency of the system and tend to distort the directional characteristics of the antenna.

The most important factor in the design of wave antennae is the determination of the damping resistance. Since the damping resistance is equal to the surge impedance of the antenna, it is possible to calculate its value, as noted in the discussion of theory, but in practice the capacity and inductance of the conductors which form the antenna may vary widely from their predicted values, hence, a calculation is of little value unless the proper corrections for external influences are known and can be applied. By far the best method of obtaining the correct value of damping resistance is to make the resistance unit variable and make adjustments of the resistance while signals are being intercepted, until a maximum response is secured from the receiver.

If an oscillator of moderate output is obtainable, the damping resistance of a wave antenna can be determined by coupling the oscillator to the antenna and inserting an ammeter in the antenna lead. The damping resistance should then be adjusted to such a value that the antenna current will remain appreciably constant for a wide band of frequencies. Ordinarily, for short-wave antenna, the value of damping resistance will be from 200 to 500 ohms.

The foregoing notes treat of the directional characteristics and efficiency of the Beverage antenna. As these characteristics largely determine its use, it is necessary to make but brief mention of the applications to which it is peculiarly suited. For the reception of signals in point-to-point communication, the wave antenna is of prime importance, for, generally speaking, it permits the reception of signals from one source only, and tends to function at an efficiency much greater than obtainable with other antennae systems. Not only is the intensity of the received signals greater, due to the fact that the intercepted waves tend to operate through the antenna and receiving equipment to produce signals of maximum intensity, but the signal-interference ratio is greatly improved, with a resultant improvement in the quality of the received signals, this latter tendency being due to the directional properties of the antenna, which naturally would tend to eliminate a great deal of interference. Since point-to-point communication is employed in practically every field of radio work, from the relaying of amateur messages to transoceanic communication, the usefulness of the wave antenna can scarcely be said to be limited. Of course there are many exceptions to this statement, for it would be practically impossible to erect a wave antenna on a ship and get it to function at anywhere near maximum efficiency. Likewise, with broadcast listeners, unless they cared to favor some particular station, the wave antenna would find but little favor, but in communication between pre-established points the wave antenna is certain to find favor.

DIFFERENCE BETWEEN VARIOMETERS AND VARIO-COUPLERS

A variometer is a variable inductance coil used in a receiving set to give a continuous variation of inductance in a circuit. They are used for tuning to short wavelengths. They consist of two coils connected in series so that one can rotate inside of the other. As the inner coil rotates its inductance successively opposes, or is added to the inductance of the outer coil, thus giving a variation from minimum to maximum values.

A vario-coupler consists of two coils, one rotating within the other, without physical connection other than the induction between them. It is used to transfer energy from one circuit to another as from the primary coil in the antenna circuit to the secondary coil in the detector circuit. It is satisfactory only for short wavelengths. The primary coil is generally tapped so as to give the proper inductance for different wavelengths, corresponding to the variation secured by using different sizes of honeycomb coils.

The Romance of the Radio Calls

By Preston Allen

Much of the romance of radio has to do with the ship operator. To him this account of the application of early nomenclature to late needs brings poignant memories. While to the novice it brings but the thrill of the picturesquely unusual. But to both, it is of interest.

"WJZ broadcasting!" The radio fan, comfortably ensconced befor his loud speaker, sighs contentedly and announces to the family circle, "Ah, here comes WJZ!" The various members of the family draw up their chairs expectantly, for it is the call they have been waiting for. Even six-year-old Billy knows that "WJZ" means the station of the Radio Corporation at Broadcast Central.

Everywhere one finds the radio man designating the different stations by their call letters. The novice quickly discovers that to become initiated into the fraternity of the air he must learn to interpret the mystic letters and he is soon speaking glibly of "listening-in on WWI" or "picking up KPO." He has many calls at his tongue's end and each is imbued with a definite personality—the 100-watt set of the Salt Lake *Telegram*, the 500-watt set of the Atlanta *Journal*. But to the dyed-in-the-wool radio man, who has served his time at sea, these groups of letters have a much deeper appeal. To him they mean more than the *Times'* evening concert or the *Star's* lecture series. For now and again out of the ether comes a call that stirs his memory, that brings a picture of limitless waters, of storm, or tragedy.

The associations and romance that built up about the different calls are due to the custom of the Department of Commerce of reissuing call letters. If a station is discontinued, the department enters after the call letters in its monthly bulletin "Strike out all particulars." This blunt inscription means that the call letters have been cancelled for that particular station and the department will reassign them. So it happens that many of the three-letter calls used by broadcasting stations throughout the country today are reassigned calls. A great number of them were formerly used by ships, and tragedies of the sea have released them for their present stations.

For instance, around Philadelphia hundreds and probably thousands of listeners tune in on WGL, the broadcasting station of Thomas F. J. Howlett. "WGL broadcasting" means to them simply that they can sit in their homes and listen to another speech, or perhaps a bit of jazz, or an aria from an opera. But the old operator, hearing this call, thinks of another time when sitting tense at his key as his ship plowed northward on the Pacific, he had picked these same letters out of space. It was late on August 19, 1913. WGL flashed through the night the information that the steamer *State of California,* of the Pacific Coast Steamship Company, had piled on the rocks in Gambier Bay, Alaska, and was sinking rapidly. In those days there were no broadcasting stations and no broadcast listeners yet up and down the reaches of the Pacific men heard that call of distress and turned to render aid. But Gambier Bay was a long way off and the *California* went down with a loss of 40 lives.

Another call which has been heard over the length and breadth of the land is WSB, the official designation of the *Journal* of Atlanta, Georgia. Into the great cities and into the waste places of the desert its entertainment has been flung. It is known from coast to coast, from Canada to Mexico. Yet there was a time when WSB was not spoken by an announcer from a steam-heated studio on top of the Journal Building in Atlanta. Spat into the storm-ridden night of September 18, 1914, followed by the international distress signal, it was the forerunner of one of the Pacific Coast's greatest marine disasters. Sitting in his cramped quarters on board the steamer *Francis H. Legget,* the operator, with a steady hand, told the listening Pacific that his ship was foundering 65 miles south of the Columbia River. This time the heavy gale, which lashed the ocean into a frenzied monster, took a toll of sixty-two lives — and the call letters WSB were without an owner.

In Ridgeway, New York, the Ridgeway Printing and Publishing Company's broadcasting station has been assigned the call letters WHN. A few years ago these letters identified the steamer *Hanalei* which plied between Portland and San Francisco. On November 24, 1914, the same WHN which now broadcasts music and speeches snapped its call into the early morning air followed by the dreaded SOS. The *Hanalei* was hard and fast on Duxbury Reef almost within sight of the Golden Gate. The wireless this time brought assistance from land and sea and, although the *Hanalei* was dashed to pieces, only one life was lost before the rescue was complete.

Down in the southwest the city of Dallas in Texas is broadcasting under a call which stirs the blood of many an old operator. This time he does not think of the time he heard that signal across the sea, but instead he pauses to wonder once again why it was that that call was never heard in its moment of distress. WRR spells to the commercial operator one of the unsolvable mysteries of the sea. The steamer *Roanoke,* call letters WRR, cleared from San Francisco on May 8, 1916, laden almost to her scuppers with freight for Mexican ports. A week later two of her firemen drifted ashore on the California coast, unconscious and unable to tell what ghastly tragedy had occurred. Still later a ship's boat bearing the dead mate was picked up at sea. And that was all. To this day no one knows what quick catastrophe overtook that ship or why the voice of WRR was still.

WRW, the call letters of the Tarrytown Research Laboratory, Tarrytown, N. Y., once belonged to the steamer *F. A. Kilbourn* of the North Pacific Steamship Company, a vessel which was known to all the old-time marine men of the Pacific Coast. She had plied the Pacific since the days of the Spanish War and the call letters WRW were among the first to be assigned in the early days of wireless. But the great war sent her to the east coast, and on June 15, 1918, her call letters followed the international distress signals over the Carribean and she burned at sea.

Another call that was known far and wide was WWI. For years the steamer *Pennsylvania* of the Pacific Mail Company had carried passengers and freight between San Francisco and Central American ports. She had carried radio since the days of the first crystal detector and many of the early Pacific Coast distance records were made on her. On November 12, 1918, she burned at sea, and Henry Ford now uses the call WWI at Dearborn, Michigan.

Another ship and call parted company when, on February 5, 1919, the steam schooner *Klamath* — WSX — bound from San Francisco to Portland with freight and passengers went ashore near Point Arena, a spot designated by mariners as the "graveyard of the Pacific." Her call of distress brought immediate assistance from nearby coasters and no lives were lost, although the *Klamath* was quickly broken up by the heavy sea. With her passing another set of call letters became available. They now designate the telephone broadcasting station of the Erie Radio Company of Erie, Pennsylvania.

In the same year another old-time call passed from the sea to eventually be assigned to a broadcasting station. This was WTK of the tanker *J. A. Chanslor.*

On the night of December 20, 1919, this vessel ran ashore two miles north of Cape Blanco on the Oregon coast. Inaccessible and treacherous, this locality made rescue difficult, and while WTK whipped the ether with his cry of distress, the *Chanslor* went to her doom with a loss of thirty lives. WTK is now known down in the southwest as the broadcasting station of the Paris Radio Company of Paris, Texas.

A marine disaster which is still fresh in the minds of seafaring men is that of the steamer *Governor*, which was rammed off Point Wilson in Puget Sound on March 31, 1921, by the Shipping Board freighter *West Hartland*, sinking almost immediately with a loss of ten lives. The call letters WGR which crackled into the head 'phones of listening operators a few seconds after the *West Hartland* buried her nose in the *Governor's* side are the same which the Federal Telephone and Telegraph Company of Buffalo, New York, now use when broadcasting to their vast audiences.

More recent still is the wreck of the steamer *San Jose* of the Pacific Mail Company's fleet. On August 8, 1921, this old-timer, while proceeding from Central American ports to San Francisco, ran aground off San Pablo reef, Lower California. The call letters WWL, followed by a description of her plight, sent the steamer *Griffdu* and the destroyer *Farquhar* rushing to her assistance. This time the wireless brought the rescuers quickly enough to save the passengers and crew from any greater hardship than a night ashore on the bleak coast. The name of the *San Jose* was scratched from the Shipping Register and her call letters WWL were reassigned to Loyola University at New Orleans, Louisiana.

As the mariner attaches sentiment to his ship, so does the commercial radio man to the wireless call. To him it is something individual and distinctive. To the Department of Commerce, however, a call is a call, and nothing more. And in this day of many ships and an increasing number of broadcasting stations, there is always a place for each call released. Even before a stricken vessel has been battered to pieces by the pounding surf on our rocky coasts, the department's practical but entirely unsentimental "Strike out all particulars" has appeared after her name, and her call is carrying through the vastness of space—in place of the dreaded SOS—the latest jazz tune.

And now, with the discontinuance of many of the smaller broadcast stations as the bigger and better ones come on the air, there arises the question of to what new use the old code letters may some day be assigned. Will it be to the radio movie which inventors assure us will soon be perfected, or to what?

A PORTABLE RECEIVER FOR DX CODE

By SIX ZEE JAY

WE would all like to have a small compact portable receiving set, but the difficulty arises when the detector is considered. A crystal detector isn't sensitive enough for use on a small indoor aerial or loop—only nearby stations being heard. And then who wants to carry a battery around to light the filament of a vacuum tube—besides dry cells cost 50c apiece and they run down entirely too soon, necessitating more "bats" and consequently a continual digging in pocket for more money. Then how are you going to get a portable receiving set that works without an aerial and is capable of bringing in all the DX signals you care to hear? Listen, sons of Radio! bend to me your cauliflower ears and you will hear of a portable receiver that brings home the bacon!

The necessary parts are listed below:

1 VT detector (Cunningham or Radiotron).
1 VT socket.
1 Rheostat.
2 23-plate variable condensers (one with vernier).
1 43-plate variable condenser.
4 Honeycomb coils (DL-35; DL-75; DL-300; DL-1500; all equipt with plugs).
1 Single mounting for coils.
1 Pair of 'phones.
1 18-22½ volt *B* battery.
1 Potentiometer (200-400 ohms).
1 Toy step-down transformer giving six volts.
1 Bakelite panel and portable cabinet.

In Fig. 1 I have tried to suggest a suitable portable cabinet to contain the whole outfit. However, if the reader contemplates building this portable receiver described he undoubtedly has a few ideas of his own regarding cabinet, etc., and so will use them the way he sees best.

Fig. 2 shows the connections. It will be noted that the circuit is the de Forest ultra-audion. It is not new—yet very efficient. Several circuits were tried, but were finally boiled down to the one shown—giving the least residual hum from the electric light lines, louder and clearer signals resulting.

The electric light lines seem to play a double role, acting both as the filament lighting supply and *as the antenna.* Tests conducted, using a six-volt storage battery for filament supply, were nowhere near comparable to results obtained using the power lines!

This portable receiver was designed and built in 1919. At that time there were no broadcasting stations and very little C. W. was used by the amateurs, mainly because the "lid" had just been lifted and the amateur was adjusting himself to his new-found liberty. So no reception was done on short waves, only 600 meter commercial spark stations and continuous wave arcs being copied.

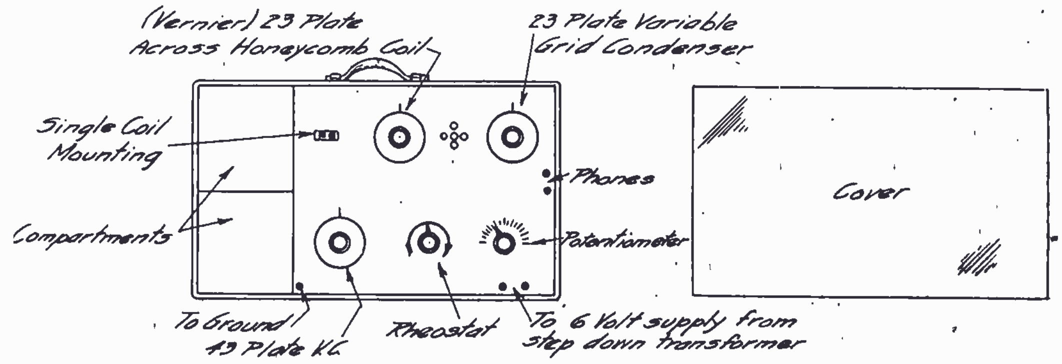


Fig. 1. Suggestion for Cabinet.

A friend built a receiving set similar to this portable and took it with him to Flagstaff, Arizona. Using no antenna (just the circuit as given in Fig. 2), he recorded spark signals from NPX, San Pedro, Calif., NPL, San Diego, Calif., KPH and NPG, San Francisco, Calif., and numerous ships. On long waves all the arc stations in the U. S. and NBA, Panama and NAW, Guantanamo, Cuba, were heard. This is even exceptionally good DX for the average antenna—but more so when *no antenna was used!!*

All sparks were brought in on the

Continued on page 89

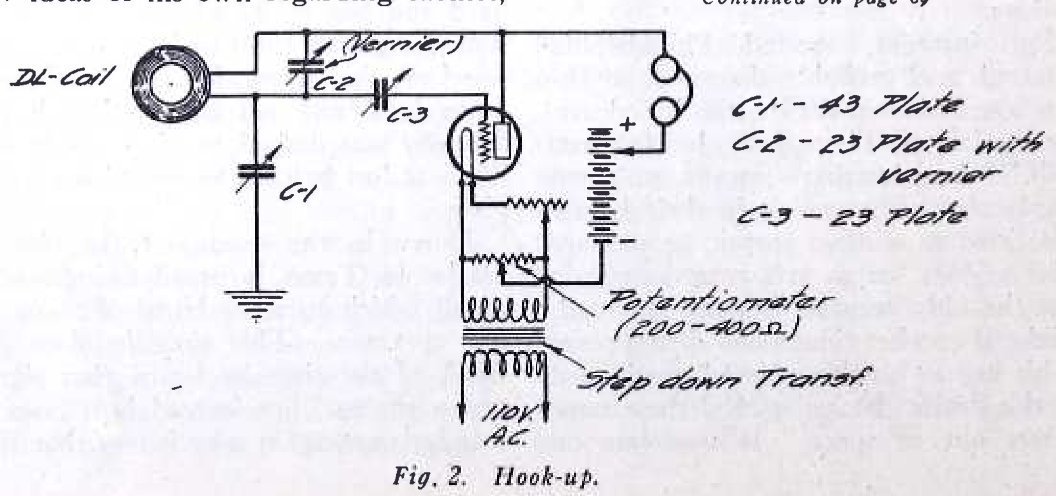
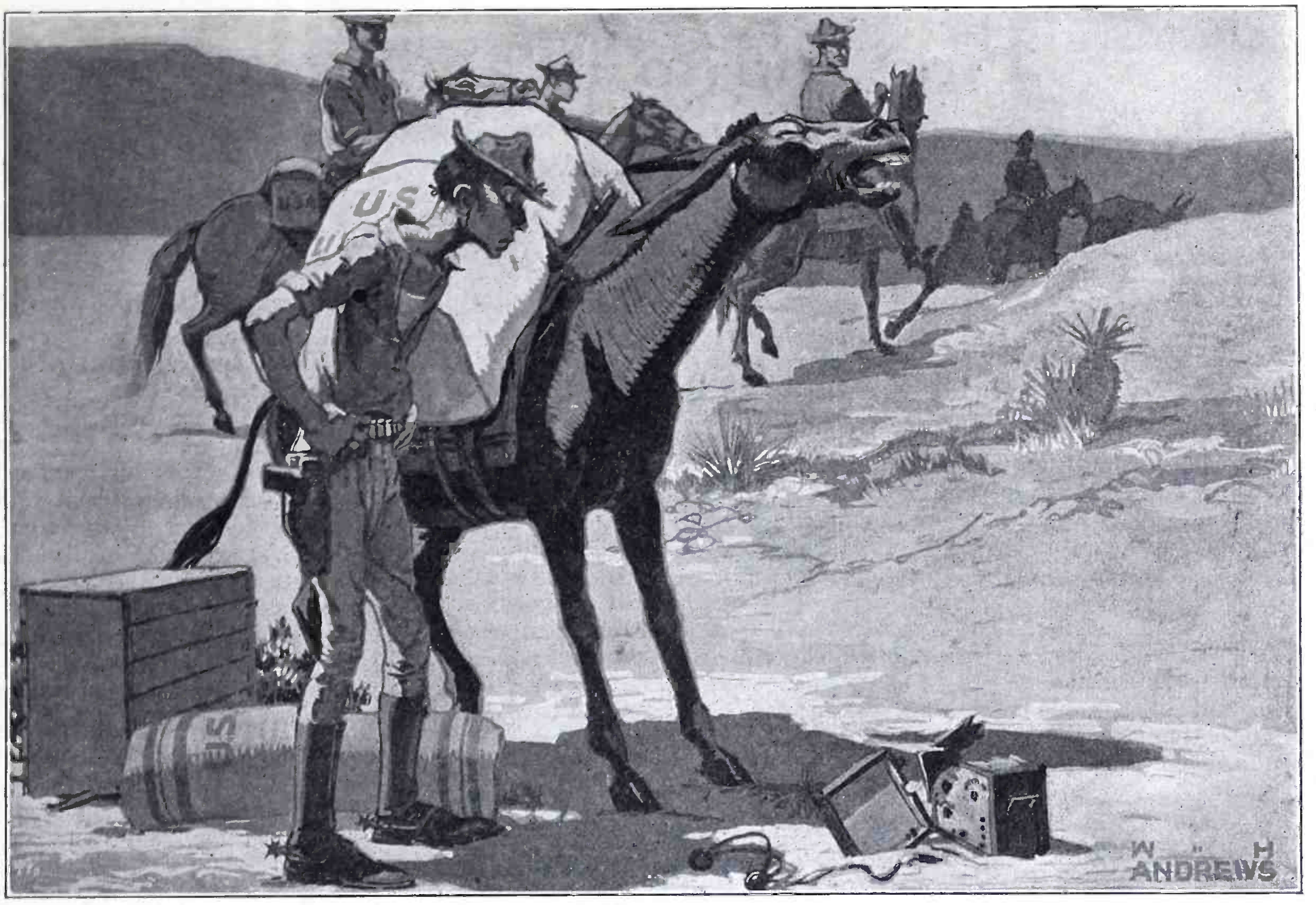


Fig. 2. Hook-up.



"A mule stepped upon the cabinet. Henderson maintained that the mule laughed out loud at him."

Barbed Wire-less

By Paul Oard

If humor is the sudden happening of the unexpected this story qualifies as funny. Anyway it shows that even a practical joke may have a happy ending.

MY story dates back to the time of Pershing's expedition into Mexico, following the historic Villa raid into the United States, and concerns particularly the tall lanky individual by the name of Henderson, who went across the Rio Grande with a detail, in the capacity of radio operator.

Henderson was a member of a small scouting party not mentioned in the news dispatches of that memorable event, but which was nevertheless an important and necessary part of that campaign. Built on lines more generous in their length than in their breadth, possessed of a perpetual stoop to his shoulders that even rigorous army training failed to do away with entirely, Henderson had, through the utter gravity that possessed him at all times, earned the title of "Sobersides." He was the object of much good-natured joking from his associates, and of some not so good natured, all of which he accepted with his characteristic gravity.

The chief task that befell Henderson at the start of the expedition was the care, and operation when possible, of a portable radio outfit that was more a matter of name than of reality. While the apparatus, from its hand-driven generator to its crystal detector, had most of the earmarks of a bona fide "wireless," it was nevertheless as full of vagaries as were some of the hard-bitten Texas mules that accompanied the detail. Its upkeep was a source of unending solicitude to Henderson, and the time that was not spent in the few hours of sleep, and in the hard traveling of the detail, he devoted to vain attempts to establish communication with that section of territory which they had recently left.

Quick marching orders had been responsible for their not bringing with them a more efficient outfit, which had been due to arrive from supply headquarters at any moment, and the present obsolete instrument had been scrambled together by Henderson at the last moment. He had protested ineffectually to his officers, but in the rush they had not listened to him.

The shavetail in charge of Henderson's detail knew as much about radio as does the average Eskimo about nut sundaes, and Henderson's repeated failures to establish communication over any distance greater than twenty miles had brought down upon his head a flood of sarcasm that delighted his associates none the less though they knew it to be undeserved. All of which served to plunge Henderson deeper into his air of reserve, which promised if nurtured much further to develop into a first-class grouch.

Following the final establishment of communication with another detail fifteen miles to the north of them, in which the commanding officer received a lengthy cipher message, and immediately after which the generator, propelled by two sweating buck privates, went up in smoke as Henderson drummed out a final O.K., the detail struck out due south. To Henderson's utter discomfiture and the secret delight of the men, the lieutenant ordered the radio equipment abandoned, profanely declaring that to burden a valuable mule with such a collection of junk was utterly *assinine*. The delight of the men was not detracted from to any extent due to the fact that at various times all had taken a hand in propelling the generator, not a light task in that climate.

Henderson now found himself in the position of a man without a country.

Continued on page 64

First Aid to Filaments

(*A "Sparks McAllister" Story*)

By Sewell Peaslee Wright

Here is another worthwhile kink dished up in most readable style. By following the suggestion you can keep full many a tube with busted filament from the dark, unfathomed junk-pile.

"ROARING reflexes!" shouted Wildcat. "Where, oh were did you get that coat of tan? Oh, baby! I'll bet that felt fine the morning after!"

Sparks McAllister stopped in his promenade down the main street and grinned proudly. A man has truly lost his youth when he ceases to glory in a mahogany hide.

"Ought to have been with me on my vacation, son," he said. "Out in the well-known open spaces, where a man's a man, and all that sort of thing."

"Huh?" queried Wildcat, who didn't read much modern fiction.

"You muffed it, boy, you muffed it; let it go. A warmed-over wise crack is a good deal like warmed-over fried fish: not so good!"

"My, aren't we wise, though!" admired Wildcat, with good-natured sarcasm, and then, changing the subject, "What kind of a set did you take along?" It was a matter of course that some kind of a set went on the vacation.

"That's right, you were out of town when we left, weren't you? Come on up to the house, and I'll show it to you."

"Fair enough," conceded Wildcat, "lead on!"

"HERE it is!" said Sparks. "Isn't that a pip, though?" He held up to view a box about the size of a Pittsburgh stogie container; not a very elegant looking box at all. Sparks was never the man to waste much effort for appearance's sake.

"The entire works; *A* and *B* batteries, headset, everything!" He opened the hinged top to show his young friend the interior.

Wildcat gave the assembly the double-o with rather admiring eyes.

"Reinartz, eh? Clever idea, that, using a spiderweb inductance and those mica dielectric variables — they're not much bigger than an ordinary dial, are they? Sure is a compact set—W.D. 12?" he broke off, indicating the tube.

"Yeh, W.D. 12; don't know why a U.V. 199 wouldn't work just as well, and save battery weight—would have used one if I'd had the available cash to blow."

"I don't know about that," argued Wildcat. "They say those dog-gone tiny filaments bust awfully easy, and a portable set like this gets considerable grief."

"Ah!" exclaimed Sparks. "I thought of that, and made due preparations. Any portable set should have some means of taking care of the tube, I think; none of the lamps will stand much abuse. Look here ———"

Sparks indicated the base of the tube socket, and on looking more closely Wildcat saw that it was mounted on what seemed to be a rubber sponge.

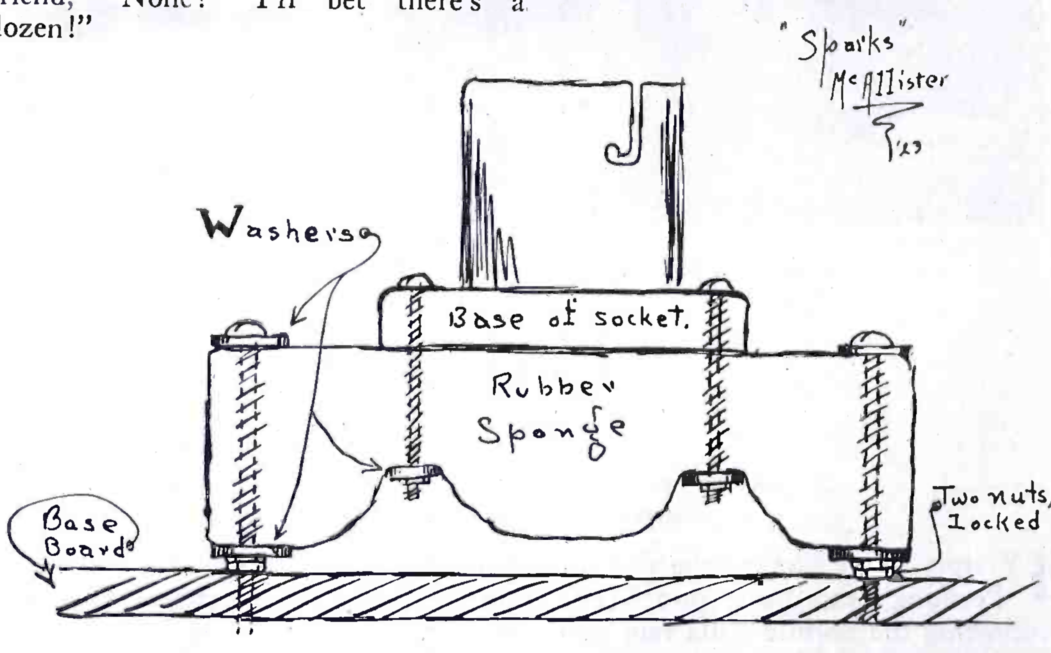
"What's the grand idea?" asked Wildcat, interestedly, scenting a kink. "Why the bathroom equipment?"

"Just a little original invention," explained Sparks, loftily. "You see, I needed a good shock absorber, and as there are none on the market ——"

"None on the market?" broke in his friend, "None? I'll bet there's a dozen!"

"Slow down, slow down!" begged Wildcat. I can't see how the thing's done through all that mess-work of wire in the cabinet; better draw a sketch of it as you go; I'll get it easier that way."

"Very well. See here." Sparks sketched rapidly with his fountain pen on the back of a message blank. "Now, is that plain to you? Washers go here and here and here," he said, indicating their positions with a branched arrow. This is supposed to be a socket, this is the base-board"—he shaded it with diagonal lines to make it look like a real cross-section— "and these nuts here are



Sparks' Sketch, Just As He Drew It.

"I've tried 'em, and they all have the same fault. They are too soft and springy; instead of breaking shock, they add to it by prolonging the vibrations caused. So, as I said before you interrupted, I invented this little affair."

"I think it's been used before, though," put in the irrepressible Wildcat. "Seems to me I read ——"

"Do you want to hear about this, or don't you?" demanded Sparks. "It is very likely that sponge rubber *has* been used before. I do think, however, that this is the best way I've seen to use it for this purpose.

"The socket is mounted on the sponge first, screwing the mounting screws tight, so as to compress the rubber as much as possible. I found it advisable to use a washer underneath, to make it easier to tighten the nut, and to prevent the nut from pulling clear through the rubber.

"After the base has been mounted on the sponge, the sponge is mounted on the base-board with four machine screws, but is *not* compressed. Then—"

locked against each other. Get all that straight, now?"

"Gotcha," returned his friend, briefly, with a nod. "How does it work?"

"It really works; I've been using it the last couple of days around the house here, and I find that it cuts down tube noises due to trucks and street cars going by, and that sort of thing, to a very noticeable degree. And you know all these new tubes are noisy that way, too!"

Wildcat nodded. "I'll say I've noticed it!" he said. "That's why I was so interested in the thing. Think I'll use it on all three tubes in that new reflex I'm making. If you say it's the berries, I'll take your word for it, Sparks."

Sparks smiled a pleased smile at the implied compliment. You can always tickle a radio man by complimenting him on his knowledge of his hobby. Ofttimes it is his one vulnerable spot. It is a peculiar thing — But there! This is a story, and not an essay.

As I have said, Sparks smiled.

A 200-Watt Phone, C. W. and I. C. W. Transmitter

By Louis Falconi, 5ZA

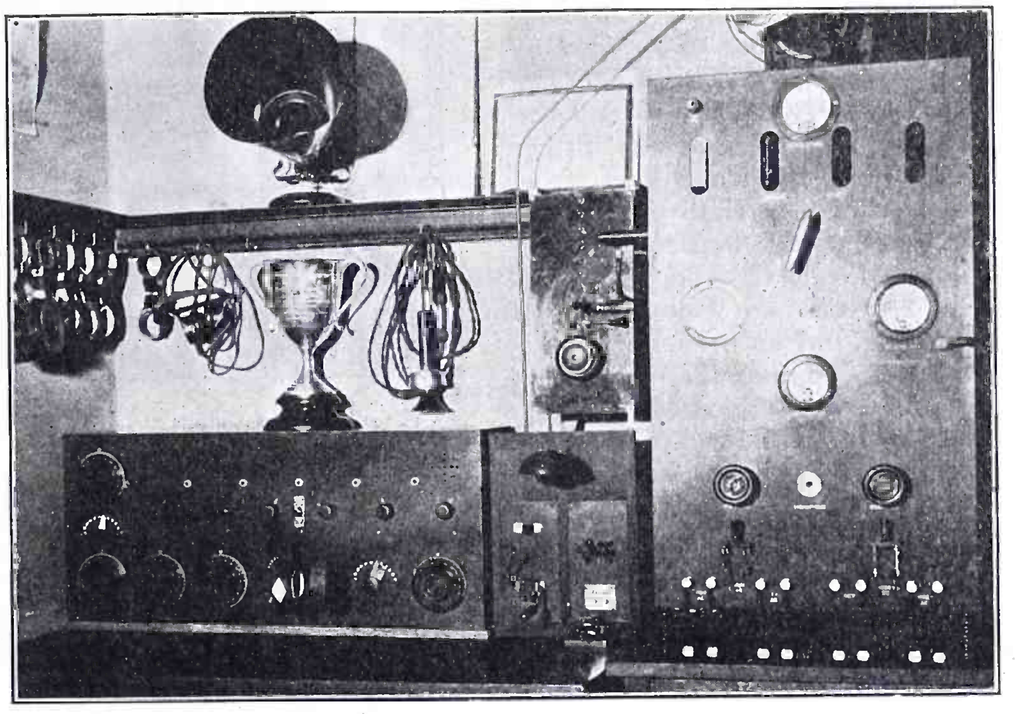
This careful description of the construction and operation of one of the most successful C. W. stations in America is full of meat for the C. W. enthusiast. This station was awarded the first Hoover cup and is still going strong.

EXPERIENCE during the past three years has fully shown the superiority of tube transmission over spark. This description of the transmitter used at 5ZA during the past year is given for the benefit of the amateur who is planning to build such a transmitter.

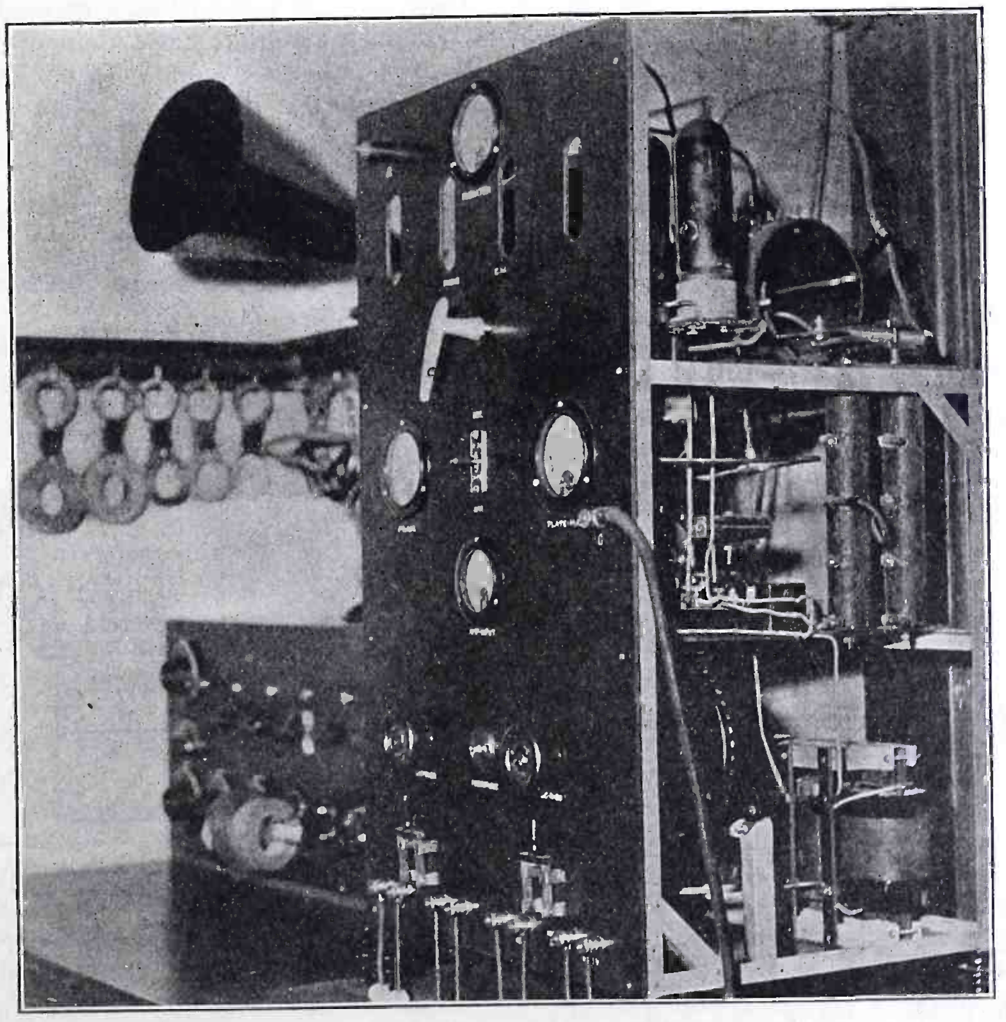
In building the 5ZA transmitter, the chief considerations were efficiency, appearance, and flexibility in operation. By efficiency is meant not only ability to cover great distances, but also quietness in operation. A transmitter that covers great distances but does so only with great interference to B.C.L.'s, is no longer considered efficient or desirable, as the new radio regulations fully indicate. It is the writer's opinion that the amateur's great problem is not how far he can reach out but how little noise he can make and still reach out. It is hoped that this article has some ideas that may prove helpful in attaining this end, possibly the one condition that will save the amateur future trouble.

The 5ZA transmitter is a combination C.W.-I.C.W.-fone unit with an output of 200 watts maximum on C. W. and I. C. W. and 100 watts maximum on fone. This much power is about the limit for the average amateur and by far the greater number will probably find it too expensive. The three methods of transmission are provided for because the real amateur (experimenter) does not wish to be restricted to any one form but usually takes great interest in all phases of radio. While it is true that for the relay of messages an efficient C. W. transmitter is all that is required, the more advanced amateur is often interested in radiofone and there is no question but that the latter is the highest development in radio today.

The unit is built into compact form of such appearance that the owner, who will be proud of its operation, will be also proud to show it rather than lock it up in some closet or scatter it all over the table with a sign "DANGER" so that the visitor will refrain from being caught in the maze of wires. Surprising to say, the "shiny knobs" do not in any way seem to affect the efficiency of the transmitter, for 5ZA has been heard in England and Switzerland, though transmission during the trans-Atlantic tests was possible on only four days due to generator trouble. The input during these tests was under 400 watts. We absolutely refuse the theory among certain amateurs that "dolling" up a set makes for poor efficiency. Training oneself in neatness is only another way of finally reaching perfection in efficiency.



Radio Station 5ZA at Roswell, N. M.



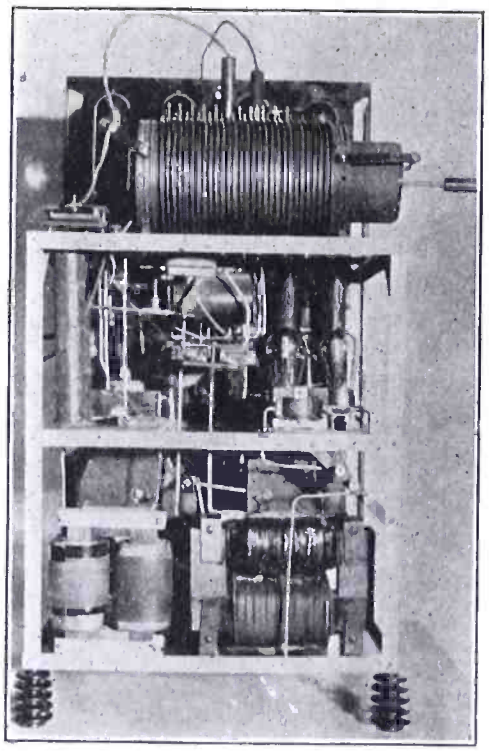
Side View of Transmitter at 5ZA

For the benefit of the "ham" who builds his own, detailed description of the various units will now be given. The lettering is as per wiring diagram. However, it is not desired to convey the idea that the specifications given are final. This article describes a good transmitter but not by any means a perfect one.

The oscillatory circuit used is called by Ballantine, the Grid Tickler. This circuit is also known as the Stanley, 1DH, Surefire, etc., etc. However, Ballantine's name appeals to me because one readily gets an idea of the circuit from the name. This circuit requires an inductance of fairly heavy conductor for the antenna-plate coil and an inductance of smaller conductor for the grid coil. This latter coil is made variable in inductance by steps and is also mounted so that the coupling to the antenna-plate will be variable. The grid coil furnishes the oscillator tube with sufficient backfeed to keep it oscillating steadily.

Antenna-plate coil L_1 has 30 turns of 3/16 in. copper tubing on a 6-in. Formica tube, turns spaced 3½ to the inch. The Formica tube is first threaded on a lathe, after which no trouble will be had in winding the copper tubing. For taps, pieces of copper tubing 1 in. long are bolted to the turns. Two rows of taps are marked, 1½ inches apart. A tap is put on every other turn and the taps staggered so that a tap at each turn will result. The position of each tap is centerpunched with a sharp punch, and holes just large enough to pass a machine screw that will fit the copper tubing, drilled. The taps are bolted on and made fast by a nut on the inside of the Formica tube. To make the job perfect, the point of contact between the tap and coil turn should be soldered. The foto of the back view of transmitter will make much of the above plainer. For tap plugs, ½-in. brass rod is drilled to fit the taps and hard rubber or Formica handles attached.

Grid coil L_2 is on a Formica tube 4 in. in diameter, wound with 50 turns of No. 16 DSC wire. Taps are taken off at 10th, 15th, 20th, etc., every five turns to end. A switch is mounted on one of the coil ends. The shaft of this switch is made extra long and a hard rubber handle attached. This makes it possible to vary the turns and also the coupling of the grid coil while set is in operation. The grid coil is mounted on two brass rods in loose coupler style. If desired, the grid coil can be made ball-shaped and mounted variometer style.



Rear View of Transmitter at 5ZA

Condenser C_1 in the antenna lead is used to enable operation on the fundamental of the antenna. The radiation resistance of an antenna is greatest at its fundamental wavelength, hence greatest energy will be radiated at that wave. Also C_1 is useful for instantly changing the wave of the transmitter to reduce interference. A large receiving condenser, the plates of which have been double-spaced will be O.K. The one used at 5ZA has 27 plates, 13 rotary and 14 stationary spaced 1/16 in. Stationary plates are 1/16-in. aluminum and 6 in. in diameter. Rotary plates are 4¾ in. in diameter.

C_2, though indicated as a variable, can be fixed after the correct capacity has been found. A good one can be made of two strips of copper foil 1½ by 3 in. and separated by mica, clamped between two pieces of Formica. In adjusting, the two copper strips are varied until antenna radiation meter reads a maximum, then the condenser is clamped tight and need not be changed unless the antenna or counterpoise is changed. The object of this condenser is to tune the actual ground connection to the counterpoise, thus making the latter more efficient. A slight increase in radiation will result.

C_3 and C_8 are the same capacity. C_8 should be husky enough to stand several thousand volts as under certain adjustments of the grid circuit, high voltages are generated which might puncture C_8 and thus short the d.c. supply. It will be best to buy R.C.A. condensers for this purpose.

C_4, C_6, C_7, C_9, C_{10}, and C_{11} are all high capacity paper and foil condensers sold under the name filter condensers. C_9 and C_{10} should stand at least 2000 volts. C_6 and C_7 can be low voltage type, as they are not subjected to high voltage strains.

C_4 is used in order to eliminate the click heard locally when the grid circuit is open and closed with the key. It absorbs the sparking at the key and makes keying much smoother for high power. C_6 and C_7 are high-frequency by-pass condensers to keep the high-frequency plate current from passing through the secondary winding of the filament transformer. C_8 is the stopping condenser required in the shunt feed plate supply

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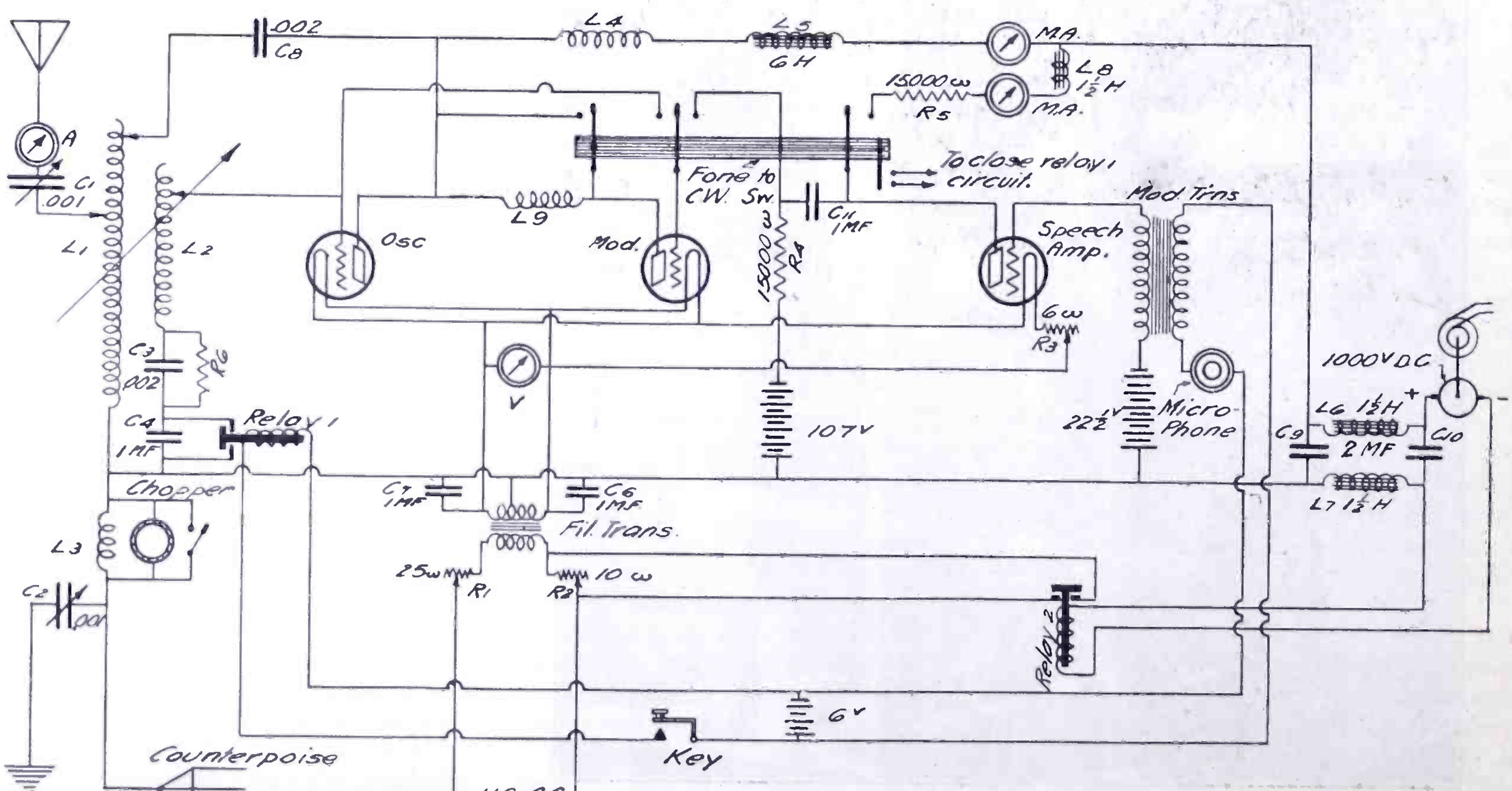

Circuit Diagram of Transmitter at 5ZA

Parallel Resonance and Coupling

By Bernard Steinmetz

This article tells in simple language why a wave-trap "traps," a choke-coil "chokes," a filter circuit "filters" and loose coupling increases selectivity. These are the practical deductions from an interesting theoretical discussion.

TO complete the study of resonance phenomena opened with the discussion of series resonance in August RADIO it is now necessary to consider parallel resonance. Fig. 1 shows a parallel

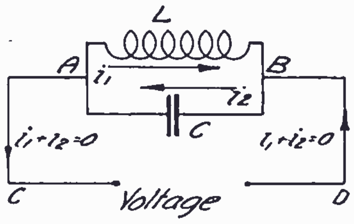

Fig. 1. Parallel Resonant Circuit

resonant circuit where the capacity C and the inductance L are connected in parallel and the impressed voltage is applied across the terminals A and B. Analysis shows that such a circuit behaves in a different manner from the series circuit.

Assuming that the values of L and C as well as that of the applied voltage are held constant while the frequency is varied, the current flow as recorded by an ammeter has the successive values indicated by the curve in Fig. 2.

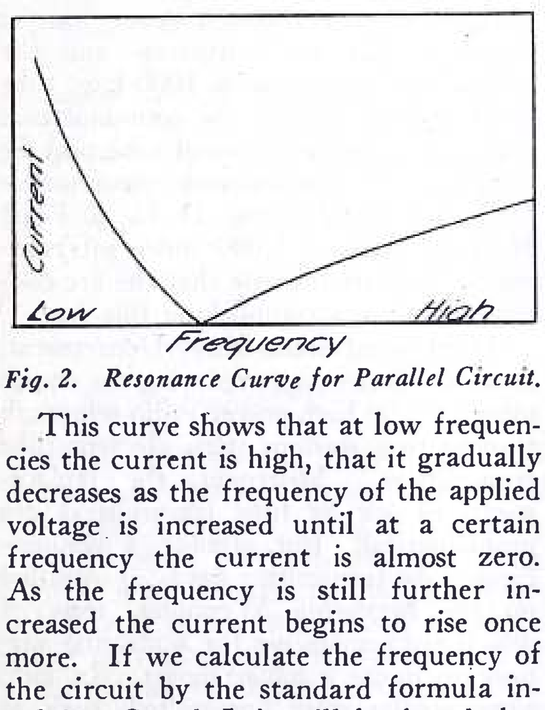

Fig. 2. Resonance Curve for Parallel Circuit.

This curve shows that at low frequencies the current is high, that it gradually decreases as the frequency of the applied voltage is increased until at a certain frequency the current is almost zero. As the frequency is still further increased the current begins to rise once more. If we calculate the frequency of the circuit by the standard formula involving C and L it will be found that the circuit is in resonance with the applied voltage when the current is zero. This conclusion is seen to be the exact opposite to that reached in an analysis of the series resonance circuit. In the latter the current was a maximum at resonance.

The limitation of current is due to the combined reactance and resistance effect of the circuit, namely its impedance. The reactance is due to the combined effects of inductance and capacity which effects vary with the frequency, which explains why the current varied with the frequency. Now if we make a series of calculations of the reactance of this parallel circuit for different frequencies and draw a curve of reactance against frequency it will have the appearance shown in Fig. 3. For

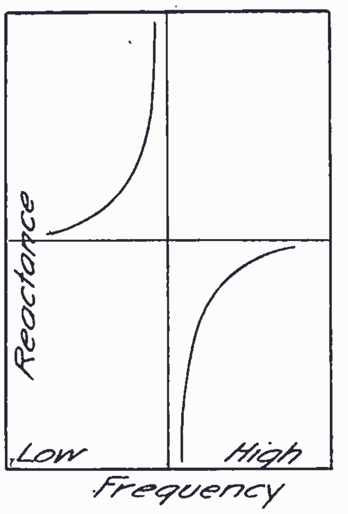

Fig. 3. Reactance Curve for Parallel Circuit.

low frequencies the reactance is small and increases as the frequency is increased. At a definite frequency the reactance reaches a maximum value, namely infinity. If the frequency is still further increased the reactance decreases. Again it will be found that the *frequency of the circuit LC coincides with the frequency at which the reactance is a maximum.* At this frequency, therefore, the impedance is also a maximum, hence the current must be a minimum. In a parallel resonant circuit, therefore, we have the case of minimum current at resonance when the impedance is a maximum, hence the opposition to the flow of current is a maximum. The exact condition for infinite reactance as shown by Fig. 3 is never attained in practice. This condition is that the resistance of the circuit be zero. Since this can never be the case the reactance is never infinite, but it is extremely great.

In order to understand why the reactance reaches such tremendous values it is necessary to make a mathematical analysis. This analysis simply consists in evaluating the impedance of a branched parallel circuit such as that in Fig. 1, and it will simply show that a parallel circuit is the opposite of the series circuit and has maximum impedance at resonance. But the physical understanding of this phenomenon can be obtained by considering the flow of currents in the branched circuit. The applied voltage is impressed between points A and B of Fig 1. Hence it drives a current through coil L and condenser C between the points A and B. This should be carefully noted, for in the case of the series circuit the applied voltage tends to drive the current around the circuit from coil L into coil C, hence the line current is the same as the coil current which is the same as the condenser current. In the case of the parallel circuit of Fig. 1, however, the line current is the current that exists in the line AC and BD, and this line current is made up of the sum of the separate coil current and condenser current. Now, due to the fact that the condenser behaves in opposite fashion to the inductance, as explained in the previous article on this subject, the currents will always be in opposite directions—they are opposite in phase in other words. As a result the direction of these two separate currents is as shown by the arrows in Fig. 1. When these two currents meet in the line AC they oppose each other and so tend to neutralize. Now at resonance the reactance due to the coil is equal but opposite to the reactance due to the condenser. Hence the current through the condenser must be equal but opposite to that through the coil. Therefore, if they meet in the outside line, these equal and opposite currents neutralize each other, producing zero current in the line, which is equivalent to having an effective reactance of infinity.

It is important to get a clear idea of this action. The reactance of a parallel circuit is infinity, when we consider the reactance between its terminals AB. But the reactance of each of the elements L and C is not infinity; they have definite values which are equal at resonance. It is when we consider the current effect in the outside line that the total reactance appears as infinite. Now actually the current in the outside line is not zero, but a very small value, as explained above, due to the presence of resistance. The reader will observe that the currents i_1 and i_2 in coil and condenser may be very great. Thus the current circulating around the parallel circuit may be larger. But the net resultant current in the outside circuit is nil, for the reason explained above.

The parallel resonant circuit thus has a maximum impedance at its own frequency, and the current in the line between its terminals is zero or nearly so, when the frequency of the current is the same as that of the circuit. A most important practical application is made of this phenomenon of parallel resonance. It is used in reducing interference and in the suppression of arc harmonics. Thus it is well known that when an arc oscil-

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Navy Comparison of Arc and Tube Transmitters

By S. R. Winters

This report of Navy tests of the relative performance of arc and vacuum tube transmitters definitely confirms the fact that the tube is the more efficient. The figures given should be of interest and value.

WHEN the supremacy of the arc transmitter or "converter" as a means for the transmission of electromagnetic waves over considerable distances is being challenged by the adherents of the electron tube, the results of comparative tests, conducted by the Radio Division of the Bureau of Engineering, United States Navy Department, are of timely and significant interest. A 30-k.w. Federal arc transmitter and a 6-k.w. 500-cycle alternating current electron-tube transmitter, for the same radiation, are of equal efficiency with respect to radio-telegraph transmission purposes, if we are to accept with a degree of finality the conclusions of the experiments about to be outlined.

The arc converter and electron-tube transmitter, the latter instrument developed by the Radio Test Shop of the Navy Department, were subjected to comparative tests at NAA, the Naval Radio Station at Radio, Virginia. Both forms of apparatus operated through the same antenna, the latter consisting of a 20-wire fan type. The constants of this antenna are expressed in the following terms: Fundamental, 1,840 meters; capacity, .007 microfarads; resistance (3,000 meters), 2.2 ohms. The antennas at the receiving stations varied in design from one wire, 400 ft. in length and 70 ft. in height, to two wires, taking the shape of a T, 500 ft. long and 300 ft. high.

The receiving stations selected for the reception of press copy sent from NAA in the experiments for determining the relative efficiency of the two types of transmitting apparatus were: Balboa, Panama Canal Zone; Great Lakes, near Chicago; Guantanamo, Cuba; Key West, Florida; Mare Island, and San Diego, California. Thus, the distances over which these messages were sent ranged from 625 miles, the distance from Washington to the Great Lakes station, to 2,101 miles, the distance to Mare Island. Balboa is 1,793 miles, Guantanamo 1,138 miles, Key West 893 miles, and San Diego 1,973 miles, from the National Capital. The receiving apparatus consisted of types SE1899, 1420, 1220, and 1420B.

The test frequencies were 7,650.4 and 113 kilocycles, corresponding to 3,950, 5,950 and 2,640 meters respectively, their relative effectiveness being in the order named. These wavelengths, in the order cited, maintained their relative effectiveness at the six radio-telegraph receiving stations.

In the copying of press matter the electron-tube transmitter evidenced a slight margin of 1% advantage over the arc converter for the same radiation, when the two were operating on a wavelength of 3,950 meters. The percentages of traffic effectiveness was 61.4 per cent for the tube transmitter and 60.4 per cent for the arc converter. However, this advantage in favor of the former was more than sacrificed to the arc transmitter when the two instruments were operating on wavelengths of 2,650 and 5,950 meters, respectively. The arc converter demonstrated an efficiency of 46.3 per cent in the handling of press copy on this wavelength, while the tube transmitter, on a wavelength of 2,650 meters, was rated at 43 per cent.

The general average of all the efficiency tests indicate the following percentages of press copied: On 3,950 meters tube, 61.4 per cent, and arc 60.4; on 2,650 meters tube, 43 per cent, and arc 46.3 per cent. The copying of press on any wavelength by the western stations, namely, Mare Island and San Diego, was taboo at 8 a. m.

Irrespective of the wavelength on which either the arc or tube transmitter was functioning, an unvarying radiation of 25 amperes was put into the antenna at NAA. This constancy was insured by the use of special calibrated radiation meters. This represented the maximum energy delivered by the 6-k.w. tube transmitter in the absence of harmonics. The 30-k.w. arc normally radiates 40 amperes, when operating on 3,950 meters, and 50 amperes, when functioning on 5,950 meters. Obviously, the arc length and voltage of this transmitter were reduced.

The relative audibility of signals radiated by arc and tube transmitters, as reflected by the comparative tests of the range of these two types of transmitters, are: Tube 3,950 meters, strength of signals, 4.7; arc, 3,950 meters, strength, 4.65; arc, 5,950 meters, strength, 4.1; tube, 2,650 meters, strength, 3.75. Thus, it is seen, that the strength of the signals is on a parity with reference to the two different types of electric-radiating instruments.

The results of the comparative tests of the range of arc and tube transmitters, for the same radiation, when operating on the same antenna, have prompted the formulation of certain recommendations. They are:

"(a) That a one-to-one factor be used in design calculations as a basis of the effectiveness of equal antenna wattage arc and tube.

"(b) That general broadcasts from NAA be conducted on a wavelength band of 3,500 to 5,000 meters, if practicable, in view of the lower antennuation of these frequencies.

"(c) That wavelengths of the band 3,500 to 5,000 meters be utilized at NAA as far as practicable in view of the greater efficiency of the main antenna in this band, the fundamental of the antenna being 1,840 meters.

"(d) That schedules from NAA with west-coast stations be not conducted during the hours that sunrise and sunset intervene."

When numerous claims, some of them extravagant, are being advanced by the respective adherents of the arc converter and electron tube for transmission purposes, the conclusions deduced from these significant tests should have a sobering influence. The increasing popularity of the electron tube—although one estimate states that 80 per cent of the electric energy radiated through space has its source in the arc converter—and the recent development of a 1000-k.w. tube lends definite cast to the contemplation that soon a relatively small tube may be employed in transmitting communications from Washington, D. C., to Pearl Harbor, Hawaii, 5,000 miles intervening, with quite the ease that the arc converter is now accomplishing this feat.

The United States Navy Department, however, is not contemplating the equipment of new high-power radio-telegraph transmitting stations with electron-tube transmitters. Moreover, the replacements of arc by tube transmitters are problematical. But, already, a medium-range tube transmitter has been installed on the battleship Wyoming, tests of which are responsible for a pleasing surprise to quote a naval report, "In fact, some results were unexpected, such as ability to receive on the same vessel during full-power operation of this tube rating about 5 kilowatts." Broadcasting stations, operating on a wavelength of 400 meters, were adjusted in resonance with the receiving equipment in an auxiliary room on this battleship, while the tube transmitter was supplying 36 amperes to the main antenna, on a wavelength of 507 meters.

Seagoing vessels, cruising in the Atlantic and Pacific oceans, have reported that signals received from this 10-kilowatt transmitter compared favorably with those received from the 30-kilowatt arc set.

Antenna Types

By Maurice Buchbinder

The several types of receiving aerials are here discussed for the information of the novice. Each is considered from the angle of the particular use to which it is adapted.

THE antenna, of whatever type its construction may be, has for its object picking up the radio wave. The most common form of antenna is one or more elevated wires, insulated at each end where it is suspended, and lead into the house where the receiving set is installed. In general, the higher the antenna above surrounding structures the better will it be. This statement, however, is limited by one factor, namely the overall length of the antenna wires. If this length be too great then it might be impossible to tune the receiving circuit to the broadcasting wavelength and thus reception will be rendered impossible at that wavelength. It may be proven mathematically that the natural wavelength of the antenna, that is, the lowest wavelength to which it may be adjusted without using a condenser in series, is approximately four times the overall length. Thus, if we have an antenna consisting of a horizontal wire 100 ft. long and a vertical lead-in into the house of 50 ft., then the overall length being 150 ft., the natural wavelength is four times that, or 600 ft.—

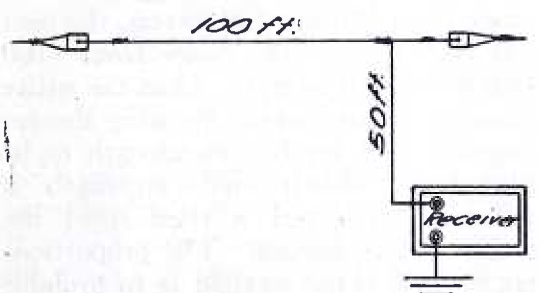

Fig. 1. Inverted "L" Type of Aerial

roughly 200 meters. Fig. 1 shows this type of antenna. It may be called the inverted L type.

We may, however, run one lead-in wire, not from one end of the antenna, but from the center. Then in calculating over-all length we need count only ½ of the horizontal portion. Fig. 2 shows this type, which has been called the T type of antenna.

The T type is always preferable to the L type because it reduces resistance, using the same amount of wire. This follows from the presence of two parallel paths for the current in the horizontal portion. Also, since the over-all length has been made shorter, we can afford to increase the height and still fall within the limit as above outlined.

Either of the two modifications mentioned may consist of only one horizontal wire or of more. It is best to use more than one wire because by so doing we decrease the resistance, again because of parallel paths for current. If more than one wire is used then they are spaced apart by using spreaders at either end. The individual wires may be separately

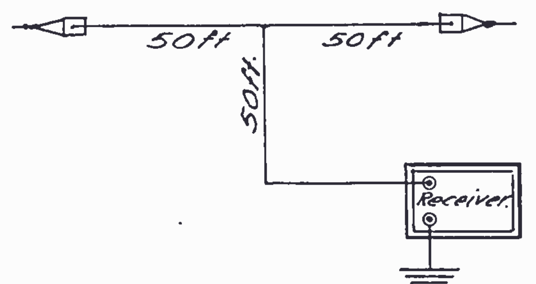

Fig. 2.—"T" Type of Aerial

insulated from the spreaders or the spreaders themselves may be insulated at the point of suspension. It is practically immaterial which method is used, and therefore the more economical one is preferable. When we so insulate spreaders instead of wires it is well to join the latter together electrically by jumpers, at either end where they are attached to the spreader.

On the basis of the above discussion we may give a model antenna design for 400 meter broadcast reception. The antenna height is of course limited by difficulty in tower construction and erection. We may put it very conservatively at 30 ft. The installer is always at liberty to raise this and may be assured that any little increase is well worth while in its returns in increased range and audibility of signals.

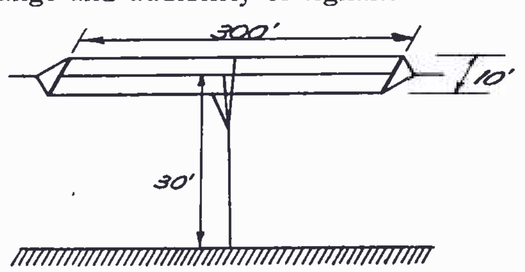

Fig. 3. Model Receiving Antenna

Fig. 3 shows the model receiving antenna. The natural wavelength is roughly 250 meters, which leaves ample allowance for any inductance the receiver may have which will tend to increase the wavelength.

In erecting an antenna of this type it is well to take advantage of its directional effect. It will receive best in a line with its horizontal length. Therefore, it should be pointed at the station which it is desired to receive best.

An entirely different type which is nevertheless just as much an antenna as the one we have just presented is the one embodied commercially by the "antenella" and similar makes. In this case the receiving circuit is using merely the house electric light wires as an antenna. The radio waves flying through space set up currents in these wires just as well as in separately suspended and insulated wires which are "true" antennas. The device which is purchased is merely a condenser which permits the radio waves to pass through to the receiver but has not sufficient capacity to allow the house current to do likewise. In Fig. 4 we show the arrangement of such a system.

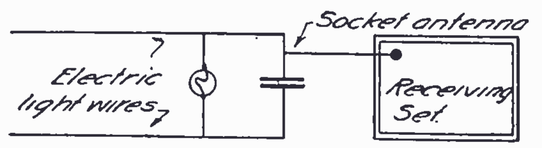

Fig. 4. Electric Light Wire Aerial

Such devices are quite satisfactory and serve their purposes admirably for nearby stations or with sensitive receivers. They are not, however, nearly as efficient for ordinary all-round broadcasting use as the first antenna type which we have discussed, designed and constructed expressly for the purpose of receiving radio waves. The advantage then of the electric light socket antenna is merely its convenience, because it does not require outdoor wires or extra construction. It can never approach the outdoor wires for distance and loudness, however, and if a beginner with a crystal receiver finds no success with it he should not despair, but erect a large outdoor antenna, and his troubles will very likely come to an end.

A third class of antenna is the loop. This is probably the most desirable of any type with a sensitive receiver. It consists of several turns of wire wound in the form of a large coil, 2 ft. possibly on a side, the turns of the coil spaced a slight distance from one another. No ground connection is needed, its place in the circuit being shown in Fig. 5.

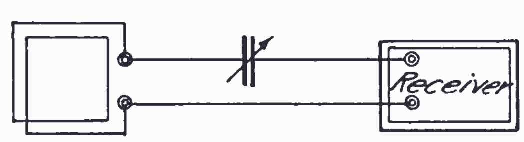

Fig. 5. Loop Aerial

The advantages of this type are that it adds one additional means of selectivity besides tuning, namely direction. The loop has the property of receiving a station loudest when the direction of the station coincides with the plane of the loop. A transmitting station located the same distance away, at the same wavelength, and using the same power, would be comparatively inaudible if in a direction perpendicular to the plane of the loop. The device is therefore constructed so it may easily be rotated.

Continued on page 59

Wavemeter Design and Operation

By Jay Emm

This is a thorough discussion of the principles underlying the wavemeter and of the many uses to which it may be put. Special attention is paid to the buzzer and phone type.

A WAVEMETER is a device for measuring the wavelength, or the corresponding frequency of an electric current in a radio circuit. It operates on the principle of resonance which has been explained in this and the preceding issue by Bernard Steinmetz. In its simplest form it consists of an inductance coil and variable condenser connected in parallel and tuned to the circuit to be measured. Resonance is indicated by maximum current flow as detected by some instrument such as a galvanometer. As the condenser is calibrated in wavelengths the reading is taken directly from it.

The prime requisite of a wavemeter is accuracy, which in turn is dependent upon sharp tuning. For if it tunes broadly it is hard to find the point of maximum current flow. Sharp tuning requires a low decrement which is calculated from the resistance R, the inductance L, and the capacity C of the circuit in accordance with the formula that decrement $\delta = 3.1416\, R \sqrt{C/L}$.

From this formula it will be noted that the decrement is decreased as the resistance is decreased. As most of the resistance is in the inductance coil, it should be properly designed in accordance with standard formulae, using stranded wire to reduce skin effect, single layer to reduce capacity, and hard rubber or glass winding forms to reduce dielectric effects.

Likewise the decrement decreases as the capacity is lessened, in proportion to the square root of the capacity, and it also decreases as the inductance increases, in proportion to its square root. So we see that a high inductance and a low capacity are essential to a low decrement.

But we cannot increase the inductance and decrease the capacity indefinitely, for we reach a certain impasse, namely the factor of resistance begins to enter once more. The more wire we use in our inductance the greater will its resistance be, and therefore the greater the decrement. Thus if we increase our inductance too much we may reach a point where any advantage in decrement gained by the favorable ratio of capacity over inductance will be more than neutralized by the increase in decrement caused by the increase in coil resistance. In practice we are therefore limited to medium values of inductance and capacity, depending upon the range of wavelengths to be covered. Thus for low wavelengths a suitable value for the condenser would be 0.0005 microfarads maximum, which would be sufficient to cover a range up to 600 meters. For higher ranges up to 3000 meters the condenser should be about 0.002 microfarads. The increase in range involves a corresponding increase in capacity. The proper value of inductance may be obtained by calculation from the wavelength formula, $\lambda = 1885 \sqrt{LC}$, since both wavelength (maximum) and capacity (maximum) are known. With any given coil and condenser the wavelength range will be proportionate to the square root of the ratio of maximum to minimum capacity values. Since most commercial condensers are designed with approximately a 9 to 1 ratio in capacity, the wavelenth range will be 3 to 1, which is found to be satisfactory for all practical purposes. Thus in the above condenser of 0.0005 microfarads, which is suitable for a maximum wavelength of about 600 meters, the lower range would be 1/3 of 600 or 200 meters. The wave meter would therefore cover the range from 200 meters to 600 meters. It will be shown later how the range of a wavemeter may be considerably increased without changing the value of capacity.

Besides considering the effect of the wavemeter constants we must also consider the effect of coupling on decrement. It is well known that when two circuits are closely coupled waves are produced even though both circuits are tuned to identical frequencies. This means broad tuning. Another way of looking at the problem is that the effect of one closely coupled circuit on a second is to increase the resistance of the second circuit, which is equivalent to increasing its damping or decrement. Wavemeters must therefore be loosely coupled so that the reaction of the circuit being measured on the wavemeter is a minimum.

Furthermore, the addition of a galvanometer, a crystal detector, or vacuum tube and telephone results in the addition of a small capacity which may influence the accuracy of the wavemeter considerably. Consequently it is best to calibrate the wavemeter *with these additional devices in circuit,* thereby correcting these errors automatically.

To increase the range it is best to employ several inductances, each of which covers a certain range of wavelengths. The smallest coil would cover say the range from 200 to 600 meters. The next larger coil would cover the range from 500 to 1500 meters, the next coil would cover the range from 1100 meters to 3300 meters. Thus the entire range could be covered by using the appropriate coil for the wavelength to be measured. When the wavelength is unknown each coil is tried until the proper one is secured. The proportioning of C/L is not so rigid as to prohibit such use of different size coils with one condenser.

A special type of condenser has been developed for wavemeter use. Its fixed plates are semi-circular and its rotating plates are specially shaped in accordance with mathematical formula which gives a straight-line wavelength curve. Thus equal condenser rotation on any part of the scale produces the same variations in

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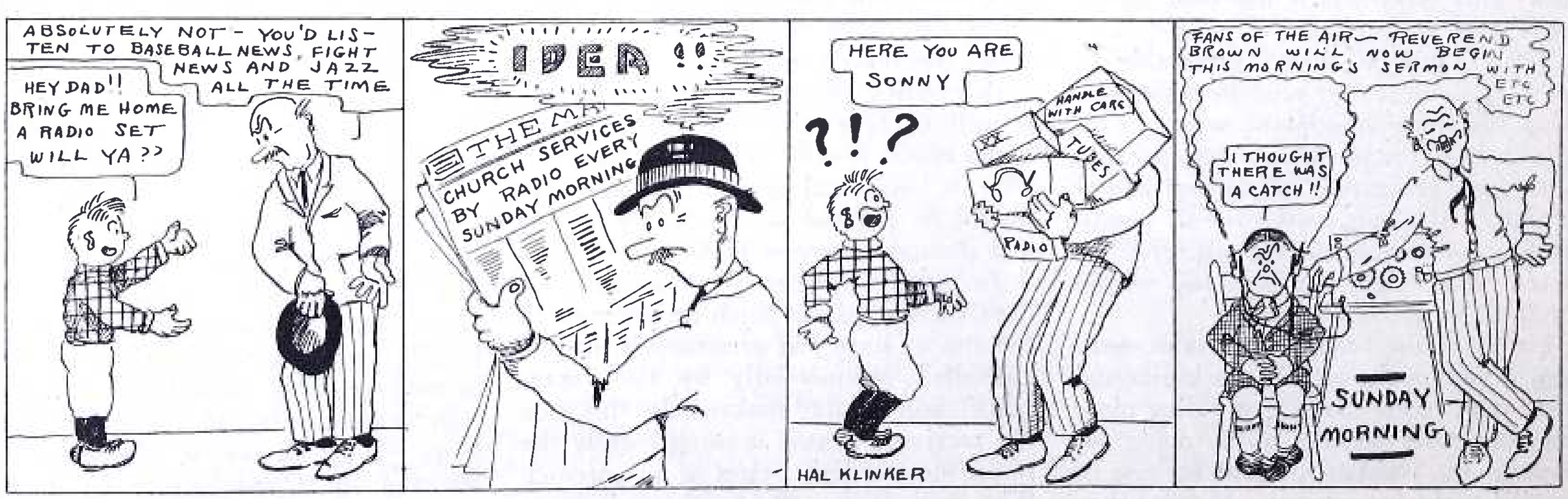


A Vacuum Tube Wavemeter

By L. H. La Montagne

This is the first of a series of articles on the practical design of radio apparatus by the author. He proposes to utilize material already in the possession of most amateurs. This article may well be read in conjunction with that by Jay Emm in this issue.

EVERY amateur should have a wavemeter. As the vacuum tube type gives more uniform results and a more sharply defined resonance point with greater ease of operation than a buzzer and phone, its construction justifies the slight additional expense.

Any standard tube may be used, but the larger the tube the better the results, as more energy will be available. Very good results may be had with an amplifier tube or other hard tube with 90 volts on the plate.

There is one important point that must not be overlooked. The circuit must be used exactly as it was calibrated. By this is meant that if dry cells furnish the source of energy for the high voltage when calibrating, they must be used in all subsequent work, unless the wavemeter is recalibrated, as it has been found that a motor-generator will change the wavelength of the circuit considerably. The same applies to all other parts of the circuit. However, the change from one tube to the other, providing it is intended to be used for the same purpose, will make no noticeable difference in the wavelength calibration. The wavemeter, if carefully calibrated, will be as accurate as the one used for standardization.

Fig. 1 gives the circuit used, which is a standard Hartley. The inductance L is an air core coil wound on a bakelite form, preferably, 3½ in. in diameter with No. 24 d.c.c. wire with a total number of 132 turns. When shunted with a .0007 mfd. condenser, the wavelength range is from 150 to 1600 meters. By tapping honeycomb coils at the center they may be used in place of the special coil and any range desired secured. The proper sizes of these coils may be easily obtained from the tables put out by the manufacturers. If it is not desired to have such a great range, part of the coil may be omitted. The size of wire may be varied from No. 20 to 26 as long as the total number of turns remain the same. The core may be three or four inches in diameter without changing the calibration too much. The diagram shows the arrangement and number of turns for each tap which goes to the two switches. These two switches are operated independently, though with a little ingenuity both may be operated at the same time. Both switches must be placed on the *same* numbered tap or the circuit will refuse to oscillate.

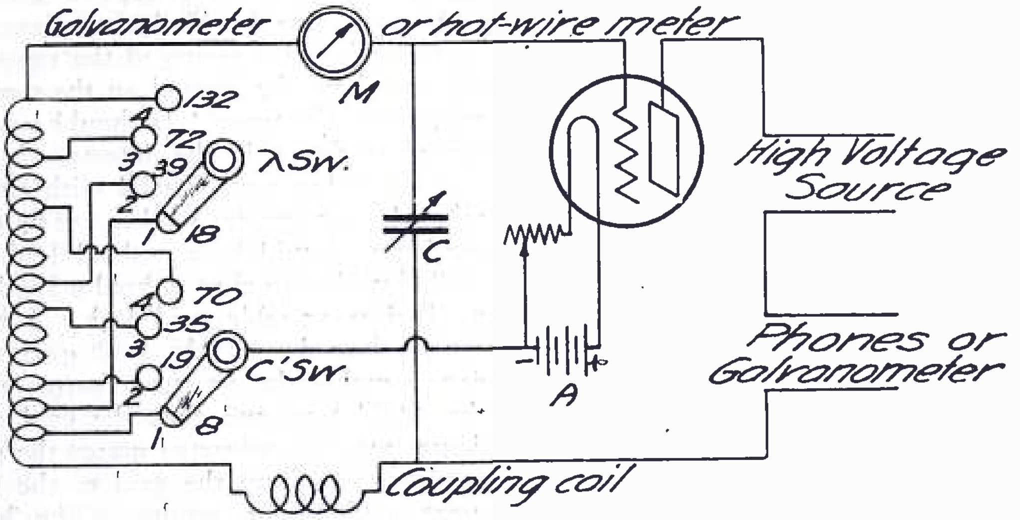


Fig. 1. Wavemeter Wiring Diagram

The condenser used in the wavemeter originally built had a capacity of .0007 mfds with decrement type of plate. A .0005 mfd. (23 plate) condenser may be substituted with a decrease in the maximum wavelength, but which will do no particular harm. It is best not to use over a .0007 condenser, as the tube may refuse to oscillate with the higher values of capacity. The condenser used should be rigidly constructed with heavy plates swung on a good-sized shaft. The end pieces should be bakelite. The contact to the moving plates should be positive. The condenser as a whole should be built so that there is a minimum amount of change possible.

The coupling coil consists of five turns of the same size wire on the same diameter core as the main coil. This coil is attached to binding posts by a flexible core to the main set so that its position may be varied. This cord must not be changed in any manner after calibration. When calibrating, the coupling coil should be in place, as it is part of the oscillating circuit. This coil is used to couple the oscillator to whatever circuit is under measurement.

The socket and rheostat is determined by the type of tube used, and may be of any standard make adapted to the tube. The high voltage may be from any source available, but must not be changed after calibration as explained before. The *A* battery may be a storage battery or dry cells, depending upon the tube used.

The galvanometer may be omitted and a pair of fones used, though the fones are not quite as satisfactory for several reasons. With the many transmitting sets now equipped with a high voltage voltmeter, the voltmeter may be used as a galvanometer by omitting the external multiplier, as the meter need not be calibrated as comparative readings only are taken. The voltmeter used this way will be found satisfactory for use with receiving tubes, but, of course, is too small for larger tubes. If a meter is to be purchased, the model 301 Weston 5 milli-ampere will be found to be very satisfactory. Extreme care should be taken not to overload any of these meters. As a precaution, some kind of resistance of from one thousand to five thousand ohms should be put in series with the meter to prevent burning out if the high voltage source is accidentally shorted.

Fig. 2 gives a suggested panel layout. A small shelf should be attached to the panel for mounting the tube and inductance coil. A liberal number of binding posts should be used so that the circuit may be broken at almost any place for

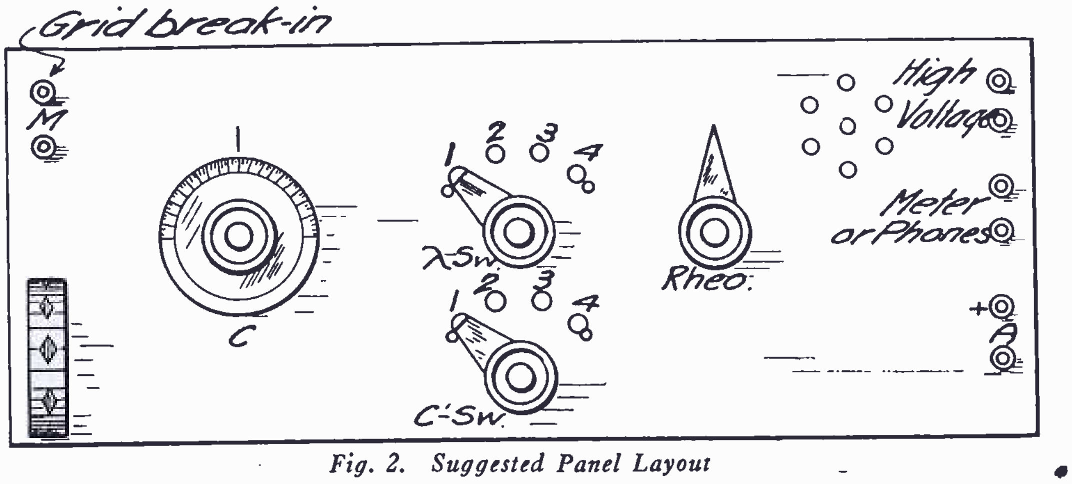


Fig. 2. Suggested Panel Layout

insertion of measuring instruments. All wiring should be rigidly soldered, and as far away from other wiring as possible. If care is not taken in the wiring, false resonance points will be introduced which will cause considerable confusion.

No grid condenser or leak is used, though with some tubes it may be necessary to use one. No difficulty was had in making the C-301 or VT-1 tubes oscillate when the grid condenser is omitted, providing the polarity of the *A* battery is as shown.

When the circuit is set up and the proper adjustments have been made, the galvanometer will show a very large deflection when the tube is *not* oscillating, and a comparatively small deflection when oscillating properly. When loosely coupled to another circuit, and the condenser *C* is varied to obtain resonance, a large increase in deflection will take place at exact resonance of the two circuits, showing the withdrawal of energy from the wavemeter circuit. The point of maximum deflection is very sharp, and is sharper the looser the coupling. This deflection may be easily passed by if the condenser is turned too rapidly. To be sure that the deflection is due to resonance, the condenser should be touched with the finger tips, which will immediately stop the tube from oscillating, and the galvanometer will drop to its former lower value. If fones are used for determining the resonance point, the familiar click will be heard when the two circuits are in tune. If an amplifier is used, more accurate results may be obtained, as the coupling may be loosened considerably more.

The usual method of calibration is followed. If the wavemeter used for calibration has a hot-wire meter on it, a double check will be afforded, as considerable energy will be transferred, thus giving a readable deflection, which will be at its maximum when the pointer on our meter is at its maximum. In some instances, a much more easily obtained reading is found with the meter in the grid circuit. Binding posts should be left to do this when building the meter. A trial will show at which place the resonance point is the most easily indicated. The meter behaves in a similar fashion to one placed in the plate circuit, though the deflection is smaller as a rule.

A few words of caution in the use and calibration. It may be difficult to get the wavemeter to oscillate below 150 meters, because of the length of the wiring, etc. If for any reason the tube should stop oscillating, a false resonance point will be indicated. This should always be tested for by shorting the condenser with the finger tips as explained above. The readings used should be those that are indicated by a sharp rise and drop of the galvanometer. The condenser should be used between 10 and 90 degrees out of a possible hundred.

If the coupling is too close to the circuit under measurement, two resonance points will be indicated. The obvious remedy is to loosen the coupling. In some cases it will be found that there is a critical coupling at which the resonance point is most easily found. The coils under measurement should be absolutely dry, as a freshly-coated coil will give no resonance indication due to the high resistance leakage along its surface. Like any other piece of apparatus, a few trials will show the correct procedure in using it.

The above instrument may be used in practically every measurement that is needed in radio work, and with a very high degree of accuracy, which is only limited by the instrument from which it is calibrated.

ADDITIONAL DATA ON THE DX BRINGER-IN

By STUART A. HENDRICK, 2BJG

Since the publication of "The DX Bringer-In" in May RADIO the author has received so many letters that it is practically an impossibility to answer them personally, so I will endeavor to clear up some of them here. Most of the letters were from men who could not make the set work properly and wanted to know where the trouble could be, while quite a few came from those who are having very good luck with this circuit. Among these, F. J. Berta of Chicago writes that:

"Using only a VT1, I have heard practically all the broadcasting stations from Havana to the Pacific Coast and this was accomplished with a single No. 18 wire aerial about 50 ft. long, 20 ft. high at the lead-in end, 7 ft. high at the far end. Since becoming interested in radio, about a year ago, I have experimented with numerous hookups, all the way from Reinartz to radio-frequency, but have not yet run across any other circuit that is as constant and dependable at all times and which does not develop temperamental tendencies but is always on the job. I have made two slight additions to your circuit, one by shunting a .0005 mfd fixed condenser across the phones and *B* battery, and also by connecting the negative *B* to the positive filament through a potentiometer used as a series resistance. I find the latter to be a very great aid in obtaining volume when tuning distant stations."

On my set I use a Pathe molded variometer similar to the Tuska. Both the rotor and the stator have 60 turns of No. 26 s.c.c. wire, coils being in series. The variometer and coil may be placed in any position, but the leads should be as short as possible, thus eliminating bus bar wiring because the leads run parallel for too long a distance and there are too many sharp corners. The primary condenser should be in the series position with a long antenna and shunted across the coil if higher wavelengths are to be received with the set. A long, low, single wire makes the best type of antenna to be used with this kind of receiver.

The original drawing of the two step did not show the ground on the secondary side of the tuner. It should be connected as shown in the detector circuit.

This set has worked well with almost all makes of standard tubes. The grid condenser should be a molded Dubilier .00025 mfd with clips to hold a Durham or Pudlin variable grid leak. I have found that the .00025 mfd grid condenser makes the set tune sharper than the .0003 type and that the grid condenser may be connected across the grid condenser or from the grid to the filament with equal results. The baseboard is ⅜ in. thick.

Radio frequency should not be used with this receiver because all the advantages of this type of tuner will be lost if it is used. It is possible to use a 20-turn honeycomb coil and a 50-turn coil in place of the special shown or spiderwebs may be used with the advantage of being able to control the coupling. This makes the set slightly more selective but it loses the volume and sharpness that are its best qualities.

A piece of sheet glass may be fastened to the back of the peep holes to cover all

Continued on page 70

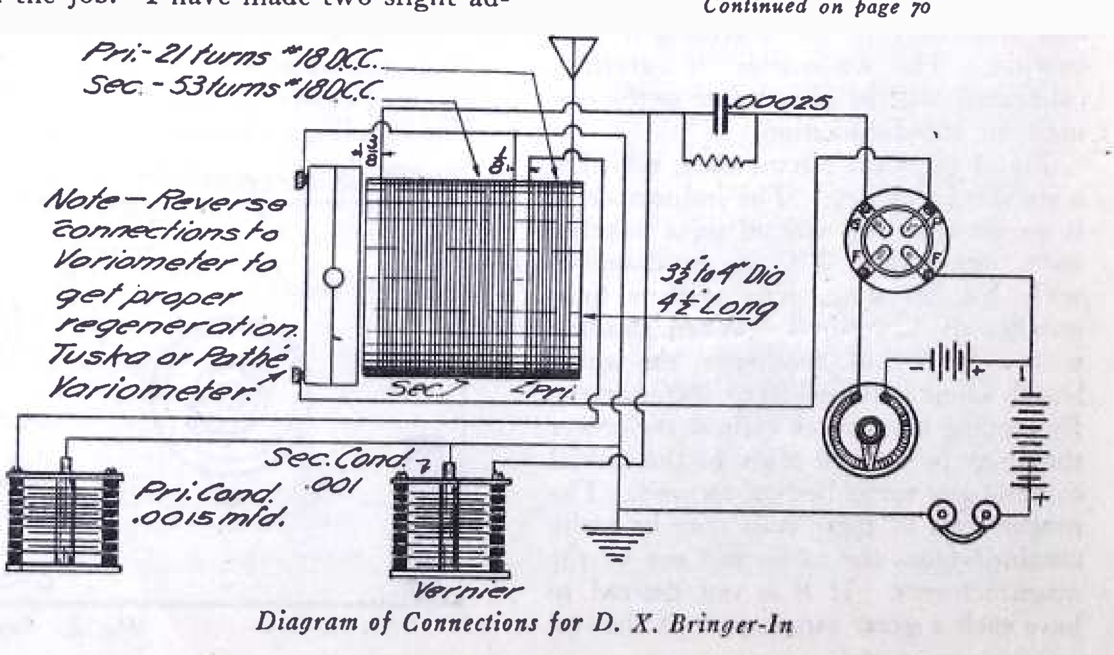


Diagram of Connections for D. X. Bringer-In

The Design of Radio Apparatus

By D. B. McGown

After a preliminary statement as to design requirements in general and inductance coils in particular practical directions are given for designing inductance coils for receiving sets. Incidentally the fundamental theory of the subject is explained with unusual simplicity.

I. General Considerations

THE first factor to be considered in the design of radio apparatus is the use to which it is to be put. Thus the design requirements for a receiving set may differ greatly from those for a transmitter. Other general factors to be reckoned with at the outset are size, cost, finish and ease of manufacture.

For receiving equipment the first considerations are the wavelength ranges of the set and the type of detecting system to be used. The wavelength range determines what stations can be heard, the detecting system whether they actually can be heard.

Then we have to consider whether the set is to be made portable or stationary; whether it is to be extremely selective or not, and whether it is to be handled by a novice or an experienced operator.

If the set is to be made portable, it should be smaller than one for permanent use. If the set is to be used near the seacoast, where interference is bad, the designer should immediately decide whether or not he wishes to sacrifice simplicity of control for selectivity, and if the user is one not experienced in the adjustment of radio apparatus, the simplicity of control again is to be considered. A single coil or single circuit set is without doubt the simplest and easiest to adjust and operate. It is very easy to build a single circuit set of smaller size than the inductive coupled set, which gives greater selectivity, although the former will not be of much value if interference is unusually severe. On the other hand, if the set is to be used for portable work, it might be of far more importance that a certain message be received at a certain time, without interference—radio being the only means of communication, say—than the disadvantage of the small extra weight introduced by the use of inductively-coupled apparatus. The increased difficulty of tuning would be unimportant, as such an operator is an expert. Thus it cannot be set down whether or not a particular set should be designed in any particular way until ALL the factors and conditions of use are known.

After the exact conditions of use are finally decided, numerous other factors must be considered before the actual drawings can be started, or other final details determined. Among these are the factors of ease of adjustment, or manipulation, under which subdivision we have all the details, such as positions of the apparatus on the panel, shape, size, and convenience of the dials, knobs, or switches; the shielding of the panel against the capacitive effect of the operator's body; the ease of change from one wavelength to another, and the permanence of adjustment of any calibrated parts of the set, whereby the operator may return to any pre-determined position or adjustment at will. The availibility of the instruments for inspection or repair is a factor which must not be overlooked, as well as their comparative freedom from unnecessary "doo-dads." The size, shape and general dimensions of the panel, or panels, and containing case, or cases, should receive their share of attention. In fact, the set is now, in the mind of the designer, all ready for assembly, assuming the ideal parts are at hand.

By ideal parts the writer means parts that, in the mind of the designer, will cover the exact purpose for which they are to be used. We should now again go over everything that is to go into the set, and determine first if these parts are available at a reasonable cost, and, if not, what can be used at a cost, or under other conditions that are reasonable. The number of receivers to be built is an important item in this connection. If there are to be only a few receivers manufactured, as is the case in the home shop, where one is the usual limit, there is no objection to a large amount of hand work, and special fitting of the parts that can be best obtained.

As far as the instruments and parts available on the market, as much care should be taken in their selection, as if they were to be made up by the builder himself, and the design of the original builders should be carefully studied, as much can be learned from it, and many of their mistakes avoided. There is a sad lack of design in some of the apparatus now offered on the market, and an attempt will be made to show how these defects may be avoided, rather than how the apparatus may be designed in detail.

II. Inductance Coils

The actual design and winding of inductance coils is one of the greatest "lemons" in the entire radio field. We see countless inductance coils, so-called "vario-couplers," and "loading coils" being tapped "every five turns," or the like. Any oscillatory circuit possesses both inductance and capacity, and the exact value of these, when connected, determines the oscillatory frequency, or wavelength of the circuit.

The ideal inductance would be a coil of zero ohmic resistance with maximum insulation between turns, which could only be obtained in a coil wound in helical form, of heavy tubing, or bar, of sufficient strength to hold it in position, without supports, in other words a spring. This is an impossible condition, except for heavy coils of few turns. Anything that is introduced into the field surrounding the coil causes *some* loss. It is customary to wind the inductances on some kind of "form," and either to support them on strips of insulating material, as is usual with transmitting inductances, in which case the coils very nearly approach the ideal inductances, or, in the case of the receiving apparatus, the wire is wound on bakelite, or cardboard tubing, which supports the windings throughout their length.

It has been found that the simple helical winding loses its efficiency rapidly when the length of the coil is increased, as long coils are found to have greater radio frequency resistance than would the same length of wire stretched out straight. To eliminate such effects, the so-called "bank winding" was developed, and afterwards the "honeycomb," "duolateral" and similar styles of special winding, where the effect is to reduce the radio frequency resistance by placing turns of high potential difference at points remote to each other, and to reduce the "distributed capacity," which will be discussed in the following paragraph.

The material used to insulate the turns of an inductance coil has an enormous effect on the inductance and capacity. In a large number of closely-wound turns of wire, as we have in any commercially made inductance coil, there is a large amount of insulation between the various parts, all of which is in the electromagnetic and electrostatic field of the coil. This insulation and the adjacent conductors have the effect of a condenser or capacity, distributed through the whole coil. It acts as a dead loss, or partial short-circuit to the radio frequency current. The form on which the coil is wound is also an important factor in the reduction of this undesirable capacity. If an air core is used, there has to be some sort of support for the wire itself. Here again we have the self-supporting feature of the honeycomb type coil, while a single layer coil would have to have something to hold its turns in place, as would also a bank wound coil. Generally bakelite or cardboard tubing is used for cylindrical coils. Tubing of the thinnest possible side-wall consistent with mechanical strength should be used, which will mean that about 1/16 in. wall tubing in bakelite, and 3/32 in., or ⅛ in. in cardboard is about as thin as is safe to use, in diameters from 2 in. upwards. Cardboard tubing should be baked in an oven, and then, whilst hot, boiled in paraffine, or a mixture of resin and paraffine, to increase its strength and stiffness and to keep out the moisture, although still better is a mixture of beeswax and resin, or beeswax, resin and paraffine. Hard rubber tubing is fairly good, but it softens readily, even at comparatively low temperatures, and is weak mechanically, quite brittle and expensive.

The insulating covering of the wire which separates the adjacent turns also has a great effect on the distributed capacity of the coil, as well as on the effective radio-frequency resistance. The ideal insulation would be air, as in the case of the entire coil, but it would be of equal impossibility to use in practice. Wire is therefore sold with coverings of silk, cotton and "enamel." The silk and cotton coverings are generally made of thin spiral windings of threads; the "single" covered wire having but one covering, while the "double"-covered wire has two coverings, wound in reversed direction. Enameled wire is covered with a large number of coats of cellulose acetate. Special means are required to properly bake and season the enamel and to prevent it from cracking or peeling when the wire is bent. Sometimes additional coverings of cotton or silk are used in addition to the enamel to give the additional insulating value of the covering, as well as the high moisture-proof insulation of the enamel.

Transmitting inductances are usually wound with copper strip or tubing, although large size, high capacity "litz" wire is sometimes used. The transmitting inductances are generally wound on forms, and supported on bakelite rods, or strips, without insulation between adjacent turns other than air.

In the design of coils for receiving purposes, litzendraht is generally to be preferred, *provided* high grade, well made "litz" can be obtained. Volumes could be written on the comparative advantages of this stranded insulated wire, and probably as much could be written about its disadvantages. Generally, twisted litz is preferable, as most of the braided type has a higher resistance than the same area of solid copper would have. Litz made up of enameled wire seems to give much better results than that made up with silk or cotton between the strands. One very important factor in the use of either litz or solid wire is to avoid any conductor covered with colored or dyed fabric insulation, as these dyes may contain metallic salts, which lower the insulating value to a large extent. Enameled wire seems to have been rejected almost entirely in radio-frequency circuits, owing to its alleged high distributed capacity.

Of considerable importance is the material, or binder used to fasten the wire to the bakelite or cardboard tube. Shellac is used in many cases, as well as some of the more common types of varnish, although they are not at all suited for radio work, owing to their large moisture content. If coils wound with poor varnish are carefully baked, after assembly, they will doubtless give fair results, but if the optimum results are to be obtained, either high grade insulating varnish should be used, or some similar substance. Baking varnish is desirable, as it will be possible to bake the whole coil at a moderate temperature, which will drive out all the free moisture and, as the varnish fills the pores, the water will be kept out.

The various types of coils used in transmitting transformers, chokes and similar coils should be made with exceptional care, as these are subjected to extremely high potential strains. Bakelite varnish, or liquid bakelite, which can be baked and vulcanized, making the whole coil one mass of solid bakelite, is a very desirable method of insulating any and all types of inductances.

In receiving apparatus collodion is often used for a binder, and there seems to be no particular objection to it, although it probably does introduce a higher loss than bakelite, or some of the better grades of varnish. It is chiefly recommended where its extremely rapid drying qualities are desired, as the ether used for a solvent will dry almost instantly. Collodion is, however, made of guncotton dissolved in ether, and is dangerously inflammable, and extreme care should be exercised to keep any flames away from it or from the ether fumes arising when it drys. Even when dry it still is very inflammable and should not be used in transmitting apparatus.

The actual design of the inductances of a radio set should be given careful attention, after the mechanical problems have been solved. The wavelength of any coil is determined by the product of its inductance and capacity, usually written as LC. For any given wavelength this is always the same. For example, if the inductance is given in microhenries, and the capacity in microfarads, the constant value of inductance and capacity for 600 meters is 0.1013, or, if the capacity of a condenser is .001 mfd, and the inductance is 510 microhenries, the product, 510 x .001=0.510; now, by consulting the "*LC* Table," which appears herewith, we find that the value for 1350 meters is 0.513, so the maximum wavelength will be a trifle below 1350 meters. The exact value can be interpolated, as in a logarithmic table, but for practical purposes it is not possible to make up an inductance coil or condenser which will be accurate to the third decimal, so we may safely assume that 1350 meters is the natural period of the circuit, at maximum. If the condenser is variable, we may assume that it has a minimum value of approximately .0001, which, substituting in the above formula, .0001 x 510 = 0.513, which corresponds to a wavelength between 400 and 450 meters, which is the approximate minimum wavelength of the coil shunted by the condenser. The actual minimum value of the condenser will probably be lower than the value given, but it will be so low that the above value can be taken as an approximate safe working margin.

TABLE I

LC VALUES

Formula: Wavelength$=1885\sqrt{LC}$

Where L is the inductance in microhenries, and C is the capacity in microfarads.

Frequency, in cycles per second in middle column.

Meters	Frequency	L x C product
150	2,000,000	0.00633
180	1,667,000	0,00912
200	1,500,000	0.01126
220	1,364,000	0.01362
240	1,250,000	0.01621
260	1,154,000	0.01903
280	1,071,000	0.0221
300	1,000,000	0.0253
320	938,000	0.0288
340	883,000	0.0325
360	834,000	0.0365
380	790,000	0.0406
400	750,000	0.0450
420	715,000	0.0496
440	682,000	0.0545
460	652,000	0.0596
480	625,000	0.0649
500	600,000	0.0704
520	577,000	0.0761
540	556,000	0.0821
560	536,000	0.0883
580	517,000	0.0947
600	500,000	0.1013
650	462,000	0.1189
700	429,000	0.1379
750	400,000	0.1583
800	375,000	0.1801
850	353,000	0.203
900	333,000	0.228
1000	300,000	0.282
1000	300,000	0.292

These constants are computed as follows:

Given, Wavelength of 600 meters, find LC constant.

Wavelength (meters)$=1885\sqrt{L \times C}$.

$600=1885\sqrt{X}$.

Solving $X=0.1013$, LC Constant.

Similar substitutions can be made for any wavelength, and the value of LC determined therefor.

The above is all very well, provided the actual values of the inductance and capacity are known. In most problems the only factor that is known is the wavelength of the station to be received, or the waveband over which it is desired to receive. If the common types of variable condensers are used having a capacity of 0.001, or 0.0005 mfd. maximum, two of the factors are known and it

Continued on page 85

LEVIATHAN'S TELEGRAPH TRANSMITTER BREAKS RECORDS

By C. W. TUCKER

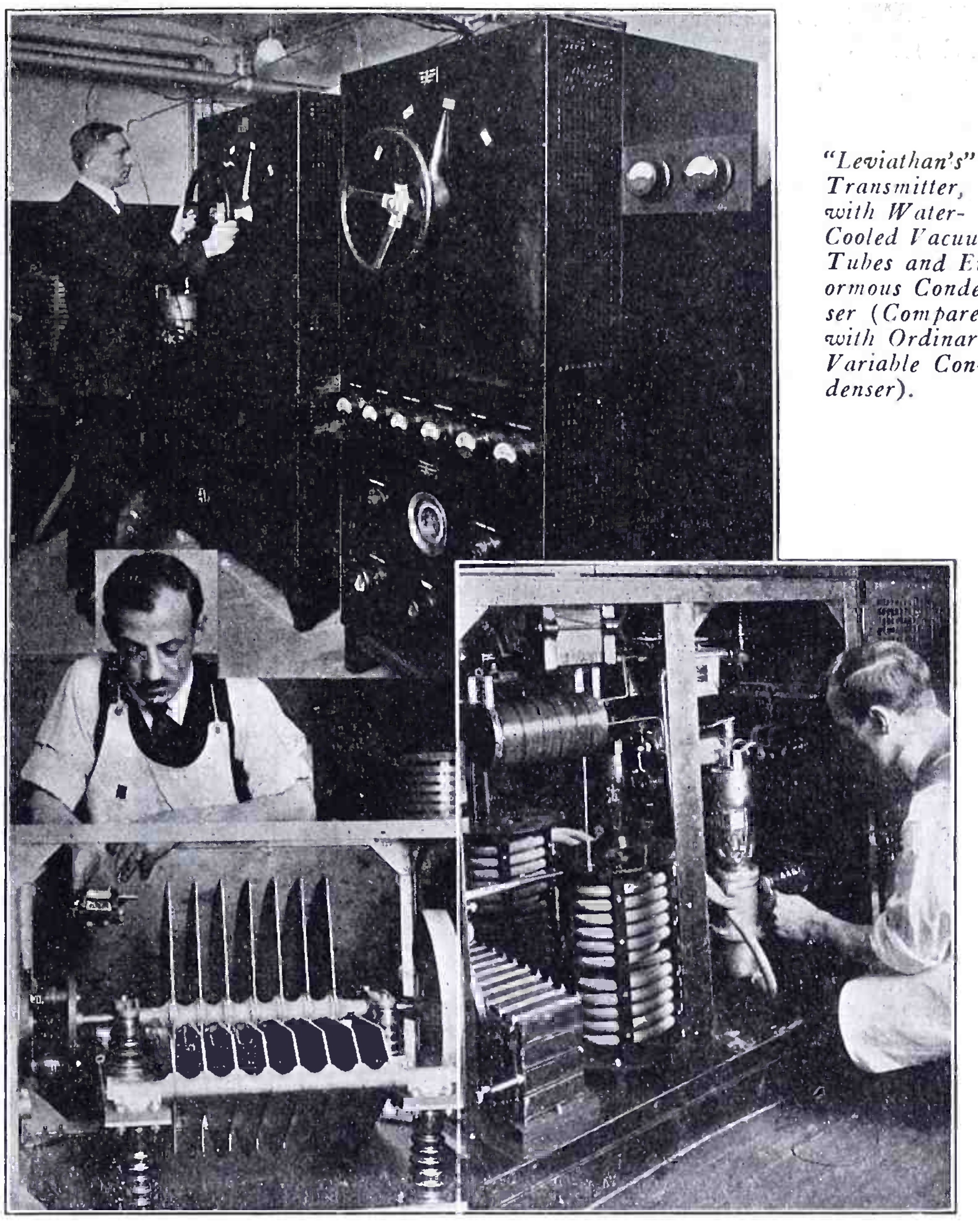
"THREE records in radio telegraph communication were broken by the *Leviathan's* high-power vacuum tube radio telegraph transmitter," said L. M. Clement, the Western Electric radio engineer who had charge of the design and construction of this powerful transmitter and who was present on the trial trip of the giant liner to witness its operation. "This transmitter handled most of the record-breaking traffic from the *Leviathan* to shore (nearly 15,000 words daily). By its means the ship was in continuous communication—day and night—with land radio stations 1000 to 1300 miles distant. The big set and a smaller one were operated simultaneously without interference to each other to facilitate the handling of this heavy traffic on the northward journey when near New York.

"The *Leviathan* was equipped with four antennas—two for sending and two for receiving. The one used by this powerful transmitter is a cage antenna 12 in. in diameter and 600 ft. long with a 'lead-in' from one end. The ship carried a corps of four R.C.A. operators who had complete charge of the operation and maintenance of this new radio telegraph installation.

"This transmitter was made possible by the 10 k.w. vacuum tubes developed in the Bell System laboratories of the American Telephone and Telegraph Company and the Western Electric Company. Two of these vacuum tubes are employed to generate the high-frequency power.

"The plates of these vacuum tubes are water-cooled," continued Mr. Clement. "In the past, the manufacture of high-power vacuum tubes has been obstructed by the fact that the heat generated in the plate could not be dissipated. This heat is caused by the force with which the little electrons traveling 1700 miles per second strike the plate—just as hammer blows will heat a piece of cold iron. This heat must be carried off or the vacuum tube will burn out. Fifty watts of power per square inch of plate surface is all that can be dissipated in vacuum tubes of the usual plate construction. The plates in the vacuum tubes used in the large broadcasting stations become very hot during operation. When W. G. Houskeeper invented his copper to glass seal, he made it possible to circulate water around the outside of the plate and to carry off in this way 28 times as much heat—1400 watts per square inch of plate surface, as could formerly be dissipated.

"As these tubes will burn out if the water supply is cut off, they are protected by a pressure indicator which breaks the circuit, cutting off the current supply when the water pressure becomes too high or too low.



"Leviathan's" Transmitter, with Water-Cooled Vacuum Tubes and Enormous Condenser (Compared with Ordinary Variable Condenser).

"It is necessary, as the plates of these tubes operate at 8500 volts, to feed the water to them through a long insulated hose which is held in two coils. To prevent excessive current leakage through the circulating water, it must be non-conducting — that is, relatively pure. For this reason salt water cannot be used for circulating purposes.

"A small pump forces this relatively pure water stored in the 20-gallon tank through the hose, coils and water jackets of the vacuum tubes. Salt water is kept flowing through a copper coil in this tank, thus keeping the circulating water cool.

"A mammoth 15-plate variable condenser is employed in the oscillator circuit of the transmitter which makes the variable condenser of the ordinary radio receiving set look like a dwarf beside this giant. The condenser plates are ⅛-in. thick, the space between the rotor and stator plates is ¾ in. The plates are so large that a 25-pound counterbalance is necessary. As this condenser operates at 14,000 volts, it is mounted on specially designed insulators.

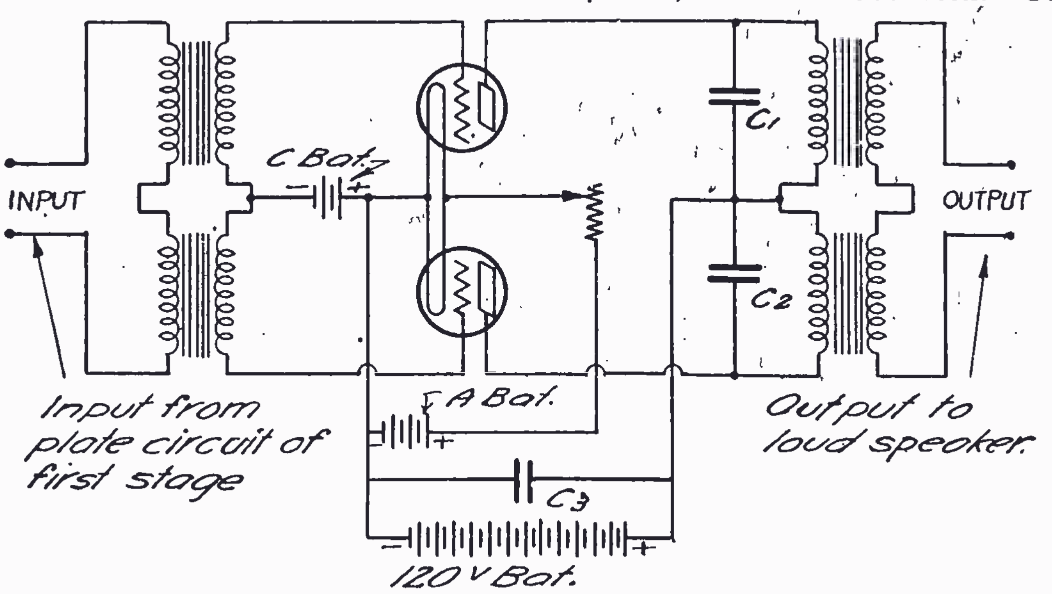
"This transmitter is designed to send messages on four different wavelengths. A rotary wave-changing switch operated by means of an automobile steering wheel permits of almost instantaneous change to any one of four wavelengths, 1800, 2100, 2400 or 2500 meters, on the *S.S. Leviathan's* antenna. Three of these wavelengths were used on the trial trip—1800, 2100 and 2500 meters—the highest and lowest were used for transmitting messages and the intermediate one for calling stations.

"Power is supplied by the ship's plant to a motor generator set which delivers 500 cycles alternating current to the transmitter. This is stepped up to the proper voltage and applied to the plate circuits of the two oscillating tubes in such a manner that the tubes function alternately. On one-half cycle of the alternating current, the plate of tube No. 1 is positive to the filament, and radio-frequency. Oscillations are set up through this tube. On the next half-cycle, the plate of this tube is negative to the filament and no current flows. At this time, however, the plate of tube No. 2 is positive to its filament, and this tube begins to function. Thus radio energy is delivered to the antenna in pulses twice per cycle of the power supply or 1000 times a second. This gives a 1000-cycle note in a crystal receiver. In an oscillating receiver circuit a beat note is also produced, which can be heard over much greater distances from the transmitting station.

PUSH - PULL CIRCUIT WITH DOUBLE TRANSFORMERS

Many amateurs who have been unable to find mid-tapped transformers for a push-pull power amplifier for a loud-speaker will be interested in knowing that one mid-tapped transformer may be replaced by two audio-frequency transformers properly connected in series. The push-pull circuit employs two tubes instead of one in the second stage, so as to prevent the distortion caused by overloading one tube.

The accompanying hook-up shows the method of connecting the tubes and transformers for the second stage of amplification. It will be noted that two input and two output transformers are used with their primary and secondary windings connected in series in the same direction around the transformer cores. In the input transformers connection to the negative of the *C* battery is made between the two secondary windings. In the output transformers connection to the positive of the *B* battery is made between the two primary windings. The input transformers should have a 3:1 ratio and the output transformers a 1:1 ratio.



Push-Pull Circuit with Double Transformers

Similar results with slightly less amplification may be secured by shunting the respective secondaries and primaries of single transformers with a resistance whose mid-point is tapped.

The theory of the push-pull circuit is that one tube is working on one-half the cycle of the audio-frequency wave and the other tube during the other half of the cycle. Ordinary amplifier tubes can be used.

The difficulties in finding the sensitive points of a crystal detector with a single cat-whisker may be obviated by using a "brush" made from steel wool such as is sold for domestic use in cleaning pots and pans. Steel wool consists of a bunch of very fine wires which may be straightened and bound together in a small brush wrapped with heavier wire. The ends are clipped evenly with a pair of shears.

LOADING THE 5-WATTER

By 6EB.

Having received many letters asking numerous questions concerning my article, "How to get 50 watts out of 5 watts," in June RADIO, I will answer a few of the more important ones asked, for the benefit of others who may try out this stunt.

It seems that some of the fellows have had hard luck in sadly seeing their tubes "cash-in." Probably the cause was putting on such high voltage to begin with. Voltage should be applied in this case very slowly, say starting out at 550, 750, 1000, and then 1500 volts. Use each voltage several days and in this way you will "harden" the tube and give it a higher vacuum which will stand the voltage and work without any trouble.

Others were puzzled about the words, "Magnet transoil." That is the name of the transformer oil I happened to have on hand, which is pretty thin and transparent. It can be bought only in 5-gallon cans or by the barrel. If you do not know of a friend who has this kind or any other kind of transformer oil on hand, you can purchase small quantities of boiled linseed or castor oil. Most any kind of insulating oil will do.

They ask if the oil became heated. Yes, after about 3 hours of operating at intervals of 10 minutes each. I would suggest using a larger container for the oil. This would take the tube longer to heat up a larger surface of oil and would also allow longer operation. Use a larger glass or crockery jar and place the tube up-side-down in same with a few pieces of lead or something heavy fastened to a wire frame and slipped over the tube to hold it down in the oil, as it will try to rise to the surface.

Now about taking the base off of the tube. An easier way I found was to use a thin gas flame, probably one from a baby soldering torch or anything similar to this, and place it so that the flame will strike the brass base of the tube. The solder on the prongs along with the sealing wax will melt very quickly. Then you can slide the whole works away from the glass and wire terminals. Be very careful not to heat the glass too much. Now solder some No. 18 bell wire to the terminals of the tube and run them over the edge of the jar as shown in June RADIO.

The funniest thing I ever heard of was when an amateur wrote me and said that he had 10 watts "pickled" in pint pars and worked the middle states from this coast, handling 22 messages and clearing "nil" with a bunch of "dx" before the castor oil heated. FB! Then he stopped the set and went to bed. Next day he started up the set and found the tubes were dead or soft, and although the plates got white hot there was no radiation shown. After two or three days' rest the tubes came back to life! (Wish the filaments in tubes would act this way.) Try tapping a tube lightly when a filament burns out and often they weld together if a voltage about one-half of the normal filament voltage of a tube is applied.

A little more about high milliamperes on the plate of a tube. I made several tests with eastern fellows and found that radiation does not always count. Using a 50-watt tube with 1500 volts, 150 mils. synchronous rectifier with no filter, and getting 5.4 T.C. amperes on 215 meters, the distant stations reported my signals much stronger after I immediately cut my voltage to 1000, raised the mils. to 250 and cut the wave to 195 meters, and getting 3.4 T.C. amperes with rectifier. The filament voltage was 11. Do not try to use much more than the normal plate voltage of the tube in this case or you will have trouble. Keep the grid current low. By this, I mean do not cause the plate to have a white spot on it or there will be a hole in it in no time. It must be the same color all over. I never had any trouble this way except once when I dropped the mils. from 450 to 100 and cooled the glass too quickly. Then the tube exploded!

Technically, all this does not seem right, but, practically, *it works.*

READERS OF "RADIO" BUY $6,000,000 WORTH OF RADIO SUPPLIES ANNUALLY

In the June issue of RADIO was published a questionnaire calling for information on how much money is spent yearly by our subscribers for radio apparatus advertised in the columns of RADIO. From the returns received to date, we find that the average subscriber spends $175 per year, and of this amount $100 per year is spent for supplies advertised in RADIO. The balance of $75 per month is spent for supplies not advertised in RADIO. The lowest amount spent per year, the questionnaires show, is $20. The highest amount, $500. On this basis it is conservative to estimate that the 60,000 buyers of RADIO are also buyers of six million dollars' worth of advertised radio supplies annually.

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.

I have a single-circuit tuner consisting of vario-coupler, variometer, .001 condenser, and a WD-11 tube. The set does not work properly, and the tube does not light. What is wrong?

D. S., Dallas, Texas.

The circuit as you now have it is wrong. See Fig. 1 for a corrected diagram. If the tube does not light, test all connections to the socket, and check out the filament battery leads. Perhaps the tube is burned out, which may account for all your trouble.

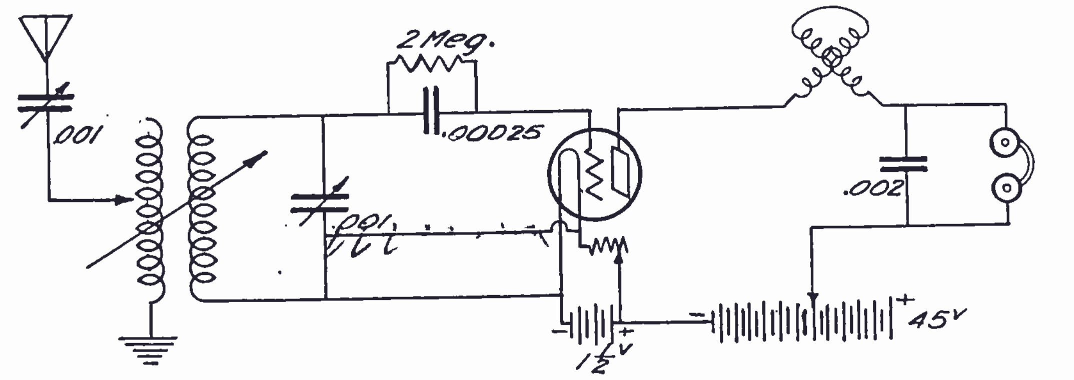


Fig. 1

Why does the radiation of my C. W. set equal 1.4 amperes when the key is first depressed, and then drop to 1.1 amperes after a minute or so?

J. F. W., Jr., Boston, Mass.

This may be caused by several things, the principal one being a drop in potential of your plate supply. This would be particularly true if your plate voltage is obtained from a storage battery. If the plates of the tubes are excessively heated, the radiation may be reduced, especially if the tube has become slightly soft through hard usage.

Please publish a circuit using a Ford spark coil for plate voltage supply in the radiophone described on Page 11 of March RADIO. What is wrong with the enclosed hook-up?

E. S., Yosemite, Calif.

A. C. from a spark coil will not operate the radiophone mentioned above. You must have a supply of direct current to operate any radio telephone, either from storage batteries, generator or rectifier. If you remove the variometer bridged across the loop in your circuit, it should work O.K.

Please publish a reversed feed-back transmitter with one oscillator and one modulator tube, with switches to use both tubes as oscillators when desired. Which is the best solution to use in electrolytic rectifiers and how many jars are necessary for either 5 or 50-watt tubes? What is the object of condensers across the filament secondary? What secondary voltage should be maintained for supplying five 5-watt tubes, through a rectifier and filter system?

J. V. R., San Francisco, Calif.

The circuit you wish is shown in Fig. 2. A solution of borax in distilled water is satisfactory. This solution must be concentrated for best results. At least one jar for every 50 volts should be the rule for either 5 or 50-watt tubes. The condensers across the secondary of the filament lighting transformer in any C. W. set are to by-pass the radio-frequency around the transformer, as the transformer usually does not have enough distributed capacity in its secondary circuit to by-pass the radio-frequency current. A secondary voltage of 600 should supply 500 volts direct current to the transmitter, through the rectifier and filter.

How can I reduce the voltage of my 1000-volt C. W. transformer, in order that I may operate two 5-watt tubes?

J. J. O'C., San Francisco, Calif.

The simplest method is to use a pair of Ward Leonard 5000-ohm resistances, one in each transformer lead. It would not help to use more rectifier jars, and the resistance is the easiest method available.

Please publish a circuit for a 10-watt C. W. set which can be used for either telephony or telegraphy. I wish to use loop modulation if possible. What is the approximate radiation that I might expect with this set?

R. W. S., Pasadena, Calif.

The circuit is shown in Fig. 2, for either loop modulation or Heising modulation. With a good antenna, a radiation of 1.5 amperes would be about normal.

Kindly answer the following questions on vacuum tube operation:

Should the grid return be connected to the positive or negative side of the "A" battery?

Should the rheostat be connected in the positive or negative side of the "A" battery?

Should the grid return be connected on the battery or filament side of the filament rheostat?

Should the negative "B" battery be connected to the positive or negative side of the "A" battery?

The majority of vacuum tube circuits differ on these points.

O. I. O., Ambrose, N. Dak.

The position of the grid return depends entirely upon the kind of tube used, and the position of the tube in the circuit. A detector should always have its grid return-circuit connected to the positive side of the filament, on the fila-

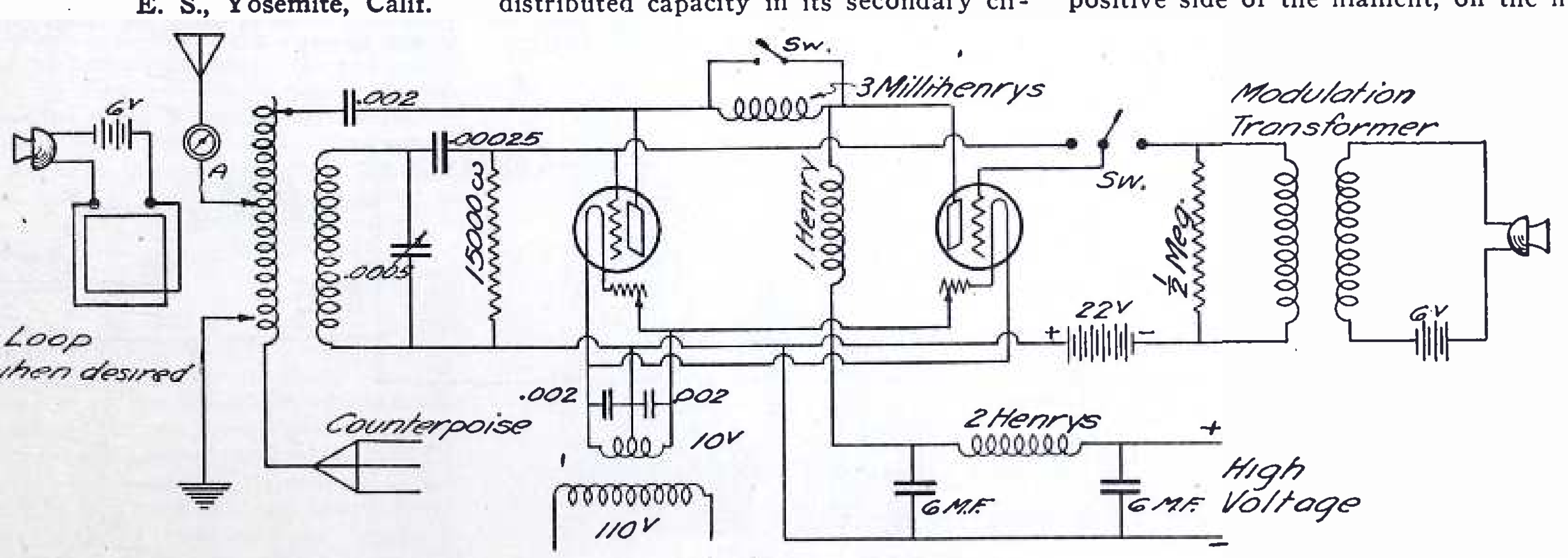


Fig. 2

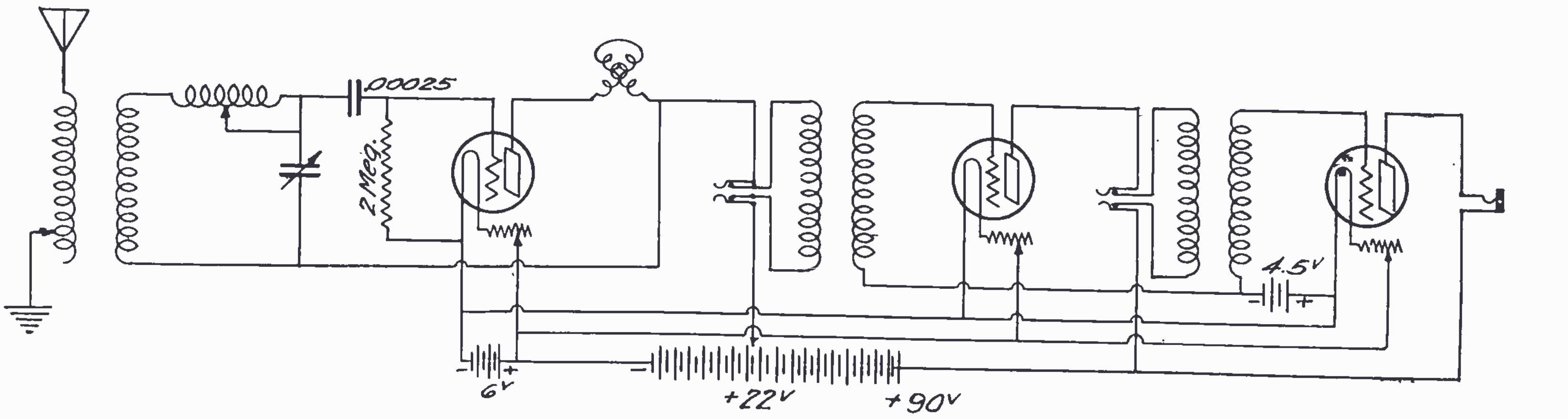


Fig. 3

ment side of the rheostat. The rheostat, whether for detector or amplifier, should be in the positive lead to the "A" battery, unless the rheostat is to be used to provide a negative grid potential to the tube, in which case it should be in the negative lead. The grid return to any amplifier must be the negative side of the filament. Where "C" or grid biasing batteries are used, the positive side of the "C" battery is connected to the negative side of the filament, and the negative of the "C" battery goes to the grid return-circuit. If no "C" battery is used, then the rheostat MUST be in the negative side of the filament circuit, and the grid return connected so that it must always pass through whatever part of the rheostat that is in the circuit.

It makes only a small difference whether the "B" battery is connected to the positive or negative side of the "A" battery, although the former is the customary connection.

Please publish a two-stage audio-frequency amplifier for use in connection with the receiver described by Six Zee Jay on page 31 of July RADIO.
G. C. G., Fall River Mills, Calif.

The circuit you wish is shown in Fig. 3.

Can I place a single-stage radio-frequency amplifier ahead of my three-circuit tuner, as per enclosed diagram, and obtain good results? L. L., San Jose, Calif.

Your circuit is correct, and you should be able to receive a much greater distance with the additional amplifier.

Please publish a circuit for four 5-watt tubes, for telegraphy only, using the Hartley circuit. I would like to use a motor-generator set, and a.c. on the filaments. W. A. M., Johnstown, Pa.

This circuit is shown in Fig. 4.

Can you give me a circuit for radio-telephone transmission, using a loop around the primary coil for modulation?
W. B., Bakersfield, Calif.

Fig. 2 shows such an arrangement, for either loop or vacuum tube modulation.

On page 34 of June RADIO appears an article by L. F. Seefred. Can you give me his address? Are both primary and secondary coils of any audio-frequency amplifying transformer wound in the same direction? Please give me the specifications for an audio-frequency transformer using the same size wire as the enclosed sample.
L. W. B., Corvallis, Ore.

Mr. Seefred's address is 343 So. Fremont St., Los Angeles, Calif. It is customary to wind both primary and secondary of audio-frequency transformers in the same direction. Sorry, but you did not enclose the sample of wire.

Where would I place a microphone in my single-circuit receiver, in order to transmit radio-telephone signals?
W. C., Los Angeles, Calif.

The microphone may be placed in the ground lead.

Can a bell-ringing transformer be used to light the filament of a detector tube? Please publish a circuit for a one-tube reflex. T. C. H., Redlands, Calif.

An arrangement for lighting the filament of a detector tube with 6 volts a.c.

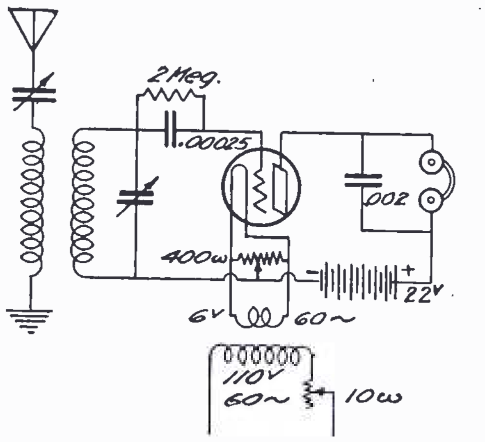


Fig. 5

is shown in Fig. 5. The article by Arthur Hobart, on page 27 of May RADIO gives the reflex circuit you wish.

I have a Westinghouse Rectigon 50-cycle battery charger which I wish to use for charging my 24-volt "B" battery. Is a resistance or special circuit necessary? S. N. P., Van Nuys, Calif.

The charging rate of the rectifier at 24 volts will probably be low enough to use with your "B" battery without a resistance or other special circuit.

What is the right value for the grid condenser used with the WD-11 tube?
A. B., San Francisco, Calif.

A condenser of .00025 mfd. capacity is correct.

BOOK REVIEWS

Elements of Radio Communication, by Ellery W. Stone, 318 pp. 5x7½ in., published by D. Van Nostrand Co., New York City; price $2.50.

This, the second edition of the author's "Elements of Radiotelegraphy," published in 1919, contains considerable new material resulting from the progress in the art during the past four years. It is a text book for school or home study. Originally intended for the guidance of radio students in the Communication Service of the Navy, the physical rather than mathematical presentation of the subject makes it well adapted for the instruction of the layman. Starting with an explanation of elementary electrical terms, their application to transmitting and receiving equipment is treated in historical order. Considerable more space is given to spark and arc than to tube apparatus, with the result that the book gives a well-defined background and a lightly-sketched foreground of the picture of radio. Consequently while it is just the thing for helping the amateur who wants to qualify for a commercial license or go into Navy work, it is not as well adapted to the needs of the man who wants to know the how and why of his own modern equipment. As a whole, the text is well above the average and constitutes a valuable addition to the radio library.

The Radio Manufacturing Co. of Springfield, Mass., have issued instructions and diagrams for the use of their radio-frequency transformer. This is tuned with a variable condenser so as to cover the range from 250 to 600 meters.

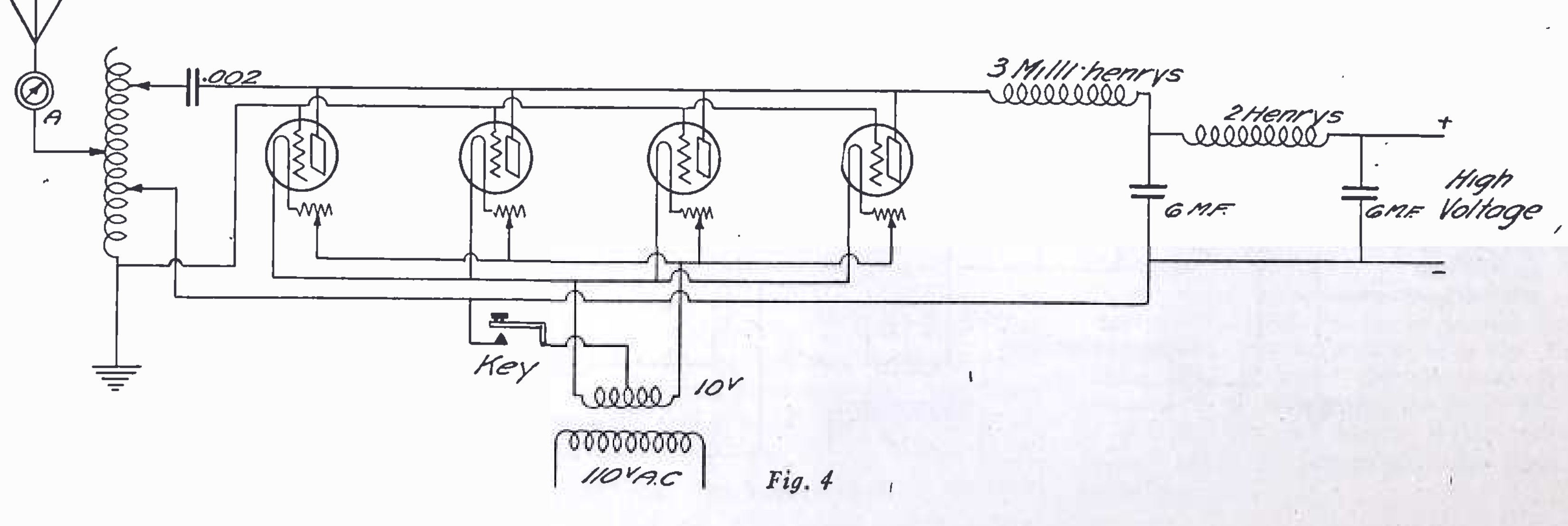


Fig. 4

I. R. E. MEDAL AWARDED TO JOHN STONE STONE

In recognition of his pioneer work in radio, Mr. John Stone Stone has been awarded the medal of the Institute of Radio Engineers, pictures of which appear herewith. The presentation is to be made at San Francisco on August 31st by Col. J. F. Dillon, supervisor of the sixth radio district. An assemblage of distinguished radio men will be in attendance to honor Mr. Stone, who is now doing research work at San Diego, Calif., as a member of the engineering staff of the American Telephone & Telegraph Co. Invitations to the meeting, which is to be held at the Engineers' Club, San Francisco, may be secured by writing to Col. J. F. Dillon, Custom House, San Francisco.

Mr. Stone has been intimately concerned with the development of radio during the last twenty-five years, all of which he saw and much of which he was. He was born in Dover, Va., September 26, 1869. Early in life he was an apt student of mathematics and physics (the study of which he began under the able tutelage of his father, Gen. Charles Pomeroy Stone, in Egypt, where his early childhood was largely passed). Upon the return of his parents to the United States in 1883 he continued his education at Columbia University, New York City, and at Johns Hopkins University, Baltimore, Maryland.

In 1889 he represented the American Bell Telephone Company at the Paris Exposition, where he installed and operated throughout the American section the American telephone system which at that time was even more superior to the European system than it is today. From 1890 to 1899 he was experimentalist and expert in the laboratory of the American Bell Telephone Company at Boston. He was a consulting electrical engineer from 1899 to 1902, where he became chief engineer of the Stone Telegraph and Telephone Company, which was organized to assist him to develop his radio inventions. He was special lecturer on Electrical Oscillations and their Applications at the Massachusetts Institute of Technology from 1898 to 1903.

He has been granted more than 120 U. S. patents and a corresponding number in foreign countries covering various inventions, including a system for centralizing the energy in telephone systems in 1893, which came into very general use in the United States and abroad. In 1897 a patent was granted to him for the first operative method of increasing the efficiency of telephone cables by the increase of the inductance of the cable. His method, however, was later superceded by an improved method patented by Prof. M. I. Pupin, of Columbia University. In 1902 and 1903 he took out a group of patents covering his so-called loose-coupling system of selective radio telegraphy, and also in 1903 patents describing the first application of electrical resonance to the useful arts, on applications filed in the Patent Office nine years earlier. The system described in these earlier patents first utilizing the principle of electrical resonance has since been popularly christened "Wired Wireless." The engineers of the American Telephone and Telegraph Company have recently reduced this system to actual practice and it is now beginning to be extensively exploited, under the title of "The carrier current system of multiple telephony over wires." He was also granted early patents for a system of radio telegraphy in which the messages are automatically rendered secret, or illegible, except at the station at which they are intended to be received, for automatically relaying messages from station to station, a system by which ships at sea might determine their bearings by radio telegraphic communication with shore stations, and also for a system of radio telephony, some of the features of which are still in very general use. His early radio patents contain so full and clear an exposition of the underlying theory and such a wealth of bibliography that they constitute a veritable treatise on the theory and early history of radio telegraphy and telephony.

Obverse of I. R. E. Medal

Reverse of I. R. E. Medal

His more recent work has been largely in the field of what is called "directive radio." In such a system the radio waves are directed in the form of a beam from the transmitting station to the particular receiving station with which it is desired to communicate, and similarly the receiving station is enabled to focus its receptivity in the direction of the trans-

Continued on page 50

HONORS AWARDED WORTHY OPERATORS

Official valor, personal heroism, and the courageous discharge of duty in the face of grave danger, received high recognition in Los Angeles on July 12, when three radio operators of the steamship *City of Honolulu,* burned and abandoned at sea, were presented with gold medals and personal checks for $500 each, by Mayor Cryer at the instance of the Radio Corporation of America. The men thus signally honored were W. P. Bell, chief operator, and his two assistants, H. D. Hancock and N. C. Kumler. These three, on October 12, 1922, affixed their names to one of the most stirring chapters of Pacific radio history, when, with a burning ship sinking under their feet, they stuck to their respective posts and summoned aid which resulted in the saving of the 250 passengers and crew, in mid-ocean, without loss of a single life.

In recognition for this service, the Radio Corporation medal for distinguished and meritorious conduct on duty, and checks, were awarded them. The presentations were made on the balcony of the city hall at Los Angeles, in the presence of city and county officials, representatives of steamship companies and other shipping interests, radio company heads, the owners of the steamship *City of Honolulu* and others.

In presenting the medals, Mayor Cryer paid a high tribute to the qualities demonstrated by the men who have given their lives to the radio work at sea under dangerous conditions.

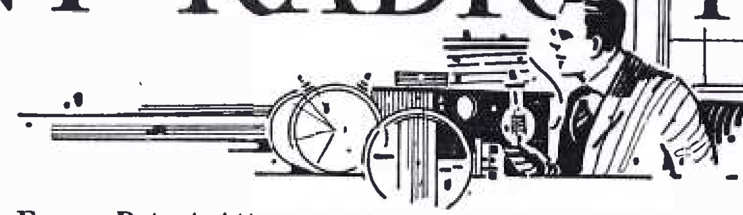
"It is my privilege," he said, "to voice the sentiments of the people of Los Angeles and Southern California, as an expression of our responsiveness to a fine sample of American heroism, loyalty to duty and acceptance of responsibility by three young men, which resulted in the saving of the lives of 250 of our people, as well as an appreciation of the miracle of radio communication, the instrument through which their loyalty and faithfulness was manifested. We marvel at the scientific achievement, and remember, too, that without the human soul such inventions would be of little use."

The medals, struck off by the Radio Corporation for the three operators, were designed and executed by Tiffany of New York. On one side they bear the replica of a steamship under full power, with the inscription: "Radio Corporation of America Medal." On

Continued on page 60

Presentation by Mayor Cryer to Operators Kumler, Bell and Hancock, with Arthur A. Isbell at Right

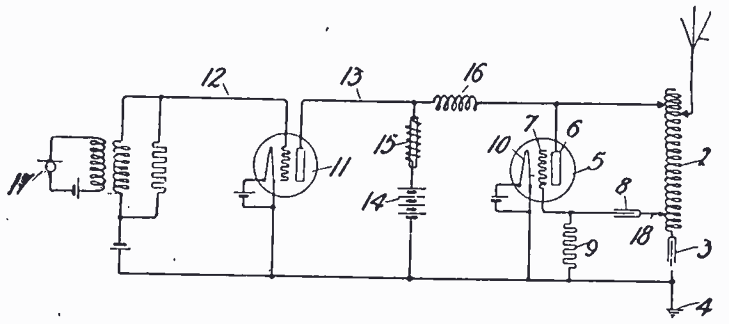
DIGEST OF RECENT RADIO PATENTS



Prepared by White, Prost & Evans, Patent Attorneys, San Francisco, who have been particularly active in the radio field for many years, and from whom may be obtained further information regarding any of the patents listed below.

J. F. Farrington, Pat. No. 1,452,032: April 17, 1923. Oscillation Generator for Signaling Systems.

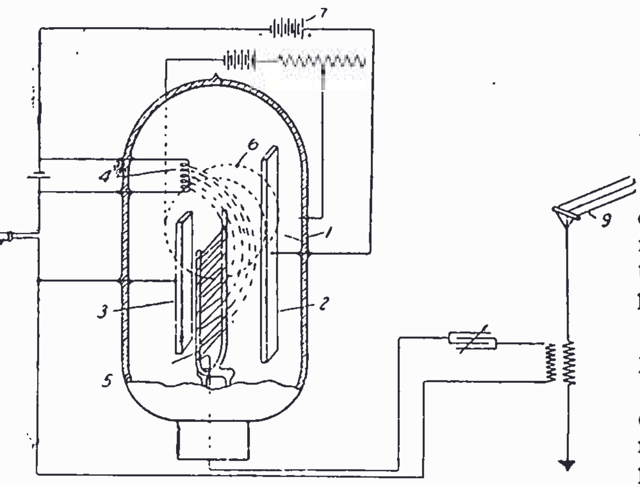
A vacuum tube oscillator *5* is described, which is so arranged that the feed-back coupling may be adjusted without interfering with the tuning of the oscillation circuit *1-2-3-4*. This is accomplished by bridging the filament and plate of the tube across the inductance *2* and capacity *3*. The feed-back coupling is accomplished by connecting the grid *7* to a



variable point of the inductance *2*. This does not interfere with the antenna tuning, although it permits a variation in amplitude by shifting this point of connection. The tube *11* is a modulator.

C. T. Allcutt, Pat. No. 1,450,275: April 3, 1923. Wireless Amplifier.

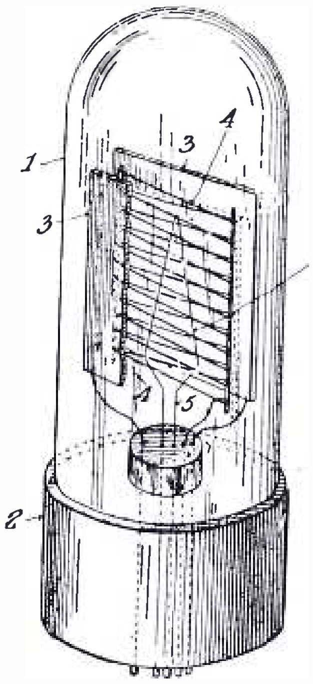
In order to increase the effectiveness of thermionic devices, it is proposed to



arrange matters in such a way that the grid or control electrode *5* acts on the stream of electrons only after its velocity has been materially reduced, and in this way the harmful accumulation of a charge on the grid is hindered. To accomplish this result a positively charged electrode *2* is added to the *3*-electrode arrangements, and a magnetic field is produced by coil *6* to cause the electrons to travel in the manner indicated by the dotted lines, and to reach the grid *5* at low velocity. The plate *3* is the usual cold electrode.

J. L. Bradford, Pat. No. 1,453,267: May 1, 1923. Electron Emitting Cathode and Method of Making the Same.

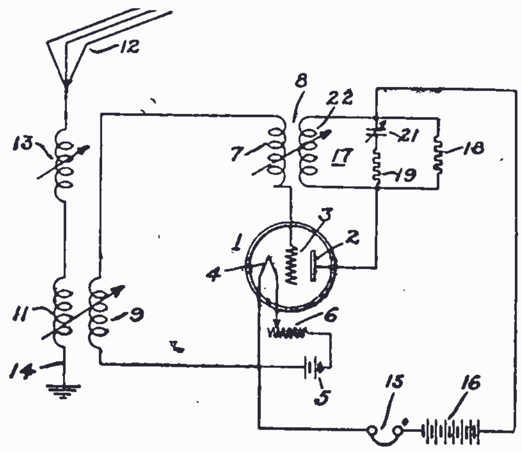
An electron discharge tube is described, in which the filament *5* has very good electron emission qualities, even when comparatively low temperatures are employed. In this way the life of the tube is very materially increased. In order to accomplish this purpose, the filament *5* is made of a homogeneous mixture of a metal base, such as tungsten, alkali oxides, and a chloride. These materials in the form of finely-divided particles are subjected to a heat almost sufficient to



melt the metal base, after which it is worked into filamentary form. One recommended composition is: 95% by weight of the metal base, and 5% of an oxide and chloride mixture. This latter mixture may have the following proportions: 60% strontium oxide, 30% barium peroxide, and 10% palladium chloride.

J. Slepian, Pat. No. 1,455,767: May 15, 1923. Wireless Receiving System.

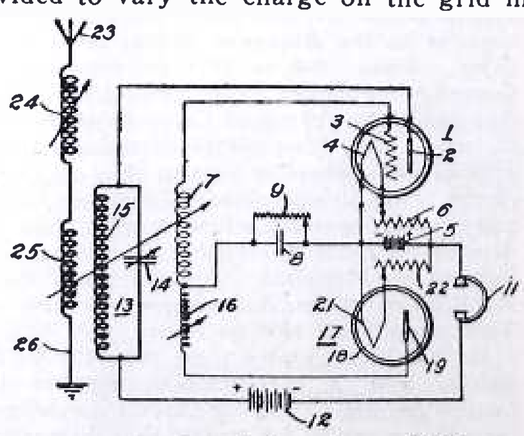
An oscillating audion for receiving is described, in which the circuit arrangements are such that the oscillations are produced intermittently, the intensities being increased upon reception of a signal. For this purpose the output and input circuits of tube *1* are coupled together as by transformer *8*, and the circuit including coil *22* and condenser *21* is tuned to the radio-frequency oscillations. The coupling is made such that it is capable of supporting oscillations. Included in the tuned circuit is a resistor *19* that has a thermal time lag and a positive temperature co-efficient. Thus after a small interval of large intensity oscillations caused by the reception of a signal, the amplitudes are damped materially. In order to increase this effect, a resistance *18* of negative temperature co-efficient and a small thermal time lag is shunted across the tuned circuit, and at intervals is active to by-pass a large portion of the current from the coupling coil *22*, thus reducing the feed-back effect. This cycle may be repeated by proper design of the resistances, either at an



audio rate for receiving constant wave telegraphic signals, or at a super audio rate for telephonic messages.

J. Slepian, Pat. No. 1,455,768: May 15, 1923. Wireless Receiving System.

In order to obviate the usual heterodyning step in receiving constant wave telegraphic signals, or to increase amplification for telephonic signals, a regenerative tube *1* is provided as a detector, which inherently produces intermittent oscillations. To accomplish this, use is made of the observed fact that if the grid condenser *8* is permitted to build up a sufficiently high charge, depending on the tube limits, it will produce tube oscillations which are intermittent. In order to control the intensity of these oscillations in accordance with the intensities of the received signals, an arrangement is provided to vary the charge on the grid in



response to signal impulses. This arrangement includes a coil *16* inductively coupled to the antenna circuit, and a rectifying tube *17*, connected across the condenser *8*. The grid leak *9* is so adjusted that the oscillations tend to start even for small signal intensities. Furthermore, with this arrangement it is possible to control the rate at which the groups of oscillations are produced, so that they may take place either at an audio rate for receiving constant wave signals or else at a super audio rate for amplifying telephonic signals.

WITH THE AMATEUR OPERATORS

RADIO STATION 9US

9US, owned and operated by V. A. Kamin at Chicago, Ill., with T. R. Lowenthal and G. Z. Weston as assistant operators, has been recently remodeled and now includes a 200-watt C. W. transmitter in its equipment. The new unit, as shown at the left of the picture, is assembled on a panel 18x24 in. with four rectangular bezels at the top. In the center can be seen three meters: milli, amp-radiation, and volt-meters repectively. Directly below is the filament control rheostat which is varied by means of a nickel-plated control handle. On either side and in the lower corners are two nickel-plated tumbler switches; the one on the left controlling the filament current, while that on the right breaks the M. G. circuit. The wiring of the C. W. set throughout is with 3/8-in. tubing.

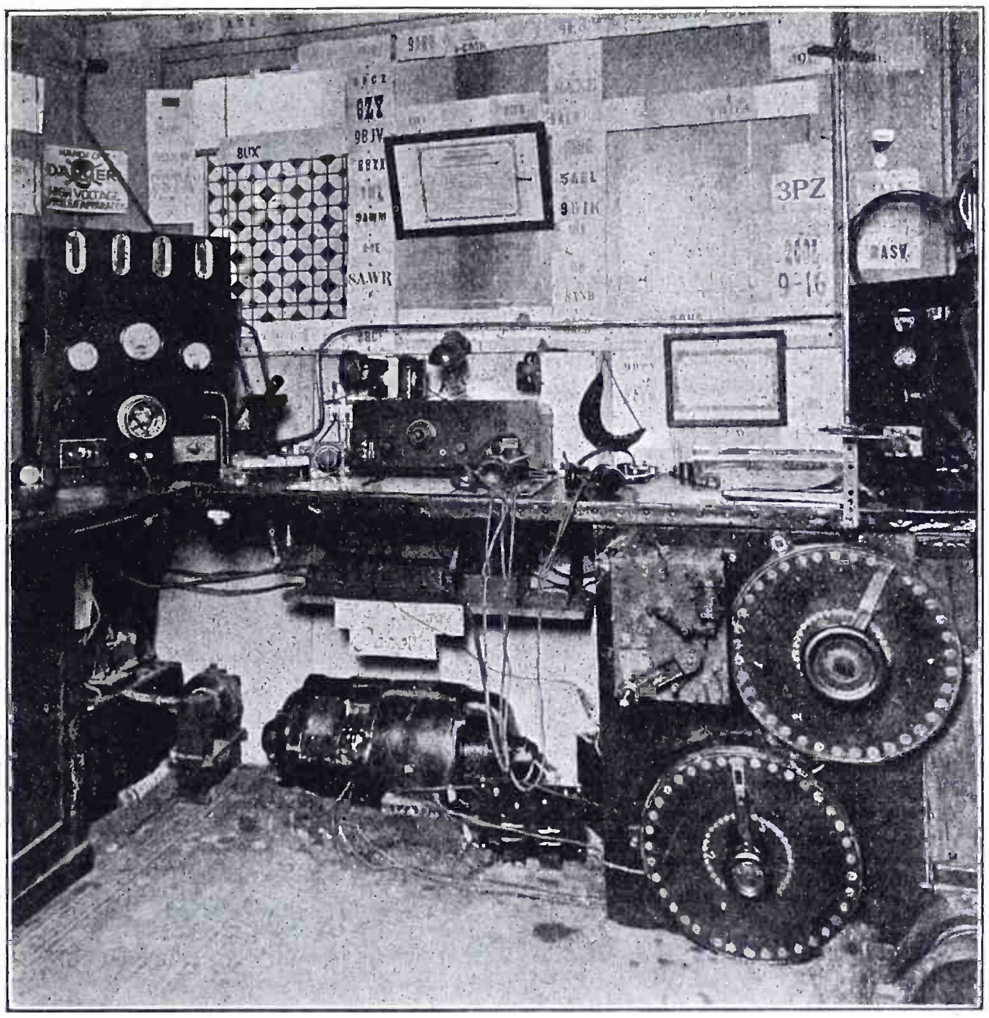
This outfit comprises four 50-watt tubes as oscillators. The connections resemble Colpitt's circuit. The tubes are mounted at the back; each directly behind a bezel upon a bakelite panel, supported by brass angle strips. The inductance, an R. C. A., is seen to the rear of the tubes. Below the tube support is the filament lighting transformer rewound on an old spark core. A De Forest oil-immersed condenser is used in the ground lead. The source of power is a G. E. two-bearing machine which supplies 2000 volts at one-half ampere. This current can be reduced to 1000 volts at one ampere by varying the field rheostats (shown on the extreme right). The motor is 1½ horse-power and runs at 1800 r.p.m. 72 segments in the commutator when filtered supply wonderfully clear current to the plates.

The station also has a 1 kw. spark transmitter with Acme transformer, glass plate condenser, rotary-gap, and heavy O. T.

To the right of the C. W. transmitter can be seen the 200-meter D.X. receiver consisting of Turney spiderweb coils, detector and two stages of audio-frequency. The selectivity of this unit is unsurpassed. Due to occasional heavy local q.r.m., a one-tube reflex set is used with a loop antenna shown in the extreme right corner.

Baldwin phones and a Magnavox are used for reproducing the "dope" to the ears of the operators. A separate M. G. (a rewound Delco) charges the *A* batteries. A view of the panel controlling this unit can be seen at extreme right-hand corner.

The "dope" is copied on a Harris Visible mill. The station is equipped with a private Bell telephone for efficient handling of A.R.R.L. messages and also to subdue local q.r.m. A Marconi change-over switch with several modifications permits operating any of the units. All of the apparatus has been constructed by the operator.



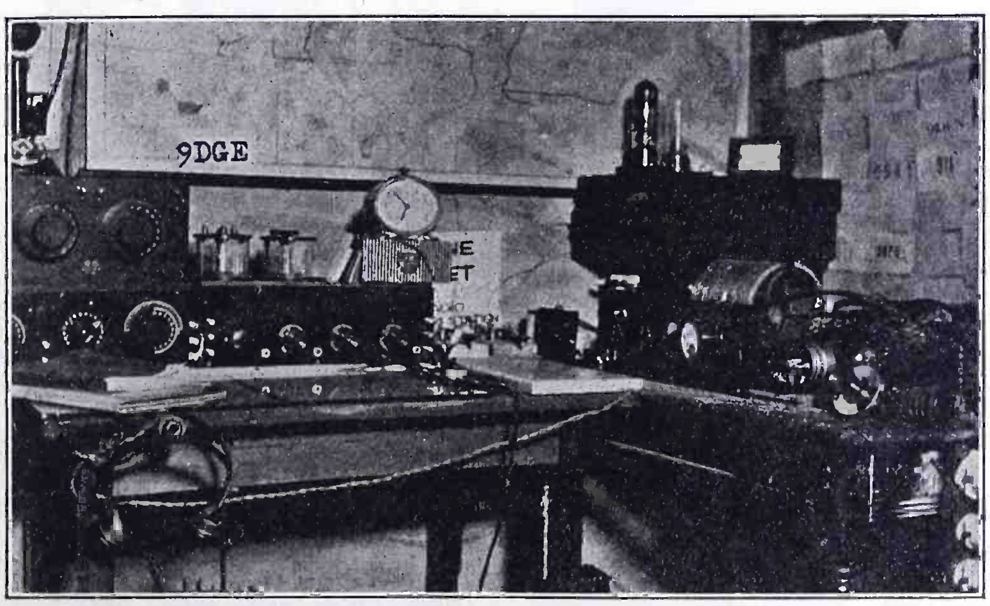
Radio Station 9US

The aerial is suspended between two steel masts—the one on "the lead-in end" 55 ft. high; the other on the open end 80 ft. high. The length is 40 ft. The spreaders are 14 ft. wide on the closed end and 26 ft. on the open end. Five wires in the flat-top with a tapering cage lead-in; all of the aerial wire is No. 12 solid Belden enamel. The insulators are rod type, heavy glazed porcelain. The counterpoise ground is buried directly under the aerial at a depth of six ft., in clay which is moist the year round. It is composed of three strips of heavy galvanized metal, spaced 9 ft. apart. Each strip is 14 in. wide and 50 ft. long. When they were laid in the 6-ft. ditches, three 6-ft. ground rods were driven through each strip, one at each end, and one in the middle. All this was then soldered.

The ground connections come together fan-shape, and are insulated all the way to the set, thereby eliminating any possibility of a "high-resistance" ground before the energy reaches the proper ground.

RADIO STATION 9DGE

9DGE is operated at Minneapolis, Minn., by H. Olson. As described in his own words, the set consists of a single UV 204 wi the reversed feed-back circuit. The plate supply is frm a 750 watt Thordason wi 60 qt jar rec. wi 6 mf filter cond 2-3000 volt mid-tap. The set operates as 10¼ T.C.A. at 300 mils. The large cabinet in the back ground is a large chke fr fone. Hve wrkd S.C. on fone as well as Col,Mich,S Dak,O and MO. Use grid modulation wi WE mic Rad abt 6 TCA Antenna is 4 wire inverted L 50ft long 70ft high, cage leads thru out set.28 wire counterpoise wi tunedgrd.Set has been hrd in all states & Can,Alaska,PrinceRupert,Hawaii, Porto Rico, Cuba,Panama,Mex,also in sub NPX at 2400 miles at sea. Receiver Grebe CR2 also single circuit wi 3 step amp WE fones.



Radio Station 9DGE

NEWS OF THE AMATEUR OPERATORS

7FH, which has been operated by Kenneth C. Stone at Junction City, Ore., was completely destroyed by fire recently and will be off the air for some time to come.

Reg. Charlesworth, 173 Paramatta Road, Haberfield, Sydney, Australia, is the owner of a very efficient C. W. set. He has been doing some remarkably good distance work in Australia and wishes to attempt communication with American amateurs, in particular those on the West Coast. The best time for establishing communication between Australia and the United States would be in the months of September, October and November, when the Australian winter has just ended and ours is just beginning. Any amateur who wishes to make tests with Mr. Charlesworth is invited to communicate with him at the above address.

Call 9DQH has been assigned to George Smith, 523 3rd Ave. S. E., Minneapolis, Minn. He wants QSL on his sigs and will answer all cards.

Call 6KJ has been issued to Ernest N. Penrose of Grass Valley, Calif. He has a 20-watt C. W. set.

Rev. J. D. Dumas, Aleipata, British Samoa, heard 6CGW (R. L. Riedman, Long Beach, Calif.), on June 15th.

6CLB has been re-assigned to M. R. Mitchell, 5643 Shafter Ave., Oakland, Calif.

Radio 6AKW has been changed to 6AJH. The station is operated by Lee Roy Potter, R.F.D. No. 1, Lancaster, Calif.

RADIO STATION 5KC

5KC, owned and operated by Vincent Rosso at Plaquemine, La., is one of the low-power C. W. stations that is doing excellent work. Using four so-called 5-watt tubes, the signals of 5KC have been reported from one time and another in every state of the Union, Hawaii, Porto Rico, Panama, Canada, Mexico and Cuba. The best record of the station was made on Jan. 10th, when *S.S. Easterner* copied the signals of 5KC with one tube 2100 miles east of Sidney, Australia, or 6000 miles from 5KC. Next record was on March 19, when 5KC broadcasted blind on schedule to Mr. C. G. Brown at Ancon, Panama, and Mr. Brown acknowledged the reception O.K. by a cablegram. Now all traffic for Panama should be routed via station 5KC.

The receiver on the left is a three-circuit short-wave regenerative with detector and three stages of audio-frequency, but for the reception of amateur's signals only one step is used.

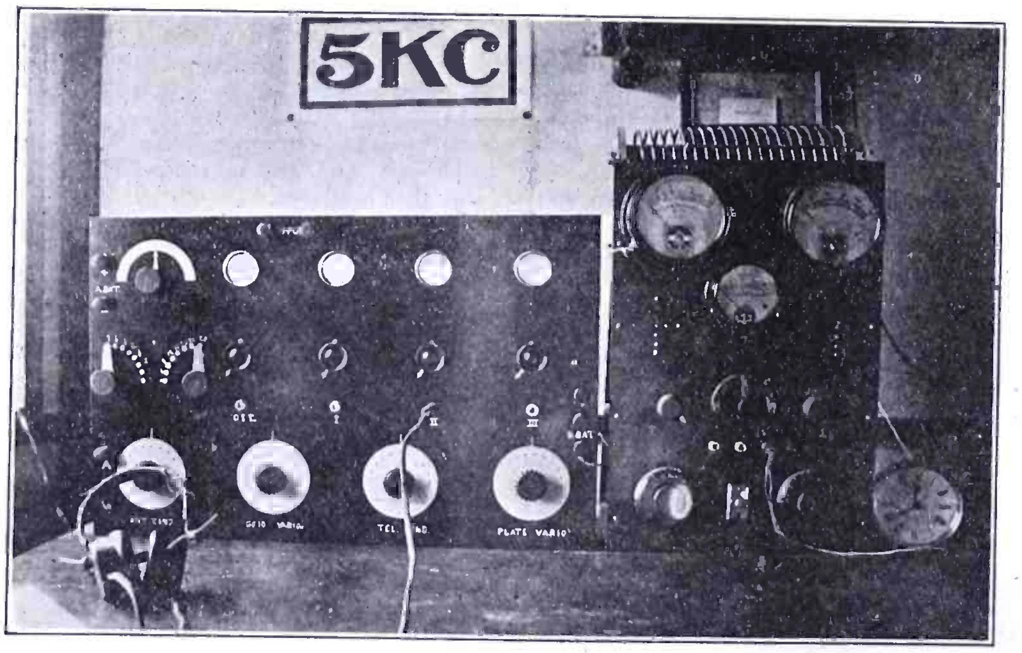
The transmitter on the right is a 20-watt C. W. in the Hartley circuit having three meters O-5 high-frequency, O-500 Milliampere, and O-15 a.c. volt meter, a .001 variable condenser across the entire inductance is used for tuning. The inductance is made by winding 20 turns of No. 6 copper wire on a form 7 in. in diameter.

The rectifier used is the bridge type using 32-pint jars with lead and aluminum plates in a saturated solution of borax. This type of rectifier will not need a center tap on the secondary as on other rectifiers and will give a very high d.c. note. Only two 1m.f. Condensers are used for filters.

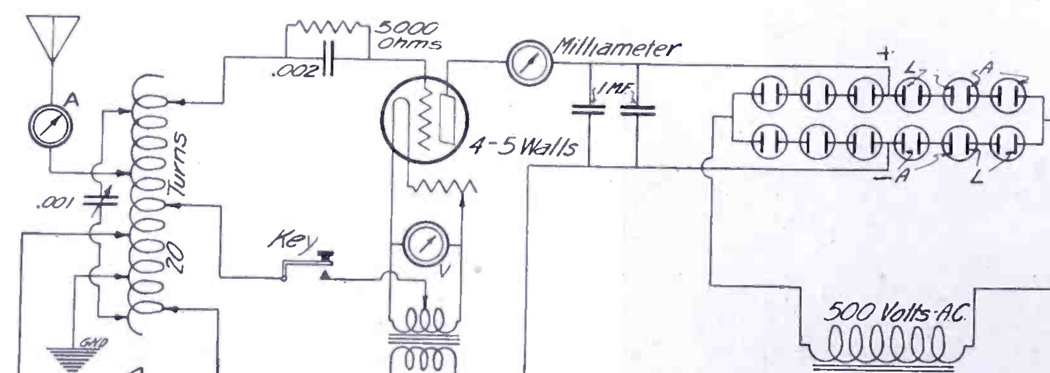
The antenna is a 5-wire (T) 80 ft. long and 60 and 67 ft. high. A one-wire counterpoise 10 ft. high and a regular ground is used.

While putting 4.2 amperes into the antenna this set has worked the following: North, Canada; south, Mexico and Panama; west, California; and east, Maine.

The National Chelsea Radio Corporation has taken over the entire output of the Chelsea Radio Co., acting as national sales agents. This will in no way affect the distribution that the Chelsea Radio Co. has built up during the past four years, other than to offer to the Chelsea radio distributors sales helps and cooperation through national advertising, both in magazines and newspapers. This will relieve the Chelsea Radio Co. of the merchandising detail and leave them free to devote their entire time to the present increased manufacturing program.



Radio Station 5KC



Hook-up for 20-watt C. W. at 5KC

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

By 6BQR, 953 West 7th St., Los Angeles, Calif.

All C. W.: 5aky, 5za, 6ao, 6aaj, 6afa, 6afq, 6agd, 6ahz, 6alv, 6alx, 6aly, (6anb), 6aou, (6aoi), 6ape, (6aqf), 6aqp, 6arb, 6aru, 6atc, 6atv, 6aty, 6auu, 6auy, 6bcl, 6beh, 6bez, 6bfg, 6bfl, 6bip, 6bks, (6biq), 6bnt, 6boo, 6buy, 6cbu, 6cds, (6cgd), 6cgq, 6chl, 6cim, 6cjb, 6cjf, 6ckf, 6cnz, 6fh, (6fy), 6gf, 6gx, 6lv, 6nx, 6tc, 6tu, 6vd, 6ze, 7adm, 7adp, 7afn, 7agi, 7agv, 7bj, (7br), 7cf, 7gp, 7io, 7iy, 7jw, 7ln, 7ly, 7nn, 7wm, 7zn, 7zv, 9amb, 9bun, 9caa, 9cfy, 9cvc, 9zt. Above list hrd during July on one-tube Reinartz. Will qsl crd on request.

By KHL, M. J. Brown, Wailuku, Maui, T. H.

4nk, 5te, 5aol, 6al, 6ao, 6ank, 6aof, (6asr), 6asv, 6av, 6bgr, (6bjq), 6bqc, 6br, 6brf, (6ceu), 6cck, (6cfz), (6chl), 6ckp, 6cma, 6cmc, (6cmh), 6cmu, 6ct, (6cmr), 6dpr, 6fh, 6gh, 6gr, 6gx, (6jx), (6rz), (6tq), 6uf, (7abr), (7agv), 7aim, 7anc, 7arv, (7bg), (7cj), 7go, (7gp), 7iw, (7iy), 7oh, 7tg, 7zn, (9aim), (9bjk), (9cca). The stations in parenthesis are exceptionally QSA here. More stations next month. Would appreciate qsl by card.

At 8DKC, One Week in June

All C. W. and heard on loop aerial with Reinartz, two audio. (1bwj), 1cki, 2aja, 2bab, (3ci), 3he, (3iw), 3afa, 3blp, 3bnu, 3buy, (3bva), (3cej), 4ft, 5xa, 5agj, (8cp), 8er, 8ft, 8ga, 8hv, 8ij, 8io, 8jg fone, 8jj, 8ju, (8nd), (8nz), 8te, 8tt, 8uk, 8vn, 8wx, 8ado, 8aft, 8agp, 8ape, 8apt, 8avd, 8awl, (8ayj), 8azc, 8azf, 8bbf, 8bda, 8bdc, 8bdo, 8bfh, 8bfk, 8bfm, (8bgl), 8bhf, 8bjv, (8bno), (8bpe), 8brc, 8bsh, (8btl), 8bvr, (8bvt), (8bwr), 8bxa, 8bzd, 8cav, (8ced), 8cei, 8cej, 8ceo, 8ces, 8cie, 8cko, 8cpz, (8cqg), (8cqh), 8cqr, 8crn, (8cur), (8cve), 8cwr, 8cxu. (8czz fone), 8dcg, (8dcy fone), (8ddk), (8ddt), 8dfp, (9of), (9ur), 9wc, 9aog, 9aps, 9apv, 9ato, 9awk, (9awu), 9azj, 9bak, 9bhr, (9bry), 9buj, 9bvp, (9bwf), (9bwp), (9hzi), 9cgt, 9chq, 9cip, (9cno), 9cnv, (9ddh), 9dfb, (9dhn), 9dhr, (9dss), 9dvk, (9dwp), (9efl), (9egw), 9ehi, (9eif). Qra 8dkc is same as 8cpy in all books. Printed cards to all who qsl by crd.—Jas. A. Wilson.

By 6BUF, 4257, 23rd St., San Francisco.
(One tube.)

6ahu, 6ahv, 6ald, 6aoi, 6apw, 6avr, 6bah, 6bcj, 6bgc, 6bic, 6biz, 6bks, 6bmh, 6brf, 6buk, 6bvs, 6cbu, 6cfz qra?, 6chv qra?, 6cim qra?, 6cmr qra?, 6cnh qra?, 6od, 6pl, 7adm, 7adp, 7ads, 7afn, 7br, 7ig, 7ln, 7nn, 7zu, 7zn qra?, 7zv, 9bun. Anyone hearing my 5-watt C. W. please qsl card to above address, and qrk. All cards answered.

By 6CLZ, Edward Doell, 2131 Grant St., Berkeley, Calif.
(May 25, then July 20.)

All C. W.: 1boq, 5za, 6's too numerous, 7adf, 7adp, 7afn, 7afo, 7age, 7agi, 7agv, 7aip, 7ak, 7bj, 7br, 7cf, 7dc, 7dh, 7gi, 7hm, 7ic, 7io, 7ks, 7ln, 7lr, 7ly, 7om, 7pj, 7sc, 7to, 7tq, 7tt, 7wm, 7ws, 7zi, 7zl, 7zn, 7zv, 9aab, 9bri, 9bxq, 9caa, 9cfy, 9zt.

Canadian—5at, 5go.

Will qsl to any of above who want check on their sigs. Pse qsl; all crds answered promptly. All stations hrd on 1 tube Reinartz.

By Herbert Settle, 462 E. Burkhart St., Moberly, Mo.

All C. W.: 2oi, 3bvg, 5afo, 5agj, 5agp, 5ao, 5av, 5hk, 5la, 5ll, 5ma, 5rs, 5rt, 5zav, 6rb, 7ha, 8amp, 8bci, 8bik, 8boa, 8caa, 8cm, 8co, 8crd, 8hh, 8oj, 8qu, 8uk, 8vv, 9aap, 9aaw, 9abu, 9acq, 9ah, 9an, 9ape, 9apw, 9auu, 9auw, 9bak, 9bam, 9bfi, 9bk, 9bl, 9bri, 9bsa, 9btc, 9btt, 9bxt, 9ca, 9ccs, 9ccv, 9cas, 9cik, 9cip, 9cgt, 9ckv, 9cr, 9cvu, 9cwa, 9daw, 9dbk, 9dbn, 9dca, 9div, 9dpb, 9dkn, 9dsa, 9dsk, 9eil, 9elb, 9gd, 9if, 9kt, 9qb, 9qf, 9rh, 9rw. If you want rept. on sigs qsl with card wi ans.

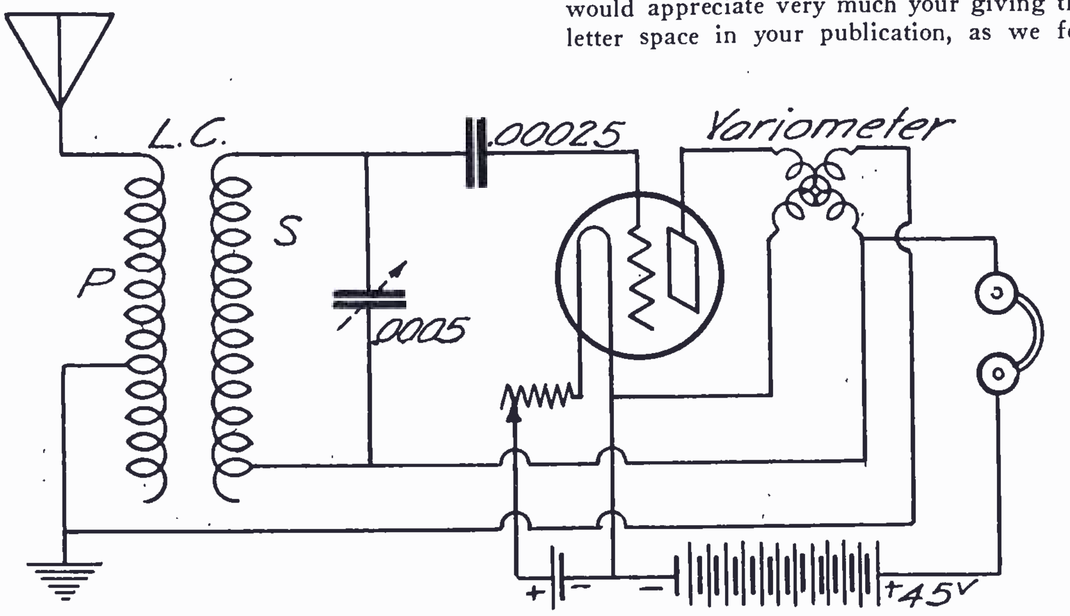
By 9ZT, D. C. Wallace, 54 Penn Ave. N., Minneapolis, Minn.

1fk, 1kc, 1ana, 1bbo, 1cpo, 2bn, 2fp, (2gk), 2qp, 2wr, (2agb), (2cbw), (2ckl), 2cto, 2cui, (2cur), (3ab), (3bg), 3jj, 3su, 3arp, (3bbv), (3bfu), (3bgj), 3bva, (3chg), (4fg), 4gl, 6km, (6rm), 6aak, (6arb), (6avn), 6beo, (6bjq), 6bnt, 6bvs, (6cbi), 6cgw, 7cf, 7ry, (7agf).

LETTERS TO THE EDITOR

Sir: After trying most all the circuits I could try on my "test" set, I decided to make up some goofy hook-up and try it out.

So, after hooking things all upside down, I went ahead and shot off the works by lighting the "TUBS," but, as usual, nothing "poped." Yes sir, seems like I'll never blow anything, darn it!



Fetters' Freak

But just then, WHAMM, in comes music enough for any broadcaster. I jumps around and lets out a yell, turns the condenser, and —well they just boomed in—yes sir, 5s, 8s and 9s, and by the time I closed the dump I had all the districts, and music had come in so it make any B. C. L. green, and old 600 jam hadn't been behind. Well I up and closed the log and decided to write you about it.

Now here's it, it'll "tick" on any wave because of the variometer, and by using a very small home-made variometer you won't need a condenser in the aerial; also instead of using a loose coupler as I did you can use a variocoupler. Now, if it's new to you as it is to me, why just go an' put 'er up in RADIO for the boys to fool with 'cause she might even work better than it is now, and if they want any pointers on it tell 'em to write me. Here's hopin' you luck at the game—I remain—JAS. L. FETTERS, 9BAU.
928 North Court St., Ottumwa, Iowa.

Phantom Receivers

Sir: A decidedly erroneous impression concerning the circuit as used in the Oard Phantom Receptor, manufactured by this company has been circulated of late, due to the publishing and marketing of wiring diagrams advertised as "Phantom" circuits, by concerns that are apparently trying to cash in on the advertising put out by our agents, Atlantic Pacific Sales Co.

A circuit diagram, purporting to be the Phantom circuit, appears in one of the leading radio publications of July issue. This diagram is similar to one issued as a Phantom Circuit by a concern located at Vacaville, California, and is nothing but a conventional single circuit, the only possible claim to originality lying in the deleting of the ground connection.

The word "Phantom" is registered by Oard Radio Laboratories in the U. S. patent office. We were, to the best of our knowledge, the first radio concern to market a radio receiving device bearing the name Phantom. Following an extensive advertising campaign of this instrument, several concerns advertised diagrams purporting to be copies of our circuit—leaving such opinion open to inference.

None of these circuits which have been brought to our attention are in any way the true Phantom circuit. It is possible that at a later date we will commercialize this circuit, but to date we have not done so. I would appreciate very much your giving this letter space in your publication, as we feel that a not altogether fair advantage has been taken of our advertising.

Thanking you for your valued courtesy in this matter, PAUL OARD.
Stockton, Calif.

Getting the Higher Waves

Sir: With the advent of broadcast wavelengths varying from 240 to 550 meters, novices have found difficulty in getting stations that formerly operated on 360 and 400 meters. This is due to the fact that their receiver was designed to respond efficiently only to the latter wavelengths, but may be easily corrected by adding inductance to the proper circuits.

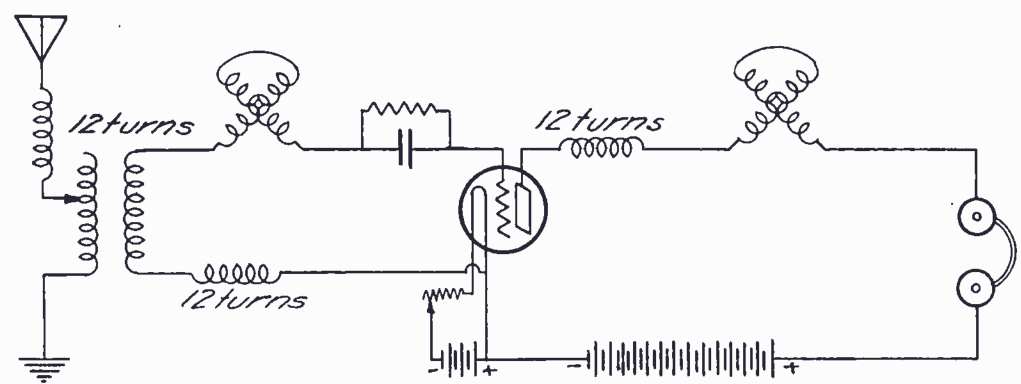
The problem is simplest for the owner of a honeycomb or spiderweb coil set, for this requires only a change of coils to receive higher or lower wavelengths. For example, with the ordinary 3-coil regenerative set with .001 mfd. condenser across the primary and secondary coils, six coils will cover the entire range from 150 to 600 meters. For wavelengths up to and including 360 meters a recommended combination is a 20-turn coil for the primary, a 25-turn for the secondary and a 25-turn for the tickler. For wavelengths above 360 meters use a 35-50-35 combination.

Similar results may be secured with slightly less efficiency in sets which have a series-parallel switch in the antenna condenser circuit. Series connection will take care of the shorter wavelengths and parallel of the higher.

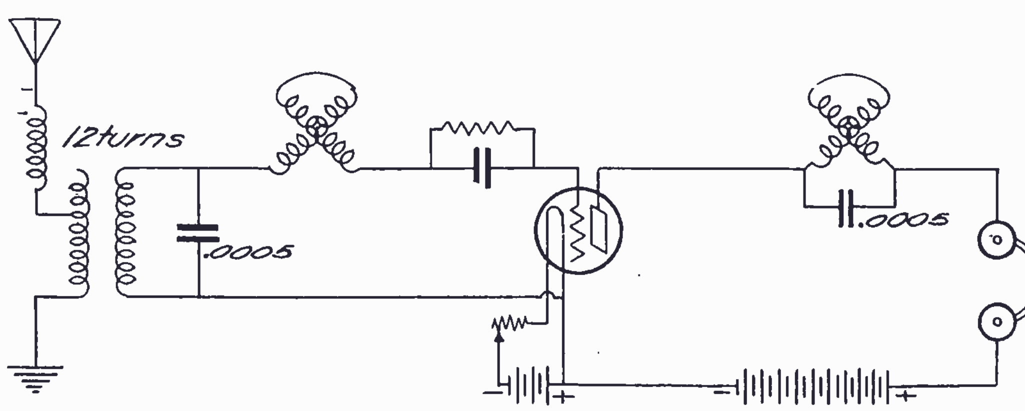
The wavelength range of any single-circuit set may be increased by placing an inductance coil in the antenna circuit, care being taken to see that it is far enough away so as not to have inductive relation to the coils already in the set. Twelve turns of No. 20 magnet wire on a 3-in. diameter cardboard tube will add about 150 meters to the reception range. By tapping every third turn a little experimenting will soon show the number of turns which give the loudest signals from a desired station.

A two-circuit set may be loaded with two such coils, one being placed in the antenna primary lead and the other in the secondary circuit.

The range of the usual type of variocoupler, two-variometer set, may be increased by adding inductance coils to the antenna primary lead, to the secondary circuit between the secondary condenser and the filament, and in the plate circuit just ahead of its connection at the tube. The same result may be more simply accomplished by putting .0005 mfd. condensers across the secondary and across the plate variometer and adding an inductance coil to the antenna lead. The series condenser in the aerial ground-circuit should be shorted. The accompanying hook-ups show the respective locations of loading inductances and capacities.
Berkeley, Calif. ARTHUR HOBART.

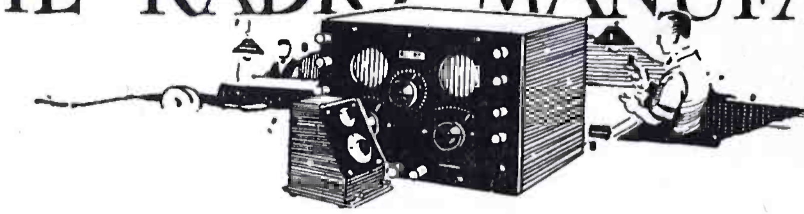


Variometer Set Loaded with 3 Coils



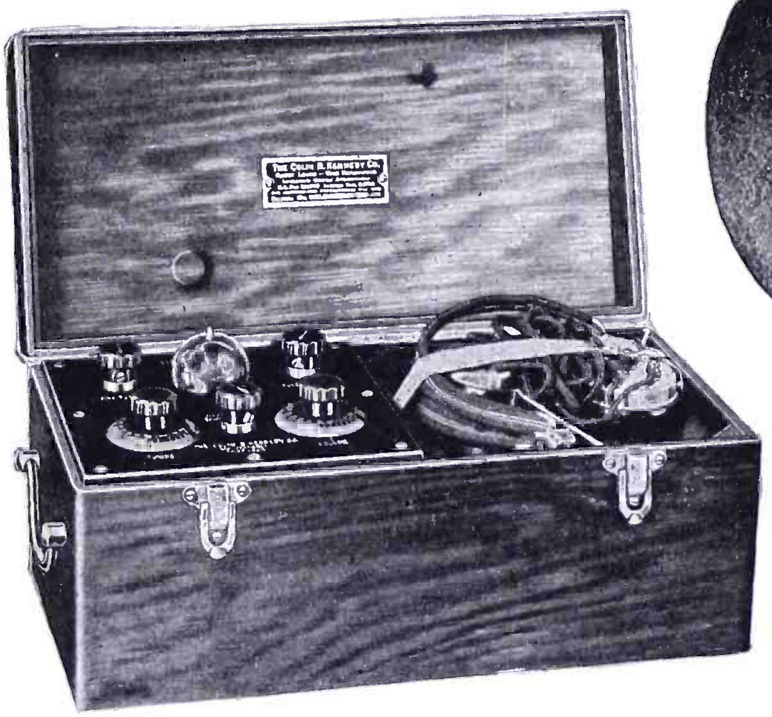
Variometer Set With "Loading" Condensers

NEW APPARATUS & SUPPLIES FROM THE RADIO MANUFACTURERS



NEW KENNEDY PORTABLE SET

The engineers of The Colin B. Kennedy Company have during the past year developed a new receiver which they feel is worthy of the appellation given to the rest of their line, namely "The Royalty of Radio." This set is now in production and is known as the Type-311 Portable Receiver. A new original principle is used in the circuit so as to permit of greatly simplified controls, and gives practically the same selectivity as the other models of the Kennedy line. Only two



Kennedy Type-311 Portable Receiver

tuning controls are needed, one for wavelength variation and one for control of the regeneration. A vernier is placed on the wavelength control, making it easy to choose between stations on nearly the same wavelength.

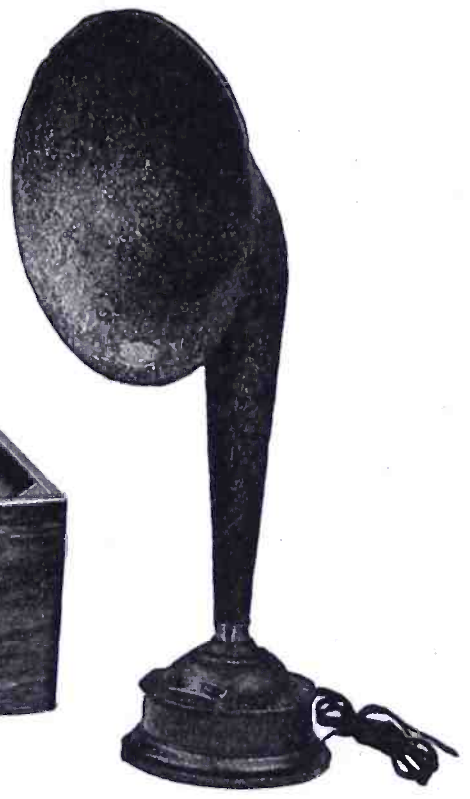
The units of the set are all mounted on a sub-panel, making the set more rugged, simplifying assembly and removing from the panel all metal parts electrically connected in the circuits. This adds to the appearance, since the main panel is free from assembly screws. The dark oak cabinet is divided into two compartments, in one of which the tuner and detector unit is mounted, while the other one is used for *A* and *B* batteries. Over the battery compartment is an oak panel and above this the phones are strapped in for carrying. The cover is deep enough to leave plenty of space for carrying a coil of flexible aerial wire over the phones if desired.

Strong catches and hinges are provided on the cover and a nickeled carrying handle is attached to one end. The cover hinge is a split one and the cover can be instantly removed when open. The set measures 7 in. x 7½ in x 15 in. and weighs 17 pounds complete. Everything that is needed for operation is contained in the cabinet.

Six-volt tubes can be used by attaching a storage battery to a pair of binding posts on the back, and disconnecting the internal *A* battery.

TRUTONE LITTLE SENIOR LOUD SPEAKER

The latest addition to the Sadler line of Trutone loud speakers is the "Little Senior" illustrated herewith. This loud speaker is built along the same lines as the "Big Senior" and has the same general appearance. The Sadler Mfg. Co. of San Francisco has been building Trutone loud speakers for more



Trutone Little Senior Loud Speaker

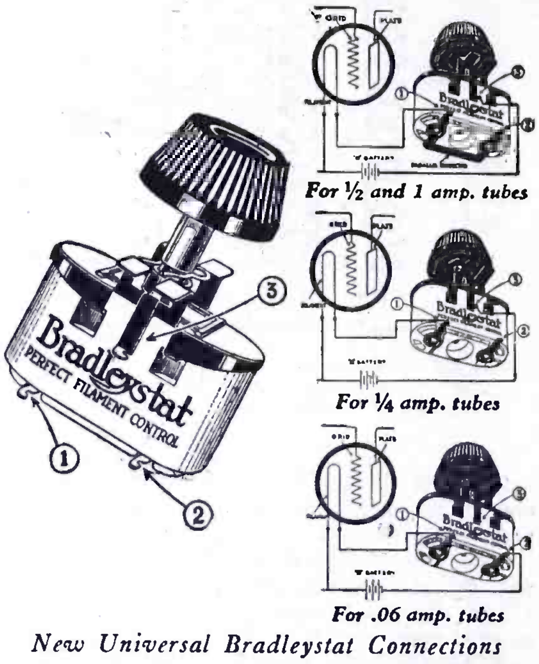
than a year and the "Little Senior," the manufacturer states, is the best instrument of the entire line. This loud speaker has the usual self-contained element in the base. A specially-constructed horn, built in the Sadler shops, permits of distortionless signals.

THE NEW UNIVERSAL BRADLEYSTAT

To keep pace with the rapid developments in radio receiving and amplifying tubes, the Universal Bradleystat, with three terminals, has been introduced by the Allen-Bradley Company of Milwaukee to supplant the former model of the Bradleystat designed largely for the old 1-ampere tube.

The Universal Bradleystat provides three ranges of control, each of which is noiseless, stepless and of exceedingly wide range. By connecting the tube circuit to terminals *1* and *2* it gives perfect filament control for the UV-199 tube or other tubes of the same class. By connecting the tube circuit to terminals *1* and *3* it is adapted for control of the UV-201A or other quarter-ampere tubes. By using the connector furnished with it the two columns of discs are placed in parallel and then by connecting the tube circuit to terminals *1* and *3* perfect control is provided for all tubes requiring over ½ or 1 ampere.

The marvelous range of the Universal Bradleystat is made permanent through the use of treated graphite discs and not loose carbon powder. The use of the graphite discs was adopted after twenty years' ex-



New Universal Bradleystat Connections

perience in the manufacture of compression rheostats and are practically indestructible. The great flexibility of the Universal Bradleystat, the extreme selectivity and the increased range, makes it an ideal filament rheostat for all critical radio receiving sets.

THE GREWOL DETECTOR

The Grewol Detector, distributed by the Randel Wireless Company, Newark, N. J., takes the crystal detector out of the group of adjusting instruments which the fan has to learn to operate. It performs all the duties of a detector but requires no more attention than a fixed condenser. It comes to the con-

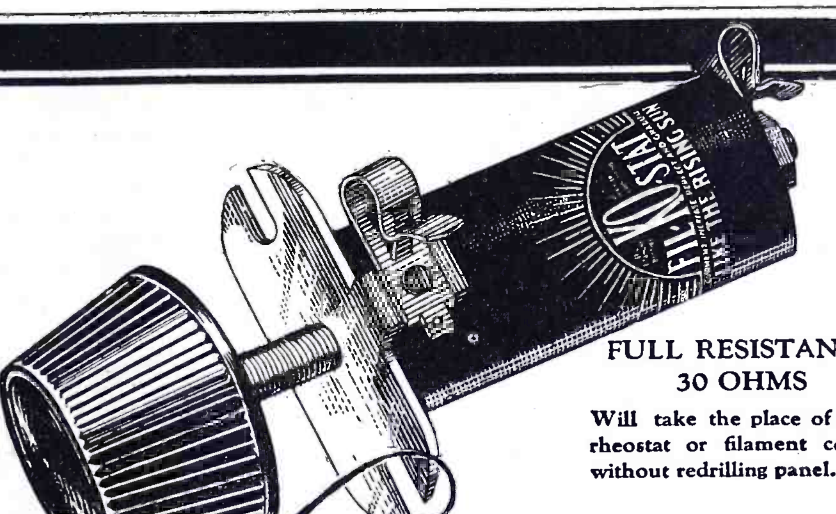
Grewol Detector

sumer already set and fixed so that the adjustment is vibration and jar-proof. At the factory, the most sensitive spot on the crystal surface is found and the catwhisker is secured so as to stay exactly on this spot. A glass cover fits snugly to keep out moisture and dust. This detector on a set can be forgotten. It will continue always to be as sensitive as the day it was purchased because the adjustment cannot be "lost."

PRICE

$2

Recommended and sold by dealers in high quality radio supplies.



FULL RESISTANCE
30 OHMS

Will take the place of other rheostat or filament control without redrilling panel.

The filament kontrol of infinite adjustment

FIL-KO-STAT

enables you to hear stations you have never heard before and gives absolutely noiseless operation

Missing What You Get

Your set is probably bringing in D X stations you never heard because your rheostat cannot control your filament action. The Filkostat gives infinite adjustment and enables you to *magnify* the weak stations and bring them in strong and clear.

Paul H. Woodruff, Editor Industrial Power, Chicago, writes that after installing the Filkostat he picked up KHJ and KWH, 2000 miles on a single tube regenerative detector.

Eighteen Times More

Laboratory research proves FIL-KO-STAT to have a fine adjustment area (i. e. ability to control filament heat and electronic flow) eighteen times greater than that of the wire rheostat and several times that of the next best filament control.

FIL-KO-STAT cylindrical design is the outcome of extensive experimentation. It gives the resistance element sufficient radiating surface to eliminate excessive heating. This is one of the outstanding FIL-KO-STAT features.

Adjusted For All Tubes

You have no screws to tamper with on the Filkostat. No adjustments to puzzle you. Experts have taken care of this for you. The Filkostat is not just fabricated. It is a laboratory product triple tested before being sent out and scientifically adjusted to the ideal "off" position for **UV200, 201, 201A, WD11, WD12, UV199, DV6A, W. E. Peanut,** ***and all other tubes.***

No Wires—No Discs

The makers of the FIL-KO-STAT express their confidence with an unconditional guarantee. Filkostat is assembled by precision craftsmen. It contains a resistance element so finely divided that further resistance is impossible. *There is nothing to break or chip.* When you buy a FIL-KO-STAT you know that you are not only getting the finest filament control made but that, its reliability and durability are fully and completely—

GUARANTEED BY THE MAKER

DX INSTRUMENT Co
HARRISBURG PA

Professional Testimony

The RADIO GUILD writes "comparisons with every reliable filament and current controlling device now available proved Filkostat far superior to all other types of filament controls giving the closest possible adjustment of any type of filament tube and the only instrument which could be used for *all tubes* giving equal critical adjustment at the high resistance as at the low resistance."

Amateur Enthusiasm

Out of hundreds of testimonials, we quote:

W. R. Hagedorn, Hay Springs, Neb. — "tried 4 different Rheostats. Filkostat beats them all."

W. R. Williams, Woodsfield, Ohio "Filkostat on a single circuit regenerative giving excellent satisfaction. The noiseless operation means a great deal."

S. George Kerngood, President of Bluebird Hats, New York "only since using it I realized how wonderful a set can be made."

Dealers' Delight

Dealers everywhere are delighted with Filkostat. Its noiseless operation has increased the joy of Radio and the "fans" are recommending it. Here's one of many interesting dealer letters.

E. M. Pace, Vicksburg, Miss. writes — "Send carton of Filkostat as early as possible. Sold sample Filkostat 5 minutes after it was received. It is proclaimed by the fan that bought it as being 100% better than the best."

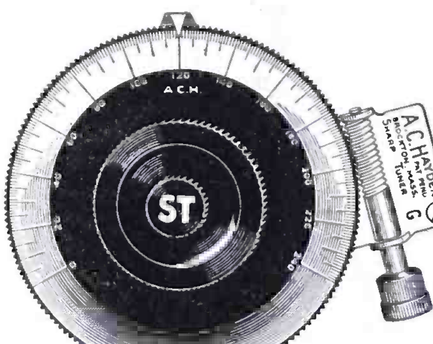
A Booklet You Will Want

By W. J. Merritt Garvey, of N. Y. World's Radio Section, Editorial Staff, Handbook of Helpful Hints for Radio Set Builders, includes tables charts, legends, statistics and 16 carefully selected hookups with diagrams and full descriptions. Reading this interesting book we discovered Mr. Garvey recommended the FIL-KO-STAT. We bought an edition of the books and will gladly send a copy anywhere at handling cost 10c. postpaid.

RADIO STORES CORPORATION
Sole International Distributors
Dept. R9 . . 218-222 West 34th Street, New York

A. C. H. SHARP TUNER DIAL

Tuning control to within 1/1000 in. in either direction is claimed for the tuner dial made by A. C. Hayden Radio & Research Co. of Brockton, Mass. This is secured by a micrometer screw and worm-gear after rough tuning has been accomplished by hand rotation of the dial. The knob *ST* is merely loosened for hand control and tightened for fine tuning.



A. C. H. Sharp Tuner Dial

The dial can be attached to any ¼-in. or 3/16-in. shaft ¼ in. long on the condenser by means of a special fitting, or on a 5/16-in. shaft without fitting. This eliminates the need of a receiver condenser. The standard dial is 3 in. in diameter. It can be easily attached in about five minutes.

WORKRITE BRINGS OUT A NEW TRANSFORMER

Predicting great enthusiasm for the neutrodyne circuit The WorkRite Mfg. Co. of Cleveland, Ohio, is preparing to meet the demand for parts for that method of receiving by placing on the market a new transformer. This instrument can also be used as a transformer for tuned radio-frequency reception or for coupler with condenser across the secondary. Bakelite tubes are used and wound with green silk wire, care being taken to see that the proper number of turns of wire are used to insure maximum efficiency. The accuracy is indicated by the fact that 16 broadcast stations were heard at Cleveland through heavy static with various dial settings.

RADIO TRADE NOTES

The Wisconsin Radio Trade Association will have an extensive exhibit in the exposition to be staged by the *Journal* at Milwaukee, Wis., Oct. 15 to 21. This will include a 20-watt broadcast station in operation, a large illuminated broadcast map, a series of tableaus suggesting the use of radio by the public and an information booth. There will also be many radio exhibits of an educational nature.

E. T. Cunningham, Inc., are arranging for a national radio tube week from September 24 to Oct. 1, during which time radio dealers throughout the country will give window displays of Cunningham radio tubes. As these displays will show all the parts which enter into a radio set, they will have a great educational value to the radio fan.

NEW RADIO CATALOGS

The Ever-Ready Battery Solution Co. have issued a circular detailing the advantages of their solution to be used as the electrolyte instead of sulphuric acid in lead plate storage batteries. It is claimed to prevent sulphation, corrosion, buckling, cracking and shedding and to greatly lessen the time required for charging a battery.

Magnus Electric Co. of New York City is distributing a new 40-page radio catalog and reference book containing valuable information concerning radio products. Copy may be had upon request.

AMERICAN AMATEURS HEARD IN AUSTRALIA AND NEW ZEALAND

Unofficial and unconfirmed reports from H. Kingsley Love, chairman of The Radio Trans-Pacific Test Committee, show that the following American amateurs were heard in Australia during the tests in May:

3ARD, J. B. Davis, 700 G St., S. W. Washington, D. C.; 3IRD (unidentified).

5AEC, R. L. Fish, 237 E. 33rd St., Oklahoma City, Okla.

6AVN—T. Shaw, 150 West 3rd St., Claremont, Calif.; 6BVG—S. F. Wainwright, 1926 Delta St., Los Angeles, Calif.; 6BV—C. H. Keeler, 5501 S. Park, Los Angeles, Calif.; 6BUM—A. L. Wessels, 1100 Standley St., Ukiah, Calif.; 6BUN—C. F. Stuart, 4066 Leeward Ave., Los Angeles, Calif.; 6CGM—Earl Wyatt, Bodega Ave., Sebastopol, Calif.; 6CGW—R. L. Riedman, 243 Euclid Ave., Long Beach, Calif.; 6HD—J. M. McKinley, 3120 Twenty-first St., San Francisco, Calif.; 6JD—V. M. Bitz, 1429 West 53rd St., Los Angeles, Calif.; 6PD—J. J. McArdle, 263 Day St., San Francisco, Calif.

7LA—David Phillips, 6601 Union Ave., Tacoma, Wash.; 7PD—B. C. Hendricks, Cornelius, Ore.

9ARC—A. H. Schaefer, Franklin St., Slinger, Wis.; 9ARL—W. H. Althoff, 119 No. Jefferson Ave., St. Louis, Mo.; 9AUL—L. C. Smeby, 1504 W. Broadway, Minneapolis, Minn.; 9GK—Fargo Radio Service Co., 117 Broadway, Fargo, N. D.; 9HRL (unidentified); 9UR—Carl W. Dean, 3151 Boulevard Place, Indianapolis, Ind.; 9URE (unidentified); 9XK—Robert R. Moore, 200 E. Armour Blvd., Kansas City, Mo.

The following were reported as being heard in New Zealand:

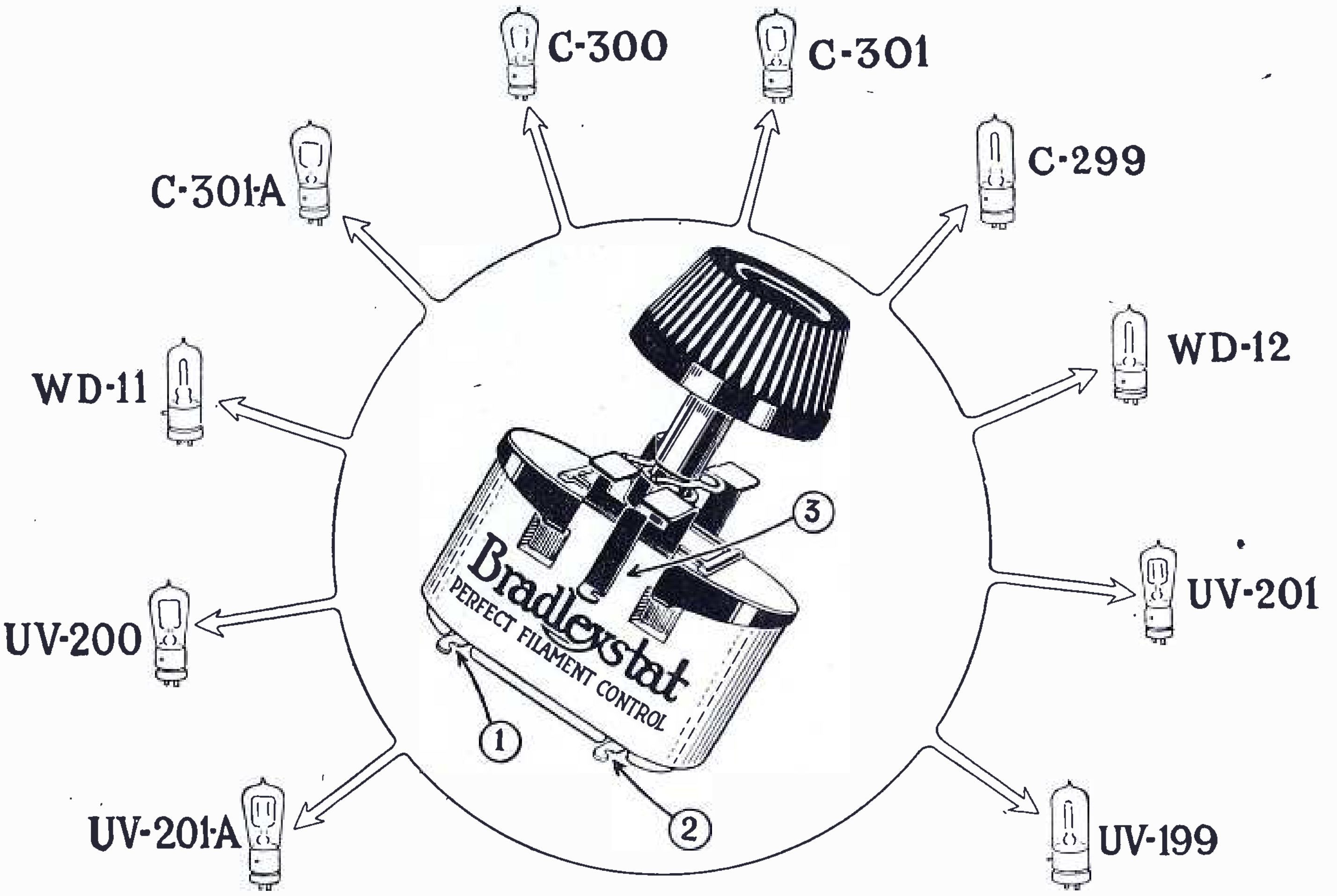
1AJP—N. W. Bishop, Jr., 301 Park Place, Bridgeport, Conn.; 3YO—Lafayette College, Easton, Pa.; 3CL—Edward C. Andrews, 32 S. Fallon St., Philadelphia, Pa.

4HW—Louis Wade, Jr., 114 Millrose Ave., Decatur, Ga.

5PX—Eugene Colston Tipton, 200 Clark Ave., Fort Worth, Tex.; 5ZB—W. L. Wellford, Jr., 205 S. Belvedere Blvd., Memphis, Tenn.

6ARB—C. Duncan, 3029 Baker St., San Francisco, Calif.; 6AWT—B. Molinari, 653 Union St., San Francisco, Calif.; 6ALK—R. A. Hancock, 408 Palm St., Anaheim, Calif.; 6APW—B. S. Pigg, 405 Maryland Ave., Glendale, Calif.; 6AJF—F. C. Jones, 1822 Hearst Ave., Berkeley, Calif.; 6AVN—T. Shaw, 150 W. 3rd St., Claremont, Calif.; 6AWX—E. Sedlacek, Jr., 267 W. Badello St., Covina, Calif.; 6AWQ—San Diego High School, San Diego, Calif.; 6ANH—D. E. Chambers, 638 E St., San Diego, Calif.; 6ALV—O. Zimmerman, 1926 Park St., Alameda, Calif.; 6AVR—C. Yates, R. F. D. No. 3, Fullerton, Calif.; 6AWP—E. W. Thatcher, 407 W. First St., Santa Ana, Calif.; 6AYD (unidentified); 6BUY—J. D. Holmes, 2732 Prince St., Berkeley, Calif.; 6BED—C. H. Smith, 126 Anza St., San Francisco, Calif.; 6BVG—S. F. Wainwright, Delta St., Los Angeles, Calif.; 6BET—M. Albertson, Jr., 852 Westchester Ave., Los Angeles, Calif.; 6BNT—W. C. Meddock, 225 Willard St., San Francisco, Calif.; 6BG—R. W. Carroll, 354 Perry St., Oakland, Calif.; 6BV—C. H. Keeler, 5501 S. Park, Los Angeles, Calif.; 6BM—N. R. Morgan, Palo Alto, Calif.; 6BWP—R. J. Purves, 328 S. Garnsey St., Santa Ana, Calif.; 6BO—H. M. Preston, Richmond, Calif.; 6BCR—C. Foresan, 1714 Alameda Ave., Alameda, Calif.; 6BQC—G. W. Schlah, 1629 Vineyard Ave., Los Angeles, Calif.; 6BUG—W. Campbell, 261 River St., Santa Cruz, Calif.; 6BUN—C. E. Stuart, 4066 Leeward Ave., Los Angeles, Calif.; 6CU—C. F. Filstead, 2010 6th Ave., Los Angeles, Calif.; 6CBI—R. L. Smith, R. F. D., Los Angeles, Calif.; 6CGW—R. L. Riedman, 243 Euclid Ave., Long Beach, Calif.; 6CMR—Radio Journal Publishing Co., Los Angeles, Calif.; 6EN—H. A. Duvall, 4963 Wadsworth St., Los Angeles, Calif.; 6FH—H. H. Steen, 2007 K St., Sacramento, Calif.; 6GD—Oliver Wright, 784 S. Molino Ave., Pasadena, Calif.; 6GF—Ernest Staats, 2318 I St., Sacramento, Calif.; 6GG—H. W. Larkin, 2487 Altadena Ave., Pasadena, Calif.; 6GR—Edw. Anderson, 1905 L St., Sacramento, Calif.; 6IF—L. J. Riedman, 1731 Atlantic Ave., Long Beach, Calif.; 6JD—V. M. Bitz, 1429 W. 53rd St., Los Angeles, Calif.; 6JN—H. Brever, 1284 W. 67th St., Emeryville, Calif.; 6KA—T. E. Nikirk, 1050 W. 89th St., Los Angeles, Calif.; 6KU—C. C. Brown, Volta Power House, Manton, Calif.; 6PD—J. J. McArdle, 263 Day St., San Francisco, Calif.; 6TI—H. R. Greer, 414 Fairmont St., Oakland, Calif.; 6VM—P. Parsons, 633 Middlefield Road, Palo Alto, Calif.; 6XP—Moorehead Laboratories, Mission St., San Francisco, Calif.; 6XBC—6XAD—L. Mott, Avalon, Calif.; 6XWI—6ZH—Lester Picker, San Ysidro, Calif.; 6ZI—R. S. Rheem, 478 Orchard St., Oakland, Calif.; 6ZW—H. R. Shaw, 987 California St., San Francisco, Calif.; 6ZZ—H. L. Goodin, Bisbee Highway (near Douglas) Ariz.; 6ZAD—J. Mahler, Jr., P. O. Box 391, Sunnyvale, Calif.; 6ZMI—6ZND—6ZG—F. W. Van Why, 2012 N.

Continued on page 50



One Rheostat for ALL Tubes -the Universal Bradleystat

The most perplexing problem in radio has been solved! It now is possible to use one rheostat for all tubes. This means that you can take advantage of all recent developments in receiving and amplifying tubes without rebuilding your set to make room for a new rheostat or an extra resistance unit to give the necessary control. The Universal Bradleystat with three terminals handles the entire range of radio tubes. A simple change of connections provides stepless, noiseless, perfect filament control for every tube.

Radio Dealers

The Universal Bradleystat is one of the greatest merchandising successes in the radio field. Dealers everywhere are capitalizing on Bradleystat superiority.

"Our electrician has requisitioned six Bradleystats for use on our steamers in connection with their radio equipment."

Deparment of Marines and Fisheries
Halifax, N. S., Canada

"I find the Bradleystat very successful. It is compact, indestructible and all that one could wish for in radio work."

G. A. Iler, Atlanta Journal

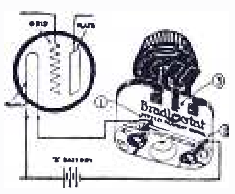
"The improvement rendered by the Bradleystat was remarkable and beyond all my expectations."

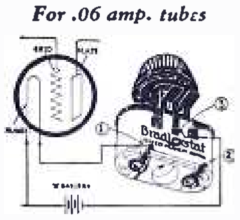
Chas. H. M. White
Massachusetts Institute of Technology

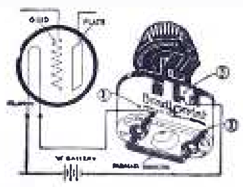
The Universal Bradleystat is a graphite compression rheostat. This means that the marvelously smooth control and long range, for which the Bradleystat is famous, are obtained by compressing two columns of graphite discs with a single control knob. In this way, you get vernier control without vernier complications.

There is no carbon dust in the Universal Bradleystat, because carbon dust can trickle out of the rheostat or become packed into a solid mass. It was abandoned many years ago by the Allen-Bradley Co. as unsatisfactory and unreliable. For your protection, the name Bradleystat is embossed on the porcelain container. Be sure to ask for the Universal Bradleystat. Try one, tonight!

Allen-Bradley Co.
Electric Controlling Apparatus
288 Greenfield Avenue, Milwaukee, Wis.
Manufacturers of Graphite Compression Rheostats for Twenty Years


For .06 amp. tubes


For ¼ amp. tubes


For ½ and 1 amp. tubes

LONG DISTANCE RECEIVER

Continued from page 11

wound on the form. The wire is woven on this form instead of wound around the outside, as on ordinary coils. This gives the coil an extremely low distributed capacity, the lowest of any known form of coil, and keeps the inductance high. The primary is wound with 60 turns of No. 18 D. C. C. wire. One-half pound of wire will be needed. The primary is tapped at the 8th, 20th, 38th and 60th turns.

The secondary should be wound with 90 turns of No. 28 double silk-covered wire. One-fourth pound will be needed. The secondary is tapped at the 15th, 30th, 55th and 90th turns. In taking off the taps, start counting from the ends of the primary and secondary which are nearest together, and count out toward the end on each coil.

A moulded grid condenser and bridging condenser should be used. The capacity of both is rather critical, and they should be .00025 and .001 mfd., respectively. The grid leak should have a resistance of about one megohm.

The results obtained with this set will depend to a great extent on local receiving conditions. It is extremely selective and sensitive. Using no amplifier, the writer has received nearly every high power radiophone in the country, in addition to copying C. W. amateur signals from all districts. The set is ideal for amateur and broadcast reception and also for 600-meter spark reception. It has a wavelength range of 180 to 750 meters, and is efficient on all wavelengths. The circuit will work equally well with any make of tube now on the market.

MUSIC FROM THE PARLOR TABLE

Continued from page 12

drowned out by the crashes. The loop receiver, however, has been in use every night to date, and the music received has been of the highest quality. Static has a muffled sound, and does not seriously interfere with reception.

Amateur interference is unknown. In fact, it is hardly possible to tune in an amateur below 200 meters. (Radio-frequency transformers become very inefficient below 250 meters in most cases.) Arc light interference, sparking commutator noises, etc., which are present in every city to a greater or lesser extent, are tuned out with ease, but in so doing it is not possible to pick up stations in line with the source of local interference and still eliminate the interference. This is of small importance in these days, however, due to the location of stations in almost every point of the compass.

Be sure and use only high-grade instruments, especially the radio-frequency

Continued on page 48

Radio Catalogue Free—

Write us a post card—

and we will send you free this 52 page catalogue of radio sets and parts. It also contains explanation of radio terms, map and list of broadcasting stations and much radio information, including an explanation of successful hook-ups and circuits.

You will be amazed at the low prices Ward's quote. A complete set for $32.50 equalling sets at $60 elsewhere—a $23.50 set that under favorable conditions has a radius of 500 miles and more.

This catalogue contains everything for the expert and amateur. Complete sets and every improved part for building sets all the most up-to-date devices—at the lowest possible prices.

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Montgomery Ward & Co. is headquarters for Radio, selling everything direct by mail without the usual "Radio-profits." Why pay higher prices? Ward quality is the best and the prices will often save you one-third. Everything sold under our Fifty Year Old Guarantee,—Your Money Back if You Are Not Satisfied. Write today for your copy of this complete 52-page Radio Book.

Write to the house nearest you. Address Dept.
Chicago Kansas City St. Paul Portland, Ore. Fort Worth

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The Oldest Mail Order House is Today the Most Progressive

Continued from page 46

transformers, as these are the heart of the set. Purchase sockets having diagonally spaced contact springs, in order to reduce capacity effects as much as possible. Interchange tubes in the various sockets of the radio frequency stages until maximum intensity is obtained. It might be well to say here that the larger the area of the loop used the greater the selectivity. Using the variometer mentioned above, it mattered not which way it was placed. It will be found, further, that rotating the loop through 180 degrees sometimes increases the signal audibility as much as 50 per cent. This again is probably due to regenerative action as mentioned above.

An interesting experiment was tried recently. The receiver was placed in the rear seat of an automobile, with the batteries on the floor, and, using the variometer for an antenna, or loop, and with the car traveling at 20 miles an hour, several stations as far away as 500 miles were picked up very easily and with the same intensity as usual. The sparking in the ignition system, however, caused interference which could not be eliminated.

The writer has placed storage batteries, *B* batteries and the Tungar charger in a box 2 ft. by 10 in. by 11 in., running all leads to binding posts on a small bakelite strip on the front of the box, and placing a double-pole double-throw switch in the interior of the box for throwing the storage battery on charge. This completes the portability of the outfit, and makes an ideal set for home use. The new quarter ampere tubes have as yet not been tried, but they will probably work better than the ones used at present. If this is true, dry cells may be substituted for the storage battery and charger, making an ideal receiver for the camping trip, with certainly a greater range and clearer reception than most of the other types now in use.

None of the adjustments are critical except that of the variable condenser, and this is easily managed by use of the small vernier. The potentiometer, or stabilizer as it is sometimes called, really controls the intensity of the signals. Rheostat adjustments are not at all critical, not even on the detector. To tune in a station, it is merely necessary to turn up the potentiometer (cut out the resistance) until oscillations begin, as denoted by the usual click in the receivers. Then vary the capacity until a characteristic whistle is picked up, and then retard the potentiometer to stop oscillations. Sometimes a slight increase in signal intensity may be obtained by readjustment of the rheostats, although this is not necessary except in real long-distance reception.

A NEW

BURGESS "B" BATTERY

Vertical Type

THE engineers of the Burgess Laboratories have designed a new "B" Battery. When we use the term 'new' we are referring only to the shape for it is vertical rather than flat as is the case of the standard Burgess "B" Batteries.

It was designed to meet a definite desire and almost an actual necessity arising through the widespread tendency to improve the appearance and convenience of home receiving sets by means of a neater and more compact assembly of equipment.

This new vertical "B" type battery saves half the floor space of the standard "B" battery. Because it stands vertically and is about the same height, it may be combined with a No. 6 Dry Battery if that type is used for the "A" or filament circuit. In the usual style of cabinet this vertical "B" battery may be slipped behind the equipment, leaving the terminals exposed at the top for convenient connections.

"A Laboratory Product"

The Burgess Battery Company is responsible for many of the vital improvements found in present day batteries, and this new vertical "B" Battery is recommended to you with every confidence that it will please you in every particular—power, silence, long life, convenience and absolute dependability.

"Ask Any Radio Engineer"

BURGESS BATTERY COMPANY

Engineers — DRY BATTERIES — Manufacturers
Flashlight — Radio — Ignition — Telephone

General Sales Office: Harris Trust Bldg., Chicago
Laboratories and Works: Madison, Wisconsin

Branches:
New York Boston Washington St. Paul Kansas City New Orleans

In Canada: **General Offices and Works: Niagara Falls, Ontario**
Branches: Toronto Montreal Winnepeg St. John

I. R. E. MODEL AWARD

Continued from page 37

mitting station from which it is intended to receive.

He was a member of the International Electrical Congress which met at St. Louis in 1904, at which he read a paper entitled "The Theory of Wireless Telegraphy." This paper has been considered to be the most masterly and comprehensive mathematical analysis written upon this subject up to that time. He has also read papers before the Canadian Society of Civil Engineers, Montreal, 1905, before the Society of Wireless Telegraph Engineers, Boston, 1908, 1909 and 1910; before the Wireless Institute, New York, 1909; before the Institute of Radio Engineers, New York, 1914 and 1915; contributed numerous papers on electrical subjects to the scientific and technical press. He is Fellow of the American Academy of Arts and Sciences, Fellow of the American Association for the advancement of Science, Fellow of the Institute of Radio Engineers, (vice-president 1913-14, president 1914-15, director 1912-17), organizer and vice-chairman radio engineers committee on national defense, president the Society of Wireless Telegraph Engineers 1907-8, delegate International Electrical Congress 1904, and second Pan-American Scientific Congress 1917, member of The Franklin Institute member of The Electro-chemical Society, associate of The American Institute of Electrical Engineers, etc. He was awarded the Edward Longstreth Medal by The Franklin Institute for a paper contributed to the Journal of that institute entitled "The Practical Aspects of High-Frequency Waves Along Wires." He is a trustee of the American Defense Society, a member of the American Academy of Political Sciences, and member of the national council of The National Economic League.

AMATEURS HEARD IN AUSTRALIA

Continued from page 44

Broadway, Los Angeles, Calif.; 6ZR—H. Berringer, Los Angeles, Calif.; 6ZZU.

7AW—B. C. Gamer, 3750 N. 30th St., Tacoma, Wash.; 7BJ—George Sturley, 206 E. 17th, Vancouver, Wash.; 7BX—J. J. Towey, 5610 20th Ave. N. W., Seattle, Wash.; 7PF—Glen Goudie, 2818 Victor Pl., Everett, Wash.; 7ZF—F. F. Gray, Butte, Montana.

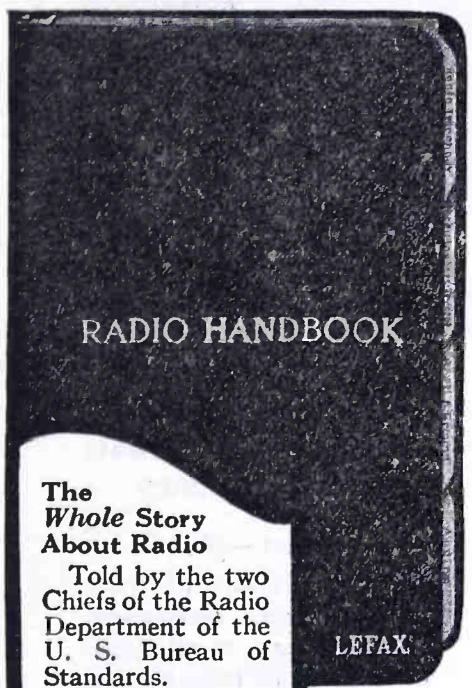
8AIO—C. W. Dalzell, 212 Spring Ave., E. Pittsburgh, Pa.; 8QK—D. W. Pinkerton, 3020 Council St., Toledo, Ohio.

9AUL—L. C. Smeby, 1504 W. Broadway, Minneapolis, Minn.; 9APW—M. G. Goldberg, 711 Dayton Ave., St. Paul, Minn.; 9AYO—Joliet Township High School, Joliet, Ill.; 9CUD—F. W. DeZonia, 1924 W. Logan St., Murphysboro, Ill.; 9DGW—R. J. Tyrrell, 1807 Selby Ave., St. Paul, Minn.; 9UU—R. W. Weisbach, 6727 Yale Ave., Chicago, Ill.; 9UR—Carl W. Dean, 3151 Boulevard Place, Indianapolis, Ind.; 9UM—G. L. LaPlant, St. Anthony, Ia.; 9MC—Albert H. Cain, Roodhouse, Ill.; 9ZT—D. C. Wallace, Minneapolis, Minn.

Similar tests are to be repeated in November under the auspices of the *Radio Journal* of Los Angeles, which also sponsored the May tests, and, it is hoped, with the cooperation of the A.R.R.L.

Lefax Radio Handbook

Distributed in the West by Pacific Radio Pub. Co., Inc.



The *Whole* Story About Radio

Told by the two Chiefs of the Radio Department of the U. S. Bureau of Standards.

"Dr. J. H. Dellinger and Mr. L. E. Whittemore, the authors of the Lefax Radio Handbook, are excellently qualified to interpret the developments of the times in radio. They rank high in the scientific world as radio engineers. They are in intimate touch with all fundamental advances in the science of radio communication."

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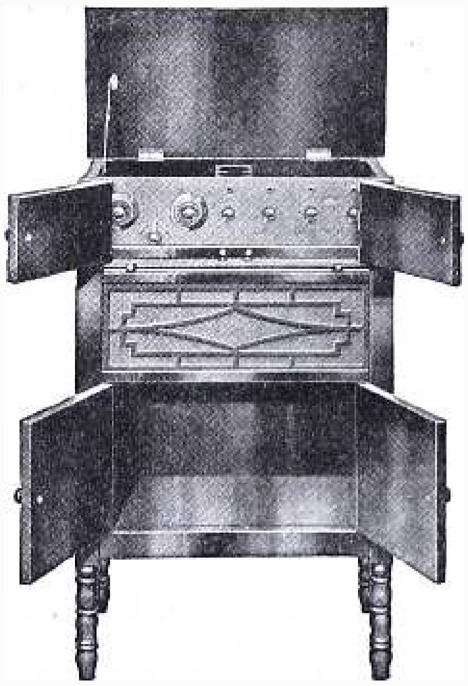
Name ....

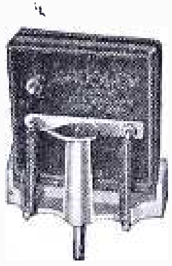
Address ....



Model XX—Price $100.

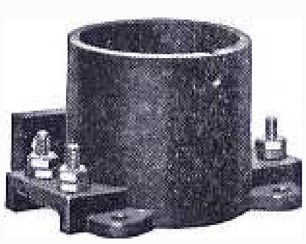
A four-tube set in a beautiful, upright mahogany finished cabinet. The hinged lid and doors give easy access to any part of the receiving apparatus. The lower compartment is for batteries.

Crosley Type "D" Condenser—$2.25.



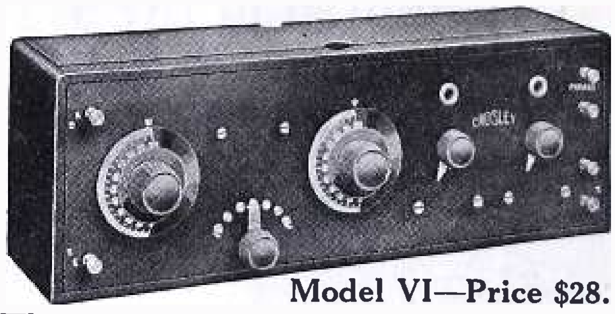
The wonderful efficiency of this new condenser has caused its popularity to grow rapidly. It increases the efficiency of your Crosley receiving set, notwithstanding its own conventional form and that it is different from the old interlocking plate type.

New Crosley Socket—50c.



A smaller and neater socket now replaces the old porcelain one. It has the unique feature of base and panel mounting found only in Crosley sockets. (Patent pending.) It fits perfectly and has the highest dielectric qualities.

For Sale by Best Dealers Everywhere
Free Catalog on Request

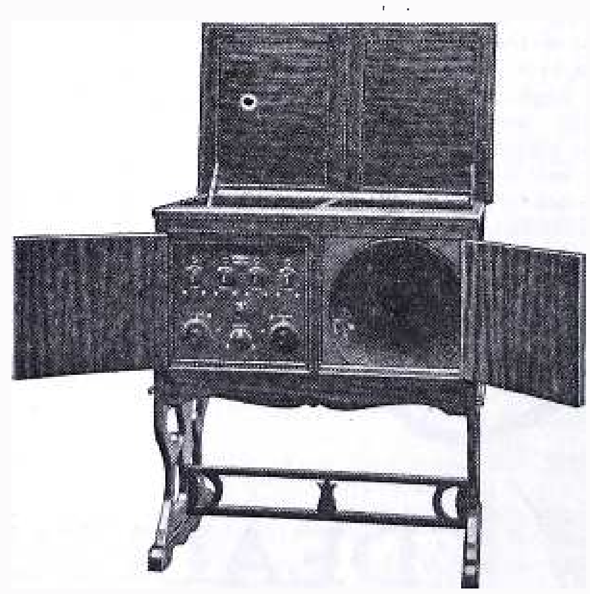


Model VI—Price $28.

This Model contains the stage of tuned radio frequency amplification brought to 100% perfection by the Crosley Co. For its price and size, it gives surprising results in long range reception. Hundreds of testimonials have paid tribute to its efficiency.

New Crosley Multistat—80c.

This multistat, of from 0 to 20 ohms resistance, will take care of all types of tubes with its high and low resistance wire. This unit solves the problem of filament control on different tubes. The smooth running, ball bearing contact is continued.



Model XXV—Price $150

A console cabinet model which is a combination of efficiency and beauty. This is designed for homes and clubs where a complete, long-distance set is required. Equipped with compartment for batteries and loud speaker.

CROSLEY

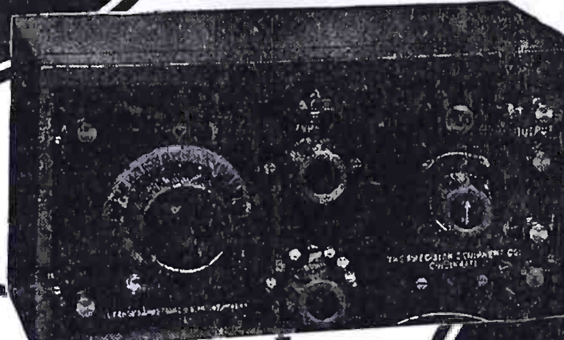
Better-Cost Less Radio Products

$20

Clear Reception at Lowest cost

Armstrong Regenerative Receiver

Licensed under Armstrong U. S. Patent No. 1,113,149



ACE TYPE V

FORMERLY CALLED CROSLEY MODEL V

THE ACE Type V is a long range regenerative radio receiver. Signals received on it are clear and distinct.

Stations from coast to coast are heard under ordinary conditions by owners of this set. Wonderful efficiency, simplicity of operation and low cost are the chief factors in the growing success of this receiver. They are the things that have made it the most popular on the market. Thousands of the Ace Type V have been sold—hundreds of letters from owners are proof of their success. Can be used with dry cell or storage battery tubes.

Those who desire to operate a loud speaker in connection with the Ace Type V, later can add an Ace Type 2 B, a new two-stage audio frequency amplifier, to the set. Then music or voice being received from a far-away station will be heard throughout the room or house. The price of the Ace Type 2 B amplifier is $20.00.

If your dealer cannot supply you, order direct, mentioning his name. Ask for "Simplicity of Radio." Your copy is FREE.

DEALERS—Write on your letterhead for attractive sales proposition.

THE PRECISION EQUIPMENT COMPANY

Powel Crosley Jr. PRES.

919 Vandalia Ave. Cincinnati, Ohio

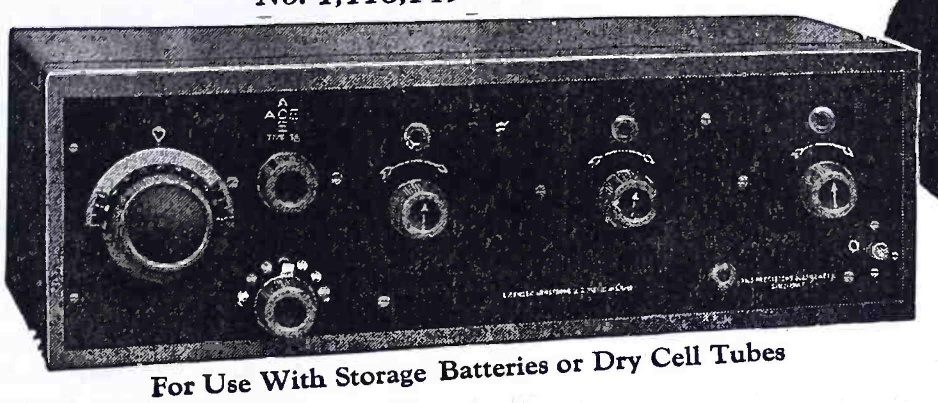
The New Ace Type 3 B

A new member of the Ace family selling for $50, which is equal to a combination of the Ace Type V and the Ace two-stage amplifier. Like the Ace Type V it is manufactured under Armstrong U. S. Patent No. 1,113,149. This set is new, but months of research work have brought it to a high degree of perfection. Out-performs receiving sets costing great deal more. A filament switch eliminates necessity of turning out rheostats when set is not in use. A person hearing a broadcasting station may turn off the set by throwing switch and come back later without retuning. A telephone jack is between first and second stage of amplification. This is for use of persons who desire to use head phones instead of loud speaker. Crosley Multistats, universal filament control rheostats for all makes of tubes, also are used in the Type 3B. **Price $50**

THE NEW ACE 3B

Three Tube Regenerative Receiver

Manufactured under Armstrong U. S. Patent No. 1,113,149



For Use With Storage Batteries or Dry Cell Tubes

ONLY $50.00

This New Ace Type 3B Armstrong Regenerative Radio Receiver combines detector and two stages of Audio frequency amplification. The lowest priced quality receiver ever offered. When you tune in with this set distant stations come in as though they were only a few miles off. The two stages make the use of a loud speaker possible—this is a desirable feature. Its efficiency has passed every test.

One of the few sets that functions perfectly with all makes of tubes. A filament switch eliminates necessity of turning out the rheostats when set is not in use. With this switch you can turn off set and come back later to same concert without retuning. The telephone jack makes it possible to use head phones. When head phone plug is inserted it automatically eliminates loud speaker, but does not affect the filament current. Has genuine mahogany cabinet with beautifully engraved panel.

If your dealer cannot supply you, order direct, mentioning his name. Ask for "Simplicity of Radio" your copy is FREE. DEALERS: write on your letterhead for attractive sales proposition.

THE PRECISION EQUIPMENT COMPANY

Powel Crosley Jr. PRES.

919 Vandalia Ave., Cincinnati, Ohio

THE ACE TYPE V

Armstrong Regenerative Receiver

Manufactured under Armstrong U.S. Pat. No. 1,113,149

The low cost of this set together with its efficiency and simplicity makes the great demand for it increase daily.

A long range receiver. Stations from coast to coast can be heard distinctly. An Ace Two-step Amplifier in connection with this set at $20 makes use of loud speaker practical. Has Crosley Multistat, which permits use of any make tube.

$20

HOW I BECAME A SUCCESS

Continued from page 14

that it was on a bit of work which I did one night, on which my fancy assistants had fallen down, that a whole division was saved from annihilation.

With the signing of the Armistice I came home, wrapped in a blanket with other souvenirs. I nestled between an airplane motor and a door from a Rhine castle. I slipped through the custom house at New York, marked "Y.M.C.A., supplies." Days later, I was back at my old job, glad to be home, a bit shabbier, a bit more worn, but still filled with the desire to make a success of my life.

The whole radio world had changed in my absence, I soon found out. Out of the war had been born the fancy-panel aristocracy to whom I was but one of the hoi polloi. My rightful place had been usurped by those I pleased to call pretenders. I saw them from time to time in their nickel-plated sockets, their mahogany cases, their glossy exteriors. I remained a simple interpreter of the codes. They had taken over the wider field of the musical arts. They were broadcast receivers.

No one will know my bitterness as I lay on a shelf, forgotten and alone. No more will one appreciate my sardonic satisfaction as I saw my ornate friends, with their complexity of tubes, coils, rheostats, and batteries whirl the world into a mass of complication. I was pained when my old friend Potentio Ometer went over to the aristocrats. I had known him in his humble days and he seemed one of us. I had thought of him as of the common people. Now he was catering to the circuits of the more advanced.

And then, one day, there in the attic where I had been stored, a ship operator—an old timer—saw me, covered with dust and spiderwebs. A smile broke over his face.

"Well, well," he said. "Here is an old friend of mine!"

I beamed up at him and twinkled all my little crystals. I wanted him to know that I appreciated his recognition. He caught me up and cuddled me under his arm, and patted me until my connections rattled. He kept talking to me in a language I understood.

"I wouldn't trade you for all the fancy junk that was ever born," he said fondly.

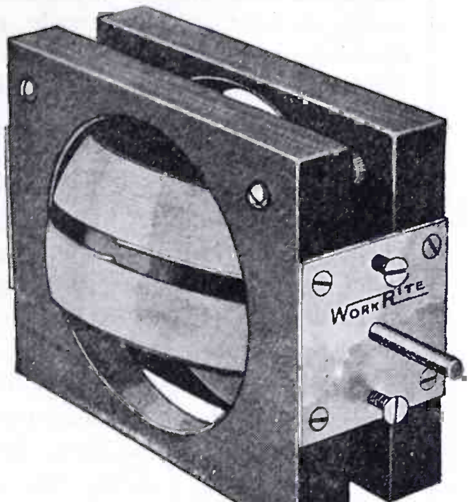
There was a dicker and I went away with him, my sliders thumping joyously against my ribs. I was going back into the world again, back to life, and art and music—back among the best of them in my shabby suit of dull oak, with my little rusty ways. But I little knew what was in store.

I spent a week in a renovatory. I was cleaned and burnished. And then,

Continued on page 58

WORKRITE TUNER TEAM

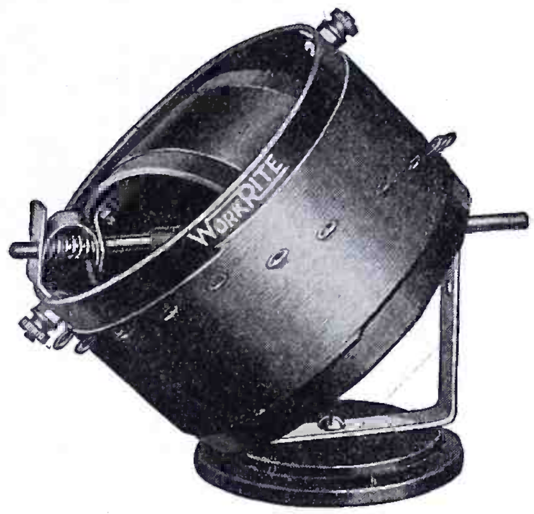
WorkRite Super Variometer



$3.50 EACH

Enormous Production Makes This Price Possible

WorkRite 180° Super Variocoupler



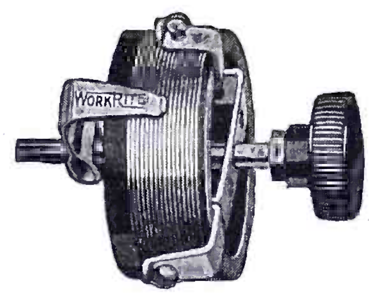
Two WorkRite Variometers and one WorkRite Variocoupler make up the "WorkRite Tuner Team", the most selective circuit possible. The WorkRite Variometer is made from fine grade mahogany, handsomely finished. Very sensitive and sharp to tune. All metal parts are made from brass and nickeled. The WorkRite 180° Super Variocoupler is made from moulded Bakelite. It is wound with green silk and has 12 taps. Range 150 to 705 meters. Look at this low price.

WorkRite Super Variometer......................$3.50 WorkRite 180° Super Variocoupler..............$3.50

New WorkRite Vernier Rheostat $1.00

The latest and best in Rheostats. 50,000 adjustments for $1.00. Pushing the knob way in turns off the filament. Turning the knob gives the very finest adjustment. Often a turn of 1/32 inch will clear up a station or separate two stations. This Rheostat is made with three different resistances so that there is a WorkRite Rheostat for any tube now on the market.

WorkRite Vernier Rheostat, 6 ohms.............. $1.00
WorkRite Vernier Rheostat, 15 ohms.............. $1.10
WorkRite Vernier Rheostat, 30 ohms.............. $1.25

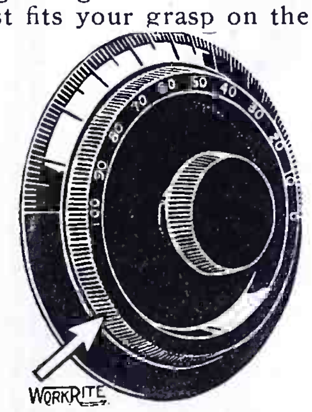


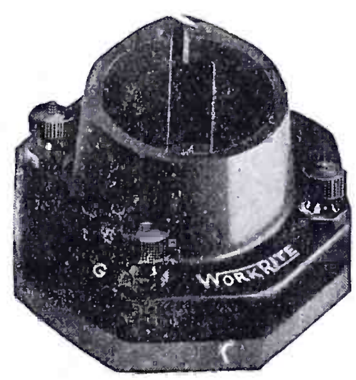
PATENT APPLIED FOR

WorkRite E-Z-Tune Dial

When you want to get a very fine adjustment on your variometers, variocouplers, condensers, etc., you always grasp your dial on the outer edge for more leverage. Right there is where you will find a knurled flange that just fits your grasp on the WorkRite E-Z-Tune Dial. You can easily make a turn of a hair's breadth. Made of the finest material, highly polished. Easily the "Snappiest" dial on the market. 3½ in. diameter. Specify whether 3/16 in. or ¼ in. shaft.

Price 75c

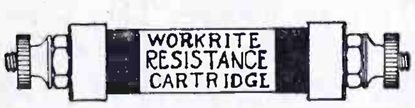




WorkRite Nonmicrophonic Socket

Here is the right socket for your UV 199 Tube. It is moulded with a sponge rubber base in one piece which is even better than the soft rubber recommended for use with this tube. Very neat and attractive. Price......... **60c**

WorkRite Resistance Cartridge



No need to buy a new Rheostat to get the required 30 ohms resistance for the UV 199 Tubes or the 15 ohms for the 201A and 301A Tubes. Just put a WorkRite Resistance Cartridge in the circuit with your old 5 or 6 ohm Rheostat. Price 15 or 25 ohm.. **40c**

Other WorkRite Products

WorkRite Hydrometer

You need one for your "A" Battery. Full instructions for the care of battery included with each instrument.
Price 75c

WorkRite Concert Headset

Extremely sensitive and free from distortion. Phone cases made from aluminum. Try the WorkRite Concert Phones side by side with any on the market. Price $6.00

WorkRite Switch Set

Just what you want. Remove parts and use the block for a template in drilling panel. Switch arms and points made to work together. Price complete, 50c.

WORKRITE NEUTROFORMER

An air-core transformer for use in the Neutrodyne method of receiving. Bakelite wound with the exact number of turns and spacing of green silk wire for maximum efficiency. Price $2.00

THE WORKRITE MANUFACTURING COMPANY

5526 EUCLID AVENUE Western Representative: B. KRUGER, 231 Douglas Bldg., Los Angeles, Cal. **CLEVELAND, OHIO**

Continued from page 56

one day, I was carried into a room where there were handsomely gowned women, and well dressed men. There was a horn there and music seemed to fill the room. My new owner introduced me to the Amplifier twins, who stood high in radio society. They took me under their wing and we got together instantly. They coupled me to an aerial, my old work. The Amplifiers stood by me through it all.

Would I sing? I would. Something thrilled within me. I felt strains of music pouring through me, from end to end. I fairly throbbed with some grand opera I had never heard. One of the Amplifiers nudged me.

"We will sing with you," he said.

Overcome, I could only rectify with all my might. And then, before that august audience, I lifted my voice and, with the Amplifier twins singing with me, we filled that room with the harmony of all space — with music that throbbed, and echoed in startling sweetness.

There was a moment of dramatic silence when the song was finished. Then a man jumped to his feet.

"By God," he said, jerking his thumb toward an ornate polished cabinet at my left. "I paid $300 for that thing and I'd trade it right now for your little crystal set!"

And in that moment, and at those words, I tasted that for which I had striven with my soul—success!

That hour of triumph is now long past. Viewing it from the vantage point of prosperity, for I am now an important element in the community, I realize that all triumphs are short-lived. But it was something to have made good on my father's wishes and expectations, and to realize that I had at last attained recognition. Which brings me to the subject of success.

In my case, success is not maintained by honesty. I am not honest. I am a deceiver, but I do it so adroitly that the public never knows it, and they believe in me and say I am successful. They say:

"I heard a wonderful concert last night on my little crystal set!"

They are wrong. They never heard a scrap of music. What they heard was me, reacting to the music. I heard it. They didn't. It took ten years of laboratory work and $1,000,000 to develop Mr. Tube to please 5,000,000 people. And when the job was all done they found out I could do the same thing without any development because I had a gift for it.

I am a success because I fool the public. I am a damned liar and they know it, but I do it so artistically, they honor me for it. That's why I am a success. Barnum discovered the same thing. That's why I say all books on success are wrong.

There is only one rule. Find your gift. Believe in it. Stay with it! Everything else is the bunk!

In moments of doubt, remember the crystal set. I got there because I had one idea and never lost it. You can do the same.

Tack this over your desk:

"Believe in yourself
and rectify like hell!"

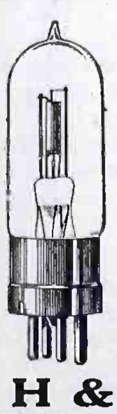
This is the advice of A. CRYSTAL SET.

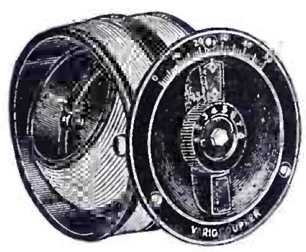
ANTENNA TYPES

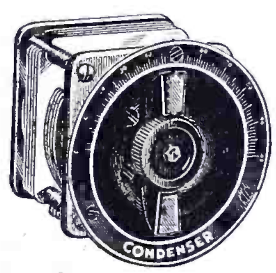
Continued from page 27

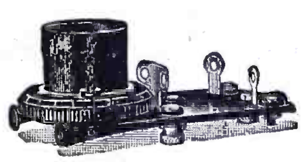
The loop is also easily constructed, and of course located entirely indoors. Its use should, however, not be attempted with a crystal receiver, but with a regenerative vacuum tube very good results are obtainable.

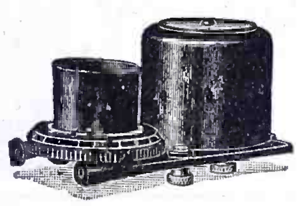
To render complete our summary of antenna types we must include indoor antennas—which are based on identical principles of construction and action as the first type but are entirely indoors. Results obtained with this are often good but they may always be considerably bettered by an outdoor device of proper height and length. Then there are freak antennas, bedsprings, fire escapes, umbrellas, and what not. These are all modifications of the first type, acting in each case as suspended conductors of small size. They give astonishing results sometimes, considering their miniature size. But always far better signals are obtained with more substantial types. They merely go to show the marvelous penetrating powers of radio waves, and the very minute amounts of radiant energy which are sufficient to recreate music, so to speak, in the earphones of the listener.











HONORS AWARDED WORTHY OPERATORS

Continued from page 37

the reverse side the medal carries the words: "Awarded for meritorious service at the time of the burning and sinking of the *S.S. City of Honolulu,* Oct. 12, 1922."

Among those present at the presentation of medals were: Congressman Fredericks, W. T. Bishop, president of the Los Angeles Chamber of Commerce; Henry M. Robinson, chairman of the Harbor Committee of Two Hundred; Edgar McKee, president of the Board of Harbor Commissions; F. P. Gregson, manager of the traffic bureau; H. M. Harding, Los Angeles Manager of the Radio Corporation of America; F. Eldred Boland, general counsel for the corporation; R. V. Crowder, passenger traffic manager, Los Angeles Steamship Company; R. F. Cullen, general passenger agent for the same company; Fred L. Baker, Ralph L. Chandler and Earl M. Leaf, also representing the company; and members of the City Council of Los Angeles.

The radio operators were introduced to the Mayor by A. A. Isbell, Pacific Division manager of the Radio Corporation, who acted as the Mayor's aid throughout the ceremonies.

The presentation of the gold medals grew out of an episode which developed on the last trip of the steamship *City of Honolulu.* The vessel left port at Honolulu for Los Angeles on October 7, 1922. On October 12 fire was discovered aboard early in the morning. The sea was comparatively calm. Operator Kumler, who was on watch, was notified of the fire and told to awaken Bell.

A general call to all ships to stand by was broadcast followed by an S.O.S. Bell handled the key and Kumler and Hancock kept up an instruction relay service with the bridge. This continued until it was seen that the ship was doomed, when Bell alone remained in the operating room and Kumler and Hancock aided ship's officers in getting the passengers safely aboard the life-boats.

By 9 o'clock in the morning the passengers to the number of 250 had left the vessel, by then a seething pyre of flame. Chief Operator Bell and Captain R. H. Lester were the last to leave the vessel. Six hours later the steamer *West Farallone,* summoned by the S.O.S. call, picked up the small boats with their precious cargoes of human freight intact. At daylight, the following morning, all were transferred to the United States Army Transport *Thomas* and landed at Los Angeles.

While floating alongside the *City of Honolulu,* awaiting rescue, the survivors watched the vessel burn to the water's edge. Days later the charred and blackened hulk, a menace to navigation, was sunk by shells from the *U.S.S. Shawnee,* to clear the steamer lane for traffic. The radio men and ship's officers and crew were personally thanked by many of the passengers for the cool-headed seamanship and executive ability under stress, which prevented the loss of a single life.

Bell, since the burning of the *City of Honolulu,* has been attached to the steamer *President Harrison.* His home is in Oakland, Hancock, a resident of Venice, is now an operator on the steamer *City of Los Angeles.* Kumler, following the fire, made a trip to the Orient and return, as operator of the steamer *West Niger.*

Small size instruments for radio control panels are illustrated and described in Bulletin No. 10 from the Roller-Smith Co. of New York City. These include both d.c. and a.c. milliameters and ammeters, millivolt meters and voltmeters for all radio purposes, including thermal ammeters for antenna circuits.

FALL RADIO SEASON OPENS WITH CONVENTION IN CHICAGO

Approximately 1,500 persons, representing all lines of radio activity ranging from amateurs and experimenters to technical men connected with the radio industry, as well as authorities of international reputation, will attend the Second National American Radio Relay League Convention, which is to be held in Chicago September 12-15 under auspices of the Chicago Radio Traffic Association. Tentative plans for the convention, which have been made public by R. H. G. Mathews of the Chicago Radio Laboratory, central division manager of the American Radio Relay League, call for a program of interest to both the amateur and the broadcast listener. A huge banquet is scheduled for Wednesday evening.

An intensive effort is being made by Mr. Mathews and officers of the A.R.R.L. at Hartford, Conn., to select speakers who will cover all phases of radio transmission and reception, bringing before those attending the convention all of the most recent developments which may be utilized for long distance work in the early fall.

One of the most important meetings at the convention on the afternoon of Thursday will be that of the A.R.R.L. Traffic Department under the chairmanship of F. H. Schnell, traffic manager of the League, when coming international amateur long distance tests and kindred matters will be discussed at length.

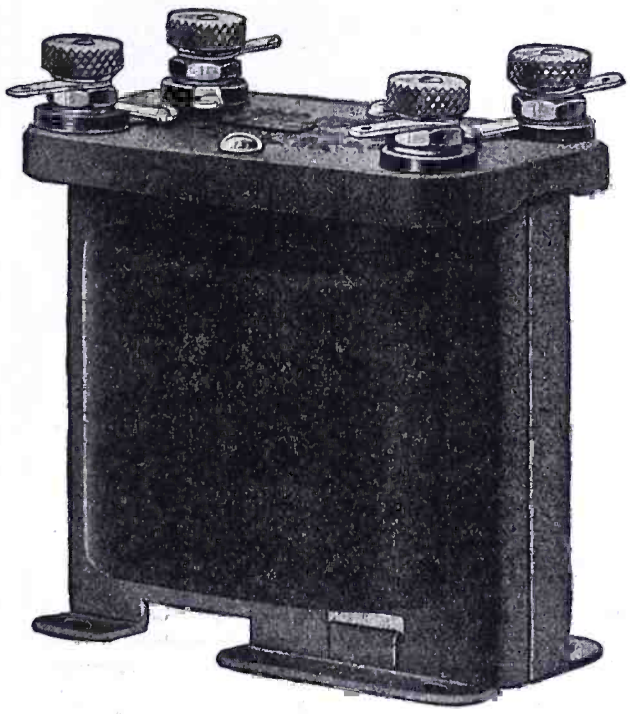
The evening will be given over to a technical meeting at which time both amateur and broadcast transmitters will be discussed. Tours will be made to local broadcast and amateur stations the following afternoon. Next is another technical meeting on the general subject "receiving apparatus." Saturday is to be a "night of mystery" and the convention will wind up with the initiation of candidates into the "Royal Order of the Wouff-Hong."

THE HONGKONG RADIO SOCIETY

With a view to stimulating the interest of local radio enthusiasts and at the same time of urging the local government to grant a provisional license to some company to start broadcasting both music and news, the Hongkong *Telegraph* recently secured over 100 names of those who wished to form themselves into a Radio Club. The first meeting was convened at the city hall on May 4, when the club was formed and officers were elected. Subsequently another meeting was called at the volunteer headquarters, when the colonial secretary was present and gave the government's views and the attitude towards radio in general. He said that they had written to the home office for an expert on wireless and for full details of the British government rules and regulations, and that until the expert did arrive they would not be in a position to grant even a provisional license to any one who is willing and ready to broadcast in Hongkong, for fear of interfering with the local naval and military stations. A week or two later a complete dispatch arrived from the home office, but they are still awaiting the arrival of the government expert, who will be able to advise the government in all matters pertaining to radio. D. Tollan is secretary of the club.

Volume! Clarity!! Delight!!!

With Correct Hook-up—Proper Inductance and Capacity—and Good Detection



You Are Assured a New and Better Amplification—Maximum Volume—Minimum Distortion

With Kellogg Shielded Type Transformers

Correct audio frequency amplification is important in the satisfactory operation of loud speakers. Proper amplification [with KELLOGG transformers] results in a clear reproduction with minimum distortion and maximum volume.

Kellogg transformers are designed to overcome any defects of existing types and to furnish the very best of amplification.

They are built complete by the Kellogg Company, using magnet wire with the very best insulation, and of exactly the correct number of turns. The metal case is heavily enameled in maroon with a Kellogg Bakelite connecting rack. The laminated cores of silicon steel are correctly proportioned and shaped for the most effective electrical field.

The primary and secondary binding posts are accessibly placed at the top of the transformers, and clearly marked so that there need be no error in connection. Every Kellogg transformer is thoroughly tested before leaving our plant and we guarantee the purchaser a product of exceptional efficiency.

No. 501—Ratio 4½ to 1—$4.50 each
No. 502—Ratio 3 to 1— 4.50 each

Kellogg Switchboard & Supply Company

Adams and Aberdeen Streets, Chicago

BARBED WIRELESS

Continued from page 21

He would have at least been able to carry the receiving equipment with him, the lieutenant having finally consented to such a course, had not a mule stepped upon the cabinet when it had slipped from Henderson's hands while he was packing it. To this day Henderson maintains that the mule laughed out loud at him, and only the rush of the moment saved the mule from a drubbing.

Adding insult to injury, Henderson was assigned to help the camp cook. From radio operator to cook's helper is not a step upward, and Henderson felt the disgrace, such as he conceived it to be, keenly. However, he had his measure of revenge, managing to even up for many of the digs that his comrades had given him. The substitution of salt for sugar was but one of them, and the men realizing that for the time being Henderson was in a position to give tit for tat, eased up on their merciless ragging and treated him with a greater measure of respect.

For the next few days the detail penetrated deeper into Mexican territory. Then a change, particularly welcome to Henderson, occurred when the detail camped at a town but recently occupied by a detachment of the fleeing bandits. Here the detail took possession of a Mexican government radio station—one of the Telephunken installations just then beginning to dot the country. At least it amounted to possession, though officially the commanding officer merely "borrowed" the plant. It was an excellent example of the radio engineers' art, with its two sturdy steel towers, immaculate instrument room and gasoline engine-driven generator.

Henderson was promptly relieved of his position as cook's helper, and directed in thinly veiled sarcasm from the lieutenant to get busy and do what he could to establish communication with the outside world. It had been five days since their own equipment had been thrown aside, and during that time they had been out of touch with the main division entirely.

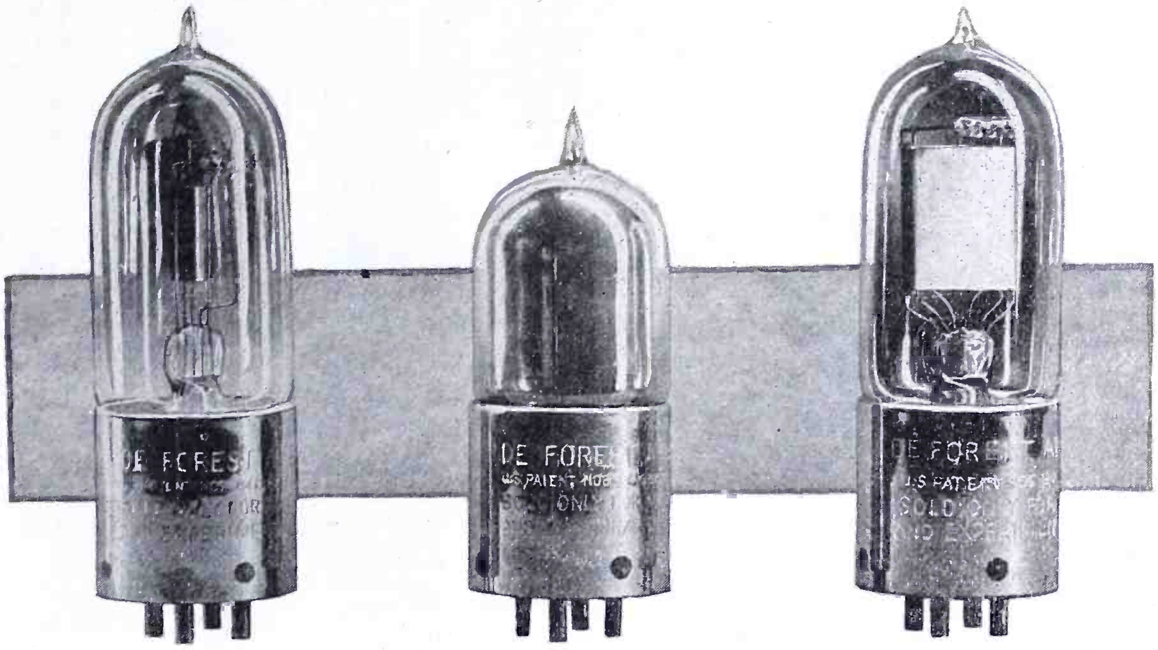
Some time was spent by Henderson in getting the wave of the station down to a point where it could be picked up by the army equipment, and it was not until the antenna had been lowered and a considerable length taken off that Henderson began drumming out his "all copy" calls. It was several hours before he finally established communication, during which time the lieutenant had spoken insultingly of radio in general and operators in particular. Then finally came back a welcome answer, and after a few minutes spent in test calls, Henderson proudly announced that communication was open. For the rest of the day Henderson stayed at his post,

Continued on page 66

De Forest
DV-1 Dry Cell Tube
$6.50

De Forest
DV-6-A Universal Tube
$5.00

De Forest
DV-2 Power Amplifier Tube
(wet cell) $6.50



The More You Know About Radio The More You Rely on De Forest

Without Lee De Forest's discovery of the vacuum tube there would be no radio today. All radio broadcasting, all radio receiving by means of tube sets, rests on De Forest patents.

De Forest has been a pioneer in radio since 1900 and De Forest is a pioneer today. That is the reason for the great success of the De Forest Reflex Radiophone. That is the reason for the success of the new De Forest tubes—DV-1 Dry Cell Tube, DV-6-A Universal Tube, DV-2 Wet Cell Power Amplifier Tube.

If you want a radio receiving set with a range on indoor loop of from 1,500 to 3,000 miles, depending on atmospheric conditions; if you want simplicity of control, clear reception without distortion and without extraneous noise; if you want operation on either wet or dry cells—see the De Forest Reflex Radiophones at the De Forest agent's today.

The D-7-A Reflex Radiophone is a three-tube set at $132.50; the D-10 Portable Reflex has a drawer in its cabinet for dry batteries and is a four-tube set at $159.00. No matter what you pay, you can't get greater radio satisfaction.

Whether you buy your set complete, or build your own from the laboratory tested De Forest parts, you can rely on De Forest, the greatest name in Radio.

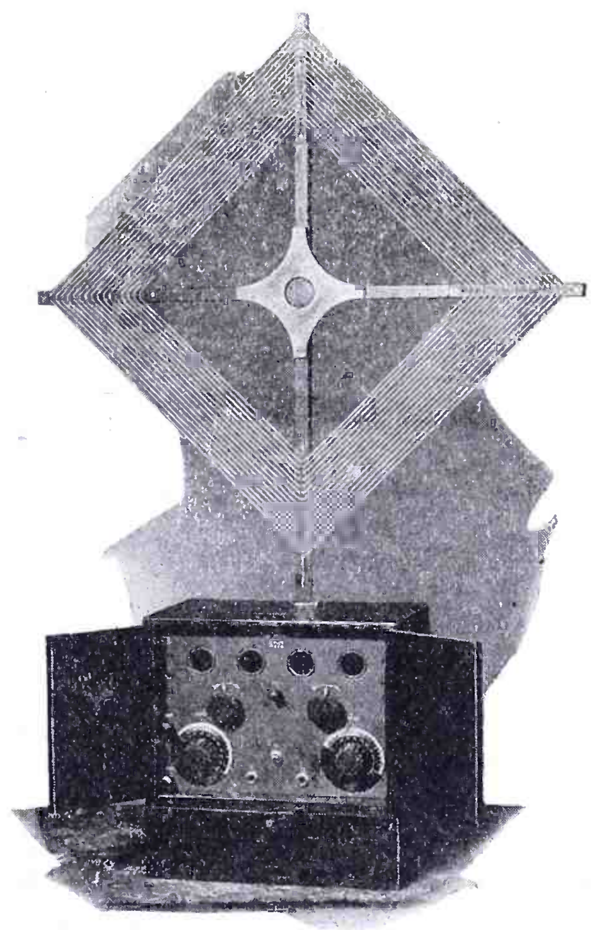
De Forest Radio Tel. & Tel. Co.

Dept. R, JERSEY CITY, N. J.

Western Sales Division
5680-12th St., Detroit, Mich.

DE FOREST

"His Daddy's Choice"



De Forest Portable Reflex Radiophone type D-10, which operates on wet or dry cells, has a reception range of from 1,500 to 3,000 miles on indoor loop; has drawer for all necessary A and B dry cells. **Price $150.00.**

De Forest products are sold only through exclusive agents, direct to the public for your protection. The De Forest Company will be glad to hear from representative men in various communities who wish to become exclusive De Forest agents. 2328

Radio Catalogs Free

Send a postcard for De Forest's Free Radio Catalog with full details and prices on sets, tubes, and parts.

Continued from page 64

standing by for the most part, but occasionally copying a cipher message for the commanding officer, or in turn transmitting an answer back.

That evening, Henderson, well pleased with the world in general and himself in particular, sat on the steps of the radio house, smoking a final pipe before turning in for a few hours' rest. The air was quiet, a sense of peace pervaded the surroundings. Henderson felt that he had put himself back on a sound footing with his officers, as indeed he had, for, with communication restored, both officers and men were in a better frame of mind. Leaning back against the door, he heard the subdued murmur of voices to the rear of the radio house. Indistinctly he heard his name mentioned a couple of times.

Henderson was endowed with the average amount of curiosity, and, deciding that if he were being discussed that there would be no harm in a little listening-in, quietly gumshoed over to a point where, unobserved, he could get a better understanding of the conversation.

Now the men were for the most part a good-natured bunch of fellows, and while they had some times rubbed it in on Henderson, he had not held it against them particularly. Just now they were putting up a practical joke on him. Henderson had never been under fire, while for the most part the rest were men who had seen real service in the Philippines or elsewhere at some time during their army career. They held the good-natured contempt of the seasoned veteran for the untrained man.

Their plan was to "rush" Henderson at a late hour, firing their guns into the air, and making a lot of noise generally. Henderson had spread his blankets in the radio house and, as the place would hold only one man comfortably under such circumstances, he had curtly ordered several others to get out. Now they proposed to stage a fake attack and find out whether Henderson would "scare."

"How about his own gun?" asked one of the conspirators.

"I drew the cartridges" was the reply. Henderson remembered that he had taken off the belt for greater comfort while transmitting his last series of messages. Breaking open the big army gun which was strapped on his hip, he verified the statement. His gun was empty.

Then followed more talk, and the men finally agreed upon the hour of eleven o'clock for the fake attack. Henderson looked at the watch which he carried. It was just ten o'colck. Time was passing faster than he had thought, and he turned and padded noislessly back to the radio house. A plan was already forming in his mind for turning the tables on the fellows.

Continued on page 68

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CONDENSITE CELORON
STANDARD RADIO PANEL

Continued from page 66

The radio cabin was surrounded by a fence, the lower part of which was composed of webbed netting, while above stretched two strands of barbed wire. A small iron gate allowed entrance to the grounds. The radio house was placed to one side of the enclosure, about fifteen feet from the fence at this point. Securing a spare coil of antennae wire that he had noted in the generator room, Henderson turned out the small battery lamp that served to light the cabin, and quietly sneaked out.

To the two top strands of barbed wire he fastened his cable and ran it back to the antenna lead-in. Clipping the cable, he fastened it in turn to the lower band of netting, and thence to the ground connection of the plant.

A small emergency spark coil outfit, somewhat similar to the type then in vogue in shipping circles, was a part of the equipment of the station, and was provided with the usual system of batteries for its operation. Henderson knew, through previous experience learned at painful expense, that the shock from this type of coil, while highly uncomfortable, would not be enough to be fatal to the average man. The men in approaching the radio house would be obliged to crawl through the fence, Henderson having padlocked the one gate that allowed entrance. They would come in direct contact with the upper and lower set of connections—a few gentle taps of the key, and, Henderson reflected, there would be considerably more action than they had figured upon.

Then having thrown the switches that connected the emergency outfit into the antenna circuit, Henderson sat down in the darkened radio room to await the coming of the men. His gun he had reloaded, with the intention of emptying it into the air to help along the general excitement. The minutes ticked away evenly, until the hands of his watch pointed to five minutes of eleven. Rising from the chair in which he had been sitting, he peered out of the window. It was pitch dark outside, and at first his eyes could make nothing out. Then dimly he distinguished vague shadowy forms crawling up along the fence. Now three of the men were preparing to crawl through. All were in direct contact with the upper and lower parts of the fence, barring the thin insulation of their clothing, which of course the spark would pierce readily.

Henderson chuckled as he reached back and pressed the key. He could picture the surprise and consternation of the men, and thought with keen relish of the hearty laugh that he would have at their expense.

When he pressed the key down, it was with the intention of holding it down only for brief intervals of time, but the contacts, pitted from constant use, arced and then stuck. The vibrator of the coil buzzed dully.

Outside the radio house rose a shrill volume of cries, curses and imprecations. Henderson cut off the hearty laugh that escaped his lips—instead of the good and hearty American cuss-words that Henderson had attuned his ears for, came a string of epithets of decided Spanish flavor. Henderson leaped for the door, grabbing an army hand lantern as he did so. The men tumbling around in a confused heap were not his comrades in arms, but by their motley uniforms, none others than some of the force of whom the American forces had been in hot pursuit. Some of those who had not yet come in contact with the fence stood as though too paralyzed by the actions of their fellows to move. Others in the background were fleeing from the scene with more speed than elegance.

Henderson emptied his gun, not into the air, but into the struggling mass of men. To one side rose the shrill cry of the bugler—as much on the job as ever. Men were coming up on the run, in various stages of undress. Over in the background rose the shrill hee-haw of an army mule. Henderson maintains to this day that it was the same one that laughed out loud at him when it stepped on the receiving cabinet which he was preparing to pack.

The next few minutes were full of action. When it was all over, and six badly messed-up bandits had been securely placed under guard, the lieutenant opened up a court of general inquiry. Henderson told his part of the story. The sheepish faces of a number of the men gathered round told the rest.

"Let me see your watch" said the commanding officer as Henderson finished his recital, in which he had mentioned the time that the men had agreed upon for their fake attack. He compared Henderson's dollar turnip with the more elaborate timepiece which he

Continued on page 70

Continued from page 69

possessed. Henderson's face fell as he noted that his own timepiece was an hour faster than that of the officer.

A questioning of the captured bandits brought out the fact that they had intended to do away with the radio operator first to prevent the possibility of a call for help, and that a force of their own men had been held further back, waiting to rush in. Only an efficient guard had prevented a larger surprise force creeping in, and the prompt response of the Americans to the first alarm had apparently frightened them off. Upon advice of scouts acquainted with the surrounding territory, plans for the chase of the fleeing bandits were abandoned.

From that time on, until the end of the campaign, Henderson was not "kidded" by the men, and when they again reached civilization he was agreeably surprised with a gift in the form of a seventeen-jeweled watch that could be depended upon to keep accurate time. While Henderson carries the gift with all evidences of pride in its possession, he has carefully stowed the dollar timepiece away, for he figures that had it not been an hour off in its reckoning that he might now be tuning a harp instead of a radio set.

D. X. BRINGER-IN

Continued from page 30

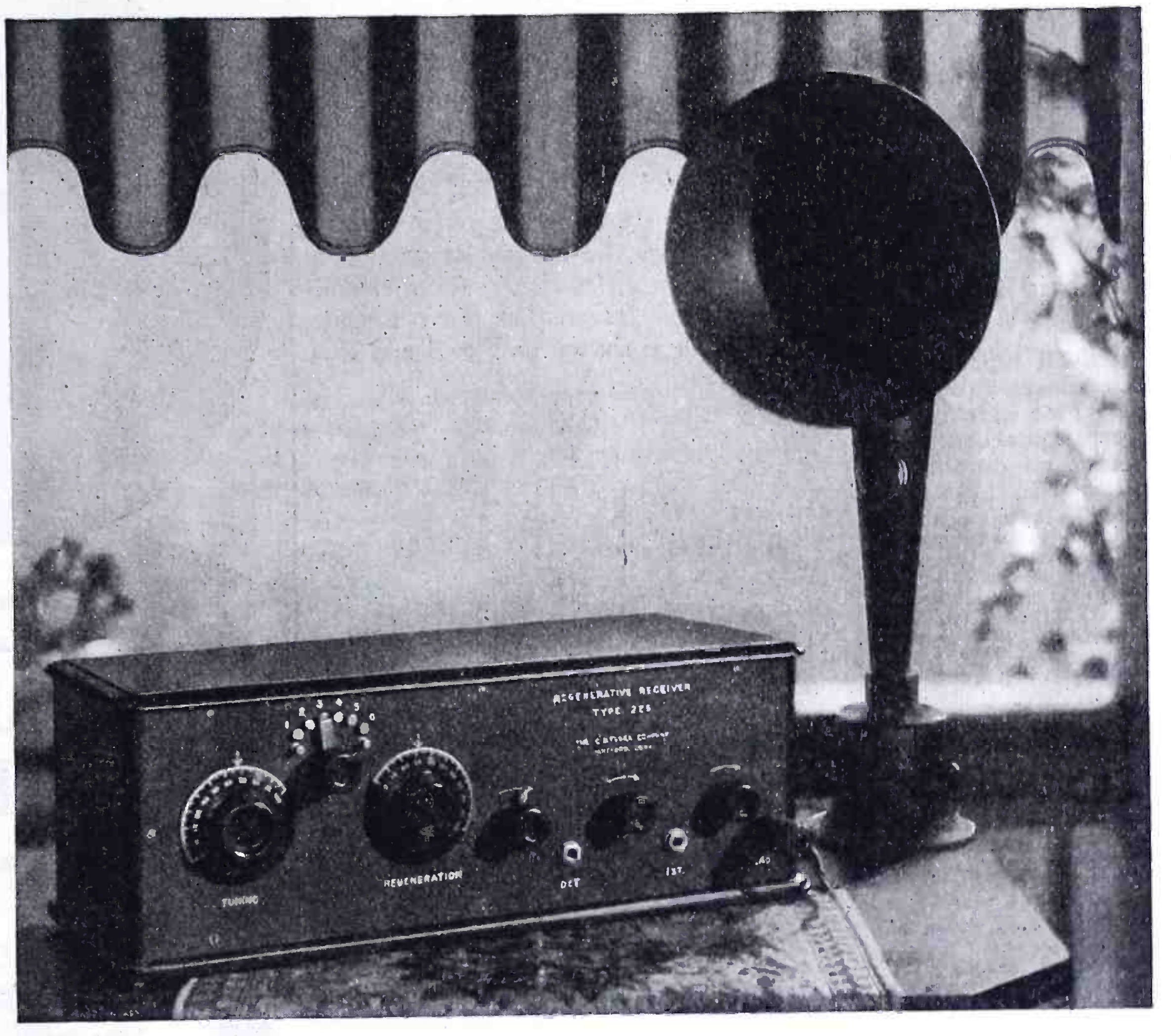
three and will make the set dust-proof if it is put into a cabinet.

The primary condenser will not have to have a vernier, as it does not tune very sharply, but a vernier is needed on the secondary condenser. The tube should be wound in the same direction as the winding on the stator of the variometer. A vernier rheostat in the detector circuit will be found convenient to keep the tube from oscillating and will help out on the DX.

In my set the three honeycomb coils are stationary, but it would be advisable to have them arranged so that the coupling may be varied. A list of the coils that I have found best in loading the set is as follows:

Wavelength	Primary	Secondary	Plate	Position of Pri. Cond.
650-1650	DL150	DL100	DL75	Series
850-1800	DL200	DL150	DL100	Series
1400-2900	DL300	DL250	DL150	Series
2500-4500	DL200	DL300	DL150	Shunt
4200-6300	DL500	DL400	DL200	Shunt
6000-14000	DL1250	DL750	DL400	Series
13000-21000	DL750	xDL1250	DL500	Shunt

By changing the position of the primary condenser in the circuit the total number of coils needed to cover all wavelengths is reduced to ten as follows: DL 75, 100, 150, 200, 250, 300, 400, 500, 750, 1250. With the above information and the accompanying sketch all those who have experienced any sort of difficulty with this circuit ought to be able to locate their trouble and get things percolating as they should.



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TUSKA RADIO

PARALLEL RESONANCE

Continued from page 25

lates in an antenna it may oscillate at a fundamental wavelength and at its third harmonic and so on. The fundamental wavelength is the main wave at which transmission takes place. But stations not tuned to this fundamental wave may be very seriously interfered with due to the presence of the harmonics to which they may be tuned. If a parallel circuit such as *LC* is inserted in the transmitting antenna as shown in Fig. 4 and this

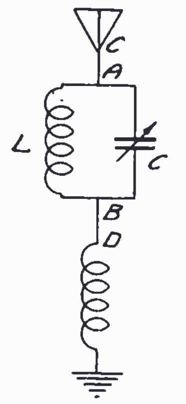


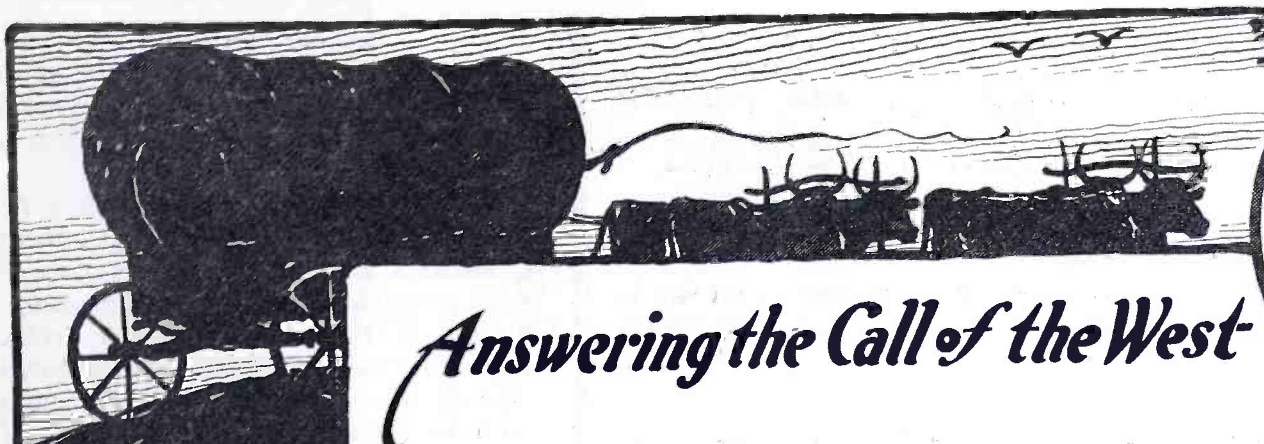
Fig. 4. Parallel Circuit for Suppressing Undesired Frequencies

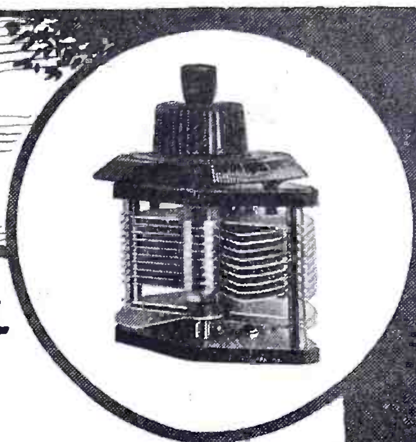
parallel circuit is tuned to the third harmonic we will have the effect described above. The reactance or impedance of this parallel circuit will be almost infinite at the frequency of the third harmonic since it is tuned to it. Hence there will be zero current of this frequency in the line or antenna, *AC* and *BD*. Thus no energy at this harmonic frequency will be radiated from the antenna and no interference will be created. There may be a very large current at this frequency in this parallel circuit itself, but none of this current will get out of this circuit into the antenna. Such a circuit is frequently called a "fly-wheel" circuit, or better still a "trap circuit." In effect it traps the current of interfering frequency and prevents it from getting out where it can do harm.

Obviously this type of circuit may also be used in receiving antennas. If an interfering wave strikes the receiving antenna, by tuning this parallel circuit until it is in resonance with the interfering wave we can eliminate this interference. For when the parallel circuit is tuned to the interfering wave its impedance to it is a maximum, hence no current at this frequency gets through the antenna into the receiver. This device will now be recognized as the familiar "wave trap." The "wave trap" is a parallel resonant circuit based on the above outlined principles.

Now it was stated above that, due to the presence of resistance, the impedance was not infinite and therefore a very small current flowed in the line. The smaller the resistance is made the greater the impedance of the circuit becomes, hence the better it will obstruct the flow

Continued on page 74





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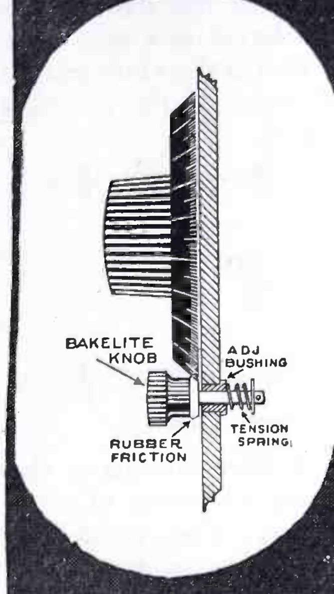

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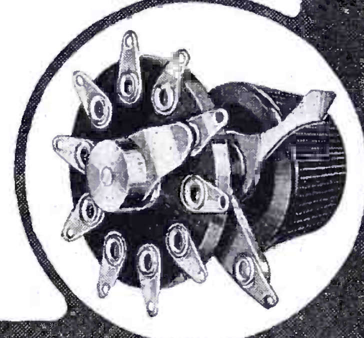

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Continued from page 72

of interfering currents. Exactly as in the case of series resonance, best results here are obtained when the coil has a minimum resistance.

It occurs to the writer that in a recent issue of RADIO, May 1923, there appeared a very practical application of this principle of parallel resonance, namely in the design of choke coils. Here use was made of the distributed capacity of a coil which, in conjunction with its inductance, formed a parallel circuit which had a natural frequency. This coil therefore had a very great impedance to currents of this natural frequency, hence it behaved as a very effective choke coil. This is therefore seen to be a clever application of the principle of parallel resonance.

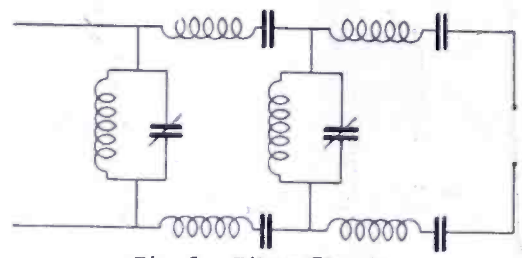


Fig. 5. Filter Circuit

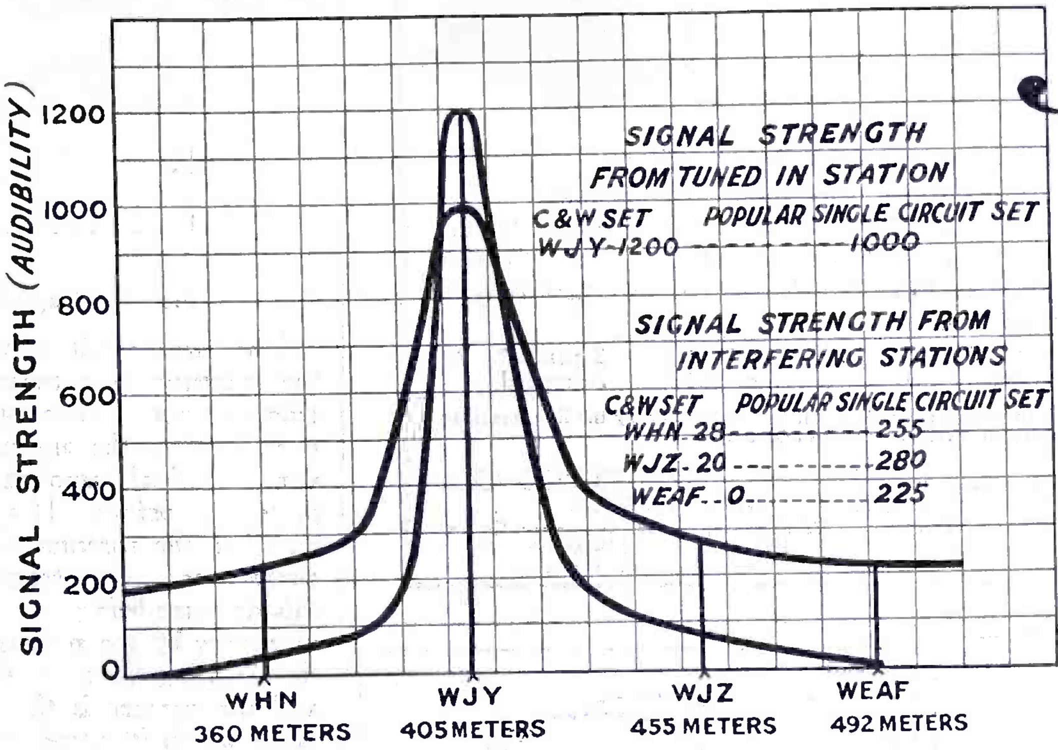
The question of filter circuits is also an application, from one point of view, of parallel resonance. The entire filter problem is an extremely complex one requiring the use of the most complicated mathematics. In filter circuits it is desired to eliminate either ripples or alternating currents of certain frequencies. By the use of a series of parallel circuits such as outlined here these circuits may be tuned to the various frequencies which it is desired to eliminate, hence they will offer a maximum impedance to currents of these frequencies which will not be able to pass them. In filter circuits it is not only desirable to eliminate certain frequencies as in the previous paragraph, but it is also desirable to let through certain frequencies. Hence series resonance circuits are employed which are tuned to those frequencies which are needed, at which frequencies the circuits have a minimum impedance and hence the desired frequencies are permitted to pass through. Filter circuits are therefore made up of a combination of series and parallel circuits, as shown in Fig. 5.

Effect of Coupling On Resonance

Coupling is always present in one form or another in all radio circuits. The different forms of coupling will not be considered here, but it may simply be said that when coupling exists between two circuits energy is extracted from one circuit by the other. Thus in Fig. 6 we have an antenna circuit in which energy is present, either because of a transmitter charging it or because of received energy from a distant transmitter. If we couple another circuit to it as shown this second circuit will withdraw a certain amount

Continued on page 76

Here is *Proof*



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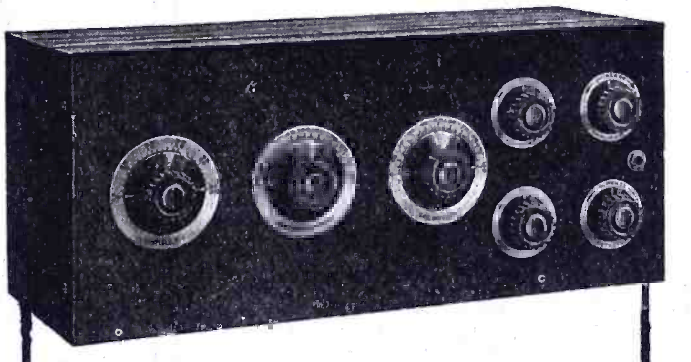

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The micro-ammeter shows a single strength of 1200 for C&W or 200 points greater than the other receiver.

Interference from other stations shown is 25, 20 and 0 for C&W—so low it is almost inaudible. Interference from other stations measures 255, 280, 225 for the other receiver—a serious annoyance.

This result is typical of C&W comparative tests.

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Continued from page 74

of energy from the antenna, the exact amount depending upon a number of factors. If such a coupled circuit does withdraw energy from the antenna the total amount of energy remaining in the antenna must be less than before this coupling was made.

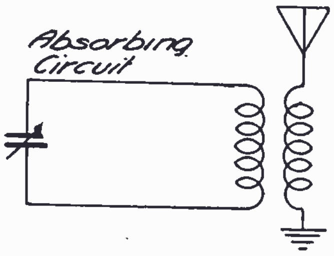


Fig. 6. Coupled Circuit

The same result may be obtained by the insertion of a resistance in the antenna circuit. Thus suppose no circuit is coupled to the antenna and that the same original amount of energy is present as before. If a resistance is inserted in the antenna we know that the current in the antenna will decrease, this decrease being due to the absorption of energy by the resistance. The closer the coupling the more energy it extracts and the greater is the equivalent resistance which it introduces in the circuit.

Now from our previous article it was learned that the addition of resistance in a circuit increased the broadness of the resonance curve, hence broad tuning and interference prevailed. Too close coupling is equivalent to increasing the circuit resistance greatly, hence broadening the tuning. This is the reason that best operation and results are secured when loose coupling is employed between any two circuits in receiver and transmitter. Loose coupling alters the resistance but little, hence does not impair the tuning qualities. Of course sufficient coupling must be employed to transfer the necessary amount of energy from one circuit to another. Thus the secondary of a receiving set must extract energy from an antenna in order to pass it on to the telephones. But maximum efficiency will be secured when enough energy is passed to the phones to give a good audible signal, while at the same time interference is reduced. By using loose coupling we may get the proper transfer of energy to give a good audible signal and at the same time avoid increasing the broadness of tuning, which results in little interference. It is true that the signal might be made louder by coupling circuits more closely and extracting more energy to actuate the phones. However, by coupling closely we will at the same time increase the effective resistance, as explained above, broaden tuning thereby and create interference. It might not be possible to hear the louder signal through this interference, thus little is gained by increasing the coupling. The same considerations

Continued on page 78

Continued from page 76

apply to the transmitter. In brief, loose coupling will give good results without the addition of the disadvantages resulting from close-coupled circuits.

This effect of increasing the effective resistance of a circuit by the extraction of energy from it by a coupled circuit is used in a practical application of the following kind. We have an antenna in Fig. 6 which has some objectionable currents flowing in it. These currents may again be due to arc harmonics or other interfering frequencies. It is desired to eliminate these undesired frequencies. We saw how this was accomplished by the parallel resonant circuit. This may also be accomplished by an absorbing circuit coupled to the antenna. By tuning this coupled circuit to the frequency of the undesired currents and coupling the circuit closely to the antenna, this circuit will absorb the energy flowing in the antenna at that frequency. This is equivalent to introducing a high resistance in the antenna, which resistance is only high at the frequency of the undesired currents. Hence the value of these currents decreases and interference is less. Such a circuit is seen to exert the same effect as a series resonance circuit and a coupled circuit. By tuning the coupled absorbing circuit to resonance with the undesired frequencies we decrease the resistance of this circuit at these frequencies to a minimum, thus enabling it to draw a maximum of energy from the antenna. At the same time by coupling closely more energy is withdrawn, more effective resistance at these undesired frequencies is introduced in the antenna, the net effect being to decrease the value of the interfering currents in the antenna.

WAVEMETER DESIGN

Continued from page 28

wavelength. Due to the scale being thus uniformly divided there can be little chance of errors in reading as in the case with the usual semi-circular condenser.

Of the several devices employed to show when the wavemeter has been tuned to resonance with the circuit which is being measured the simplest is a small incandescent lamp connected in series with the wavemeter. When the circuit is being tuned the lamp lights due to the induced voltage causing a current to flow through it. As resonance is approached the brilliancy increases and at resonance it is a maximum. This cannot be used to measure receiver currents, as the voltage will not be sufficient to light the lamp. It is satisfactory for low transmitter current work, but care should be taken in coupling the wavemeter, as if it is too closely coupled a large enough current may be induced in it to burn the small lamp out.

For accurate work with transmitter circuits it is necessary to use a thermo-ammeter or galvanometer connected in series with the wavemeter. Resonance is indicated by the reading of the meter, maximum deflection indicating resonance.

For receiver work a practical and very sensitive resonance indicator is the combination of crystal detector and telephones which is employed as shown in Fig. 1. As the wavemeter circuit is varied the signals heard in the phones become loudest when resonance is reached. Fig. 2 is probably the best form of connection, giving maximum sensitivity with medium increase in decrement.

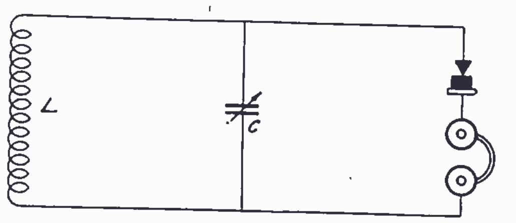


Fig. 1. Wavemeter Employing Crystal Detector and Phones as a Resonance Indicator

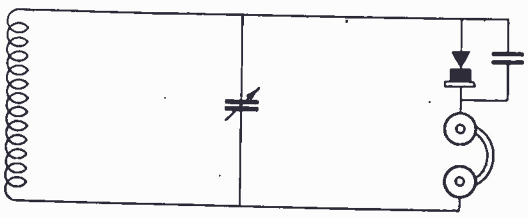


Fig. 2. Approved Connection for Wavemeter

Where oscillations do not exist in the circuit which is to be measured, the wavemeter may be employed for the generation of such oscillations by attaching a buzzer to it as shown in Fig. 3.

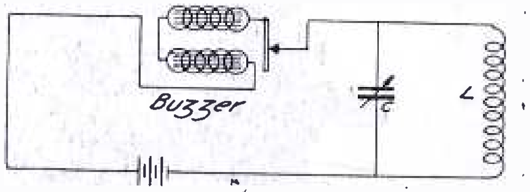


Fig. 3. Use of Buzzer to Generate R. F. Oscillations

The current through the buzzer causes it to vibrate, at the same time the condenser *C* is charged to the battery voltage. At the break of the buzzer contact the condenser discharges through the inductance and so gives rise to oscillations of the frequency of the circuit. By varying the wavemeter condenser the frequency of the oscillations may be varied also. When using a buzzer to excite oscillations in the wavemeter it is advisable that the wavemeter be calibrated with the buzzer on and in circuit, as it may seriously affect the accuracy of the calibration otherwise.

Methods

In wavemeter measurements the oscillations may be either damped or modulated, or undamped. If the former it will be understood that a crystal detector and phones or ammeter may be used as the resonance indicator. If the latter, only the thermo-ammeter may be used as resonance indicator.

To measure the wavelength of a closed oscillating circuit the wavemeter is coupled closely to the circuit and roughly tuned to resonance. The coupling is then loosened and the wavemeter accurately tuned to resonance. The coupling is then loosened very much until a good resonance indication is secured with the loosest possible coupling. The reading of the wavemeter is the wavelength of the closed circuit. The experimenter should accustom himself to working always with the very loosest coupling. This is the foundation of all accurate work.

This measurement may be applied to determining the wavelength of the closed circuit of a transmitter and receiver. It is therefore applicable to calibrating both transmitter and receiver circuits. For receivers the measurement may be carried out for different values of inductance and capacity in the secondary, hence a calibration curve of the secondary of the receiver is obtained. By connecting the antenna to either primary of the transmitter or receiver a calibration of the primary circuits may also be secured. When this is done be sure that the coupling between primary and secondary of the set is placed at zero and that the secondary is open. Otherwise the secondary will absorb energy from the primary, react on it and produce coupling waves, and so destroy the accuracy of the test. With such a calibration of both primary and secondary the operator should have little trouble in setting his set at any desired wavelength. This also enables him to determine without trouble the wavelength of any signals which he is receiving by simply referring to his calibration curve of his receiver. In making measurements of the loaded antenna circuit the wavemeter should always be coupled to the ground lead rather than to any part of the oscillation transformer. This can be easily accomplished by simply twisting a single loop in the ground lead. This will furnish sufficient coupling without altering the wavelength to any extent. In fact, with transmitter sets it will be found that sufficient coupling can be secured by simply coupling the wavemeter to the ground lead itself.

To measure the wavelength of open circuits such as the fundamental of an antenna it will be necessary to excite the unloaded antenna. The simplest way in which this may be done is by the use of a buzzer as in Fig. 4. Here the vibration of the buzzer opens and closes the antenna circuit. When open, the antenna is charged to battery potential, when closed it discharges. During the discharge the antenna vibrates at its fundamental. By coupling the wavemeter loosely to the ground lead, or to a single loop in the ground lead and tuning to resonance the natural wavelength of the antenna may be found.

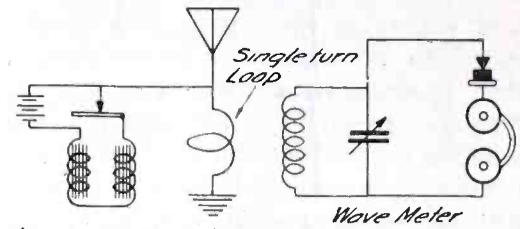


Fig. 4. Method for Making Antenna Oscillate at Its Fundamental

Another method for setting up oscillations in the unloaded antenna by means of the buzzer is indicated in Fig. 5. Here a single loop in the ground lead is connected to the buzzer as shown. At the make of the buzzer, current flows through the loop. At the break, due to its inductance, a voltage is induced in

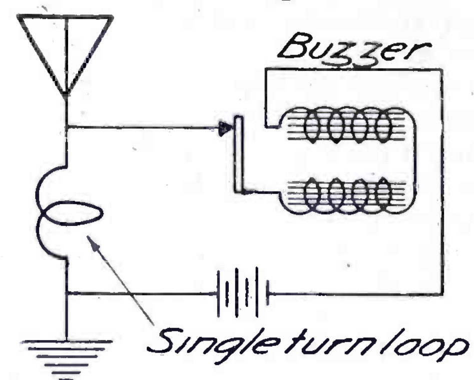


Fig. 5. Method for Making Antenna Oscillate at Its Fundamental

the loop which discharges through the aerial and sets up high frequency oscillations at the fundamental of the antenna. In the former case the antenna capacity is charged to a voltage and then discharged at the make, while in the latter the voltage is generated in the inductance which then discharges through the antenna at the break. The amateur should know both methods.

To measure the inductance of an antenna two inductances of known value are required. Let these be L_1 and L_2. Let the antenna inductance be L_a. The antenna is excited with each of the known inductances in series with it and the wavelength of the antenna loaded is determined by means of the wavemeter. Let the resonant antenna wavelength be λ_1 with coil L_1 in circuit, and λ_2 with coil L_2 in circuit. The wavelength of the antenna is given by the formulas

$$\lambda_1 = 1885 \sqrt{(L_1 + L_a)\, C_a} \quad (1)$$

$$\lambda_2 = 1885 \sqrt{(L_2 + L_a)\, C_a} \quad (2)$$

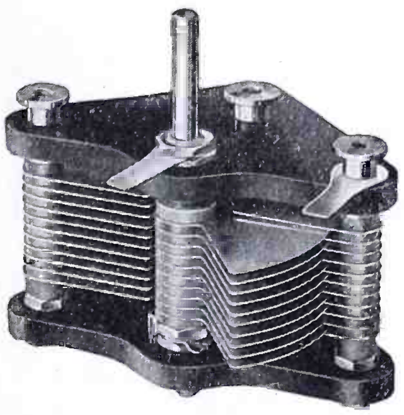
From these two equations we find that

$$L_a = \frac{L_1 \lambda_2^2 - L_2 \lambda_1^2}{\lambda_1^2 - \lambda_2^2} \quad (3)$$

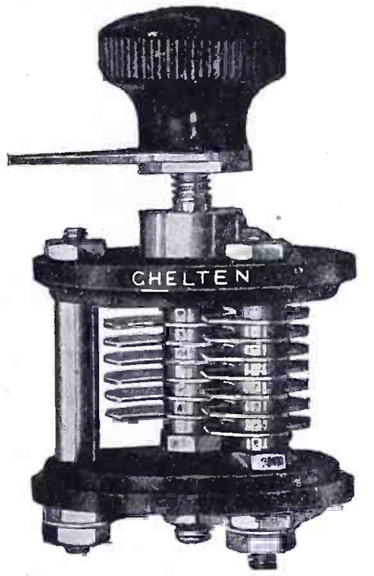
Hence, knowing the values of L_1, L_2, λ_1 and λ_2, we can calculate the antenna inductance L_a. This is the accepted method.

Continued on page 82

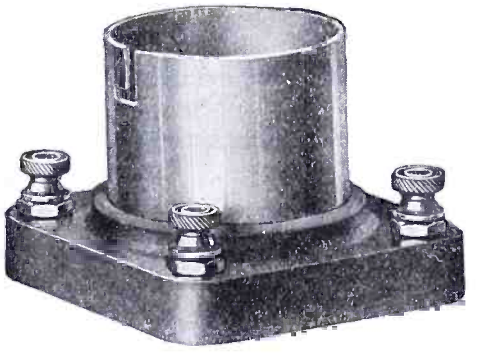
A Midget Vernier and Other Chelten Radio Products



Chelten Variable Condenser
21 Plate
Cat. No. 810



Chelten Midget Vernier
Cat. No. 850



Chelten Tube Socket
Cat. No. 740

The "Chelten Midget Vernier" is a really remarkable little instrument. Though small in size its seven stationary and six rotar plates permit sharper tuning than is usually possible with other Verniers. Those who are satisfied with nothing but the best are usually the ones who are securing the most satisfactory results from their Radio Equipment.

The Chelten line of Radio Products is noted for its high quality. Every part is made to micrometer measurement and only the best of materials obtainable are used. Insist on CHELTEN. We manufacture a complete line of Condensers, Sockets, Rheostats, Plugs, Jacks, Grid Leaks, Crystal Detectors, and Bakelite Dials and Knobs.

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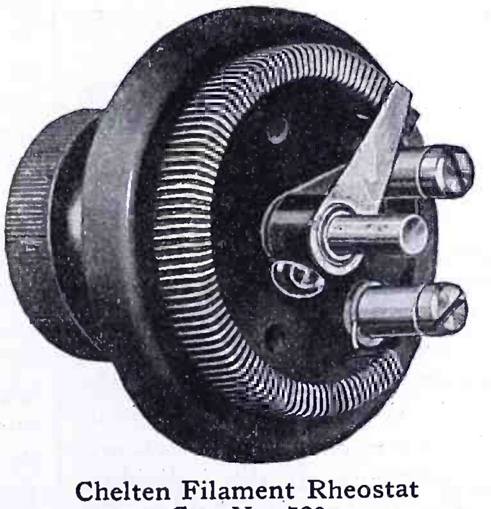
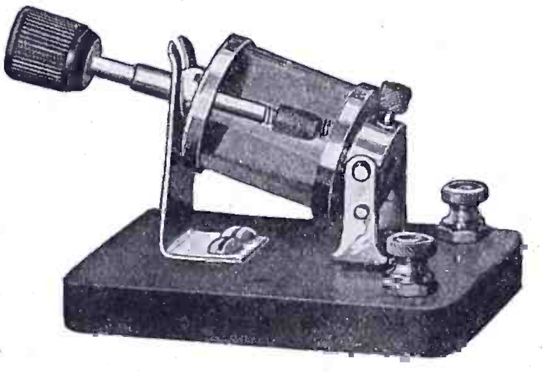
Chelten Hexagonal Plug
Cat. No. 746



Chelten Filament Rheostat
Cat. No. 720



Chelten Crystal Detector
Cat. No. 750

THE CHELTEN ELECTRIC COMPANY

4863 STENTON AVENUE, PHILADELPHIA, PA.

Continued from page 80

To measure the capacity of an antenna, knowing the value of L_1, L_a, and λ_1, we can substitute these in equation (1) to find the antenna capacity C_1.

To measure capacity, a known inductance L is connected in parallel with the unknown condenser and oscillations excited in the circuit. The wavelength of the circuit is then measured and read off on the wavemeter. Call this wavelength λ. Knowing λ and L, we can at once calculate the unknown capacity C_x from the wavelength relation. $\lambda = 1885\sqrt{LC_x}$.

The same method is applicable to the measurement of inductance, only instead of having a known inductance we now require a known capacity.

It is well known that when two circuits are coupled together and are tuned to resonance the resultant emitted wave is not a pure wave (unless the coupling is zero), but is a wave having two peaks, one on either side of the resonant wavelength. This means that the energy from a coupled transmitter is not concentrated on one wave but is spread over a band of waves, resulting in interference. Most of the energy is concentrated in the peaks of the coupling waves. These waves will be separated a certain amount, depending upon the degree of coupling. If the coupling is very tight they will be separated considerably, resulting in an extremely broad wave. If the coupling is extremely loose these coupling waves are closer together and may coincide for negligible coupling. In this last case all the energy is confined to the one resonant wave, hence little interference is created. It is desirable to know what sort of a wave is being sent out from a station. The following method will give this information:

The primary and secondary of the transmitter are tuned to the same wavelength by means of the wavemeter. Each circuit is tuned individually with the other circuit open and at zero coupling so that no reaction effects are produced. In this way we know that both circuits are in exact resonance. The entire transmitter is set operating and the wavemeter coupled very loosely to a single turn loop in the ground lead. A thermo-ammeter should be used in the wavemeter circuit as the resonance indicator. The wavemeter is now detuned below the frequency of the individual circuits and a reading is taken of the wavemeter reading and the current in the thermo-ammeter of the wavemeter. This is done for a number of different settings of the wavemeter on each side of the resonant wavelength of the transmitter. In this way we are able to determine how much energy is being radiated at wavelengths other than the resonant wavelength. If a curve is drawn showing wavelength readings against ammeter readings of the wavemeter it will have the appearance showing in Fig. 6. In this measurement the original settings of the transmitter must be kept constant.

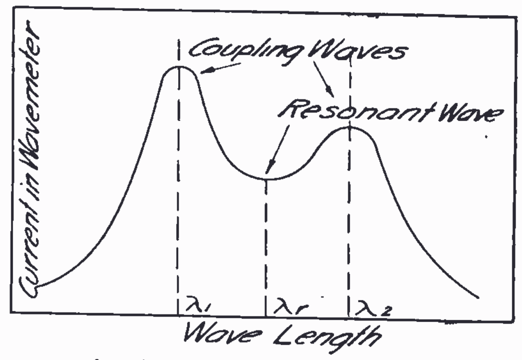


Fig. 6. Coupling Wave Curve

It will be observed that at each side of the resonant wavelength of the transmitter there is a peak. The wavelengths represented by these peaks are the "coupling waves" which are due to the reaction of one circuit on the other. The energy from the transmitter is thus seen to be distributed over a fairly wide band of wavelengths on either side of the resonant wave. Most of the energy is seen to be in the coupling waves. A different curve is obtained for different degrees of coupling. If the coupling is made tighter the coupling waves are spread farther apart, the radiated energy is distributed over a greater band of wavelengths, meaning greater interference is created. If the coupling is made very loose the coupling waves approach each other and at extremely loose coupling they coincide with each other. Thus all the energy is now confined in a very narrow band of wavelengths, hence less interference is produced. Which explains the importance of loose coupling in transmitters.

The above coupling curves refer to spark transmitters. In the case of C.W. transmitters there is little distribution of energy on wavelengths other than the resonant, since the decrement of the wave is zero. However if the damping factor of the circuit itself is high, that is, if the circuit has high effective resistance, a broad resonance curve is secured, the method being the same as given above. Likewise a receiver circuit may be measured for its resonance curve with the wavemeter and if its resistance is high it also has a broad resonance curve. The looser the coupling the sharper the resonance curve. If the transmitter has an extremely sharp resonance curve, while the receiver has an extremely broad resonance curve, tuning will be very bad, since the receiver gives a good response to wavelengths detuned from its resonance wave.

The coupling coefficient and mutual inductance may be obtained from a curve such as resonance curve, Fig. 6. We know from measurement the resonant wavelength of the transmitter. From

Continued on page 84

Continued from page 82

the curve we find the values of the two coupling waves, λ_1 and λ_2. It may be shown by a simple mathematical calculation that the coupling coefficient is given by the following simple equation:

$$\text{Coupling Coefficient} = K = \frac{\lambda_2 - \lambda_1}{\lambda_r}$$

in which λ_r is the resonant wavelength, λ_2 the larger and λ_1 the smaller coupling wave. By substituting our values in this equation we have our coupling coefficient.

The mutual inductance M is given by the equation

$$M = K\sqrt{L_1 L_2}$$

in which K is the coupling coefficient, L_1 and L_2 the self-inductances of the primary and secondary circuits respectively obtained as previously described.

The wide variety of uses and measurements to which the wavemeter may be put is now evident from the above. These uses may be multiplied many times. Almost any investigation requires a wavemeter and many uses may be found for it around amateur stations. Thus by exploring with a wavemeter the cause for the absorption of considerable energy in the vicinity of a transmitter has been found. It should therefore constitute the principal adjunct of any well equipped amateur station.

Did you ever take out all the tubes in the set, when you had a "phony" noise, and clean them off? Proceed as follows: take out one tube at a time, with the set in operation, and clean off the pins, both sides and ends, with some very fine sandpaper or emery cloth. Also polish up the contact springs in the socket. Many times 50% of the noise comes from such a source. It is well to disconnect the antenna and ground when you do this, as then you will only have the local noise in the set, without trouble from static, etc.

THE DESIGN OF RADIO APPARATUS

Continued from page 32

only remains to build an inductance to suit, which will have an approximate value equal to that desired. It will be found in general that the formulas used for inductance calculation are rather involved, and subject to quite large margins of error. Probably one of the simplest ways to design an inductance is to take a unit number of turns of wire, of given diameter, on a unit sized core, and actually measure the value.

Thus inductance value can be very easily measured, if a calibrated condenser and wavemeter are at hand. Set the unknown inductance up, with the variable condenser in shunt thereto, thus forming a simple oscillatory circuit. Now arrange the wavemeter so that it can be used to excite the unknown circuit, the wavemeter buzzer acting as a driver. A crystal detector should be included in the unknown circuit, so that the resonance point may be determined with ease. This set-up is illustrated diagrammatically in Fig. 1, where the

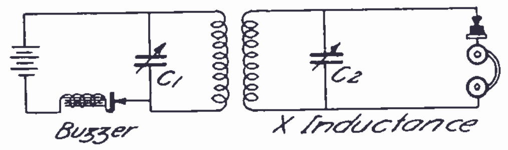


Fig. 1. Method of Inductance Measurement

wavemeter is shown to the left, with a driving buzzer, and the unknown inductance, shunted by the calibrated variable condenser C_2 is used as the receiving circuit. The condenser C_2 need not be calibrated, if its exact value is known, and is of any value from 0.0005 to 0.0015 mfd., as the wavemeter will generally be the only variable element necessary. When the resonance point is determined, and the wavelength read off, the capacity being known, the value of the inductance L can be readily determined by comparison with LC table, as the wavelength and capacity will give two of three unknowns, and it is then perfectly simple to substitute and obtain the inductance from the LC constant. For example, if the wavelength happens to be 420 meters, and the capacity 0.001 we have an LC constant of 0.0496, which, divided by 0.001 is 49.6 microhenries, inductance. Table II gives some sample inductances which were made up, and measured in exactly the way described, and these may be used for a rough basis for design, as they are only comparative figures.

Continued on page 86

TABLE II

MEASUREMENTS OF INDUCTANCE COILS WITH FORMICA TUBE FORMS

COIL No.	1	2	3	4
Wall Thickness (in.)	1/16	¼	¼	¼
Outside Diam. (in.)	4½	3½	3½	3½
L of Winding (in.)	15/16	9/16	⅝	25/32
Size of Wire.......	22 d. c. c.	20-38 d. c. c. Litz.	3-16-38 d. c. c. Litz.	20-38 d. c. c. Litz.
No. of Turns......	22	26	29	28
Wave Length.....	425	350	410	350
Capacity in Mfd...	.00061	.0003	.00039	.00036
L C Constant......	.0513	.0345	.0473	.0345
Total *L* of Coil....	8.42	11.49	11.85	9.59
L per Turn........	.038	.0443	.0409	.0342
Type of Winding..	Single Layer	2 Layer Banked	3 Layer Banked	Single Layer

NOTES

All wire in this table was wound on the form without the use of varnish, shellac, collodion or other binder. The use of such substances would doubtless raise the value in every case.

The litz wire given as "20-38" was made up of 20 strands of No. 38 enameled wire, with two coverings of cotton. The "3-16-38" litz was made up of three cables, each of which was made up of 16 strands of No. 38 enameled wire, the three cables being twisted together and covered with two coverings of silk. No dyes or other colors were used in these coverings, both of which were of "natural" finish. The solid wire used was covered with two coverings of white cotton. This was standard commercial magnet wire.

Slight errors were introduced by the capacity of the leads from the inductances of the condensers, which were about 5 in. long in each case and were made up of the ends of the windings. No attempt was made to make correction for this.

If but one wavelength band is to be received, say 400 meters, it is only necessary that a very slight variation from this be provided. But usually a set is required to cover a considerable range of wavelengths, for example, from 220 to about 550 for broadcast reception, or from 300 to 2000 for ship work. Amateur receiving equipment has a smaller range of wavelengths, generally, for normal work, but as a rule the owner desires to receive everything from the lowest to the highest wavelength in use for any service. This, of course, leads to complications. If a short band of wavelengths is to be received, a single inductance, shunted by a variable condenser, will suffice. If a larger band is desired, it will be necessary to provide some method of changing the amount of inductance in circuit, either by tapping the coils, by interchanging them, or by varying their own self-inductance, as is the case with the inductometer type commonly called a "variometer."

If the user wishes to receive over all the bands from 150 to 700 meters for example, and is especially interested in the reception of CW signals, he wants, first a receiver capable of receiving over that band. Second he wants some sort of apparatus that will detect these CW signals. This is most simply accomplished by some form of self-heterodyne apparatus, which means a vacuum tube detector. As the receiving station is to be located in a city, and in a place where interference is bad, he will probably desire to use inductive coupling. Therefore, it is simply a problem to determine what will be best to fulfill the needs of the above set of conditions.

Assume that the antenna is of average amateur size, and has a natural period of 150 meters, and a capacity of 0.0005 mfd. Thus, the inductance, as calculated from the *LC* table will be approximately 12 microhenries. Now, in this receiving set we will use a variable condenser in SERIES with the antenna, so the actual capacity will be less than the figure given, as the antenna and condenser in series will have the effect of two condensers in series. Thus, with 0.0005 in series (say half of a 0.001 condenser), the capacity will be decreased to 0.00025 mfd., which, with the low value of 12 microhenries will give a value to *LC* of only 0.0030, which corresponds to a wavelength of about 108 meters, which is considerably below the minimum of 150 meters, although, as it is right in the middle of the condenser scale, we can add inductance to a considerable value, without disturbing the condenser setting. As the *LC* constant for 150 meters is 0.00633, and we have the capacity given, as 0.00025, the *total* inductance required will be 25.3 microhenries. The antenna supplies 12 microhenries of this, so we must add the difference, or 13.3 microhenries, in our inductance coil. Actually this will be only an approximate value, but we will say 13.0 microhenries for the value of the first step of inductance. The number of turns, etc., can be easily approximated from the data given in Table II above.

We now have the value of the first step of the inductance, and we must figure the values for the various other steps. In order to increase the wavelength to twice the value given, or to 300 meters, we must increase the value of the inductance by the ratio of the SQUARE of the inductance value. In plain English, this means for a given value of inductance, say 25 microhenries, for 150 meters, we must increase the value of the inductance to FOUR TIMES that for 300 meters, or the approximate inductance would have to be 100 microhenries. This can be seen from an examination of the formula in Table 1, where the wavelength is given as $1885 \sqrt{LC}$. If the condenser capacity is to remain the same, as it can be assumed to be, the value of *L* will vary as the *square*, so for twice the wavelength the inductance will rise to a value of $4L$; for three times the wavelength it would be $9L$, for four times $16L$, etc.

Thus, we can see that the type of inductance with taps spaced equally is almost worthless. If the inductance value is correct for a given wavelength range on the first tap and the inductance value on the second tap is increased to twice the first value, we will have only about 1.4 times the wavelength of the original circuit, and for the third tap only about 1.8 times the original wave. If the taps are taken off at small intervals, as is usually the case, the operation will be even less efficient than this. It will be found that the wavelength range on adjacent taps is almost exactly the same. For example, if the inductance is tapped every 10 turns, from 10 to 100, assuming that the first range of 10 turns is correct, we must have 30 more turns, or a total of 40 turns for twice the original wavelength, and 90 turns for three times the original; or, in other words, the total 100 turns will give only slightly more than three times the wavelength of the first ten turns. Actually, if tapped at 10, 40, and 90 turns, we would be able to cover the exact wavelength range that we would if we had taps at every 10 turns, up to 90.

This same condition exists in the inductance shunted by a capacity, as is used in the secondary circuit of a receiver. The capacity of this circuit being variable through the range of value of the shunt condenser.

To return to the actual winding design of the primary coil. We have found that we will need 13 microhenries of inductance in the first tap, for a minimum wavelength of 150 meters, with the series condenser, of 0.001 mfd., half in use. This will give a good range of variation for adjustment. If too large a capacity is used too great a change in wavelength will be made every time the condenser is moved, and if too small we will need a good many more taps than is required for an optimum number of adjustments. For a wavelength of 300 meters, we will need, according to the data given above, a total of four times the total value given, or 4 x 25 = 100 microhenries. From this we can subtract the value of the antenna, of 12 microhenries, and the value of the inductance already added, of 13 microhenries, or a total of 75 microhenries will be needed to get to 300 meters. If we can get a minimum of 120 meters with the condenser in series, and a maximum of 270 meters, (assuming the effective minimum of the condenser 0.00008 mfd, and a maximum of 0.001 mfd). Now, this will result in the most efficient wavelength band, being somewhere between 130 and 200 meters, so if the same condenser is used, with the total of 100 microhenries of inductance, we will have a minimum of 170 meters, and a maximum of about 550 meters, with the optimum range between about 250 and 450 meters. For a longer wavelength range, of 700 meters, we would have to add another inductance tap, and it would be necessary to calculate the total inductance in the same manner as stated above, which would require a total of 350 microhenries of inductance, which would give a minimum wavelength of about 350 meters, and a maximum of about 1150, but with an optimum range of from about 400 to about 800 meters, which will cover the maximum range desired, of 700 meters, with great ease.

The secondary circuit can be designed in exactly the same way, except that there will not be the external variable factor of the antenna. The shunt condenser will be fixed in range, and its actual value depends on the use of the set. As we wish to use the set primarily for the reception of continuous wave signals, which are extremely sharp, we will have to use a condenser of small capacity, in order that the angular change of the condenser will not cover too great a wavelength per degree. A condenser with a maximum of 0.0005 is as large as should be used for the best results. Besides this, as we intend to use a vacuum tube detector, we wish as high a potential across the condenser as possible, as the larger the condenser the lower the potential across its terminals and the weaker the signal, so, if we increase the capacity to much over 0.0005 mfd., we will lose efficiency. The condenser capacity should be assumed to be about 0.0002 or 0.00025 mfd., minimum operating capacity, and the *LC* constant, for 150 meters being known, the value of the inductance can be easily calculated, and the various values determined.

The receiver being designed for the reception of undamped waves, we must have some sort of system for making the latter audible. This can be most simply accomplished by some form of "feedback," which makes the vacuum tube oscillate. The simplest way to accomplish this is by the use of a "tickler" coil, where the plate is coupled to the grid, and the plate inductance is capable of variation in respect to its mutual inductance to the grid circuit. This can be most simply accomplished by the use of a variometer for the tickler, and mounting the secondary coil on the end thereof. (For complete description of such a receiver, with working drawings, see article by the author in January, 1923 RADIO.)

The antenna and secondary circuit must be arranged so they can be "coupled" inductively. This can be accomplished in a number of ways. The primary and secondary could be mounted on concentric tubes, and slid within one another, as is the case of the old fashioned "loose coupler," or some more convenient system can be adopted. Generally some portion of either the primary or secondary circuit is wound on a short tube, and arranged so it is connected in series with whichever circuit is most convenient, and then this small section (which usually is the total on the first tap of the inductor) is mounted so its inductive relation to the other circuit can be varied at will. (This is most simply brought out in the common type of "vario-coupler.")

The mounting and arrangement of the various controls on the panel, and the material, and arrangement of the panel, containing case, etc., should receive as careful attention as the design of the inductance coils. The uses of the various parts will determine to a large extent their location. The primary and secondary condensers should be used more than any other factors, and these should be placed in the most convenient positions, and the next important factors are the coupling and feedback controls. After these come the inductance switches, and finally the tube rheostat and bridging condenser are considered. The actual location of these various factors should be determined by the builder himself. The panel should be made of material having a high insulating value, and therefore bakelite or some similar substance should be used. Metal panels are used in some cases, owing to their freedom from body capacity effects, but these are often extremely difficult of manipulation in the builder's hands, and the standard method of fastening a grounded metal "shield" back of the panel will usually be found to be simpler.

PORTABLE RECEIVER

Continued from page 20

"hiss," however, oscillations being controlled nicely with the 23-plate variable grid condenser.

Don't think that the hum of the power lines, always prevalent, will prevent the reception of DX signals! The hum is negligible and while the circuit is oscillating is hardly noticeable, the oscillations having the tendency to quench the hum. On long waves, especially, the hum is practically nil. It seems as though the longer the wavelength the less the hum.

Use the electric power lines, in conjunction with a small step-down transformer, to light the filaments of the vacuum tubes in our C. W. receiving sets! For spark and fones I don't suppose it would work very well, because of the loud hum—*but for C. W. it ought to prove a God-send!* Why don't some of you give it a trial? I never did like the idea of a messy storage battery, anyway, and maybe we can throw it out like we did our spark sets! How about it fellows?

If the residual hum on 200 meters is unbearable, so that any C. W. reception is out of the question, why not change the received short waves to long waves by means of a frequency changer, similar to Armstrong's super-hetrodyne? On long waves the hum seems to be nil, while, as the waves diminish in length the hum increases proportionately. I believe this is worth a fair trial!

To get back to the portable receiver—the step-down transformer is equipped with two long cords, so that it can be placed away from the receiving set and table, so that the magnetic hum from the alternating current will not annoy one while listening-in, and the other cord fitted with plug to insert in electric light socket. The compartments are for the step-down transformer, 'phones, honeycomb coils and miscellaneous odds and ends.

Always remember that when you are sending, don't go any faster than the fellow that sends to you goes. He usually works at about the speed that is comfortable to him, and if you "crowd" him he is liable to miss out entirely. Don't forget that, although he may seem a "lid" to you and that he may seem disgustingly slow, that you were once that way yourself, as, according to all reports, there have been no youngsters brought up who knew the code before they could talk.

A 200-WATT PHONE, C. W. AND I. C. W. TRANSMITTER

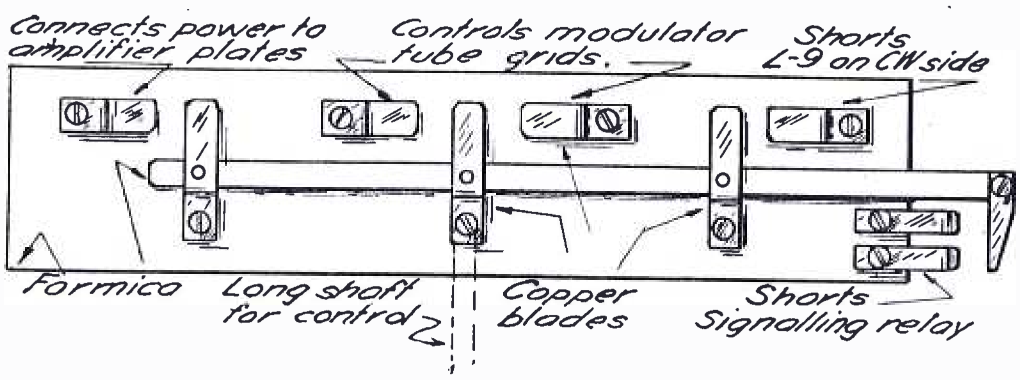
Continued from page 24

system to keep the d.c. generator from shorting through the antenna-plate coil. C_9 and C_{10} in connection with the filter chokes, form the filter system to eliminate the commutator hum of the generator. C_{11} couples the speech amplifier to modulator tubes.

Choke L_5, the constant current choke for fone modulation, has 3000 turns of No. 26 SCC magnet wire on one leg of a core 1½ in. square with a window 1½ by 6 in. One of the legs of the core is made so that an air gap can be left between it and the rest of the core. This is done by building three sides of the core C-shape and the coil is wound on the long leg of this part of the core. The other leg is made separate

L_8 is used in connection with the speech amplifier and more will be said about it under that caption. Its size is not important. The secondary of a spark coil with core inserted will be O.K.

A changeover switch is provided so as to transfer from C. W. to fone and accomplish following operations: L_9 must be placed in circuit between oscillator and modulator plates, grids of modulators are disconnected from oscillating position and connected to modulation circuit, juice must be applied to the plates of the speech amplifier, filaments of the speech amplifier tubes must be lighted and since signaling is accomplished by a relay, the contacts on the relay must be shorted. To make all these changes would require several separate switches which are not very desirable



and when assembled pieces of cardboard are placed between the leg and the rest of the core. The air gap is varied by using more or less cardboard. The object of this coil is to keep the plate current supply steady. The air gap prevents distortion of speech when coil is operating with core nearly saturated. The gap should be just as small as good modulation will permit.

L_9 is a radio-frequency choke placed between the oscillator plates and the modulator plates to prevent the high-frequency energy in the oscillators from backing up into the modulators. Its size is determined by the wavelength of the transmitter. A honeycomb coil with a natural period the same as the wavelength used will be correct.

L_4 is another radio choke identical to L_9. Its object is to prevent the high-frequency energy in the plate circuit of the oscillators from backing up into the d.c. generator. A better form for this choke would be a small honeycomb shunted by a small variable condenser. This combination could then be tuned exactly to the wavelength used when maximum choking effect would be had. The less energy lost here, the more will be available for the antenna.

L_6 and L_7 are the filter chokes. These are wound on a square core, transformer style, with 2000 turns of No. 26 SCC wire on each leg of a core 1 in. square and a window 2 by 4 in. The coils should be well insulated from the core and layers should also be insulated from each other. This also applies to L_5.

where changeover is to be accomplished at short notice. A special switch was built from standard switch parts so made that all operations could be controlled by one knob. The diagram of the switch will explain its construction. The switch jaws and blades are obtained from plain knife blade switches. The jaws have small copper angles soldered to them so that they can be mounted flat instead of upright. All blades are connected together by a Formica strip so that when the center blade is moved the other blades follow suit. C. W. position is to right and fone position is to left. The shaft of the center blade is made extra long and is soldered to the blade. The shaft sticks out from front of transmitter panel and a knob is attached. If other changes are desired in the circuit, other blades could be added.

A filament lighting transformer with a capacity of 400 watts will be required to light the filaments of four 50-watt tubes and two 5-watt speech amplifiers. There being none on the market, one was built. However, the amateur who does not care to build one can get along O. K. with a 300-watt and a 75-watt transformer, the former for the power tubes and the latter for the speech amplifiers. A 400-watt filament transformer has the following dimensions:

Core 1¾ in. square with window 1½ by 5½ in.

Primary 268 turns No. 15 BS SCC magnet wire.

Secondary 34 turns No. 6 BS DCC wire or two No. 8 wires wound together.

A tap is taken at the exact center of the secondary winding.

The secondary voltage will be about 14.

To bring the voltage down to 10 for the power tubes, a rheostat is placed in the primary of the filament transformer. This rheostat should be 25 ohms and able to carry 5 amps. Another rheostat will be required to cut down the 10 volts to 7.5 for the speech amplifiers. This is 3 to 6 ohms and carries 5 amps. A voltmeter to indicate voltage of power filaments or speech amplifier filaments is used. An anticapacity switch shifts the voltmeter from power tube filaments to speech amplifier filaments.

Two speech amplifiers are used to supplement the hand microfone when a modulator power of more than 20 watts is used, as the hand microfone will be unable to furnish sufficient output to fully modulate the transmitter with a 100-watt modulator. Resistance coupling is used. Though this type of coupling is possibly the least efficient, it produces best modulation and is easier for this set, since a resistance must be used to cut down the 1000-volt d.c. to about 500 for the speech amplifiers. Choke L_8 was found to improve modulation greatly. With it, ½ amp. greater antenna current change was noticed with speech. Also modulation seemed to be more snappy. Resistance R_5 is 15,000 ohms and should be big enough to carry the plate current of two 5-watt tubes, about 100 micro-amperes. For this resistance, and also for the grid leak resistance R_8, it is best to use two units of Cutler Hammer unit resistors, 8000 ohm units. These units can be ordered tapped as desired. A tap every 2000 ohms is convenient. A plug system can be used to short the part of resistance not wanted. Two units are needed for the grid leak so that variable powers of 50 to 200 watts can be used. R_5 will be entirely in circuit.

R_4 can be made up of small grid leak resistance. The current carried is small, hence the smallest size will be O.K. This should have a resistance of from 15,000 to 20,000 ohms.

The meters are all of Jewel make. The plate ammeter for power tubes is a 500 micro-ampere instrument; the plate ammeter for amplifiers is a 100 micro-ampere; the voltmeter is 15 volts; the radiation TC ammeter is 8 amps.; and a d.c. plate voltmeter would also be desirable.

Two relays are used, one in order that the grid circuit be kept as short as possible, which could not be very well done if keying was done directly. A cheap 20-ohm relay will be O.K. if the points are removed and hard tungsten points substituted. The points furnished are too soft and the slight spark will cause sticking. When transmitter is used for fone, this relay must be shorted so that the oscillator tubes can oscillate steadily. Two contacts are provided for this purpose on the change-over switch. The second relay is not absolutely required but is another refinement in obtaining a pure tone for C.W. transmission. Since the power tube filaments are lighted by the 110-volt a.c. line which runs the motorgenerator motor, each time that the key is closed, the motorgenerators take more power from the a.c. line, causing a drop in that line, and this drop is also transmitted to the filaments, causing them to flicker. To obtain a pure tone, the filaments must burn steadily, so that the flickering has a tendency to blur the note of the C. W. signal. On English sets, this drop is compensated for by a choke in the primary of the filament transformer. This choke is shorted every time the key is closed by extra contacts on the key. In the 5ZA transmitter, a relay in the d.c. power line shorts a resistance in the filament transformer primary, producing the same result. The resistance is made variable to accommodate varying drops. If the resistance is correct, the drop in the a.c. line will be exactly balanced and the filaments will burn steadily. The negative lead of the d.c. should be carried through the relay.

The chopper, contrary to the usual method, is placed in the ground lead. The grid chopper is O.K. for low powers but for higher powers the tubes persist in oscillating and are also overstrained. A small inductance L_3 of 3 or 4 turns 3 in. in diameter is connected in the ground lead and the chopper arranged to short this inductance. Thus two waves will be transmitted, one with inductance and the other without inductance. A receiver tuned to either wave will receive just as many impulses per second as the chopper shorts inductance L_3. In practice, L_3 is made just large enough to fully modulate the C. W. sigs. The size will vary with the wavelength, the longer the wave, the bigger the coil. This system is ideal for calling, as a broad wave is radiated. The amateur should not use this system of transmission any more than is absolutely necessary, as local interference is terrific. When not in use, a switch shorts L_3.

The panel and frame are made of ¼-in. Formica, 18 by 30 in. and of angle aluminum respectively. Heavy aluminum sheet is cut into strips 1½ in. wide and these strips are bent like angle iron, ¾ in. on a side. Every tinshop has the necessary apparatus to cut and bend the aluminum strips. The form of the frame can be best understood from the various pictures. The bottom is a solid piece of Formica. Two sets of shelves are placed back of the panel. The middle shelves are 6 in. wide and are mounted at right angles to panel. The top shelves are placed parallel to the front panel. Top shelves support tubes

Continued on page 94

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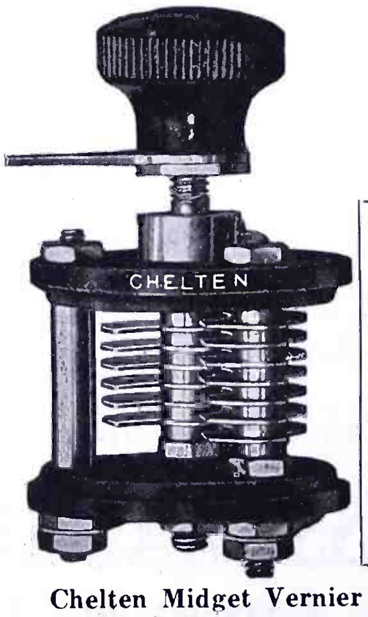

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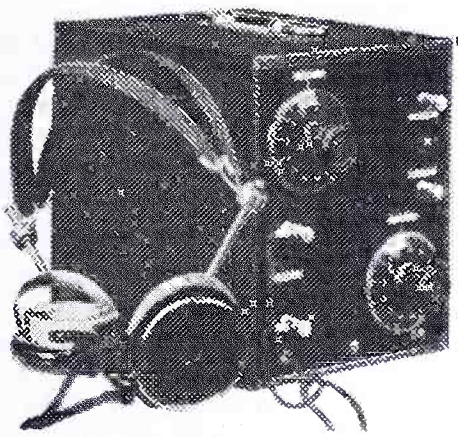

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Continued from page 91

and inductances. Middle shelves support the grid circuit and amplifier circuit. The bottom supports the transformer and the filter chokes. Four insulators support the completed unit.

The arrangement of the apparatus is best studied from the pictures. The front view shows the radiation meter at the top. At extreme left top corner is antenna connection post. Below these are the peep holes for the power tubes. Two left tubes are modulators and two right, oscillators. Under peep holes, in center of panel is the change-over switch control. In this case a Ford coupe door knob is used, hi. The short end of the knob is filed sharp to resemble a pointer. Although the knob is made of aluminum, this does no harm, as the changing process MUST not be done with juice on the plates of the power tubes. The switch itself is mounted just in front of the power tubes and just above top shelf. Immediately under the change-over switch knob is the anticapacity switch controlling the filament voltmeter. At right of this is the plate micro-ammeter for power tubes and to left is the voltmeter. Below anticapacity switch is the micro-ammeter in the plate circuit of the speech amplifiers. Below this meter is the microfone jack. This jack has two extra contacts so that when plug is inserted the speech amplifier is lighted. To left of jack is the rheostat in speech amplifier filaments, and to right, rheostat in primary of filament transformer. Left DPST switch controls 110 a.c. and right switch controls 1000 d.c. Binding posts in pairs from left to right are, 110 a.c., 6 d.c. Key, 1000 d.c. The unit is mounted on a special cabinet just visible. Cabinet contains biasing bats, chopper, compensating relay and battery charger.

The side view also shows the units on the front of the panel, as well as the engraving. At top are the power tubes, also the antenna inductance. In front of coil is C_8. On the middle shelf are the two units of the grid-leak resistance with plug system for its variation. Signaling condenser C_4 and relay are just to left of resistances. The resistances are just the right length so that through bolts from top to middle shelf hold them in place. The grid condenser is just back of resistances, not visible. At left under middle shelf, L_4 is seen below on bottom shelf. At right are the filter chokes. To left of these is the rheostat in primary of filament transformer.

In the back view is seen at the top the antenna coil with grid coil in place, and also the long handle to control grid coil. The tap and plug arrangement of antenna coil is plainly outlined here. At left of antenna coil is C_8.

Left middle shelf holds grid circuit controls. Right shelf holds the units of the speech amplifier. On this shelf may be seen the modulation transformer, two amplifier tubes, and further back the two units of resistance for R_5. The units for R_4 are just back of the tubes, one unit being visible. The two condensers to left of tubes are C_6 and C_7. These are connected across the filament circuit leads. The coil above and back of the condensers is L_5 supported under tube shelf. Honeycomb coil under top shelf is L_9.

Below on bottom shelf, at left, are filter coils, at right filament lighting transformer. R_1 is back of the filter chokes and R_3 is back of transformer. The small strip of Formica with three binding posts is for connecting the biasing bats.

All wiring of antenna circuit is continued with 3/16 in. copper tubing. Plate and filament circuits are wired with No. 6 copper wire. Other circuits are wired with No. 14 copper wire. All wires are spaghetti covered.

Best results are obtained with a minimum of turns in the grid coil and the coupling just as loose as steady oscillation will permit. The grid coil is coupled to the end of the antenna away from the grounded end. Results have been unsatisfactory any other way. If the set does not oscillate at first, reverse connections to grid coil, as there is a right and a wrong way to connect the grid coil. When the set has started to oscillate and the radiation meter to indicate, decreasing the turns in the plate circuit will increase the input and also increase radiation up to a certain point. It is better to start with antenna plug and plate plug near each other, both located about center of coil. After the set has started to oscillate, reduce the grid turns and coupling until set quits oscillating, then increase coupling slightly to make set oscillate. Then move antenna plug until wave desired is obtained. Then reduce plate turns until greatest radiation is obtained with normal input into plates of tubes. Slight readjustment of the grid coupling will now probably increase radiation and lower input. With four tubes as oscillators, radiation should be about 6 amps. To adjust for fone, throw C. W.-fone switch to fone side. Increase plate turns and increase grid coil turns. Also increase grid leak resistance. Throw in d.c. switch. Radiation should be about 3½ to 4 amps. If modulator tubes get red, increase bias battery. If oscillator tubes get too red, increase plate turns. Tubes should barely show red when working O.K. Whistling into microfone should make radiation go up at least one amp. Input into plates of power tubes will be up to 400 microamperes for C. W. and 250 microamperes for fone.

The best record is that with 7 amps. in antenna on C. W. Sigs from 5ZA can be cut out 1½ blocks away and music received from long distances. C. W. has been heard in all states, England, Switzerland, Porto Rico (WKD) Panama, Alaska, Hawaii, all districts of Canada, Honduras, Costa Rica, Mexico, west of Hawaii, and on both oceans. Longest distances worked are 4OI Porto Rico and 1BDI Orono, Maine. Input never over 400 watts.

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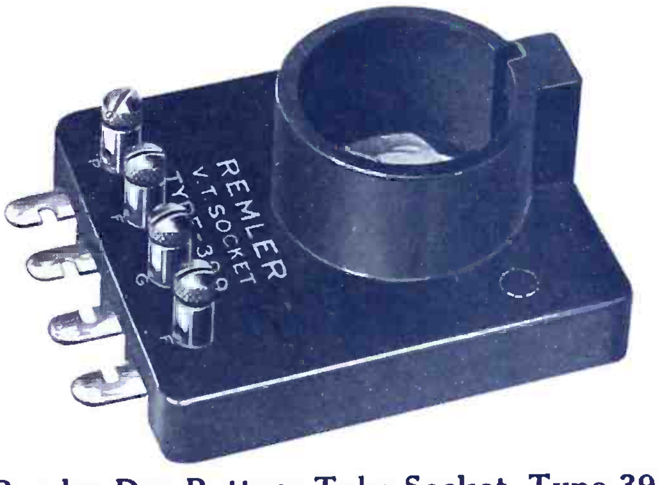

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