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RADIO PROGRESS

"Always Abreast of the Times"

IN THIS ISSUE:

Suppressing the Carrier Waves
Regeneration and Reflex
Unradiating the Single Circuit
A New System of Audio Frequency
Saving the Storage Battery's Life
Some Live Problems in Radio

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PUBLISHED TWICE A MONTH

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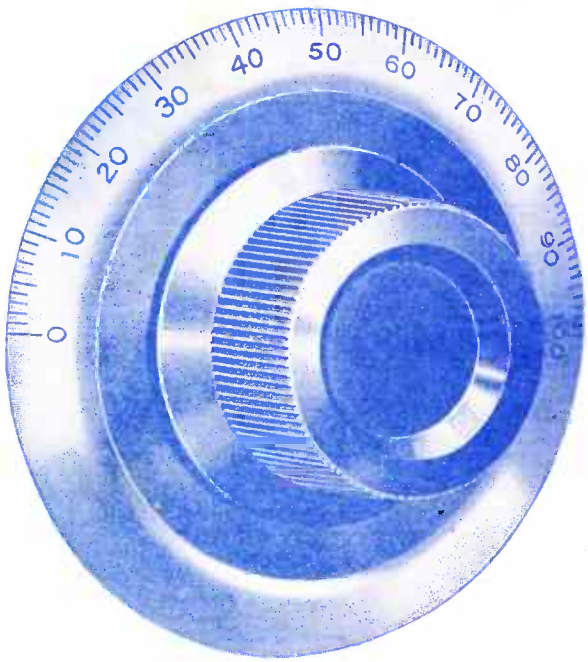

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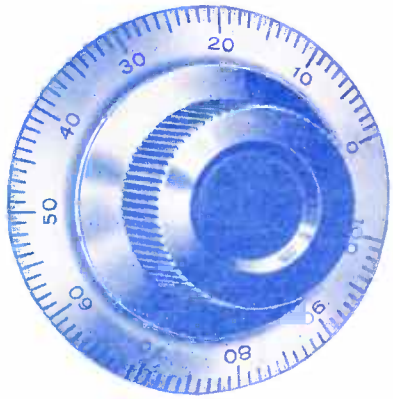

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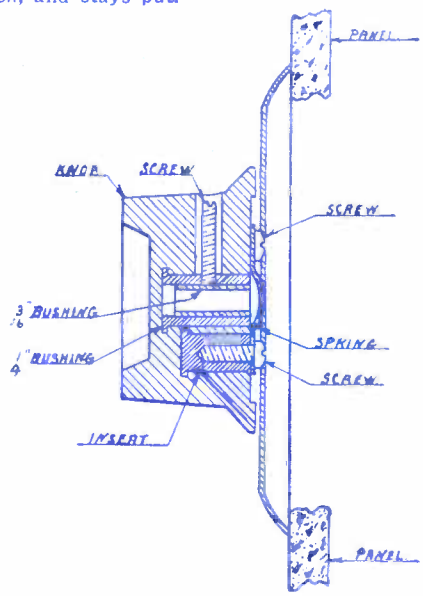

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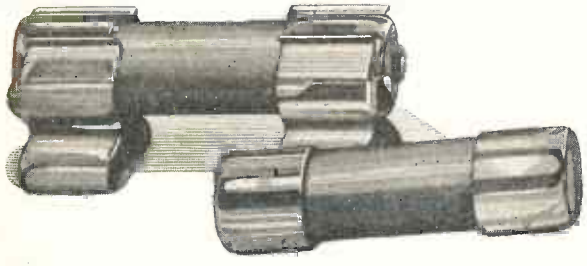

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RADIO PROGRESS

HORACE V. S. TAYLOR, EDITOR

Volume 1 Number 8

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JULY 1, 1924

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Don't miss the next issue of Radio Progress—Read about a New Method of Dispensing with All Your Batteries, "A," "B" and "C."

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RADIO PROGRESS

"ALWAYS ABREAST OF THE TIMES"

Vol. I, No. 8 JULY 1, 1924 15c. PER COPY, $3 PER YEAR

Suppressing the Carrier Waves

New Method of Combining Radio and Audio Frequency

By VANCE

ONE of the difficulties which the amateur finds when he tries to understand the why of radio is to get a good understanding of the carrier wave. The action of this vibration has been already explained, but will be briefly reviewed before showing how it may be omitted. When a new broadcasting station is designed, the owners apply to the radio inspector of their district, and he assigns to them a wave length and a call signal, which may consist of three or four letters. The letters which he assigns are purely arbitrary. For instance, WBAP is in Forth Worth, Texas; WCAP in Washington, and WDAP in Chicago. It is generally understood that these letters are given out in an irregular manner and no particular significance is attached to them by the public.

But when it comes to the wave length, then many people think that it has a special meaning. In this they are mistaken. There is no more connection between wave length and location than there is between call letters and the companies they represent. To be sure, certain kinds and sizes of stations are assigned certain bands of wave lengths. By a band of wave length is meant all the different figures which lie within that range. A band from 360 to 400 meters would include 365, 370, etc. But the exact figures of any station are decided by the radio inspector in accordance with the schedule of stations near the new one. Of course, if in a certain state there is another station already working at 450 meters it is unlikely that the same wave would be assigned to a new comer.

Getting the Proper Length

After the wave has been assigned, how does the station obtain it on their sending equipment? This is done by means of adjustments on their coils and condensers. The coil, it must be remembered, acts like a weight, whereas the condenser is a spring and the combination of the weight and the spring decide how fast the oscillation will be. To get a slow oscillation, which is the same as saying a long wave length, either the weight or the spring, or perhaps both, must be made large. If the sending station, after checking up with a wave meter which measures the length, finds that it is sending at too long a wave length, then they remedy the trouble by reducing the number of turns in the coil or cutting down on the number of plates in the condenser. After they have adjusted the apparatus to give the right wave length, the carrier wave is a continuous oscillation up and down and looks like Figure 1. This wave is obtained from the oscillation tube. The height of the curve is determined by the loudness of the wave. If the station is a powerful one and uses big tubes and a high "B" battery voltage, then the current flowing into the aerial will be large and the height up and down will be great. The *number* of waves per second depends only on the frequency or wave length, and must conform to that given by the government, as just described.

Next the Audio Wave

Now suppose that some one starts singing into the microphone. The vibration of the diaphragm in the transmitter will be irregular and shaped perhaps as in Figure 2. If you inspect a victrola record under a microscope it will show a line like this. Here again, the height up and down represents the loudness, but the distance between peaks, which represents the time or shows how fast the waves follow each other, is determined by the pitch of the note being sung. The high notes come rapidly, and so the peaks are close together, but the low notes, since they are much slower in following each other, are spaced a little farther apart.

Like a Soldier's Procession

It must not be thought that the speed referred to means the velocity with which the sound travels. High notes

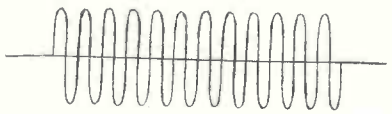


Fig. 1. Usual Carrier Wave

and low notes both cover the ground in the same time. All music will travel a fifth of a mile in a second, so that if you hear the music from a loud band a mile away you know it took five seconds to reach you. The pitch of the note does not depend on this speed. It is determined by the closeness with which the waves come together. It is like a parade of soldiers marching along in single file. The whole parade moves at the same speed, which may be three miles an hour, but up near the head of the procession we have a company which represents a high tone. These soldiers

are marching one behind each other so that they nearly step on each other's heels. That will represent high C on the piano. A little later in the line we

Fig. 2. Audio Wave Sung

find a company where the soldiers are spaced five feet apart. They are still marching just as fast, that is, three miles an hour, but they don't pass us in the grandstand nearly as frequently. This corresponds to middle C as shown in Figure 3. Behind them is another lot which straggle along ten feet apart. Of course, this will represent the next octave lower. This is illustrated in Figure 4. The same thing applies to radio waves. A high frequency station like KDKA, which runs at 926,000 cycles per second and a low speed station like KYW 560,000 cycles, both have waves that travel seven times completely around the earth in a second. But in the former case their soldiers are spaced close together, whereas in the latter they are more widely separated.

Audio on Radio Waves

Now let us see what happens when we impose the audio wave of Figure 2 on the back of radio wave Figure 1. This is done by the modulator tube in the sending station. The radio frequency comes in spaced just as before, but its loudness, as represented by the height up and down, is controlled or modulated by the audio frequency. Notice that the upper line A is exactly the same as the audio wave shown in Figure 2 and that line B is again the same thing, except of course, since it is the lower limit of the wave, it is turned upside down.

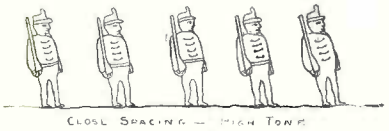


Fig. 3. Soldiers Like Audio

Curves A and B do not appear at all in a real picture of the wave, as sent out from the station. They are shown in our sketch merely to assist the eye in seeing that the peaks of the radio wave form a curve just like that of Figure 2. To get a true picture of the radio wave, both A and B must be rubbed out.

Like Surf at Seashore

A better picture of what is going on may be conveyed to the mind if you imagine yourself at Atlantic City after a big storm. The surf comes pounding in along the beach and in your hotel room you can hear it thundering on the shore. Now suppose a friend opens and shuts a window. When it is wide open the sound is loud. As he gradually closes it, it dies out more and more until when the window is shut tight the booming of the surf comes in only softly. If this up and down motion of the window is represented by the line in Figure 2, then the sound of the surf will be shown by Figure 5. Here each

Fig. 4. Men Have Separated

individual wave of the ocean corresponds to one of the radio waves in the sketch, while the general loudness corresponds to lines A and B.

Like Ordinary Station

This operation, as just described, fits all the ordinary broadcasting stations. But the University of Illinois, which runs station WRM, has recently been trying various experiments with the

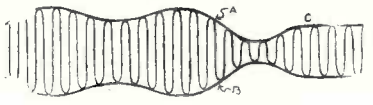


Fig. 5. Like 2, with Carrier

idea of eliminating the continuous carrier wave illustrated by Figure 1. It seems a waste of energy, both in the receiving station and in the transmitting radio to have such a carrier going all the time. They have developed a different method of sending. Instead of a carrier like Figure 1, which runs continuously and is cut down from time to time, in accordance with the music, Figure 2, they use a zero carrier, and rather than cutting down, build it up, as determined by the audio wave. This is shown by Figure 6.

It will be observed that A and B are still just the same as shown in Figure 2, also the radio frequency is spaced just as before, that is, it is still the same wave length, but instead of having a continuous carrier, which is largely wasted, we have a zero carrier. At point C, where the singer has stopped

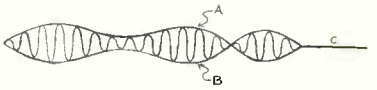


Fig. 6. Carrier Suppressed

for an instant and the audio wave dropped to zero, observe that the radio frequency has also been reduced to nothing, and the ether is undisturbed.

Detector Separates Waves

When either of these waves, Figures 5 or 6 is fed to a detector, it skims the audio wave off the back of the radio by suppressing the lower half of the radio curve, as already explained in our June 1 issue, "Changing Radio to Audio Waves." But the latter has some advantages. In the first place the tuning is somewhat sharper, since all the energy is used, rather than a fraction of it. Sharper tuning results in a clearer tone for the music you want to hear, and also in the more perfect cutting out of interfering stations. The second advantage is that all the sending station energy goes into the waves, which are wanted instead of supplying a lot of unnecessary noise. From this it follows that the sending range of the station is considerably increased.

If this new scheme of transmitting can be worked out so that it is a commercial success without too much apparatus, it bids fair to become the standard method of broadcasting.

BOARD OF TRADE LOSES WDAP

The Drake Hotel of Chicago, has recently taken over the management of WDAP. This is the station which has been run up until now by the Chicago Board of Trade. They have been putting such excellent concerts on the air that we are sorry to hear of the change. However, Mr. Jack Nelson, who has been director, will still be retained, and this probably insures equally good programs in the future.

A New System of Audio Amplification

Use This in Your Two-Step Audio Frequency Receiver

By CHARLES H. M. WHITE, Consulting Engineer

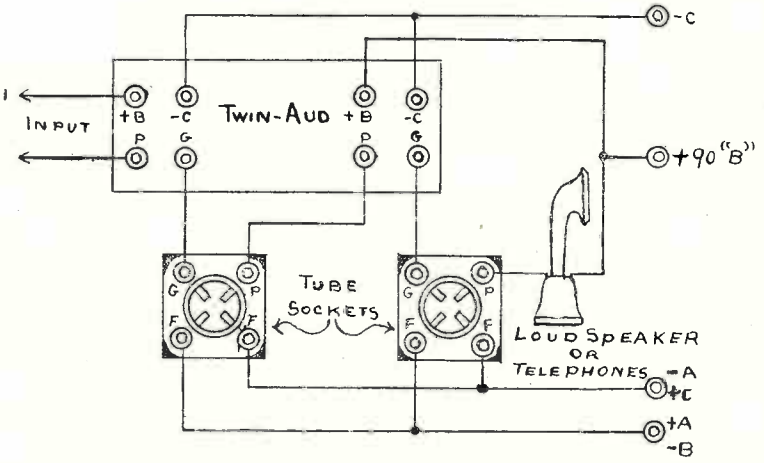
MANY fans do not realize the good results to be obtained by well balanced audio-frequency amplification. In fact, many throw together their audio amplifier parts of the circuit, after spending much time and trouble in perfecting the radio-frequency and the aerial tuning circuits. No matter how sensitive and selective the latter may be, little satisfaction will be had if poor quality results from the neglect of the former. Recently, however, there has been a marked tendency towards the improvement of audio-frequency amplification. This trend is shown by the increasing demand for the higher grade audio transformers in place of the poorly constructed and designed units selling for a lower price.

As an engineering problem the lower speed of oscillation presents nearly as serious problems to be mastered as the higher, but they are of a different nature. In radio amplification we want selectivity, but with audio frequency we do not want selectivity since we wish to amplify equally over the entire audio-frequency band because voice currents are composed of frequencies from 200 to 2,000 oscillations per second, approximately, while music ranges from 30 cycles for the deep bass notes of an organ to 5,000 cycles per second to the extreme high tones of a violin. The problem of keeping the oscillation transformer from being selective and still making it sensitive over the entire audible range, which is 30 cycles to 5,000 cycles, is indeed difficult and has been mastered by only a few manufacturers.

Just as there is a marked tendency for a radio-frequency circuit to oscillate, there is a similar tendency for the audio circuit to do it, too. Ofttimes this vibration takes place at an audible frequency, that is below 10,000; it takes the form of a howl. Then again, the oscillation takes place above the audio range, but it results in distortion. In other words, an audio-frequency circuit has regenerative principles of feedback which tend to make it selective, or more sensitive to one frequency than another. Many radio engineers have tried to cure howling by using a transformer of a lower ratio in the second stage, but, personally, I am not in strict accord with such practice, since the solution, to my mind lies in the transformer itself and not in reducing the ratio for the later stages. The advantage of high ratio transformers is the fact that they give more amplification than those of lower ratio but their main disadvantage is that they are more selective and show a tendency to oscillate at a certain frequency, generally audible and so produce howling and distortion.

Many radio engineers realized the benefits of high ratio and therefore set about the task of curing its ills. Recently, the Peerless "Twin-Aud" has been developed. A Twin-Aud is two separate audio-frequency transformers mounted on the same transformer core. There is a certain electrical reaction between the magnetism of the two because of this style of mounting, which can be used to counteract any tendency towards oscillation. The result is that high quality amplification is obtainable over the entire audio-frequency range without the tendency towards howling or distortion. This arrangement also has the advantage of cancelling out quite a bit of tube noise in the same manner as push-pull amplification, and yet, for volume per tube as well as quality of received note, it is, in my opinion, superior.

Since the Twin-Aud is really nothing more than two well designed audio-frequency transformers mounted together so that their magnetic fields exert a corrective effect unobtainable with two separately mounted transformers, the hookup is similar to those made with two of ordinary type. The arrangement however, makes it possible to assemble the two stages more compactly than with the two separate units. As a matter of general practice it is well to use a "C" battery if more than 45 volts of "B" battery are employed. A "C" battery not only clarifies reception but also reduces the "B" battery current which makes your batteries last much longer. The amount of "C" battery will depend upon the amount of "B" battery and the type of vacuum tubes used.



Continued on Page 8

Boosting the Wave Length

By E. J. BUSSARD

When The Crosley Radio Corporation's WLW Broadcasting Station began using their new 423 meter wave, it was found that many owners of receiving sets did not know how to adjust their radios to tune in on the high wave length. It appears that there are quite a number of receiving sets on the market, manufactured one to three years ago, which will tune to wave lengths no higher than 400 meters. It can be readily seen that a radio of this nature is of no value for hearing programs between 400 and 600 meters.

In the majority of cases, these receivers are of the single circuit type. It is easy to correct this type of set to receive higher wave lengths. The most common method is to insert a small loading coil (explained below) in the antenna circuit. In quite a few cases, however, it is only necessary to increase the length of the receiving antenna by adding, say 50 feet of wire. Another common method is to remove the adjustable condenser from the serics connection with antenna circuit and place it in parallel with the variocoupler coil of the receiver.

Making a Loading Coil

A few words of explanation of the various methods may be interesting. By a loading coil is meant an inductance coil; usually only a few turns of wire are necessary, placed in the antenna lead, one side of the coil being connected to the antenna lead-in and the other to the aerial binding post. This method is especially adapted to sets having only an inductance coil or variocoupler for tuning. To construct a loading coil, take a tube three to three and a half inches in diameter and wind it with 20 to 40 turns of No. 24 or No. 26 gage D. C. C. (double cotton covered) wire. This tube should be of insulating material such as formica, hard rubber, etc., although cardboard tubes are often used with success. The size of this coil will be determined by the size of the inductance already in the receiver. For instance, if the tuner will receive stations broadcasting on 400 meters at its highest setting, only 8 to 12 turns of wire will be required to raise the wave length to 430 meters. However, should 360 meters be the maximum, then 20 to 25 turns would be required. If there is only an inductance coil in the receiver for tuning, then a small fixed condenser of approximately .00025 Mfd. capacity, connected one terminal to the antenna binding post and the other to the ground binding post, will be very satisfactory. If the circuit is tuned by a condenser used in series with a variocoupler, the wave length range may be increased enough by connecting it in parallel with the stator.

The Variometer Set

A few complaints have been received from people using three-circuit tuners. Undoubtedly the difficulty here lies in the type of variometers used and it will, in the majority of cases, be necessary to substitute variometers having the proper characteristics for tuning between 200 and 600 meters. In a few cases, it may be possible to wind a few turns of wire on the variometer and correct this defect to some extent, but the novice will find no little difficulty in doing this.

KDKA'S NEW STUDIO

When changes, now under way, are made in the Pittsburgh Post studio of the world's pioneer broadcaster, KDKA, the famous Westinghouse station will have a pickup studio perhaps better than anything of its kind in the world.

The new Pittsburgh Post studio is now being installed in a separate operating room, built-in to the main one, in which will be installed all apparatus necessary for the operator to change over microphones or make adjustments to the amplifying apparatus.

The new operating room is noise-proof and will have a two-way connection with the transmitting station located in East Pittsburgh 14 miles away, so that changes made during the operation of the station will be instantaneous.

Window for Booth

In this operating booth will be located all the amplifying apparatus and the various switches which are usually seen in the ordinary studio. In order that the operator can see what is going on, a window has been built in the side of the operating room. This window can be closed when the station is working to permit conversation between the transmitting station operators without its being broadcast.

This change is one of numerous ones that have been made in the Pittsburgh Post pickup station of KDKA, its first since they began broadcasting from downtown Pittsburgh.

It is not generally known that East Pittsburgh, where the sending aerial is located, is 14 miles east of Pittsburgh and that most of KDKA's broadcasting is done from outside points, or pick-up stations as they are called. In broadcasting events from Pittsburgh and the surrounding district KDKA uses 34 pick-up points.

CAN YOU TALK ILO?

It is the Popular Radio Language

The Spanish and French lessons taught by radio from the WLW Broadcasting studio of The Crosley Radio Corporation met with such hearty responses from the listener-pupils, that a new language will be added in September. Ilo, "La Internaciona Linguo," will enable listeners in other countries to enjoy more fully the numbers announced from the Crosley station, for plans now being formulated will include the studio director's announcements in several languages. In addition to the announcements, students will be taught the Ilo language in the regular Crosley Radio University classes. Fred Smith, who spent many years in Europe, is studio director of the WLW station and will supervise the classes.

NEW SYSTEM OF AUDIO

Continued from Page 7

If any radio fans are interested in the further construction and characteristics of this circuit as shown in the diagram, I shall be pleased to put them on the right path if they will only address me in care of Radio Progress enclosing a self-addressed envelope. If you are now getting imperfect audio-amplification you will do well to give this new system a trial before you make changes in your circuit. A receiver is no better than its audio amplifier.

Development Work Pushed by G. E.

Latest Device Prevents Interference from Lighthouse Signals

NONE of the big radio companies are satisfied with the present state of the art, although every one will admit that wonderful progress is being made. The thousands of experimenters who are trying out new hook-ups all the time have accomplished a great deal in developing radio, but the time has come when more laboratory work is needed to make much further advance. For this reason a large experimental radio station will shortly be built by the General Electric Company for a more complete investigation of radio phenomena and broadcasting. It is understood that the cost of the experimental station will be approximately $150,000, and that it will be located on land recently acquired by the company in Schenectady.

While no plans have been drawn for the new station it is understood that the General Electric Company will build a power house capable of delivering high power at various frequencies, and antenna structures will be erected for a wide range of wave lengths so that systematic investigation can be made of the advantages of various frequencies in solving the many problems with which radio now has to deal.

Interferes with Code

At present the ordinary wave length used ranges from about 250 up to 550 meters for ordinary broadcasting. If either higher or lower lengths are used, interference is found from the code of amateurs or commercial ship stations. But in addition to this band of frequencies several of the big stations have been tied together by wave lengths of around 100 meters. This is low enough so that it avoids trouble from the 150 to 200 meter band of the amateur practicing code. By the word "band" is meant all the different speeds of vibration which give wave lengths within these limits. That is, it would take in frequencies from 151, 152, 153, etc., up to 200 meters.

The requirements of the present-day broadcasting program, including stock reports at noon, an afternoon concert for those at home, evening stock and market quotations, weather reports, musical programs, plays and religious services, have filled up the available time. It has also been found that the space available in the power house and operating section of the big broadcasting station is not sufficient to permit experimental work without interfering with the regular programs. On this account a new station was considered necessary for intensive experimental work.

2XI Equals WGY

The broadcasting station now known the world over as WGY was originally built, several years ago, for experimental purposes. Operating under the experimental license 2XI, it has conducted various radio experiments, and added materially to the fund of available knowledge.

Even now you will sometimes hear the call 2XI late at night and some times the music will come through even

Fig. 1. Old Lighthouse Waves

better than from WGY, while again it may be somewhat inferior. This is owing to the fact that new stunts are constantly being tried, and if they seem promising are worked out at greater length in the laboratory. But such experiments take considerable time and lots of space for the set-up.

Two Wave Lengths Together

It is well known by advanced radio fans and those familiar with the workings of this station that the regular programs have been broadcast for many months at two wave lengths—the regular one of 380 meters available to those using standard receiving outfits and also a lower wave length of 107 meters which has been found particularly well adapted to long distance transmission for re-broadcasting. On several occasions during the early spring, WGY's programs have been re-broadcast by the British Broadcasting Company in London and thus made available to the British Isles as well as to France and other continental countries. This is only one of the experimental developments to which WGY has contributed.

Why You Don't Get 107

The reason the average radio has not been able to pick up this 107 meter wave is because the lowest wave length which most sets can get is around 250 or 275 meters. In order to build over a set to receive this short wave length, which runs at a much higher frequency or speed of vibration, it is necessary to redesign the coils and condensers so that they are considerably smaller than what is used at present. Even when the variable condensers are turned so that they read zero on the dial it must be remembered that there is still quite a bit of leakage capacity, even in the best instruments. To this must be added the leakage capacity between the various wires in the set. When all these facts are thought of it is not surprising that the ordinary radio can not be made to oscillate at the tremendous frequency of three million times a second, which is the equivalent of a 100-meter wave.

Blazing the Trail

No one believes that radio and radio broadcasting will remain stationary. The remarkable advances which have been made in the last few years indicate a continued rapid development. The General Electric Company aims to perfect broadcasting so that it may become even more reliable and satisfactory. The service which radio now renders to the farmer and to all that large proportion of the population in outlying districts is

invaluable, but it can be made an even greater factor by further perfecting.

Light Ship Radio

An illustration of one of the devices just put out from their laboratory which may be mentioned is an improved sending apparatus for fog signals.

Marked improvement in the sending of signals from lightships and lighthouses has been achieved through the development by radio engineers of the General Electric Company of a vacuum tube radio transmitter expressly designed for this sort of work. In tests which have just been completed on Lightship 108, at Staten Island, the new tube set showed superior efficiency as compared with a typical spark set, of the type which has been used for a number of years by the United States Bureau of Lighthouses.

The diagrams explain this action more fully. They show how the waves look for sending the letter D in code. D is made by sending a dash and two dots. Figure 1 shows the wave form under the old scheme. It will be seen that dash consists of several series of impulses, each one starting strong and then dying away. These individual impulses are

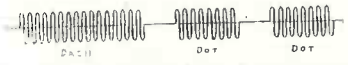


Fig. 2. Letter "D." New Style

caused by the spark breaking across the spark gap. Each time a spark occurs, a train of waves is sent out. Of course, this wave train gradually fades out, because of the resistance in the circuit. It is very much like a piano. When a piano key is struck the note starts quite loud and then gradually dies away. If the same note is struck in rapid succession, then the tone will be sustained, but the ear will be able to catch the different individual impulses and a picture of the note will look just like Figure 1. The dots are made in the same way as the dashes, except they are not prolonged for the same length of time.

Does Not Waste Energy

Figure 2 shows the new scheme of sending out the waves. Here the tube set gives an oscillation which does not die down at all. This is known as a sustained wave. Here again the dash and dot are alike except that the dash is considerable longer. It is easy to see that the second style of sending will be much more efficient than the first. There is the same difference between a lot of jerks and a steady pull.

During the tests, both of the fog signal radio transmitters were adjusted to give about ten amperes in the aerial. It was found that the total power consumed by the spark set averaged around 2300 watts, which was nearly 50 per cent. greater than the power consumption of the tube set, the latter being about 1650 watts.

Saves 26 Bulbs Burning

The watts are a measure of the power used, or expressed in another way, of the fuel consumed per hour in running the station. One of the most popular size of incandescent lamps which you use for lighting your kitchen is the 25-watt bulb. In cutting the power as just mentioned, there is a saving of 650 watts which would keep 26 ordinary electric lights burning continuously. This, you see, is quite a worth while result.

This will have a direct bearing on the question of fuel supply to lightships and lighthouses, since the power for these sets is supplied by gas engine driven generators, in which kerosene is usually burned. If the lightship or lighthouse is in an inaccessible location, as is often the case, a considerable saving in fuel and other expenses can be effected if fuel ships are not required to make the trip as frequently as at present.

The tube set was shown to be safer to operate and much more simple than the spark sets heretofore in use. The efficiency of the set is due to the use of the latest type of sending tube, called the XL.

Won't Knock Out Music

This set, the development of which has now been completed by the General Electric Company, was particularly welcomed because of its non-interference characteristics. The spark sets heretofore used have been the cause of many complaints from listeners to broadcasting stations, who have been annoyed by interference originating with these sets. This condition will be remedied by the use of the tube sets.

This is because the new sets send out a very smooth wave at an exact and unvarying wave length, and only radios tuned to this particular speed will pick them up. The older sets were adjusted to give this same length, as closely as possible, but they did not send out a pure wave. Various harmonics or higher frequencies (shorter wave lengths) were radiated at the same time and it was these extra and unwanted vibrations which caused all the trouble to neighboring broadcast listeners.

Lighthouse Bureau Tests

The outcome of the tests with the new set was a recommendation by Superintendent of Lighthouses of the Third District, J. T. Yates, to the Bureau of Lighthouses in Washington, that these tube sets be generally adopted for the bureau's radio beacon stations.

The radio signals sent out during fog have played no small part in the safe guiding of vessels and the saving of life. The signals are transmitted at 1000 meters in combinations of dots and dashes which enable pilots of vessels within range to determine, from the combination, what station is sending and its direction from the ship. Each station sends in regular repetition.

Got Your License?

The American Telephone and Telegraph Company stated recently that more than forty broadcasting stations throughout the United States that were formerly infringing their patents had taken licenses. Inquiries in regard to licenses and applications for licenses are being received in considerable numbers. Permits under the patents of the American Telephone and Telegraph Company are being granted to broadcasting stations now infringing under conditions which have been generally accepted as fair and reasonable.

PRIZES FOR SUBSCRIPTIONS

Head Phones
or
Transformers

FREE if you secure two subscriptions for RADIO PROGRESS for one year— your own and that of a friend.

Regeneration and Reflex

Hook-up of Tirdyn Shows An Unusual Combination

THERE has been considerable inquiry recently about the Tirdyn set. This word (pronounced Try-Are-Dine) is made up of the numerals 3R3, combined with the popular ending "dyn," which comes from the Greek word meaning powerful. These three R's stand for regeneration, reflex and radio frequency.

What the Three R's Mean

In this connection it might be well to explain the meaning of these three terms. Regeneration is used in the same sense as with the ordinary set. This signifies that there is a tickler coil connected in series with the plate or output circuit, which feeds energy back to the grid, in the customary manner. This is the same action, which is the subject of the patent litigation between Major Armstrong and DeForest, which, up until recently, has been called the Armstrong Patent, but has only just been awarded by the courts to Lee DeForest.

Radio frequency amplification is made use of in the first tube. This increases the volume of the incoming carrier wave and so extends the range considerably. The reflex action takes place by using this same first tube, which already has been used as a radio amplifier, in the further capacity of an audio frequency amplifier. It is in this manner that we get the three R's referred to above.

Use of the Third Tube

So far we have employed only two tubes. The waves coming in through the first are amplified and passed to the second as a detector. From there they are looped back through the first again, and amplified at audio frequency, thus increasing the loudness of the signal, as well as the range. The jack, which appears on the front of the panel is connected at this point, and when phones are inserted, only these two tubes are connected, but if it is desired to use a loud speaker, then the phone plug is withdrawn and this connects in the third tube, which acts as a second step of audio. This makes the music loud enough to be heard on any loud speaker.

Figure 1 shows the appearance of this set with the cover closed. The numerals in circles referring to the different parts are the same throughout all the diagrams. Aside from the two rheostats, Nos. 4 and 5, the panel has only three controls. Dials 1 and 2 adjust the capacity of the grid circuits of the radio amplifier and the detector. This is what furnishes the sharp tuning of the set. Handle 3 controls the amount of feedback. But instead of turning it, it is pushed in and pulled out in the usual Crosley manner. When it is pulled out it brings the movable coil (connected in the plate circuit) up close to the stationery coil (detector grid circuit). This gives close coupling and a large amount of feedback. Pushing on the knob, thus separating the coils, produces the action between them, and so cuts down on the regeneration. With average operating conditions the normal position of the handle is about one-half way out.

Figure 2 shows a rear view of the panel. Of course, the set is turned the other way around so that the right hand side of the set viewed from the front is now shown at the left. An explanation of the figures shows:

1—This is the variable condenser, tuning the grid circuit of the radio amplifier.

2—The same thing in the detector circuit.

3—Is the movable coil governing the feedback. It corresponds to rotor of a variocoupler, and is adjustable by pushing in and out.

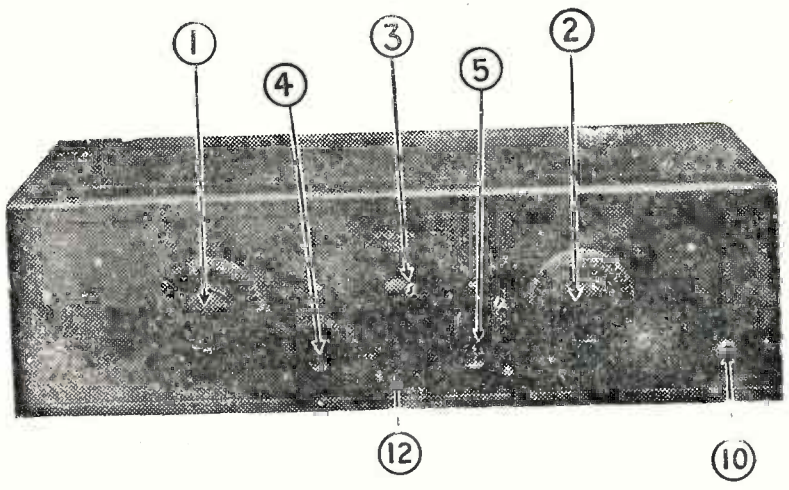


Fig. 1. Outside View of Tirdyn

4—The rheostat controlling the filament current of both radio and audio amplifiers.

5—The same for the detector.

6—First stage audio transformer.

7—Second stage ditto.

8—Antenna coupler. This consists of a primary in series with an aerial and a secondary connected to the grid.

9—The radio frequency transformer. It is also the stator of the variocoupler for introducing regeneration to the detector. Primary and secondary coils are

both wound on this stator in regular spider web construction.

10—Phone jack for use with first audio step only.

11—By-pass or stopping condenser in detector plate circuit.

12—Main switch for shutting off entire set.

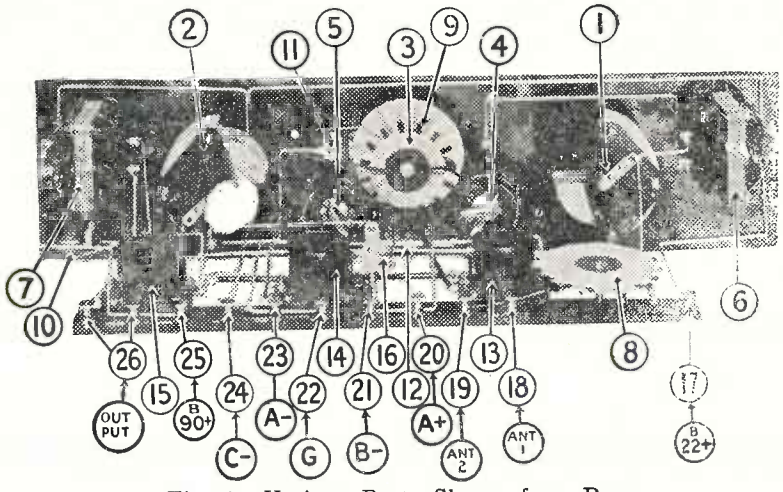


Fig. 2. Various Parts Shown from Rear

13—First tube, both radio and audio frequency amplifier.

14—Second tube detector.

15—Third tube. Second stage of audio amplification.

16—Grid condenser .00025 mfd. and grid leak 1 to 4 megohms depending on tube used for detector.

17—"B" plus terminal for detector.

18—Aerial connection, giving sharp tuning.

19—Aerial connection, giving louder results, but not sharp as 18.

20—"A" plus battery terminal.

21—"B" minus battery terminal.

22—Ground.

23—"A" minus battery terminal.

24—"C" minus battery terminal "C" battery is not needed if only 45 volts of "B" battery are used on the amplifiers. In that case, posts 23 and 24 are to be connected together by a short piece of wire, but where a higher voltage is used on the amplifiers, then it is desirable to connect a "C" battery. Its voltage should depend upon the amount of "B" battery used in accordance with the table on the direction sheets, which accompanies every amplifier tube.

25—"B" plus battery 45 to 90 volts.

26—Loud speaker terminals.

Hook-up is Shown

Figure 3 shows a simplified hook-up of the set, leaving out the filament connections, which are standard. Figure 4 shows the same hook-up in the pictorial style. The way the circuit works is this. The radio waves come from the aerial to the adjustable loading coil L shown in the upper left hand corner of figure 4. This coil is actually mounted on the inside wall of the cabinet.

This loading coil is used only to compensate for different lengths of aerial. With a short one, 25 feet or so, the entire coil is used. A 100-foot antenna will need not more than the first tap in series, and if it is as long as 150 feet, then the entire loading coil is disconnected and out of use. The other terminal of coil L is connected to binding post A1 or A2, or, as just mentioned, with a long aerial the lead-in is connected direct to one of these two terminals. These are the leads of the primary coil. No. 18 has only a few turns, and so gives very loose coupling, resulting in sharp tuning. No. 19 has more turns, and so the tighter coupling gives less selectivity, but increased volume. The secondary of this coil, wound on the same spider web, runs to the grid of the first tube. It is tuned by condenser 1.

Output to Transformer

The output from the plate runs through primary of radio transformer R. back through condenser C to the filament. The secondary of this transformer runs through grid condenser and leak to the grid of the detector tube. It is tuned by variable condenser 2. The plate circuit of the detector passes through the adjustable tickler 3, and then the primary of the first audio transformer, A1.

The secondary of the audio transformer impresses the audio frequency on the grid by running through the secondary of coil 18. Since this latter is a radio frequency coil, and has only a few turns, it does not affect audio frequency at all. The audio output from the plate after going through the primary of radio transformer R, (which again does not affect it, owing to its few turns), reaches the jack. If the phones are plugged in, the signals are heard with one radio and one audio amplification, as just described. But if the phone plug is pulled out of the jack, then the primary of audio transformer A2 is inserted in series. The secondary of A2 goes to the grid of the third tube and

Continued on Page 13.

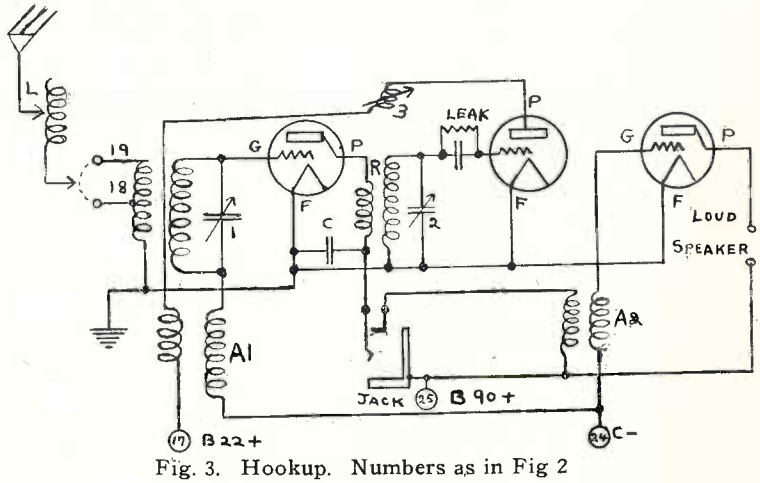


Fig. 3. Hookup. Numbers as in Fig 2

Common Sense in Seven Chapters

1. Night Range Versus Day Range

The night range of sending and receiving stations is much greater than the day range. Do not expect to hear stations a great distance away in the daytime. There are nights, rare in winter, and common in the summer, when it is impossible to bring in distant stations. This is due to atmospheric conditions beyond human control. This condition should be met philosophically as something that cannot be avoided, and not used as the basis of a complaint to the radio dealer who sold you your set.

2. Batteries Are the Fuel

A radio set will not work satisfactorily when the batteries are run down or nearly so. Keep your storage battery well charged, or if you use dry cells, always use some that are in good condition. Test your B batteries with a voltmeter occasionally and renew them when the voltage is 1/3 below normal. This is 15 on 22 volt block or 30 on a 45 block.

3. Watch the Details

Don't talk about the wonders and mysteries of radio, and the scientific and delicate sets that have made it possible, and then condemn the dealer or manufacturer when your set won't work with the aerial disconnected, the vacuum tubes burned out, or the batteries connected with the wrong polarity. A scientific instrument, even so popular a one as a radio set, must be treated in an intelligent manner.

4. Learn the Art of Tuning

If you have not learned to tune properly, but manage to tune in one long distance station, don't condemn your set because you do not hear them all. The fact that you heard *one* distant station shows that the set is all right; all you need is patience and practice, and you will be able to get the same far away stations as your neighbors.

5. Brighter Tubes Means Less Life

Don't expect to get louder or clearer music when your vacuum tubes are turned up brighter than normal. If anything, the reception you receive will be less loud and there will be unpleasant noises introduced. Remember, also, that a slight overload on the tubes will make them burn out in a fraction of their normal life.

6. Don't Miss To-day's Program

Radio does not change overnight any more than does the automobile, the phonograph or the sewing machine. The set that you buy to-day will be good a year from to-day, and probably for many more years. The long-distance receiving sets in thousands of homes at present are practically identical, except for some refinements, with the sets that were used by radio-telegraph enthusiasts five years ago. If you have postponed getting a good set because you are waiting for a radical change in radio, you are missing more enjoyment than the individual who puts off buying an automobile for the same reason.

7. Lightning Protection Simple

With a loop or an indoor aerial there is of course no need for antenna protectors. In the case of the outdoor aerial, the condition is somewhat different. During a storm the aerial may pick up some static electricity, which should be provided with an easy path to the ground, in order to protect the receiving instruments. The danger is *not* that the aerial will be struck, but that the static charges are likely to overload your receiver if not provided for by an approved lightning arrester.

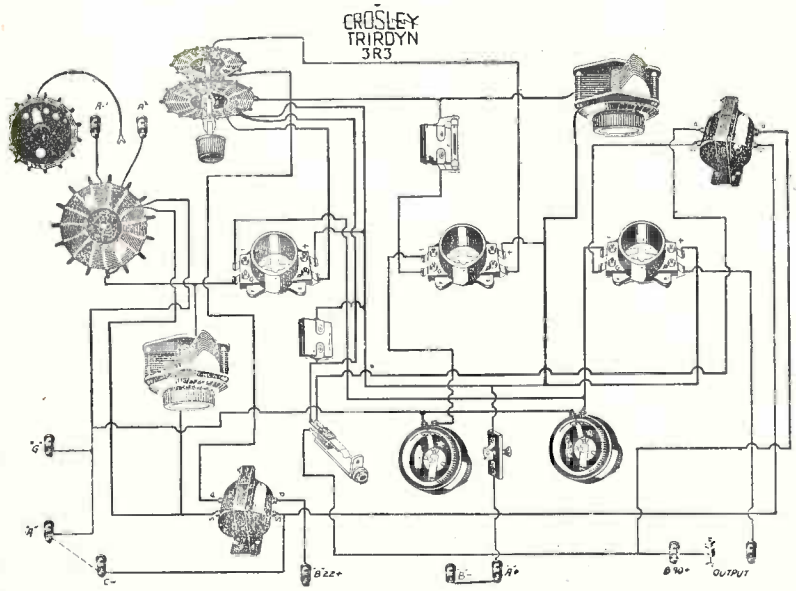


Fig. 4. Pictorial Hookup of Trirdyn

REGENERATION AND REFLEX

Continued from Page 12.

the output from the plate runs through the loud speaker in the usual manner.

Advantages of the Trirdyn

It will be seen that this set will not radiate and cause trouble to the neighbors, even though it employs a feedback control. If this regeneration is turned too high so that the detector oscillates, it will not squeal into the air as many other receivers do, since the radio frequency tube is inserted between it and the detector. This tube does not oscillate. Furthermore, the loose coupling between the primary and secondary of 8, the antenna coupler, would stop any radiation originating in the set from getting out into the air.

Another advantage is the sharpness of tuning. It has been found that two stations differing by only a few meters in wave lengths can easily be separated. Any kind of tubes can be used, but UV-200 and 201-A are usually recommended for this outfit.

Picture of a Popular Performer

Mr. Edwin F. Goldman

THEIR DANCE MUSIC IS GOOD

Mr. Edwin F. Goldman, is shown here. He is the conductor of the famous Goldman Band. Indeed, it was his ability which founded and has kept up this well known group of musicians. WJY, New York, (405 meters) are fortunate to be able to broadcast such good music as this aggregation of players is producing. If you want some good, lively dance music, tune into them some evening, and you will be delighted.

The programs, arranged and directed by Edwin Franko Goldman, are noted as being the most unique and most ambitious band concert programs attempted by any organization in the country, and the fact that the Goldman Band is the only organization to have given seven consecutive New York seasons is proof enough of the exceptional success of the attempts.

PUTTING MADISON SQUARE ON THE AIR

In bringing signals of adequate volume from the Democratic National Convention at Madison Square Garden, New York, to the antenna of WGY, at Schenectady, N. Y., the sound energy picked up by the microphones in New York was amplified at six different points on the journey.

As the voice or sound was picked up by the microphones in Madison Square Garden and converted into electrical vibrations, an amplifying unit built up the energy to counteract the loss sustained in transmission over wires to the studio of WJZ at Aeolian Hall on 42nd street, New York. At the control room of WJZ the signal was amplified for feeding to the air and part of the energy, normally sent to the station was diverted by wire to the Walker Street Terminal of the Western Union. Here the signal was boosted or amplified for the third time and sped on its way Schenectady-ward. At Sedgwick avenue, where the control wire leaves the New York city cable and goes into an open wire, strung on poles, a fourth amplification took place. This fourth stage gave the signal sufficient strength to reach the control room of WGY in Schenectady. There a fifth stage of amplification was applied to the message to overcome line loss over the quarter-mile of wire between the control room and power station. The last power amplification took place at the power station and the signal was then impressed on the radio apparatus and given to the listening fans tuned in on 380 meters. The journey of an electrical vibration from Madison Square Garden to the ear tuned in to WGY is made with the speed of light.

To assure good service to its followers WGY had nine operators along the circuit. The men were apportioned as follows: At Madison Square Garden, one man; WJZ control room, one man; Walker Street terminal, one man; Sedgewick avenue, two men; WGY control room, two operators; WGY power station, two men.

Unradiating the Single Circuit

This Will Also Increase the Selectivity of Your Receiver

By HARRY A. NICKERSON

THE single-circuit regenerative receiver is probably more used in the United States to-day than all other circuits combined. Among the obvious reasons for its popularity are its simple controls, low cost, and good results for small investment. It is the radio "Ford." But the single circuit is losing its popularity in favor of more expensive and elaborate sets for two reasons:—it is not sufficiently selective, and it radiates when improperly operated.

Because of its many good features, it is unfortunate that it should be the target for so much abuse. When the owner of the expensive set begins to compare his "stations heard" and "distance" records, he often finds his single-circuit neighbor has him badly beaten.

Mr. William Van Hoogstraten

Ten Feet of Wire Does It

This article is not intended to describe a "cure-all" for the two great defects of the single-circuit, but it does tell how, by the mere addition of ten feet or so of wire, the single circuit will gain marked selectivity and give less offence as a re-radiator. The idea may be adapted to other forms of single-circuit than that most commonly used, but the directions apply specifically to the single-circuit described as "a variocoupler set, using the tickler coil for producing regeneration" or as "the standard single-circuit regenerative set" or, sometimes, as "the Armstrong hook-up."

Fig. 1 illustrates the "standard single-circuit;" "S" is the stator of the variocoupler, which usually has from 60 to 80 turns of No. 22 or No. 23 wire. "R" is the rotor of the coupler. The arrow T pointing toward the stator is the tap switch; the dots represent four switch points or taps on the stator. If taps are taken from the coil to two sets of switch points, it is suggested that the set which is fine tapped (only one turn per tap) be eliminated and the taps used be four at most, connected as shown in the figure. It has been found that two or three taps in the standard single-circuit will give all the fineness of control desired, since the condenser is used for the fine tuning.

Note that the grid return is connected to the "A" Battery Plus, not to "A" Minus. This connection is recommended

Continued on Page 16

PHILHARMONIC ORCHESTRA

The New York Philharmonic Orchestra is one of the most popular musical organizations in the East. Our photograph shows William Van Hoogstraten, its conductor. Radio fans, who tune to 455 meters, will be able to pick up the Stadium Concerts of this orchestra from station WJZ three times a week.

with all detector tubes, although the return to Minus "A" is better with amplifier tubes. The "A" Plus connection is standard practice nowadays for detectors.

High and Low Divide

In operation, the radio frequency comes in from the aerial through condenser C, which is adjusted for fine tuning, then through coil S, and out the tap switch T, which gives coarse tuning. to ground. The secondary, or grid circuit, is hooked up to the grid, through grid condenser and leak and to coil S, through tap switch T to the filament. The output starts at plate T, then to the rotor R of the variocoupler to the point X, where the radio and audio frequency divide. The radio, or high frequency, goes through the by-pass condenser Cb and back to the filament, but the low or audio frequency goes from X through the phones and B battery to the filament.

Fig. 2 shows the same single circuit with the changes made for its improvement. It has become a set with an untuned primary P, which is inductively coupled to the secondary formed by stator of the variocoupler.

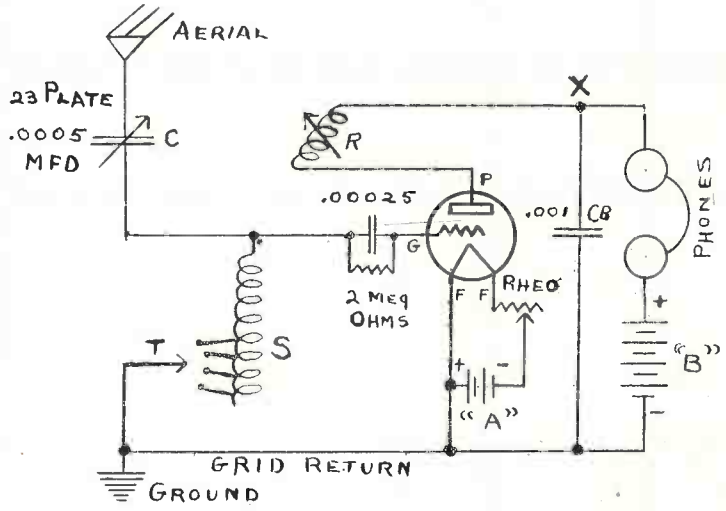


Fig. 1. Typical Single Circuit Radio

By "inductively coupled" is meant the action which occurs when two coils are spaced close together and one of them carries an alternating current. In such a case, a corresponding voltage is induced or generated in the other coil.

Such a set has a good reputation, not only for selectivity, but because it reradiates but little. The variable condenser is removed from the aerial, and is connected across the original coupler stator winding. No changes are made in the grid condenser or in the tickler connections, or in the battery hook-up. The real change is in the winding of the untuned primary outside the usual stator coil. The correct position of this winding and the number of turns in it are both a matter of experiment, but very excellent results may be had without the necessity for experimenting, providing the general directions given are followed.

Primary Not Tuned

The action in this case is as follows: The radio waves come down the aerial through coil P to ground. This primary does not need to have an adjustable tuner, as it will respond to all wave lengths. The secondary coil S, which is the stator of the variocoupler, is connected to the grid through the grid leak and condenser as before. The other end of the secondary runs to ground through the tap switch T, which gives coarse tuning. Fine tuning is accomplished by the adjustable condenser C, which you will notice is in parallel with the secondary. The operation of the output circuit is just the same as before.

First, as to the exact number of turns in this outer or "untuned" circuit. If wound directly over the original stator winding, where selectivity is desired especially, the number may be reduced to as low as three. This works well with a long antenna, say 150 feet, and short wave lengths, below 400 meters.

For short antennas, the number may be from 4 to as many as 15, but not more than ten seems to give better results than the larger number. The number 7 was selected, as it seemed to average best in tests made by the writer.

While this is not shown in the diagram, it is evident that if desired, the outer coil might be tapped, say at 2, 4, 7, 10 and 15 turns, so that trial might be had of the various numbers to see which would give the best results. If the original single circuit has two switch levers with their separate sets of switch points, use could be made of the points connected to the fine taps, by disconnecting these from the stator coil and using them on the outer coil winding, to vary it. In this case, the switch lever used with the fine taps would be connected to the ground.

Use of Sealing Wax

This outer winding should be of double cotton or silk covered wire, of gauge No. 18 to No. 24. The writer used No. 22 D. S. C. (double silk covered). If there is any doubt as to the quality of the insulation, a strip of paper may be wound on the stator and the outer winding wound over this. If care is used, a drop of sealing wax will hold the ends of the outer coil firmly enough in place, or collodion may be used as a binder, plus the drop of wax.

The length of wire necessary to wind the outer coil may be computed by figuring each full turn to be 3 1/7 times the diameter, plus a foot or two extra for connections.

To avoid undesirable hand-capacity, the rotor of the condenser must be connected to the ground as shown. This is absolutely essential. The condenser should be shielded with a strip of copper or tinfoil on the back of the panel. This also is grounded.

The winding of the 7-turn coil must be carefully done. The 7 turns may be wound closely together or spaced. They may be placed at either end of the stator or in the middle, or be wound so as to cover the whole length of the stator, spaced.

Winding the Primary

If the coupler stator is wound half on one end of the tube and half on the other end with shaft between, and consists of 80 or more turns. it is suggested that by all means, the 7 turns be wound just

above the middle of the stator winding on the half of the stator coil that is connected to the grid of the tube, at its end away from the middle of the winding. If, on the other hand, the stator winding is continuous, the 7-turn outer winding may best be wound at the end of the stator winding, or near its middle, toward the "filament" end of the stator winding rather than toward the "grid" end.

Care should be taken that the 7-turn coil be wound over some part of the stator that is sure to be used when tuning. For example, if it were wound on the lower half of the stator in Fig. 2, then when the switch lever was set on the highest tap, the 7 turns would perhaps be too far away from the stator coil in use to give the necessary energy transfer required for proper operation of the set.

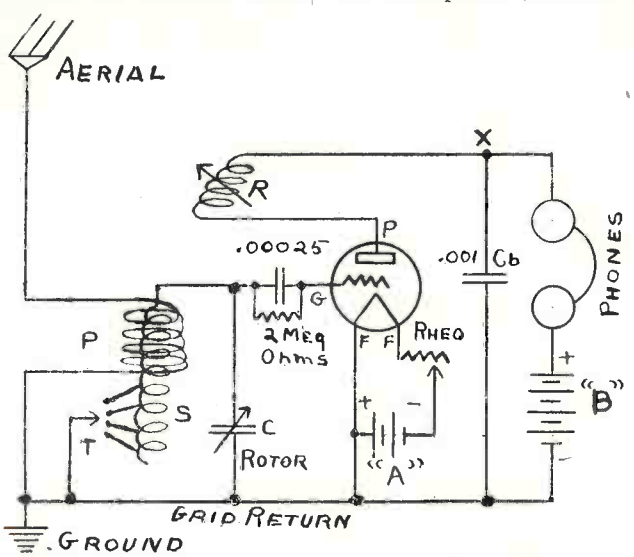


Fig. 2. Squeals Have Been Extracted from Fig. 1.

In case it is found that the variable condenser "C" will not tune down to, say, 250 metres, without setting the variable condenser "C" at practically its minimum capacity, it will be found that tuning will be improved by taking off another tap in the stator coil, so a less number of its turns may be used.

If, on the other hand, when using the highest number of turns of the stator, it is found that considerably higher than 550 metres is reached, a part of the end of the stator coil winding (not from the grid end of the stator, of course) should be removed until a little more than 550 metres is reached with maximum setting of the variable condenser.

It will probably be found that 45 to 65 turns of the stator coil may be used with a 23-plate variable condenser in shunt with it, to cover nicely the broadcast band of wave-lengths. The number of turns used will, of course, depend on the closeness of winding of the turns and the diameter of the stator winding form. If an 11 or 13-plate condenser is used, probably at least 65 turns will be needed to reach 550 metres.

Do not expect to hear distant stations with this changed single-circuit unless the tickler connections in the original circuit are so made that regeneration is obtainable over the broadcast band. If the set refuses to make a rushing or clicking (sometimes a violent squawk) in the phones when the tickler dial is moved through its circle of revolution, the leads to the tickler (rotor) should be reversed. If regeneration is still lacking, a larger phone condenser, a new tube, an antenna-ground system with lower resistance, higher filament current, a higher or lower "B" voltage or new B battery, change in value of grid-leak, a new grid condenser, or the attention of some radio expert, may be required to remedy the lack of regeneration. A regenerative set that won't regenerate won't give better results if the changes suggested in this article are made. But a good single-circuit may be improved in selectivity and in lessened tendency to re-radiate when improperly operated by making the hook-up that of Fig. 2.

WHICH WOULD YOU DO?

A thorough plan to adapt radio to the public school is now being tried out by the research director of the Oakland, Cal., public schools with the help of KGO, the Pacific Coast station of the General Electric Company. Tests already made show the boys and girls like school a lot better since the radio has been put in.

Dr. Virgil Dickson, research director of the Oakland schools, reports that the committee working on this problem is divided into two groups which do not agree. One believes that a lesson by radio should be limited to a subject of special importance, broadcasting a good speaker who knows more about it than anybody else. This is the lecture type of lesson and will be limited to specialists.

Group two thinks that radio should be a means for giving actual classroom lessons. They believe that radio may take the place of the classroom teacher and give the same kind of lesson; however, the regular teacher will listen in, and point out upon maps, globes or charts, the topics referred to by the radio instructor. The classroom teacher will also direct operations of the class and see that pupils make proper notes.

The lecture plan of group one has already been tried out by broadcasting one lesson in music and another on Indian customs. Reports from various schools listening in prove that both lesons were successful. Opinions of group two have not yet been proved, as the test lessons on geography, Shakespeare, and commercial arithmetic have not yet been fully reported. Under both systems the radio teacher was helped by some of her pupils speaking into the microphone. This made it seem real to the class.

The attention of the children was held by musical numbers. Plans for the Shakespeare lesson included music played for five minutes at the beginning, again in the middle and once more at the end of the talk. By this means the minds of the students and teachers were freshened for the attention necessary to grasp the main points in the talk. The five minutes of music in the middle of the lesson let slower pupils catch up with their note taking. At the end of the lesson the five minutes of music seemed to rest the entire class and put them in smiling humor before dismissal.

Some Sending Station Stories

HENRY FORD ON THE RACES

Most of the thirteen million automobile owners are interested in the International 500-Mile Race at Indianapolis, yet only about one hundred and fifty thousand of them get an opportunity to see it. But this year, The Prest-O-Lite Company, whose enormous factory is directly across the road from the Speedway, broadcast the race through the Chicago Tribune Station, WGN, and the speed fans got a realistic impression of the race on their radio. A special wire was run from a soundproof booth in front of the judge's stand at the Speedway direct to the broadcasting station at Chicago.

Arrangements were made to cover everything that was doing at the huge 2½-mile brick oval. Telephone lines from all important points at the track led to the sending booth. For instance, experts stationed at the pits told the story of the pit stops of the cars. Reporting the standing and the speeds of the cars was a job requiring quick thinking, as the race proved to be the fastest and most bitterly fought in the history of the classic. Now one driver was ahead, then another.

The broadcasting was very realistic. The roar of the motors, the cheering of the crowds, the quick commands of the drivers as they stopped for supplies and hasty adjustments were so graphically transmitted from the pits that listeners said. "Everything was there except the smell of burning rubber." Henry Ford supplied an unexpected feature by addressing the radio fans on the significance of the race in relation to the automobile industry. Mr. Ford, who himself was a builder and pilot of racing cars in the early days of his career, was referee of the race.

It is reported that the broadcasting aroused unusual interest. Hundreds of thousands of sets tuned in and in radio stores, garages and private homes great crowds followed the progress of the race on special charts. Thousands of telegrams, letters, and applause cards were received thanking The Prest-O-Lite Company and the Chicago Tribune for the wonderful program, and congratulating them on their success.

ARE YOU A FOREIGNER?

Victor Saudek, conductor of the KDKA Little Symphony Orchestra, is arranging a series of international radio concerts and musical programs which will be broadcast from Station KDKA. A schedule is being prepared in which one evening will be devoted to each nation, and the concert will be broadcast in the language of that nation as well as in the English language. Although KDKA has already broadcast several programs in Spanish for the South American and Latin countries and other broadcasting stations have transmitted concerts in foreign tongues, this is the first time that a complete series of international concerts have been arranged. Mr. Saudek is also endeavoring to secure the consuls of the various nations to deliver the welcoming address. The national "dish" of the nation whose concert is being broadcast, which will be served with the refreshments for the broadcasting artists, will also be an additional feature.

CANOEING BY RADIO

How beneficial and valuable from advertising purposes a radio broadcasting station can be to a municipality was recently beautifully illustrated in Springfield, Mass., in connection with a shipment of canoes from Old Town, Me., to a Springfield hardware establishment. The shipping tag bore the name of the hardware store and nothing else but the inscription, "Springfield, the home of WBZ." With the number of cities and towns throughout the States with the name Springfield, mail clerks might have experienced some difficulty in locating the consignee. But the additional material on the tag referring to the Springfield Westinghouse radio station left little doubt as to where the canoes were going.

HAND ORGANS NOT INCLUDED

A curious fact has been noted by Station WBZ in comments from radio listeners regarding organ broadcasts. Very few persons, prior to radio, ever heard an organ other than in a church or a "movie," and the idea of an organ studio is novel to them. Through the courtesy of WBZ, fans have been able to compare two organs, the one in the Steinert Studio where the Aeolian organ is played and the one in the Estey Studio bearing that name.

ANNOUNCED IN THREE LANGUAGES

Fans who receive broadcasts from Canada's premier radio station CKAC, are familiar with the fact that all announcements have been made in French and English.

Soon, a third language will be added: "La Internaciona Linguo"—ILO, the perfect radio auxiliary international language—simple, neutral, expressive and logical.

Jacques N. Cartier, director, and his staff of announcers and story-tellers, are studying Ilo, and find it extremely easy to learn.

By the time the new big plant of CKAC has been installed, everybody connected with the studio expects to be able to talk Ilo, and then this musical "tongue" will be on the air regularly.

Heretofore, CKAC has found two languages enough for its needs, but now that constantly increasing numbers of radio enthusiasts are clamoring for Ilo—"Well, not to advance is to recede," according to J. N. C., "and in Ilo all fans have a new standard! There is no other way possible for us to satisfy everybody. All non-English and French fans, within our range, advocate Ilo."

Mr. Cartier points out that CKAC serves a big Italian colony, a Greek village, a miniature Vaterland, a tiny Chinese town, a large Jewish settlement and several other small colonies.

"SLEEPING SICKNESS"

A radio fan in Charlottesville, Virginia, writes that the only trouble with the Westinghouse Station KDKA is that the directors in charge of the station have sleeping sickness. The concerts are received very clearly and distinctly and are enjoyed regularly each evening according to the letter, but this listener requests that "KDKA stay up a few hours later in the evening."

Saving the Storage Battery's Life

Don't Commit First Degree Murder on Your Battery

By W. S. STANDIFORD

THE storage battery is the most important piece of apparatus used in radiophone receiving sets to light the vacuum tube filaments, and sometimes to operate the plate circuits; it is often called the heart of radio set equipment. Good signal reception depends to a large extent upon the care which the batteries receive so as to avoid getting hissing, frying and scratching noises (which are often blamed upon static electricity) along with the signals.

Many persons have an idea that electricity is actually stored in these devices, just the same as if a lot of apples were put away for winter use in a basket. As a matter of fact, it is the *energy* of electricity that is put into the cell, and withdrawn later with a limited loss. What occurs is, that the energy of the charging current changes the chemicals in both positive and negative sets of plates into a different chemical form. After the charging current is cut off, the battery is connected to the radio outfit; when its circuit is closed, these chemicals are changed back to their original form, and in doing so, generate electrical energy.

Acid and Alkaline Cells

There are two types of storage batteries on the market: the first consists of specially prepared lead plates standing in a solution of sulphuric acid and water. The other is known as the Edison battery; its plates are made of nickel steel, and contain nickel peroxide and spongy iron immersed in a solution of caustic potash. Both kinds have their advantages and disadvantages, there being no perfect storage cells made. Storage battery capacities are rated by their manufacturers in ampere-hours. Thus a 60-ampere hour cell will supply 6 amperes of current for 10 hours, 3 amperes for 20 hours, or 1 ampere for 60 hours. That is, the current times the hours equals 60. But it would ruin a storage battery to take 60 amperes out of it in one hour's time; the plates would buckle under such a rapid discharge rate. Batteries in radio service, as contrasted with those used for automobile lighting and self-starting, operate at extremely low discharge rates, one, two, or three amperes being about an average current; it depends upon the number and kind of tubes used.

Radio vs. Auto Batteries

Conditions of battery working in the automotive and radio fields differ considerably; the radio field demands a steady current discharge without frequent recharging, while the automobile outfit is constantly being recharged with the result that the current consumption is at a minimum. As storage batteries have, before the advent of radio sets, been used mainly in intermittent work, their ratings in ampere-hours is based on this method of operation and will not be exactly true in continuous use. In purchasing and using storage batteries, the above facts should be kept in mind, and cells bought which have a large ampere hour rating. The radio novice should realize, that while a 40 ampere hour battery costs less than one of 120 ampere hours, the former will become exhausted in one-third of the time of the larger one, thus making it necessary to bother with frequent recharging, which costs money and loss of time.

When Is It Charged?

For the benefit of those amateurs who have a recharging outfit and are unable to tell when a storage cell is fully recharged, the following pointers will be of interest. The completion of charging is known by several signs. The colors of both plates are fully restored, the positive being a rich dark chocolate brown and the negative a light grayish blue color. The density of the acid is brought back to its highest value, 1.275 to 1.300. The pressure is over two volts and in some cases may be 2.5 at the end of a recharging period. Copious streams of gas bubbles are given off from both plates; oxygen at the positive and hydrogen at the negative. These bubbles appear at first in small quantities, but they increase more plentifully as the plates are completely charged. The acid and water mixture at this stage looks quite milky.

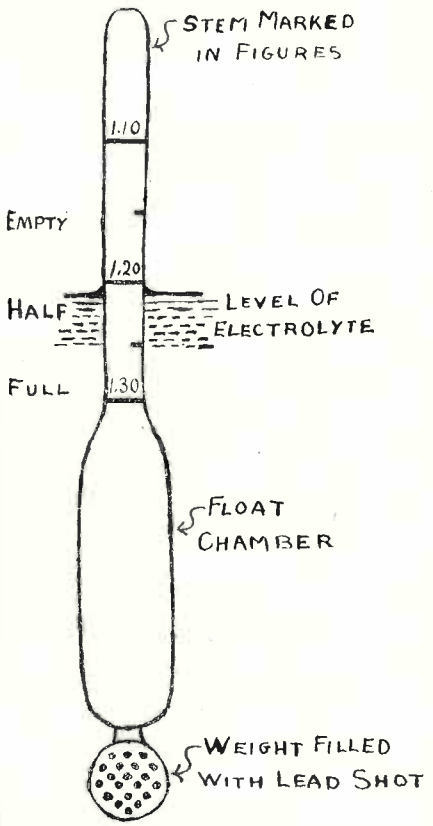


Fig. 1. Battery Hydrometer

When nearing completion of the charge, a fine spray is given off from the surface of the acid, (called electrolyte). This gas is a mixture of oxygen and hydrogen and it is very explosive. On this account, the battery ought to be kept away from all flames.

The acid spray is quite corrosive and it should be kept away from carpets and upholstering. The most used device for testing whether a storage battery is fully

charged, or otherwise, is called a "hydrometer" and it can be bought at any automobile or electrical supply store for 50c to $1.00. The explanation of the working of this instrument is simple. Sulphuric acid used in battery solutions and known as "electrolyte" is heavier than water alone. The hydrometer merely indicates the relative weight of the solution as compared with that of pure water. As a charged storage battery discharges, the sulphuric acid leaves the water and goes into the plates, forming lead sulphate. When a battery is discharged, a large amount of the acid has combined with the lead compounds in the plates. Naturally, as the solution is weak in acid, it is lighter, and the float of hydrometer sinks deep. But when a battery is fully charged and the acid is in the mixture, the latter has become heavier, thus forcing the hydrometer to ride high.

The same action is noticed in swimming. It is much easier to learn in salt water than in fresh, because the salt water, being a lot heavier, buoys a person up. It is even more marked for a person swimming in the great Salt Lake, in Utah. Here the water is so salient that it is very heavy and it is impossible for a swimmer to sink in it. Going still further, if you take a pan of mercury and lay a flat iron in it, you will find that the iron itself will float on the surface of the quicksilver.

In reading a hydrometer the line right opposite the surface of the liquid is used. Where the water touches the float there will be a little curve in the surface, but no attention is paid to this. When we say the hydrometer reads 1.220, we mean that the lever of the electrolyte comes opposite that point. This is illustrated in Figure 1. Only the float of the hydrometer is shown. It is ordinarily contained in a glass syringe which is used to suck the liquid out of the battery cell. The float consists of three parts: the upper part or stem is marked with lines and figures showing the condition of the battery; the middle is the float chamber and is hollow to make it light; the lowest part is a weight and is usually filled with lead shot, so that it will sink and hold the hydrometer right side up. Oftentimes the lead shot are held from rattling by a small amount of sealing wax.

A fully charged battery should read nearly 1.300. A specific gravity of 1.260 indicates a quarter discharged battery. 1.225 shows that it has been one-half used; 1.185, three-fourths gone and 1.150 entirely discharged. Under no circumstances is it advisable to let any battery get more than three-quarters discharged, because the formation of a hard crust of lead sulphate increases so rapidly, that it is difficult to reduce it by recharging. A storage battery should never be left in a discharged condition, but should be recharged again without delay. Another important point to remember is that a fully charged battery (even if it is not used) will gradually discharge itself through electrical leakage in from 10 to 15 weeks. Ordinary water from faucets or wells should not be used to make electrolyte or refill batteries on account of the iron and other impurities which it contains. Boiling won't help. Use nothing but distilled water and also chemically pure sulphuric acid. They can be obtained at any garage.

Hot weather is severe on storage batteries, as it causes the water to evaporate much faster during this period than at other times, thus uncovering the tops of the plates, and allowing the action of the electric current to bend and twist them until they are no longer useful. A new battery then is required, which unfortunately is quite an expensive piece of equipment. Keep a close watch on the water, adding to it twice a month. The acid does not evaporate and needs replacing only if it has been spilled or has leaked away through a cracked jar. Caution, in making up acid electrolyte; always pour the *acid* slowly into the *water*, stirring it with a glass rod; do not reverse this proceeding or it will fly up into your face.

Overcharging a battery in the summer time will also heat the plates and electrolyte, causing evaporation from the tops of them and ruining the battery. As a matter of fact, the evaporation of water in a battery is continuous in cold as well as hot weather, although it is heavier during the latter months. Another cause of battery trouble is charging while the level of the electrolyte is lower than the tops of the plates. If the solution covers only one-half of the plates' surface, a normal charging rate acts on the lower half as if a double amount of current were being sent into a battery, with the result that the plates not only buckle, but also a loosening of their active material occurs, which will therefore fall to the bottom of the cell where it is not only useless, but short-circuits the plates if it piles high enough. Rapid overheating causes damage, resulting in considerable expense later.

Inexperience or carelessness in undercharging, if continued for some time, also makes the plates become harder and offer greater resistance to the charging current. Should a normal charging current be sent into a battery in the above condition, it will produce enough heat to make their plates buckle.

Winter weather is also hard on storage batteries; they should not be kept in any place where they will freeze, as once frozen, a storage battery is totally and permanently ruined. Freezing causes the grids in the plates to expand and crack, thus allowing their "active material" to soften and drop to the bottom of the container. The greatest damage is done when a battery freezes while it is in a discharged condition. The safest course to pursue in the winter time is to keep the battery fully charged, whether it is used for radio work or on your automobile.

It is a fact, proved by experience, that a fully charged battery will stand a lower temperature than one that is discharged; the contrast between them is very interesting. Thus one fully charged won't freeze until a temperature of 70 degrees below zero is reached, while a discharged one freezes at 14 degrees above zero. A quarter discharged battery congeals at 60 degrees below zero, and if half discharged, at 20 degrees below zero. Another point to be remembered in the winter is that when distilled water is added to the electrolyte to maintain its level above the tops of the plates, the water must be thoroughly mixed with the solution before a battery is exposed to the possibility of freezing. Should the water not be well mixed with the electrolyte, freezing and damaging of the battery will result, even though the latter be fully charged.

The best way to stir the electrolyte and water is to charge the battery for a short time after it is full. In this way the bubbles and gases, which are given out, will mix up the solution perfectly. In case this is not possible, then by sucking the electrolyte up and down with a hydrometer syringe, the same results may be obtained.

American Radio Relay League

DUTCHMAN ARRESTED FOR SENDING

The decision that it is not a crime for an experimental radio amateur of Holland to communicate with hams in this country has helped the standing of amateurs in the Netherlands, according to a report received by the American Radio Relay League.

Even after a prominent French telegraph amateur was decorated with a gold medal for the skill with which he talked across the Atlantic ocean on short wavelengths, amateurs in Holland were regarded as something equivalent to the boll weevil. The authorities were inclined to think they were a menace to their community.

The science of radio among the young men of the country had kept abreast of progress much better than the laws, with the result that H. J. Jesse, Jr., a prominent radio experimenter at Leiden, Holland, was made the defendant that the courts might decide whether it was lawful for a citizen to transmit.

It was charged that Jesse's telegraph and telephone station was not intended for public communication and that messages had been exchanged "without authority having been obtained from the minister of Waterstaat." (That's what they call the Radio Inspector.) He had in fact, taken part in trans-atlantic radio tests and communicated with amateurs in the United States as far west as Nebraska.

The defense pointed out that regular telegraphic communication in competition with commercial traffic was not intended and that the case was in the class with work concerning laboratories. The clerk of the open ministry congratulated the defendant for having communicated with a station in America. It was shown the defendant was not guilty and the case was dismissed.

AIRSHIP GOES "ON THE AIR"

Rochester, N. Y., recently showed that radio messages can come from a point high up in the air as well as "through it." The radio operator on the Navy's big airship Shenandoah gossiped for a while with radio amateurs below.

"To the Rochester amateurs," read one message in code. "You are the first bunch that have waked up to-day. Best regards."

This was not a casual greeting, attempted as a pastime for the Shenandoah's crew, but part of a systematic program for testing out the possibilities of short wave amateur communication. Some time ago the American Radio Relay League learned from the Navy Department that a short wave transmitter was being installed on the airship for the express purpose of enabling its operator to communicate with amateurs should it be needed in emergency during flights.

The radio outfit on the Shenandoah is now regarded as the most complete of any ever installed on an aircraft; it has facilities that allow the use of practically all wave lengths from 100 meters to the long waves commonly used by big commercial stations. The advantage of the complete equipment is to give the crew of the airship a chance to avail itself of assistance, for direction finding and other purposes, of all classes of radio stations which would be useful in time of emergency.

Even the broadcast band has not been excluded from this arrangement, for the Shenandoah's operator, after sending the foregoing message to amateurs, shifted over from code to voice and gave the following message to station WHAM:

"We have been hearing your broadcast station WHAM, at Rochester, and it is coming in fine. If WHAM cares to, they might report our position to the Naval Air Station at Lakehurst."

The operators at WHAM immediately forwarded the telegram to Lakehurst and then turned on the transmitter and informed the Shenandoah they had complied with the request.

LISTEN FOR "ARCTIC" ON 120 METERS

William Choat, radio operator for the Canadian Government Steamer "Arctic," which is leaving Quebec the first of July on her annual trip to Baffin Bay, may be the first amateur operator to relay back to Canada and the United States the complete details of the winter experiences and home-coming arrangements of Captain Donald B. MacMillan, Arctic explorer.

The departure of the "Arctic," under the Northwest Territories Branch of the Canadian Department of the Interior, comes at a time when the arrival of daylight in the Far North is beginning to shut off the radio contact between MacMillan and radio amateurs of the American Radio Relay League in Canada and the United States.

The radio messages that have come from Donald Mix, the explorer's radio operator last fall and winter, have become gradually less frequent as darkness began to leave the polar regions. Of late there have been only a few weak messages that have sufficed to show the "Bowdoin's" crew have come through without hardship. The last one told of the explorer's plan to start for home soon.

This year the "Arctic" will carry a short wave I. C. W. (interrupted continuous wave) outfit which will enable its operator to transmit on the amateur wavelengths between 100 and 150 meters. This equipment is in addition to her two regular sets, consisting of a standard 600-meter 2-kw. spark transmitter and a continuous wave transmitter working on a 2,100-meter wavelength.

The Radio Branch of the Department of Marine, which looks after the radio equipment on the "Arctic," wants to carry on tests with amateurs of the American Radio Relay League in Canada and the United States, and had the special short wave equipment installed for this purpose.

The call which has been assigned to the "Arctic" is VDM, while that of MacMillan's ship is WNP. Special permission has been granted for all Canadian licensed amateur stations to use the wavelength of 120 meters during specified hours, although transmission on this wave will not be permitted for any other communication.

In order that amateurs will know when to be at their stations for communication with the expedition, a definite schedule has been arranged during

which Mr. Choat will listen for signals. He will stand watch on the short wavelength daily, except Wednesday and Saturdays from 11 p. m. to midnight, Eastern Standard Time. Saturday, however, the hours will be extended from 11 p. m. to 3 a. m.

The "Arctic" is a wooden ship of 762 tons gross and carries sails in addition to her engines. As it is impossible to insulate the heavy guys which hold the three 80-foot masts, the ship is not regarded as ideal for radio work, although it is expected that this handicap can be overcome by the use of high power.

The ground for the radio equipment is provided for in the form of a copper plate secured to the side of the ship. If this should be torn off when the vessel encounters ice floes, it will become necessary to utilize the engine propeller.

NOW SAY DOCTOR MAXIM

Hiram P. Maxim, the inventor, upon whom the honorary degree of Doctor of Science was just conferred by Colgate University at its 106th commencement, has been president of the American Radio Relay League from its beginning. In fact, it was Dr. Maxim who first thought of organizing a non-commercial association of radio amateurs, and from that time to this, he has championed the cause of the transmitting amateurs of the country.

This new honor comes at a time when Dr. Maxim's work in behalf of amateur radio is beginning to secure recognition from radio experimenters in all parts of the world. In recent years long distance tests of the A. R. R. L. with amateurs in Europe, Australia, New Zealand and South America have brought the amateurs of this country into world-wide prominence, which gave rise to Dr. Maxim's election as president of the Temporary Committee of Organization of the International Amateur Radio Union.

This committee is designed to knit together the radio societies of the world in the same way that the American Radio Relay League has done with those in the United States and Canada. Interest in amateur radio in foreign countries is increasing fast, and the proposed international association will be a powerful influence in world affairs.

The international union of amateurs will bring to the experimenters of foreign nations many of the privileges enjoyed by telegraph operators in North America, as well as recognition of their value in times of emergency. The amateurs of the United States have frequently been a wonderful help in areas affected by storms and other disasters. Their merits have been recognized by the railroads and the government.

A WIRELESS QUESTIONNAIRE

A check-up of amateur radio conditions in all foreign countries is being made by the American Radio Relay League to learn the amateur progress throughout the world. In recent months sending operators have been at work in countries where it did not seem possible there could be the slightest interest in radio.

Apparently there are few places where experimenters cannot obtain equipment for building radio sets if they persist. In countries where their existence has not been recognized, they are called "bootleg" operators. The radio laws in most countries are poor.

With these conditions in mind, Charles A. Service, assistant secretary of the A. R. R. L., has sent this questionnaire to radio societies in about twenty countries:

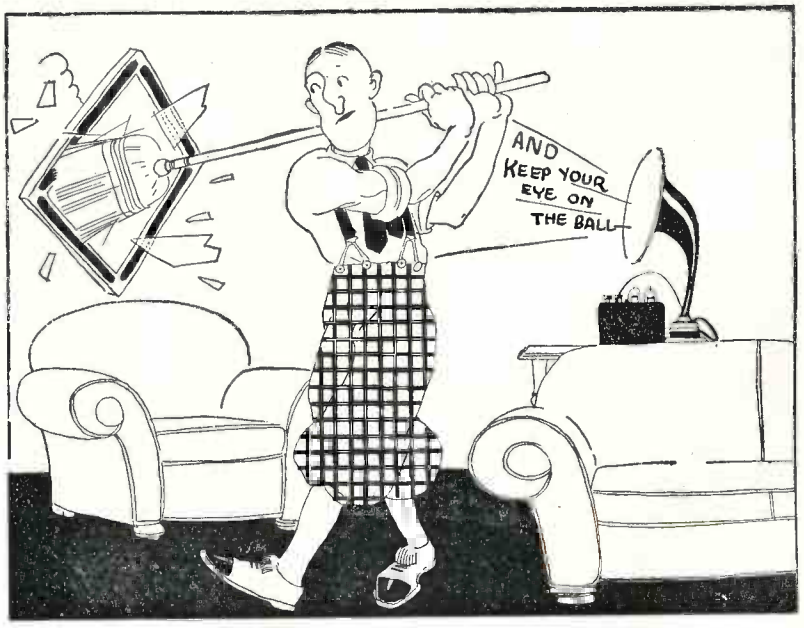
"Digest of government radio laws now in force or pending, relative to amateur radio, both receiving and transmitting.

"System of call letters used? Numerals, letters or combinations? Are they assigned by the government or individuals? Is the call list published and by whom? Cost?

"What is the name, title and address of the government department or official in charge of radio activities in your country?

NEW HIGH POWER STATIONS STARTING

The Class B stations are the powerful broadcasters, which can be heard over a large part of the United States. The United States Department of Commerce lists 49 Class B stations at present, and 14 more are being built. Some of these have not been revealed to the public as yet, but bigger stations are already planned for Chicago, Cincinnati, Denver, Hartford, Hot Springs, Huston, New Orleans, and New York.



Broadcast Bill delights in golf,
And will improve his play,
By following the golfing "pro"
Who broadcasts every day.

At home last night he took a ball
And placed it on a "tee."
He swung.—and tho he missed the ball,
He made a "hit," you see.

—By Del.

NOVEL TOOLS FOR THE FAN

Two rather interesting tools have just been put on the market by Stevens & Company. One of them is a Spintite wrench for turning *round* thumb screws or nuts. Such nuts are used for the four terminals of vacuum tube sockets, as well as on many other places in the radio. It has always been rather awkward to tighten these with pliers, especially in a compact set. This tool, as shown in our picture, has a large number of sharp teeth on the inside of a

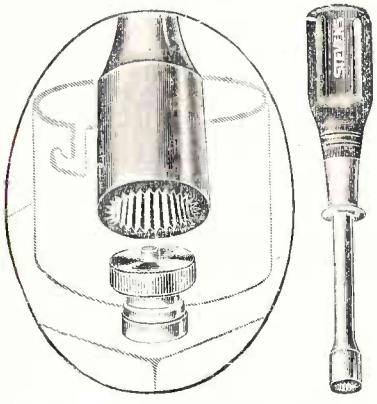


Fig. 1. Wrench for Round Nuts

tube, which fits tightly over the nut. This tube has a hole which is bell-mouthed at the end. This allows it to fit tight on a nut, even though it may vary a bit from standard size. By pushing this wrench down over the head of the nut a good grip is obtained and it is easy to turn it down tight enough so there is no danger of a loose contact.

Vise Will Not Mar Threads

Another new tool made by the same company is a Screw Clamp. This is a sort of vice, but as shown in Figure 2, it has three holes tapped in the jaws. These take numbers 6, 8, and 10, screws, which are the only sizes used in most sets. By clamping a screw in one of these holes, it can be held securely while it is cut to the right length, or filed as desired. In this way there is no danger of marring the thread. This will be appreciated by those who have found the end of a screw so badly damaged that it is next to impossible to start the nut on it.

Cutting Down Waiting Time

Oftentimes you have heard the announcer say, "One minute, please," and then after waiting five minutes by your watch have wondered how he gets that way. Of course, it is not the director's fault, as it takes considerable time to get the artists in place, and being somewhat temperamental, they have to be treated in a leisurely fashion.

But station WTAM, Cleveland, the radio station of the Willard Storage Battery Company, has recently tried an experiment in reducing this waiting time by broadcasting alternately between two studios. On the night of May 28 they made a record for a new type of broadcasting.

An average of three seconds was maintained between numbers on the program in spite of the fact that alternate selections were rendered at two points, seven miles apart.

The stunt was worked between the Cleveland Plain Dealer studio and the Willard station of WTAM. Half of the artists were at one place and the rest at the other. All the announcing was from the Plain Dealer studio.

Especially interesting is the fact that the switch over from one point to the other was accomplished without the aid of any signal or communication other than the radio itself. This was done by use of a code word spoken so that listeners were unaware that a code signal for the switch over was being given.

Both studios were equipped with receiving sets tuned to the station's wave. The Plain Dealer station led off and the first number was followed by the announcer explaining what was being done. He ended his announcement with the word "studio" which was the code signal for the operator in the transmitting room to cut in, and to the artist at the Willard studio to start broadcasting.

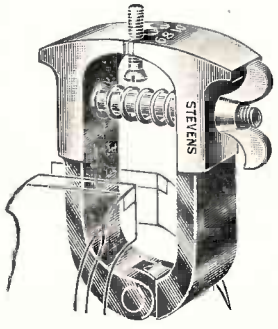


Fig. 2. Screw Clamp

As the music stopped at the Willard studio, the operator threw his switch, cutting back to the Plain Dealer station where the announcer had been listening on a receiving set. Allowing three seconds to make the change in connections, the announcer started his statement of the next number.

"Studio" being the last word of every announcement, was the signal for the operator to throw his switch from one studio to the other but to the listening radio fans it was just part of the announcement.

While one station was broadcasting, artists at the other were taking their places to be in readiness to follow. In this way shorter intervals elapsed between numbers than could have been possible if all the broadcasting had been done from one place.

REINARTZ RECEIVES REWARD

John L. Reinartz, famed radio experimenter of South Manchester, Conn., was honored at a special meeting at the Seaman's Church Institute in New York recently when he was presented with a cup by the special committee of the Executive Radio Council of the Second District. The cup is to be offered annually to the amateur who contributes the greatest advancement in radio communication for the year.

This is the first time this cup has been awarded, and Reinartz has thus been signally honored by the amateurs of the second district for his accomplishments in the development of receiving and transmitting circuits, which made recent transatlantic amateur work possible. The cup will be awarded on the same basis as the Institute of Radio Engineer's "Liebmann Prize,"—for merit only.

DISCARD ALL YOUR BATTERIES

Don't miss the next issue of RADIO PROGRESS, as you will find a description of a new method of dispensing with all your batteries. "A," "B" and "C."

Fone Fun For Fans

He Didn't Shake—Much

Sam had passed through a harrowing experience. He had seen a ghost.

"Ah jes' come out of de cowshed," he said, "an' ah had a pail of milk in mah hand. Den ah hears a noise by de side of de road an' de ghost rushes out."

"Did you shake with fright, Sam?" asked one of his dusky audience.

"Ah don't know what ah shook wid. Ah hain't sayin' suttin ah shook at all. But when ah got home ah found all de milk gone, an' two pounds o' butta in de pail."—Progressive Grocer.

Professor (in engineering class)—What's a drydock?

Stude—A physician who won't give out prescriptions.—Crosley Radio Weekly.

He Gets a Date

She—Isn't the sunset beautiful?

He—Yes, but what chance has it with your face around?—Tennessee Tar.

A Case in the Short Circuit Court

A chap was arrested for assault and battery and brought before the judge.

Judge (to prisoner): "What is your name, your occupation, and what are you charged with?"

Prisoner: "My name is Sparks, I am an electrician, and I am charged with battery."

Judge: "Officer, put this guy in a dry cell."—The Inland Merchant.

The Goodnight Message

The patter of tiny feet was heard on the stairs and Mrs. Blank raised her hand for stillness among the members of her bridge club.

"The babies are going to give me their goodnight message," she whispered. "Listen, it always gives me a feeling of reverence."

The silence was intense as the women listened: "Mama," came the shrill whisper. "Willie found a bug."—Crosley Radio Weekly.

Foretaste

Little Bob: (about to go out with mother)—Mama, you must take some money with you."

Mother—No, Bob, I'm not going to use any.

Little Bob—Yes, you must have money for chocolate; I might start crying on the street, you know.—Detroit News.

Blame Father

"How'd you get so bowlegged?" asked one corner ornament of the other in the neighborhood of Pike and Madison streets on the lower East Side. "Did they let you walk too soon?"

"Naw," growled the bow-shinned one; "my old man used to swat flies on my head, an' he swatted me so hard he bent my pins."—Radio Merchandise.

He—If you hadn't taken so long getting ready, we should have caught that train!

She—Yes, and if you hadn't hurried me so, we shouldn't have had so long to wait for the next one!—Crosley Radio Weekly.

THIS BEATS THE AIRPLANE

The fact that radio waves can be made to go "there and back in nothing flat" was demonstrated at WTAM, radio station of the Willard Storage Battery Company, broadcasting from the Cleveland Plain Dealer studio.

A late dance concert of request numbers was being put on the air when a fan called the studio by long distance telephone from St. Thomas, Ontario, placed his loud speaker to the telephone and sent back over the wire the same music that was being sent out by radio fifteen feet away.

The speed of the round trip of the signals was so great that the music came back from Canada at the same instant that it was going into the microphone in the next room.

Here is the circuit of the music; telephone wires carried the signals from the studio to the transmitting set, seven miles away. From there the ether carried them to St. Thomas, about 100 miles, straight across Lake Erie. From St. Thomas they were put on the wire again, going about 400 miles around the lake to get back to the studio. And the return was instantaneous with the start.

Some one has suggested that if the speed could be increased just a little more so that the music returned to the sending just an instant *before* it left, it would save an immense amount of trouble, as the artists could be dispensed with entirely, by hooking the receiver up to the sending station. This would result in a sort of perpetual motion.

DEAD END TURNS ARE BADS

Most radio sets contain a tap switch, working on switch points, which are connected to taps on a coil. This may be a variocoupler, or perhaps a spider web coil and the taps are often located from one to ten turns apart. These coils are usually made too big. This is necessary, since the manufacturer does not know what wave lengths you are trying to get, nor can he tell how short an aerial you are going to use. The length of the coil is governed very largely by these two considerations—the longer the wave length, the more wire you need in the coil and antenna. But for a given wave length, the longer the aerial, the shorter must be the coil, since it is the *sum* of the two working together that picks out the station you want. If the manufacturers of your radio knew you were going to use an aerial of exactly 100 feet they could cut down the wire in your coil so that the longest wave length would be receivd on the last tap.

But after you have installed your set, you will find that most of your work is done on only a few buttons of the inductance switch. Say there are ten switch points and you use only Nos. 4, 5, 6 and 7. Then the extra turns beyond the seventh are not doing you any good. On the contrary, they are really causing harm. This is for two reasons. First, the extra wire reduces the sharpness of tuning somewhat as it tries to vibrate at its own particular wave length. Besides that, additional and unnecessary losses will be created in this superfluous wire. To avoid these two troubles, it is well to unwind and discard the extra unnecessary turns. By doing this you have increased both the selectivity and also the loudness of your set.

In this illustration Taps No. 1, 2 and 3 were not used either, but of course, the wire to which they are connected cannot be discarded as it is in circuit, since the electricity flows through it before getting to taps 4 to 7. The presence of these switch points, while useless, is not detrimental.

Some Live Problems in Radio

Static Hardly Bothers the Commercial Station Now

By E. F. W. ALEXANDERSON, Consulting Engineer General Electric Co.

THE real romance in research lies in the early stages. When long distance radio was first put to important use, during the war period, many thrilling episodes occurred.

One of these took place in a station that had been hastily reconstructed and forced into the service of maintaining communication with France while we were yet building and experimenting in radio. Originally the station had been of the Marconi type, but had become obsolete, and its reconstruction consisted in setting up a high-frequency alternator and building a primitive transmitting plant around it. Trouble soon developed in the antenna insulation. Often an insulator would blow up with an explosion, but sometimes it would give a warning by a flickering light.

Spy is Discovered

The station was strongly guarded by marines who were quick on the trigger, and one dark night the guard saw a flickering light in one of the wooden shacks which was used to house the outdoor tuning coils. He thought it was an enemy spy and would not take any chances, so he peppered the shack with his automatic rifle. After a little while the insulator exploded and the station went dead. This gave the marine convincing proof that somebody had planted a bomb.

Firearms played no part, however, in the final solution to this problem of insulator breakdown. It was technical knowledge acquired by scientific investigation that furnished the means of eliminating the trouble. This is but one such incident.

Not Many Precedents Here

The development of commercial radio in all its phases has afforded an unusual opportunity for the application of scientific engineering methods. In most other branches of engineering there are many previous cases to help the engineer in his choice of methods. In radio communication there were but few such precedents; practically every problem was a new one and had to be solved by new means. In addition to this element of newness, there was the additional complication of having to deal with forces of Nature which are not under control and therefore subject to the law of chance. At the outset these laws of Nature were very little understood and all of them are not yet entirely known. For instance, what are the causes of fading and exceptional increase of signal strength, or periodic fluctuation of signals? It can only be stated that these phenomena are observed to have something to do with the change from daylight to darkness and that they are more pronounced at the shorter wavelengths.

That great enemy of radio communication, atmospheric disturbance, or static, is by this time pretty well understood and under control. It is really this fact that makes commercial radio communication at all possible.

Making a Business of Code

To bring about order and reliability in sending signals, we must take into account the effect of probability and averages. This can be readily understood by radio amateurs or broadcast listeners. When we receive clear signals from across the continent, we tell the world about it. Similarly, when the sportsman catches a big trout, he tells his friends of it as an event. But, professional fishermen succeed in furnishing fish for the market *every* day. Thus it is the aim of the radio engineer to explore the sea of the ether, to weather its storms, and to provide continuous service day and night.

The transoceanic radio station is a power station. Its input is kilowatts and its output is words. The problem of radio engineering is to fix the relation between these two. This relation between kilowatts and words is a chain comprising four separate links which are being studied by specialists in the following subjects:

(1) Efficiency and cost of sending.
(2) Wave transmission and fading.
(3) Static.
(4) Speed of sending messages.

Efficiency and Cost of Radiation

The first subject deals with the radio power station and the aerial. Four types of antennas are used in the system of the Radio Corporation of America. Three of these are adaptations of old structures, but the fourth, the Radio Central antenna on Long Island, is designed from the ground up.

Figure 1 shows two different styles of aerial. The difference depends entirely where the lead-in is attached. If it comes from the ends of the wire, as shown at L, then from the similarity with the letter, it is called an "L" type

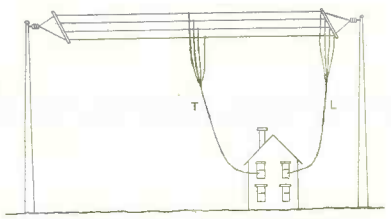


Fig. 1. L and T Aerials

aerial. But if the lead-in comes from the centre, then it makes a "T" antenna. Of course, both lead-ins should never be used together, as shown in the diagram. Either L or T must be omitted. Figure 2 shows another well-known type of construction. It is called the umbrella. Only one pole is needed, and from its top the various aerial wires radiate out in all directions. From four to ten of these may be used. Part way down an insulator is inserted and below this the wire acts only as a guy. Figure 3 shows the Beverage antenna, which will be described in greater detail a little later.

The radiation efficiency of an aerial depends upon the effective height, the ground resistance and the wavelength. In antennas for long waves most of the energy is absorbed locally and only a small proportion is radiated.

The object of modern aerial design has been to get the biggest radiation for a given antenna cost, as well as the biggest for the power consumed. These two requirements are opposed to each other, and, as usual in design, a compromise must be arrived at. A high radiation efficiency can be had only by the use of a very expensive antenna. There is a third requirement that the operating voltage must be kept within practical limits. The best compromise between these needs has been obtained in the long multiple tuned Beverage antenna with moderately high towers operated at high potential. The Radio Central antenna has twelve ground connections distributed over a distance of three miles, and has 300 miles of wire buried in the ground. Through these devices the

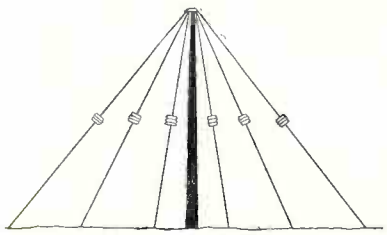


Fig. 2. Umbrella Aerial

ground resistance has been reduced to 1/20 ohm. Antennas of types previously used had ground resistances of about 2 ohms. The losses in the ground have thus been reduced to less than 3 per cent.

The practical measure of the power of a transmitting station is not the energy radiated, but the product of the amperes in the aerial, and its effective height. This unit of radiation is called the meter-ampere.

Tremendous Power

If we have an aerial 60 feet high (equivalent of about 20 meters) and the ammeter in the line reads 10 amperes, then the radiation will be 20 x 10 or 200 meter-amperes. The radiating power used in a typical transoceanic telegraph station is about 50,000 meter-amperes, whereas a representative broadcasting or ship station has the power of only a few hundred meter-amperes. The distance that can be covered under normal daylight conditions by a transmitting station is about proportional to the number of meter-amperes used, provided that a wavelength has been selected which is suitable for communication over such a distance.

Wave Transmission

The second subject is wave propagation. The longer the wavelength the greater is the cost of antenna structure and the lower is the radiation efficiency. From this point of view, it would seem that long waves would be undesirable. If sending were limited to the hours of darkness, this would be true, but in commercial communication the daylight hours are the most important, and during those hours the absorption of the short waves is so great that better and more economical communication is obtained by the long waves. For each distance there is a certain wavelength which gives the best compromise between absorption and radiation efficiency.

One Cause of Fading

The absorption of short waves is high over dry sandy ground. It is also found that irregular land and water break up short waves into several paths which meet again in such a way that the oscillations combine. The waves will thus unite sometimes in phase (in step) and cause an increase of signal strength, and sometimes out of phase thus causing periodic fading of the signal. Practical experience can be summed up in the rule that the most economical wavelengths for reliable daytime communication over any distance is about 1/500 of the distance. It is about 3,000 miles from New York to Europe. As there are around 1,600 meters to the mile, this makes the distance 4,800,000 meters across the water. Dividing this by 500 as just described, we get the answer of about 10,000 meters for the best wave length for talking to Europe. This is one of the most popular frequencies in use to-day for this service.

Atmospheric Disturbances "Static"

The third subject deals with the atmospheric disturbances. Our modern receiving systems eliminate about nine-tenths of the static, but the balance left determines the speed of receiving the message.

We now know enough about these subjects to enable new radio circuits to be calculated with the same ease as we design a motor. The engineer starts at the receiving end and gathers his facts and reasons backward in order to determine what power, wavelength, etc., the transmitting station must have to serve the purpose most economically.

This can best be illustrated by an example. The first step in planning a new station is to make measurements of static at the places where the signals are to be received. These measurements should extend throughout the season of the year when conditions are worst.

All disturbances were originally called "static," because they were thought to be like static electricity. The idea which is the basis of modern work is different, however. The ether is imagined to be a disturbed ocean with waves of every length rolling in from all directions. These waves are of the same nature as the signal wave. The disturbing waves, which are of *different* length from our signals, can be shut out in the same way that is used for cutting out other signals, that is, by tuning. But disturbing waves which have the *same* length as our signal are just like it in every way, and so pass through the tuning system like the signal.

Elimination of "Static"

This shows that some additional way must be found if we want to get rid of the static which happens to be the same wave length as the station we are listening to.

If a radio set is built to be sensitive to waves coming from only one direction, then static from any other point can be shut out even if it does have the same wavelength. This is the principle of directional reception, on which the receiving stations of the Radio Corporation are based.

Each improvement in the direction effect of the receiving system has helped speed up traffic. The development of the

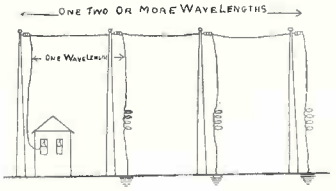


Fig. 3. The Beverage Invention

receiver at Riverhead, Long Island, has already reached the point where messages from Europe are received on an aerial 30 miles long and signals from South America on another antenna 20 miles long. The aerial consists of two telegraph wires mounted on wooden poles.

The Wave Antenna

The basis of this system is the so-called "wave antenna" invented by Beverage. In its simplest form it consists

of a single wire, one wavelength long, mounted on telegraph poles or even laid on the ground. This antenna is sensitive to waves from only one direction. The radio wave coming in from the ether starts a vibration in the end of the wire and travels along this conductor with the velocity of light. In the meantime, energy is continuously added to the wave in the wire from the ether oscillation which travels alongside it, so that the wave in the wire keeps building up and so is strongest at the far end of the conductor, where the receiving set is located.

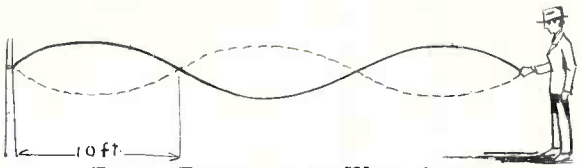


Fig. 4. Theory of the Wave Antenna

As actually constructed, the aerial is several wave lengths long. The one shown in Figure 3 equals three waves. Notice that the aerial has a ground connection through a coil spaced each wave length apart. The coil is adjusted by experiment, so that instead of oscillating as a whole, the antenna is broken up into several vibrating sections. This is like the clothes line experiment, which has been mentioned before. Figure 4 shows a clothes line 30 feet long, which is vibrating in three ten-foot sections. It will be easily appreciated that there will be a lot more energy in this line, than there would in only a single ten-foot length, but the speed of oscillation, that is the wave length, is the same in either case.

Won't Work for Broadcasting

Another advantage of this type of construction is that by having several grounds in parallel, the resistance is reduced considerably below that of a single ground. Of course, such an aerial will not work for broadcasting. It has to be tuned to receive only a particular wave length from one certain direction. As an illustration, if you wanted to hear KDKA only, then you could build such an antenna and the volume of tone would be deafening, but you could not get another station at all. This is no objection when considering a trans-Atlantic station, which is built to work with only one other place in Europe.

Selection of Receiving Site

Static usually comes from the land side and so if the signal comes from the ocean we can design the receiving system so that it reduces the static, but not the signal.

An interesting case was found which shows this action clearly. It was desired to send a message from A to B (Figure 5). But unfortunately, powerful static was flowing towards B from the same point. It would have been impossible to keep up communication on bad days. This was overcome by building Station C off to the side as shown. A could send to C without any trouble, because it lay outside the static belt, and C could relay the message on to B because it was nearly right angles to the direction of the static flow, and so the Beverage antenna would pick up the signal along the line in which it pointed, but did not bring in any static.

Two lines of favorable direction were thus substituted for the one less favorable; just like a sailboat which requires two tacks to arrive at a point straight to the windward. This is a very unusual case, but it shows that a practical solution can be found even under most unfavorable circumstances.

Speed of Commercial Signalling

The fourth subject deals with the speed of reception. It has been found in wireless that the quickest signalling speed depends on the relative loudness of the signal and the static. Here is the reason:

The shortest part of a code letter is a dot. The letter D, for instance, is made up of a dash followed by two dots, like this, —.. and of course the faster the speed the shorter must be the dot. So if the loudness is kept constant, then the total energy in the dot sign must be inversely proportional to the speed.

If a dot lasts for say one-fifth of a second, it has used up a certain amount of energy, but if we let it run for only a tenth of a second, obviously there will be one-half as much energy as before. When the strongest "bang" of static at any time contains as much energy as a dot in the telegraphic code, it may be mistaken for a dot, or it may break up a dash into two dots, thus signaling the wrong letter. So it is necessary to send code slowly enough so that the total energy of a dot is somewhat greater than the maximum energy of a single atmospheric impulse. Thus if the wave amplitude (or loudness) is doubled, the length of the dot may be shortened to one-half. This explains why in practice the sending speed is proportional to the power and also why it is inversely proportional to the atmospheric disturbance.

Measurement of Signal and Static

It can thus be seen that in developing new stations we must have accurate data on the intensity of the static. Methods have been developed for measuring signal strength as well as atmospheric disturbances. The unit of measurement is microvolts per meter. The meaning of this term is "millionth parts of a volt per meter effective height of the receiving antenna."

For instance, suppose we have an aerial thirty feet effective height. This is the equivalent of ten meters. When we measure the signal strength, we find

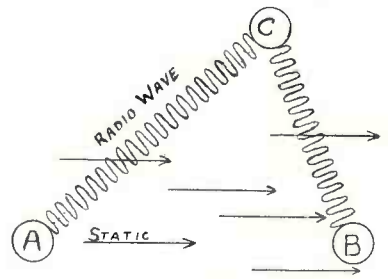


Fig. 5. Outwitting the Static

the pressure is 1,000 microvolts, then the strength of the signal coming in was 1,000 divided by 10, which equals 100 microvolts per meter. If the aerial had been twenty meters high the reading would have been twice as great, or two thousand. Dividing 2,000 by 20 gives us 100 again, which is, of course, correct, as the strength of the signal coming through the air does not depend on what kind of aerial it will strike shortly. Static strength is measured in the same way.

Measuring instruments have been developed by which charts can be made to show by curves the intensity of the sta-

tic in all directions. Such charts are made for every hour of the day.

One of these charts is shown in Figure 6. This tells us that most of the static is coming in from the North, as the distance from zero in the center out to the point P is large. To the East and West the static is not so bad, but the best direction of all is toward the South, where it will be seen that only a little disturbance is shown. In other directions, like the northeast for instance, it is possible to find how strong the static comes in by drawing the line in that direction. Q shows such a line to the northeast and from it we see that only a moderate disturbance would bother us from there. If the diagrams throughout the year resemble the one shown in Figure 6, it proves that the best way of setting up an aerial would be to have it run north and south, with the free end to the south.

Static Charts

Examination of these charts will show what portions of the static can be eliminated by directional reception and what the intensity will be of the static which cannot be eliminated. Assume that this investigation shows that the total static for the afternoon hours of the summer is 500 microvolts per meter. Reception under such conditions without the directional receiving system would be totally impossible. Suppose, however, that the polar charts show that only 10 per cent. of the static falls within the quadrant from which the signals are to be received. The portion of the static which cannot be eliminated has then a strength of 50 microvolts per meter (10% of 500). A transmitting station that can give a signal of 50 microvolts per meter could then be expected to handle traffic at a rate of 20 words per minute during the worst hours of the day and at a higher rate during the remaining hours. If this is not fast enough to handle the expected volume of traffic, it may be decided to use a signal intensity of 100 microvolts per meter. This would speed up receiving to a rate of 40 words per minute during the worst hours.

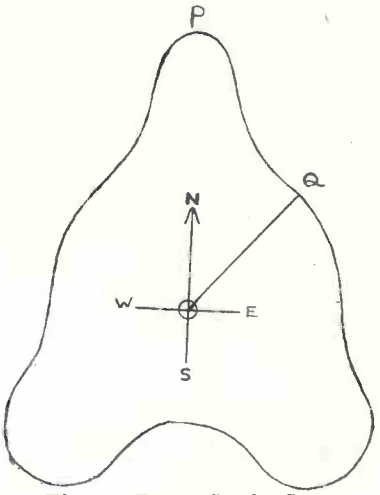


Fig. 6. Polar Static Curve

Prediction of Traffic Capacity

Information is now available on transmission efficiency, from which it can be predicted what radiating power is needed in the transmitting station in order to give the desired signal strength at the receiving station. Assume that a signal of 100 microvolts per meter requires a transmitting station of 50,000 meter-amperes. This would be a station of the size used in transatlantic service. On the other hand, suppose that no attempts were made to reduce static interference by directional reception and that it was expected to receive a message by increasing the signal strength. This would require a strength ten times as great, which would mean a radiated energy one hundred times as great. Such a use of brute force would not be practical nor economically possible. These figures are right for most cases of talking to Europe.

Talk Round the World

There is now a chain of American-built stations around the earth which are either in operation or in construction. When the chain is completed, it will be possible to link them together, and send a signal which will automatically be relayed from station to station and circle the earth with the velocity of light. If it is sent from New York, it can be relayed over San Francisco, Honolulu, Shanghai, Sweden or Poland, and back to New York. It would arrive one-seventh of a second later than the time it started.

The fact that radio telegraphy has now definitely attained the commercial stage does not mean that the end of its development has been reached. By the continued application of scientific engineering principles to the solution of its problems, as they arise, radio telegraph service will grow to fill a greatly extended field of utility. But this is not all. The knowledge which has been gained in making radio telegraphy dependable is now available for application to broadcasting. There is reason to believe that the same principles will go a long way toward eliminating the uncertainty that to-day attends the daily reception, over long distances.

RADIO PROGRESS
8 Temple St. (P. O. Box 728)
Providence, R. I.

Date.....

You may enter my subscription to RADIO PROGRESS

for .....year { 1 year $3.00 / 2 years $5.50 }

Signature.....

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HURRAH FOR THE FOURTH

As you have noticed, we are very patriotic in this issue, and have the covers dressed in Red, White and Blue. The next thing to decide is how to celebrate the big day. The general talk now is to make the Fourth "Safe and Sane." But when you spring this idea on the boys, they do not take to it very kindly. How can a compromise be effected between the older folks, who frown on giant firecrackers, and the younger ones, who must have some excitement?

Radio Reconciles Them

This is where radio comes in. We venture to predict that there is not a boy or girl in the country who would not prefer to have a radio set rather than a lot of firecrackers. When you realize that a good crystal set, together with phones, can be bought for around five or six dollars, it is hard to turn the youngsters down on the question of economy. Of course, this suggestion will not apply to families who live more than 15 or 20 miles from a good sized broadcasting station, for that is about the limit which any ordinary crystal set will pick up. The occasional reports of 500 and 1,000 miles are either made by unreliable persons, or else the program was received on the crystal as re-radiated from some nearby user of a high-powered vacuum tube radio.

So You Can Hear, Too

There is one further great advantage about giving the boys a radio set. It is something like presenting your son with a train of cars at Christmas time—that is, he will probably complain because he does not get much of a chance to play with it himself. For this reason, it is perhaps best to suggest two or three pairs of phones.

DISCUSSING DISTORTION

We might almost have said, "Disgusting distortion," as next to the squeals from your neighbors' oscillating sets this is probably the worst feature of radio at present. Some people use this word without a clear understanding of just what is meant. Suppose you are listening to a concert from a distant station and it gets weaker and weaker until you can hardly hear it. That isn't distortion. That's fading. Or perhaps in the middle of a song you hear a terrible squeal. That is your neighbor's set being improperly operated. Or, again, some one starts putting in a load of coal near by. That is static.

Turn Down Tickler

But when you hear a station pretty well,—a man talking loud enough to be heard easily, but his words are very difficult to grasp so that you have to put your whole mind on it before you can catch what he is saying,—then that is distortion. It may come from any one of three places. Perhaps it is in the set. If so, there may be several reasons; a tickler coil turned up too far will cause it. So will a tube which is improperly adjusted. Poor audio transformers are also a source of such trouble.

Another place where this undesirable feature occurs is in the loud speaker. Sometimes a set will operate very nicely using ear phones, but when a loud speaker is plugged in, the orator seems to be talking with his mouth full of mush. In such a case we naturally blame the horn. There has been considerable improvement in the last year or so in the matter of proper designs of this unit. The modern loud speakers are a great improvement over those of a year or two ago.

Blame the Station

The third place to look for the distortion is in the broadcasting itself. When the sending station has its pick-up, (the microphone where the artist sings), connected by a *short* line to the sending apparatus and the aerial, then no trouble is experienced. But if, as is occurring more and more frequently, the performance is given in one city and it is connected by long distance telephone to the broadcasting studio, 50 to several hundred miles away, then serious distortion may be introduced by the characteristic of the toll line itself.

Why the R's

A wire line is quite different from the ether in this respect. The latter is entirely non-selective in its effect on sounds. The letter S and the letter T, for instance, are both reduced in loudness by the same proportion as they are transmitted through the air. But, unfortunately, this is not true of a wire telephone line. When talking over the long distance the sounds of some letters will be reduced to half, while others will be almost entirely suppressed. As an example, the sound of R does not carry through very well. This is why telephone operators when repeating the number you have

Continued on Page 30

Rx DR RADIO PRESCRIBES.

NOTE: In this section the Technical Editor will answer questions of general interest on any radio matters. Any of our readers may ask not more than two questions, and if the subjects are of importance to most radio fans they will be answered free of charge in the magazine. If they are of special interest to the questioner alone, or if a personal answer is desired, a charge of fifty cents will be made for each answer. This will entitle the questioner to a personal answer by letter. However, if the question requires considerable experimental or development work, higher rates will be charged, which may be obtained upon application.

Question. Why does the music stutter when the tap switch is moved slightly?

Answer. This shows that there is too much looseness in the tap switch, and for this reason a poor contact is made between the switch point and the switch arm. This trouble occurs fairly frequently in the average set. The remedy is simple. Take off the rotating arm and bend the spring toward the contacts. When the arm is now replaced the tension between it and the contact points will be considerably greater than before, and so the current will have no difficulty in flowing across the break. If the adjustment is properly made, then no sound will be heard in the receiver as the switch handle is oscillated back and forth a small amount.

Question. What is the best way of finding out whether a trouble is inside or outside the set?

Answer. It is a rather difficult matter to be sure in which of these places the trouble lies if reception is only fair. Of course, if *nothing* is heard it always indicates that the set is out of order, for even a poor aerial and ground will bring in some local music. The best way of testing out the equipment in case local stations are heard, but no distance, is to borrow the aerial and ground of some friend whose outfit is working well. The doubtful set may be transported as a whole with "A" and "B" batteries, unless it is known by a meter test that the batteries are in first class shape. If this is the case, then the neighbor's batteries may be borrowed for temporary use to save transporting this extra weight. Connect your radio to your friend's aerial and ground. If now the distant stations come in well it shows that your aerial or ground is at fault, but if reception is not any better on his aerial, which is already known to be good, then the difficulty must lie in your set itself.

Question. What kind of rheostat is used in Crosley sets?

Answer. This is a rather special rheostat, which is designed for use with all the different kinds of vacuum tubes. An ordinary 6-ohm rheostat is satisfactory for WD-11, WD-12 and UV-200, but has not high enough resistance for a 199 or 201A. A rheostat should have a resistance of about 20 ohms to work these latter tubes. It might be asked why a 20-ohm rheostat wouldn't work with a UV-200. There are two reasons. In the first place this takes one ampere for the filament current, and that is too much to run through a 20-ohm rheostat without overheating it. Even if the rheostat handle is turned so that the amount of resistance in the circuit is only one or two ohms, the condition will not be helped. These high resistance units are wound with fine wire and running one ampere through such a small diameter causes too much heat.

A second objection is the fact that a twenty-ohm resistance does not have nearly as sensitive control as when used with a UV-200 tube. That is, a very small movement of the handle causes too big a change in the brightness of the filament. Crosley gets around this trouble by building half the resistance of coarse wire and the other half of fine. When a 200 tube is used, only the coarse wire is in circuit, and so the control is accurate and there is no overheating. When a 201A is substituted, the control handle is turned around to the left to include some of the fine wire in series with the coarse. This is sufficient to bring the total resistance up to 15 or 20 ohms as desired.

Question. Will a vernier condenser increase the selectivity of my set?

Answer. No, a vernier condenser does not increase the selectivity or volume of a radio. It is intended to do only one thing, and that is to make it easier to adjust for any given wave length. Once adjusted, the station is no louder or clearer.

DISCUSSING DISTORTION

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called will often say "thrrrrrree," thrilling the R to make sure that you hear it.

Of course, the telephone companies have been working on this problem for a long time, and they have some long distance lines which by careful design have been made pretty nearly distortionless. Many of their wires are not fixed in this way. This accounts for the fact that with the same set and loud speaker you will sometimes get a speech through very clearly when relayed from a distant city, and at other times the enunciation will be very poor. This is noticed more with speech than with music, since we know what the words ought to sound like, while distorted music may be the fault of the artist.

UNITED STATES BROADCASTING STATIONS ARRANGED ALPHABETICALLY BY CALL LETTERS

Abbreviations: W.L. wave length in meters; K.C., frequencies in kilocycles; W.P., watt power of station.

		W.L.	K.C.	W.P.
KDKA	Westinghouse Elec. & Mfg. Co., East Pittsburgh	326-	920-1000	
KDPM	Westinghouse Elec. & Mfg. Co., Cleveland, O	270-	1110-	250
KDPT	Southern Electrical Co., San Diego, Cal	244-	1230-	100
KDYL	Salt Lake Telegram, Salt Lake City, Utah	360-	833-	100
KDYM	Savoy Theatre, San Diego, Cal	280-	1070-	100
KDYQ	Oregon Institute of Technology, Portland, Ore	360-	833-	100
KDYX	Star Bulletin, Honolulu, Hawaii	360-	833-	100
KDZB	Frank E. Siefert, Bakersfield, Cal	240-	1250-	100
KDZE	The Rhodes Co., Seattle, Wash	270-	1110-	100
KDZF	Auto. Club of So. Cal., Los Angeles, Cal	278-	1080-	500
KFAD	McArthur Bros. Mercantile Co., Phoenix, Ariz	360-	833-	100
KFAE	State College of Washington, Pullman, Wash	330-	910-	500
KFAF	Western Radio Corp., Denver, Col	360-	833-	500
KFAJ	University of Colorado, Boulder, Col	360-	833-	100
KFAQ	City of San Jose, San Jose, Cal	360-	833-	250
KFAR	Studio Lighting Service Co., Hollywood, Cal	280-	1070-	150
KFAU	In. Sch'l Dist. of Boise City, B'ise H. S., Boise, Id	270-	1110-	150
KFBB	F. A. Buttrey & Co., Havre, Mont	360-	833-	100
KFBK	Kimball-Upson Co., Sacramento, Cal	283-	1060-	100
KFCF	Frank A. Moore, Walla Walla, Wash	360-	833-	100
KFCM	Richmond Radio Shop, Richmond, Cal	360-	833-	100
KFCZ	Omaha Central High School, Omaha, Neb	259-	1160-	100
KFDH	University of Arizona, Tucson, Ariz	360-	833-	150
KFDV	Gilbreth & Stinson, Fayetteville, Ark	360-	833-	200
KFDX	First Baptist Church, Shreveport, La	360-	833-	100
KFDY	*So. Dakota State College, Brookings, So. Dakota	360-	833-	150
KFEL	*Winner Radio Corp., Denver, Col	254-	1180-	100
KFEQ	J. L. Scroggin, Oak, Neb	360-	833-	150
KFEV	Felix Thompson Radio Shop, Casper, Wyo	263-	1140-	250
KFEX	Augsburg Seminary, Minneapolis, Minn	261-	1150-	100
KFEZ	Amer. Society of Mech. Engineers, St. Louis, Mo	360-	833-	250
KFFQ	*Markehoffel Motor Co., Colorado Springs, Col	286-	1050-	100
KFFV	Graceland College, Lamoni, Iowa	360-	833-	100
KFFX	McCray Co., Omaha, Neb	278-	1080-	100
KFFY	Pincus & Murphy, Alexandria, La	275-	1090-	100
KFGC	Louisiana State University, Baton Rouge, La	254-	1180-	100
KFGD	Chickasha Rad. & Elec. Co., Chickasha, Okla	248-	1210-	200
KFGH	*Leland Stanford Jr. Univ., Stanford Univ., Cal	273-	1100-	500
KFGJ	Mo. Natl. Guard, 138th Infantry, St. Louis, Mo.	265-	1130-	100
KFGX	First Presbyterian Church, Orange, Tex	250-	1200-	500
KFGZ	Emmanuel Missionary Col., Berrien Sprs., Mich.	268-	1120-	250
KFHD	Utz Electric Shop, St. Joseph, Mo	225-	1330-	100
KFHF	Central Christian Church, Shreveport, La	265-	1130-	150
KFHJ	Fallon & Co., Santa Barbara, Cal	360-	833-	100
KFHX	Robert W. Nelson, Hutchinson, Ks	229-	1310-	150
KFI	Earle C. Anthony, Inc., Los Angeles, Cal	469-	640-	500
KFIF	Benson Polytechnic Institute, Portland, Ore	360-	833-	100
KFIX	R. C. of Jesus Christ of L.D. Sts., Ind'p'nd'n'e, Mo.	240-	1250-	250
KFIZ	Daily C'm'nw'lth & O.A.Heulsm'n, Fond d'L'c,Wis.	273-	1100-	100
KFJC	Seattle Post Intelligencer, Seattle, Wash	270-	1110-	100
KFJK	Delano Radio and Electric Co., Bristow, Okla	234-	1280-	100
KFJM	University of N. Dakota, Grand Forks, N. Dak	280-	1070-	100
KFKB	Brinkley-Jones Hospital Association, Milford, Ks.	286-	1050-	500
KFKQ	Conway Radio Laboratories, Conway, Ark	250-	1340-	100
KFKX	Westinghouse Elec. & Mfg. Co., Hastings, Neb	341-	880-1000	
KFLR	University of N. Mexico, Albuquerque, N. M	254-	1180-	100
KFLV	Rev. A. T. Frykman, Rockford, Ill	229-	1310-	100
KFMQ	University of Arkansas, Fayetteville, Ark	263-	1140-	100
KFMS	Freimuth Dept. Store, Duluth, Minn	275-	1090-	100
KFMX	Carleton College, Northfield, Minn	283-	1060-	500
KFMZ	Roswell Broadcasting Club, Roswell, N. M	250-	1200-	100
KFNF	Henry Field Seed Co., Shenandoah, Iowa	266-	1130-	500
KFOA	The Rhodes Co., Seattle, Wash	454-	660-	500
KFPT	*The Deseret News, Salt Lake City, Utah	360-	833-	500
KFQB	*Search Light Publishing Co., Fort Worth, Tex	254-	1180-	100
KFQC	*Kidd Brothers Radio Shop, Taft, Cal	227-	1320-	100
KFQD	*Chovin Supply Co., Anchorage, Alaska	280-	1070-	100
KFSG	Echo Park Evangelistic Ass'n, Los Angeles, Cal	234-	1280-	500
KGN	Northwestern Radio Mfg. Co., Portland, Ore	360-	833-	100
KGO	General Electric Co., Oakland, Cal	312-	960-1000	
KGU	Marion A. Mulreny, Honolulu, Hawaii	360-	833-	250
KGW	Portland Morning Oregonian, Portland, Ore	492-	610-	500
KHJ	Times-Mirror Co., Los Angeles, Cal	395-	760-	500
KHQ	Louis Wasmer, Seattle, Wash	360-	833-	100
KJR	Northwest Radio Service Co., Seattle, Wash	270-	1110-	100
KJS	Bible Institute of Los Angeles, Los Angeles, Cal	360-	833-	750
KLS	Warner Brothers, Oakland, Cal	360-	833-	250
KLX	Tribune Publishing Co., Oakland, Cal	508-	590-	500
KLZ	Reynolds Radio Co., Denver, Col	360-	833-	500
KNT	Grays Harbor Radio Co., Aberdeen, Wash	263-	1140-	250
KNV	Radio Supply Co., Los Angeles, Cal	254-	1180-	100
KNX	Electric Lighting Supply Co., Los Angeles, Cal	360-	833-	100
KOB	N. M. C. of Agri. & Mech. Arts, State Col., N. M.	360-	833-	500
KOP	Detroit Police Dept., Detroit, Mich	286-	1050-	500
KPO	Hale Bros., San Francisco, Cal	422-	710-	500
KQV	Doubleday-Hill Electric Co., Pittsburgh, Pa	280-	1070-	500
KSD	Post Dispatch, St. Louis, Mo	545-	550-	500
KTW	First Presbyterian Church, Seattle, Wash	360-	833-	750
KUO	Examiner Printing Co., San Francisco, Cal	360-	833-	150
KUS	City Dye Works & Laundry Co., L. Angeles, Cal	360-	833-	100
KWG	Portable Wireless Tel. Co., Stockton, Cal	360-	833-	100
KWH	Los Angeles Examiner, Los Angeles, Cal	360-	833-	500
KYQ	Electric Shop, Honolulu, Hawaii	288-	1040-	100
KYW	Westinghouse Elec. & Mfg. Co., Chicago, Ill	535-	560-1000	
KZM	Preston D. Allen, Oakland, Cal	360-	833-	100
WAAB	Valdemar Jensen, New Orleans, La	268-	1120-	100
WAAC	Tulane University, New Orleans, La	360-	833-	100
WAAF	Chicago Daily, Drovers Journal, Chicago, Ill	286-	1050-	200
WAAM	I. R. Nelson Co., Newark, N. J	263-	1140-	250
WAAW	Omaha Grain Exchange, Omaha, Neb	360-	833-	500
WAAZ	Hollister-Miller Motor Co., Emporia, Ks	360-	833-	100
WABA	Lake Forest College, Lake Forest, Ill	265-	1130-	100
WABE	Young Men's Christian Assn., Washington, D. C.	283-	1060-	100
WABI	Bangor Ry. & Elec. Co., Bangor, Me	240-	1250-	100
WABL	Conn. Agri. College, Storrs, Conn	283-	1060-	100
WABM	F. E. Doherty Auto. & R'dio E. Co., Saginaw, M.	254-	1180-	100
WABN	Ott Radio, Inc., La Crosse, Wis	244-	1230-	250
WABP	Robert F. Weinig, Dover, Ohio	265-	1130-	100
WABT	Holliday-Hall, Washington, Pa	252-	1190-	100
WABU	Victor Talking Machine Co., Camden, N. J	225-	1330-	100
WABX	Henry B. Joy, Mount Clemens, Mich	270-	1110-	150
WBAA	Purdue University, West Lafayette, Ind	360-	833-	250
WBAD	Sterling Electric Co., Minneapolis, Minn	360-	833-	100
WBAH	The Dayton Co., Minneapolis, Minn	416-	720-	500
WBAK	Penn. State Dept. of Police, Harrisburg, Pa	400-	750-	500
WBAN	Wireless Phone Corp., Paterson, N. J	244-	1230-	100
WBAP	Wortham-Carter Pub. Co., Fort Worth, Tex	476-	630-	750
WBAV	Erner & Hopkins Co., Columbus, Ohio	389-	770-	500
WBAW	Marietta College, Marietta, Ohio	246-	1220-	250
WBAY	American Tel. & Tel. Co., New York, N. Y.	492-	610-	500
WBBF	Georgia School of Technology, Atlanta, Ga	270-	1110-	500
WBBG	*Irving Vermilya, Mattapoisett, Mass	248-	1210-	500
WBBM	Frank Atlass Produce Co., Lincoln, Ill	255-	1330-	200
WBBO	Michigan Limestone & Chem. Co., Rodgers, Mich.	250-	1200-	500
WBBQ	Frank Crook, Pawtucket, R. I	252-	1190-	100
WBBR	*Peoples' Pulpit Ass'n, Rossville, N. Y	273-	1100-	500
WBR	Penn State Police, Butler, Pa	286-	1050-	250
WBT	Southern Radio Corp., Charlotte, N. C	360-	833-	500
WBU	City of Chicago, Chicago, Ill	286-	1050-	500
WBZ	Westinghouse Elec. & Mfg. Co., Springfield, Mass.	337-	890-1000	
WCAD	St. Lawrence University, Canton, N. Y	280-	1070-	250
WCAE	Kaufmann & Baer Co., Pittsburgh, Pa	461-	650-	500
WCAH	Entrekin Electric Co., Columbus, O	286-	1050-	100
WCAJ	Nebraska Wesleyan Univ., Univ. Place, Neb	360-	833-	500
WCAL	St. Olaf College, Northfield, Minn	360-	833-	500
WCAM	Villanova College, Villanova, Pa	360-	833-	150
WCAP	Chesapeake & Potomac Tel. Co., Wash'gt'n, D. C.	469-	640-	500
WCAR	Alamo Radio Elec. Co., San Antonio, Texas	360-	833-	100
WCAS	W. H. Dunwoody Ind. Inst., Minneapolis, Minn.	246-	1220-	100
WCAT	S. Dakota State Sch. of Mines, Rapid City, S. D.	240-	1250-	100
WCAU	*Durham & Co., Philadelphia, Pa	286-	1050-	250
WCAY	Kesselman-O'Driscoll Co., Milwaukee, Wis	261-	1150-	250
WCBC	Univ. of Michigan, Ann Arbor, Mich	280-	1070-	200
WCBD	Wilbur G. Voliva, Zion, Ill	345-	870-	500
WCK	Stix, Baer & Fuller Dry Goods Co., St. Louis, Mo.	360-	833-	100
WCM	University of Texas, Austin, Tex	360-	833-	500
WCX	Detroit Free Press, Detroit, Mich	517-	580-	500
WDAE	Tampa Daily Times, Tampa, Fla	360-	833-	250
WDAF	Kansas City Star, Kansas City, Mo	411-	730-	500
WDAG	J. Laurance Martin, Amarillo, Tex	263-	1140-	100
WDAH	Trinity Methodist Church, El Paso, Texas	268-	1120-	100
WDAK	The Courant, Hartford, Conn	261-	1150-	100
WDAP	*Drake Hotel (Whitestone Co.), Chicago, Ill	360-	833-1000	
WDAR	Lit Brothers, Philadelphia, Pa	395-	760-	500
WDAU	Slocum & Kilburn, New Bedford, Mass	360-	833-	100
WDAX	First National Bank, Centerville, Iowa	360-	833-	100
WDBH	*Worcester, Mass	268-	1120-	100
WDBK	*M. F. Bros. F., H. & Radio Co., Cleveland, O	248-	1210-	100
WDBR	*Tremont Temple Baptist Church, Boston, Mass.	256-	1170-	100
WEAF	American Tel. & Tel. Co., New York, N. Y	492-	610-	500
WEAH	Wichita Board of Trade, Wichita, Kas	280-	1070-	100
WEAI	Cornell University, Ithaca, N. Y	286-	1050-	500
WEAJ	University of S. Dakota, Vermillion, S. Dak	283-	1060-	200
WEAM	*Borough of N. Plainfield, N. Plainfield, N. J	286-	1050-	150
WEAN	Shepard Co., Providence, R. I	273-	1100-	100
WEAO	Ohio State University, Columbus, Ohio	360-	833-	500
WEAP	Mobile Radio Co., Mobile, Ala	360-	833-	100
WEAS	Hecht Co., Washington, D. C	360-	833-	100
WEAU	Davidson Bros. Co., Sioux City, Iowa	360-	833-	100
WEAY	Iris Theatre, Houston, Texas	360-	833-	500
WEB	*Benwood Co., St. Louis, Mo	273-	1100-	500
WEBH	*Edgewood Beach Hotel Co., Chicago, Ill			
WEV	Hurlburt-Still Electric Co., Houston, Texas	360-	833-	100
WEW	*St. Louis University, St. Louis, Mo	280-	1070-	100
WFAA	Dallas News & Dallas Journal, Dallas, Tex	476-	630-	500
WFAB	Carl F. Woese, Syracuse, N. Y	234-	1280-	100
WFAH	Electric Supply Co., Port Arthur, Tex	236-	1270-	150
WFAN	Hutchinson Elec. Service Co., Hutchinson, Minn.	360-	833-	100
WFAV	Univ. of Nebraska, Dept. of E. Eng., Lincoln, Neb.	275-	1090-	500
WFBW	*Ainsworth-Gates Radio Co., Cincinnati, Ohio	309-	970-	750
WFI	Strawbridge & Clothier, Philadelphia, Pa	395-	760-	500
WGAQ	Glenwood Radio Corp., Shreveport, La	360-	833-	100
WGAW	Ernest C. Albright, Altoona, Pa	261-	1150-	100
WGAY	Northwestern Radio Co., Madison, Wis	360-	833-	100
WGAZ	South Bend Tribune, South Bend, Ind	360-	833-	250
WGI	Am. R'dio & Res'ch Corp., Medf'd Hillside, Mass.	360-	833-	100
WGL	Thomas F. J. Rowlett, Philadelphia, Pa	360-	833-	250

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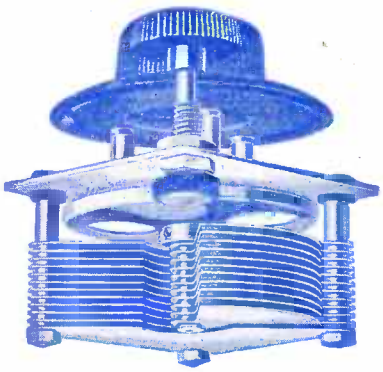
WGY	General Electric Co., Schenectady, N. Y.	380-	790-	1000
WHA	University of Wisconsin. Madison, Wis.	360-	833-	500
WHAA	State University of Iowa. Iowa City, Iowa	484-	620-	500
WHAB	Clark W. Thompson, Galveston, Tex.	360-	833-	200
WHAD	Marquette University, Milwaukee, Wis.	280-	1070-	100
WHAG	University of Cincinnati, Ohio.	222-	1350-	200
WHAH	Rafer Supply Co., Joplin, Mo.	283-	1060-	250
WHAM	University of Rochester, Rochester, N. Y.	283-	1060-	100
WHAS	Courier-Journal & Louisville Times, Louisville, Ky.	400-	750-	500
WHAZ	Rensselaer Polytechnic Institute, Troy, N. Y.	380-	790-	500
WHB	Sweeney School Co., Kansas City, Mo.	411-	730-	500
WHK	Radiovex Co., Cleveland, Ohio.	283-	1060-	100
WHN	George Schubel, New York, N. Y.	360-	833-	100
WHO	*Des Moines, Ia.	526-	570-	500
WIAC	Galveston Tribune, Galveston, Tex.	360-	833-	100
WIAD	Howard R. Miller, Philadelphia, Pa.	254-	1180-	100
WIAJ	Fox River Valley Radio Supply Co., Neenah, Wis.	224-	1340-	100
WIAK	*Journal-Stockman Co., Omaha, Neb.	278-	1080-	250
WIAO	*School of Eng. of Milwaukee, Milwaukee, Wis.	246-	1220-	100
WIAR	Paducah Evening Sun, Paducah, Ky.	360-	833-	100
WIAS	Home Electric Co., Burlington, Iowa.	360-	833-	100
WIK	K. & L. Electric Co., McKeesport, Pa.	234-	1280-	100
WIP	Gimbel Brothers, Philadelphia, Pa.	508-	590-	500
WJAB	*American Electric Co., Lincoln, Neb.	229-	1310-	100
WJAD	Jackson's Radio Eng. Laboratories, Waco, Tex.	360-	833-	150
WJAG	Norfolk Daily News, Norfolk, Neb.	283-	1060-	250
WJAN	Peoria Star, Peoria, Ill.	280-	1070-	100
WJAQ	Capper Publications, Topeka, Ks.	360-	833-	100
WJAR	The Outlet Co., Providence, R. I.	360-	833-	500
WJAS	Pittsburgh Radio Supply House, Pittsburgh, Pa.	250-	1200-	500
WJAX	Union Trust Co., Cleveland, Ohio.	390-	770-	500
WJH	Wm. P. Boyer Co., Washington, D. C.	273-	1100-	100
WJX	Deforest Radio Tel. & Tel. Co., N. Y., N. Y.	360-	833-	500
WJY	R. C. A., New York, N. Y.	405-	740-	500
WJZ	Broadcast Central, New York, N. Y.	454-	660-	500
WKAA	H. F. Paar, Cedar Rapids, Iowa.	268-	1120-	100
WKAF	W. S. Radio Supply Co., Wichita Falls, Tex.	360-	833-	100
WKAP	Dutee W. Flint, Cranston, R. I.	360-	833-	250
WKAQ	Radio Corp. of Porto Rico, San Juan, P. R.	360-	833-	500
WKAR	Michigan Agr. College, E. Lansing, Mich.	280-	1070-	500
WKBF	*D. W. Flint, Providence, R. I.	286-	-	500
WKY	*WKY Radio Shop. Oklahoma, Okla.	360-	833-	100
WLAG	Cutting & Wash. Radio Corp., Minneapolis, Minn.	416-	720-	500
WLAH	Samuel Woodworth, Syracuse, N. Y.	234-	1280-	100
WLAJ	Waco Electrical Supply Co., Waco, Tex.	360-	833-	150
WLAK	Vermont Farm Machine Corp., Bellows Falls, Vt.	360-	833-	500
WLAL	Naylor Electrical Co., Tulsa. Okla.	360-	833-	100
WLAN	Putnam Hardware Co., Houlton, Me.	283-	1060-	250
WLAW	Police Dept. City of N. Y., New York, N. Y.	360-	833-	500
WLBL	*Wisconsin Dept. of Markets. Stevens Pt., Wis.	278-	1080-	500
WLW	Crosley Mfg. Co., Cincinnati. O.	309-	970-	500
WMAB	Radio Supply Co., Oklahoma, Okla.	360-	833-	100
WMAC	Clive B. Meredith, Cazenovia, N. Y.	261-	1150-	200
WMAF	Round Hills Radio Corp., Dartmouth, Mass.	360-	833-	500
WMAH	General Supply Co., Lincoln, Neb.	254-	1180-	100
WMAJ	Drovers Telegram Co., Kansas City, Mo.	275-	1090-	250
WMAK	*Lockport, N. Y.	273-	1100-	500
WMAQ	Chicago Daily News, Chicago, Ill.	448-	670-	500
WMAT	Paramount Radio Corp., Duluth, Minn.	266-	1130-	250
WMAV	*Alabama Polytechnic Institute, Auburn, Ala.	250-	1200-	500
WMAY	Kingshighway Presbyterian Church, St. Louis, Mo.	280-	1070-	100
WMAZ	*Mercer University, Macon, Ga.	261-	1150-	100
WMC	"Commercial Appeal," Memphis, Tenn.	500-	600-	500
WMU	Doubleday-Hill Elec. Co., Washington, D. C.	261-	1150-	100
WNAC	Shepard Stores, Boston, Mass.	278-	1080-	100
WNAD	University of Oklahoma, Norman, Okla.	360-	833-	100
WNAN	Syracuse Radio Telephone Co., Syracuse, N. Y.	286-	1050-	200
WNAP	Wittenberg College, Springfield, Ohio.	231-	1300-	100
WNAS	Tex. Radio Corp. & Austin Statesman, Austin, Tex.	360-	833-	100
WNAT	Lenning Brothers Co., Philadelphia, Pa.	360-	833-	250
WNAV	People's Tel. & Tel. Co., Knoxville, Tenn.	236-	1270-	500
WNAX	Dakota Radio Apparatus Co., Yankton, S. D.	244-	1230-	100
WOAC	Pagan Organ Co., Lima, Ohio.	265-	1130-	150
WOAG	Apollo Theatre, Belvidere, Ill.	273-	1100-	100
WOAH	Palmetto Radio Corp. Charleston, S. C.	360-	833-	100
WOAI	Southern Equipment Co., San Antonio, Tex.	384-	780-	500
WOAL	William E. Woods, Webster Groves, Mo.	229-	1310-	100
WOAN	Vaughn C'nserv't'ry of Music, Lawrenceb'rg, Tenn.	360-	833-	200
WOAP	Kalamazoo College, Kalamazoo, Mich.	283-	1160-	100
WOAV	Penn. Nat'l Guard, 2d Bat, 112th Inf., Erie, Pa.	242-	1240-	100
WOAW	Woodmen of the World, Omaha, Neb.	526-	570-	500
WOAX	Franklyn J. Wolff. Trenton, N. J.	240-	1250-	500
WOC	Palmer Sch. of Chiropractic, Davenport, Iowa.	484-	620-	500
WOI	Iowa State College, Ames, Iowa.	360-	833-	500
WOK	Pine Bluff Co., Pine Bluff, Ark.	265-	1130-	250
WOO	John Wanamaker, Philadelphia, Pa.	508-	590-	500
WOQ	Western Radio Co., Kansas City, Mo.	360-	833-	500
WOR	L. Bamberger & Co., Newark, N. J.	405-	740-	500
WOS	Mo. State Marketing Bureau, Jefferson City, Mo.	441-	680-	500
WPAB	Pennsylvania State College, State College, Pa.	283-	1060-	500
WPAC	Donaldson Radio Co., Okmulgee, Okla.	360-	333-	200
WPAH	Wisconsin Dept. of Markets, Waupaca, Wis.	360-	833-	500
WPAJ	*New Haven, Conn.	268-	1120-	100
WPAK	North Dakota Agri. Col., Agri. College, N. D.	360-	833-	250
WPAL	*Avery & Loeb Elec. Co., Columbus, Ohio.	286-	1050-	500
WPAM	Auerbach & Geutell, Topeka, Kas.	360-	833-	100
WPAZ	John R. Koch (Dr.), Charleston, W. Va.	273-	1100-	100
WQAA	Horace A. Beale, Jr., Parkesburg, Pa.	360-	833-	500
WQAC	E. B. Gish, Amarillo, Tex.	234-	1280-	100
WQAM	Electrical Equipment Co., Miami, Fla.	283-	1060-	100
WQAN	Scranton Times, Scranton, Pa.	280-	1070-	100
WQAO	Calvary Baptist Church, New York. N. Y.	360-	833-	100
WQAQ	Abilene Daily Reporter, Abilene, Tex.	360-	833-	100
WQAS	Prince-Walter Co., Lowell, Mass.	265-	1130-	100
WQAX	Radio Equipment Co., Peoria, Ill.	360-	833-	100
WOJ	*Calumet Baking Powder Co., Chicago, Ill.	448-	670-	500
WRAA	Rice Institute, Houston, Tex.	360-	833-	200
WRBC	*Immanuel Lutheran Church, Valparaiso, Ind.	278-	1080-	500
WRK	Doren Bros. Electric Co., Hamilton, Ohio.	360-	833-	200
WRAL	No. States Power Co., St. Croix Falls, Wis.	248-	1210-	100
WRAM	Lombard College, Galesburg, Ill.	244-	1230-	250
WRAV	Antioch College, Yellow Springs, Ohio.	242-	1240-	100
WRAX	Flexon's Garage, Gloucester City, N. J.	268-	1120-	100
WRAY	Radio Sales Corp., Scranton, Pa.	280-	1070-	100
WRC	Radio Corp. of America, Washington, D. C.	469-	640-	500
WRK	Doren Bros. Electric Co., Hamilton, Ohio.	360-	833-	200
WRL	Union College. Schenectady, N. Y.	360-	833-	500
WRM	University of Illinois, Urbana, Ill.	360-	833-	500
WRW	Tarrytown Radio Research Lab., Tarrytown, N. Y.	273-	1100-	150
WSAB	S. E. Mo. State T'chers' Col., Cape Girardeau. Mo.	360-	833-	100
WSAC	Clemson Agri. Col., Clemson College, S. C.	360-	833-	500
WSAD	J. A. Foster Co., Providence, R. I.	261-	1150-	150
WSAH	A. G. Leonard, Jr., Chicago, Ill.	248-	1210-	500
WSAI	U. S. Playing Card Co., Cincinnati Ohio.	309-	970-	500
WSAJ	Grove City College. Grove City, Pa.	360-	833-	250
WSAR	*Doughty & Welch Elec. Co., Fall River. Mass.	254-	-	-
WSAP	Seventh Day Adventist Church, New York, N. Y.	263-	1140-	250
WSAV	*Clifford W. Vick Radio Const. Co., Houston, Tex.	360-	833-	100
WSAW	Curtis & McElwee. Canandaigua, N. Y.	275-	1190-	100
WSAX	*Chicago Radio Laboratory, Chicago, Ill.	448-	670-	1000
WSAY	Irving Austin, Port Chester, N. Y.	232-	1290-	100
WSB	Atlanta Journal, Atlanta, Ga.	428-	700-	500
WSL	J. & M. Electric Co., Utica, N. Y.	273-	1100-	100
WSY	Alabama Power Co., Birmingham, Ala.	360-	833-	500
WTAB	*Fall River Daily Herald, Fall River, Mass.	248-	-	-
WTAC	*Johnstown, Pa.	275-	1090-	150
WTAM	The Willard Storage Battery Co., Cleveland, O.	389-	770-	1000
WTAN	Orndorff Radio Shop, Mattoon, Ill.	240-	1250-	100
WTAQ	S. H. Van Gorden & Son, Osseo, Wis.	225-	1330-	100
WTAR	Reliance Electric Co., Norfolk, Va.	280-	1070-	100
WTAS	Charles E. Erbstein, Elgin, Ill., near	286-	1050-	500
WTAT	Edison Electric Illum. Co., Boston, Mass.	246-	1220-	100
WTAW	*College Station, Texas.	280-	1070-	250
WTAY	*Oak Leaves Broadcasting Station, Oak Park, Ill.	283-	1330-	500
WTG	Kansas State Agri. Col., Manhattan Ks.	360-	833-	500
WWAD	Wright & Wright, Inc., Philadelphia, Pa.	360-	833-	500
WWAE	Alamo Dance Hall, Joliet, Ill.	227-	1320-	500
WWAF	Galvin Radio Supply Co., Camden, N. J.	236-	1270-	100
WWAO	Michigan College of Mines, Houghton, Mich.	244-	1230-	250
WWJ	Detroit News. Detroit, Mich.	517-	580-	500
WWL	Loyola University, New Orleans, La.	268-	1120-	100

* Alterations and additions.

For Summertime Radio by Roadside Stream or Rolling Surf—

Here are the makings for as fine a little portable set as you will see anywhere this summer. A set you will show with pride and your friends will listen to with real enjoyment. Furthermore, it can be made really portable, just about camera size. If you can't do the work yourself, let your radio friend do it for you.

A Coto Compact Portable Set is Easily built. Two tubes give Loud Speaker Volume on near Stations. Excellent D. X. on Phones



Superior Audio Amplification for the Coto Portable Set

The writer of this advertisement listened last night to Chauve Souris from Boston via WEAN. Two tubes and Table Talker, fine volume and splendid tone. Never heard better reception on any set. That is the kind of radio this 5 to 1 ratio transformer gives every time.

Type 4000 . . . . . **$5.00**

Volume, Sharp Tuning and Lasting Efficiency

The electrical characteristics of this SILVER PLATED Condenser with Vernier are really remarkable. For the .0005 Mfd. Condenser, maximum capacity is .000540, minimum capacity .0000240, power factor .00063. Even if you do not understand the significance of these figures, the tuning of your Coto set will tell you.

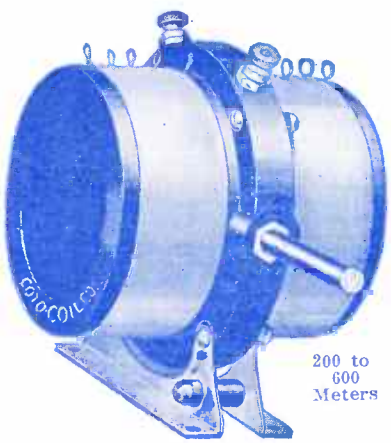
Type 3505 .0005 Mfd..... **$5.00**

Other capacities are .001 Mfd. $6, and .00025 Mfd. $4.50.

And a Real Compact Variocoupler in Polished Brown Bakelite

The compactness of the Coto Air Condenser and this popular variocoupler enables you to build your set on panel 5 x 10 or even 4 x 8 inches. Size of variocoupler is only 3¼ x 3 x 3¾ inches, yet it operates perfectly over the whole broadcasting band of wavelengths. Mounts either on base or panel.

Type 9000. . . . . **$5.50**



200 to 600 Meters

If Your Dealer Fails You, Clip This Special Coupon

Don't attempt to substitute parts if you want best results. Enclose coupon and money order with letter giving dealer's name.

We will ship through him the same day your order is received.

Coto-Coil Co.

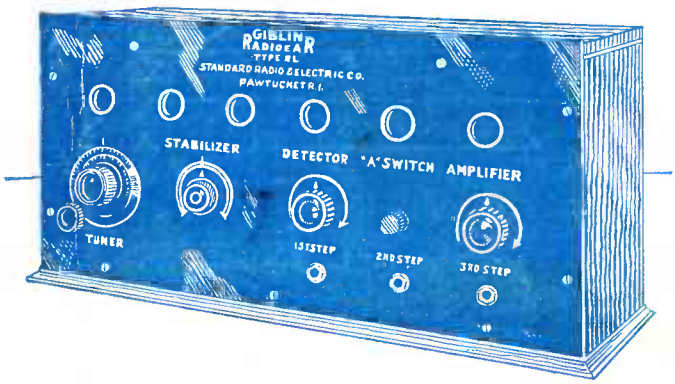
87 Willard Avenue

Providence, R. I.

GIBLIN
RADIO APPARATUS

The Giblin Broadcast Receiver

THE Giblin Radio Frequency Broadcast Receiver makes it possible to obtain radio entertainment without the necessity of erecting outside antenna wires or using a troublesome ground wire. A small, loop aerial placed near the set will pick up signals, which, though they have come long distances, and are weakened by hills, valleys, trees and buildings, will be clear and of great volume. Many families, living in apartments where it is undesirable or impossible to erect antenna wires, can now hear enjoyable, ever-changing programs through the day and evening by "listening-in" with a Giblin Radio Frequency Broadcast Receiver.



The set comprises two stages of radio frequency amplification, a detector and three stages of audio frequency amplification. The parts are mounted on a sub-base to which a Bakelite panel is attached. It is enclosed in a handsome solid mahogany cabinet.

The Giblin Audio-Frequency Amplifying Transformer
Price $4.50

The Giblin Radio-Frequency Amplifying Transformer
Price $5.00

Buy Giblin Products from your dealer

Write for descriptive circulars

STANDARD RADIO & ELECTRIC CO.
PAWTUCKET, RHODE ISLAND