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RADIO PROGRESS

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"Always Abreast of the Times"

IN THIS ISSUE:

WATCH FOR HOOK-UP NUMBER

YOU WILL UNDERSTAND THIS MAGAZINE---AND WILL LIKE IT

PUBLISHED TWICE A MONTH

RADIO PROGRESS

HORACE V. S. TAYLOR, EDITOR

Volume 1 Number 16

Contents for

NOVEMBER 1, 1924

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In Our Next Issue

Do you know that it is cheaper to run a storage "B" battery if you are using a set with three or more tubes in it? If you can charge this "B" battery at home you will also save a great deal of bother. How to do it is explained in **"Charging 'B' Battery at Home,"** by Arnold.

A very good article on constructing cabinets appeared in our pages a month ago, and an equally good description of how to varnish and finish the cabinet is given in **"Putting Piano Finish on Your Cabinet,"** by Standiford.

The Tropadyne Circuit is one of the popular new hook-ups that has just been developed. A description of this hook-up with directions for building it will be found in **"The New Tropadyne Circuit,"** by Fitch.

After a crystal set the radio fan naturally turns to a single tube receiver. If you have such an outfit, it is not difficult to change it into a reflex set at very small cost. This will give a very great increase in loudness, and is explained at length with diagrams by Rados in **"Reflexing the One Tube."**

Many people ask when to use a Variocoupler and when a Variometer. The difference between these two instruments, with the underlying reasons, is given at length in the article, **"Variocoupler or Variometer—Which?"** by Taylor.

RADIO PROGRESS

"ALWAYS ABREAST OF THE TIMES"

Vol. 1, No. 16 NOVEMBER 1, 1924 15c PER COPY, $3 PER YEAR

Coils—Why Some Are Better Than Others

It is the Lines of Magnetic Force Which are Important

By HORACE V. S. TAYLOR

WHEN you build a wireless set, wire is one of the most important things. Of course, it is the wire used to wind the coils and not a conductor strung through the street like a telegraph line, which is important in radio. When you open the cover of a radio set, you always find one or more coils, no matter whether the set is a single circuit crystal or a nine-tube superheterodyne.

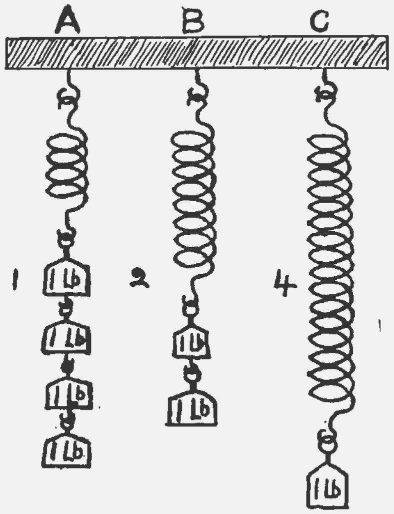


Fig. 1. Coil is Like Weight

There are a great many wrong ideas about the action of a coil, and why some are better than others. For instance, in some places you see a statement that the inductance varies as the square of the number of turns. This would mean that by doubling the turns we should get four times the inductance. Other authorities state that the inductance varies directly as the turns, which would only give twice the inductance in the above example. Which one is right?

What Kind of a Coil?

As a matter of fact both answers are right, depending on what kind of coil we have. This will be explained in a few minutes. To begin with, the reason why a coil is used is because it furnishes electrical weight to the system and this allows it to vibrate. It is exactly like a weight attached to a spring in mechanical vibration. A heavy weight makes a slow speed and a heavy coil has the same effect.

Referring to Fig. 1, we see that a short spring with a heavy weight corresponds in time of oscillation to a long spring with a light weight. The rule is that the product obtained by multiplying the value of the spring by the value of the weight gives the tuning factor. So in Fig. 1 a spring 1-inch long with 4 pounds on it will bob up and down at exactly the same speed as a spring 2 inches long with 2 pounds on it. Again the same vibration will happen with a 4 inch spring and 1 pound weight.

If this is understood in Fig. 1, then it will be easy to follow the electrical case as shown in Fig. 2. Here the spring is represented by a condenser of one micafarad and the weight by the coil, with an inductance of four millihenries. This will give the same wave length as a circuit with a 2 mfd. condenser and a 2 mh. inductance or a 4 mfd. capacity and a 1 mh. coil.

Coil is a Weight

From this you will see that it is the weight of the coil measured electrically which counts. The resistance plays practically no part in determining what wave length the coil will have. Of course, it is an advantage to have the resistance as low as possible because all the current is wanted to operate the set and to force current through a high resistance uses a lot of energy. That is why coils are wound with fairly good sized wire. If the same number of turns had been wound into the same space using much

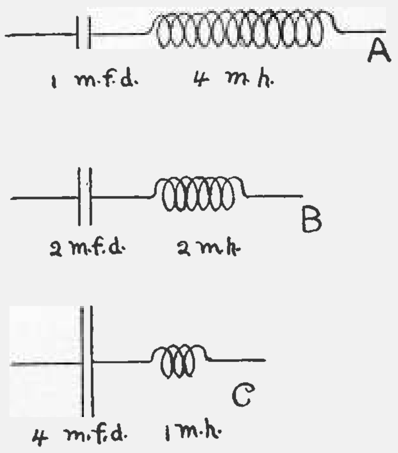


Fig. 2. Coil and Condenser for Tuning

finer wire, the tuning of the coil would have been practically unchanged, that is, it would have sent out the same wave length. It would have had this disadvantage, however, that the music coming through it would not have been nearly so loud, as considerable of the energy received would have been used up in the unusually high resistance.

The question that naturally comes to mind at this point is, what causes the weight of the coil? We have already said that it is not the resistance. That has no part at all. To understand this it is necessary to know something about the magnetism of a coil or solenoid, as a long coil is called. When a solenoid is connected into a battery circuit so that a current flows through the winding, it makes a magnet of the coil and this magnet is powerful enough to turn the needle of a compass or pick up small iron articles. It does this because of the so-called "magnetic field," which exists all

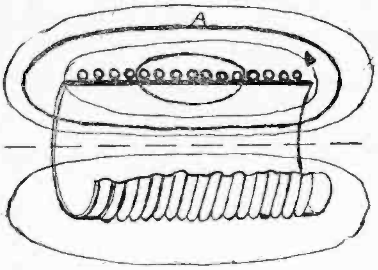


Fig. 3. Long Solenoid

around the coil. This field is merely a name for the magnetic effect, but it is convenient to show it by means of lines drawn around the coil as shown in Fig. 3.

What "Average Line" Means

The solenoid shown in Fig. 3 consists of a single layer of insulated wire, wound on a cardboard or fibre tube. This in the drawing is shown cut open so that at the top we see the coarse section of the tube and wires, while in the lower part of the drawing the outside view appears as we naturally see it. The various lines running around the wires and through the center of the tube represent the lines of force, as explained in the preceding paragraph. Notice that one of these lines is rather heavier than the rest, and is labelled "A." This represents the average line. It is spaced at such a distance that the magnetism outside of it is just the same in amount as that inside. Of course, it is rather hard to locate this experimentally, but the position shown in the figure would be about right.

All the lines of force are closed on themselves, that is, they have no beginning or ending. Naturally they all run through the center of the tube. Most of them surround all the wires, as for instance, the line A, but a few are crowded into such a small distance that they do not take in the entire number of turns of wire. This can be seen represented in the center of the winding space.

Measuring the Coil

There are two things of special interest in a coil. One is the amount of magnetism it can make, and the other is its electrical weight, as we have just been discussing. The amount of magnetism of the coil is found by running a current of exactly one ampere through the turns and then determining by the pull of the solenoid, or in any other convenient way just how much magnetism is produced. This may be expressed in various ways, but a convenient one is to leave the answer as so many lines. Of course, if we double the current to two amperes, there will be twice as many lines—that is the number is proportional to the current. That is why we must have a unit current of one ampere flowing when the measure is made, or else the result would not mean anything.

The electrical weight of the coil depends not only on the turns, but also on the lines of magnetism. As a matter of fact, the weight is proportional to the product of the magnetic lines multiplied by the number of turns. From this it can easily be seen that to get an effective coil (one which is quite heavy) we must have either a large number of turns, or a large number of lines, or both. Of two coils with the same number of turns, the one that has most magnetism will be the better.

What Makes the Lines?

The quantity of magnetism which exists or flows is determined in just the same way as the quantity of water flowing in a pipe is effected. We all know the the higher the pressure, the more

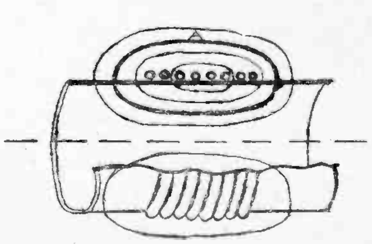


Fig. 4. Short Wound Coil

water we get. That is why a fire engine, pumping at high pressure, will squirt a lot more water into the flames than if we just had the city pressure on the fire hose. But, besides the pressure, the other important thing is the size, or we might say, the resistance of the pipe. A large pipe with a low resistance will naturally pass a great deal more fluid than a small one. In other words, the smaller the resistance of the pipe, the more current we get, even with the same pressure. The same thing holds true in the magnetic case.

The resistance of the magnetic circuit is called "reluctance." It means exactly the same thing as the resistance of the pipe. If there is a big area to conduct the magnetism, then the reluctance is low and lots of lines will flow. On the other hand, if the area is small, it will

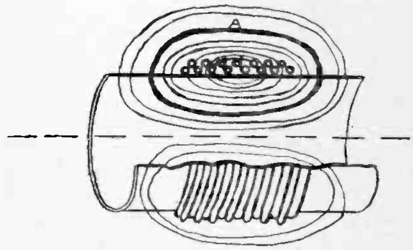


Fig. 5. Two Layer is Efficient

be like a small pipe, and the magnetic current, if we may call it that, will be reduced proportionately. But there is another thing besides cross section of the pipe which influences its current, and that is its length. You probably know that if you have an ordinary water pipe connected to the street main fifty feet away, you will get plenty of water, but if you use the same size of pipe, and run it several hundred feet, it will take you quite a while to fill up a bucket because the flow will be so small through its great length. The same thing applies in the case we are discussing. If the length of the magnetic circuit is a long one, then with the same current flowing in the solenoid the number of lines will be small, but if the circuit is a short one we shall get proportionately more magnetic effect.

What the Average Line Does

The "length" of the magnetic circuit may not seem to mean very much since some of the lines are very short, as shown in our picture, and others send out far beyond the limit of the drawing. What is meant by this length? In such a case, it is found by experiment that the average line is a measure of the magnetic circuit. If this line A is a long one, then the amount of magnetic flux will be small, but if it is short, the flux will be so much greater. Expressing it another way, if we have two coils with the same number of turns wound on the same tube and having the same current, then the amount of magnetism will be inversely proportional to the length of the average line A. The proportion is inverse because a long line means a small amount of magnetism, and a short line a large amount.

With these facts in mind, we can analyze the effect of different forms or kinds of windings. Fig. 3 shows a coil composed of a single layer of 16 turns. This gives a certain number of lines, which in our drawing we have represented as 4 on each side. (Some of the lines in the lower half are omitted to avoid confusion.) The average length of line A is about 4½ inches. Now look at Fig. 4. This has half as many turns, that is, 8. It is wound on the same tube and has the same current—one ampere—flowing through it. The average turn is now 2¼ inches long, or half that shown in Fig. 3, since the length of winding is only half as great. In this case the number of turns causing the magnetism is one half, and the reluctance holding back the magnetism is half, which will give the same number of lines—4. This will be seen from our water pipe analogy. If we have 2 pipe lines and the second has half the pressure forcing the water through, and half the area allowing water to flow, then the current in the two will be just alike. Compare Fig. 3

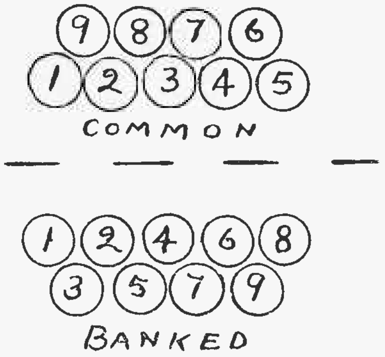


Fig. 6. Two Styles of Coils

and 4. Once more we shall see that the magnetism in either case is the same.

How the Weight Varies

Now what shall we say about the inductance or weight of these two coils. You will remember that the rule was just given that the inductance (weight) equals the product of the number of turns multiplied by the number of lines. In Fig. 3 the weight is 16x4=64, while in Fig. 4, the weight works out as 8x4=32. From this we see that the inductance of the first coil is twice that of the second.

Now let us see what happens when we wind the coil in two layers. Fig. 5 shows a tube of the same size as before, and 16 turns wound in two layers of 8 each. This one ampere current flowing through this solenoid gives the same magnetic force as that of Fig. 3, which also had 16 turns. But notice that the length of the average line will be the same as the 8 turn coil in Fig. 4. This is because the same amount of tube length is used in both cases. Since the same pressure is used, but only half the resistance, we shall get twice the magnetism or 8 lines instead of 4. Again compare the water pipe. Instead of having half the pressure on our large pipe that we do on the small one, we apply the same to both. Naturally twice as much water will flow through the big diameter pipe.

A Very Efficient Coil

From this it will be seen that the short coil in Fig. 5, although having the same number of turns as the long one of Fig. 3 will, nevertheless, give us twice the amount of magnetism. This, as explained, is owing to the fact that the reluctance of the short path is only half as great. The inductance of this coil will be 16x8=128, as compared with 64 for coil 3 and 32 for coil 4.

Now let us return to the first part of this article. There it was stated that in some cases the inductance varied directly as the first power of the number of turns. This is seen to be true by comparing Fig 3 and 4. The eight turn coil has an inductance of 32, while the 16 turn inductance coil was 64. This you will see is exactly a two to one ratio for each and so the proportionality holds. Again it was stated that in some cases the inductance varied as the *square* of the number of turns. This is seen by comparing Figs. 4 and 5. The 16 turn coil in Fig. 5 has twice the turns, but four times the inductance of Fig. 4, and so the variation is as the square of the turns. If we had used three times as many turns, we should have got 9 times the inductance (3x3=9).

How to Tell Which is Which

The rule which applies to all cases, may be expressed in this way. In single turn coils, where the length of winding along the tube varies as the number of turns, then the inductance varies directly as the turns. But if the length of winding is kept the same, and additional turns are put on in layers on top of the first, then the inductance varies as the square of the number of turns. This rule will hold in all cases.

Noticing again that with the same amount of wire Fig. 5 is four times as effective as Fig. 3, it naturally follows that the two layer coils are much more efficient than the single layer. This is indeed correct. Why then, are most

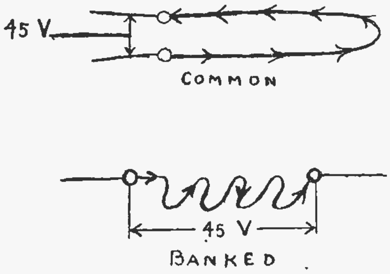


Fig. 7. High and Low Capacity

radio coils wound in a single layer? The answer is to be found in the fact that a two layer coil as usually wound has a great deal of leakage capacity, and so will not give good tuning.

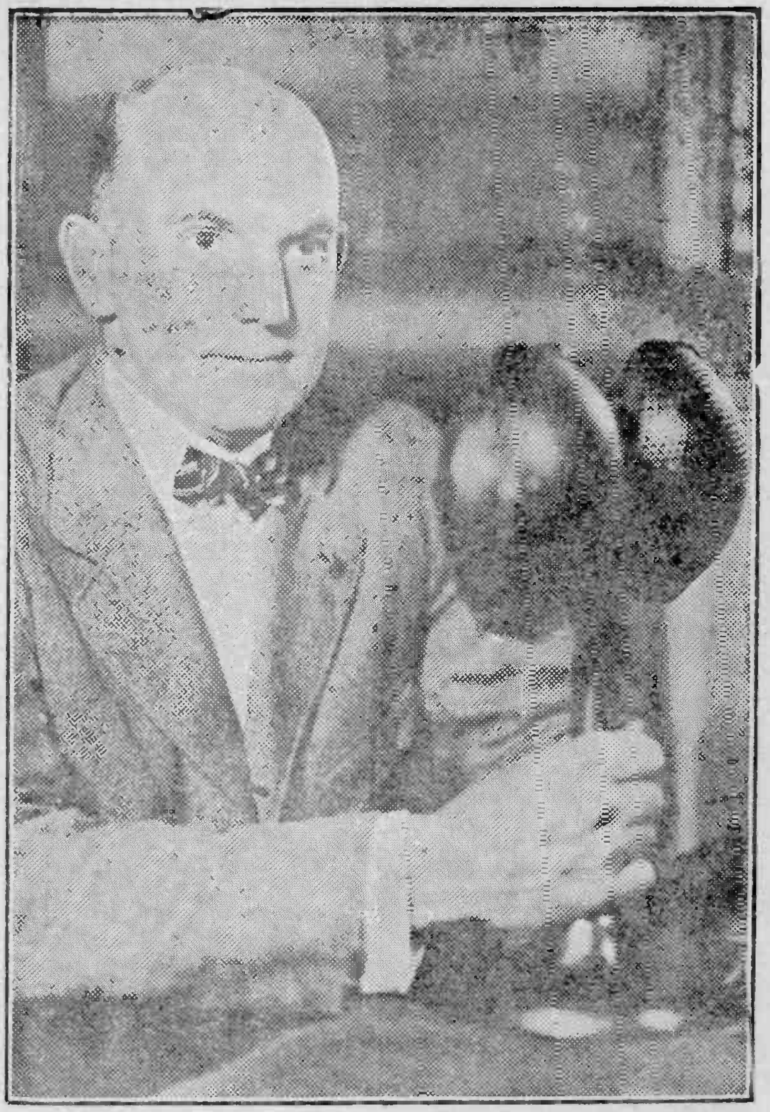
What Makes the Leakage

You will remember that a condenser may be defined as any two conductors separated by an insulator. Here we have the upper layer a conductor separated from the lower layer by the insulation wrapped around each wire. To be sure the two layers are connected at the other end of the coil, but this does not prevent a large amount of leakage capacity between the two ends of the winding, which are at the same end of the coil. In the single layer of coil, the two ends of the winding are separated by the full length of the solenoid, and so the capacity action is very small, but in the two layer coil, the end lies directly on top of the beginning, and so the capacity is large.

How can we arrange so that the beginning of the winding shall lie at the opposite part of the tube from the ending? There is only one way— that is by winding a "banked" coil. This means that instead of winding a complete layer and then another one on top of it, you wind the two layers at the same time. Fig. 6 illustrates this. These circles shown

Continued on Page 30

Portraits of Popular Performers



Prof. L. R. McClung of New York University

Our photograph shows the portrait of Prof. L. Reid McClung, of the Department of Economics, New York University. He is to conduct the third subject, which is a course on "Economics" from Station WJZ, October 27 to November 7.

This "Air College," is proving the practical value of radio broadcasting as an aid to education. This is demonstrated in the cooperative action between the New York University and the Radio Corporation of America in opening the Fall Term. This term consists of fifty-four twenty minute lectures covering eight subjects, to be broadcast from WJZ every weekday evening. They started October 7th and continue until December 23rd.

The "Air College" has as its principal object the spreading of interesting information of the popular type. It is presenting through the radio many attractive lectures on subjects of general interest.

After more than a year of careful experiments by both university and WJZ officials as to the possibilities of this new field, these eight courses of the fall term were decided on. Although the work will be in line with that of the classrooms it will be simplified enough to be easily understood by any intelligent "Listener-in."

Who Are the Faculty?

The "Radio Faculty," as the board of professors of the "Air College" is called, is composed of leaders of thought. They include Professor Ralph V. D. Magoffin, Professor of Classics at the university, E. George Payne, Professor of Educational Sociology, Reid L. McClung, Professor of Economics, Edward C. Smith, Professor of Political Science, J. Edmund Woodman, Professor of Geology, Charles E. Bristol, Professor of Biology, and Mrs. Clara E. Breakey, Lecturer on Home Economics.

Each of the courses was especially selected and prepared with the idea that the mind of the radio audience is quite composite. Human interest and popular treatment, two great needs of successful radio addresses, have been stressed in the choice of subjects and professors for the radio lectures. The course for the first term takes up eight subjects in turn, each to be covered completely before going on to the next. The schedule still to come is as follows:

Oct. 27-Nov. 7th—"Economics," by Prof. Reid L. McClung.

Nov. 10-26th—"Geology," by Prof. J. Edmund Woodman.

Dec. 1-5th—"Biology," by Prof. Charles E. Bristol.

Dec. 8-12th—"English."

Dec. 15-23rd—"History and Development of Civilization," by Prof. E. George Payne.

MAKING HAY WHILE SUN SHINES

The value of harvest weather forecasts broadcast during the summer months, is shown by the following letter received by WGY from a New York State farmer: "I have listened to the harvest forecast every day. We cut our hay by the forecast, and not one bit of it got wet, and we now have it all in, thanks to your broadcasting of the harvest weather." The harvest forecast was especially prepared by the Albany office of the United States weather bureau for the information of New York State farmers.

Picking Out One Millionth of a Second

Selectivity Depends on Catching Vibrations at Tremendous Speed

By DR. ALFRED N. GOLDSMITH, B. S. PhD., Fellow, I. R. E., Chief Broadcast Engineer, Radio Corporation of America

IN the leisurely days of old, mankind's unit of time was the day, or possibly the hour. But it seems that to-day men live faster as well as longer than in the times when the speedy runner was the quickest means of getting important news from one point to another. How far we have gone in squeezing the value out of every instant of time is perhaps indicated by the new unit of time, already familiar to the radio engineer, that is, the micro-second or millionth of a second. The first thought of the broadcast listener, at the mention of the micro-second would undoubtedly be: what is the use of this incredibly tiny space of time? The answer to this question: the fundamental events in radio broadcasting happen in micro-seconds; that is, the separate electrical vibrations which gave birth to the flying radio wave lasted but one millionth of a second or so for each oscillation.

Suspended high over the broadcasting stations are long stretches of wire, carefully insulated from the supporting towers. See Fig. 1, which shows the aerial at WRC, Washington. To start the radio wave, large radiotrons are employed which pump electricity into the suspended wires and out of them very many hundred-thousands of times each second. You may think of the suspended aerial wires as a sort of electrical tank. A large quantity of electricity is pumped into it and sucked out again at very frequent and regular intervals. The number of times per second that the electrical charges are forced into and out of the aerial is called the "frequency" of the station, and is expressed in "kilocycles." The kilocycle is a thousand vibrations per second, so that when we see a station described as having a frequency of 640 kc. ("kc." being the abbreviation for kilocycles), it means simply that the frequency or number of electrical vibrations in the aerial wires in each second is 640,000. In other words, each vibration takes about one and a half micro-seconds.

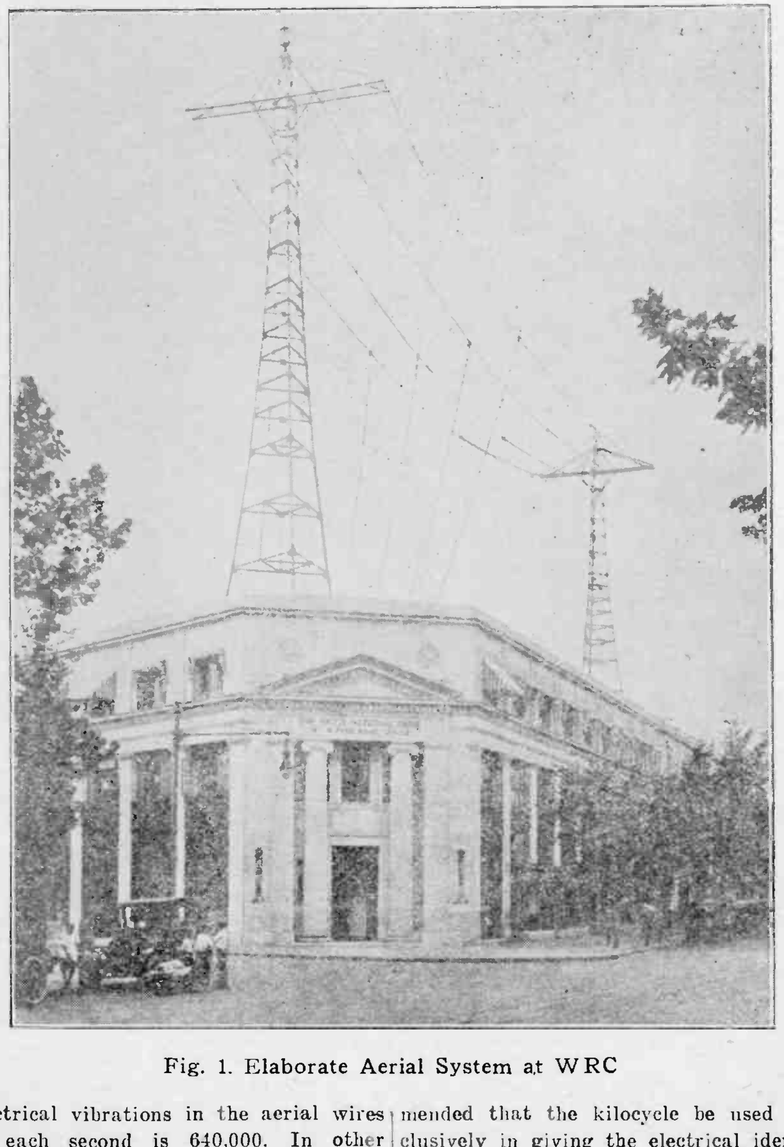


Fig. 1. Elaborate Aerial System at WRC

Discarding Wave Lengths

The Bureau of Standards has recommended that the kilocycle be used exclusively in giving the electrical identification of stations, rather than the wave length in meters. The wave length is simply the distance from crest to crest of the long radio waves which, sweeping across country with the speed of light, carry the radio message. It is, in fact, very easy to convert meter waves into kilocycles of frequency. The rule is to divide 300,000 by the wave length in meters to get the frequency in kilocycles. Thus, a 300-meter wave length corresponds to 1,000 kilocycles (or, in everyday language, a million swings per second).

There are a number of technical reasons, which need not be discussed, why kilocycles are a better way of describing

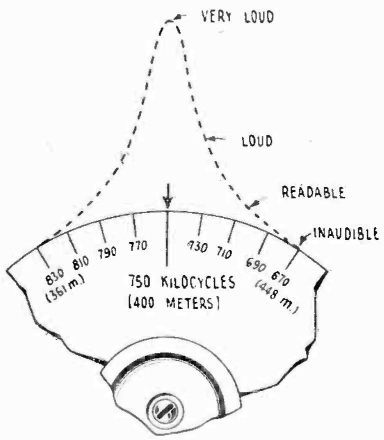


Fig. 2. Curve of Crystal Set

a station than meters wave length. There is one interesting point in connection with the frequency of a station which is worth notice. The frequencies of any two stations must not come nearer to each other than ten kilocycles, or else they are bound to interfere with each other when music is being transmitted, and no amount of tuning on any kind of receiver can prevent this. It is for this reason that the Second National Radio Conference, in drawing up the recommendations which afterwards became regulations of the Department of Commerce, advised that no stations should be assigned frequencies less than ten kilocycles apart.

Keeping Exactly on the Wave

The frequency of a station (or the wave length) is measured by means of a device known as a wave meter, and every high-grade broadcasting station is provided with a precise wave meter so that the frequency of the station can be set accurately, and each station, so to speak, is thus kept in its own front yard. Occasionally a station is not accurately on its own frequency, and there is produced a whistling note (known scientifically as a "beat note") in its signals and in the signals of the nearest station (in frequency). For example, if two stations happen to be tuned to frequencies of 600 and 602 kilocycles, the reception of each of them will be spoiled in some localities by a shrill 2-kilocycle note which will break up the music and speech of each, whereas if they were 600 and 610 kilocycles, no interference would be noticed. Therefore it is very necessary that stations should be accurately tuned and remain so.

Tuning a station to a definite frequency is a useful process since it enables the listener, by tuning his receiver correspondingly, to pick only that broadcaster, and to disregard stations of other frequencies unless they are too powerful or unless his own receiver is lacking in "selectivity," which is the ability to separate stations on neighboring frequencies. The higher frequencies lie at the lower end of the dials on most sets so far manufactured, corresponding as they do to the shorter wave lengths. It is to be hoped that the radios of the future will be marked in kilocycles, and that their scales will run so that the low frequencies lie at the lower end of the dials and the high vibrating speed at the upper end of the scales. The range of frequencies allotted to some of the various types of service are as follows:

For telegraphing across the Atlantic, 12 to 60 kc. (25,000 to 5,000 meters); For overland operation, 60 to 100 kc. (5,000 to 3,000 meters); For ship long distance signals, 100 to 150 kc. (3,000 to 2,000 meters); For shorter distances at sea, 300 to 500 kc. (1,000 to 600 meters); For all broadcasting, 550 to 1,350 kc. (546 to 222 meters); For amateur operation, 1,350 to 2,000 kc. (222 to 150 meters).

Frequency and Distance

Some people have the impression that the distance of a station from them is connected in some way with the frequency or wave length of the transmitter. There is no such relation. Nearby stations may have low or high frequencies; this depends entirely on the assignment of frequency from the Department of Commerce. The Department assigns a frequency to each station on a systematic and scientific basis, depending entirely on the class of the station, its location relative to other broadcasting stations, and the reducing of interference between stations. The aim of the Department, which is being attained, is to permit every broadcast listener in the United States to hear any station within the range of his set without interference. It is a fact that some persons, being located almost within the shadow of the towers of a powerful sending station, cannot escape hearing it with the average radio, and such persons should take a reasonable attitude toward a condition which is being continually improved. The steady increase in the selectivity of receivers, in the skill of operation by the broadcast listeners and by the sending stations themselves, is bound to lead to conditions practically free from interference in the reasonably near future. In the meanwhile, it is well to remember that the Department of Commerce and the various National Radio Conferences are well aware of the problems involved and are leaving no stone unturned in their attempts to satisfy everyone. They must be guided by the idea of the "greatest good for the greatest number," and they are very successful in most cases.

Billions of Miles of Waves

It is interesting to visualize exactly the electrical effects produced by a station like WJZ of the Radio Corporation of America, at Aeolian Hall, New York. This station has a frequency of 660 kilocycles (455 meters). Every second there are therefore 660,000 electrical vibrations sent out, which carry the music or speech as controlled radio waves. In an evening's entertainment, there have therefore been a total of seven thousand million vibrations, and the total end-to-end length of all the waves sent out is over two billion (2,000,000,000) miles. The individual electrical vibrations last only about one and a half micro seconds or very little over a millionth of a second. It is of such unusual elements that a broadcast program is electrically composed, and the mind of man in this scientific age must gradually accustom itself to these new and unusual units of time and space. It is the exact timing of the waves that allow sharp tuning.

On a winter's night, there may be passing through the air, waiting to be trapped by a suitable receiver, literally hundreds of radio messages from broadcasters, transoceanic stations, and marine senders. It is evident that some powerful scientific agency is required to pick out any desired one of these messages sharply and clearly, and free from interference from the rest of the myriad of hurrying signals which accompany it. Every broadcast listener knows the practical side of the solution, namely the process of "tuning" his receiver to the desired signal, with the more or less complete cutting out of all the other stations.

A Wave Length All Its Own

Every signal has its own wave frequency (expressed in kilocycles) or wave length (in meters). Consider a 750-kilocycle (or 400-meter) signal. In Fig. 2 the tuning dial of the receiver is shown set to this frequency, and the strength of the signal is then "very loud," which is indicated by the height of the dashed-line curve drawn above the scale on the dial. If, however, the incoming signal were of the same power, but of a frequency of 730 kc. (kilocycles), its loud ness in the telephones would be less, as shown at the point marked "loud" on the dashed-line curve. If the signal frequency were still less, say 700 kc., it would become "readable" only, and if the signal frequency dropped to 670 kc., it would be practically "inaudible." Such a receiver as this would therefore discriminate completely between equal signals, one of which was on 750 kc. (400 meters) and the other on 670 kc. (448 meters).

A good crystal receiver has about this selectivity or power of selection between signals of different frequencies, but the radio engineer would regard this as rather poor for any vacuum tube set. Receivers using radiotrons should give much greater selectivity than this. To take an extreme instance of excellence, the effects shown in Figure 3 should be studied. It will be seen that while the signal is very "loud" at 750 kc., remains at practically the same loudness to 755 kc., and then drops very rapidly becoming "inaudible" at 756 kc.

Good and Poor Selectivity

The type of set shown at "A" in the drawing will therefore pick up signals falling within a band of frequencies about 160 kc. wide (80 on each side) and has very little selectivity. It will not cut out local interference to any great extent, and its user must be content with listening to the strongest of his local stations. The type of receiver shown at "B", however, will respond only to signals within the narrow band of frequency about 10 kilocycles wide. It has extremely good selectivity. In fact, it is not possible to improve its selectivity any more without hurting the quality of the music received from an ordinary broadcasting station.

Theory and experiment agree in showing that a band 10 kc. wide is required for good musical reproduction, and any radio that receives a band of less than this width is really too selective and will destroy the quality of the concerts. It was for this reason that the Department of Commerce, acting on the recommendations of the Second National Radio Conference, assigned frequencies to broadcasting stations 10 kilocycles apart. Then they could be entirely separated from each other by a receiver having the greatest usable selectivity, while the various sending stations in turn would not interfere with each other by producing audible whistling or "beat" notes when they were transmitting.

Four Different Classes

The following tables give in a general way the degrees of selectivity, or power of distinguishing between signals of equal strength at different frequencies, and the usefulness of each class, in case the radio is tuned to 750 kilocycles (400 meters):

1. Equal signals become inaudible 80 kc. off tune (that is, at 670 kc. or 448 meters). This is *poor* selectivity, and will barely enable the listener to distinguish between local stations.

2. Equal signals become inaudible 30 kc. off tune (that is at 720 kc. or 416 meters). This is *good* selectivity, and will in general enable distinguishing between local signals and some distant ones.

3. Equal signals become inaudible 10 kc. off tune (that is, at 740 kc. or 405 meters). This is *very good* selectivity, and will meet most requirements of reasonable interference-prevention.

4. Equal signals become inaudible 5 kc. off tune (that is, at 745 kc. or 403 meters). This is *excellent* selectivity, and will meet all possible requirements. It is, in fact, the very limit of selectivity which can be employed with ordinary broadcasting transmission without injuring the quality of music. So greater selectivity than this is undesirable, and cannot be used.

Only a Few Class 4 Sets

As a general rule, it may be said that a good crystal receiver of the single circuit type will have selectivity in Class 1 of the above table; a non-regenerative receiver will fall between Classes 2 and 3 and generally nearer Class 2; a properly used regenerative radio will be in Class 3, and the building of a Class 4 receiver requires special design and construction.

The selectivity which can be obtained from a radio depends not only on its design but also on the correctness of its use. Even the best receiver carelessly used will not yield all the desired results. For this reason, a series of suggestions are given below for getting the greatest selectivity from various types of receivers and so avoiding interference as far as possible.

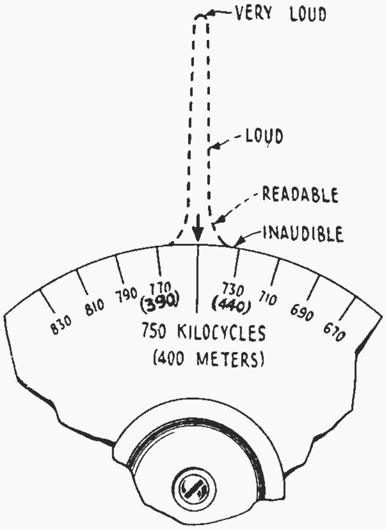


Fig. 3. **Curve of Super Het.**

How to Tune in

1. In using a non-regenerative radio of the two-circuit type, reduce the value of the coupling between the antenna circuit and the secondary circuit as far as permissible for the desired signal strength. The tuning of the antenna and secondary circuits will then be sharp.

2. In using a single-circuit regenerative receiver, do not use an antenna any larger than is required to give a loud signal on the most powerful local station *when the tickler has been brought up to the point where further increase begins to spoil the quality of the music.*

3. If difficulty with howling or covering the wave length range is experienced under the condition mentioned in

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Raising the Limit on Power

It is Best to Shout in a Noisy Room

By POWEL CROSLEY

BROADCAST listeners to-day face three kinds of interference; (1) from code stations, (2) static, and (3) so-called "Birdies," or the whistling and squealing of certain types of receivers, particularly the single circuit sets. See Figure 1. There have been various methods suggested and discussed of eliminating these evils and conditions are far better now than they were a year ago. Some people have suggested that all code stations be shut down. Of course that is impossible. Many listeners who object to this form of interference do not realize what code stations are doing.

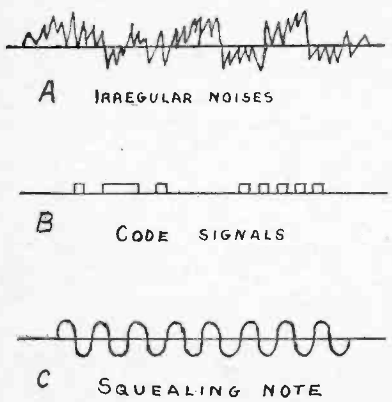

Fig. 1. Three Kinds of Trouble

Naturally this evil, if it is so called, can not be eliminated and therefore the best solution is to overcome it by the use of greater power in the broadcasting stations.

Drown Out Static

Now let us consider the second form of interference—static. Static eliminators of various kinds have been put in the market, but so long as the signal strength is low and static is about the same in loudness, or of even greater power, (more than 1000 watts) it seems hopeless to attempt to do more than reduce the evil. Stations using super power will cut through static and overcome instead of eliminate it.

And now for the third form of interference—whistling types of radio receivers being operated by our neighbors. It has been suggested that radiating receiving sets be eliminated, but that would be hardly practicable, because nearly all radiate to a certain degree.

How Marconi Did it

Those who try to eliminate the various forms of interference through drastic means are overlooking the obvious solution of the problem, which can be covered in two words—*more power.* Compare the present day broadcasting conditions with those in the early days of radio code communication. It is said that when Marconi sent the first signal, the letter S (which in code is three dots), across the Atlantic, two kilowatts of power were used. That power was not enough for reliable signals across the Atlantic. This was increased to 50 kilowatts. Even then it was too low for sure results, and it was not until 200 kilowatts were used that satisfactory service could be rendered.

In the early days of Marconi's famous "S" transmission mentioned above, static was the worst form of interference encountered. It was then, it is now and probably will be for some time to come. Static, at certain seasons, is far more serious than the squeals or so-called "Birdies" from radiating receivers.

Radio receiving-set development has advanced far ahead of the broadcasting stations. The latter, with few exceptions, have a power of 500 watts, or one half kilowatt. There are three or four of the present-day super broadcasting stations outside the United States that are using from 5 to 10 kilowatts. These give from ten to twenty times better results with any receiving set under any condition, than do the 500 watt stations. If it were possible to improve receiving sets 100 per cent, it might be compared with an increase of from one half to one kilowatt in the power of a broadcasting station.

Music Louder Than Static

Listen in early in the evening to a distant station when the signal strength is very small. The slightest static will blot out the music. Interference from poor operation of even a first class receiving set, even if it is located in the next apartment, will blot out the incoming signals. As darkness falls and transmission conditions improve, the signal strength of the far-away station becomes stronger. Finally the relation between the strength of the received signal and static (or squealing) becomes such that the music is much louder, and interference no longer bothers.

From this I conclude that broadcasting stations must increase their power to overcome all forms of interference. Development in sending equipment offers great opportunity for the improvement of receiving conditions. With increased power, reception will improve in direct ratio. Nothing would prevent the use of transmitters with power running into the hundreds of kilowatts. The dawn of tomorrow promises the owner of the most simple type of receiving set the ability to tune in high-powered European stations with the same ease with which today he tunes in 500 watt stations at a distance of 100 miles. And with such increase in the power of broadcasting stations the bugaboo of interference from static, code stations and radiating receivers will disappear.

MAN WRIGGLES HOLES IN SOCKS

P. H. Elwell, a resident of Dover, N. H., just can't make his feet behave when he hears music. The other night he was listening to a late program of music being broadcast from KDKA. Unconciously he kept wriggling his toes to the music until, when he investigated some time afterward he found he had worn holes in his brand new hose. He is sending the bill to the station.

10,000 Diners Eat Together

Probably the Biggest Banquet in History Tied In by Radio

IT is an old story to have the after dinner speeches of a big banquet sent over the air to thousands of listeners in localities where the meeting takes place. Recently there have been several occasions where a banquet was broadcast over the whole nation, and even across the water to England. The first there is a record of was when the Massachusetts Institute of Technology alumni met a short time ago and the speeches were heard from Maine to California and also picked up in Great Britain. All these, however, were the outsiders listening to the speeches of the insiders.

Broadcasting has advanced so far that when the H. J. Heinz Company, of Pittsburg, decided to celebrate Founders Day in honor of the man who started the company, they arranged to have all their 62 branches take part in the festivities by radio. So in 62 cities of the United States, Canada and Great Britain 10,000 diners sat down to a banquet together with radio as the medium to tie these scattered banquets into a unit.

Toastmaster and Orchestra

With the banquet in Pittsburg acting as the key, the entire program at the Heinz plant was broadcast from the short and long wave station of KDKA, and was picked up on special receiving equipment already installed in the various banquet halls and with loud speakers acting as toastmaster, speakers and orchestras, each of the scattered banquets enjoyed the same program as was carried on in Pittsburgh.

The effect upon the diners was the same as though all were meeting under the same roof, though at the extreme point, the office in San Francisco and that in London, 8,000 miles separated them.

The dinner started at 6:30 o'clock, Eastern Standard time at Pittsburgh, following the unveiling of a memorial to H. J. Heinz, founder of the company, which was erected through contributions of employees. Emil Fuchs was commissioned to design the memorial, which centers in a bronze figure a little larger than life size. Supplementing the statue are two bas-reliefs. The three works were completed in New York. Simple unveiling services took place in the rotunda of the Administration building at noon. Howard Heinrich, factory superintendent acting for the employees, made the presentation speech and the memorial was received by Mr. Heinz.

President Coolidge There

Speakers at the banquet included such distinguished persons as President Calvin Coolidge, who talked from the White House, Charles M. Schwab, Secretary of Labor James J. Davis, and Senator George Wharton Pepper, who made their addresses from Pittsburgh. Other members of the President's cabinet, Senators and Congressmen, the Governor of Pennsylvania, and state, county and city officials gathered at the banquet table with captains of industry and finance, masters of the professions and leaders of thought.

Special direct telephone line connections were made between the White House and Pittsburgh. This special line carried the President's message to Pittsburgh where it was impressed simultaneously on a public address system installed in the banquet hall and also on the long and short wave transmitting stations of KDKA.

Two Kinds of Radiation

As has been discussed before the sending station, at East Pittsburgh, transmits on two different wave lengths. The ordinary one which is heard by most all sets in the Eastern parts of the United States and some of the most powerful ones in the West, runs at 920 kilocycles per second, which is equivalent to a 326-meter wave length. The high frequency oscillator at the same station sends out 3,200 kilocycles, which is equivalent to a 94-meter wave length. The difference in these two may be seen by referring to Fig. 1. The upper curve shows the form of the wave before it is modulated, that is just as it comes from the oscillators. As this wave is radiated out into space the distance from peak to peak is 326 meters—just about one-quarter of a mile.

The high frequency wave before modulation looks just like the other one except in its measurements, which are made from one wave to the next. This distance will be found to be only 94 meters, slightly more than one-quarter as long as the other one. This is shown in the lower part of Fig. 1. Notice that the height of both is about the same because they are approximately equally loud but that the spacing is very much closer with the latter. Modulating the wave by the voice currents breaks it up into groups and the same number of groups per second occur no matter which wave is being used.

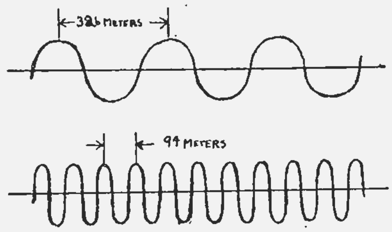

Fig. 1. Two Waves of KDKA

Getting His Cue

The Westinghouse Company made arrangements in the White House for the President to hear all the details of the banquet, on a radio receiver, as it was broadcast. Through this arrangement the President could tell the progress of the banquet and be ready to start his address at the proper moment.

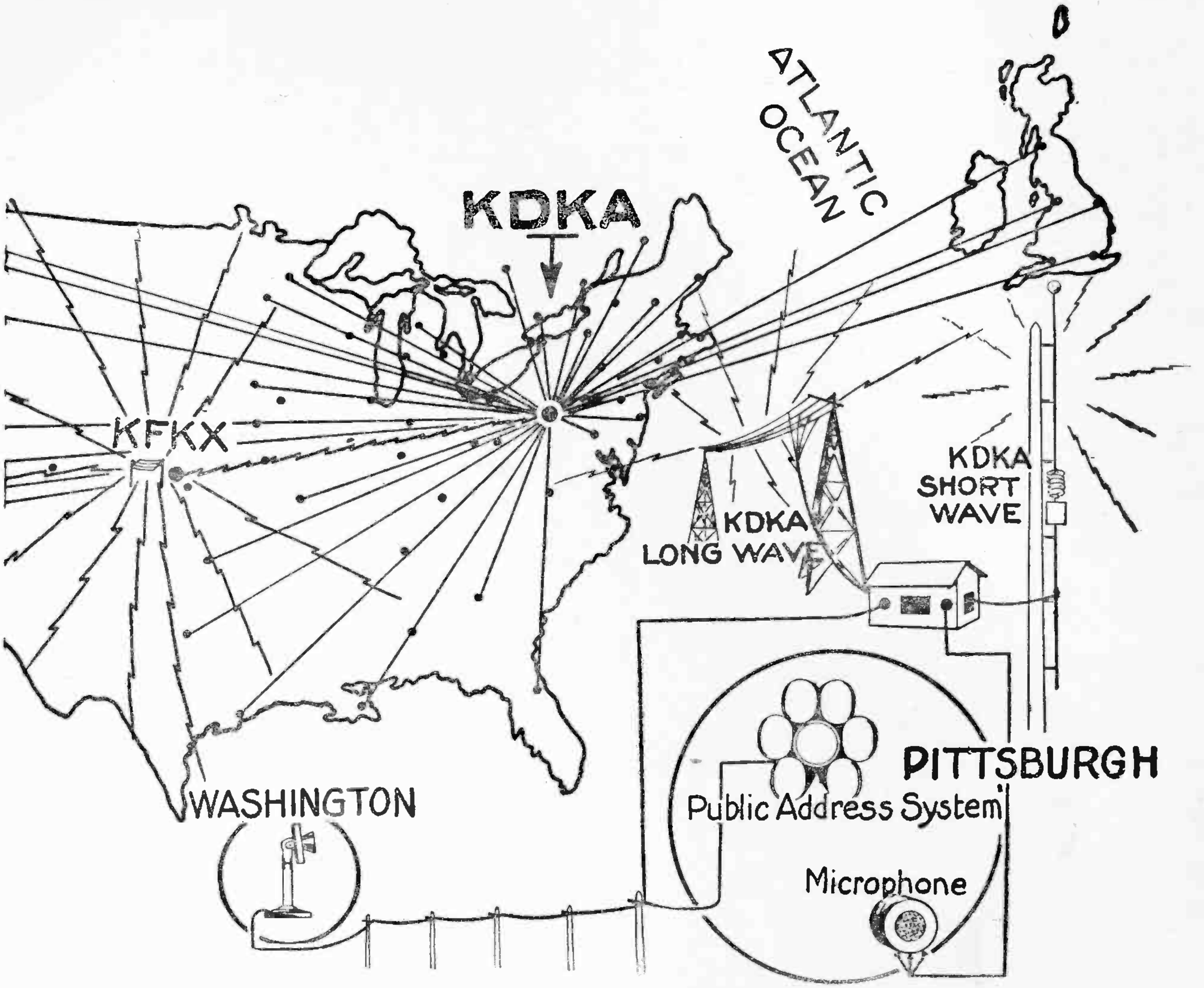

Fig. 2. How Long and Short Waves Both Helped Out the Banquet

All other speakers were at the banquet table. Here a most complete system of microphone pickups was installed. There was a cluster of three microphones on the speakers' table all controlled by an operator seated in another part of the hall. The operator also took care of the various amplifying units and other pickup apparatus.

The voices impressed on this pickup installation were carried to the transmitting stations located at East Pittsburgh and from there broadcast on the long and short waves. KDKA'S repeating station, KFKX, located at Hastings, Neb., picked up the short waves and there rebroadcast the banquet proceedings over the Rocky Mountains to the Pacific Coast. Fig. 2 gives a diagram of the way connections are made. Notice the telephone at Washington shown in the lower left hand. This is the one used by President Coolidge. It terminates in the battery of loud speakers installed at the Pittsburgh banquet. The diners were able to hear the President's voice just as well as if he had been sitting at the table with them. A tap off this line ran to the sending station shown just above the word Pittsburgh. The microphones at the speakers' table were also connected with the sending station. Two lines from the transmitter were carried to aerials, one for the long wave on the regular antenna, and the other for the short wave, as explained above. Very few listeners in the United States have sets that can tune down as low as 94 meters, so KFKX, at Hastings, Neb., changed these waves to 341 meters which is their particular broadcasting wave. These signals reached as far as the Pacific Coast.

Making a Blanket

To insure the greatest possible blanket of radio signals being thrown over the largest territory, the Westinghouse stations, KWY, at Chicago, and WBZ, at Springfield, Mass., also picked up the short wave relaying signal of KDKA and repeated their respective wave lengths the entire Heinz program.

At each of the various cities where the banquets were held, special receiving equipment prepared by the Westinghouse Company, under the direction of an experienced operator, picked up the signals on either wave and again amplifying the messages sent them through a unique loud speaker so as to be easily heard by the assembled guests.

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Some Sending Station Stories

HELP! MURDER!! POLICE!!!

A woman's scream, a cry of murder or an urgent appeal for help and police coming from an otherwise peaceful domestic circle, does not always mean that murder is afoot. Before you rush madly to the rescue of a distresed damsel, calmly ring the doorbell, and (still calmly) ask if the WGY Players are on the air. The scream may have originated in the broadcasting studio at Schenectady, and the words may be simply the lines of a melodrama enacted for the entertainment of the radio audience. This cautious approach to the apparent scene of action may save both you and the man-of-the-house acute embarrassment. A Danville, Illinois, resident recently wrote that this happened to him. During a performance which he was getting on a loud speaker his neighbors ran all around the halls of his apartment house to his door seeking the cause of a woman's screams of murder. As he opened the door before it was broken in by the would-be rescuers the act was concluded and the orchestra started to play. Then the sheepish visitors silently withdrew.

KEEPING THE WOLF FROM THE DOOR

The old saying that our towns and cities are only a week away from starvation has more truth in it than is generally supposed. Town folks and city dwellers realize today more than ever that their own lives and livelihood depend upon whether or not the farmer has good crops and is prosperous. For this reason everyone should be kept in touch with rural life and the more important farm problems of the day.

To cover this particular field, station WDAR (Lit Brothers) in Philadelphia, with the assistance of *The Farm Journal*, has decided to give farm and city folks a special broadcasting service every Monday evening at 7:45 P. M.

These talks are sent out under the title "Short Agro-Waves," and the broadcasting will be done by Charles P. Schoffner, Associate Editor of *The Farm Journal*. This service will be practical, entertaining and interesting; everything pertaining to farm and rural life will be covered in a brief but comprehensive way.

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10,000 DINERS EAT TOGETHER

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In Great Britain, the pickup point was in the office of the Heinz Company at London. Here special receiving equipment was installed and the short waves received. From London, special telephone connections carried the program to the other headquarters of the company in Great Britain, located at Liverpool, Hull and Bristol.

Canada Listened In

Canadian cities had the same receiving equipment as that installed in the cities of the United States.

More than 3,000 diners took part in the key banquet at Pittsburgh. To provide space for all the diners an entire factory floor was cleared and arranged as a dining hall. Steam ovens were installed in one end, tables arranged, a speakers' table mounted, and the whole hall draped to present a pleasing appearance. On the speakers' table were mounted two sets of microphones; one set being for the public system installed and the other set to act as a pickup for KDKA. Because the hall was so large that a speaker's voice could not carry adequately to all parts of the hall the standard public address system was installed to amplify the voices of the various speakers.

Each Man Has Two Voices

Because of the installation of the two sets of microphones, each speaker had his voice carried in two ways. In one, the voice was amplified and carried to all parts of the hall through the public address system. In the other the voice was amplified and then broadcast to all parts of the world.

Through the use of the long and short waves of KDKA in broadcasting this event and also the use of KFKX as a repeating station, the entire proceedings were readily received by all the radio fans of the United States and Canada. As a radio event which had no parallel in history, a large part of the radio public of the North American continent took advantage of this fact and tuned in for the Heinz radio banquet.

Founders Day radio banquets were held in the following cities:

Scotland—Glasgow.

England — London, Liverpool, Hull, Bristol.

Canada—Montreal, Toronto, Winnipeg, Leamington.

United States—Albany, Allentown, Pa., Baltimore, Birmingham, Boston, Buffalo, Chicago, Cincinnati, Cleveland, Columbus, Dallas, Denver, Des Moines, Detroit, Duluth, Harrisburg, Hartford, Houston, Indianapolis, Jacksonville, Kansas City, Los Angeles, Louisville, Memphis, Milwaukee, New Orleans, New York, Norfolk, Oklahoma City, Omaha, Philadelphia, Pittsburgh, Portland, Me., Portland, Ore., Rock Island, Salt Lake City, San Francisco, Savannah, Scranton, Seattle, Sioux City, Spokane, St. Louis, St. Paul and Syracuse.

LONG DISTANCE TALK TO TRAIN

What is supposed to be a record for long distance radio reception on a moving train was accomplished recently by K. A. Stark, a representative of the Andrea Radio Equipment Company of New York, while on the way to the Radio Exposition at San Francisco. Shortly after leaving Pittsburgh, Stark picked up the program being broadcast from Station KFKX at Hastings, Nebraska, while many other stations within a radius of six hundred miles of the fast speeding train were also heard. The equipment was installed on the Union Pacific Overland Limited and according to certain railroad officials such radio receiving apparatus may soon be a part of the train's regular equipment.

SENDING STATION STORIES

Continued from Page 15

WHAT DO RADIO FANS WANT?

By R. K. Morton

The rivalry of the Philadelphia radio stations, WDAR and WIP, in a contest to see which can broadcast the most and the best novelties brings up the question, what do radio fans want to listen to? This must be indicated in letters to radio publications and to the stations themselves, and comment in radio sections of newspapers.

Broadcasting is charged up, by most stations, to advertising. This is one reason why call letters and artists should be announced before and after the selection. It is financially essential that the studios cater to public tastes. The listener-in protects his own interests by keeping in close touch with the stations. If some of the finest stations are not to close down or to overlook broadcast items which would be appreciated by fans, the listeners-in should express their preferences in magazines such as this.

How About Young People's Club?

Many stations have children's clubs and adults' radio fraternities. Do fans want a radio *young people's* club, of any kind? Land lines and telephone wires are costly. How many like remote control programs? How many want public meetings broadcast? For instance, station WNAC, Boston, endeavors to broadcast the first performance of popular shows in certain theatres. Is this novelty widely approved? How many want programs for their psychological effect or artistic balance?

Some announcers are strictly dignified and business-like. Others feel they must be "snappy" and jolly and witty. Which do *you* approve? Do you like regular features, unexpected novelties, or just the usual talks, artists' programs, and orchestras?

To illustrate, take four typical broadcasting stations, and examine their programs for a single night recently.

1. WGY. Total broadcast, 4 hours—15-minute talk, 50 minutes for farm notes and useful features, and the remainder of the time, orchestra music.

2. WNAC. Total broadcast, about 4½ hours—one-half hour for baseball notes, cooking, farm notes, etc., and the rest concert music.

3. KDKA. Total broadcast, 4½ hours—nearly 1½ hours for farm notes and other useful information, a 25-minute lecture, and the rest concert and orchestra selections.

4. KYW. Total broadcast, 5 hours—1 3-4 hours for genuine public service, and the rest music.

Is it worth while for stations to seek all kinds of unusual stunts to broadcast? Which of the above programs seems to you the most desirable?

There are many types of programs which a radio station may broadcast. What the radio fans say emphatically that they want they will get.

DRAMATIC EVENTS COMING

The WGY Players, the oldest group of radio actors on the air, have returned to Schenectady, after an absence of ten weeks. Their opening production was "Silence," a crook-play by Max Marcin.

Edward H. Smith, director and leading man of the WGY Players since the first experimental air play, "The Wolf," has assembled practically the same company for 1924-25 as was used last season. The chief exception is Miss Viola Karwowska, who was the first leading woman of the players and who has not been heard for a year. Miss Karwowska has been engaged to play emotional leading roles. She has a voice of unusual beauty of tone and those who have followed the WGY Players will remember her work in "The Garden of Allah," "A Fool There Was," "The Green Goddess," and many others.

TOUR EUROPE FREE

Every Thursday evening WEAF is presenting a series of radio travelogues, in which you will be conducted to various countries and the interesting places in them. The routes are geographically correct so that if you wanted to, you could step into your car and follow them with only a little more detailed information and questions on the way. The customs and habits peculiar to the places will be described to you and in most cases you will be given an opportunity to hear music either composed in the place where you are visiting or else adapted to that place. These travelogues are given through the courtesy of the Packard Motor Company and are conducted by Mr. Charles D. Isaacson, who is particularly gifted with what we might call "the seeing eye and the hearing ear," and who has unusual ability to pass his impressions on to you. "Touring with the Packard Eight," is a real and valuable feature.

PICKING OUT ONE MILLIONTH

Continued from Page 11

suggestion 2 above, place a .0005 microfarad mica condenser across the ground and antenna binding posts of the receiver.

4. In using two-circuit regenerative receivers, keep the coupling from antenna to secondary circuits as loose as will give the desired signal with tickler adjustment well up toward the point where further increase begins to disturb the quality of the music. If necessary, reduce antenna dimensions as well and add a condenser to the set as mentioned under suggestion 3.

5. Be satisfied with signals of reasonable loudness.

6. The selectivity of any type of set being necessarily limited, it is necessary to be content with nearby station concerts if one is located very close to such stations. Distant station reception, if absolutely required, must then wait for the later evening hours.

Every so often, the broadcast listener will be told of some receiver that picked up a very distant station loudly through powerful local stations on nearby frequencies or wave lengths, without interference. If he cannot duplicate these results, it is no good reason for being discouraged, because transmission conditions vary so much from night to night that no general conclusion can be drawn. Distant stations are sometimes amazingly strong. It is not meant that receivers of Class 4 high selectivity will not accomplish wonders compared to those of Class 1 having poor selectivity. What is meant is that "one swallow does not make a summer," and that single records prove very little.

1922 IS ANCIENT HISTORY

The Standardization Committee of the Institute of Radio Engineers is revising the "Definitions of Terms and Standard Graphical Symbols," which was last issued in 1922. This work is being pushed rapidly through sub-committees which handle the following branches of the subject: Radio telegraphy transmitting sets, receiving sets, radio telephony, electron tubes, antennas, direction-finding apparatus, and systems.

The Modulated Wave

By R. H. LANGLEY, Radio Engineer General Electric Company

THE wave in space which brings us the broadcast music or voice is known as a "modulated, high-frequency, electro-magnetic" wave. Let us examine this rather imposing expression and see what it actually means.

The voice or music which we wish to transmit varies in frequency from about 30 cycles up to about 4000 cycles per second. An electro-magnetic wave could be created at these low frequencies. But it is found that it would travel only slightly further than the sound waves themselves. There would therefore be very little to be gained by changing the sound wave into an electro-magnetic wave of the same frequency or speed of vibration.

1000 to 1 Ratio of Speed

It is found that a high frequency electro-magnetic wave will travel to enormous distances. The term "high frequency" in this case means vibration speeds from about 30,000 to about 3,000,000 cycles per second. It will be seen at once that these frequencies are of an entirely different order from the voice and music frequencies. Roughly, they are 1000 times as great, or stating the fact in another way, one thousand cycles of the high or radio vibrations will occur during one cycle of the voice or audio frequency.

The modulated wave is a combination of the audio and the radio frequency. The radio frequency part of the wave is spoken of as the "carrier" because it is used to carry the audio frequency. The radio frequency is modulated by the audio frequency, and we ordinarily think of the audio frequencies as existing in the complete wave as a change in amplitude or strength of the radio frequency. The successive cycles of the carrier frequency vary in intensity or strength in accordance with the audio frequency. This is shown in Figure 1.

A Wave with Two Fields

When we say that the wave is electro-magnetic, we mean that it consists of two parts. One part is a magnetic field **exactly like that** given by the familiar horse-shoe magnet.

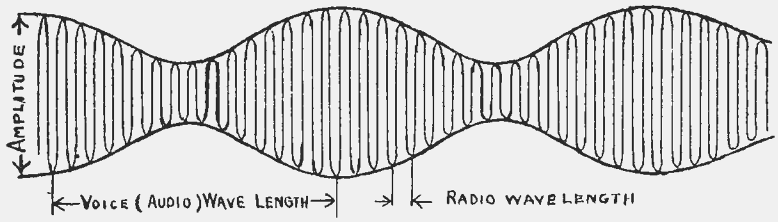

Fig. 1. Carrier Wave Modulated by Audio Frequency

Fig. 2. Audio Wave That Modulated Fig. 1.

Figure 3 shows how a horse-shoe magnet will attract the needle of a compass. As the magnet is turned around, the the needle will follow it, the north pole of the compass pointing to the south pole of the magnet. Evidently there is something around the horse-shoe which fills the space and causes the compass needle to move. This something is called the "field", and is shown in diagrams by the light lines running from one pole of the magnet to the other.

The other part of the field is an electro field, exactly like the one that can be obtained by rubbing a piece of glass with a cork, by which the glass will then pick up small bits of paper. In the wave, these two fields, electric and magnetic, move through space together, at the velocity of light, or 186,000 miles per second. They would circle the globe at the equator seven times in the tick of a clock.

The process by which the radio frequency is modulated at the audio frequency is relatively simple. A vacuum tube oscillator is used. As long as the plate voltage (from "B" battery) on this oscillating tube is constant, the resulting wave has constant amplitude or strength, and is not modulated. In order to modulate the wave, the plate voltage is varied up and down in accordance with the audio frequency, and the amplitude of the resulting wave in space varies in the same way.

Figure 2 shows the wave form of the audio vibration which is being sung to the microphone. You will notice the shape of this curve is just like the top line in Figure 1.

Three Frequencies at Once

Now, it is found that this wave of changing intensity (Fig. 2) is exactly equal to the sum of three constant frequencies, that is, three frequencies whose amplitude does not change. Of course one of these is that of the carrier, at which the transmitting tube is oscillating. This corresponds with the wave length of the broadcaster, as given in the newspaper. The second frequency is equal to the sum of the carrier and the voice frequency, and the third is the difference between them. This will be illustrated in a moment. These sum and difference frequencies are known as the side bands. With a receiver that is sufficiently selective, we can tune to any one of these three oscillation speeds and detect it Remember that each of these frequencies is constant, and that it is only their sum which varies in amplitude. It is easy to see why the sum does change in intensity, because, since the three frequencies are slightly different, they cannot stay in step with each other, or, as we say, in phase with each other, and will consequently add up to help each other at certain times, and at other times will act against each other (subtract), and reduce the amplitude or intensity of the combination.

As an illustration of what is meant, look at Figure 4. Here we have a fast vibration shown in a full line, labelled F. A slower vibration of the same strength is shown dotted at S. These two waves add up into the resultant R shown in a heavy line. At 1 both waves are in phase (in step) and so the resultant is quite strong. At 2 you will notice that

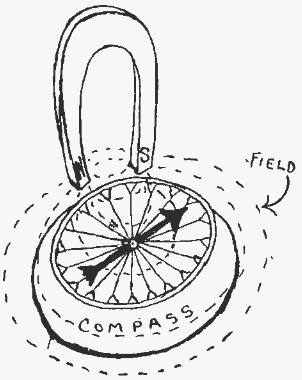

Fig. 3. Magnetic Field from Poles

they are getting out of step and so the resultant is no bigger than either of the two components F and S. At 3 the fast wave has got a lap ahead of the slow one and so the two are just out of phase. For that reason they add up to zero. At 4 wave F has gained a whole cycle on S, and they are in phase again and add up to a strong resultant. This action is continued indefinitely. Of course, with the side bands and the carrier there are *three* such waves all adding together at the same time, but the idea is just the same. It is merely more complicated to illustrate in a drawing.

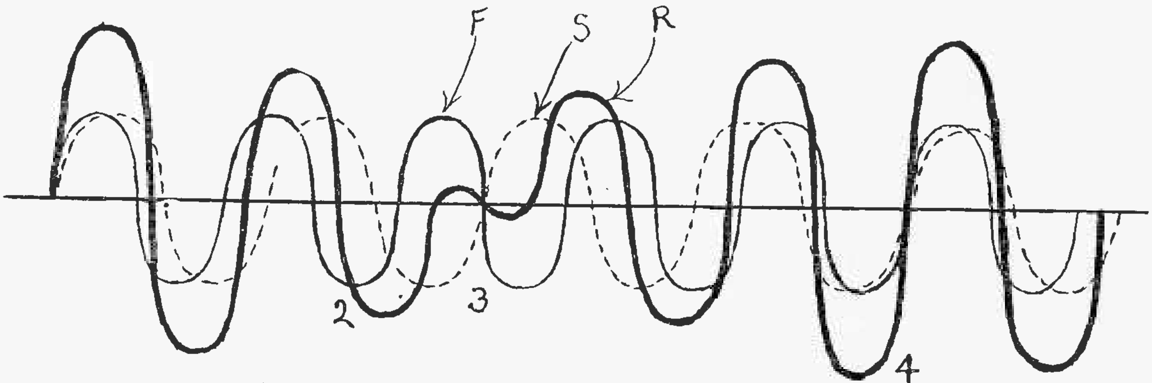

Fig. 4. How Two Waves of Different Speeds Add Up

What is Meant by Frequency

No two successive cycles of the modulated wave are alike in amplitude. But are they alike in frequency? Before we can answer this question, we must say what we mean by this word. When it is applied to something that repeats itself exactly time after time, it has a very definite meaning. The "frequency" is the number of these exactly similar cycles that occur in one second. But when the cycles are constantly changing, what shall we say? It is like a man driving an automobile. If he goes along fairly fast you say he is traveling twenty miles an hour. We do not mean that in the next hour he will go exactly twenty miles. But if he should continue at the same rate of speed for another hour, he would cover that distance. Perhaps he stops his car inside a minute. That, however, does not change the fact that he *was* going twenty miles an hour. In the same way we can only say that the frequency at any instant is the number of cycles which would occur in one second if all the following cycles were exactly like the one occurring at that instant. In a modulated wave therefore, we must think of the frequency as constantly changing in its instantaneous value.

The limits between which the frequency of a modulated wave changes are the sum and difference of audio and radio frequencies, which we have called the side bands. Let us take a numerical example now, and see how this all works out.

When He Sings High C

Let us say that the carrier or radio frequency which we wish to use is 800,000 cycles per second. This corresponds roughly to a wavelength of 380 meters, (like station WGY) that is, the peaks of the wave as it travels through space will be 380 meters, or about a quarter of a mile apart. Let us say that the voice frequency at the instant we are considering is 1000 cycles per second. This corresponds roughly to high C on the piano.

The modulated wave, then, has a nominal frequency of 800,000 and its amplitude varies up and down 1000 times per second in accordance with the voice frequency.

The side bands will be the sum and the difference of these two frequencies, that is, 801,000 and 799,000 cycles per second, and the instantaneous value of the frequency of the modulated wave will vary between these two as limits. It is seen at once that if a receiver is to respond to this modulated wave, it must not tune so sharply as to give a different intensity to the different speeds in this band. If it amplifies the 800,000 cycle part of the wave 100 times, when tuned to that, it must give practically the same amplification up to 801,000 cycles and down to 799,000 cycles, or else the music will be distorted.

Musical notes contain frequencies as high as 4000 or 4500 cycles per second. The receiver must therefore have a band of uniform response 8000 or 9000 cycles wide. It need not, however, have a band any wider than this. This is the limit to which the selectivity of a broadcast receiver can be carried, and to which it should be carried, if we are to be able to chose between broadcasting stations at will. Each station uses a different nominal frequency, and these nominal frequencies as assigned by the Department of Commerce are 10,000 cycles apart, so that as the waves vary up and down 4000 or 4500 cycles each side of the nominal frequency, they will not overlap each other.

Until the advent of the super-hetrodyne receiver, nothing even approaching

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Squelching Squeals in an Amplifier

The Resistance Connected Unit Has No Distortion

By EDWARD W. SMITH

THE progress of the radio art since broadcasting first started has no better illustration than in the development of the audio frequency amplifier. When the first types of vacuum tubes made possible audio frequency amplification there was an immediate rush for apparatus which would bring in distant stations. Various types of detector tubes were tried by experimenters with varying plate voltages, filament currents and so forth.

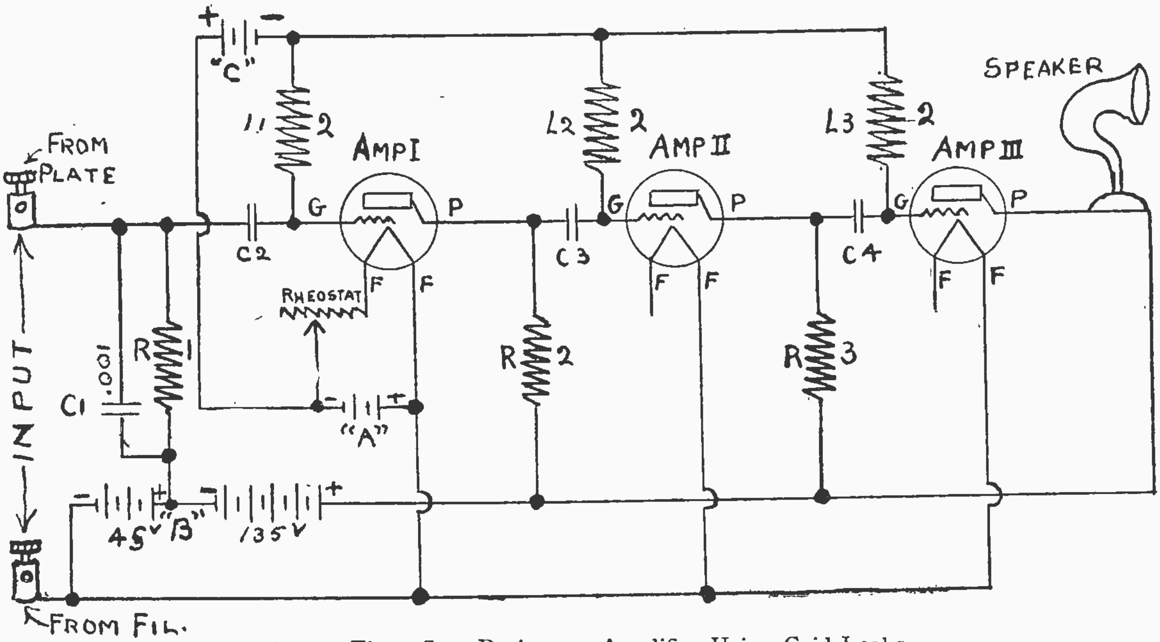

Fig. 1. Three-Step Resistance Amplifier Using Grid Leaks

When the radio fans found they could not get farther with the sensitive detectors then available they turned to two or three steps of audio. At first quality was not thought of. The idea was to be able to boast to your neighbor that you copied a message 100 or 1000 miles away. Even now many listeners would rather pick up a cross country station whose call letters they must guess at, rather than listen to a good program a few hundred miles away.

Now, however, the tendency seems to be toward good quality from stations easily within range rather than distorted reproductions from far distant stations.

Advancing Amplifier Design

Audio frequency amplifier design has followed this same order to a great extent. The first audio amplifiers were coupled between tubes by transformers which were undeveloped and highly inefficient, giving poor quality but some increase in volume. Next there was a period of amplifier construction involving two, three, and even four stages of transformer coupled audio steps with high ratio transformers. Last of all, however, designers turned their attention to the construction of transformers which gave enough volume with good quality. It is at this stage of the game that the resistance coupled amplifier comes into favor.

The resistance coupled amplifier is one of the oldest and best units ever produced. In the first rush for quantity of sound rather than quality it was thrown aside and almost forgotten in favor of transformer coupling. But users of this style find that it is easier to hear what the speaker says, that is, distortion is avoided, and besides this the squeals and howls which are sometimes heard in transformer coupling are absent when resistance is used instead. Naturally, making such a change will not remove the squeals which come in from neighboring regenerative sets. But what it will do is to prevent good amplifiers from adding a squeal obligato of their own. Briefly the theory of the resistance coupled amplifier is as follows:

Theory of Coupling

The varying voltage on the grid of the first amplifying tube causes a varying current to flow in the plate circuit of that tube in the usual way. This current is made to pass through a pure resistance connected in the plate and "B" battery circuit, and of such size as to have a large part of the voltage drop around the plate circuit across its terminals. As the current through the plate varies as just described, naturally the voltage drop, which is caused by it, will change in that proportion. This change in potential is then passed on to the grid of the next tube through a condenser of suitable size. Since the voltage drop passed on to the next tube is obtained by the passage of audio frequency current through a pure resistance it follows that the voltage change will be exactly proportional to the current change. This is in accordance with Ohm's law—the basis of all current action. As the voltage change follows the fluctuations in current so precisely, there can be no distortion by this method of amplification, provided that the tubes are operated properly. One of the disadvantages of this method is that the only amplification obtained is that of the tube itself. That is, the extra step up which is ordinarily found in the transformer connecting one stage to another is missing. This disadvantage is not serious, however, as it is customary to use three stages of resistance steps where two transformer coupled tubes would otherwise be employed. This will be explained further in a later paragraph.

In the following discussion a description of the necessary apparatus will be given. The circuit diagram is shown in a typical resistance coupled amplifier.

Kind of Units Used

The resistances, R1, R2, R3, in the diagram Fig. 1, are of the type known as "lavite" resistances and are of 50,000 ohms resistance. Higher resistances can of course be used up to 100,000 ohms or thereabouts with slightly increased amplification per stage. It can be shown, however, that increasing these values much beyond the first one mentioned does not give so much of an increase in amplification, and at the same time the necessary "B" battery voltage becomes excessive.

The condensers C in the diagram can be conveniently of a capacity from .003 up to .100 gfd. (microfarads). However, a good value which will answer all purposes is .006 mfd. This should be insulated with mica.

A condenser of this size will offer a low impedance path to frequencies as low as 100 cycles. For higher frequencies it will offer a path of still less impedance.

Putting on a Grid Bias

The grids of all tubes may be maintained at the proper negative potential by means of a "C" battery which is connected to the tubes through grid leaks of approximately 2 megohms resistance as shown in Fig. 1. This "C" battery voltage depends on the amount of plate pressure used, say in the neighborhood of 4 to 6 volts.

If desired the "C" battery may be left out and the proper bias or voltage impressed on the grid can be obtained by using a correct value of grid leak resistance. In this case the leak is connected to the plus side of the "A" battery as shown in Fig. 2. The first leak should be about one megohm. The second step employs one-quarter of a megohm, and the third 1-20th (50,000 ohms). By using the proper value perfect results may be obtained.

The plate battery may have a voltage of from 100 to 200 volts with increasing output for the higher voltages. A plate battery of 200 volts is to be recommended. Remember that a good part of the "B" battery pressure is used up in forcing current through the coupling resistance, D1, R2, etc. Only what is left is actually impressed on the plate. If a voltage of say 90 is found desirable to use in the circuit of a certain vacuum tube then we must have at least double that on our "B" battery terminals in order to make up for what is lost through the resistance. That is why the detector should have a tap on the "B" battery taken at 45 volts rather than the 22, as usually connected. With such an adjustment you will find that about 22 volts actually reaches the detector so that it will work as usual.

Comparing Two Kinds

With a 3-stage resistance coupled amplifier, using the marked values of resistance, capacity, and so forth together with UV-201A tubes, a voltage amplifica-

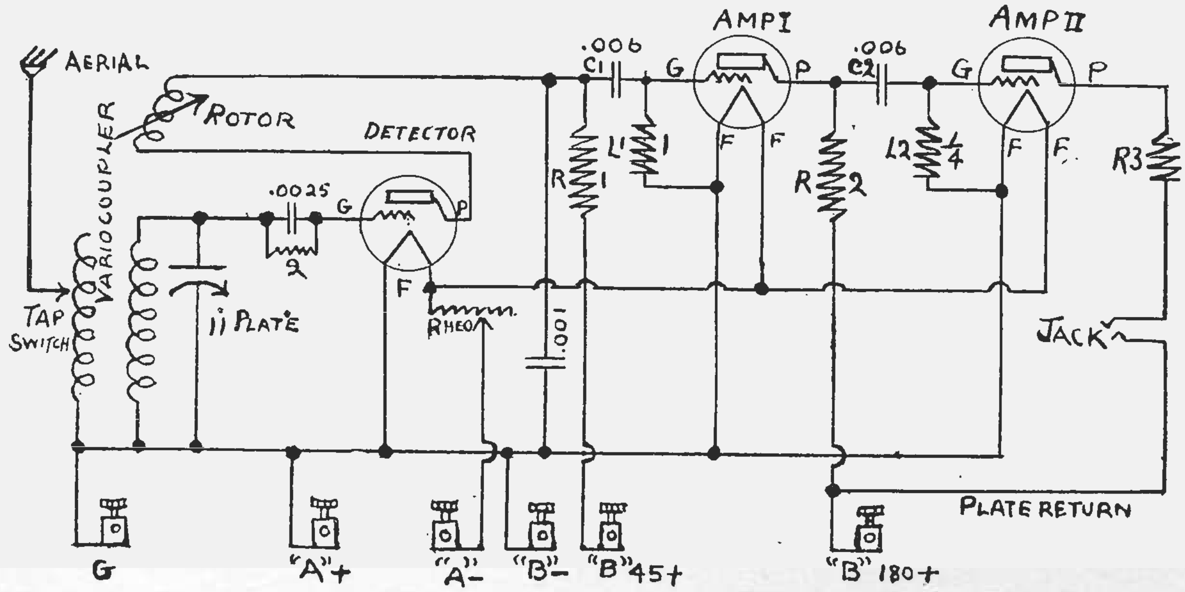

Fig. 2. Detector and Two Steps Resistance Amplifier Without Leaks

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Learning to Talk Radio

Which New Language Is Best, Ilo or Esperanto?

By OLIVE D. ARNOLD

THIRTY or forty years ago, some one who found difficulty learning French or German, decided that it would make it a lot easier if there were not so many exceptions to the rules to be learned. It was hard enough to learn the rules themselves, but after spending hours and hours to master them, then it was found the fun had just begun. For every page of rules there were ten pages of exceptions. Wouldn't it be fine if a foreign language had only a few rules, and no exceptions?

With this idea at the start, various languages have been built up which are easier to learn than any of those in natural use today. But they all had one big trouble. Nobody could speak them. Until the coming of radio there was not much of an incentive for people to learn a general language. Of course, there were a good many occasions where it was necessary for men of different nations to understand each other, but in most of such cases the men who met together were delegates to the convention and had been chosen from those educated in foreign languages. Many were able to talk in English, French, German, or Italian, and so could select some language which all could use. Take the delegates to the League of Nations for instance. You do not hear of any trouble about the nations getting together as all the members have learned several foreign languages.

Different with the Fan

But in radio broadcasting we see a different picture. Most of the fans have learned to talk only one language. Perhaps they studied French and German in high school, but how much do they remember of it now? When a fan in America has a good radio set and listens to Montreal talking French, and Cuba singing in Spanish, he begins to wish that he could understand these other languages. And across the water, the condition is much worse. The various nations are packed in a lot closer together, so that five or six different languages can be picked up by a good set almost any night. As improvements are continually made in the art it seems likely that we shall be able to pick up Europe ourselves in the near future. What good will it do, though, if we do not happen to understand Parley Vous or Sprechen Zie?

Of course, the ideal way would be for all the rest of the world to learn English. The foreign nations all believe this too, except they substitute French, Spanish, or whatever language they happen to speak. So it looks as if a new language would have to be used which was different from any of the natural ones now spoken. The big question is, "What shall it be?"

Ilo and Esparanto

There are only two built up languages, which are now being considered. The oldest of these is Esperanto, and the newer Ilo. (I pronounced as in machine). This latter is often called Ido, but recently some of the leading users have taken the initials of "International Language" and added the "O" which shows the word to be the noun and so named Ilo. In the rest of this article we shall call this language by the newer name, but it is to be understood that either one means the same thing.

All those interested in an international language are divided into two camps, each favoring one of these two tongues. The rivalry between them is very keen. Most of the articles written on the subject seem to be very bitter toward the opposite side, and do not give it justice in the discussion. After a considerable study the following comparison between the two is made.

Ilo Easier for Americans

If you already speak English you will find Ilo very much easier to learn. There are five reasons for this, as follows:

1. *Alphabet.* Ilo uses the ordinary alphabet with which we are all familiar. Esperanto has twenty-eight letters. It leaves out "Q," "W," "X," and "Y," and adds six other ones which requires a special font of type. These are "C," "G," "H," "J," and "S," each with a little accent mark called a circumflex on top, and "U" with a small semi-circle on top. Naturally, these six letters, with their accents, do not appear on any ordinary typewriter and so a special typewriter

ILO.	ENGLISH.	ESPERANTO.
Ni admiras bone kultivita agri, bela e neta vilaji ed urbi, piktinda vali, foresti, abismi, o montegi kun eterne blanka somiti. Anke omna ti qui prizas turismo, sporto od amuzaji, trovas maxim bona okazioni en Suisia.	We admire well cultivated fields, beautiful and neat villages and towns, picturesque valleys, forests, chasms or mountains with eternally white summits. Also all those who like travel, sport or amusement, find the best opportunities in Switzerland.	Ni admiras bone kulturitajn kamparojn belajn kaj purajn vilaghojn kaj urbojn, pentrindajn valojn, arbarojn, intermontajhojn, au montegojn kun, eterne blankaj suproj. Ankau chiuj tiuj, kiuj shatas turismon, sporton au amuzajhojn, trovas plej bonajn en Syisujo.

Fig. 1. Saying the Same Thing in Three Languages

must be used to indicate them, or else a dash or apostrophe can be used after each one to show that letter is special. However it is done, it is quite awkward. The same trouble appears when trying to send Esperanto in wireless code. Most hams use the letter "h" after the above letters or a "c" in front of the special "h" to show that it is not the ordinary letter transmitted. It is quite complicated until you get the hang of it. As just mentioned Ilo uses the ordinary alphabet.

2. *Pronounciation.*. Both languages pronounce the vowels about the same way. A is pronounced as in father; I as in machine; E, O and U about as in English. The consonants in Ilo are about like what we are used to. The same is true of Esperanto with a few exceptions. J is like the English Y; C is TS. This is rather hard in some cases, as for instance the word meaning "Know," which is "Scias." This is pronounced "Stsias." Try this on your piano and you will see it is not a very easy combination to pronounce. Besides this, the six new letters must be learned. Take it all in all, the pronounciation of Ilo can be learned in a small fraction of the time needed for Esperanto.

3. *Looks.* If you glance at a page of Ilo it looks something like French, Spanish or Italian. When, however, it is Esperanto, you would think that it was Russian, or Bohemian. Those who have never studied a foreign languag get scared at the appearance of Esperanto. Those who are familiar with French, or Italian are able to re d a lot of Ilo at sight. In the examples of both languages, which we show (Fig. 1), you will notice the difference. But remember that owing to the lack of the special type with the accent marks on them, these latter have all been omitted. If they had been inserted correctly, it would have made the appearance of the Esperanto considerably worse.

4. *Word Order.* Since Ilo uses about the same word order as English they do not need any changes in the endings of the words to show which is the subject and which the object of the verb. In some foreign languages each noun is inflected or changed to show which is which. Of course, we do that ourselves in some cases. For instance, we say, "I hit him" or "He hit me." But "John hit Harry" or "Harry hit John" unchanged. In Ilo the uninflected forms are used and the order of words is depended on to show who did the hitting and who got hit, just as in English. In Esperanto you can use various orders of words, but to show which is the subject and which the object, it is necessary to change the last letter of the word. To an American this seems an unnecessary complication.

5. *Vocabulary.* Both these languages have so few rules and no exceptions to them that the only hard thing to learn is the vocabulary. In this, Ilo is way ahead of its rival. Esperanto started with the idea of using a good many words which were common to several languages and they did pretty well considering that they did not have very much experience to go by. But the inventors of Ilo made a very special point of this and spent a great deal of time in getting words which would be familiar to the inhabitants of all the big countries. The main part or root of a word in Ilo is recognized by the foreign learner in the following proportions:

French, 91 per cent.; Italian, 83 per cent.; Spanish, 79 per cent.; English, 79 per cent.; German, 61 per cent.; Russian, 52 per cent.

This may seem to give unfair advantage to the French and Italians owing to the fact that the proportion of words recognized by them is higher than that of English. But it must be remembered that the words were picked out which appear in the greatest number of languages and the French are particularly fortunate in that so many of their words are used by several other different nations. At any rate, the Americans do not find it very hard to pick up words in Ilo, whereas in Esperanto, it is much harder. For instance, the author found that picking out pages at random and never having studied either language, he was able to read enough Ilo at sight to make out what they were talking about while with Esperanto he had no idea what any of it meant.

Discussing the Advantages

Most discussions of the two seem to be beside the point. For instance a great deal is said about their relative age. It does not seem as if this enters into the question at all. The adherents of Esperanto make the age of their language a big point. If this is important, why not learn Aztec, which is some thousands of years older?

Another point is the relation of one to the other. It is said that Esperanto is the original and Ilo an offshoot. This is undoubtedly true, but is that fact not in favor of the latter? It was only because the former had many errors that an offshoot was needed. Everyone admits that Ilo is much more logical and is nearer perfection as a language. But those who are in favor of Esperanto claim that their language is better because of this very fact. They say it is much more human, because it is imperfect. That may very well be, but when any one is studying hard to try to pick up a new language he does not care whether it is human or not,—what he wants is something that is easy to learn and remember.

Growth of the Language

As Esperanto is considerably older its adherents point to its long growth as a good factor. The other tongue, they say, was made from an idea rather than a growth. The same thing may be said comparing the money of England and United States. In England the money system was the growth of years. The result was pounds, shillings, and pence. Four farthings make a penny; twelve pence, one shilling; twenty shillings, one pound; twenty-one shillings, one guinea (if we have not remembered wrong.) When Congress first met in the new United States, they decided they did not care about growth, they wanted the best idea. Result—one hundred cents make a dollar. Which do you prefer?

In the total number of people who have studied the language, Esperanto is naturally ahead. Since it is a great many years older than its rival and was the first practical international language made, it naturally follows that more people have studied it. As Pat said, "Where will you find a new friend that stuck to you as long as an old one?" This is the one claim in which Esperanto wins. If both were to start today as brand new, there is not a chance in the world that the latter would be given a second thought. But it has got a good start and a great many of the best educated men, especially abroad, have studied it.

Is This a Big Advantage?

The question arises though, as to how great an advantage this is. Just take the trouble to ask your friends if they have learned Esperanto. We venture to

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WHAT THE THIRD CONFERENCE DID

THE Radio Conference, which took place the early part of October, at Washington, was called together, as you will remember, by Secretary of Commerce Hoover. Just like the first two, the third accomplished a lot of real work. This is to be expected after seeing the smooth way in which radio affairs have been handled in the last year or so.

There were seven major decisions arrived at by the Conference. Perhaps we should not say decisions, for as we have mentioned before, the last Congress did not pass the bill which was to have given the Federal Government the right to decide a lot of perplexing questions. As a result, the authority of our government is rather weak when it comes to radio matters, and a large part of the control, which the radio department exercises, is by the voluntary consent of the governed. While no doubt this is an ideal situation as long as the present high standard continues, we advocate giving the government at Washington the right to command instead of merely suggesting.

The Seven Big Results

The first decision arrived at was to hold down the size of the big sending stations practically to the present limit. So far, no one in the United States is allowed to do regular broadcasting on the ordinary wave length, using more than 1000 watts (1 kilowatt) of power. This is the amount of energy needed to run two ordinary flat irons. Putting it that way, it does not seem very large. There are a few stations outside of the United States which are regularly using up to five kilowatts. Besides this the General Electric and Westinghouse have both received special experimental licenses to use several kw in their development work. This is done mostly at short wave lengths of around 100, and so is never heard by the listener using an ordinary radio.

Those opposed to increasing the limit of power brought out the fact that a large number of the powerful stations are located in or near big cities. This means that further increase in the power would put the inhabitants of these cities at great disadvantage when it came to their trying to receive outside stations while the local one was running. Some of the big broadcasters felt that this trouble could be avoided by locating the superpower transmitters some distance, say twenty-five miles, outside the city limits. A discussion of the problem from this angle is found in this issue of RADIO PROGRESS.

Left to Secretary Hoover

The meeting finally decided not to pass a special rule on this matter but to leave the decision to the Bureau of Commerce and Secretary Hoover, since they had already handled other radio problems in such a satisfactory way. The understanding is that in general the limit is to be one kilowatt as before, but that a very few broadcasters will be allowed to use up to five kilowatts under special license. These few stations will be watched very carefully, and if they seem to show an advance in the art, then later on this limit will probably be raised still higher.

The second decision was to increase the band of broadcasting wave lengths to include from 200 to 545 meters. This will allow several more big broadcasting stations to operate at the same time without interfering. When it is considered that there are between 500 and 600 stations licensed to send in the United States and that some of them are already so powerful that they are heard from one coast to the other, it is easy to see that more different wave lengths are needed. The action of the meeting in throwing open a wider band for this use will help relieve this situation.

The Censor is Unpopular

The third point was that no censorship or monopoly would be permitted. Of course, the regular rules against indecent language, libel and the like, hold in radio as they would in a newspaper, but short of illegal utterances each broadcasting station is allowed to send what it pleases. Monopoly is also frowned upon. We are glad to note that the freedom of the air is to continue in the future, as it has in the past. Comparing conditions in America with those abroad, where a rigid censorship is maintained, will show how much better our plan is than that across the water. In spite of the freedom which is allowed to our stations, we have not run across any complaints against matter which has gone out from any of the broadcasters. This is a splendid record.

The fourth decision was to cut the 300-meter band off the assignment to ships. Not much sending of code has been done at this frequency, but whenever any ship did use this wave length to send dots and dashes, it caused a great deal of interference with the programs being sent out by broadcasters using around this band. Furthermore, the 600-meter channel is not to be used by vessels except for sending SOS signals (the danger call on the sea). The ship stations, which used to send on these waves, oftentimes did not have the best of equipment, and so their dots and dashes had broad enough tuning to be heard by radio listeners who were picking up one of the higher wave length stations. This change will not have any bad effect on communications between vessels and will clear up a great deal of complaints on the broadcasting bands.

Connecting the Big Stations

The fifth agreement reached was that of interconnection. Secretary Hoover himself made a big point of this. He thinks it is the biggest development of the art during the last year. There have been several instances recently where fifteen or more stations have all been connected together, and so sent out a program which has been heard over the entire United States. This seems to be the coming thing. Of course, the small local station will not be eliminated by it. It is like the newspapers—the big metropolitan issues are sent around the country to a radius of several hundred miles from the office, but that does not kill the small local issues, which are widely read for their local news. If the big stations several times a month are linked up for a national program, the people will be just as glad to listen to their local talent from the smaller broadcasters the rest of the time.

The sixth decision of the Conference was gradually to change over the frequency of the Class C stations. These, you will recall, are the ones which operate on 360 meters. Up to a year ago all the senders in the United States were scheduled to use either 360 or 400 meters. At the second Conference this was changed to allow those that wanted to make a shift the privilege of using other speeds of vibration. Many of the smaller stations thought that the cost would be too great to redesign the apparatus, and so they stuck to their old wave length, 360 meters. Such senders were classed as C stations. At the present time the cost of altering the wave length is small, and the number using this one frequency is so great as to cause a good deal of interference. For this reason the radio department will endeavor to change over the frequency of many of the smaller stations as occasions offers. This is to be left to the discretion of the department.

More Money Needed

The seventh big subject discussed by the Convention was the lack of funds to carry on radio work by the Government. In the program for saving money which the Federal authorities are pledged to follow, a lot of the savings has apparently taken place in the radio section. While we are all heartily in favor of saving money so that our taxes can be reduced, it was the opinion of the meeting that it might be better to cut down on some of the large number of government clerks and officials and use a little bit more in the radio section. At the present time there are less than twenty-five qualified inspectors to take care of the whole United States. It does not seem as if they were likely to crowd each other in their work covering roughly three million square miles. It was the sense of the meeting that Congress should be asked to appropriate funds for a more adequate supply of radio inspectors.

In reviewing the results of the Conference, we are very glad to see what a lot of constructive work was accomplished.

GOING TO SCHOOL AGAIN

While most of us look back with pleasant memories to our school days, we do not want to go back again—at least to the studying part. It is pretty hard to find time to get out a text book and study some hard problem. That is why it is going to be slow work to introduce a new language to the radio audience.

Radio fans, as a whole, seem to be interested in being able to talk with other nations, but of course, we have got beyond sign language —we have to have words to talk. As explained at length in an article in this issue of RADIO PROGRESS, there are two possible languages either of which apparently might answer the present need. Our contributor seems to be strongly in favor of Ilo. As he sums it up, the big advantages are the ease of Ilo and the establishment of Esperanto.

This is going to be a live issue. It probably will not be the politicians who decide it. What good will it do to have a body of men choose a certain language if you and a million more others will not learn the new language? The whole point as we see it is to find the popular choice. We shall welcome letters from our readers as to what they think of the merits of these two tongues.

THE THRILL OF A LIFETIME

The question of paying radio artists is being brought up again. It seems that some of the singers whose silvery voices have delighted our ears have begun to want to exchange some silvery coin for the silvery voice. This is naturally beginning to alarm some of the broadcasters, because the latter get no direct return for their service to the public in sending.

Many seem to think that there will always be plenty of talent who will be glad to contribute their services free to the sending station. Undoubtedly there always will be plenty of people who will be glad to perform before the microphone without asking any pay, but will they be the kind of talent that we wish to hear? The first time a singer goes on the air and realizes that his voice is reaching thousands, perhaps hundreds of thousands of listeners, he gets the thrill of a lifetime. But after the first few times the novelty wanes and he begins to think about pay for his time. It is not surprising that this question is being agitated by the artists.

How They Do It In England

An Interview with Capt. P. P. Eckersley, Chief Engineer of the British Broadcasting Company

THOUGH lacking something of the personal touch which it is given in England, radio broadcasting in the United States has made great strides in the face of tremendous difficulties. As a tax supported enterprise, the British Broadcasting Company has the full support of the government. For this reason it has large sums of money at its disposal to spend on programs. This has made it possible to secure many artists of a type which the stations in the United States, owned by private concerns, could not well afford, or could not present to the public because of contract clauses prohibiting their broadcasting. This last applies to many opera and phonograph stars.

Quite naturally, however, radio programs in the two countries have developed along much the same lines. Concerts, both classical and jazz, organ recitals, talks by prominent men and women on subjects of general interest, important meetings or dinners of various societies, the children's hour, etc., are common to the programs of both countries. You in America, on the other hand, have been able to broadcast major athletic events while they were in progress. We hope to arrange to do this in the near future. Then, too, we are broadcasting political speeches for the first time during the coming election—a thing you have done in the past.

Interested in Broadcast Plays

We have never experimented with the full length play, but have done a great deal with the shorter productions. Formerly we brought in outside artists when producing plays, but we have recently established several reportoire companies which present one or more one-act plays during an evening's entertainment.

I feel that a distinctive radio artist and a radio drama will be developed. These will differ from the stage or platform artists and the spoken or moving picture drama. Your players, and their work, are a step in that direction. In England we now have a number of professional artists who devote themselves exclusively to radio work. There will be more and more of that sort of thing.

They Don't Hunt DX Abroad

The distance fan is not as common among the English listeners as among the Americans. This is due largely to the fact that the majority of the outfits in England are crystal sets. Most towns in England are within 15 or 20 miles of a sending station. There are, however, a considerable number of fans who are extremely interested in receiving distant stations, and the trans-Atlantic tests were very popular.

England, with 20 broadcasters on May 1, 1924, has almost exactly the same number of stations in proportion to its population as the United States has with 500. England's stations are located to better advantage, however, so that most of the population can get at least one broadcaster on crystal sets.

WHAT THE DIAMOND MEANS

Buyers of hard rubber radio panels now are protected against inferior materials. The Rubber Association of America, Inc., has adopted stringent quality standards for hard rubber radio panels, as well as a special diamond-shaped symbol which will appear on panel containers to indicate that the contents meet the Association's standards. This special symbol may be used only by manufacturing members of The Rubber Association whose panels conform to those requirements. Its use signifies that the manufacturers guarantee the quality and special suitability of their products for radio work.

This action by The Rubber Association of America, Inc., solves a very troublesome problem. Hard rubber of inferior quality, much of it never intended for radio use at all, has flooded the market since the very first days of the art, much to the detriment of the hard rubber product really meant for radio work. Hard rubber of the proper qualities is so perfectly suited for this work that it has been the material to which many radio enthusiasts—both amateur and professional—have naturally turned. But the presence in the market of quantities of low-grade hard rubber has confused the situation, and there has been little to aid a buyer in distinguishing good hard rubber panels from bad.

The Rubber Association of America, Inc., is made up of most of the leading rubber manufacturers of the country. By consenting to take a part in specifying proper quality standards for hard rubber panels, the Association has come to the rescue at a time when a strong hand was needed to clarify the situation.

The Hard Rubber Manufacturers Division of The Rubber Association has adopted specifications covering absorption, volume resistivity, phase difference angle and dielectric constant. These are the most important qualities which determine the suitability of any radio panel for its particular work. Hard rubber excels in these properties. Consequently, the purchase of such radio panels which meet the Association's quality standards assures all of these advantages to the radio enthusiast.

MEN WERE ASHAMED OF RADIO

Radio merchandising conditions have greatly changed in the last three years. Years ago youngsters were the main radio buyers. Whenever an older person would drop in to purchase wireless apparatus, he would always make it promptly known that the apparatus was intended for his son and not himself. Older persons were really ashamed to admit they experimented in what was then considered boys' play. Now the situation is changed. There are really comparatively few boys that form the purchasing market. No man is now ashamed to admit he is building his own radio receiver. Then, again, in the older days the demand for receiving apparatus of the higher grade did not exist; every one was interested in more powerful transmitting apparatus.

Fun For Fans

Reliable Signs

He—"Do you believe in signs and omens?"

She—"Yes."

He—"Last night I dreamed you loved me. What does that mean?"

She—"That you were dreaming."—*Korsaren (Christiana).*

Indisputable

Vicar—"What would happen if you were to break one of the ten commandments?"

Willie—"Well, then there would be nine."—*The Continent (Chicago).*

One feature of the radio—a lot of people have learned to pronounce Schenectady.—*Enarco News.*

Information Wanted

He—"Do you like Kipling?"

She—"Why—I don't know. How do you Kipple?"—*Epworth Herald.*

Now We Know What it is

A jazz band is a group of citizens who are paid for playing static.—*Detroit Times.*

Or the Snake's Hips

The wife and daughter of Lieutenant Berry of the Great Lakes Training Station approached a gate guarded by a sentry, who had orders to allow no one to enter.

"Sorry, but you'll have to go around to the main gate."

"Oh, but we're the Berrys."

"Lady, I don't care if you're the cat's meow, you can't go through this gate."—*Crosley Radio Weekly.*

SQUELCHING SQUEALS

Continued from Page 20

tion of about 200 can be obtained, as compared with about 400 for certain frequencies with the transformer coupled amplifier. One might draw the conclusion from the above figures that if we placed a resistance and a transformer coupled amplifier side by side, that the latter would give twice as loud a sound output.

This is not the case, however, for the following reason. Most of the energy in a piece of music is carried in the frequencies below 400 cycles, with comparatively little energy in the high notes. If now we place a 3-stage resistance coupled amplifier and an ordinary 2-stage transformer coupled amplifier side by side we find that there is very little difference in the volume of sound output from the two, due to the fact that the resistance coupled amplifier is increasing the loudness of the frequencies in the lower region practically as well as those in the higher range. The ordinary transformer coupled amplifier drops out most of the low frequencies, and so the output of the resistance coupled unit sounds just about as loud and at the same time has the highly important advantage of giving uniform tone multiplication over the speech and music range.

Hooking Up the Set

In Fig. 2 we have a complete hookup of a four tube set consisting of a detector and three amplifiers. As shown the detector is of the two-circuit regenerative type, although any other first class receiver would be just as well. The tap switch, shown connected to the aerial, gives control of the primary tuning, while the secondary is adjusted by the 11-plate tuning condenser. A grid leak of one or two megohms and .0025 grid condenser completes the primary circuit. The output from the plate is led through the rotor of the varicoupler, which serves to give regeneration. From there the radio frequency wave passes through the .001 by-pass condenser back to the filament. The "B" battery current is taken from the 45-volt tap, through the coupling resistance R1, which has a value as already described of 50,000 to 100,000 ohms (1/20 to 1/10 megohms.) The fluctuation in voltage caused by the change in current through its resistance is fed through the condenser, C1, to the grid of the first amplifier tube.

This condenser is needed to prevent the voltage of the "B" battery from being impressed on the grid of the first step. Such a high pressure on the grid might damage the tube which is designed for only a small fraction of a volt in that location. Instead of using a "C" battery, as shown in Fig. 1, the same result is obtained by connecting the grid leak L1, with the lower end hooked up to the A plus terminal. By giving the leak a proper value, the correct bias is supplied to the grid. For the first amplifier tube a leak of one megohm will be found about right. The output from step one is fed to C2, the coupling condenser of the second step. The resistance, R2, is like R1, but is connected to the 180-volt tap of the "B" battery rather than the 45-volt point. This is because the amplifier tube uses about 90 volts on the plate itself. Allowing 90 volts drop in the coupling resistance, R2, than the total needed will be 180 at the "B" battery. Of course a difference of 30 or 40 volts at this point will not be serious, as the pressure on the amplifier plates is not at all critical.

Varying the Leaks

For the second tube, it is well to use a smaller value of resistance in the grid leak. About 1-4 of a megohm is found right for this location. If a third step of amplification (not shown in Fig. 2) is used, a resistance of 1-20th megohm (50,000 ohms) is customary. This third is not shown, but it is hooked up exactly like steps 1 and 2, except for the value of the grid leak. It will be seen that the output from the plate of the last step runs to the jack through a resistance, R3. This is not really necessary, but owing to the high value of "B" battery used it is usually better to employ a resistance of 4000 or 5000 ohms at this point. Otherwise, the current through the loud speaker will be unusually large, which is an unnecessary drain on the "B" battery.

Instead of using resistance, R3, the same results may be accomplished by running the plate return from the last tube back to the 90 or 120 volt tap on the "B" battery. This reduces the current through the last tube without needing resistance R3.

In conclusion it may be said that anyone who constructs an amplifier after the instructions given above may be sure of pure, faithful amplification.

American Radio Relay League

NEW WAVES FOR OLD

President Hiram P. Maxim, of the American Radio Relay League, and Kenneth B. Warner, Secretary, represented amateur interests on the Hoover Commission at the Third National Radio Conference. They expressed pleasure at the decision of the conference to continue, in about the same form, the short wave lengths allotted recently on trial to the amateurs by the Department of Commerce. The action of the conference approves the Department's assignment of such waves, and both of the League officials remarked that the situation of the amateur remains the same except for small changes that will improve results.

The amateur subcommittee of the conference recommended that all amateur transmitters be required to be loose-coupled, which is a voluntary suggestion of amateur interests still further to remedy interference. The committee further advised that amateur phones and I. C. W. (interrupted continuous wave) sets, which are more apt to interfere than others, should be limited for use entirely to that band of wavelengths between 170 and 180 meters. Other members of this group dealing with amateur problems were Charles A. Stewart, vice-president of the A. R. R. L.; A. H. Halloran, editor of "Radio"; A. H. Lynch, editor of "Radio Broadcast"; Zoh Bouch, P. C. Oscanyon, Dr. C. B. Jolliffe, C. M. Jansky, Jr., and E. H. Armstrong, inventor and former amateur.

The Conference Report

"The conference has allocated to amateurs the same frequency bands that are now in use with some minor changes in their location," say the confrence report to Secretary Hoover. "The temporary allocation of waves below 150 meters made by the Department to the amateurs some months ago is given definite approval with some slight changes in the bands. The net result of this is to give amateurs an increase over what they had at the end of the conference a year ago, and to allow them a greater area for operation."

It was brought out at the conference that the short waves, which had been assigned amateurs as a test of their efficiency, had been a substantial factor in reducing interference with broadcasting. Secretary Hoover made it clear that the value of amateur experiments with such waves were such that the conference would do well to look to the further protection of amateur interests. The amateurs were assigned 150 to 200 meters; 74 to 85.6; 37.5 to 42.8; 18.7 to 21.2 and 4.7 to 5.3, the lower wave-length bands being written in decimal figures in order to make the kilocycle rating read in whole numbers.

The amateur representatives at the conference were much pleased with the spirit of co-operation which pervaded all the sessions. They reported that broadcasters displayed no interest in short waves except for relaying between sending stations for inter-connection, actual broadcasting for the public continuing on present waves, which existing radios are prepared to receive. All of the waves below 150 meters have now been assigned by the conference, however, there being several channels each for relay broadcasting, toll telegraphy, beam transmission, etc.

Mr. Maxim's Report

In the statement which he read before the conference Mr. Maxim declared that he represented not only 17,000 members of the A. R. D. L., located in every state of the Union, but also the amateurs of most of the civilized countries whom, he said, "look to us Americans to preserve and protect amateur radio." Continuing he said: "Those of you who are not informed on foreign matters will be surprised to know that the laws in several countries in various parts of the world have actually been modified to give their amateurs the privileges and the freedom already enjoyed by amateurs of this country.

"All that we desire is to be permitted to continue to use the bands that we now occupy, to continue to produce contributions to radio science, and to perfect large numbers of young men in radio telegraphic communication."

OMAHA TO HOLD CONVENTION

The first convention of the American Radio Relay League's Midwest Division, which includes the states of Nebraska, Iowa, Kansas and Missouri, will be held in Omaha, Neb., November 24, 25 and 26 under auspices of the Citizen Radio Club of Omaha.

An interesting and elaborate program has been arranged which will keep amateur delegates entertained the entire three days. A. A. Hebert, field secretary of the A. R. R. L., will be present and will make one or two addresses on the League and its work.

TALKING ROUND THE GLOBE

The report that the "ends of the world" had been united by amateur radio, as announced by the American Radio Relay League, comes as a complete surprise to all transmitting amateurs. They all find it difficult to believe that two operators, within a few hundred miles of the Antipodes, or points on the earth just opposite each other, have communicated with one another over 11,900 miles of land and sea. This surprising feat, which was accomplished by C. W. Goyder of London, England, and Frank D. Bell of Waihomo, New Zealand, came during a period of remarkable "radio weather" when a number of long-distance records were being made.

Beginning with the two-way contact between amateurs in California and New Zealand, world's records were made and brushed aside in rapid succession without special effort, or prearranged schedule. All of this communication was with three New Zealand operators, Frank Bell, Ralph Slade, and Ivan O'Meara of Gisborne. It was thought that the limit of this long distance work had been reached when contact was made between H. Johnson of Short Beach, Conn., and New Zealand.

Was It a Freak?

While some explain the phenomenon by stating that all the records were a result of "freak atmospheric conditions," experienced once in several years, English amateurs want to believe that Goyder's remarkable record means the time is not far off when operators in that country will be in active and consistent communication with private citizens throughout the entire British Empire. The growing desire of these amateurs to communicate with all of the British colonies, though they be on the opposite side of the world, is given greater impetus by this latest world record.

The announcement of the record made by the London and New Zealand amateurs was received with amazement by Hiram R. Maxim, president of the A. R. R. L., who commented upon it as follows: "This marks the accomplishment by amateur radio of almost the greatest distance available upon the earth. In communication from London, England, to New Zealand, the signalling was done practically half way around the world, and therefore it is impossible to find two points much farther apart.

"This puts private citizens, located anywhere on the earth's surface, in communication with one another, and the achievement marks an epoch in radio progress. We can expect from now on that a world-wide system of private citizen radio communication will quickly develop. The amateurs who have accomplished this great feat have placed their names high on the honor roll of radio."

Focussing the Waves

Radio receiving conditions at the Antipodes have been investigated extensively by the French Government, and a private American radio enterprise, leading to one definite conclusion; reception is far better at the Antipodes and immediate vicinity than it is a thousand miles or so closer to the transmitter. The radio waves, travelling in all directions around the earth's surface, apparently come to a focus with greatly increased volume directly opposite the point where they were transmitted.

Scores of amateurs are now asking whether Goyder's and Bell's signals took the longer or the shorter way around the earth, and they have not found anyone who can answer the question. It is probable that the signals followed the dark belt, rather than the sunshine.

THE MODULATED WAVE

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the degree of selectivity just described could be obtained. Thus it was that we often heard two and three stations at the same time, and were unable to eliminate a powerful nearby station and listen to more distant ones. In the superhetrodyne receiver, however, we can obtain this remarkable degree of sharpness of tuning. We can separate stations that differ by less than one per cent in frequency and yet not distort the music by cutting off the side bands.

Apropos

Sunday school teacher—"Now each pupil will quote a Bible verse as he drops in his pennies."

Junior (after some desperate thinking,—"A fool and his money are soon parted."—*Crosley Radio Weekly.*

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912,

Of Radio Progress, published semi-monthly at Providence, R. I., for October 1, 1924.

State of Rhode Island, County of Providence, ss.

Before me, a Notary Public in and for the State and county aforesaid, personally appeared John F. O'Hara, who, having been duly sworn according to law, deposes and says that he is the owner and publisher of the Radio Progress, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, John F. O'Hara, Box 728, Providence, R. I.; editor, Horace V. S. Taylor, Box 728, Providence, R. I.; business manager, John F. O'Hara, Box 728, Providence, R. I.

2. That the owner is: John F. O'Hara, 8 Temple Street, Providence, R. I.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

JOHN F. O'HARA.

Sworn to and subscribed before me this twenty-third day of September, 1924.

(Seal) ELIZABETH O'HARA,
Notary Public.
(My commission expires June, 1926.)

BROADCAST BILL HAS A CLOSE SHAVE

Now the Cuties bob their hair,
The men all have to wait
And if they first must get a shave
They're apt to miss a date.

A man's sheet like "Police Gazette"
Is nowadays no more seen;
Instead upon the pile you find
"Embroid'ry Magazine."

So Broadcast Bill is barbing where-
While sitting in a row
The men can wait their turn and hear
The strains of Radio.

By Del.

℞ DR RADIO PRESCRIBES.

NOTE: In this section the Technical Editor will answer questions of general interest on any radio matter. 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 work, higher rates will be charged.

Question. Can a 50-volt "B" battery tester be used for checking the condition of "A" batteries?

Answer. No, it is not satisfactory to use this instrument. In the first place an ammeter is the best to use, since an old cell falls off in current a good deal quicker than it does in voltage. A new dry cell should show 25 to 30 amperes on short circuit through an ammeter. A low reading volt meter will be of some value as a test in case an ammeter is not at hand. The pressure of a new cell is 1½ volts, while an old one falls off to about 1.0 before it is valueless. Of course, these figures may be read on a 50 volt meter, but the deflection in each case is so small that it is not possible to get any accuracy in the reading.

Question. There has been considerable talk recently about a 24-t be set. What kind of hook-up is used?

Answer. We have not any record of the diagram of connections of this set, but it is very likely that it is of no value at all. A good step of amplification is so powerful in increasing the loudness of the signal fed to its input terminals, that two, or at most three amplifiers are all that can ordinarily be used at any single frequency. As a proof of this, just try to hook up three good audio steps together and then listen to the horrible racket produced. The trouble is that all tubes have a slight amount of noise created by very small mechanical vibrations, such as come in through the socket. Besides this, there is a slight hiss in the operation of the tube itself, which ordinarily can not be heard. However, when two amplifiers are put on after the first tube, they magnify the vibration and the hiss just as they do the music, and if they are efficient they will make the noise so loud as to be objectionable.

Of course, there are various sets, which use three audio amplifiers. If you look them up you will find in general that some means are taken of cutting down the output of at least one step. Either a condenser is shunted across the secondary of the transformer, or a high resistance is connected in series, or perhaps the third step will have a very low ratio transformer. Of course, if we sacrifice the multiplication of a step to a small fraction of what it normally is, then two tubes can be used to give the same effect that a single efficient step would accomplish. There is no advantage in wasting tubes in this way.

Besides the audio amplifiers, three radio steps might be used and in the superhetrodyne three intermediate frequency steps also. That makes a total of nine amplifiers with two detectors and one oscillator, bringing the total number of tubes up to twelve.

Such a set is so horribly noisy (unless silenced as described above) that it is not nearly as satisfactory as one of less number of tubes.

Question. Some wave traps claim that they can tune out any local interference and get distance stations. Is this true?

Answer. No, it is impossible for any wave trap to accomplish such extraordinary results. The best a trap can do is to reduce a local station to a fraction of its loudness, while a distant station is also cut down in volume, but not nearly in the same proportion. The fact that a trap will sometimes seem to improve the loudness of a far off broadcaster merely shows that the radio set was improperly adjusted in the first place. If it is correctly tuned, then a trap will do no good at all in bringing it out, and as a matter of fact whatever losses (even though they may be small) occur in this instrument will be subtracted from the output of the radio set.

In case the local station is somewhat bothersome and the distant station which you want is fairly loud, the trap will be of great benefit, since it will reduce the interference to a point where the outside concert can be enjoyed. But if you are so close to the home station that it completely overpowers the outside wave, then it is hopless to try to silence it completely except by getting a better radio set.

Question. When I turn on the "B" batteries with the filaments already lighted, I notice that the filament grows a little dimmer. Why is that?

Answer. This does not usually happen except with the UV-199 tubes. This variety takes such a small current from the "A" battery (only 1/16 of an ampere) that the plate current forms an appreciable part of the whole. When the "B" battery is turned off all the current from the "A" battery runs through the whole filament. When the "B" battery is connected, however, some of this is diverted through the electron discharge from the filament across to the plate. That means that while 1/16 ampere flows into the "A" battery tube terminal, somewhat less than that flows out through the other terminal, the difference going out though the plate. Since the average current through the filament has thus been reduced, it follows that the light given out will be diminished, and the tube will grow dimmer.

Question. How can a storage "B" battery be charged from an ordinary charger?

Answer. It is rather difficult to describe this without going into considerable detail. In the next issue of RADIO PROGRESS an article on this subject will give detail instruction and information on the operation.

COILS—WHY SOME EXCEL

Continued from Page 7

represent a cross section of the wires themselves, magnified quite large. The numbers in the circle show the order in which the turns are put on. Thus it will be seen the first turn goes at the left, the second turn right side of it, then the third, etc., until the end of the winding is reached at 5. The sixth lies on top of 5, the seventh on 4, etc., until the end turn lies right over the beginning This is the natural way to wind the coil and it gives four times as efficient a solenoid as the single layer in point of inductance. The trouble is, as just explained, the distributed or leakage capacity is so high as to prevent sharp tuning in radio.

How to Bank the Winding

The lower half of Fig. 6 shows the order of winding a banked coil. Two turns are put on side by side. Then the third is wound on top of 2. 4 goes side of 2 and 5 on top of it. 6 is side of 4 and 7 on top of it. This scheme of winding is continued until the end of the solenoid is reached. Such a winding gives exactly the same inductance as an ordinary two layer coil, but the leakage capacity is reduced to a small fraction of what it would otherwise be. The only reason that most coils do not use this winding, comes from the fact that it is rather difficult to make the wire stay in place. When you attempt to wind wire 3 on top of 1 and 2, it is apt to spread 1 and 2 apart and crowd in between them. To make a neat looking job requires a great deal of practice.

Doubling Back on Itself

Fig. 7 shows the effect of the common winding in doubling the current path back on itself. Suppose we put 45 volts across the terminals of the solenoid. With the common form of two layer coil the electricity will run along the lower layer to the right (of course, spinning around the tube from turn to turn) until it gets to the end, and then will loop back through the upper turns, coming out about where it started. This puts full pressure of 45 volts between the lower end turn and the upper one. It is this closeness which gives the high capacity. With the bank winding, on the other hand, the current goes through a lower layer turn and then an upper layer one, back to the lower, then to the upper, continuing this action, as shown, just like the teeth of a saw. The end is spaced the full length of the coil away from the beginning, so no two turns have very much voltage between them. The result is the low capacity and sharp tuning of the bank winding.

It may be asked how various type of coil compare—ordinary solenoid, honeycomb and spider web coils. The honeycomb coil consists of a great many layers, and so it is very efficient from the point of view of inductance. The wires cross each other at an angle and so the distributed capacity is not nearly as great as it would be if the wires were parall l. The first and last turns are separated only by the number of layers in the coil, and being much closer than in a single layer, so will cause more capacity than in such a coil with the same number of turns. However, it must be pointed out that it is not fair to compare with a coil of the same turns. It is the inductance which you want. Comparing with a coil of the same inductance we find its distributing capacity is low. On both points then the honey-comb is very satisfactory. The chief reason it cannot be used in a variocoupler for instance is because it is quite difficult to arrange to take off taps at intermediate points in the winding.

Comparing a spider web coil with the others, we find that while not quite as efficient as the honey comb, it excels the solenoid, both in inductance and lack of leakage capacity. That is one reason why this form of winding is proving very popular.

In conclusion we may state that, for an ordinary variocoupler, the single layer winding with taps is the most practical form. If considerable more inductance is needed to tune to the high wave lengths used in code, then this solenoid should be banked in two or perhaps three layers. If a coil with large inductance and no taps is needed, then a honey-comb best fills the bill. For miscellaneous coils, which do not need a rotor turning inside (like a variocoupler) the spider web is very efficient and easy to wind.

LEARNING TO TALK

Continued from Page 22

say that you will find that not one man in every 100 you ask has ever studied it. Besides this, it is a fact that most of those who do know it are the men who have specialized in languages and have already learned several. For such it would be very easy indeed to switch to Ilo, since admittedly this is an offshoot from Esperanto and uses all the best parts of that language. The great body of people in America do not know either of the rivals and there is no question but what Ilo could be learned by them in a fraction of the time taken for Esperanto. It's a case of the college professors, who can learn languages easily against all the rest of us who prefer the easy one.

We have said that for an American, Ilo is much easier to learn. The same thing applies to France and Italy, only more so. Ilo is considerably closer to their language even than it is to English. Germans and Russians will find it harder than we do, but the same is true of Esperanto.

Actual Comparison of Languages

Refer to Fig. 1 and see how the three look.

Having read them aloud, do you not agree that the deciding factor should be "easiest for the greater number of people?"

Any one who has had a high school education will be able at least to follow along when reading the Ilo and comparing with the English. The Esperanto is not nearly so natural. It would be even worse if the six special letters were used.

Let Us Pick the Best

In the next few years, one or the other of these rivals will undoubtedly be selected and probably it will be popular opinion which makes the choice. By all means, let us consider that when once it is picked out the winning language will probably last for a long while, perhaps centuries. It seems foolish because every thousandth person you meet has learned Esperanto that we should standardize on the poorer of the two. If one in five, or even in ten had learned it perhaps we ought to consider them and use their language but with nearly 100 percent of the world still ignorant of both, it seems reasonable to select the one which has the best chance of being learned by all.

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
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	Boise High School, Boise, Idaho	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
KFCL	Los Angeles Union Stockyards, Los Angeles, Cal.	236	1270	500
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
KFDX	First Baptist Church, Shreveport, La.	360	833	100
KFDY	*So. Dakota State College, Brookings, So. Dakota	273	1100	100
KFEL	Winner Radio Corp., Denver, Col.	254	1180	100
KFEQ	J. L. Scroggin, Oak, Neb.	268	1120	100
KFEX	Augsburg Seminary, Minneapolis, Minn.	261	1150	100
KFFV	Graceland College, Lamoni, Iowa	280	1070	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	100
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
KFHJ	Fallon & Co., Santa Barbara, Cal.	360	833	100
KFHR	*Seattle, Wash.	263	1140	100
KFPL	*Dublin, Tex.	252	1190	
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	*D'ly C'm'nw'h & Seifert Radio C'p., 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.	291	1030	1000
KFLV	Swedish Evang. Mission Church, Rockford, Ill.	229	1310	100
KFMQ	University of Arkansas, Fayetteville, Ark.	263	1140	100
KFMX	Carleton College, Northfield, Minn.	283	1060	500
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
KFQU	W. Riker, Holy City, Cal.	234	1280	100
KFQV	Omaha Grain Exchange, Omaha, Neb.	231	1300	100
KFQX	Alfred M. Hubbard, Seattle, Wash.	233	1290	250
KFQZ	Taft Radio Co., Hollywood, Cal.	240	1250	250
KFRB	*Hall Brothers, Beeville, Tex.	248	1210	250
KFSG	Echo Park Evangelistic Ass'n, Los Angeles, Cal.	234	1280	500
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.	283	1060	250
KNT	Grays Harbor Radio Co., Aberdeen, Wash.	263	1140	250
KNV	Radio Supply Co., Los Angeles, Cal.	254	1180	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
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
WABP	Robert F. Weinig, Dover, Ohio	265	1130	200
WABU	Victor Talking Machine Co., Camden, N. J.	225	1330	100
WABX	Henry B. Joy, Mount Clemens, Mich.	270	1110	500
WAHG	*A. H. Grebe & Co., Richmond Hill, N. Y.	316	950	500
WBAA	Purdue University, West Lafayette, Ind.	283	1060	250
WBAD	Sterling Electric Co., Minneapolis, Minn.	360	833	100
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	1000
WBAV	Erner & Hopkins Co., Columbus, Ohio	423	710	500
WBAW	Marietta College, Marietta, Ohio	246	1220	250
WBAY	American Tel. & Tel. Co., New York, N. Y.	492	610	500
WBAX	*Wilkes-Barre, Pa.	254	1180	
WBBG	Irving Vermilya, Mattapoisett, Mass.	248	1210	500
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	250
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.	283	1060	500
WCAL	St. Olaf College, Northfield, Minn.	360	833	500
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	Milwaukee Civic Broad. Assn., Wilwaukee Wis.	261	1150	250
WCBC	Univ. of Michigan, Ann Arbor, Mich.	280	1070	200
WCBD	Wilbur G. Voliva, Zion, Ill.	345	870	500
WCCO	*Washburn-Crosby Co., Minneapolis, Minn.	417	720	500
WCK	Stix, Baer & Fuller Dry Goods Co., St. Louis, Mo.	360	833	100
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
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
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	294	1020	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	275	1090	100
WEAY	Iris Theatre, Houston, Texas	360	833	500
WEB	Benwood Co., St. Louis, Mo.	273	1100	100
WEBH	Edgewood Beach Hotel Co., Chicago, Ill.			
WEBJ	Third Avenue Ry. Co., New York, N. Y.	273	1100	500
WEBL	R. C. A. United States (portable)	226	1330	100
WEEI	*Edison Elec. Ill'm'n't'g Co., Boston, Mass.	303	990	500
WEV	Hurlburt-Still Electric Co., Houston, Texas	263	1140	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
WFAN	Hutchinson Elec. Service Co., Hutchinson, Minn.	286	1050	100
WFAV	Univ. of Nebraska, Dept. of E. Eng., Lincoln, Neb.	725	1090	250
WFBG	William F. Gable Co., Altoona, Pa.	261	1150	100
WFBH	Concourse Radio Corp., New York, N. Y.	273	1100	500
WFBI	*Galvin Radio Supply Co., Camden, N. J.	236	1270	100
WFBW	Ainsworth-Gates Radio Co., Cincinnati, Ohio	309	970	750

		W.L.	K.C.	W.P.
WFI	Strawbridge & Clothier, Philadelphia, Pa	395	760	500
WGAQ	'Youree Hotel, Shreveport, La	360	833	100
WGAY	Northwestern Radio Co., Madison, Wis	360	833	100
WGAZ	*South Bend Tribune, South Bend, Ind	275	1090	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
WGN	Drake Hotel (Whitestone Co.), Chicago, Ill	370	810	1000
WGR	Federal Manufacturing Co., Buffalo, N. Y	319	940	750
WGY	General Electric Co., Schenectady, N. Y	380	790	1000
WHAA	State University of Iowa, Iowa City, Iowa	484	620	500
WHAD	Marquette University, Milwaukee, Wis	280	1070	100
WHAG	University of Cincinnati, Ohio	222	1350	200
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	Radiovox 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
WIAK	Journal-Stockman Co., Omaha, Neb	278	1080	250
WIAR	Paducah Evening Sun, Paducah, Ky	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
WJAR	The Outlet Co., Providence, R. I	360	833	500
WJAS	Pittsburgh Radio Supply House, Pittsburgh, Pa	286	1050	500
WJAX	Union Trust Co., Cleveland, Ohio	390	770	500
WJAZ	*Chicago Radio Lab., Chicago, Ill. (portable)	268	1120	100
WJH	Wm. P. Boyer Co., Washington, D. C	273	1100	100
WJY	R. C. A., New York, N. Y	405	740	750
WJZ	Broadcast Central, New York, N. Y	454	660	500
WKAA	H. F. Paar, Cedar Rapids, Iowa	278	1080	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
WLAH	Samuel Woodworth, Syracuse, N. Y	234	1280	100
WLAL	Naylor Electrical Co., Tulsa, Okla	360	833	100
WLAN	Putnam Hardware Co., Houlton, Me	283	1060	250
WLBL	Wisconsin Dept. of Markets, Stevens Pt., Wis	278	1080	500
WLW	Crosley Radio Corp., Cincinnati, O	423	710	500
WMAC	Clive B. Meredith, Cazenovia, N. Y	261	1150	100
WMAF	Round Hills Radio Corp., Dartmouth, Mass	360	833	500
WMAH	General Supply Co., Lincoln, Neb	254	1180	100
WMAK	Lockport Board of Commerce, 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
WNAP	Wittenberg College, Springfield, Ohio	231	1300	100
WNAT	Lenning Brothers Co., Philadelphia, Pa	360	833	250
WNAX	Dakota Radio Apparatus Co., Yankton, S. D	244	1230	100
WNYC	City of New York, New York, N. Y	526	570	1000
WOAC	Pagan Organ Co., Lima, Ohio	265	1130	150
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
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
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	100
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	283	1060	250
WPAM	Auerbach & Geutell, Topeka, Kas	275	1090	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	248	1210	100
WQJ	Calumet Rainbo Broadcasting Co., Chicago, Ill	448	670	500
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
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	500
WSAC	Clemson Agri. Col., Clemson College, S. C	360	833	500
WSAD	J. A. Foster Co., Providence, R. I	261	1150	100
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
WSAP	Seventh Day Adventist Church, New York, N. Y	263	1140	250
WSAR	Doughty & Welch Elec. Co., Fall River, Mass	254	-	-
WSAV	Clifford W. Vick Radio Const. Co., Houston, Tex	360	833	100
WSAX	Chicago Radio Laboratory, Chicago, Ill	448	670	1000
WSB	Atlanta Journal, Atlanta, Ga	428	700	500
WSOE	School of Eng. of Milwaukee, Milwaukee, Wis	246	1220	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
WWJ	Detroit News, Detroit, Mich	517	580	500
WWL	Loyola University, New Orleans, La	268	1120	100

* Additions and changes.

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