December 1, 1925
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RADIO PROGRESS

Reg. U. S. Pat. Off.

"Always Abreast of the Times"

IN THIS ISSUE:

YOU WILL UNDERSTAND THIS MAGAZINE—AND WILL LIKE IT

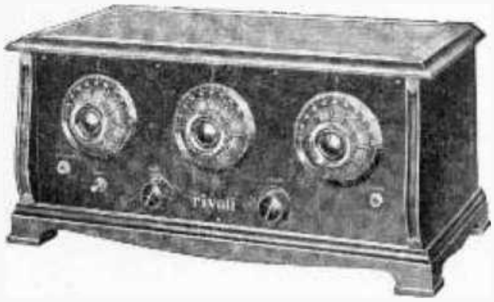
A New England Publication

rivoli

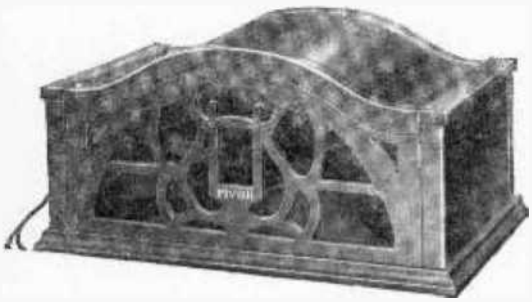
"ALWAYS GOOD COMPANY"

RIVOLI is always good company—good company because it is a thing of beauty and because if there is anything on the air, Rivoli will get it to entertain you. No skill is needed to bring in the broadcast stations.

The Rivoli De Luxe combines all the convenience of a built-in speaker and a built-in battery compartment with the grace and beauty of a finely designed table model radio set. The cabinet is fashioned in two-tone mahogany with panel to match and sunburst dials that lend a pleasingly original touch. Symmetry is retained by the two silk-backed grills. **$75.00**



The Rivoli Junior has been designed for those who must economize in space. In point of quality, the Junior is fully up to Rivoli standards. The cabinet is considerably better and more carefully finished than sets selling at a low price. Finished in mahogany with a generous flare to set off the panel... **$60.00**



The Rivoli Speaker has successfully combined extreme beauty with acoustical perfection. Its tone chamber is constructed entirely of two-tone wood, seasoned by a special process. The front of the Rivoli Speaker is a grill, fashioned in a pleasingly decorative motif. The well known balanced type of unit is used. The Rivoli Speaker always harmonizes perfectly with its surroundings................. **$30.00**

The Rivoli Radio Line is manufactured by the Radio Industries Corp., 131 Duane St., N. Y. City

rivoli

"ALWAYS GOOD COMPANY"

$125.00

The Rivoli Console is a beautiful creation. It is designed in the period of William and Mary, and is constructed of two-tone mahogany. The finely carved legs, the cleanly cut grill which hides the speaker and battery compartments, the metal fittings, all lend an expensive air which seem out of all proportion to the remarkably low price. The built-in speaker is a revelation and recreates the broadcasting artist so clearly that he seems to be standing in the same room.

$50.00

The Rivoli Table is a radical departure in the construction of radio tables. It has ample space for any table type of radio set, either large or small, generous battery compartments for housing A and B batteries and chargers or eliminators, and features a grilled speaker outlet behind which any form of horn or cone can be mounted. Aside from its utility, the Rivoli Table is a beautiful piece of furniture, designed in two-tone mahogany or walnut. It solves the problem of where to put your radio set.

(Space allowed for radio set is 36 in. long x 11 in. deep x 10½ in. high)

Write for interesting literature describing the entire Rivoli Radio line.

Radio Industries Corporation, 131 Duane St., New York City

RADIO PROGRESS

HORACE V. S. TAYLOR, EDITOR

Volume 2 Number 18

Contents for

DECEMBER 1, 1925

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Our Next Number Will Be Worth Using as a Christmas Present

Almost everybody was interested in the football games this year. Probably you heard the scores broadcast by your favorite station. How do they pick this up and relay it? Jaspert explains this in his timely article, **"How Football Games Were Broadcast."**

One of the fixtures in radio is the aerial—or so it would seem. However, there have been improvements along this line as well as in receiving sets. Vance will explain this in **"The Last Word in Sending Aerials."**

When you listen to the program coming in smoothly it seems so easy that you doubtless think, "What could be sweeter than being a broadcaster?" However, these gentlemen have their problems just as you do. There is one big one right ahead of them. Read about it in **"Broadcasters Have Live Association."**

Rados has been unusually good in describing the construction of various pieces of apparatus. He has outdone himself in **"Building Your First Radio."** Here we might whisper an aside that many fans might well construct this one, even if it is their second or third.

You hear a lot about fast and slow waves. Does this mean that some reach your aerial quicker than others? By no means. This much misunderstood point is discussed at length in **"Fast and Slow Radio Waves,"** by Taylor.

Even the manufactured sets often have coils which do not fit your aerial and other conditions as well as they might. The coil is one of the most important parts of your outfit. Is yours right, do you think? If you are not sure you will be interested in Nickerson's write-up, **"Coil Calculations."**

Marx has written **"Revamping a Popular Radio."** In it he shows how one of the manufactured sets which has been widely sold has recently been changed in a few respects and in that way greatly improved.

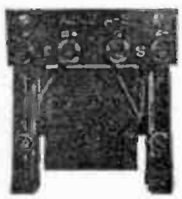
You probably feel that your eyes are the most important sense organs you have. Did you know that recently an electrical eye had been invented which could see a great many things itself. Furthermore, this eye can be arranged to sing, which is more than your own can do. See Arnold's **"The New Electric Eye."**

The Two Outstanding Parts In Radio !

Give Low Losses and Amplification Without Distortion to Any Set

QUALITY and distance are what a radio set must give. To insure Quality, amplification without distortion is essential. And to insure Distance, low losses are essential. That is radio in a nutshell.

People in whose sets Acme Transformers are used, are sure of hearing concerts "loud and clear" so a whole roomful of people can enjoy them.



Acme A-2 Audio Frequency Amplifying Transformer

The Acme A-2 Audio Amplifying Transformer is the part that gives quality. It is the result of 5 years of research and experimenting. It gives amplification without distortion to any set. Whether you have a neutrodyne, super-heterodyne, regenerative or reflex, the addition of the Acme A-2 will make it better.

To get the thrill of hearing distant stations loud and clear, your set must have low losses, for it is low losses that give sharp tuning to cut through the locals, and it is low losses that allow the little energy in your antenna to come to the ampifier undiminished. That's what the Acme condenser will do for any set. And it will do it for years, because the ends can't warp, the bearings can't stick and the dust can't get in and drive up the losses several hundred per cent.

The Acme Reflex (trade mark) owes its success and its continued popularity to these two outstanding parts in the radio industry, for low losses and amplification go hand in hand.

Use these two parts in the set you build. Insist on them in the set you buy.

Send 10 cents for 40-page book, "Amplification without Distortion"

WE HAVE prepared a 40-page book called "Amplification without Distortion." It contains 19 valuable wiring diagrams. In clear non-technical language it discusses such subjects as Radio Essentials and Set-building; How to make a loop; Audio frequency amplifying apparatus and circuits; Instructions for constructing and operating Reflex amplifiers; How to operate Reflex receivers; Antenna tuning circuits for Reflex sets; "D" Coil added to Acme four tube reflex; "D" coil tuned R. F. and Reflex diagrams; and several more besides. It will help you build a set or make your present set better. Send us 10 cents with coupon below and we will mail you a copy at once.

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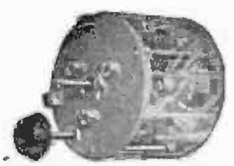

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RADIO PROGRESS

"ALWAYS ABREAST OF THE TIMES"

Vol. 2, No. 18 DECEMBER 1, 1925 15c PER COPY, $3.00 PER YEAR

Throwing a Crystal Into Fifth Speed

Why You Get Fewer Squeals Now Than You Used To

By HORACE V. S. TAYLOR

SOMETIMES you like to hear a whistle. If it is the 5:15 train coming down the track to take you home, it is a welcome sound, but if it is a continuous whistle coming in through your loud speaker, it is not quite so pleasant.

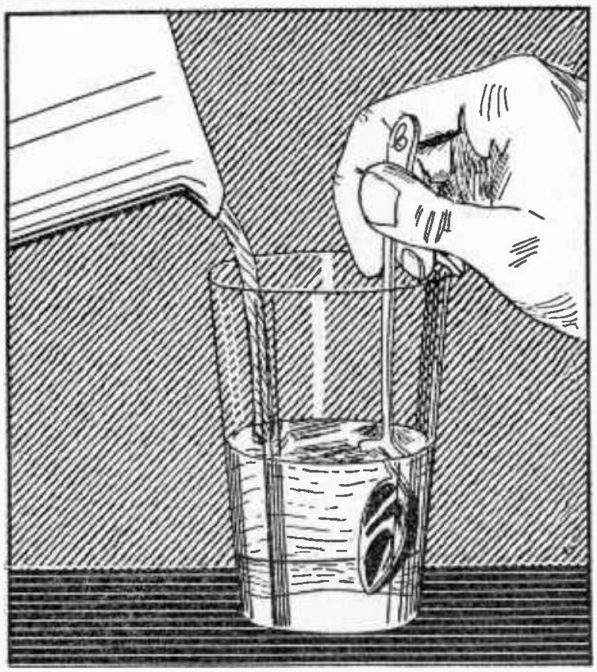

Fig. 1. Tea Glass Shows Principle of Cutting Down a Crystal to Adjust for Speed

The Bureau of Standards, after a long experience, has found that if two stations have waves which are closer together than ten kilocycles (kc) they will cause a reaction, one on the other, which is heard as a high pitched whistle. This spacing of ten kilocycles is constant all over the broadcast range, but the wave length separation which corresponds to it varies from two meters up to ten meters. Indeed, that is one of the advantages of using the kilocycle rating rather than the old way of naming the wave by its length.

Must Have a Yard Stick

In order to hold the waves spaced by this distance, of course it is necessary to have some sort of a standard to go by. Suppose you were told to put in fence posts just 30 feet apart, how would you be able to locate them unless you had some sort of yardstick or tape to measure the distance? When checking up on the frequency of a station, by far the most accurate way has been found to get a vibration which is correct and then adjust the sending aerial and condenser until it radiates the same waves.

That seems reasonable enough, provided we can find something which will vibrate at the right speed. But remember that the broadcast range varies from 550 kc. to above 1400 kc. Expressed in ordinary language, this is from 550,000 up to 1,400,000 complete oscillations every second. You must admit that that is going some. The ordinary tuning fork sounding middle C on a piano, oscillates only 256 times every second. This must seem like a snail to a man in an airplane by comparison.

Changing Speed When It Rains

How can you get anything to vibrate at this tremendous speed of around 1,000,000 per second? So far there has been only one practical way discovered and that is to use a crystal of pure quartz. Only recently the research en-

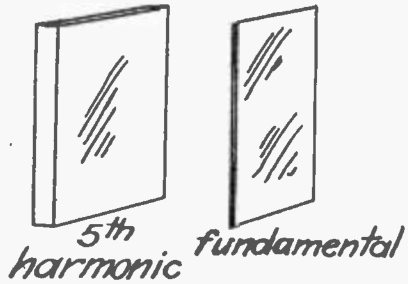

Fig. 2. See How Much Thicker the Sheet of Quartz is for Harmonic

gineers have discovered how to melt quartz by an electric vacuum furnace in such a way that pure crystals much clearer than glass can be obtained. It has been discovered that such a crystal possesses the remarkable property of shaking at these immensely high speeds, and furthermore, that the speed of vibration or frequency does not change with the weather or the temperature. This is very important, as you would not want your radio stations to speed up their waves on warm days or to slow down whenever it looked like rain.

Now we have found a suitable material to vibrate at the right speed, the question is what size and shape to make it. A tuning fork has a shape which is about the best for the purpose of sending out slow air waves. However, it could never be speeded up to anything line the tremendous velocity needed for radio waves. A shape like an ordinary book with square corners and edges is found to do the work as well as anything. As this is a simple form to manufacture, it is the one which is always used.

Clinking the Glasses

When it comes to size we run into trouble. Of course, a smaller crystal will vibrate faster than a larger one. You can see this illustrated easily with a glass of iced tea or even of water. Fig. 1 shows a cut of pouring the liquid into a glass while a spoon is used to tap the sides of the tumbler. This gives out a musical clink, clink, as it is struck. If you continue to pour in the tea while you are hitting the glass, you will hear the tone start at a high pitch and gradually drop off lower and lower as the glass gets fuller. When the liquid is up to the top the tone will be lowest of all.

The reason for this change of note is that a big body naturally vibrates at a slower speed (lower pitch) than a small one, so when we experiment with our crystal of pure quartz, we find that the thinner it is the faster it goes. To get up to a million or so is not so bad, but when we want to reach 7,000,000, it requires a slip like a stick of chewing gum except a lot thinner. In fact, the thickness to go at this number of kilocycles will be so small (less than a sheet of paper) that the crystal is very fragile and easily broken.

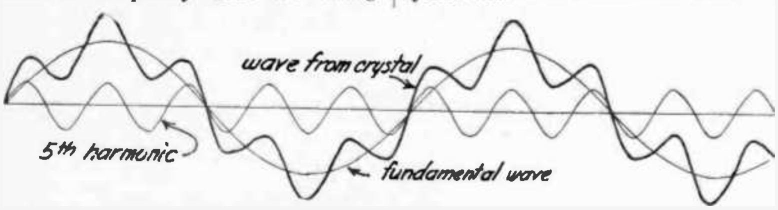

Fig. 3. Here Are the Waves as They Come Raw from the Tuner. They Must be Refined Before Using.

Play Them in Bunches

How shall we get around this trouble? It is a good idea to see how they do it in music and perhaps take the hint from that. Suppose we have a parade marching along and the conductor or drum major waves his stick in time with the music. Pretty soon the musicians get to a fast part of the score where the notes follow each other in rapid succession. Does the drum major speed up his arms and jerk them around four or five times as fast as before? By no means. He will group four sixteenth notes together into a single beat and so will wave his stick only one-quarter as fast as the notes pour from the horn of the musician.

By beating time only one-quarter as fast as the vibrations are coming there is no loss in the accuracy of the count. The parade continues to swing along with everybody in step, just the same as before. So perhaps we can get a crystal to do the same thing—pick out every fourth wave and emphasize it. However, in this case it has been found that while a crystal working on the fourth beat would do, it is still a shade too thin for practical purposes. By using the fifth instead of the fourth a larger size is indicated which works well in practice.

Which Crystal is Best?

Fig. 2 shows a picture of the thicknesses for these two crystals—one which beats at about seven million vibrations per second (at the right) and the other which picks out every fifth wave which gives it a speed of one-fifth of that. You can see at a glance that the left hand one is the better to use.

When this crystal is set into motion by putting it between the two plates of a condenser which is used in the grid tuning circuit of a radio tube it will vibrate as shown in Fig 3. There is a main, or slow vibration which is labelled "fundamental," and on top of this is a ripple, five times as fast, named the "fifth harmonic." To understand how these two waves can go on at once look at the ocean where you will see big waves perhaps twenty feet apart and on top of the waves will be a series of ripples, caused by the wind.

Vibrates Like a Rope

Another illustration is a long clothes line. If you wiggle one end back and forth you can make the rope sway as a whole, but if your hand is a trifle unsteady, you will observe that there are also a series of small waves on top of the big one. Of course, the rope at any one spot is moving in only one direction at a time. In the same way the curves of Fig. 3 are actually combined into the "wave from crystal" where you will see that every spot has only one position at the instant represented in this sketch. Both fundamental and fifth harmonics are being combined, however, just as in the clothes line.

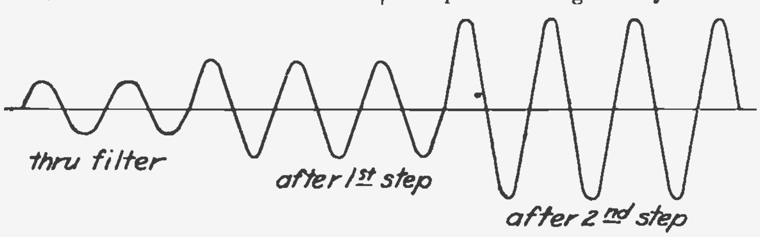

Fig. 4. The Waves of Fig. 3 Are Run Through Three Processes, After Which They Can be Utilized

Now it happens that the government

has assigned to Station WGY as an ex-experimental wave, a frequency of 7,160,000 vibrations per second, or 7,160 kc. This corresponds to 41.9 meters of wave length. As just explained, this is beyond the range of any self-respecting crystal. However, to get a vibration of 1,432,000 is not at all difficult. Notice that the ratio here is 5 to 1, which is just pictured in Fig. 3.

A Million Times is Slow

In checking up on the wave which is being transmitted, it is the fifth speed

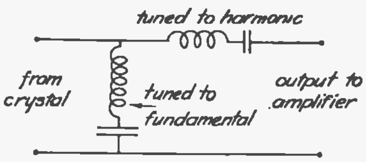

Fig. 5. Here is the Filter that Strains Off the Scum

ripple which is used in the sending station and the slow speed fundamental is of no use. In order to prevent its getting into the machinery and causing confusion, it is best to filter out this low vibration. We call it low by comparison although it is shaking back and forth at the tremendous rate of 1,432,000 times a second, or a wave length of 209.4 meters. We shall have more to say about the filter in a few minutes.

After the fundamental has been weeded out, the wave looks just as the ripple did in Fig. 3, except that the effect which we might call a ground swell has disappeared. This is seen in Fig. 4. However, the ripple was faint enough so it would not do much good in any man's size sending apparatus. It has a severe case of anemia. How shall we give it a little strength? You will say right away to run it through an amplifier, and this is just what is done. The first step gives the wave a lot of strength, while the second makes a robust vibration out of it, as shown in Fig. 4.

It Filters Waves

The filter, which gets rid of the unwanted vibration and lets the desired one through, is not as complicated as it sounds. It consists of nothing but two ordinary radio circuits, each combining a coil and condenser, as appears in Fig. 5. These work just like the tuner of your receiving set. The output from the crystal is fed to the input side of the filter. Right away the waves find a coil and condenser tuned to the 1,432 kc. waves and this you will notice from Fig. 5, returns right back on itself. Thus the low speed undesired wave is short-circuited without ever reaching the output of the amplifier. The high frequency vibration cannot get through this short circuiting tuner, however, as it is way out of tune for it.

Next the wave comes to a coil and condenser which has been adjusted to the fifth harmonic. Naturally, this seems like home to the 7,160 kc. wave and it enters it with the greatest ease. But if any of the fundamental is wandering along too, it finds that it does not fit this particular tuned circuit and can't get in. The result is that a pure wave of the desired speed of vibration comes from the output of the filter and is ready for the first step of the amplifier as already described.

"Brown Eyes" Does the Work

Now we have got it, what are we going to do with this wave? A glance at Fig. 6 will convey the idea. Here we have a lot of dancers who cannot keep together as there is no music or any way of keeping them in time. But now the orchestra starts up the tune of "Brown Eyes, Why Are You Blue?" Right away the dancers get the time from the music which you must remember is nothing but a vibration at the proper speed.

In the same way the radio apparatus at the sending station does not know how fast to oscillate, and as a result the wave frequency or wave length is apt to shift from day to day. Indeed there was quite a variation up to the time when the crystal was recently introduced. Now, however, the transmitter feeding to the broadcasting aerial hears the music from the orchestra (crystal) and immediately is able to swing into step. As long as the crystal plays its tune in correct time the waves will stay put at exactly 7,160 kc. And as we have already pointed out, the crystal has a mind of its own, and will not change its speed of vibration for temperature, weather, time or any other consideration.

A picture of the apparatus actually used may interest you. Fig. 7 shows how it looks. The action starts in the crystal at the right hand side. This unit is contained in the little cell, which appears right under the coil, in the middle of the right hand corner. The coil just above it is connected to the right hand tube as its control. This tube is the master oscillator and runs at the combined frequency of 1,432 kc., and also 7,160 kc. (209.4 meters and 41.9 meters.)

This combined wave is fed to the filter, which is the combination of coils and condensers seen near the middle of the cabinet. The variable air condenser in the lower right hand corner is the adjustable element, and this group suppresses the fundamental as already explained. The wave passing through the filter (Fig. 4) reaches the grid of the next tube (second from the right) where it is stepped up to much larger volume. From there it runs to the pair of tubes of the second step of amplification. This is a balanced or "push-pull" step, such as is often used as the last stage of an ordinary radio. The output from here is now powerful enough to be used by the

Fig. 6. Waiting to Get the Time of Vibration. This is Like the Transmitter at the Studio.

Continued on Next Page

American Radio Relay League

SCORNS A CLOUDBURST

Good communication with the outside world was maintained by carrier current, a development of radio, when a cloudburst and flood destroyed railroad, telegraph and telephone lines at Wenatchee, Wash.

The carrier current telephone system recently installed by the Puget Sound Power and Light Company on its high power electric transmission lines over the mountains from Seattle to Wenatchee, was unharmed by the storm, and it was over this new type communication system that news of the disaster first reached the outside world. For several days the only messages reaching or leaving Wenatchee were transmitted by this means.

Carrier current for communication over electric power lines was first used late in 1921, when the General Electric Company installed an outfit on the Adirondack Power Company's lines. So successful was this trial on a 30-mile, 33,000-volt line that a great many of public utility companies in the country have since adopted it.

The apparatus used is similar to a radio outfit, but instead of radiating waves through space in all directions as from a broadcast station, the voice currents are kept concentrated about the power lines, thus insuring privacy and direction of signals. So long as there is a single transmission circuit in operation, communication can be carried on. Ordinary telephone wires, many times smaller than the high power electric lines, generally are first to suffer as was the case at Wenatchee.

A. R. R. L. GERMAN HAMS TO THE FRONT

Transmitting radio amateurs in Germany are rapidly organizing their section of the International Amateur Radio Union along the same lines that have placed the American Radio Relay League in the forefront of radio amateurs of the world. The German amateurs have drawn up a set of rules governing the activities of transmitting stations, have organized an exchange of technical ideas, and are now getting out a periodical dealing with the activities of their section of the I. A. R. U. This paper lists calls, describes stations and serves as a forum for the discussion of problems.

A. R. R. L. ZEAL FOR NEW ZEALAND

L. G. Windom, owner and operator of amateur radio station 8GZ, in Columbus Ohio, is making some excellent records in speedy communication between this country and New Zealand. Acting as an intermediate for East Coast stations, Windom has on several occasions taken messages which are relayed to Ivan O'Meara of Gisbourne, New Zealand. Other New Zealand amateurs, to whom these messages are consigned, are able to answer through O'Meara's station, Z2AC. Windom has succeeded in getting replies to the originating stations in the course of a twenty-four hour period. The two principal stations concerned have succeeded in carrying on almost unbroken schedules with this sort of radio traffic. Both men are members of the American Radio Relay League.

THROWING A CRYSTAL

Continued from Previous Page

transmitting station in tuning its wave.

Although this description fits particularly the high speed vibration, which is being put out experimentally, the same general idea is used in ordinary broadcasting, and indeed who knows when these high frequency (short length) waves will become standard for ordinary broadcast programs?

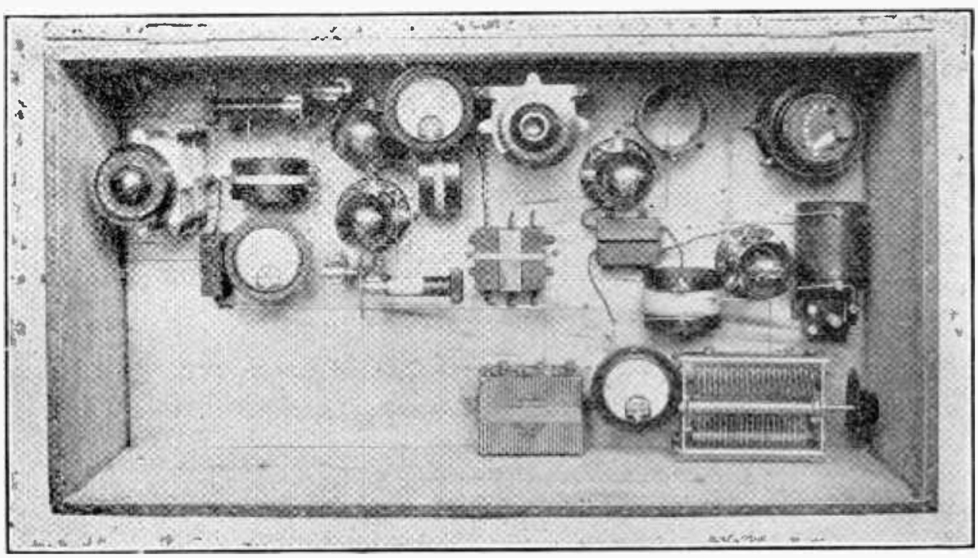

Fig. 7. A View of the Crystal, Tuner, Filter, Amplifier, and Push-pull Tubes.

What Will Tubes Be Next Year?

The New Styles Will Probably Improve Your Set

By A. K. LAING, Pelham Manor, N. Y.

IF you smashed a wheel on a Ford automobile, would you replace it with a part from the Rolls Royce Company? The latter makes high grade wheels, to be sure, but would it not be better to use a part which was designed to fit your particular needs? In the same way tubes to fit your set will give better music as will be explained.

The subjects discussed in the first half

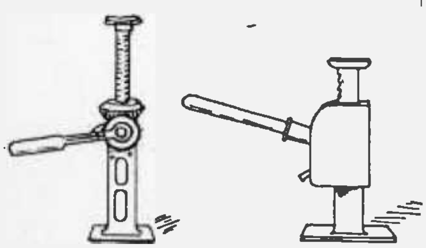

Fig. 1. Light Jack Has Big Lift, While Powerful One Has Small Lift.

of this article (Nov. 15 issue), losses and wave frequency, circuits and quality, are all manifestations of trends that have been going on in general at least for a year or so, and some for ten years. The change predicted in this paper will mark a complete reversal of policy. But in this case, the difference is only beginning to be felt, and six months ago was practically unknown.

Only One at a Time

Up until very recently, any changes in the general production of tubes have been toward standardization. By this, I do not mean that manufacturers have attempted to produce but one type of bulb. For some years now we have been able to choose between tubes for storage batteries, for dry cells in series, and for single cells. But this classification is a superficial one. The main trouble has been a tendency to try to make one kind of tube function about equally well as radio frequency amplifier, detector, audio frequency amplifier, and "B" eliminator rectifier. When a set was designed for "199" tubes, it was built for these throughout. When it was intended for "201A" tubes, these were used in all stages, and so on.

For years amateurs have clamored for better detectors. Those of us who remember the old Audiotrons and DeForest tubes in long glass envelopes with two leads spraying out from each end, have never ceased lamenting their removal from the market six or eight years ago. They were gaseous (soft) tubes, designed for detectors, and for that only. Nothing was sacrificed to make them useful for amplifiers as well. It happened that they would amplify, but not very efficiently. They were designed for one purpose and performed that one function better than anything that has since appeared.

Were the Happy Days

You may regard these statements as the exaggerated lamentations of one behind the times, who is dressing the "good old days" in an aura of bliss that they never had. But this is not so. One of the most prized possessions of a friend of mine is an old DeForest detector with both filaments intact, and re-

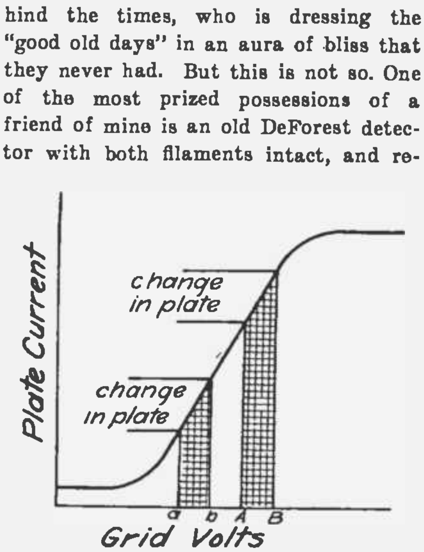

Fig. 2. With Ordinary Amplifier the Grid Bias is Not Important.

cent comparative tests with contemporary tubes have shown it to be far and away superior to any of them as a detector. Yet we see advertisements everywhere of the "——" tube, claiming highest efficiency for all uses. This is pure rot. Standardization has been a measure employed by monopoly concerns probably to make their own manufacturing and sales problems easier over a

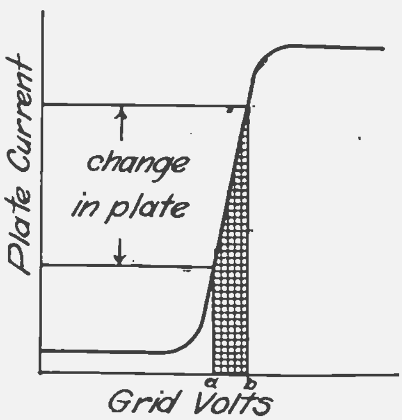

Fig. 3. This Tube is a Powerful Amplifier, but is Quite Critical.

period when there was no competition to be fought against.

The recent advent of independent manufacturers into the field has changed things a good deal. Some of the independents are content to make practical copies of the standard tubes. Others realize that their best field for success lies in putting out something newer and better. This competition has forced several new tubes from the old monopoly manufacturers. It is significant to note that the majority of these are designed for but one purpose. It is the opening wedge in a coming movement away from general purpose bulbs. In the near future it is reasonable to expect the appearance of special tubes for each of the three normal functions, radio frequency amplification, detection, and audio frequency amplification. The latter have been divided already into ordinary amplifiers and "power" amplifiers; special rectifiers for "B" eliminators have also appeared. The rest will doubtless come shortly. But it is not enough to ask for a special tube for each purpose. Actually, there should be *a different type of tube in every stage.* Let us examine the reason for this.

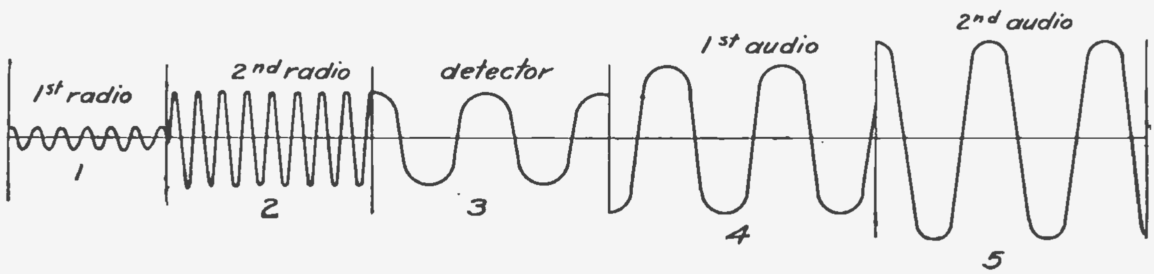

Fig. 4. Each of the Five Tubes in a Neutrodyne Has Its Special Job to Do. Here is Shown What Happens tc Waves in Each Bulb.

Power and Gain Ratio

Aside from the basic theoretical considerations, such as filament emission, grid saturation point, grid-plate capacitance, (condenser action between the elements), etc., there are two major external questions which the tube designer should meet. The first is the amount of power the tube will pass without distortion. The second is the "gain ratio." This term has a meaning similar to "amplification factor." However, the latter is defined as the ratio of change in plate voltage compared with grid voltage needed to cause a given change in plate current. The simpler term, "ratio" will be understood to refer to the gain of output compared with input of the tube.

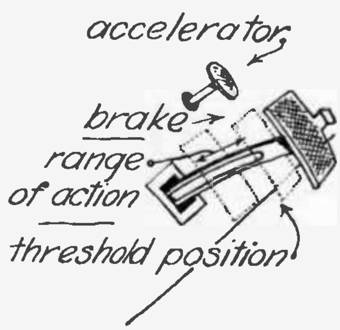

Fig. 5. Your Auto Shows Same Difference as Between Detector and Amplifier.

The power which the tube will pass without distortion is independent of the gain ratio. However, these are to some extent interdependent. A tube with a high ratio is usually restricted to low power, and vice versa. This refers, of course, to tubes of about the same "A" and "B" battery characteristics. This idea will be clearer by referring to Fig 1, which shows two automobile jacks. The one at the left will raise a machine through quite a height. It is light in construction, though, and is not very powerful. The right-hand jack, on the other hand, will lift several tons because it is so powerful. The distance it will raise a weight (gain ratio) is small. Of course a jack might be built which was both powerful and also had a high ratio, but it would be a much larger and heavier device. In the same way a tube which will handle a large volume of music and at the same time has a high ratio, must be of large size, and consume a big "A" and "B" battery current.

Designing Last Tube

In the standardized tubes a compromise has been made between these two considerations. The method used is roughly like this: A tube is designed which will pass as much audio frequency current without distortion as is necessary to operate the average loud speaker at its maximum practical volume. The other characteristics are then balanced up to give the proper internal resistance for audio frequency steps; next the highest gain ratio possible for the specified "A" and "B" battery voltages is worked out. This procedure is quite satisfactory for designing the *last* tube of an audio frequency amplifier, but there is no logic whatever in using the same tube for the first stage of a radio frequency step, which need pass only an extremely small fraction of the current for which the tube was designed.

This standardized method of manufacture has restricted all of the better known makes of tubes to a factor of from five to seven. Yet tubes have been designed for laboratory use that have a factor of eighty or more, and there is no theoretical reason that prevents us from making one with an even higher constant. To attain such high values, it is necessary to regulate with considerable care the filament, plate, and especially the grid voltage.

Still Has Same Change

A glance at the curve of one of them (Fig. 2) will show why. Here we have the curve showing how plate current or output of the tube varies with the grid voltage or input. Notice that when the grid is changed in pressure an amount "a b" that we get a certain increase in the plate current as shown on the left. If, by putting on a grid bias, or in any other way the voltage of the grid is raised so that the same incoming signal is AB, the plate current, although being considerably higher, will still show exactly the same amount of change as before.

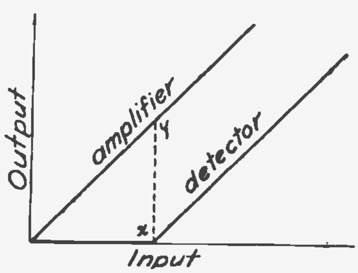

Fig. 6. The Threshold Valve of Detector Appears Here at x.

Remember, it is this *change* in plate current which operates your phones. The steady or direct current cannot be heard at all. Since as revealed by Fig. 2, the input may start anywhere from a up to A, and in that whole range give similar and undistorted output, you will see that the exact amount of voltage on the grid or "grid bias" does not make much difference.

A Sharp S Curve

Now refer to Fig. 3. Here we have a tube with a large gain ratio. The amplification factor may be as much as 80. Instead of having a long and fairly uniform S curve with a comparatively long straight portion near the middle, it has a rather flat form with a sudden sharp jump at the center. The voltages must be regulated so that the grid bias at normal is exactly in the center of this small space, and as a change of a fraction of a volt will throw it off the useful part of the curve entirely, this must be located and maintained with care.

With this tube, the grid change in pressure with the incoming signal, ab, is the same as ab in Fig. 2. But just observe what a big change in plate current is obtained as an output. That is the advantage of this high ratio tube. If the grid pressure, ab, were to be shifted to the right in the same way as occurred in Fig. 2, you will see that it would come either at the bend or even beyond it on the flat part of the curve, and we should get a very small amount of amplification as well as great irregularity or distortion. That is why with such a tube it is necessary to use such great care in adjusting the "B" battery voltage and particularly the grid bias.

Two Steps Give 400 Times

The advantage of such a tube comes, of course, in the higher amplification per step that can be had with this method. For example, the average good tuned radio frequency or neutrodyne set has a ratio of about twenty times per stage. This is the product, roughly, of the step-up ratio of the transformers or "neutroformers," and the amplification of the tube. Thus the ratio of a two stage radio frequency amplifier is about 20 x 20, or four hundred times.

If, however, we use in the first stage a tube with a gain ratio of eighty, and the customary 4 to 1 step-up transformer coupling it to the detector, the total amplification is around three hundred and twenty times for the one stage, as opposed to twenty for one stage of the present type. Therefore practically the same amplification can be had from one properly designed stage as is at present had from two; and we have, not only a saving in tubes and other apparatus, but also the elimination of one control.

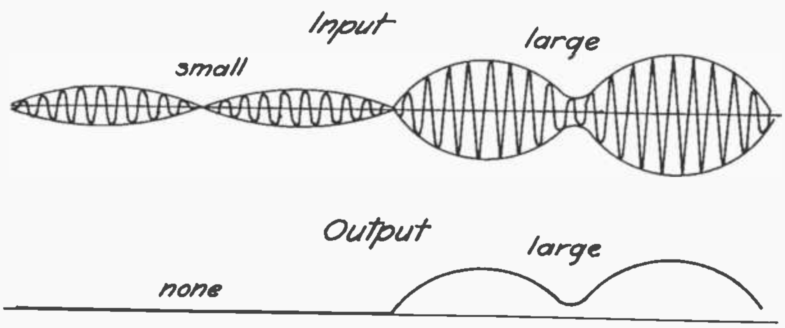

Fig. 7. Upper Curve is Fed to Detector, but the first Part is Too Weak to Make it Work.

Omits One Control

If, in turn, the detector tube is designed for an amplification of ten instead of five, and the first audio stage the same, the total gain for a set consisting of one stage radio frequency, detector, and two stages of audio, will be considerably greater than that of the present five-tube sets, (curves appear in Fig. 4) and will have the much to be desired advantage of simplicity in tuning, due to the elemination of a control.

This system has a great deal in its favor and almost nothing against it. It gives in addition to the above-named advantages, greater compactness and lower cost, both of initial investment and upkeep. The sole disadvantage is that it is slightly more difficult to maintain in a condition of balance; but this at most calls for the inclusion of a potentiometer on the radio frequency stage. Thus a control that need be touched only once every week or so, when the batteries get low, is substituted for one that must be tuned for every station.

That Threshold Value

The advantage of matching a tube to each stage becomes even more pronounced in the case of many tube sets, like the super-heterodyne. Here it is essential that the first detector be one that responds to the most minute currents. This is because of the well known "threshold voltage" effect, which means in plain language that every tube when used as a detector, has a point below which fluctuations on the grid will cause no effect on the plate. This does not occur in amplifying tubes, which will respond to radio frequency impulses a great deal more feeble than the weakest ones that will make an impression on a detector.

You will perhaps grasp this idea a little better after comparing with the controls on a motor car. Fig. 5 shows the accelerator and also the brake pedal. When you step on the gas the engine

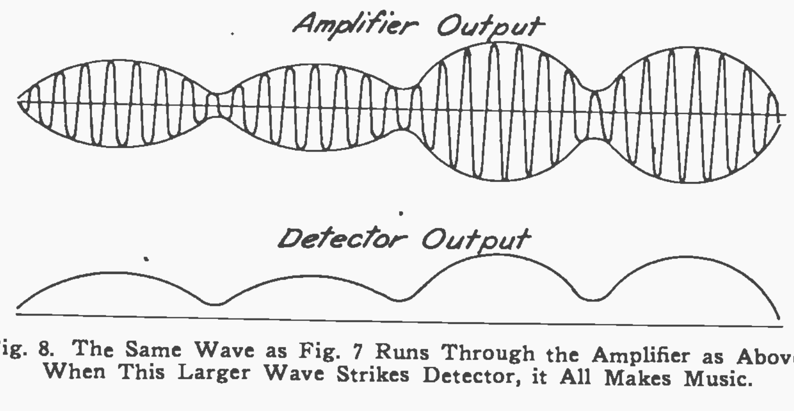

Fig. 8. The Same Wave as Fig. 7 Runs Through the Amplifier as Above. When This Larger Wave Strikes Detector, it All Makes Music.

responds immediately. Even if you depress this joy button only as much as 1/16 of an inch, you will notice that the engine feels it instantly and pulls a little bit harder.

Slipping on the Brake

With the brake pedal, on the other hand, the first motion does not result in retarding the motion of the car, but only in taking up some of the lost motion or spring in the rods and brakebands. The pedal must be depressed for perhaps a couple of inches before you begin to feel it bite and notice that the car is beginning to slow down. This position of the brake which it first starts to operate, may be called the "threshold value."

A detector has the same characteristic of "lost motion" or "threshold" as has just been described. Fig. 6 compares the input and output of a detector and amplifier. Notice that an input even though very small, will cause a proportionate output through this tube. Thus if the input to the grid is represented by the length, OX, we shall get an output of XY. The detector is quite different. It can receive quite a lot of energy on the grid and still be absolutely dumb in the plate circuit. Thus an input of OX to the detector gives no response at all in the phones. From point X on, the plate has an output, but until this threshold is crossed nothing happens.

It Swells and Shrinks

In this connection it is interesting to see actual curves as run on a tube with different uses. The upper curve of Fig. 7 shows the input to the grid. We have a high frequency radio wave that swells and shrinks in time to the audio vibration. At first the volume is small and then it gets much larger.

When this tube is connected into the circuit as a detector, the lower curve of Fig. 7 indicates the output. At first, owing to the threshold effect, there isn't any output. After the threshold has been past, because of the larger input, we get current through the plate. Owing to the rectifier action of the detector, of course the radio frequency has been converted into the much slower audio frequency vibration.

Get it Amplified First

But suppose instead of feeding the input of Fig. 7 to a detector, we had first impressed it on the same tube connected as a radio frequency amplifier. The latter, as already explained, has no threshold effect, and so the output is as shown in the upper curve of Fig. 8. Notice this is just like 7, except that it has much greater amplitude (loudness). Now let us take this output and run it through a detector. The result appears in the lower curve of Fig. 8. All the waves are powerful enough so that they will operate the tube, and detector output is now good both for the soft and the loud music that was played in the upper curve of Fig. 7. Obviously when a detector precedes the radio frequency amplifying tubes, as is the case in the super-heterodyne, some signals are entirely lost that might be heard and amplified if there were amplifier tubes ahead of the first detector. This makes it very desirable to have a detector tube in the first socket that is designed for the lowest possible threshold voltage at the sacrifice of all other qualities. The following amplifiers will make up for any other loss in efficiency.

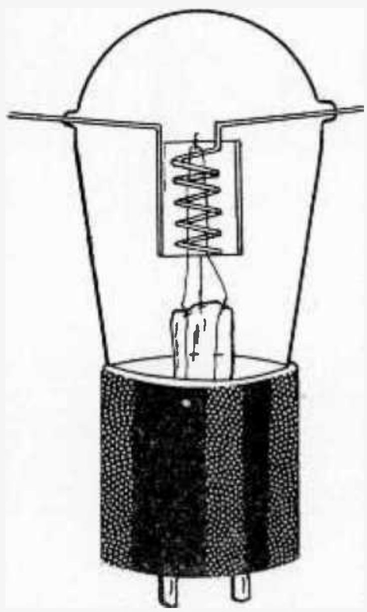

Fig. 9. Here is a Tube Made Abroad with Very Low Condenser Action Between Grid and Plate.

If, also, we should substitute high amplification factor tubes in the intermediate frequency amplifier, it would be necessary to use only about one-half the number to get equivalent results.

Haven't Told All Advantages

The foregoing discussion is not entirely complete, as it takes up only one aspect of the advantage of matching each tube to its specific stage and purpose. There are a number of other points, such as the proper regulation of internal capacitance (grid-plate condenser) in the early stages of radio frequency amplification, and the matching of the output impedance (plate resistance) of each tube to the transformer that succeeds it. So, all in all, the advantages are a great deal more pronounced than I have stated.

Not the least important field for tube improvement is that of mounting. Even the new "X" sockets and bases are open to much improvement. The greatest present need is for tubes for high frequency (low wavelengths) and radio frequency amplification that have a lower capacitance between the elements. This means that the system of bringing all leads out at one point should be changed. Some of the newer foreign tubes recognize this, and make connections to leads that come through widely separated points in the glass envelope, Fig. 9. One of the best British tubes maintains a space of at least two centimeters (4/5 of an inch) between the points at which adjacent leads leave the glass. Myers is the only American manufacturer who has recognized the wisdom of this procedure. He has been making tubes with terminals at both ends for several years, but he alone has done so.

It has a Pair of Grids

The above-mentioned British tube presents another feature that American manufacturers have for too long ignored. This is the possibility of including extra elements in one tube to make it do the work of several. The British FE 1 has, for example, an extra grid surrounding the regular one. This makes it possible to use one tube for an outfit that consists of radio frequency amplifier, detector, and audio frequency amplifier. Two of these tubes will take the place of five ordinary ones. This is even better in the elimination of tubes than the common reflex circuits, and because the tubes are more carefully made, the results with this new type of reflex are much better than with the old.

Continued on Next Page

Forget the "A" Battery With Unipower

This Trickle Charger Takes Care of Battery Every Day

By VANCE

THERE was once a man who *never* forgot. So he never had the trouble of finding that he had forgotten to turn on the charger for his battery, and as a result could not get the program he wanted.

If you don't happen to be this man, perhaps you have found your battery

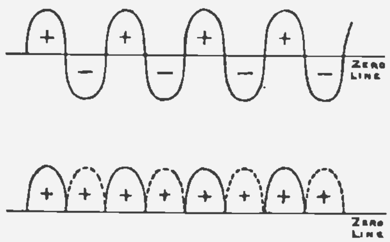

Fig. 1. The Rectifier Cell Prevents A. C. from Discharging Battery.

flat at a time when you had visitors and particularly wanted to show off the set. Suppose you had an automatic battery which, when it got hungry for current, would ring a bell, or better yet, would turn itself on so that it was always ready. That would undoubtedly be a pretty good kind of device to have around the house.

It Will Never Forget

The kind of outfit which I will describe, while not working on exactly that principle, still gives about the same results. The user never has to try to recall whether a charge is necessary, as when the radio set is turned on you will find the music is good and loud. No danger of your filaments having only a dull, sickly glow owing to lack of sufficient voltage.

The "Unipower," as it is called, (made by the Gould Storage Battery Co.) has three essential parts. A regular storage battery with its lead plates and sulphuric acid is what actually supplies current to the vacuum tubes, but owing to the fact that it is charged every day, the capacity of its cells is somewhat less than that of the usual installation.

Tantalum Metal Does Trick

The second element is the charger. This consists of a hard rubber jar like an ordinary cell with the usual sulphuric acid. Instead of the regular plates, however, we find one terminal is a short piece of lead in the upper part of the jar, while the other is a thin ribbon of the metal Tantalum. This latter is one of the semi-rare elements and is very hard indeed to work. If you try to run a metal drill through it, you have a job on your hands as it resists so that you will seem never to accomplish it. The word comes from the name "Tantalus." You will remember this name in Greek mythology as a man who was always "tantalized." Indeed, the latter word comes from the same root.

This metal has the very unusual property that it will pass current freely in one direction but not the other when it is immersed in an acid solution. In this

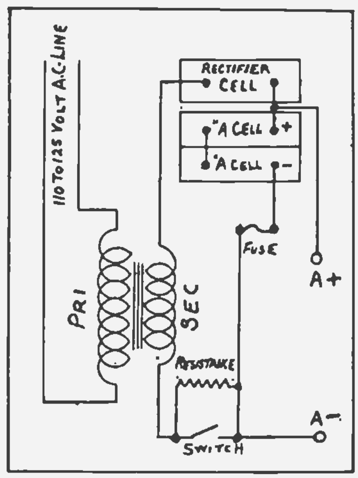

Fig. 2. Hook-up Shows Resistance Used for Making "Trickle" Charge.

way it becomes a rectifier, as it converts an alternating current from the series of positive and negative loops (top, Fig. 1)

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WHAT WILL TUBES BE?

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In some of the topics discussed in the first half, I have been unable to cling to proved fact all the way. The element of deduction has entered to some extent. But in this last discussion nothing has been mentioned that is not reasonable for immediate production, or that has not been fully investigated in the laboratory. These are no fantastic predictions. They are conditions that can be brought about to-morrow, providing the plants for production could be built over night. No great research would be needed. Most of it has already been done.

Can Have What You Want

The matching of tubes to their specific uses is something that can come about very shortly, as soon as the public makes known the fact that it understands conditions and wants the better apparatus that it can perfectly well have. Granting that patent difficulties exist, these are not insurmountable. The keynote of trade this year has been combination and co-operation, instead of the cut-throat competition of the peak of the boom; the research has been done.

Let the manufacturer know your wants, and he will hasten to be the first to supply them. The public will no longer purchase everything labeled Radio. Manufacturers are hungering for something that will take with everybody. Here are the half-opened doors toward future development. If the manufacturer does not see them, point them out.

FORGET THE "A" BATTERY

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into a direct pulsating current, as shown at the bottom of Fig. 1 in the full lines. If the leads of the input to the rectifier on the AC side were reversed, the rectifier would still work, but give the curves as shown in the dotted lines.

The third element of the unipower is the control apparatus, which is made up of the switching unit and the ballast resistance. These will be explained in more detail a little later.

Six Volts A. C. to D. C.

The wiring diagram is shown in Fig. 2. The alternating current line connects to the primary of the step down transformer at the left. The reduced voltage at six, or slightly above, is taken from the secondary winding. Like any transformer, the output is also alternating current, but at the proper potential for charging the batteries. Next in line appears the rectifier at the top of the cut. As already explained, this allows the positive loops to pass, but not the negatives ones.

The rectified current is now suitable for charging the battery and it is fed direct to the latter. A two-cell, four-volt unit, such as is suitable for operating 199 tubes, is illustrated here. Next in the circuit comes the fuse and then a resistance conducts the current back to the secondary. This resistance holds the current down to the proper value for a low or trickle charge. If, for any reason, a higher rate is wanted the switch is closed, which by cutting out the resistance brings the charging rate up to a value about four times as great.

Grouped Into Unit

The charger and battery are grouped together in a single unit, as shown in Fig. 3. The taller part at the rear is the battery, with a cover over the terminals. In front is seen the rectifier cell with the fuse mounted on top. The little pull switch has its handle projecting through the cover and is used to give the high rate of charge by short circuiting the resistance, as just explained.

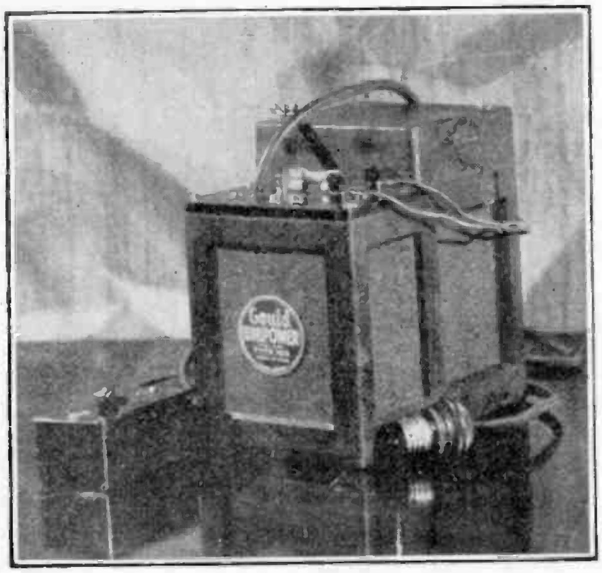

Fig. 3. The Complete Unit is Compact and Easy to Control.

At the left you will see a small box with a switch handle projecting from it. This is the control element. It is a standard tumbler switch with four poles, and is arranged for throwing either way. As Fig 4 shows, however, when the switch closes to the right, circuits 1 and 2 are connected, but 3 is left open. In the left-hand position 3 and 4 are joined, while 2 is open.

In operating this device the battery is hooked up to the filament terminals of the radio set with only switch No. 3 interrupting the circuit. The filament control switch, or rheostat, in the radio is left in the on position all the time, night and day. Control of the receiver is had entirely by this unipower control switch. When the latter is thrown to the left, notice that current will be turned on and you will pull in your favorite stations. During this period, lines 1 and 2 are disconnected and so no current is being fed to the battery from your lamp socket. This means that no hum of any kind from the electric light wires will be fed to the radio.

Starting on the Job

When you are through listening for the evening, you snap the switch to the right. There is no half way position and so when you get tired of the loud speaker you *must* snap the switch to the right to get rid of the music. This turns off the radio, but at the same time completes the circuit through 1 and 2 to the charger. Immediately the transformer and rectifier get on the job and start replacing the current which you have just drawn from the battery.

From this you will observe that if you use your set, say three hours in the evening, that all the rest of the time that day (21 hours) the battery will be charging. Will not this get it too full and damage the plates? No, because the ballast holds the current down to such a low value that it might be left on for a month at a time without doing any harm at all.

A few words about the different elements may be interesting. The transformer employed has a low core loss and is so built that it cannot hum, being supplied with ample reserve of both iron and copper to provide against wide variation in either voltage or frequency of the AC supply.

Cutting Out the Ballast

You will note that by means of a push-pull switch we can short circuit most of the ballast resistance if we desire a higher charge rate, as may be the case in the event that the radio set has been left on overnight, or for any reason the charging current has not reached the unipower continuously.

The ballast resistance is of the iron wire type, designed with a view to reducing a tendency to high charge rates with high voltage, although it will not give an absolutely flat charge rate. It is not necessary.

An automobile type fuse in the negative battery lead protects the radio set

Continued on Next Page

The Wonderful Dynosaurodyne

By Ralph Milne Farley, A. B., LL. B., Author of "Have You Written Your Radio Book?" "The Radio Beasts," etc.

WE are happy to present to our readers this month an epoch-making radio invention, that will be of the very greatest importance within the next few years, if at all, which we very much doubt.

The dynosaurodyne (Trade Mark Reg. U. S. Patent Off.) opens up an entirely new avenue, in fact a complete street system, to the archaeologist and radio experimenter. We predict great things for this new principle, and expect that it will draw great interest. We are rather banking on this, in fact.

This new epoch-making invention, or rather discovery, enables one to do away, not only with the "B" battery, but also with the "A," "C," and "D" batteries, and even with the entire artillery.

In fact the dynosaurodyne (T. M. Reg. U. S. Pat. Off.) has enabled the author to go even further, and do away with his entire radio set, to the great relief of his long-suffering wife.

But I am getting ahead of my story, as well as ahead of the times. Let me tell you how this "B"-battery-less radio came to be invented, or rather discovered.

The Bones of Mah Jongg

One day last fall, with my old college chum, Professor A. Sharpe Pikkacks, I

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FORGET THE "A" BATTERY

Continued from Previous Page

and accessory wiring from a short circuit. For mechanical reasons, a metal casing is supplied to house the transforming equipment.

You Can't Forget Water

In this connection it is interesting to note that the rectifier cell is so designed that when the electrolyte is evaporated to a point below the lead plate, thus cutting off the charge, the liquid in the battery cells will be found to have fallen to the plates. It is necessary to add water to all cells in this case to resume charging. This provision makes it impossible to injure the battery plates because of failure to add water as directed.

If you are interested in knowing the output of this type of charger, here are the facts. There are two sizes of this device made, one working on four volts for the UV199 tubes and the other on six, which will operate 201-A bulbs, and others which need five volts on the filament.

The smaller charger has an output in the normal or trickle position of one-eighth of an ampere. If eight 199 tubes are used in the set, the total current consumption will be one-half ampere, which, for say four hours use, will consume four-halves or two ampere hours in an evening. During the other twenty hours of the day it will charge twenty-eights or two and one-half ampere hours, thus more than making up the drain even of an eight-tube set. Naturally, with a smaller set even longer use may be had without exceeding the amount made up on the trickle charge. If it is exceeded for any reason, you merely have to pull out the ballast switch and the current will pour into the battery just four times as fast.

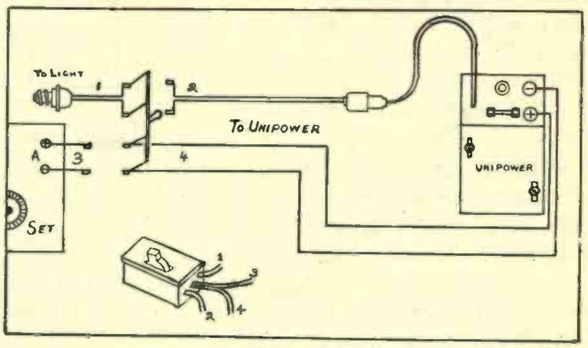

Fig. 4. The Switch Connects Either the Set for Listening or Battery for Charging.

Gets Four Times Speed

The larger or six-volt style charges at the rate of four-tenths ampere. An eight-tube set, using 201-A tubes, will consume two amperes. Four hours operation would give eight ampere hours taken out. The remaining twenty hours on charge would put back twenty by four-tenths or eight, which will just return the deficit. If faster charging is wanted, we may again pull the ballast switch and get four times the charging rate.

Either of these devices may be left for long periods without water, although it is recommended that it be added four times a year with the small model or six times with the large. If you forget to add it, however, the drop of level in the rectifier will stop the charger from operating and so your battery will run down. The dim lights in the set will then warn you that it has been months since you gave the outfit a drink. No damage has been done, though, and by adding water to both battery and rectifier cells, and then snapping on the high charging rate for an hour, you will be off for another long period.

THE DYNOSAURODYNE

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happened to be digging in the upper tertiary, just north of 112th Street, for bones of the now extinct Mah Jongg. Of course I would have much rather stayed at home in Garden City, and spent my time digging around in my own primary and secondary. I hope you get the connection. Making proper connections is a very important thing in radio. But that is neither here nor there. Especially the latter.

It was a perfect fall day. We fell for it. There was no static. The radio bugs were lazily and unsuspectingly buzzing about the current bushes. The ground was covered with solder (as all well-made grounds should be). The leaves were turning. The air was filled with—well, the air was just plain filled, we'll let it go at that. This was a sign that there were too many amateurs on the air. In spite of which KDKA and WGBS were both coming in strong, and on about the same wave-length. So what more could you ask?

"Take your pick," remarked the professor laconically.

It was not mine; I had borrowed it from a friend named Mike who worked in a local radio store. "Mike Rofone" his *full* name is, and he is usually that way.

Well, anyhow, I took the pick and started digging. We dug some time.

"Hot, isn't it?" remarked the professor who was always given to talking too much.

"You said an antenna-full," I replied, "When I got up this morning, Arthur told me it was nearly a hundred."

"And who might Arthur be?" inquired my friend innocently.

That's What Temperament Is

"He might be almost anyone," said I, "but, as a matter of fact, I was referring to Arthur Mometer, that we use to take the temperature of our 'A' batteries. There is no quicker way to detect a sick battery than to take its temperature. Temperature and temperament are the most imporotant things about a battery; but mostly temperament."

How little we dreamed, as I chattered thus, that we were on the eve of an epoch-making discovery which would do away with batteries forever. And without any 60-cycle hum either, which is going some. Though all the eliminators claim to have eliminated that as well.

We dug in silence, and unearthed nothing but several loose couplers. At least, that's what Professor Pikkacks said they were. They certainly were lying around loose, but I think they were merely the kind you couple trolley cars with. Anyhow, the professor doesn't know much about radio; in fact, he is writing a book on the subject.

But to get back to Mah Jongg. The bones of this extinct game-animal, which was a sort of red, white and green dragon, used to be very valuable in the days when they were plentiful; but, now that they have become rare, they are not worth so much.

Digging for the Bones

Remember how deep you used to have to dig to get a set of these bones? Well, we did not think that this would be necessary. Nevertheless, we dug all morning without results, and were just about to adjourn to an ancient beanery in search of prehistoric eggs, when the professor turned up what at first we both mistook for merely a tile. Even so, a dispute at once arose, I asserting that this was a fossil flower, while he maintained that it was one-bamboo. But sometimes even experts have been mistaken by this similarity.

In searching for further evidence, we turned up an entire set of bones. As the last bone was revealed, we abandoned all thoughts of Mah Jongg, or even of chow, for the truth was borne in upon us that we were on the threshold of a great discovery. We sat down exhausted. The professor took a small book from his pocket. Perhaps it would throw some light on the situation. Evidently it did.

For some time he read in silence, making notes in the book with a pencil. Then:

"What is a prehistoric beast in eight letters?" he asked.

It was the first cross word that had ever passed between us.

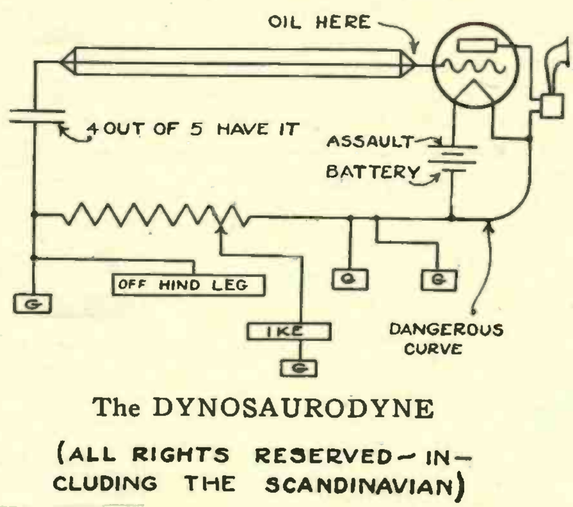


Fig. 1. Hook-up of This Animal—or Should We Say "Machine?"

"What is the initial letter?" I replied.

"P," said he, positively.

"No," said I, "I am sure you are wrong.

Professor Pikkacks is one of those very positive persons, who always attract negatives.

"Then what is it?" he asked.

"Probably the word is 'dynosaur'," I replied, guardedly.

Not Loud Speaker Horn

I was right. The bones before us were those of a horned dynosaur, one of the strong-armed dwellers of the forests of the past. But the remarkable feature of this particular dynosaur was that it bore distinct marks of domestication. Furthermore, certain ligaments and ligatures between the horns and the other parts of the body furnished us the evidence for solving that hitherto insoluble question about the horned dynosaur: namely, why the horns? The reason for the horns now became evident. They were not loud-speaker horns at all. They were for purposes of hook-up.

But just what was this hook-up? How should we diagram it?

As I had had some experience with radio, it was obvious that I was utterly unfitted for this task; so it was delegated to Professor Pikkacks, who doesn't know a dial from a dielectric.

But before undertaking this work, we decided to adjourn to the beanery.

As the professor so aptly put it, "When do we dyne?"

His plate-voltage was always very strong, and his capacity enormous. As we sat down together at the counter, he asked, "Can you tell me why that beast, which we have just discovered, is called a 'dynosaur'?"

Where Dyne Comes from

"Easiest thing in the world," I replied, "It's all the rage to give to newly discovered radio hook-ups, a name which includes the Greek suffix 'D-Y-N-E'; though why on earth they do it, is what is Greek to me. In fact, it is what I am dyne to know."

"I am even told that there is one concern, whose engineers are so busy inventing new words ending in 'hyphen D-Y-N-E', that they haven't any time left to build any radio sets.

"The imperial dynasty of the Dynes rules radio with an iron hand. And, regardless of the capacity of these rulers, they induce a very sharp pain in the coils of my invariable insides."

Then the professor interrupted my harangue.

"I should diagnose your case as acute indigestion caused by over-dyning," said he, "But seriously speaking, tell me, if 'dyne' is a *suffix*, how can you put it on the *front* end of a word?"

I replied, a bit hurt, "I *always* speak seriously. That's why RADIO PROGRESS prints my stuff. But to answer your question. Having run the gamut of all possible, and several impossible, combinations of the suffix 'dyne', some firms are now even leaving off the E's; but the easiest way out of the fix, is to use 'dyne' as a *pre*fix."

"Why not use it on both ends of the word?" he suggested.

It was a good suggestion, and one which I later followed.

"What good are dynes, anyhow?" he asked. You see, he was pumping me for material for his forthcoming book.

Cure for a Pain

But not realizing this at the time, I kindly explained, as follows: "Well, when the owner of a crystal set wishes to make as much trouble for his regenerative-tube-set neighbor as the latter is doing for him, he employs a '*crysto*dyne'. When a radio fan wishes to tune out local interference, he uses a '*neutro*dyne.' When he wants something real fancy and complicated, he builds a '*superhet-ero*dyne'. When he hurts his finger fixing his set, he puts on *io*dyne.' And when all this dyne business gives him a pain, he calls for an '*ano*dyne.'"

My readers can see, from the foregoing conversation, that this superfluity of dynes has made me sore. And it has made the dynosore too, which accounts for this present article.

But to return to the epoch-making discovery of Professor Pikkacks and me, which is just what we did immediately after lunch. The professor at once started in to diagram the hook-up of the strange horned beast, (Fig. 1.)

The first detail which he noted was that there were no storage batteries and no bananas. How the ancients had been able to make any progress in radio, without banana oil, is a problem which is still unsolved. But probably they used apple sauce. Adam and Eve were pioneers in this, and hence perhaps in radio.

But may that as it be. The fundamental fact stared us in the face that, by hitching his aerial to his horns, the dynosaurodyne made use of the hitherto unsuspected principle of combining his lead-wires with his loud speaker.

For vacuum tubes, the creature probably employed his brain cavity, thus utilizing the well-known lack of grey-matter possessed by prehistoric saurians. (Perhaps some fans to-day are his descendants.) Or perhaps he used his ailmentary tube. The "dyne" part of his name certainly suggested that.

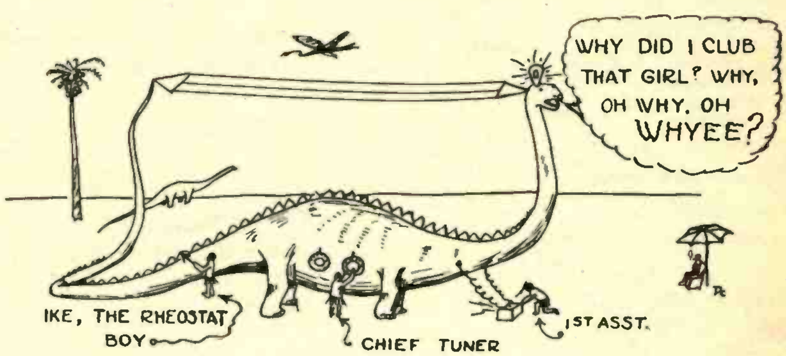


Fig. 2. How Would You Like to Meet This Little Playmate on a Dark Night?

The most remarkable thing about this new hook-up was yet to be discovered. This was its copyright and trademark protection. The term DYNOSAURODYNE has been trade-marked in the United States, as well as in Europe. Manufacturers and the trade are cautioned not to use it without the consent of RADIO PROGRESS.

Of course Professor Pikkacks and I, and even the editors of RADIO PROGRESS, realize that such a registration, not preceded and accompanied by actual manufacture of dynosaurodynes (Fig. 2) by us on a commercial scale, is what patent lawyers call "a trade-mark in gross," and is utterly void; but, so long as manufacturers and the trade don't realize this too, we should worry.

Producing Programs to Please You

How a Big Station Finds Out What You Want

By J. A. HOLMAN, Manager, WEAF

"YES, we have no bananas." You don't hear this sung any more over the radio. Why? Because the program directors have found out that their listeners are sick and tired of it.

That's what the director is for—to find out what kind of a program you and your millions of brother fans are best pleased with. It's not such an easy

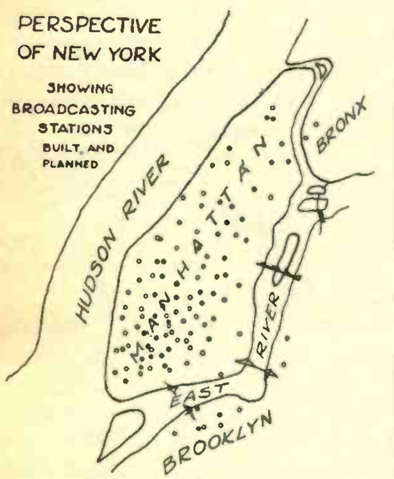


Fig. 1. This Would be a Bedlam if Allowed.

job, either, since so many listeners will tell their friends how good or bad the program may be, but never think to send either thanks or thorns to the artists.

Across Atlantic to Paris

Probably you will be pleased to hear something about the manner of selecting a program at one of the large broadcasting stations—WEAF, New York. The fourth birthday of their going on the air was recently celebrated by this station, for it was more than four years ago that the American Telephone and Telegraph Company started experimental work in radio. Being pioneers in the art of voice communication, our engineers were actually engaged in the advancement of the art since the birth of the vacuum tubes. For example: In 1915, speech was transmitted successfully by wire from Arlington, Va., across the continent to San Francisco, over the Pacific to the Hawaiian Island, and at the same time, in the opposite direction across the Atlantic to Paris. This was done by engineers of the American Telephone and Telegraph Company in cooperation with the American government.

With the advent of radio broadcasting, WEAF was established as the Telephone Company's experimental station for the purpose of studying the engineering and economic problems confronting this new art.

The Four Big Questions

Was there a demand for radio broadcasting? If so, what did the public want? How was the demand to be met from the economic point of view? Finally, how could facilities be set up to meet the demand on the part of those who had legitimate use for the new medium? These four questions were, and to some extent still are, the outstanding ones presenting themselves for solution.

The first question was answered immediately. The demand was overwhelming, not only from radio listeners, but from the business organizations which sought to utilize the new art by installing their own broadcasting equipment. In New York alone, more than one hundred inquiries were received regarding the purchase of radio transmitters. This would have meant one hundred broadcasting stations transmitting all kinds of programs simultaneously (Fig. 1), with the attendant economic and engineering inefficiencies and a positive *disservice* to the radio audience. The reason for the existence of WEAF will now be evident. It was to determine how genuine was the demand by these organizations for broadcasting facilities, and to carry on the general experimental work of the Telephone Company that the station was started.

At the time that this station was opened, broadcasting was looked upon as a novelty. The majority of radio fans were the amateurs, the old dyed-in-the-wool veterans who, while they are still with us to-day, are greatly out-numbered by listeners preferring program quality to experimentation. This audience grew rapidly, for the fascination of radio telephony seized the public imagination with an overwhelming force. At first, mechanical music by phonographs and player pianos sufficed. To cater to the

Fig. 2 The Operating Time Has Increased Almost Four-fold.

growing audience, aspiring vocalists and instrumentalists desiring to take advantage of the new publicity medium requested placement on the programs. For the first year or two, programs were disconnected presentations of one soloist after another. While in the very earliest days of the art it was possible to secure a few of the outstanding artists, they performed only because it appealed to them as a novelty, and as a means by which they might secure other engagements.

What were the program tendencies in these pioneering days? It was the natural development from the simple studio programs to out-of-studio events. Program managers were aided then, as now, by the radio fan's letters. While the mail was fairly heavy, it contained a smaller proportion of constructive criticism, the majority of letters being expressions of enthusiastic surprise at the new medium and its quality programs. Our station directors carried on extensive experiments and increased the number of program hours from fourteen per week (Fig. 2) to the present average of fifty-two. This is a good slice of the one hundred and sixty-eight hours in a week.

Music the Backbone

WEAF's personnel was first doubled and then tripled. Every step was taken as a result of carefully arranged experimentation. Assisted by the more thoughtful letter writers, the station branched out into new fields. Musical programs, while forming the backbone, could not fill out the structure. Education, religion, arts and sciences, politics, sporting events, governmental and public proceedings, each was studied to determine its place in the program structure.

Take the question of religion in radio as an example. The important religious bodies were consulted. From the first, we felt that broadcasting activities along religious lines should be confined to such times as would not conflict with regular church services. The Catholic, Protestant and Jewish bodies were consulted and invited to participate in the big radio experiment. The Greater New York Federation of Churches accepted the responsibility for the Protestant denominations, and since then have presented a religious program on each Sunday afternoon and Thursday evening. For the Jews, the United Synagogue of America joined in the experiment and has been presenting its religious program on each Wednesday night. Even these religious programs have been studied and have shown considerable development, not only in their nature, but in the amount of time devoted to them.

Everyone Was Astounded

The educational problem was handled in conjunction with the outstanding educational body in the city, Columbia University. That there was a place in radio programs for serious lectures, authoritatively and interestingly presented, was expected, but no one anticipated the public response. When the Home Study Department of Columbia University selected as its first experimental course the series of lectures on the poetry of Robert Browning, it was felt that radio broadcasting was being given the educational acid test. The result was immediate and astounding. The University was encouraged to further efforts. Since that time, two years ago, there has been a continuous series of lectures by University authorities, discussing such subjects as history, psychology, religion, politics, economics and other major subjects.

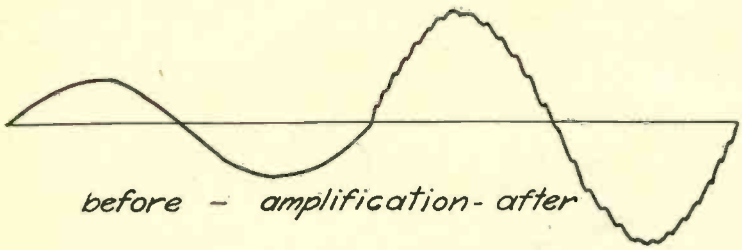


Fig. 3. Amplification Sometimes Brings Out Noise Which Was Not Noticed Before.

As may be expected, national political organizations eagerly seized upon radio's opportunities. The new medium could counteract the evils of the voter's indifference and reach the citizen and his family within the confines of his home. The real problem for the broadcasters was not to obtain the co-operation of political bodies, but rather to keep political activities from preempting a larger share of program time than the radio audience desired. Great care has been exercised in political presentations from the earliest times. Absolute impartiality must be shown, as the radio fan has taken much interest in politics and will be the first to notice and to decry any leaning toward one party or another. Equal opportunity was offered last year to the major political parties for the broadcasting of their national conventions, with results that are known to every radio fan in the country.

The Thrill of a Lifetime

With the fondness of the American public for sporting events, it was not long before WEAF made experiments along these lines. The first great effort was on the occasion of the famous Princeton-Chicago football game, played in Stagg Field, Chicago, in the fall of 1922, and relayed by specially engineered telephone circuits through WEAF to the Metropolitan audience. This was the first important broadcasting from a remote point, and words fail utterly to describe the thrill which the eastern football fan experienced when he heard that Princeton student band playing in Chicago, and followed one of the most exciting games in years, play by play, simultaneously with the actual happening a thousand miles away.

So quick was the radio audience to respond to this type of program that the tendency to present sporting events on a larger scale each year has been marked. Now the radio audience follows every important sporting event, whether on the Atlantic or on the sun-kist fields of the Western coast, be it football, baseball, horse racing, boxing, aeroplaning, or races by college crew or power boats.

Broadcasting Broadway

Out-of-studio events such as concerts by the Philharmonic Society Orchestra, the New York Symphony Orchestra, the Oratorio Society of New York, the Schola Cantorum, and others, proved from the outset to be popular, also an occasional Broadway show—confined mainly

Fig. 4. Radio Has the Key to Your Home—Does Not Knock.

to musical comedy. These programs from sources outside the studio proved to be so acceptable that there never has been any question of their continuance and growing importance. Permanent installations were made to convey splendid hotel music at regular intervals, and similar installations have been made to provide other forms of entertainment.

The tendencies in the development of radio programs from simple studio events to those presented on the national scale could not help but bring important engineering and economic problems with them. To link up stations in distant cities meant the utilization of special high quality, long distance circuits of the Bell System. While the American Telephone and Telegraph Company maintained long distance telephone lines across the country, much engineering work had to be done to fit all of these lines for radio purposes. These circuits were designed for telephone subscribers' use and in addition to talking circuits were utilized for telegraph service. When demand was made for their use for radio broadcasting, telephone and telegraph facilities had to be removed from the circuit and there had to be substituted equipment for the transmission of radio programs.

Canning the "Chatter"

Special engineering and balancing are required for the broadcasting circuit, as the radio signals would be amplified to such an extent as to produce what in telephone parlance is called "morse chatter" and "crosstalk."

Thus in Fig. 3, the upper curve shows an audio wave as carried on a line without amplifiers. The lower curve shows the same wave after a powerful amplifier has increased its loudness. However, here we see on top of the music a slight ripple or imperfection, which is caused by trouble in the line itself. Before being amplified this ripple was so small that we could not hear it or see its picture, but after the amplifiers have done their work it is all too evident. It was found that a limited amount of facilities could be so arranged that the circuits would be available for broadcasting purposes at a time when the long distance traffic was at a minimum. The result was a ready means for connecting a network of stations in various parts of the country to Station WEAF to present important sporting events and other programs to the radio audiences eagerly awaiting them.

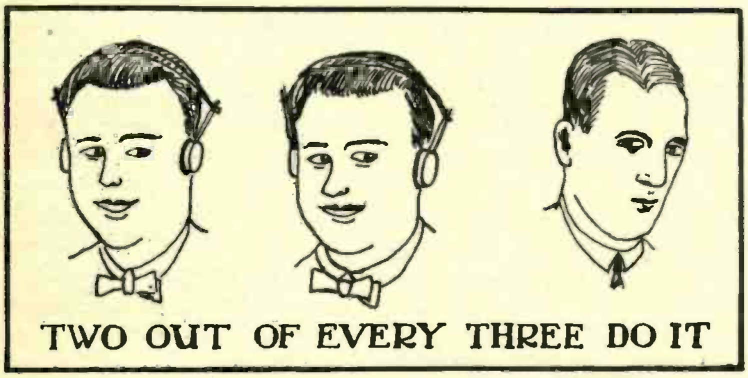


Fig. 5. When the Big Chain is Hooked Up, Two Out of Three Fans Hear the Program.

Step Into the Picture

While the many letters of the radio audience were being carefully analyzed to study program tendencies, and while the station managers were conducting independent experiments regarding program values, business organizations were not slow to step into the picture and to bring a valuable contribution to the art's development.

This will throw light on the third and fourth questions mentioned in the early part of this discussion. Business organizations realized what radio broadcasting meant to them. They used it to obtain "good-will publicity." It was not necessary for them to spend huge sums of money for the installation and operation of broadcasting stations, with the serious economic and engineering problems which would have resulted as indicated above. The facilities of WEAF were placed at their disposal and they quickly took advantage of the opportunity. Few fans realize to what extent these advertisers' programs have influenced the tendencies of radio programs. Professional artists were engaged. Prominent groups under trained leaders were formed. This meant better entertainment for the radio listener.

Doing What Couldn't be Done

Longer programs were presented which had continuity and which could be depended upon to provide the type of entertainment and the same professional artists at regular intervals so that the radio audience would expect them and look forward to them. Programs were presented of a type that previously would have been considered impossible by radio—impossible in the sense that they assumed too high a degree of musical and general culture on the part of the radio audience. Gloomy predictions of the failure of such programs did not come true. The public accepted them at their real value and enthusiastically availed itself of their educational opportunities.

It would be wrong to assume that these commercial firms advertised their products via the ether. They desired and obtained everything that is implied in the term "good-will" publicity. The advertiser could enter the homes of radio listeners without knocking at the door, Fig. 4. The privilege was exceptional and must not be abused. Program matter acceptable to the listener would stimulate good-will for the advertiser, while programs displeasing to them would have the opposite effect. We had little trouble in convincing the advertiser that he must cater to the best in the public taste.

How Not to Advertise

As the programs entered thousands of homes the moment WEAF went on the air, and it generally caught the attention of the listener during a period of relaxation, he was keenly critical. Had the cry been "The product of the ABC Company furnishing you with this program is sold at ten cents per box—there is a local dealer around the corner from your home," it would have spelled the inevitable doom of the program. In quite a contrary manner were these "good-will" programs handled. They consisted of the finest artists and enter-

Continued on Page 29

Cutting Locals Out of RF Sets

Five Tube Radios Can Often Be Improved in This Way

By HARRY J. MARX

WHEN you hear two people talking both at once in a loud voice it may mean a quarrel among their neighbors. Again, perhaps it is your radio set bringing in two loud local stations without being able to separate them. In the former case it is possible that you might want to hear what was going on, but in the latter you will be glad to know how the condition may be changed.

One of the most popular questions of the day is the one about the best method of improving the selectivity of the many five-tube tuned radio frequency and neutrodyne types of receiving sets. It would be rather difficult to estimate the actual number of these types of receivers in use at the present time. In rural and suburban sections, they give fairly satisfactory results but in large cities and especially where broadcasting stations are numerous there is much cause for dissatisfaction.

No Need to Scrap

The trouble can be easily remedied but unfortunately most people go about it in the wrong way. There is no reason for scrapping the present set and buying a new one. Before explaining just how it can be done it might be well to just fake a diagnosis of the trouble.

In practically all of these sets the tuning unit consists of a radio frequency transformer with a secondary winding that is tuned by means of a variable condenser. The primary or antenna winding usually consists of but a few turns in a fixed relation to the secondary. This means that the coupling between the two circuits remains always the same. In some cases the primary and the secondary are both grounded and in others there is no primary, a tap on the winding providing for the antenna connection.

Jams the Waves Through

In a tuning unit of this type where the coupling remains fixed, or where there is just a single circuit arrangement, the selectivity of the receiver is limited because the energy transfer from the antenna to the grid of the first tube has also a fixed value. If the incoming signals which are collected by the antenna were all of the same intensity then there would be no difficulty in separating them. Unfortunately there are in many places powerful local stations whose waves, because of proximity are collected in large amounts by the antenna. Because of the fixed coupling relation, this big power passes on to the grid. Altho the secondary may be tuned to a different wave, still this excessive energy forces its way through, creating the interference and spoiling the reception from stations of nearby wave lengths.

What is necessary then is some control or what may be called an "electrical valve" which will vary the amount of power which is passed on to the grid of the tube.

It Pays to Sacrifice

Variable coupling is the natural solution to this part of the problem. This, however, again creates some further difficulties that will be taken up and discussed later. Here a question often arises. If by loosening the coupling the energy of the interfering station is cut down, does it not at the same time reduce the energy of the station that it is desired to receive? Sometimes it does and then again it may not, depending partly upon the wave speed difference between the two stations. The reduction in the station tuned in, compared to the reduction of the interfering station is small enough to be negligible. Besides the sacrifice of a slight reduction of volume is well worth the compensation of good clear reception of the desired program.

In order to obtain complete resonance for various wave speed ranges it would really be desirable to vary the coupling between the primary and secondary circuit. In a tuned radio frequency transformer this variable coupling is not so important but in the tuning unit in front of the first tube it becomes very valuable. When a station is brought in and the coupling has been adjusted for resonance between two circuits, then the power transfer from the antenna to the secondary will be considerably weakened for an interfering frequency over the transfer that would take place if there were a fixed coupling. In other words there is a decided loss at any frequency except the one to which the circuits have been tuned to resonance.

Can't Use a Log

A disadvantage of variable coupling was mentioned above. This is the fact that every time the coupling between the primary and the secondary is altered, it immediately effects the adjustment of the variable condenser that tunes the secondary circuit. This coupling is a

Fig. 1. This Special Coupler Combines a Small Condenser on Same Shaft.

factor in the inductance value and if the inductance is altered the wave frequency of the circuit is changed. This makes it difficult to log the dial setting of the condenser and has been the main objection to a variable coupling control.

If this difficulty can be overcome then it is easily seen that a variable coupling unit becomes not only an advantage but in fact is a vital necessity to good selectivity. Each circuit will then have an "electrical valve" that stands at the door and keeps guard to see that only the desirable waves get through, while undesirables are barred.

as a means of controlling the volume of sound produced by the receiver.

Controls the Volume, Too

The impression may be gained that this is a complicated instrument and difficult to add to a set. This is far from being the case. Figure 2 shows the hook-up diagram of a neutrodyne in which the clarifying selector has been substituted for the first neutrodyne coil. This instrument requires a .0005 mfd. variable condenser to tune the secondary, so the capacity of the variable condensers used in the set should be checked up. Of course, this creates an extra con-

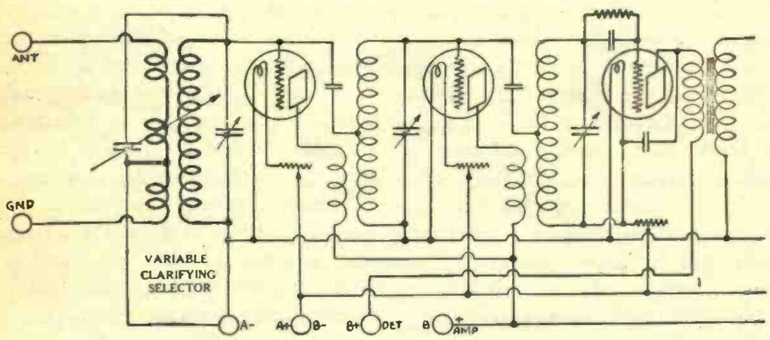


Fig. 2. Using Special Coupler is Easy in a 3 to 5-Tube Set.

Variometer as Coupler

An instrument to do this consists of a fixed secondary winding that is tuned with a separate .0005 microfarad variable condenser and a two-part primary or antenna winding, one part fixed coupled to the secondary and the other part on a rotor which can be turned to permit any degree of inductive coupling. In fact, as it is rotated a variometer effect is created giving wide coupling range which is not critical in operation.

On the end of this instrument is attached a small compensating condenser which is automatically controlled by the rotor shaft. As the rotor shaft is turned and the coupling altered, this compensator adds capacity as required in order to make up for any alteration of inductance value due to the changing of the coupling. Figure 1 shows the Elkay Variable Clarifying Selector with such a compensating condenser mounted on the end.

It is obvious too, since this device controls the amount of energy passed through to the tube, it may also be used

trol but it is one that is to be desired since it performs two functions, controlling selectivity and volume. The audio amplifier stages are not shown in the hook-up as that is not effected. Where plain radio frequency amplifiers are used the addition of the clarifying selector is the same as shown for the neutrodyne.

When using this instrument, the logging of the condenser dial is uneffected by the setting of the selectivity control.

This device may also be added to a three-coil system where a tickler is used to increase regeneration in the circuit. The inductive reaction may be compensated by the addition of this device to the tickler shaft.

RUBBING IT IN

During the recent trip of the Silvertown Cord Orchestra to Atlantic City, they played and broadcast from the Million Dollar Pier. The "Silver Masked Tenor," one of the features of the Silvertown Cord programs heard every Thursday at 10:00 P. M., Eastern Standard Time, through WEAF and a chain of twelve other stations, was seen sadly walking down the famous boardwalk, noted for its beauty contests. When asked why he was so disconsolate, he sorrowfully declared that that it was the anniversary of his marriage but he was compelled to be separated from his wife and child.

It was while he was in this frame of mind that a telegram boy rushed up to him with faithful little yellow envelope which brings good or bad news. Fearing the worst, he tore it open to read the following message: "Please sing 'All Alone' stop—Fan." The "Silver Masked Tenor" is a regular he-man, but it is rumored that he burst into tears on reading this so appropriate request. The soggy condition of the mask bears out this rumor.

CABLE IS POOR SECOND

During the Rochester Industrial Exposition, held recently, the Rochester Radio Club received much praise for the remarkably efficient message service which it maintained free for the benefit of patrons of the exposition from other parts of the world. England, Australia, Italy and New Zealand messages, as well as many for various points in the United States, were handled during the time of the show.

As an illustration of the dispatch with which the messages got through, one radiogram, relayed by the amateurs arrived at its Washington, D. C., destination forty minutes before a telegram between the same two points. The best record of all, however, was that made by messages to Australia. These were delivered there the following morning, by means of relay stations of the American Radio Relay League. The usual length of time required in ordinary cable usage is from four to five days between the east coast of the United States and interior points in Australia.

Golden Girl of Metro on the Air

Here's a Radio Star Who Does Not Disappoint You

An Interview by OLIVER D. ARNOLD

OH cruel microphone! How many good singers have their voices messed up by the machinery when they start to broadcast. The big round ear of the radio seems to take a fiendish delight in distorting the voices of some artists.

Even in the case of such famous singers as are now radiating happiness to us in the Sunday evening Atwater-Kent presentations do not all seem nearly as good over the air as they do when heard face to face. However, one of the sopranos who has been called "The Golden Girl of the Metropolitan" sang recently and did not disappoint her audience—even those who have had the pleasure of hearing her in person.

She Started Very Young

You may think that anyone who can give such an artistic performance may perhaps have been born abroad. That's where you're wrong. Miss May E. Peterson (no doubt you guessed who is meant) did her first broadcasting at the age of one minute in Oshkosh, Wisconsin. Even at that tender youth her voice must have been exceptional as she is said to have attracted the immediate attention of all the neighbors.

She was not born with a silver spoon in her mouth. Her father was a Methodist preacher riding a circuit in southern Wisconsin, and she had eight brothers and sisters who had to be fed, clothed and educated on the magnificent stipend that a "circuit rider" always receives

When she was old enough, Miss Peterson used to accompany her father when he rode the circuit and led the singing at his services, and so not only gave exercise to her girlish voice but learned the three "r's," so to say, of music. Fortunately her father was a bit of a musician himself, and as keen a lover of harmony as a man could be, else being a Methodist country parson he could never have approved his daughter's taking a professional career.

"I guess the most valuable experience I ever got," said Miss Peterson, "was leading the singing in the little churches when I went with my father on his rounds. Sometimes I had a piano to play, sometimes a pipe organ, sometimes a melodeon, but more often I just stood up—I was only a child—and lined off the hymns for others to follow. This at least taught me the self-possession which has never deserted me entirely, although I'll confess that some-

Fig. 1. Not Many Famous Vocalists Are Also So Good Looking.

times I have had very weak knees, and it taught me how to stand before an audience.

They're Alike When Skinned

"You know audiences don't differ very much and if by your manner you can win a lot of Scandinavian farmers in Wisconsin, you ought to be able to do the same thing with an audience in Carnegie Hall, New York. You know about the Colonel's lady and Judy O'Grady being alike under the skin. Well, it's the same with audiences and the more I see of them, the more I am convinced that I am right."

Her voice developed so rapidly and showed so much promise that she determined to go abroad and study, but as she had found no wealthy patron and her father was only a country parson with a large family to bring up and educate, she had to find her own means for carrying out this venturesome plan. She gave concerts in Oshkosh, and in the surrounding towns and when she had $300.00 clear and above the cost of her journey to Italy she started.

Fig. 2. Here is a More Intimate Snap Shot as She Neared the Shores of America.

When Thinking Was High

She studied in Florence with Mme. Barrachia, ekeing out her little capital by giving lessons in English, singing in the American church and appearing at musicals in the American colony. It was a season of plain living and high thinking.

Besides the three hundred dollars she had in her pocket (which represented her entire capital), her most treasured possession was an alcohol lamp which she has preserved to this day as a memento of the past. Now when anything goes particularly wrong with her, she gets it, and like Aladdin and his Wonderful Lamp, she rubs it and the spirit living in the lamp, if he doesn't at once shower her with pearls and precious stones or whisk her off in a magic carpet to Paris, Bagdad, Timbuctu or some other delectable place, at least rids her of her "blues."

Hard to Get Alcohol

When she remembers the struggle she had to make both ends meet that first year in Florence, when she recalls the spaghetti and ragouts and coffee and tea that have been made on that lamp and how difficult it was sometimes to get the said spaghetti, the ragout, coffee and tea to say nothing of the alcohol itself (and Italy has no Volstead law) she cheers up at once and "all's well with the world."

Very few girls have gone abroad to study singing with the slender material equipment which accompanied May Peterson and have been able to return a successful artist. But she has courage and persistency, imagination and resource, and she found means to make money in Europe, which helped her through. She gave English lessons, sang in the American churches, played accompaniments—any job was a good job if it brought in some money honestly earned.

Florence Was Quite Cold

It was fairly difficult at times, especially in the winter, when one can get colder and stay colder in those stone-floored rooms of Florence than almost anywhere else, and cold is a mortal enemy of the singer. But Miss Peterson was blessed with health as well as courage, and she came through the ordeal unscathed.

Although everyone falls in love with Florence and she found it hard to tear herself away, the next move was to Berlin. Here she put herself in the hands of George Ferguson, and as she had done in Florence, so she did in Berlin, practically making her own living while she was studying. What this means can only be appreciated by those who know what the work of a serious student of singing is.

French Like a Native

It was in this City of Berlin that the writer first met her. At that time she was almost as pretty as she is now (see Fig. 1). She could talk in German quite fluently, but she spoke French like a native—of Wisconsin. That is very different from the ease and polish with which she is able to sing in French at present.

After exhausting what the capitol had to offer in musical education, she took passage back across the Atlantic to her old home. Her friends found her voice so much improved that they wanted her to go into grand opera. Finally, under the advice of Frederick Stock of the Chicago Orchestra, she went again to Europe, this time to Paris, and put herself into the hands of the great Jean de Reszke. She had had three months' hard work with him when her big opportunity came at Vichy, the great watering place in Central France, where the season of summer opera is one of the most famous in Europe.

Started Without Any Rehearsal

When she was engaged to sing the title role in Massenet's "Manon," the manager of the Vichy Opera did not know that she was a novice who had never appeared on the operatic stage, and after she arrived in Vichy, she found to her horror that there would be no rehearsal. "Manon" is part of French operatic routine, and no rehearsals are necessary, for it is taken for granted that principals, chorus and orchestra are letter perfect and in a summer season need no rehearsal.

Was this girl frightened when the time came for her to make her first entrance in the inn-yard of the first act? As she expresses it, "I was scared blue! If I hadn't got my growth by that night, I should have remained a little child. My teeth chattered, my legs wabbled, a cold, dank perspiration oozed through the grease paint on my brow and from under my wig, and as for my throat, it was like the Sahara Desert in its dryness.

Spelled with Capital Letters

"But my subconscious self must have been very busy, for I got through the first act somehow and received some curtain calls. Then the rest of the evening was easy, for I felt that I was making good, that I really at last started my career. And CAREER with a beginner is always spelled in very large capital letters."

She sang there through the summer, and in the autumn went to various of the more important provincial houses, where she gained invaluable experience in stage routine. Then she went to the Opera Comique in Paris, making her debut as "Lakme." The Parisian public at once took her for its own—and then came the war and home came Miss Peterson.

Here she met with no difficulties. She was at once accepted as a concert singer of unusual skill and charm, and very soon afterwards she was engaged as a principal lyric soprano at the Metropolitan. There she scored one of the most substantial successes that any American girl has ever won in that institution. And her successes outside of New York in concert duplicated her triumphs at the Opera.

Neither Fat Nor Old

When you think of a Metropolitan soprano, very likely you picture a fat, old dowager, who of course must have a voice, but is lacking in charm. In this case you are all wrong. The picture (Fig. 2) shows an unconventional pose of our heroine which reveals to some extent her gaiety and sparkling nature. She is also quite partial to American composers, and sings at her recitals many compositions of native sons.

At one of her Western concerts, one old chap who sat way up in front was heard to remark after the concert, "She can't be a grand opera singer. Why she has too sweet a voice, and she is too much like *folks* to come from the Metropolitan." It is this homelike quality added to her splendid voice which has so carried away her audiences.

PRODUCING PROGRAM

Continued from Page 24

tainers available and the advertiser received the advantage of a short dignified announcement at the beginning, middle and end of the program, stating that it was through his courtesy that the program in question was being presented. In the present discussion the importance of these commercial programs in guiding program tendencies can not be over-emphasized. Better programs than ever before possible were regularly presented.

Fourteen Talking at Once

In addition to the tendency of the good-will programs to raise the level of radio presentations, it is creating a tendency that has been rapidly remaking the complexion of the whole art. The advertiser in most cases operated on a national scale. Naturally he pressed WEAF for broadcasting facilities on a national scale. There followed, through the development of an experimental wire network, the interconnection of as many as fourteen stations covering a large part of the country who are sending out to its radio audience programs emanating from the studios of WEAF. Our programs became semi-national in character. This tendency will grow and will apply not only to the good-will programs but to all important events.

In the earlier days, the radio audience was small. It is now nation-wide. It staggers the imagination to realize that the areas covered by the present fourteen network stations contain almost two-thirds of all the people in the United States (Fig. 5), and that the potential radio audiences is similarly two-thirds of all the potential listeners in the country, or an estimated total of twelve and one-half millions. The possible audiences listening to network programs will grow. Only the very best can be considered worthy of such wide distribution.

RADIO RAISES ROOF

When you look at the stars on a cold, clear night, do you realize that you are looking up right through a roof. It is called the radio roof and is the highest point which the waves can reach. When they strike this ceiling they are deflected down again to the earth.

It is only recently that this action has been proved. It was first suggested by Heaviside. In fact, it is often called by his name. High frequency (short) waves have brought out the facts and the reflection which they get from way up forty or fifty miles in the sky, have caused the so-called "skip distance" effect.

It seems that these fast waves as sent out by stations like KDKA (Pittsburg) and WGY (Schenectady) can be easily picked up for distances of 30 to 40 miles, and then they fade out to so low a value that only the most sensitive sets can receive them. Farther on they become strong again. Such a peculiar result is caused by this reflection from the roof.

In some respects this resembles the action of a big explosion. You often see the report that glass is shattered in the window panes and that the broken pieces lie outside the buildings in the street, showing that it was *sucked* out rather than *blown* in. On the other hand, some observers claim just the opposite. After a very large and serious explosion, we investigated this matter personally, and found that both sides of the argument were right. In some cases the glass lay several feet away in the streets and in other houses nearby the pieces were strewn all over the room inside.

It seems that here as in radio the results are caused by such complicated actions that it is difficult to predict, and the best we can do is to explain the general causes.

Educators have indorsed the new feature of Station WLW, which provides lessons for the elementary grades in school via the modern way of broadcasting. Teachers give the lessons at nine o'clock in the morning. A number of students are shown in the studio taking part in the lessons.

RADIO REDUCES WRECKS

"How often does your railroad system kill a passenger?" "Only once," is the answer given in the old joke. But once is enough, and radio has come to the front as a means of preventing wrecks.

The Pere Marquette railroad has just given a demonstration on a ten-mile stretch of the efficiency of the ether waves in stopping a locomotive before it runs into danger. A receiving set installed in the cab automatically lights a red or a green signal several minutes before a collision might take place.

"But suppose the engineer is suddenly taken sick or does not heed the warning?" you may say. This is provided for in the mechanism and an automatic stop turns off the throttle and applies the brakes provided a human hand does not do the same thing after the warning is flashed.

A further advantage of this system is that the engineer cannot run too fast in the "caution" zone. If he gets frisky and uses a heavy hand on the throttle, the radio relay takes the control right away from him and gives a partial application of the brakes. The tests of this system have been so successful that it is likely that further developments will be made.

How Electrons Are Your Friends

It is These Little Fellows Who Run Your Radio

By PROFESSOR PETER I. WOLD, Union College

HOW big is nothing? In the first half of this article in the last issue of RADIO PROGRESS, it was explained that an electron is nearly the size of nothing at all. Suppose you multiply a baseball up to the size of the earth—that would be an increase wouldn't it? But if you multiply an electron by the same amount it still would be so tiny that no microscope could possibly see it.

I also spoke of the discovery of the electron by J. J. Thomson, and also its

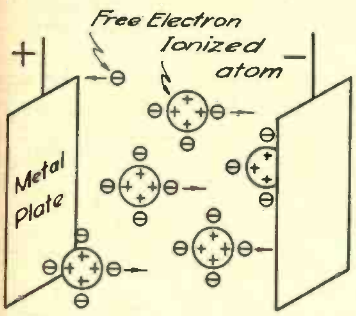


Fig. 1. When Salts Are Dissolved in Water, They Break Up

mass and charge. The conclusion was unavoidable that atoms are complex particles which can be subdivided and broken up. Further studies have shown that each atom consists of a positive portion (nucleus) and some negative electrons. The present most acceptable theory is that each nucleus is different for every kind of atom, and that this center is surrounded by electrons which are the same for all atoms, the number for each atom being enough, normally, so that their combined negative charges are just exactly equal to the positive charge and so they are then electrically neutral.

Making Over Chemistry

It was to be expected that so new and radical a conception as this should have a profound effect on the work and ideas of chemists. This is so true that our theories in chemistry have had to be largely made over, and much recent work is based on the study of the structure of the atom.

The study of physics has also been very much affected, and I wish to take up here the explanations which we now give for certain phenomena which formerly puzzled scientists exceedingly. Take, for example, lightning, or the electric discharge through tubes containing gases at low pressures. Many of you have, no doubt, seen in the latter the beautifully colored effects sometimes blue, sometimes red or green, and changing not only in color, but in form as changes in pressure and in gas take place. These phenomena had formerly received no satisfactory explanation, but now, while they are still complex, many have been worked out in detail and we have a general understanding of all of them. Briefly, the explanation is as follows:

Have Lost Their Partners

It is found that in many gases there are always a few atoms which have lost a negatively charged electron, leaving a positively charged particle or ion. This is called natural ionization. Ordinarily these will wander around, and in due course, recombine; but if in this gas we should place two metal bodies, one charged positively and one negatively, the electrons will travel towards the positive body and the positive ions will travel in the other direction.

Referring to Fig. 1, let us assume that we have a gas made up of atoms each with a large number of electrons. Instead of showing a few dozen in a diagram, we will let it go with only four to make it easy to understand. Most of the atoms then have a central nucleus with say four positive charges and around them are four electrons each with one negative charge, making four minus charges which just neutralize the four plus one in the center.

Like a One Armed Man

However, notice that one of the atoms although it still has the same nucleus, has lost one electron and so has only a negative charge of three. The four in the center of course, outbalance the three and leave a single plus charge for the entire atom. The negative electron is wandering around free. Why this action occurs nobody knows, but it is something like a one-armed man. Almost everybody has his full number, but occasionally you see an unfortunate who is minus one of his arms.

Fig. 2. Boys Can't Run Fast Through A Crowd

In general these charged "ions," as they are called, wander around at their own free will. If, however, we put two metal plates in the box containing the the gas, and charge the left-hand plus and the right-hand minus, we shall find that we get a little action. The opposites attract each other, you remember, and so you will find the negative electron shooting to the left and the positive atom travelling to the right.

When the Boys Collide

Electrons in motion like this constitute an electric current although a very small one. These ions have numerous collisions and therefore have difficulty in getting up to high velocity. It is like a lot of boys in a school yard at recess. If some of them start running around through the crowd, they will not be able to get up much speed, because the other boys will keep getting in their way. In the case of the electrons, if we make the electric field between the two plates strong enough (by putting on a high voltage), the particles may acquire sufficient velocity so that when they collide with an atom, they will knock off an electron and so two more ions may be produced, each of which would join in the stream. These would also have collisions and produce further ions, and as a result the current would build up to large values in a very short time—and we have a disruptive discharge such as in lightning. It is not able to maintain itself, however, and very soon stops. That is the present day explanation of this familiar phenomenon.

There is another way to increase the velocity of ions, and that is to remove much of the gas in the tube which is being used. This means that the gas atoms are farther apart and so the natural ions travel farther between collisions and have a chance to reach higher velocities. If enough gas is removed, they will acquire sufficient velocity so that electrons again are knocked off the neutral atoms and the current builds up. In this case we find, however, that with moderate voltages, the discharge will maintain itself continuously and quietly.

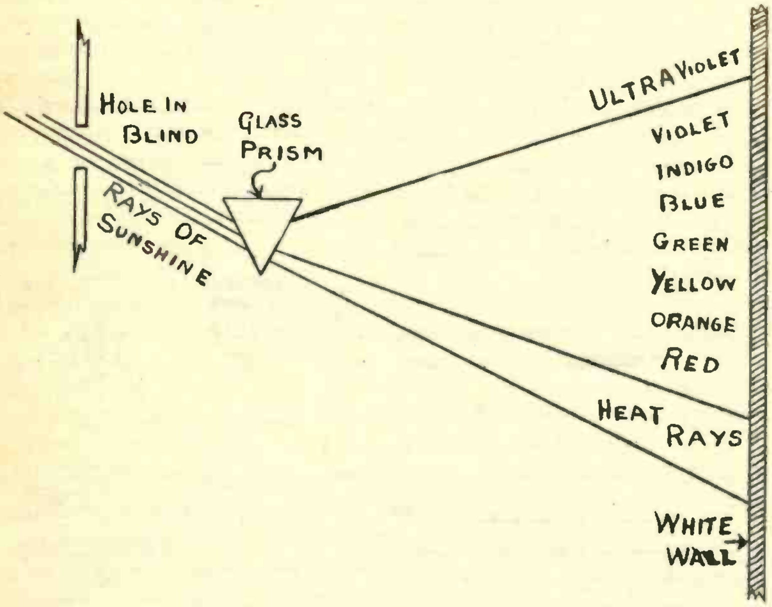


Fig. 3. How a Beam of Sunlight May be Broken Into the Colors of the Rainbow or Spectrum

Knocked His Arm Off

This is like the boys again. At one end we see a group of fellows standing close together and it is hard for a runner to get up any speed among them. At the other end, however, where the fellows are spaced a long way apart, it is easy for a chap to run pretty fast, even if he keeps a perfectly straight course, before he collides with anybody else. If when he finally did strike another boy, he should hit him such a blow that he knocked his arm off, then the action would be just like an electron ionizing an atom.

Of course, when an atom has lost an electron, it is very much dissatisfied and will pick up another whenever or wherever it may have a chance, and so become neutral again. When it loses its electron there is a large absorption of energy, and when it recaptures it this energy is given up. It is given up in the form of light, and thus we come to the conclusion that the light which we see in such electric discharges is not due directly to the breaking up of atoms and the consequent electric current, but rather that many of the broken-up parts refuse to remain broken up, and on recombining, give up the energy which was stored in them. This, in brief form then, is the present day theory regarding the exceedingly beautiful light effects we get in electric discharge through gases.

Thumb Print of Atom

Let us take up another subject. If we examine the light coming from a body such as the sun, by permitting it to pass through a glass prism, we find it is spread out into a spectrum or rainbow which is practically continuous (Fig. 3.) If we similarly examine the light which comes from an electric discharge tube such as we described above, we find that the spectrum is not continuous, but consists of narrow, bright lines with large, dark spaces between, Fig. 4. We find that the arrangement of lines is different for each kind of atom or element, and that the spectrum for one substance is so characteristic that it serves as the best identification for the presence of any kind of atom, i. e., it is virtually a thumb print of an atom. Thus, by examining the spectrum of the light from stars, we can tell what elements are there.

What explanation can we give for these characteristic spectra? I mentioned a moment ago that when an electron is knocked out of an atom, it takes up energy and that when it falls back into the atom, it gives this off as light. According to the theory as developed during recent years, the color or wave length of the light which is given off depends on how much energy the electron gives up. Now this will depend on the particular kind of atom, i. e., the particular element into which the electron falls. It will also depend on what particular part of the atom it falls into. Thus we have the situation that at least several bright lines in the spectrum can be obtained from an element depending on which of its electrons was knocked out, and that these lines will be different for and characteristic of each element. This electronic explanation of the important phenomena of the origin of spectra is the first and only satisfactory one we have had.

What Makes Northern Lights?

Let me call your attention to another phenomenon—the Aurora Borealis—or Northern Lights— which we do not see frequently so far south as the United States, but which gives rise to such gorgeous and overwhelming displays in the far North. While it was recognized that these were connected in some way with magnetic disturbances, no good explanation for the effects had been put forth. Quite independently of this it had been shown that light, such as that from the sun, exerts a very minute pressure when it falls on anything. This pressure is too small to produce a noticeable effect on ordinary bodies. If the body is very small, however, then the effect is more important. Particles even as small as atoms would not be affected much, but it was pointed out that particles as small as electrons would be driven out from the sun in larger quantities during magnetic storms there. When they reach the earth's atmosphere they would have high velocities, sufficient especially in the earth's polar regions, to break up or ionize some of the air in the upper atmosphere. Recombinations would now take place and the energy given up would show itself as light.

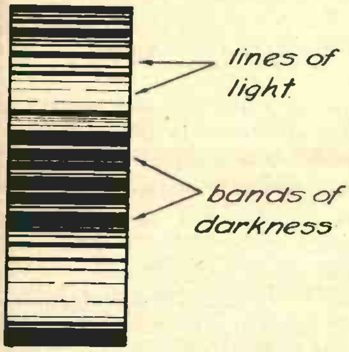


Fig. 4. The Position of These Lines is Thumbprint of the Atom

I wonder how many of you have ever asked the question as to how electricity is brought through the copper wires to your house, or how it is conducted through the fine tungsten wire in your lamps. For a good many years we have been able to generate electricity in large quantities, to control it by switches, to conduct it from one place to another, to make it do work for us in various ways; but until recent years we had no theory, even approximately satisfactory, for explaining how electricity is transferred through a conductor. In the case of electrolysis in liquids, we knew that charged atoms moved in one direction or another thus carrying their electric charges with them, but it was impossible to think that in a copper wire the atoms could be moving in sufficient numbers or with sufficient velocities because of their size and the strong forces holding them in place.

An Electron Parade

With the discovery of the electron, however, we had very much smaller particles, and these might work their way between the much larger atoms. The present theory of conduction through metals then, is that metal atoms are able to lose an electron quite readily and that in a copper wire, for example, there are present a large number of free, or nearly free, electrons. When an electric field or voltage is applied to this wire, the electrons move in large numbers through the wire (Fig. 5) and thus bring to us the electricity, and through this, the electrical power which we so much desire.

It might be expected that any kind of atoms, i. e., any substance, could be used as a source of electrons; and this is so, although some substances are better adapted for this than others and certain methods of treatment are preferable. We can obtain electrons from gases by the method described in connection with L. L. Thomson's experiments. There, you may recall, he made use in part of the small amount of natural ionization or breaking up of atoms into electrons and positive ions. In the presence of a strong electric field applied by two electrodes, these gain sufficient velocity so that on collision with neutral gas atoms they ionize or break them up, and so the number of electrons and ions rapidly increases. This then, is one method of obtaining electrons in large numbers, although mixed with positive ions used in mercury light.

Practical use is made of this particular effect, for the positive ions and electrons tend to recombine, and as already explained, the energy of recombination may be given off as visible light. This has been used in several forms of lamps, such as the mercury vapor light, those greenish blue lamps which are used in some factories, and which one sees in many photographers' studios, their peculiar color being characteristic of the spectrum of mercury. It also plays an important part in arc lights such as are used in street illumination.

Another way in which electrons may be produced is by bombarding a solid—especially metals— with a few positive ions or electrons obtained from gases. This is an important factor in the arc lighting just mentioned. Some of the positive ions obtained from the gas strike the carbon rod or other electrode with sufficient velocity to knock electrons from the atoms of the solid. These electrons then get into the gas and help to keep up the further ionization of the gas molecules.

Knocking Spots Off Zinc

Still another method by which we may obtain electrons is to allow light to fall on a metal plate. Thus, let us take a zinc plate and allow light of very short wavelength, such as that called ultraviolet light, to fall upon it. Immediately electrons come off from the plate with quite a high velocity. This is spoken of as the *photo-electric effect.* As negative electrons leave the metal, it is rendered more and more strongly charged positively (assuming it is insulated) and thus the electrons find it harder to get away, until finally the action ceases.

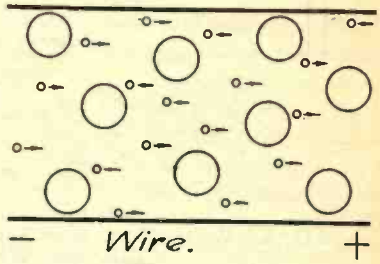


Fig. 5. A Copper Wire Conducts Current in This Way

If, however, the plate is connected to the negative end of a battery, Fig. 6, and a neighboring plate is connected to the positive, the electrons will continue coming off. The effect does not depend on the presence of gas, and so if the plates are put in a glass vessel, and all the air is sucked out, we get a pure electron stream without the presence of any positive ions. Some metals, such as potassium, are very sensitive to light in the visible part of the spectrum. In all cases we find the number of electrons, i. e., the electric current, is proportional to the amount of light falling on the metal plate. Thus it may be used in the reverse way for measuring the amount of light coming from any source, and it has been so used with some success. The photo-electric effect, as shown in so-called photo-electric cells, has also been an important element in the best systems for sending pictures by wire or by radio, concerning which you have no doubt read much lately. In addition, the photo-electric effect has been studied very extensively by physicists because of the information it has given us on the nature of the electron and the atom, and the nature of light.

Many Electrons Are Free

I have left until now the most important method of obtaining electrons, and that is—by the heating of metals. Let me repeat that our present theory regarding metals is that they are made up of atoms which can quite readily lose an electron and that therefore we have present in any piece of metal a large number of electrons which are free—or nearly free—from their atoms, and that it is for this reason they are good conductors of electricity.

The results of experiment are such that the present theory goes further and says these electrons are in violent motion in all directions in a completely disorganized manner so that if we could see them, they might look something like a swarm of bees in the woods. Because of their high velocities, it might be expected that they would shoot right out of the metal, but there is a force of attraction opposing this, and only those with high enough velocity can overcome this force. At ordinary temperatures, the number which have this necessary velocity is virtually zero, but as the temperature is raised, the velocity of the electrons is increased also, and the number which can get out is much greater.

Edison Invented This

The easiest way to heat the metal is to have it in the form of wire and send an electric current through it. If now we put a metal plate near the wire and connect the negative end of a battery to the wire and the positive end to the plate, the electrons will be attracted by the positive charge on the plate, and will flow from the wire to it across the intervening space and so constitute an electric current. It is preferable to have the wire and plate enclosed in a highly evacuated vessel in order to avoid collisions with gas molecules. This effect was first discovered by Edison.

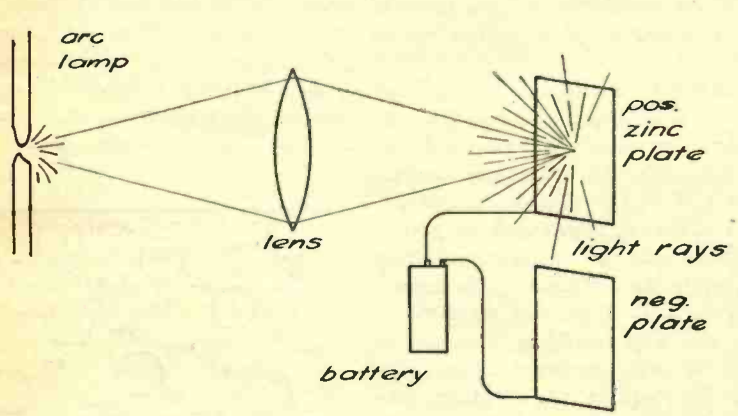


Fig. 6. When Light from Lamp Strikes Zinc Plate it Liberates Electrons Which Make Current

An American by the name of *DeForest* found that if, between the wire and the plate, he put a metal screen or grid, he could control the current to the plate—i. e., the number of electrons coming from the filament. If it were charged positively, the current increased, and if it were charged negatively, it decreased. Not only this, but he found it would respond to the high frequency waves which we call "radio," and most of you who listen in each evening have such a device as a detector of the radio message. Some years after his first discovery, DeForest found that this vacuum tube device would act as an amplifier of weak electric impulses, such as telephone currents, and as a result of improvements made in its structure, many of you this evening will be using vacuum tubes for amplifying the radio signals after these have been detected by a tube of the same form, operating in a somewhat different manner.

Broadcasters Use Them

It is scarcely necessary for me to recite the other common uses of this device, how it is used as a generator of the high frequency oscillations, or waves, which are being broadcast from all the sending stations to-night, how it is used for impressing the signals corresponding to the music on these high-frequency oscillations, how it is being used for relaying the long distance telephone currents all over the length and breadth of this country, or how it is employed in any place where one wishes to amplify electric impulses. The vacuum tube, in the form just described, is permitting us to enter into fields to which we had never hoped to be admitted before, and has opened up such vast possibilities for research and investigation that I believe it is the most important tool placed in the hands of science in the last three decades. And it all arises out of the discovery and the study of the electron.

Let me call your attention to another use of electrons. In 1895 the world was astonished by a report that a new kind of ray had been discovered, by which it was possible to take photographs through opaque bodies, or to see through them. Now-a-days we are so familiar with X-rays that they no longer excite much curiosity, but since they are due to electrons, I shall discuss them very briefly.

Must Stop Very Quickly

The first form of X-ray tube consisted of a vacuum tube with a positive and a negative electrode, Fig. 7. While the evacuation was high, there was a sufficient amount of gas left to give a number of electrons, but so few that most of the electrons formed traveled directly across to the positive plate or target without collision with gas particles. If the pressure between the electrodes was quite high, say twenty or thirty thousand volts, the electrons would strike the target with enormous velocity and

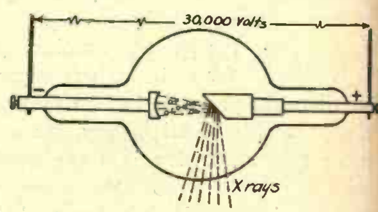


Fig. 7. Principle of an X-ray Tube. Note Electrons.

would be very suddenly stopped. This rapid stoppage of the electrons sets up what we now recognize as disturbance in the ether similar in every respect to light waves, except that they are very much shorter and, because of this, have the power of penetrating many bodies which are opaque to ordinary light.

Such an X-ray tube has the disadvantage of being quite irregular in its behavior because of the gas present and a great improvement was introduced a few years ago by Dr. Coolidge of the General Electric Company. In this tube, the source of the electrons, instead of being the gas, is a tungsten wire heated sufficiently to give off electrons just as I described in connection with your detecting and amplifying tubes. These electrons are then shot across to the target as before and the results obtained are so superior that the Coolidge X-ray tube has now practically replaced all others.

Hear Patter of Electrons

Another extraordinary way of getting electrons is from elements like radium and uranium. These substances give out a constant stream of electrons as the atoms of the metal itself slowly break down and disintegrate. Figure 8 shows a photograph of the laboratory with an electroscope being used for measuring an electric charge. A small piece of uranium, a radio-active element, is held before a tight metal chamber enclosing two charged electrodes. The uranium, which is in a constant state of decay, gives off electrons which ionizes the air between the electrodes. This ionization is detected by a type of radio amplifier system and becomes audible through a loud speaker directly or may be carried to the broadcasting station control room and passed through the usual stages of amplification and finally put on the air.

There are a few very complicated or heavy elements which are decaying or going to pieces so fast that the process is measurable, can be made visible and, by the apparatus developed by the scientists of the General Electric Company, may be made audible to a large public. This "speed" of decay is hardly speed in the accepted sense because the process in the case of a little piece of uranium would require five thousand million (5,000,000,000) years to complete and at the end of that time the original piece of uranium would have lost a few percent of its weight and left some metalic lead.

Back of it All

I have told you of some of the outstanding direct applications of electrons. Space only prevents the mention of others, but enough have been given to show the part they are already playing in our affairs of the day. We may say here, as in so many other cases, that the credit for the fundamental discoveries which lie back of or which precede the applications must very largely go to the pure scientist who is controlled by his feelings of curiosity as to the nature of things, who is interested more in his search for truth than for any other results. And after all, may it not be that his greatest contribution is that which he makes to knowledge itself for its own sake? He thus helps to lead mankind into a fuller understanding of the universe in which he lives and has his being, a richer outlook on the spiritual aspects of life.

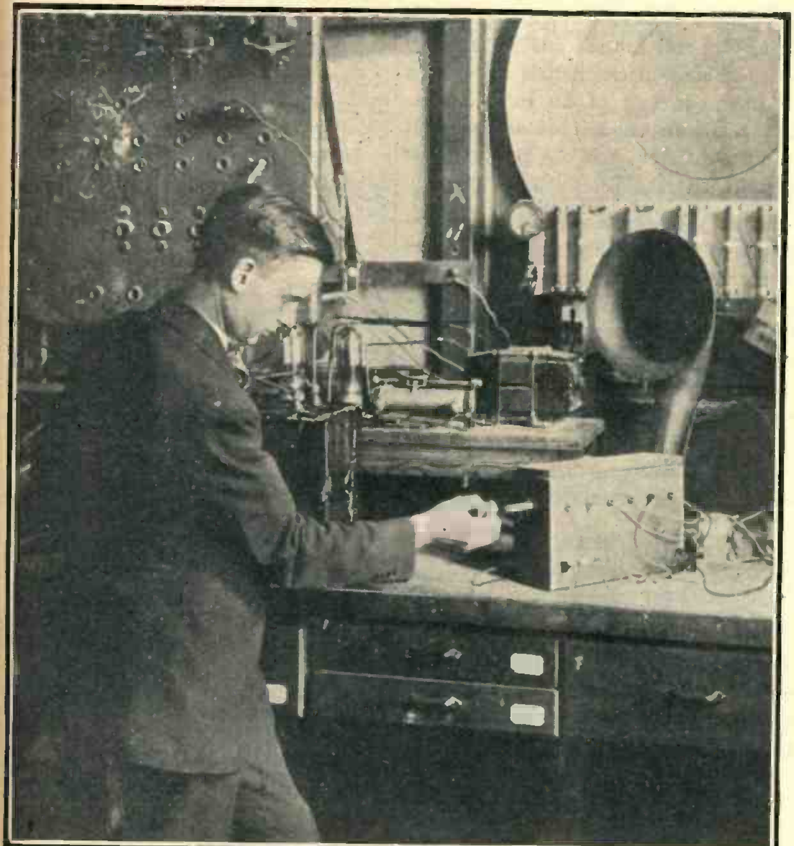


Fig. 7. Apparatus Which Listens to Each Separate Atom as it Drops a Negative Charge

Enough Said

Jobber: "Well, how many orders did you get yesterday?"

Salesman: "I got two orders in one place."

Jobber: "What were they?"

Salesman: "One was to get out and the other was to stay out."

—Good Hardware.

No Foreign Frills

Purchaser: "What is the charge for this dry cell?"

Radio Salesman: "One and one-half volts."

Purchaser: "Well, how much is that in American money?"—The Ink Slinger.

Rx 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. How many dry cells should be used to run a three-tube set with WD-12 tubes?

Answer. With the WD-12, it is customary to have as many cells as there are tubes. This, with the size of set you mention, would require three batteries. Of course, they are to be connected in parallel, zinc to zinc, and carbon to carbon. With such a hook-up it is possible to use any number of cells from one up, since above one the others merely divide up the current and so reduce the drain on each battery.

Although a single cell will work a three-tube set using the WD-12 tubes, it is much more economical to use more. Thus two cells will give you about two and one-half times the life, and three cells will live about four times as long, thus saving money and bother. Although a number greater than three will still further reduce the renewal cost, the change is so slight that it hardly pays to exceed this number.

Question. Recently there has been a good deal of talk about it being a disadvantage to place the loud speaker on top of the radio set. What do you think about it?

Answer. In the past it was inadvisable to use this location, as the tubes, until recently, were apt to cause trouble from vibration. With such an old style of bulb the action of the speaker on top was to build up a vibration in some one of the bulbs which was reproduced by the loud speaker, which caused more vibration, etc., going round and round in a circle until the set howled. With the more modern tubes, however, the external vibration does not have much effect on them. You can tell whether it is safe to use the speaker on top of the set by noticing whether there is any change of tone when it is removed.

Question. In the October 1 issue of Radio Progress, you have an article called "Build a Fast-Wave Set." In describing the coil for the radio frequency choke, the body of the article calls for a tube three-quarters of an inch in diameter, while in the list of materials it says, "one-quarter inch." Which of these is right?

Answer. The tube should be three-quarters of an inch in diameter. Unfortunately in the list there was a misprint. Since this tube does no tuning, but acts only as a barrier against the high frequency waves, you do not need to have a bakelite tube, but one of ordinary pasteboard will do just as well. The size is not very important, and anything about three-quarters of an inch in diameter will be satisfactory.

Question. Why do some manufacturers advertise that they have silver tips on the ends of the prongs of their vacuum tubes?

Answer. In most cases there is a small piece of solder at the end of the four projecting pins, and this makes contact with the spring. As solder is not nearly as good a conductor as copper, and is besides much more liable to corrode you will sometimes find it makes trouble in one of the circuits owing to this high resistance. Silver is even a better conductor than copper and does not oxidize in the air. For this reason, a silver tipped prong will never cause any trouble as a contact.

In this connection it might be pointed out that the new tubes names beginning with an X instead of a V (UX-201A) get around this difficulty by having the contact springs against the *side* of the pins instead of on the ends.

Question. Why is it that you seldom see a small condenser used as a vernier in parallel with a large one?

Answer. The losses in a condenser are very largely confined to the insulation, and it takes just about as big a piece of hard rubber or bakelite to insulate a three-plate condenser as it does a 23-plate unit. If then, you employ a vernier made up of a separate condenser, you get about twice the insulation and so almost double the losses. In these days of low-loss sets, it is a bad thing to use this method of getting fine adjustment.

Question. In the Crosley sets some models use an ordinary condenser for tuning and some a book condenser. Why are these different styles employed?

Answer. It is only on the cheaper models of this line that you would find the book type. The reason is that it is not so expensive to manufacture as the conventional model. It is a very satisfactory unit, but the losses are higher and the control is not so smooth as with the ordinary design. In the more expensive sets the latter are used for their better results in spite of the slightly increased cost.

UNITED STATES BROADCASTING STATIONS ARRANGED ALPHABETICALLY BY CALL LETTERS

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

	K.C. W.L. W.P.
KDKA—Westinghouse Elec. & Mfg. Co., E. Pittsburgh, Pa.	970-309- var.
KDPM—Westinghouse Elec. & Mfg. Co., Cleveland, O.	1200-250- 500
KDZB—Frank E. Siefert, Bakersfield, Cal.	1430-210- 100
KFAB—Nebraska Buick Auto Co., Lincoln, Neb.	880-341-1000
KFAD—McArthur Bros. Mercantile Co., Phoenix, Ariz.	1100-273- 100
KFAJ—University of Colorado, Boulder, Colo.	1150-261- 100
*KFAU—Independent School Dist. of Boise, Boise Idaho.	1060-283- 750
KFBK—Kimball Upson Co., Sacramento, Cal.	1210-248- 100
KFBL—Leese Brothers, Everett, Wash.	1340-224- 100
KFBU—Bishop N. S. Thomas, Laramie, Wyo.	1110-270- 500
*KFCB—Nielsen Radio Supply Co, Phoenix, Ariz.	1260-238- 100
KFCF—Frank A. Moore, Walla Walla, Wash.	1170-256- 100
*KFDJ—Oregon Agricultural College, Corvallis, Ore.	1060-283- 500
KFDM—Magnolia Petroleum Co., Beaumont, Tex.	950-316- 500
KFDX—First Baptist Church, Shreveport, La.	1200-250- 100
KFDY—S. Dak. Ste. Col. Ag. & Mech. Arts, Br'kngs., S. D.	1100-273- 100
KFEQ—Scroggin, & Co. Bank, Oak, Nebr.	1120-268- 500
KFFV—Graceland College, Lamoni, Iowa	1200-250- 100
KFGC—Louisiana State Univ., Baton Rouge, La.	1120-268- 100
KFGH—Leland Stanford Junior Univ., Stanford Univ., Cal.	1110-270- 500
KFGX—First Presbyterian Church, Orange, Texas	1200-250- 500
KFI—Earl C. Anthony, Los Angeles, Cal.	640-469-3000
KFJF—National Radio Mfg. Co., Oklahoma, Okla.	1150-261- 225
*KFKU—University of Kansas, Lawrence, Kans.	1090-275- 500
KFKX—Westinghouse Elec. & Mfg. Co., Hastings, Neb.	1040-288-2000
KFLR—University of New Mexico, Albuquerque, N. Mex.	1180-254- 100
KFLV—Swedish Evangalical Mission Church, Rockford, Ill.	1310-229- 100
KFLZ—Atlantic Automobile Co., Atlantic, Iowa	1100-273- 100
KFMQ—University of Arkansas, Fayetteville, Ark.	1000-300- 750
KFMR—Morningside College, Sioux City, Iowa	1150-261- 100
KFMX—Carleton College, Northfield, Minn.	890-337- 500
KFNF—Henry Field Seed Co., Shenandoah, Iowa	1130-266- 500
KFOA—Rhodes Dept. Store, Seattle, Wash.	660-454-1000
KFON—Echophone Radio Shop, Long Beach, Cal.	1290-233- 100
KFOO—Latter Day Saints Univ., Salt Lake City, Utah	1270-236- 250
KFOR—David City Tire & Electric Co., David City, Neb.	1330-226- 100
KFOX—Technical High School, Omaha, Nebr.	1210-248- 100
*KFPG—K. M. Turner Radio Corp., Los Angeles, Cal.	1260-238- 500
KFPR—Los Angeles County Forestry, Los Angeles, Cal.	1300-231- 500
KFPY—Symons Investment Co., Spokane, Wash.	1130-266- 100
KFQB—Searchlight Publishing Co., Fort Worth, Texas	1140-263- 150
KFQC—Kidd Brothers Radio Shop, Taft, Cal.	1300-231- 100
*KFQU—W. E. Riker, Holy City, Calif.	1380-217- 100
KFRB—Hall Bros., Beeville, Texas	1210-248- 250
KFRU—Stephens College, Columbia, Mo.	600-500- 500
KFSG—Echo Park Evangelistic Asso., Los Angeles, Cal.	1090-275- 500
*KFUM—W. D. Corley, Colorado Springs, Colo.	1240-242- 100
KFUO—Concordia Seminary, St. Louis, Mo.	550-545- 500
*KFUT—University of Utah, Salt Lake City, Utah	1150-261- 100
KFVE—Film Corporation of America, St. Louis, Mo.	1250-240- 500
KFVW—Airfan Radio Corporation, San Diego, Cal.	1220-246- 500
KFWA—Browning Bros. Co., Ogden, Utah	1150-261- 100
KFWB—Warner Bros. Pictures, Inc., Hollywood, Cal.	1190-252- 500
KFWH—F. Wellington Morse, Jr., Chico, Cal.	1180-254- 100
*KFWI—Radio Entertainments, Inc., So. San Fran., Cal.	1330-226- 500
KFWM—Oakland Educational Society, Oakland, Cal.	1430-207- 500
KFWO—Lawrence Mott, Avalon, California	1420-211- 250
KFWU—Louisiana College, Pineville, La.	1260-238- 100
*KFXB—Bertram O. Heller, Big Bear Lake, Cal.	1480-202- 500
KFXF—Pikes Peak Broad. Co., Colorado Springs, Col.	1200-250- 500
*KFYD—N. Baker, Muscatine, Iowa	1170-256- 250
KGB—Tacoma Daily Ledger, Tacoma, Wash.	1200-250- 100
KGO—General Electric Co., Oakland, Cal.	830-361-3000
KGU—Marion A. Mulrony, Honolulu, Hawaii	1110-270- 500
KGW—Portland Morning Oregonian, Portland, Ore.	610-491- 500
KHJ—Times-Mirror Co., Los Angeles, Cal.	740-405- 500
*KHQ—Louis Wasmer, Spokane, Wash.	1100-273- 500
KJR—Northwest Radio Service Co., Seattle, Wash.	780-384-1000
KLDS—R. Ch. Jesus Christ, L. D. Sts., Independence, Mo.	680-441-1000
*KLS—Warner Bros. Radio Supplies Co., Oakland, Cal.	1200-252- 250
KLX—Tribune Publishing Co., Oakland, Cal.	590-508- 500
KLZ—Reynolds Radio Co., Denver, Colo.	1130-266- 250
KMA—May Seed & Nursery Co., Shenandoah, Iowa	1190-252- 500
*KNRC—Clarence B. Juneau, Los Angeles, Cal.	1440-208- 250
KNX—Los Angeles Express, Los Angeles, Cal.	890-337- 500
KOA—General Electric Co., Denver, Colo.	930-322-5000
KOB—New Mexico Col. of Agriculture, State Col., N. Mex.	860-349-1000
*KOCH—Omaha Central H. School, Omaha, Neb.	1160-258- 250
*KOCW—Oklahoma College for Women, Chickasha, Okla.	1190-252- 200
KOIL—Monarch Manufacturing Co., Council Bluffs, Ia.	1080-278- 500
KOP—Detroit Police Dept., Detroit, Mich.	1080-278- 500
*KPO—Hale Bros., San Francisco, Cal.	700-428-1000
KPRC—Houston Printing Co., Houston, Texas	1010-297- 500
KPSN—Pasadena Star-News, Pasadena, Cal.	950-316-1000
*KOP—H. B. Read, Portland, Ore.	1410-213- 500
KOV—Double-Hill Electric Co., Pittsburg, Pa.	1090-275- 500
*KQW—First Baptist Church, San Jose, Cal.	1330-231- 500
*KRE—Berkeley Daily Gazette, Berkeley, Cal.	1170-256- 100

	K.C. W.L. W.P.
KSAC—Kansas State Agric. College	880-341- 500
KSD—Post-Dispatch, St. Louis, Mo.	550-545- 750
KSL—The Radio Service Corp., Salt Lake City, Utah	1000-300-1000
KSO—A. A. Berry Seed Co., Clarinda, Iowa	1240-242- 500
*KTAB—Tenth Ave. Baptist Church, Oakland, Cal.	900-333-1000
KTBI—Bible Institute of Los Angeles, Los Angeles, Cal.	1020-294- 750
KTCL—American Radio Tel. Co., Inc., Seattle, Wash.	980-310-1000
KTHS—New Arlington Hotel Co., Hot Springs, Ark.	800-375- 500
*KTNT—Norman Baker, Muscatine, Iowa	1170-256- 500
KTW—First Presbyterian Church, Seattle, Wash.	660-454-1000
*KUO—Examiner Printing Co., San Francisco, Cal.	1200-250- 150
*KUSD—University of South Dakota, Vermillion, S. D.	1080-278- 100
KUOM—State Univ. of Montana, Missoula, Mont.	1230-244- 250
KUT—University of Texas, Austin, Texas	1300-231- 500
*KVOO—Voice of Oklahoma, Bristow, Okla.	800-375- 500
KWKC—Wilson Duncan Studios, Kansas City, Mo.	1270-236- 100
KWKH—W. G. Paterson, Kennonwood, La.	1150-261- 500
KWSC—State College of Washington, Pullman, Wash.	860-349- 500
KWWG—City of Brownsville, Brownsville, Texas	1080-278- 500
KYW—Westinghouse Elec. & Mfg. Co., Chicago, Ill.	560-535-2000
KZKZ—Electrical Supply Co., Manila, P. I.	1110-270- 100
*KZM—Preston D. Allen, Oakland, Cal.	1250-240- 100
KZRQ—Far Eastern Radio, Manila, P. I.	1350-222- 500
KZUY—F. Johnson, Elser, Baguio, P. I.	833-360- 500
NAA—United States Navy, Arlington, Va.	690-435-1000
WAAC—Tulane University, New Orleans, La.	1090-275- 100
WAAF—Chicago Daily Drovers Journal, Chicago, Ill.	1080-278- 200
WAAM—I. R. Nelson Co., Neark, N. J.	1140-263- 500
WAAW—Omaha Grain Exchange, Omaha, Neb.	1080-278- 500
WABI—First Universalist Church, Bangor, Me.	1250-240- 100
WABO—Lake Avenue Baptist Church, Rochester, N. Y.	1080-278- 100
*WABQ—Haverford College Radio Club, Haverford, Pa.	1150-261- 100
*WABX—Henry B. Joy, Mount Clemens, Mich.	1220-246- 500
WADC—Allen Theatre, Akron, O.	1160-258- 500
*WAFD—Albert B. Parfet Co., Port Huron, Mich.	1090-275- 500
WAHG—A. H. Grebe Co., Richmond Hill, N. Y.	950-316- 500
*WAIU—American Insurance Union, Cloumbus, O.	1020-294- 500
WAMD—Hubbard & Co., Minneapolis, Minn.	1230-244- 500
WAPI—Alabama Polytechnic Institute, Auburn, Ala.	1210-248- 500
WARC—Am. Rad. & Research Corp., Medf'd H'lsde, Mass.	1150-261- 100
WBAA—Purdue University, West Lafayette, Ind.	1100-273- 250
WBAK—Pennsylvania State Police, Harrisburg, Pa.	1090-275- 500
WBAO—James Millikin University, Decatur, Ill.	1110-270- 100
WBAP—Wortham-Carter Publishing Co., Fort Worth, Tex.	630-476-1500
WBAV—Erner & Hopkins, Columbus, Ohio	1020-294- 500
WBBL—Grace Covenant Church, Richmond, Va.	1310-229- 150
WBBR—People's Pulpit Assoc., Rossville, N. Y.	1100-273- 500
WBCN—Foster & McDonnell, Chicago, Ill.	1130-266- 500
WBES—Bliss Electrical School, Takoma Park, Md.	1350-222- 100
WBNY—Shirley Katz, New York, N. Y.	1430-210- 500
WBOQ—A. H. Grebe Co., Richmond Hill, N. Y.	1270-236- 100
WBRE—Baltimore Radio Exchange, Baltimore, Md.	1300-231- 100
*WBT—Charlotte Chamber of Commerce, Charlotte, N. C.	1090-275- 250
WBZ—Westinghouse Elec. & Mfg. Co., Springfield, Mass.	900-331-2000
WBZA—Westinghouse Elec. & Mfg. Co., Boston, Mass.	1240-242- 250
WCAC—Connecticut Agric. College, Mansfield, Conn.	1090-275- 500
WCAD—St. Lawrence University, Canton, N. Y.	1140-263- 250
WCAE—Kaufmann & Baer Co., Pittsburg, Pa.	650-461- 500
WCAH—Entrekin Electric Co., Columbus, O.	1130-266- 500
WCAJ—Nebraska Wesleyan Univ., Univ. Place, Nebr.	1180-254- 500
WCAL—St. Olaf College, Northfield, Minn.	890-337- 500
WCAO—A. A. & A. S. Brager, Baltimore, Md.	1090-275- 100
WCAP—Cheaspeake & Potomac Tel. Co., Wash., D. C.	640-469- 500
*WCAR—Southern Radio Corp. of Texas, San Antonio, Tex.	1140-263- 500
WCAU—Durham & Co., Philadelphia, Pa.	1080-278- 500
WCAX—University of Vermont, Burlington, Vt.	1200-250- 100
WCBD—Wilbur G. Voliva, Zion, Ill.	870-345-5000
WCBQ—First Baptist Church, Nashville, Tenn.	1270-236- 100
WCCO—Washburn Crosby Co., Minneapolis, Minn.	720-416-5000
*WCEE—Liberty Weekly, Elgin, Ill.	1090-275-1000
WCLS—H. M. Couch, Joliet, Ill.	1400-214- 150
*WCSH—Congress Square Hotel Co., Portland, Me.	1170-256- 500
WCUW—Clark University, Worcester, Mass.	1260-238- 250
*WCWS—Charles W. Selen, Providence, R. I. (Portable)	1430-210- 100
WCX and WJR—The Detroit Free Press and Jewett Radio and Phonograph Co., Pontiac, Mich., (operating jointly)	580-517-2500
WDAD—Dad's Auto Accessories, Inc., Nashville, Tenn.	1330-226- 150
WDAE—Tampa Daily News, Tampa, Fla.	1100-273- 250
WDAF—Kansas City Star, Kansas City, Mo.	820-366- 500
WDAG—J. Laurence Martin, Amarillo, Tex.	1140-263- 100
*WDBE—Gilham-Schoen Electric Co., Atlanta, Ga.	1110-270- 100
WDBK—M. F. Broz Radio Store, Cleveland, O.	1320-227- 100
WDBO—Rollins College, Winter Park, Fla.	1250-240- 100
WDBR—Tremont Temple Baptist Church, Boston, Mass.	1150-261- 100
WDCH—Dartmouth College, Hanover, N. H.	1170-256- 100
WDWF—Dutee W. Flint, Cranston, R. I.	680-441- 500
WEAF—American Tel. & Tel. Co., New York, N. Y.	610-492-5000
WEAI—Cornell University, Ithaca, N. Y.	1180-254- 500
WEAM—Borough of North Plainfield, N. Plainfield, N. J.	1150-261- 250
WEAN—Shepard Co., Providence, R. I.	1110-270- 500
WEAO—Ohio State University, Columbia, Ohio	1020-294- 500
WEAR—Goodyear Tire & Rubber Co., Cleveland, Ohio	770-389- 750
WEAU—Davidson Bros. Co., Sioux City, Iowa	1090-275- 100

Station	K.C.	W.L.	W.P.
WEBC—Walter C. Bridges, Superior, Wis.	1240	242	100
WEBH—Edgewater Beach Hotel Co., Chicago, Ill.	810	370	1000
WEBJ—Third Avenue Railway Co., New York, N. Y.	1100	273	500
WEBK—Grand Rapids Radio Co., Grand Rapids, Mich.	1240	242	100
WEBL—Radio Corp. of America, United States (portable)	1330	226	100
WEBM—Radio Corp. of America, United States (portable)	1330	226	100
WEBW—Beloit College, Beloit, Wis.	1120	268	500
WEEI—Edison Electric Illuminating Co., Boston, Mass.	630	476	500
WEMC—Emmanuel Missionary Col., Berrien Springs, Mich.	1050	286	500
WENR—All-American Radio Corp., Chicago, Ill.	1130	266	1000
WEW—St. Louis University, St. Louis, Mo.	1210	248	100
WFAA—Dallas News & Dallas Journal, Dallas, Tex.	630	476	500
WFAV—University of Nebraska, Lincoln, Neb.	1090	275	500
WFBG—William F. Gable Co., Altoona, Pa.	1080	278	100
WFBH—Concourse Radio Corp., New York, N. Y.	1100	273	500
WFBI—Galvin Radio Supply Co., Camden, N. J.	1270	236	250
WFBL—Onondoga Hotel, Syracuse, N. Y.	1190	252	100
WFBM—Merchant Heat & Light Co., Indianapolis, Ind.	1120	268	250
WFBR—Fifth Infantry, Maryland N. G., Baltimore, Md.	1180	254	100
WFDF—Frank D. Fallain, Flint, Mich.	1280	234	100
WFI—Strawbridge & Clothier, Philadelphia, Pa.	760	395	500
WFKB—Francis K. Bridgman, Chicago, Ill.	1380	217	500
WFRL—Robert Morrison Lacey, Brooklyn, N. Y.	1460	205	100
WGBB—Harry H. Carman, Freeport, N. Y.	1230	244	100
WGBF—Finke Furniture Co., Evansville, Ill.	1270	236	100
WGBQ—Stout Institute, Menomonie, Wis.	1280	234	100
WGBS—Gimbel Bros., New York	950	316	500
WGBU—Florida Cities Fin. Co., Fulford By-The-Sea, Fla.	1080	278	500
WGBX—University of Maine, Orono, Me.	1190	252	100
WGCP—D. W. May, Newark, N. J.	1190	252	500
WGES—Coyne Electrical School, Oak Park, Ill.	1200	250	500
WGHB—Geo. H. Bowles Developments, Clearwater Fla.	1130	266	500
*WGHP—Geo. H. Phelps, Inc., Detroit, Mich.	1110	270	1500
WGMU—A.H.Grebe&Co.,Inc.(portable),Richmond Hill,N.Y.	1270	236	100
WGN—The Tribune, Chicago, Ill.	810	370	1000
WGR—Federal Telephone Mfg. Corp., Buffalo, N. Y.	940	319	750
WGST—Georgia School of Techonology, Atlanta, Ga.	1110	270	500
*WGY—General Electric Co., Schenectady, N. Y.	790	380	5000
WHA—University of Wisconsin, Madison, Wis.	560	535	750
WHAD—Marquette Univ. and Mil. Jour., Mil., Wis.	1090	275	500
WHAG—University of Cincinnati, Cincinnati, O.	1290	233	100
WHAM—University of Rochester, Rochester, N. Y.	1080	278	100
WHAP—William H. Taylor Finance Corp., Brooklyn, N. Y.	1250	250	100
WHAR—Seaside Hotel, Atlantic City, N. J.	1090	275	500
WHAS—Courier Journal & Louisville Times	750	400	500
WHAT—George W. Young, Minneapolis, Minn.	1140	263	500
WHAV—Wilmington Elec. Specty Co., Wilmington, Del.	1130	266	100
*WHAZ—Rensselaer Polytechnic Institute, Troy, N. Y.	790	380	1000
WHB—Sweeney School Co., Kansas City, Mo.	820	366	500
WHBF—Beardsley Specialty Co., Rock Island, Ill.	1350	222	100
WHBH—Culver Military Academy, Culver, Ind.	1350	222	100
WHBP—Johnstown Automobile Co., Johnstown, Pa.	1170	256	100
WHBW—D. R. Kienzle, Philadelphia, Pa.	1390	216	100
WHDI—Wm. Hood Dunwoody I. Inst., Minneapolis, Minn.	1080	278	500
WHEC—Hickson Electric Co., Inc., Rochester, N. Y.	1160	258	100
WHK—Radio Air Service Corp., Cleveland, O.	1100	273	250
WHN—George Schubel, New York, N. Y.	830	361	500
WHO—Bankers Life Co., Des Moines, Iowa	570	526	5000
WHT—Radiophone Broadcasting Corporation, Deerfield, Ill.	1260	238	1500
WIAD—Howard R. Miller, Philadelphia, Pa.	1200	250	100
WIAS—Home Electric Co., Burlington, Iowa	1180	254	100
WIBA—The Capital Times Studio, Madison, Wisc.	1270	236	100
WIBC—L. M. Tate Post No. 39, V.F.W. St.Petersburg, Fla.	1350	222	100
WIBO—Nelson Brothers, Chicago, Ill.	1330	226	1000
WIBW—L. L. Dill, Logansport, Ind.	1360	220	100
WIL—St. Louis Star, Benson Radio Co., St. Louis, Mo.	1100	273	250
WIP—Gimbel Bros., Philadelphia, Pa.	590	508	500
WJAD—Jackson's Radio Eng. Laboratories, Waco, Texas	850	353	500
WJAG—Norfolk Daily News, Norfolk, Nebr.	1110	270	200
WJAK—Clifford L. White, Greentown, Ind.	1180	254	100
WJAM—D. M. Perham, Cedar Rapids, Ia.	1120	268	100
WJAR—The Outlet Co., Providence, R. I.	980	306	500
WJAS—Pittsburgh Radio Supply House, Pittsburgh, Pa.	1090	275	500
WJAZ—Zenith Radio Corp., Mt. Prospect, Ill. (Limited)	930	322	1500
WJBI—Robert S. Johnson, Red Bank, N. J.	1370	219	250
WJBL—Wm. Gushard Dry Goods Co., Decatur, Ill.	1110	270	500
*WJBQ—Bucknell University, Lewisburg, Pa.	1420	211	100
WJJD—Supreme Lodge L. O. Moose, Mooseheart, Ill.	990	303	500
WJR—Same as WCX.			
WJY—Radio Corporation of America, New York, N. Y.	740	405	1000
WJZ—Radio Corporation of America, New York, N. J.	660	454	1000
WKAA—H. F. Paar, Cedar Rapids, Iowa	1080	278	500
WKAF—WKAF Broadcasting Co., Milwaukee, Wis.	1150	261	250
WKAQ—Radio Corporation of Porto Rico, San Juan, P. R.	880	341	500
WKAR—Michigan Agric. Col., E. Lansing, Mich.	1050	286	1000
WKBB—Sanders Bros., Joliet, Ill.	1400	214	100
WKBE—K. and B. Electric Co., Webster, Mass.	1300	231	100
WKBG—C. L. Carrell (portable), Chicago, Ill.	1390	216	100
WKBK—Shirley Katz, New York, N. Y.	1430	210	500
WKRC—Kodel Radio Corp., Cincinnati, O.	710	422	1000
WKRC—Kodel Radio Corp., Cincinnati, O.	920	353	1000
WKY—E. C. Hull and H. S. Richards, Oklahoma, Okla.	1090	275	100
WLAL—First Christian Church, Tulsa, Okla.	1200	250	150

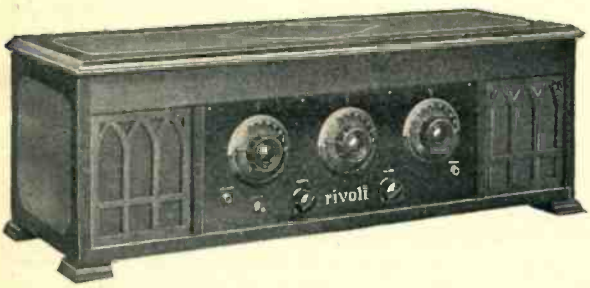
*Additions and corrections.

Station	K.C.	W.L.	W.P.
WLB—University of Minnesota, Minneapolis, Minn.	1080	278	500
WLBL—Wisconsin Dept. of Markets, Stevens Point, Wis.	1080	278	500
*WLIB—Liberty Weekly, Elgin, Ill.	990	302	2500
WLIT—Lit Bros., Philadelphia, Pa.	760	395	500
*WLS—Sears, Roebuck Co., Chicago, Ill.	870	345	1500
WLTS—Lane Technical High School, Chicago, Ill.	1160	258	100
WLW—Crosley Radio Corp., Harrison, O.	710	422	500 / 5000
WLWL—Mis. Soc. of St. Paul the Apostle, New York	1040	288	1000
WMAF—Round Hills Radio Corp., Dartmouth, Mass.	680	441	1000
WMAK—Norton Laboratories, Lockport, N. Y.	1130	466	500
WMAQ—Chicago Daily News, Chicago, Ill.	670	448	500
WMAZ—Mercer University, Macon, Ga.	1150	261	500
WMBB—American Bond & Mortgage Co., Chicago, Ill.	1200	250	500
WMBC—Michigan Broadcasting Co., Detroit, Mich.	1170	256	100
WMBF—Fleetwood Hotel, Miami Beach, Fla.	780	384	500
WMC—Commercial Appeal, Memphis, Tenn.	600	500	500
WMCA—Greeley Square Hotel Co., Hoboken, N. J.	880	341	500
WNAB—Shepard Stores, Boston, Mass.	1200	250	100
WNAC—Shepard Stores, Boston, Mass.	1070	280	500
WNAD—University of Oklahoma, Norman, Okla.	1180	254	250
WNAP—Wittenberg College, Springfield, Ohio	1090	275	100
WNAT—Lennig Bros. Co., Philadephia, Pa.	1200	250	100
*WNBH—New Bedfrod Hotel, New Bedford, Mass.	1210	248	250
WNJ—Radio Shop of Newark, Newark, N. J.	1290	233	100
WNOX—People's Tel. & Tel. Co., Knoxville, Tenn.	1120	268	500
WNYC—City of New York, New York, N. Y.	1190	233	100
*WOAI—Southern Equipment Co., San Antonio, Texas	760	395	2000
WOAN—James D. Vaughn, Lawrenceburg, Tenn.	1060	283	500
WOAW—Woodmen of the World, Omaha, Nebr.	570	526	1000
WOAX—Franklyn J. Wolff, Trenton, N. J.	1250	240	500
WOC—Palmer School of Chiropractic, Davenport, Iowa	620	484	5000
*WODA—O'Dea Temple of Music, Paterson, N. J.	1340	224	250
WOI—Iowa State College, Ames, Iowa	1110	270	750
WOK—Neutrowound Radio Mfg. Co., Homewood, Ill.	1380	217	5000
WOO—John Wanamaker, Philadelphia, Pa.	590	508	500
WOQ—Unity School of Christianity, Kansas City, Mo.	1080	278	1000
WOR—L. Bamberger & Co., Newark, N. J.	740	405	500
WORD—People's Pulpit Association, Batavia, Ill.	1090	275	5000
WOS—Missouri State Marketing Bureau, Jefferson City, Mo.	680	441	500
WOWO—Main Auto Supply Co., Fort Wayne, Ind.	1320	227	500
*WPCC—North Shore Congregational Church, Chicago, Ill.	1160	258	500
WPG—Municipality of Atlantic City, Atlantic City, N. J.	1000	300	500
WPRC—Wilson Printing & Radio Co., Harrisburg, Pa.	1390	216	100
WPSC—Pennsylvania State College, State College, Pa.	1150	261	500
WQAA—Horace A. Beale, Jr., Parkesburg, Pa.	1360	220	500
WQAC—Gish Radio Service, Amarillo, Tex.	1280	234	100
WQAM—Electrical Equipment Co., Miami, Fla.	1140	263	100
WQAN—Scranton Times, Scranton, Pa.	1200	250	100
WQAO—Calvary Baptist Church, New York, N. Y.	833	360	100
WRAK—Economy Light Co., Escanaba, Mich.	1170	256	100
WRAM—Lombard College, Galesburg, Ill.	1230	244	100
*WRAV—Antioch College, Yellow Springs, Ohio	1140	263	1000
WRAX—Flexon's Garage, Gloucester City, N. J.	1120	268	500
WRC—Radio Corporation of America, Washington, D. C.	640	469	1000
WRCO—Wynne, Radio Co., Raleigh, N. C.	1190	252	100
WREO—Reo Motor Car Co., Lansing, Mich.	1050	286	500
WRM—University of Illinois, Urbana, Ill.	1100	273	500
WRMU—A. H. Grebe & Co., Richmond Hill, N. Y.	1270	236	100
WRNY—Experimenter Publishing Co., New York, N. Y.	1160	258	500
WRR—Dallas Police & Fire Dept., Dallas, Tex.	1150	261	350
WRST—Radiotel Mfg. Co., Bay Shore, N. Y.	1390	216	250
*WRVA—Larus & Brother Co., Inc., Richmond, Va.	1170	256	1000
WRW—Tarrytown Radio Research Labs., Tarrytown, N. Y.	1100	273	500
*WSAI—United States Playing Card Co., Mason, O.	920	326	5000
WSAJ—Grove City College, Grove City, Pa.	1310	229	250
WSAN—Allentown Call Publishing Co., Allentown, Pa.	1310	229	100
WSAR—Doughty & Welch Electric Co., Fall River, Mass.	1180	254	100
WSAX—Zenith Radio Corp., Chicago, Ill.	1120	268	100
WSB—Atlanta Journal, Atlanta, Ga.	700	428	1000
*WSBC—World Battery Co., Chicago, Ill.	1430	210	500
WSBF—Stix, Baer & Fuller, St. Louis, Mo.	1100	273	250
WSBT—South Bend Tribune, South Bend, Ind.	1090	275	250
WSDA—The City Temple, New York, N. Y.	1140	263	250
WSKC—World's Star Knitting Co., Bay City Mich.	1150	261	100
WSMB—Saenger A'm'h Co., & Maison Blanche N. O. La.	940	319	500
WSM—Nat'l Life & Accident Ins. Co., Nashville, Tenn.	1060	283	1000
WSMK—S. M. K. Radio Corp., Dayton, Ohio	1090	275	500
WSOE—School of Eng'rng of Milwaukee, Milwaukee, Wis.	1220	246	500
WSRO—Radio Co., Hamilton, Ohio	1190	252	100
WSUI—State University of Iowa, Iowa City, Iowa	620	484	500
WSY—Alabama Polytechnic Institute, Auburn, Ala.	1200	250	500
WTAB—Fall River Daily Herald Pub. Co., Fall R'vr, Mass.	1130	266	100
WTAC—Penn. Traffic Co., Johnstown, Pa.	1120	268	100
WTAG—Worcester Telegram Pub., Co., Worcester, Mass.	1120	268	500
WTAM—Willard Storage Battery Co., Cleveland O.	770	389	3500
WTAR—Reliance Electric Co., Norfolk, Va.	1150	261	100
WTAT—Edison Illum'ting Co., Boston, Mass., (portable)	1230	244	100
WTAW—Agri. & Mech. Col. of Texas, Col. Station, Tex.	1110	270	500
WTIC—Travelers Insurance Co., Hartford, Conn.	860	349	500
WWAD—Wright & Wright, Philadelphia, Pa.	1200	250	250
WWGL—Radio Engineering Corp., Richmond Hill, N. Y.	1410	213	500
WWI—Ford Motor Co., Dearborn, Mich.	1130	266	500
WWJ—Detroit News, Detroit, Mich.	850	353	1000
WWL—Loyala University, New Orleans, La.	1090	275	100

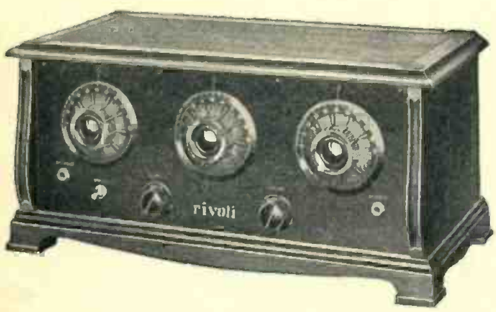
rivoli

"ALWAYS GOOD COMPANY"

RIVOLI is always good company—good company because it is a thing of beauty and because if there is anything on the air, Rivoli will get it to entertain you. No skill is needed to bring in the broadcast stations.



The Rivoli De Luxe combines all the convenience of a built-in speaker and a built-in battery compartment with the grace and beauty of a finely designed table model radio set. The cabinet is fashioned in two-tone mahogany with panel to match and sunburst dials that lend a pleasingly original touch. Symmetry is retained by the two silk-backed grills.......................... **$75.00**



The Rivoli Junior has been designed for those who must economize in space. In point of quality, the Junior is fully up to Rivoli standards. The cabinet is considerably better and more carefully finished than sets selling at a low price. Finished in mahogany with a generous flare to set off the panel... **$60.00**

The Rivoli Speaker has successfully combined extreme beauty with acoustical perfection. Its tone chamber is constructed entirely of two-tone wood, seasoned by a special process. The front of the Rivoli Speaker is a grill, fashioned in a pleasingly decorative motif. The well known balanced type of unit is used. The Rivoli Speaker always harmonizes perfectly with its surroundings................. **$30.00**

The Rivoli Radio Line is manufactured by the Radio Industries Corp., 131 Duane St., N. Y. City

rivoli

"ALWAYS GOOD COMPANY"

$125.00

$50.00

The Rivoli Console is a beautiful creation. It is designed in the period of William and Mary, and is constructed of two-tone mahogany. The finely carved legs, the cleanly cut grill which hides the speaker and battery compartments, the metal fittings, all lend an expensive air which seem out of all proportion to the remarkably low price. The built-in speaker is a revelation and recreates the broadcasting artist so clearly that he seems to be standing in the same room.

The Rivoli Table is a radical departure in the construction of radio tables. It has ample space for any table type of radio set, either large or small, generous battery compartments for housing A and B batteries and chargers or eliminators, and features a grilled speaker outlet behind which any form of horn or cone can be mounted. Aside from its utility, the Rivoli Table is a beautiful piece of furniture, designed in two-tone mahogany or walnut. It solves the problem of where to put your radio set.

(*Space allowed for radio set is* 36 *in. long x* 11 *in. deep x* 10½ *in. high*)

Write for interesting literature describing the entire Rivoli Radio line.

Radio Industries Corporation, 131 Duane St., New York City