December 15, 1924
15 Cents a Copy

RADIO PROGRESS

"Always Abreast of the Times"

IN THIS ISSUE:

HOOK-UP NUMBER, JANUARY 15

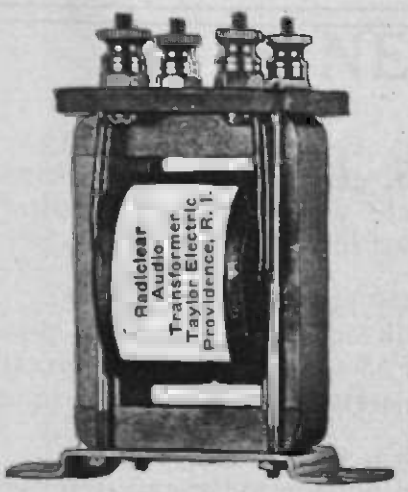
YOU WILL UNDERSTAND THIS MAGAZINE--AND WILL LIKE IT

A New England Publication

CHANGE THAT HOOK-UP

Perhaps you have run across an unusually good hook-up. Even at that we can suggest a change which will undoubtedly give you clearer signals. That will result from using Radiclear Audio Transformers instead of those you now have.

Maybe you don't think it makes much difference what kind of an audio transformer you use. If so, try out this test. Pick up some station with your detector only which comes in clear, but faint. Then plug into the first step of audio. The chances are strong that while the music will be a lot louder, you will notice that the piano has lost some of its character, and the tones of the violin are not as bright as they were before.



There is a lot more noise, too. Of course, what noise was there before will naturally be made louder but many transformers throw in a lot of their own for good measure. If you find that such is the case you will know that it is *not* a Radiclear.

A PECULIAR THING ABOUT THIS TRANSFORMER

Strange to say when you are listening to a distant station talking, you can understand the words. That is because the Radiclear transformer does not distort and also because it makes no noise itself. That is why it is often known, as "The Noiseless Transformer."

In spite of the fact that this device is the result of a great deal of engineering skill and laboratory work it sells for $3.95 postpaid by check or money order.

Or if you prefer, we will ship it to you C. O. D. for $3.95 plus postage. In either case we will refund your money if you are not satisfied at the end of two weeks' trial.

Send in your order to-day

SOMETHING YOU OVERLOOKED

It is not too late to send a couple of Audion Crystals as spares to your friend for a Christmas present. A good crystal will hold up with ordinary use for six months or more, which will take him through the year.

Although these crystals are sold with a money back guarantee, it is very unusual for us to be asked to replace them. That is because careful inspection eliminates those crystals which are not up to our high standard. Remember that these crystals are alive all over—drop the cat whisker anywhere and you will hear the program.

They are put up in a wooden box lined with cotton, so that they will reach you in good shape. You will be surprised at the price for such a wonderful guaranteed crystal, only 25c. postpaid. Use the coupon for ordering.

TAYLOR ELECTRIC CO.

1206 Broad Street

Providence, R. I.

The Taylor Electric Company,
1206 Broad Street,
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Please send me the following by parcel post. (Mark which one you want.)

Radiclear Audio Transformer @ $3.95
Audion Crystal @ 25c.
Gold Plated Cat Whisker @ 15c.

☐ I enclose $.... to pay for these. (These above prices include the postage for sending.)

☐ Send them to me C. O. D. I will pay the above price plus postage.

(Indicate which way you wish to pay.)

..... (Name)

..... (Address)

RADIO PROGRESS

HORACE V. S. TAYLOR, EDITOR

Volume 1 Number 19

Contents for

DECEMBER 15, 1924

RADIO PROGRESS is issued on the 1st and 15th of each month by the Oxford Press at 8 Temple Street, Providence, Rhode Island. John F. O'Hara, Publisher. Yearly subscription in U. S. A., $3.00. Outside U. S. A., $3.50. Single copies, 15 cents. Entered as second-class matter, April 4, 1924, at the Post Office at Providence, R. I., under the Act of March 3, 1879. Address all communications to RADIO PROGRESS, 8 Temple Street (P. O. Box 728), Providence, R. I. Title registered at United States Patent Office.

GOOD THINGS COMING IN NEXT ISSUE

Do your batteries ever cause you any trouble? Dry cells sometimes give out after lasting only a couple of weeks. **"Close Circuit Batteries for Radio,"** by Standiford, in our next issue describes a kind of battery which will last much longer at less expense.

So many radios are glaringly home made. They may work well, but no one could possibly mistake them for factory built, even though the cabinet may be a good one. If you want to lose the home-made read, **"A Professional Touch for Your Set,"** by Nickerson.

At this time of year many new aerials are being put up. But the newcomers are not the only ones who don't know much about antennas. Even those installed by old hands could frequently be greatly improved. This is discussed in **"The Radio Man Explains Aerials,"** by Taylor.

Can you boast about Coast-to-Coast reception? Perhaps you are not getting all you can out of your set, or maybe you are trying to overwork it. The natural limits of various sets with different kinds of broadcasting is described in the article, **"How Far Should Your Set Hear?"**, by Goldsmith.

No doubt you know that pictures are now being whisked through the air. Several articles have appeared which pretend to explain how this is done. None that we have seen gives as clear descriptions as can be found in, **"Waving Photographs Three Thousand Miles,"** by Vance.

Engineers believe that atoms are built up out of electrons. If an atom is a thousand times too small to see what shall we say of electrons? And yet, with the new apparatus described by Bartlett, in **"Now Electrons Can Be Heard,"** is explained how we can prove their existence by our ears.

Are you ever sick? We hope not, but if you are then the apparatus which **"Takes a Portrait of Heart Beats,"** as described in our next issue, would be a distinct help in diagnosing your disease.

RADIO PROGRESS

SPECIAL HOOK-UP NUMBER

TO BE ISSUED

JANUARY 15th

Undoubtedly you have tried following various wiring diagrams and found that they were not what they pretended to be. This will be a carefully selected list of sets which do work. They include the best hook-ups of crystal sets, single tubes, regenerative and non-regenerative, two and three tube radios, reflexes and also the more ambitious styles, like neutrodyne and superheterodyne.

Among them you will find several, anyway, which you will wish to try out.

15 Worthwhile Hook-ups

RADIO PROGRESS

"ALWAYS ABREAST OF THE TIMES"

Vol. I, No. 19 DECEMBER 15, 1924 15c PER COPY, $3 PER YEAR

What Causes Sharp Tuning?

Ways and Means of Increasing Your Selectivity

By HORACE V. S. TAYLOR

A DUET is a fine thing, but when it consists of a girl singing, "Drink to Me Only with Thine Eyes" and a bagpipe playing "Coming Through the Rye," it is not so good. When you listen to a distant program and the local station suddenly butts in, you naturally wish you had more selectivity in your set.

There are a good many wrong ideas about selectivity. Some people seem to understand one thing and others something else when this word is spoken. What it really means is this—the selective set will pick up a station when the

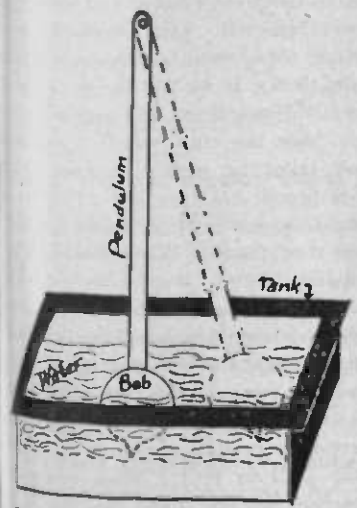


Fig. 1. Resistance Shows Swing

dials are turned to its particular wave length, and when they are shifted slightly the station disappears. With a receiver, which is not so selective, the station will be heard when the dials are shifted a considerable distance.

Tuning Out Not Enough

But it is not enough that a radio be able to tune out a local station. It must be able to pick up distant ones at the same time. For instance, as an extreme case, it is possible to tune out a local station by turning the rheostat off, which naturally gets rid of everything. This may sound silly, but it is no different in idea from some of the methods of tuning out stations which are occasionally proposed. For instance, it has been proposed quite seriously to put a high resistance in the aerial line. Of course, this will get rid of a local station, because it is almost like disconnecting the aerial, but it prevents any chance of pulling in outside programs.

Another scheme that is sometimes proposed is to use two aerials; one for ordinary work, and the other, a very short one, to be employed only when local stations are going. If the idea is merely to separate the home broadcasters when two or more are going at once, this plan will work all right, but most radio fans, in reading the recommendations, naturally conclude that a short aerial will pick up distance when the local studios are operating. They are much disappointed when they try it out, as such short antennas will not bring enough energy from across the continent to be heard well, even late at night, after the interference has stopped.

Disadvantage of Sharp Tuning

With all the advantages which selectivity gives in being able to hear a thousand miles through nearby interference there is also one drawback. If you have a sharp tuned set, so that the local programs are held down to only a few degrees on your dial, then by the same token outside stations will be restricted to only a small fraction of the degrees on the dial, which broad-tuned radios have. Suppose that on your neighbor's set the home talent can be heard all the way from twenty to eighty on the tuning dials. That is a band of sixty degrees. Late at night he finds that a distant station (let us say, WGY) can be heard from 48 to 49 on the dial. That

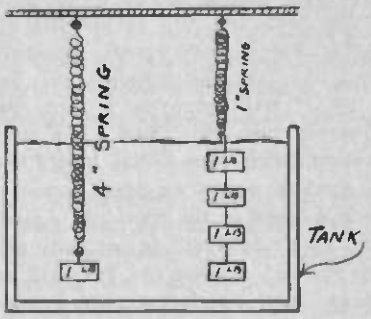


Fig. 2. Heavy Weights Run Longer

is a satisfactory range for picking up a far away broadcaster.

Now suppose your own radio is selective, or sharped tuned. The local station does not bother you very much because it is restricted on the dial from 50 to 65. This is only fifteen degrees, which is one-quarter of the 60 which your neighbor's set required. From this you can see the ratio that his outfit covers is four times the distance on the dial that yours does. Now his would tune

in WGY over one degree, so yours will respond only when the dial is set within one-quarter degree. This small space will be much harder to hit, with the result that you may occasionally turn right through their program without noticing it. In any event, it will be a good deal harder to tune accurately to this station with your set, since you have to hit it a lot finer than he does. That is the disadvantage of a selective set.

Like Postoffice Letters

This resembles the sorting of mail in the postoffice. Suppose that the postman throws the letters for each city down in great big heaps. Then the mail for New

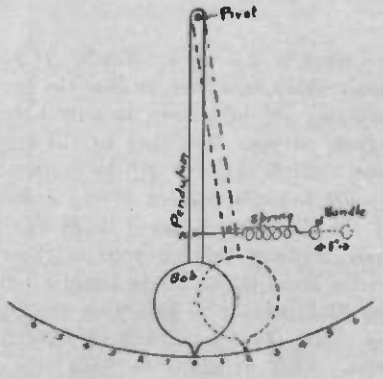


Fig. 3. A Case of Tight Coupling

York City will occupy a whole corner of the room and will spread out over twenty feet of floor space. A smaller town like Troy, for instance, will have a pile of mail occupying a floor space of perhaps two feet. Now a new ruling goes into effect that all the letters must be stacked neatly together instead of being dumped on the floor. As a result, New York's mail will be carefully piled into five feet of space, and Troy will now occupy only six inches, which might easily be overlooked, owing to its restricted space.

Another way of looking at it is like a map. Perhaps you have heard the story of the Chinese boy that wanted to work for an American firm in China in another city from where his parents lived. His father would not hear of his leaving his home town. So the American showed the parents a map of the district, and when they saw that the two cities were only one-half an inch apart on the map, they readily consented to his going. It all depends on the scale. If you have a map which shows New York and San Francisco spaced ten inches apart, then you can't expect the streets of a city to show at all. On the other hand, if you want to pick out the various streets, then you will find that each county covers a very wide area in the map.

What Makes Sharp Tuning

There are two ways in general of increasing the selectivity of your set. The first of these is to cut down the resistance. There are a few places in a radio where resistance is an advantage, and must be used. For instance, the rheostat will immediately come to your mind. It is necessary here to reduce the amount of pressure or voltage on the filaments of the vacuum tube, and this is done by inserting the proper amount of resistance in the "A" battery circuit. Another place where it is needed is the grid leak. Without it a negative charge would accumulate on the grid and by its repulsion would prevent the negative electrons from crossing over from the filament to the plate. By using the proper amount at this point this negative charge is allowed to leak off the grid and so maintain the efficiency of the tube.

In most circuits in the hookup resistance is an unwelcome visitor. Unfortunately, however, we can't get away from it. Every material has this quality and the reason copper is used so universally is because its value is the lowest. To be exact there is just one metal which has a lower resistance than copper. Pure silver beats it out, but only by a very few per cent. The difference is so slight that if silver cost only 1/10 of what it does, it would not pay to use it instead of copper. No other material can come near copper in this respect.

If some new alloy could be found, which had considerably lower resistance than copper at any reasonable price, it would drive out this latter material and our sets would be a lot better. But unfortunately, there is no chance of any such discovery being made. The reason is this. When two or more metals are alloyed together the resistance of the mixture is always higher than that of the best conductor. The essential point is that while resistance can be raised by alloying, it can never be lowered.

Why Resistance is Bad

We all remember that tuning a radio set is getting the swings or vibrations of the receiver to correspond with those of the transmitter. Let us see how resistance affects the timing of a vibrator. Look at Fig. 1, and you will see a pendulum swinging back and forth in a tank. The latter is empty and the pendulum swings out a distance of several inches, depending on how hard it was pushed at the start. Let us say that it swings in an arc which is twelve inches long. This is the length of the path just after it has started vibrating. If we do not push it again its length or amplitude of swing will gradually decrease. The friction of the air and of the pivot are the two things which cause the swing to keep diminishing. If we

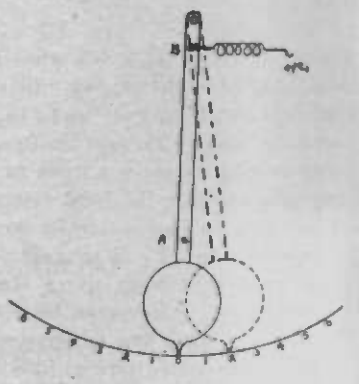


Fig. 4. Coupling Is Too Loose

make the pivot run on ball bearings, the pendulum will keep oscillating for a longer time, since this decreases the friction there. If we put the whole business in a vacuum tank, and suck out all the air, then the time which the pendulum bob takes in coming to rest will be lengthened considerably. This is because the air friction, which had slowed down or damped the vibration, is now missing.

It is a difficult matter to tell with the eye just when the pendulum stops moving entirely, and for that reason we will use as a measure the time which it takes to drop to 1% of its initial swing. This particular pendulum took five minutes to stop (fall to 1%). When we put ball bearings on the pivot this time it increased to say seven minutes. By exhausting the air so that it oscillated in the vacuum, the time was lengthened to ten minutes. But now let us fill the the tank with water. Immediately the pendulum dies rapidly and the swinging will last only one minute. Why has

this action occurred? Because the resistance to the oscillation is now great.

Increasing the Damping

We have just found that by putting water into the tank the oscillations were damped out much quicker. If, instead of water we should use mercury, the resistance would be a lot higher, and the vibrations would be all over in perhaps half a minute. But if we should fill up the tank with cold molasses, we should find that the oscillations wouldn't last any time at all, since the pendulum would gradually sink to rest in the straight-down position without even passing that point and oscillating at all.

That is exactly what happens in a radio set. If the resistance in the grid circuit is small, then the oscillations, which have started, will continue and the hook-up will be sharp tuned. If, by leaving joints unsoldered or using a small wire or in any other way, we increase the resistance of this circuit then the oscillations will die a great deal quicker and as a result the set will not tune out local stations. From this it follows that special pains should be used to keep down the losses particularly in the grid circuit.

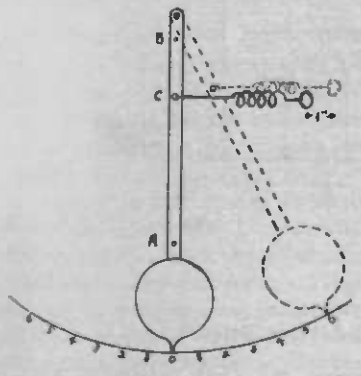


Fig. 5. Getting Biggest Swing

Maintaining the Swing

As we have mentioned, it is unfortunately necessary that we use a material (copper) which has some resistance. Since we can't get rid of it, how are we going to minimize its effects? Fig. 2, will show how this condition can be improved. As has been explained before (See May 1, 1924 issue of RADIO PROGRESS) the coils of a radio set correspond to weights, while the condenser is like a spring. The tuning factor, which picks out any particular wave length, is always equal to the product of the value of the spring, multiplied by the value of the weight, or to put it in electrical language, the capacity of the condenser (Microfarads) times the inductance of the coil (Millihenries). If this product is correct, the tuning will be the same, no matter whether we use a large capacity and small coil, or a small capacity and large coil.

Vibrating in Water

Which of these will be better from the point of view of sharp tuning? Fig. 2, shows two different vibrators, which have the same tuning factor and so will pick up the same frequency or wave length. The first one has a four inch spring and a one pound weight. The product, then is 4x1=4. The second has a one inch spring and a four pound weight, and again the product is 1x4=4. Suppose we put these two vibrating systems into a tank of water, as shown. We know they will both oscillate at the same speed, because the tuning factor is the same (4). Which one will continue vibrating longer? Undoubtedly you will see right away that the heavy weight and stiff spring at the right will have considerably more energy that the light weight and flexible spring at the left. For this reason the small condenser and big coil at the right will be oscillating long after the small coil and big condenser at the left has stopped.

This shows us in which direction we ought to go in constructing a sharp tuning set. Instead of using a 43-plate condenser and small coil, we shall do considerably better to use a 23-plate condenser and more turns on our coil. The tendency of modern design is all that way. As a matter of fact, you will find that a good many sets are now using as small capacities as 11-plate condensers, and there is a chance that this movement will go farther. The only limit is that various parts of the set—wires,

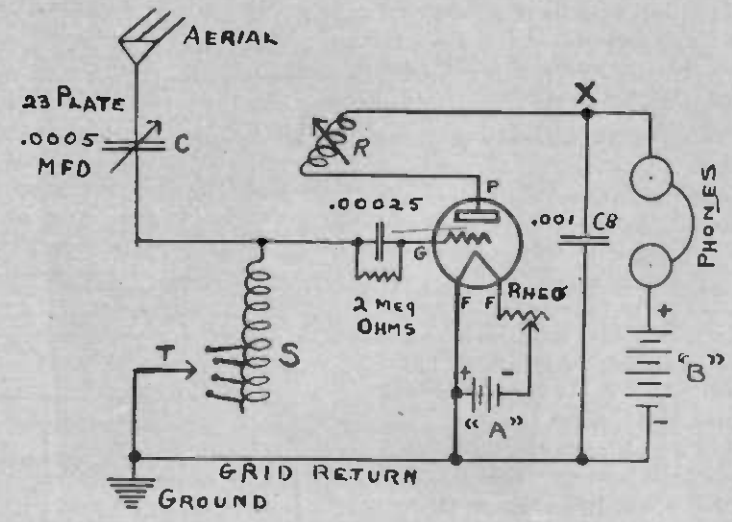


Fig. 6. Too Tight to Tune Out Local Stations.

connections, binding posts, etc., all have a certain amount of capacity themselves, and if we try to cut the adjustable quantity down too small, we reach the place where it no longer has enough control over the total capacity in the circuit.

Tight and Loose Couplings

It was mentioned that having the resistance low, was one of the two big ways of sharpening up a set. The other is getting the right coupling. This is a rather difficult matter, and we can approach it best by comparing the action of a pendulum. Referring to Fig. 3, a pendulum is supported by a pivot so that is can swing back and forth over a scale graduated in inches from 0 to 6 on each side of the center point. This has a light flexible spiral spring attached to point A near the bottom of the rod. The other end of the spring has a handle, which may be pulled to the right to set the pendulum in motion, swinging. As it sways back and forth let us pull this handle to the right for a distance of just one inch and then let it go back again

as the bob swings back to the left. This action of pulling the spring handle to the right and then letting it go again, is to be repeated regularly, timing it with the oscillation.

Since the spring will let the bob over-travel somewhat, the latter will swing back and forth a distance of perhaps two inches each side of the zero, even though the spring handle is pulled back and forth for a distance of only one inch. However, this motion will not be greater than a couple of inches, since the spring is fastened so low down on the rod that it makes a fairly tight coupling with the pendulum.

Too Loose a Coupling

Now, in Fig 4, let us do the same thing, except that we shall move the point of attachment of the spring from A up to position B, very close to the pivot. The same motion will be given to the handle at the end of the spring. Again, the bob will oscillate back and forth over an amplitude of two inches each side of the 0. It is not held back any more by the tight coupling, which it had in Fig, 3. But the trouble here is that the attachment is so near the pivot that it has little effect on the bob, or in other words, the coupling is now too loose to get up much of a swing. That is why the oscillations are still quite small.

Now let us move the point of attachment. this time to position C, which is perhaps one-third of the way down the rod. This appears in Fig. 5. With the same movement of the spring handle we now get a very vigorous oscillation of the pendulum, since it swings out six inches each side. The reason for this big oscillation is because the coupling is now just right. It is not restrained in its motion by having too close an attachment to the slow moving spring as it is was in Fig. 3, nor is it so independent of the spring motion as occurred with the loose coupling of Fig. 4.

In our receiving set we have the same kind of action. If the coupling is either too tight or too loose, we do not get the maximum loudness and selectivity. This degree of coupling is effected either by changing the location of one coil relative to another, or by turning it. The way this is changed nowadays is by a variocoupler. The rotor of the variocoupler, when swung into line with the stator, gives tight coupling, but when turned at right angles, the value drops nearly or quite to zero.

A Case of Tight Coupling

A hook-up which has tight coupling is shown in Fig. 6. The primary circuit is from aerial, through the tuning condenser C direct to the coil S and then the tap switch T to ground. The secondary oscillates between the Grid G and grid condenser through coil S and grid return to the filament. You will notice that coil S is common to both circuits that is why the coupling is so tight, because the two circuits are almost rigidly connected. The output of this tube runs from plate P through the rotor of the variocoupler R to the phones and back to the filament. Such a hook-up gives very broad tuning and is not as loud as it should be on distant stations. It corresponds to Fig. 3, in our pendulum diagram.

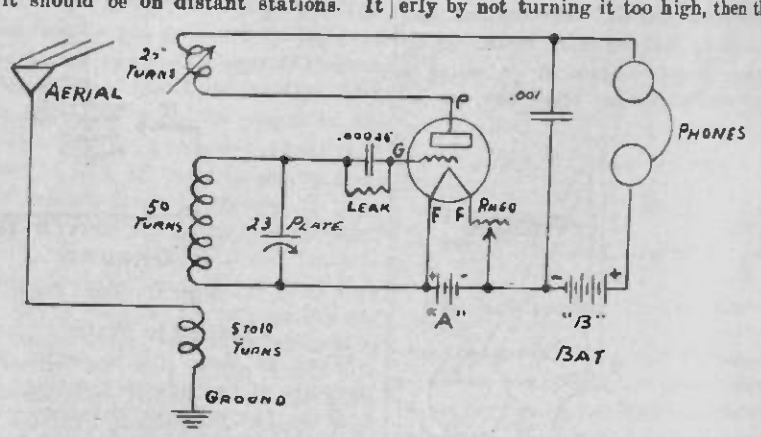


Fig. 7. Loose Coupled Set for Selectivity

A modification of this circuit which will give sharper tuning and more volume is illustrated in Fig. 7.

Circuit of this Hook-up

The output of this circuit, you will notice, is just the same as before. The difference is in the primary. Instead of using the same coil for both aerial and grid we now have a primary consisting of from five to ten turns, wound on the same tube as the stator of the variocoupler. The stator coil itself is connected so that it oscillates between the grid and the filament of the tube, just as it did in Fig. 6. The tuning condenser is no longer needed in the primary but is put across to leads of the stator of the variocoupler.

With this modification you will find that the circuit is much sharper tuned than it was before. The reason is that the aerial is no longer tightly coupled to the tube. The reason that the drawing specifies five to ten turns is because a variation can be made at this point to control the amount of coupling. The more turns there are in this primary coil, the tighter will be the coupling. By experimenting with this coil you will find a value which will give results which are louder than they were before making the change and also will cut out local interference to a considerable extent.

A Golden Rule Set

Another big advantage of this hook-up, as in Fig. 7, is that such a set will not radiate very much. If the tickler or variocoupler rotor is adjusted properly by not turning it too high, then this receiver will not radiate at all. Of course, this remark is also proof of the single circuit hook-up of Fig. 6.

However, if, through improper adjustment (which often happens) the tickler is turned too high, so that the set oscillates, then the amount of sueh radiation fed back to the aerial will be small with Fig. 7, whereas in Fig 6, it was so great that all your neighbors were seriously disturbed. For that reason we strongly recommend building over all single circuit regenerators to the form shown here.

Wedding of Phonograph and Radio

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

ENGINEERING is always widening its scope, and new fields which are at first developed by a hit-or-miss method gradually become the subject of orderly and rapid development by skilled engineers. No devices more fully illustrate this evolution from chance trials to systematic improvement than those two related instruments; the radio receiver and the phonograph:

The nature of the music first put out by phonographs, and later by the first radio loud speakers, "designed" by guess work, was very crude. When it is contrasted with the superb effects which can be obtained today under the right conditions, the effects of good engineering can be seen, and the possibilities of the future appear even more attractive.

Diaphragm of Great Importance

Up to the present, the acoustic problems in the production of sound have been very similar for the radio receiver and the phonograph. Each uses a small vibrating disk or diaphragm to produce the sounds. In the case of the phonograph, the diaphragm is generally a circular piece of mica mounted in the reproducer of the phonograph. This is vibrated by a mechanical connection to the needle resting on the record. In the case of the radio loud speaker, diaphragm of iron or other suitable materials is vibrated by the magnetisms of a coil, through the agency of currents which are produced by the radio receiver and its amplifiers. The defects of such diaphragm systems may be very serious unless every feature of the dimensions, mounting, and control of this disk is thoroughly understood and accurately worked out.

The sound produced by the diaphragm in each case passes through a horn and is modified by it. Here again is ample opportunity for good or bad design and fine or poor results. The material of the horn, its size, shape, and mode of attachment are all of importance, and require careful study and experimentation to get the best results. The radio receiver has the best of the problem,

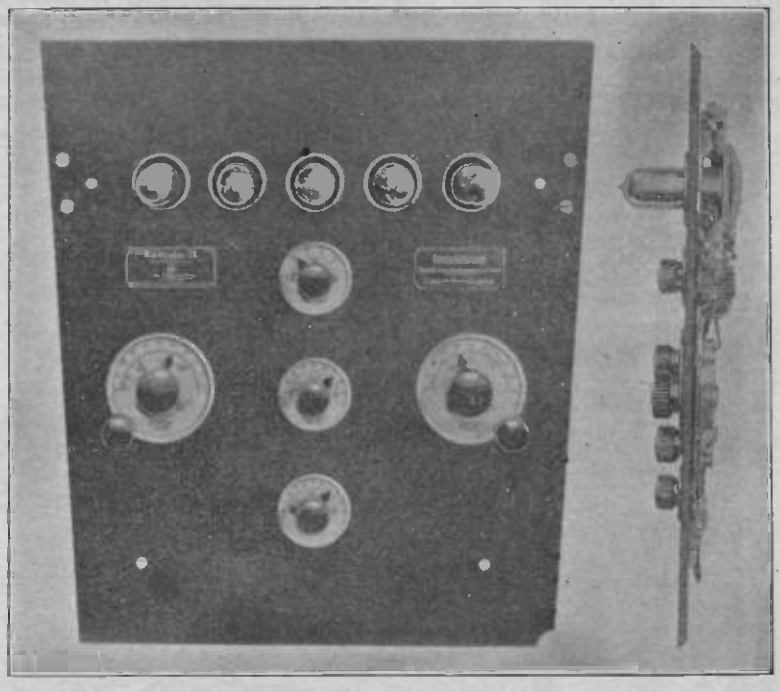


Fig. 1. Note Extreme Thinness of This Radio Set

in one way, because one can increase the amount of available power for vibrating the diaphragm as much as may be desired up to a limit by amplifiers, while the power obtained from a needle riding in the groove of the phonograph record is strictly limited. Each field has found its own best solutions, and satisfactory results are now being obtained.

The Two Not Enemies

The output of a phonograph and that of a radio receiver are not so much alike, nor so competitive, as is sometimes believed to be the case. A phonograph record is, of course, a reasonably permanent article. Even if the record is worn out, it can be replaced by the purchase of a duplicate. It represents the result of a considerable number of rehearsals of the artist, and may fairly be assumed to be the best recording possible of the particular selection. But the broadcast performance is final—that is, if it is not quite what the broadcaster desired, it can nevertheless not be recalled or modified. And it is heard once, and cannot be played over and over again. A phonograph record can also give us music or speech from persons who are absent at the time; they may even be dead. The broadcaster must confine himself to persons and actions of the present unless he too uses records as his "raw material" for broadcasting.

Unless you have the choice of a great number of broadcasting station programs which you can pick up, the phonograph will be more likely to furnish just the kind of music which you want at any time. This assumes that you have plenty of money and are willing to buy the assortment of records required for your desired range of entertainment.

It Has the Delicate Touches

The capabilities of the radio set are unique in a number of respects. Suppose an important speech is to be de-

livered on a given evening. It may reach a million homes by radio, with all the timeliness and personal interest which it carries. It may carry to the radio audience the words of the greatest statesmen or leaders in other fields of activity at the instant they are spoken, and with all the delicate individual touches which make such

Fig. 2. How Set of Fig. 1 is Applied to a Popular Console

speeches so interesting. This cannot be done in the form of a permanent record; the psychology of hearing a phonograph record is quite different from that of the reaction to an actual radio speech. Broadcasting carries the best concerts being given in a group of nearby cities to all residents of the great area surrounding them, and at the very instant that the concert takes place. It gives performances lasting for many hours, where the trouble and expense of gathering a similar entertainment in phonograph records would be prohibitive, even if it were not frequently impossible to assemble the desired program in the form of records. Furthermore, there are no interruptions in the performance of a play or opera in radio broadcasting. Besides this, it is the best means of bringing the newest artists before the entire public, probably before their efforts have been crystalized in record form.

The recent rapid development of the radio drama and of political broadcasting indicates other fields which will probably remain exclusive to radio. The *romance* of radio is something no other art can have. Through the miles of darkness, carried by no visible force, come the concerts and speeches which entertain and instruct us. There is and always will be a thrill in the knowledge that an annihilator of space has been placed at the disposal of mankind. Men have always felt the cramping limitations of their own slow means of travel. The trouble of travel to a distant city is sufficiently trying to make its elimination by radio a permanent and stable human asset.

Thin as a Shadow

It is therefore logical to expect that radio and the phonograph will to some extent supplement each other. Each will supply its quota of enjoyment in its own way, and use its own capabilities to the full. The combination of the two fields is, in fact, being rapidly worked out. Fig. 1 shows a radio receiver which may be installed in the lid of certain vertical phonographs, or in a suitable part of some console models. The most noticeable and unusual feature of this set is that it is carefully adopted to phonograph requirements; notice in particular its extreme thinness. The space taken up by such a receiver is only about one-tenth of that of the usual equivalent separate sets. Every resource in design had to be applied to produce so unusual a result. The average thickness of this instrument is less than one inch. While experimental hand-made receivers may have been built as thin as this, it must be remembered that the form shown can be put through quantity production in factories, which is a very different matter from assembling of a single model. The fundamentals of design have been so well worked out that almost any hook-up could now be worked into the same thin form.

When installed in the proper phonograph lid, the combined instrument has the appearance shown in Fig. 2. The possibilities of such a double model are quite striking. You listen to a popular broadcasting station concert, and then, deciding to hear some particular favorite song or dance, you can play the desired record on the same instrument and hear the music coming from the same horn. Thus the scope of each instrument is widened by the combination. It seems likely that the development of the radio field will show again, as it has many times before, that new inventions do not always drive out the old devices, but that they supplement them and broaden their usefulness.

Who Designs the New Models?

You may be interested to know how

the men who invented these improvements were trained. Some people think all radio designers are amateurs, and others are under the equally serious delusion that all radio designers are professionals. The reason for this confusion of thought is simple. Very few people are quite clear in their minds as to what constitutes a radio amateur and what a professional, or how a man passes from one class to the other.

In baseball, it is not a very difficult question to settle. When a youngster leaves the back lot class and gets a regular paid position on a team which plays before fans who pay admission fees, there is no doubt that he has passed from amateur to professional. Baseball, in common with most sports, will always have the amateur and professional groups, and will draw its skilled players in the professional class from among ex-amateurs.

In medicine, on the other hand, there is (or should be) no amateur class. The old "herb doctor" is now a rare specimen, and indeed few people nowadays would like it very well if they were told that their doctor was an amateur. They would feel that his inquisitive questions about their aches and pains and his method of prescription by guess and treatment by trial was likely to make him a lot happier than his patient. In fact, most states prohibit the practice of medicine except by fully licensed professionals.

Getting Mileage a Game

That is, in the field of sports, amateurs and professionals exist peacefully side by side, while in the grave emergencies of life nothing but professionals, and the best of them, can be tolerated. Radio falls between these extremes, and this is one reason for the difficulty in deciding what a radio professional is. There is something of the sport element in radio, since it gives amusement and entertainment of the highest sort. Then, too, the lure of distance has been largely emphasized and has led many persons into using radio almost as a game. In playing it, the idea is to see how many stations you can get in an evening and what total distance from you of all the stations added together. In this case, the quality of the entertainment is almost a matter of indifference —all that is asked is to pick up the call letters. For a while, many people enjoy this sport and some of them get permanent pleasure from it.

On the other hand, there is a more serious side to radio. It is a tremendous social and political agency, an extremely potent teacher, and a unifying force stronger than anything known. It is a means of cultivating musical and literary taste and of bringing the masterpieces of every form of melody to a host of persons who would otherwise be shut off, by the barrier of distance, from enjoying them. In this respect radio must give service of a reliable sort. Ease of operation and certainty of results are required, rather than delicate adjustment and a sporting chance of hearing the station sought.

Fig. 3. Symbol of Institute of Radio Engineers

Radio professionals stress reliability as well as range, while amateurs generally go after distance records. Even the best organized amateur associations which handle radio relay traffic do not attempt to guarantee transmission and reception; but they always try to reach out further and further to the very bounds of the attainable range of the station. A large margin of operating safety is not asked of experimental and amateur operation, but it is becoming more common in professional circles.

Where They Come From

There are two sources of radio professionals. One group are amateurs who gradually drift into the radio business, either as the result of a good business offer from some one with the necessary capital, or else because they develop some device, such as a receiving set, which looks like a commercial proposition, and for which they secure the necessary capital. The sobering influence of the daily problems of design and sales change the attitude of the ex-amateur who has gotten into business. This is not always the case; it must be remembered that the ideas expressed in this discussion are all general and may have some exceptions.

The second, and more usual source of radio professionals, is from the engineering schools and the radio test divisions of the larger concerns in the field. A radio engineer and designer, according to the view of that great society, The Institute of Radio Engineers, is an electrical engineer who has specialized in communication and particularly in radio. While the Institute and the State legislatures have not approved the idea of a definite degree of "Radio Engineer" or R. E., the Institute has indicated the general nature of radio engineering in the above definition.

No Degree of "Radio Engineer"

This brings out the point that the degree of "Radio Engineer" is self-conferred in this country, and without the sanction of recognized engineering organizations, of great universities, or of the State. Membership in The Institute of Radio Engineers, in the grade granted to the applicant by its Board of Direction, on the basis of his training and experience, is a high honor, and is properly indicated by letters following the holder's name. Thus, persons genuinely interested in radio become Associate Members of the I. R. E., those having considerable engineering experience become full Members, and engineers of long standing, full responsibility, and eminent achievement in the field, are eligible for the grade of Fellow of the Institute.

It may be mentioned that the Institute of Radio Engineers is an entirely non-partisan and scientific society, free from any commercial connections, and that it numbers among its membership thousands of radio engineers, including practically every one of standing in the United States and abroad. Full information about it is sent out from its secretarial headquarters in New York City. Radio workers will be interested in its emblem which is illustrated in Fig. 3. The two arrows, one curled around the other, represent in direction and relation the electric and magnetic forces which are present in the radio wave.

Since these are the basic forces of radio transmission and reception, their picture is an appropriate symbol for the engineering institute representing the radio field.

It Costs Something to Experiment

Professional activities in all lines are more expensive than amateur activities, and this is particularly true in the radio field. Large equipment is necessary for a suitable research and development laboratory, where precise measurements as well as general experiments are to be carried out. The radio equipment of the amateur may run from a few dollars to a thousand dollars or more in extreme cases. The equipment for a professional laboratory may be from $10,000 to $1,000,000. A corner of such a work-shop is shown in Fig. 4. As the years pass, amateur work will no douht continue, and will give real pleasure to the fans as a sport and as a form of personal enjoyment. The professional work, while perhaps less romantic, will become more and more concentrated and effective, and will produce for the public a constant succesion of more reliable and successful receiving sets.

To the amateur, radio is a constant source of pleasure, and, subject to the rights of others, his activities are well worth while. To the professional, radio is a serious struggle to extend to the entire public, including the least skilled broadcast listener, the great benefits of modern radio. That it is also a "bread-and-butter" problem in the case of the professional makes him even more worthy of consideration and appreciation. It is by the result of his efforts that radio will come into its own and render its full service to humanity.

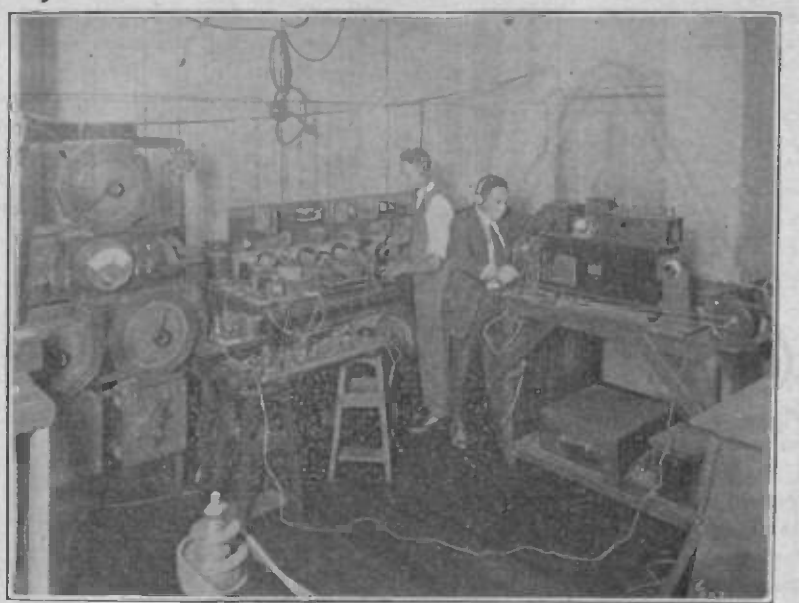


Fig. 4. Testing High-Speed Equipment in Laboratory

ROXY GANG INVADES MASSACHUSETTS

Stations WEEI, Boston, and WDBH, Worcester, Mass., have been added to the chain of stations now broadcasting the Capitol Theatre program on Sunday evenings. This makes a total of five stations simultaneously transmitting this Sunday evening feature. WEAF, N. Y., WCAP, Washington, D. C., and WJAR, Providence R. I., being the other three. The first part of the program, consisting of music by featured artists and the Capitol Grand Orchestra, is taken from the stage of the theatre while the second half brings "Roxy and His Gang" before the microphone in the special studio located in the theatre building.

At this time it is of interest to relate the history of the broadcasting of Sunday evening programs from the Capitol Theatre. After months of experiments with a microphone installed above the orchestra pit where the Capitol Grand Orchestra render their selections, WEAF for the first time on Sunday, November 19, 1922, broadcast the overture together with incidental music. This, however, did not become a weekly feature of that station's program until December 17 of the same year.

When it All Started

On the evening of February 4, 1923, from a special studio built for broadcasting, "Roxy and His Gang" made their debut, and from that night on became the leading feature of all broadcasting programs.

It was not until October 14, 1923, nearly a year later, that the second station was linked with WEAF for the purpose of broadcasting simultaneously this Sunday evening feature. On that date WCAP, the broadcasting station of the Chesapeake and Potomac Telephone Company, located in Washington, D. C., was furnished this program by means of telephone lines. One week later WJAR, The Outlet Company of Providence, R. I., was also added in the same way, thus tying together three broadcasting transmitters and furnishing each with the same program.

Seen as well as Heard

Another interesting fact in connection with the popularity of the broadcasting of "Roxy and His Gang," was the recent appearance of the entire ensemble for one week at a Providence (R. I.) theatre. They were scheduled to give ten performances throughout the entire week but created such a sensation that an extra matinee was found necessary to meet the demands of audiences which had heard them via radio each Sunday evening and had come from far and near to see them in a personal appearance.

So, with the addition of two more sending stations, "Roxy and His Gang" are going to invade new territory and win the hearts of thousands who will experience something new in the art of radio broadcasting.

CUTTING IT FINE

The Bureau of Standards measures the frequencies of broadcasters to one-tenth of 1 per cent. Engineers of one large company are making such measurements to within one-one thousandth of 1 per cent. That is like knowing the distance between New York and Boston to an accuracy of a few feet.

How to Compare Two Radios

Are You Undecided Which Make of Set You Want?

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

THERE are so many sets on the market at the present time (and each one is the best—see advertisements) that it is hard to make a decision on which set to buy. Usually it is possible to narrow the choice down to two or three. Many firms are willing these days to send out a couple of different makes on trial. But even in your own home it is sometimes hard to tell which one gives a better performance.

The trouble is this—it takes so long to change over all the connections from one set to another that the particular piece of music which you heard on the first is long since over. It is not very

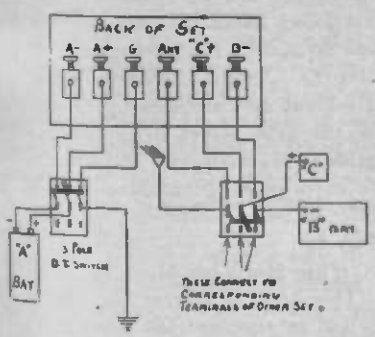


Fig. 1. Complete Scheme

satisfactory to compare a loud band playing jazz with an orchestha rendering soft symphonies. In order to get a good basis for making a choice you should be able to switch from one set to the other not only with the same artists performing, but also with the same phrase of music so that you can be sure loudness at the sending station was the same in both cases.

Switches Will Do This

In making comparison tests between radios as just described, it is advantageous to have a double throw switch by which either of the two sets may be quickly connected to the antenna and ground and to the batteries. The arrangement of a switch to do this is complicated by the fact that various manufacturers use different methods of connection between the "A," "B" and "C" batteries.

Considering the two plate voltages and one grid bias or "C" voltage, a nine pole double throw switch would at first sight seem to be required in order to prevent short circuits of the batteries due to differences in inter-connection in the sets. These nine points would be: Antenna, ground 90 "B"+, 45 "B"+, —B, +A, —A, +C and —C.

Leaving Out Three

An investigation shows that a six pole double throw switch can be made to do the work, because the 90 volt, the 45 volt, and the —C are all insulated in any receiver. These three points can therefore be omitted from the switch and terminals can be provided for them to which all the sets may be permanently connected as indicated on the instruction card. The switch will then carry:

Antenna, ground, —B, +A, —A and +C.

Instead of a six pole double throw switch, which is a little hard to obtain at the ordinary radio store, you may

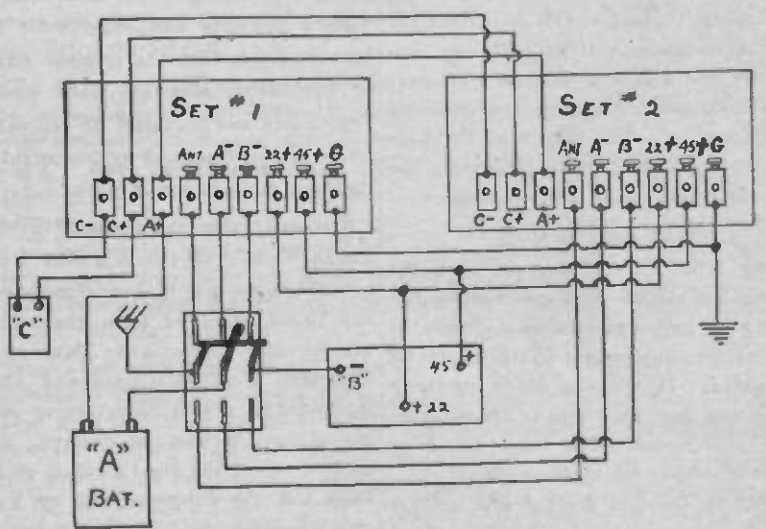


Fig. 2. Simplified Hook-up—3-Pole Switch

use two three pole switches. These will be connected as shown in Fig. 1.

In this diagram only one radio set is shown connected to the upper position or throw of the switches. The other set for comparison is to be hooked up to the lower throw in exactly the same way. The extra connections, that is the C—, 90 "B"+ and 45 "B"+ are to run to the correct posts of both batteries at the same time (in parallel.) When operating these two switches be sure you use both hands and throw the blades either up or down on both sets at the same time.

This arrangement has the further decided advantage that terminals can be provided for various "B" and "C" bat-

Continued on Page 14

Sending Station Stories

EVER HEAR A BASSOON?

One of the most unusual series of addresses ever arranged for broadcast audience is starting this week, from KDKA, at East Pittsburgh, Pa. Victor Saudek, director of the Little Symphony Orchestra, will present a series of educational talks on orchestral instruments.

Mr. Saudek, who has been actively connected with various organizations famous in the musical world in the past 30 years has arranged a series of talks on the instruments making up the Little Symphony Orchestra. Each instrument in the orchestra will be taken up separately and a general talk on what part this instrument plays in the ensemble will be given. The player of the particular instrument will illustrate the various points made in the address.

Why Each Is Used

The talks are unusual in that the public has seldom been given an opportunity to have analyzed and illustrated the various instruments making up an orchestra. It will be made perfectly clear why such instruments are included in the orchestra. The talks will be a musical education in themselves.

Mr. Saudek has divided his lectures into three groups, as follows: First group—Wood-wind instruments: piccolo and flute, oboe, English horn, clarinet, bass clarinet, bassoon and contrabassoon. Second group—basses: French horn, trumpet and cornet, tympani and percussion instruments such as drums and cymbals. Fourth group—string instruments: violin, viola, violincella and bass viol.

In preparing the talks Mr. Saudek stated that few of the public know what instrument make up an orchestra and even fewer know the reason for including the various instruments in the ensemble. Aside from such instruments as the violin, viola, cornet and the drums, very few people can describe the sounds made by the various instruments.

The addresses will be given Monday and Thursday night during the coming weeks until the series is concluded.

EAT AND GROW THIN ON THURSDAY

Unmistakable proof has been received that the girls in the vast radio audience know what they want, and are determined to get it, at least so far as broadcast programs are concerned. This has resulted in considerable expansion of the WJZ Women's Hour Program. In the few weeks since the special morning hour of broadcasting especially for women was inaugurated by that station so many vehement requests and suggestions have been received, that the original number of subjects treated has been doubled. Practically every subject of general interest is now discussed by competent authorities at least once a week.

The daily menu as prepared by Mrs. Julian Heath, of the National Housewives' League, and Eleanor Gunn's Fashion Talks, prepared from the comprehensive and authoritative data of the "Women's Wear" European and American bureaus, are broadcast every morning to meet the popular demand. John C. Cutting of the Meat Council of New York and the Etiquette talk by Vogue are scheduled for Mondays. Dorothy Ethel Walsh's famous "Home Beautiful" talks and Grace Isabel Colbron's book reviews fill out Tuesday's hour. "Household Equipment," by Ethel Peyser, "Care of the Baby," by the Henry Street Visiting Nurse Association, and household hints by the Tribune Institute are heard Wednesdays. "Eat and Grow Thin," by Vance Thompson, "Dress Embroideries" and Mrs. Roberts' "Arts and Decorations" talk fall on Thursdays, and Mrs. Pauline Peck's "Shoppers' Guide" and the "Be Your Own Decorator" talk come every Friday.

From that schedule it would appear that the modern housewife has more trouble with food and clothes than she does with either children or husbands, with inexpensive interior decoration running the first two a close race.

COMPARE TWO RADIOS

Continued from Page 13

tery voltage and the sets under test can be connected directly to these terminals as just mentioned.

For example, terminals can be provided for 22, 45, 90 and 135 volts "B" battery and for 4½ and 9 volts "C" battery. Inasmuch as opening the switch disconnecte the —B and +C, and disconnects the "A" battery entirely, from all sets, there is no possibility of a short circuit, due to differences in interconnections.

(Editor's Note)—While this scheme of connections is the best possible for laboratory tests it uses more apparatus and wiring than the average fan wants to bother with. For many of the popular makes of radio on the market a further simplying can be accomplished.

The ground connections can be run to any set since practically all the sets in the world are grounded and one does not affect another. This will eliminate one terminal. Furthermore the "C" battery as is almost universally the case gives out no current as it is connected in the grid return from the amplifier grids to the filaments. No difficulty will be experienced in hooking up both the "C" battery connections, as shown in Fig. 2.

This Hook-up Must Be Tested

This hook-up it must be remembered is not as sure as that given in Fig. 1. If one of the radios, which you are comparing, happens to ground the plus and the other the minus of the "A" battery, then a heavy current will flow in this battery when the switch is closed, either up or down. To test this, turn off all rheostats and then take off one terminal right at the "A" battery. Notice whether there is any flash. If so, it means that the internal connections of the two sets are so different that this simplified scheme will not work and you will have to go back to Fig. 1.

In case one or both sets omit the "C" battery, then its terminals at the switch may be left disconnected, or if preferred, since these units are quite cheap, separate "C" batteries may be hooked up without running through the switch.

Modern Loud Speaker Design

By EDWARD W. SMITH

CAN you remember back in the dark ages of radio when there were no vacuum tubes, but only crystal detectors to bring in the signals? In those days there was no need for having loud speakers, since the signals were often so faint that the best pair of phones hardly made them heard.

But the vacuum tube detector increased the signal strength so much that it is now possible when within a few miles of a powerful broadcasting station to pick up the programs on a loud speaker in a quiet room. And when we use amplifying transformers in one or two steps we get so much current from the output circuit that we can work a horn on distant stations. Since these have made possible the generation of large audio currents, inventions have been sought so that these currents might be changed into sound waves with as little distortion as possible. The idea is that a more or less exact reproduction of the original sound may be made, both as regards quantity as well as quality. In considering the problem, it might be well to decide first just what qualities are desirable in a loud speaker, in order that we may have some definite objective in view.

In order that the speaker may be as nearly perfect as possible, it should be able to handle any audio frequency voltages applied to it in such a way that the reproduced sound wave will contain vibrations of the same amplitude and frequency as the constituents of the voltage applied to the loud speaker. In other words the translation from electrical to sound waves should be as faithful as possible.

Must Not Lose the Ripples

For instance, look at Fig. 1, which shows in a rough way the difference in vibration between a tuning fork, sounding Middle C on the piano, and a violin, playing the same note. Both of them have 256 vibrations per second, since this is the speed which gives the tone of C. But while a tuning fork gives a perfectly smooth wave which sounds rather flat and dull to our ears, on the other hand the violin gives a wave which has a large number of ripples in it. It is these ripples or harmonics riding on top of the main tone wave which give the particular kind of note, or "timbre," which makes it easy for us to tell what kind of an instrument is playing. If the loud speaker takes the violin wave and in reproducing it leaves out some of the ripples, then the timbre will be destroyed and the tone will no longer be natural. If it is particularly bad, and all the harmonics are omitted, then the note will sound like a tuning fork.

The horn's sensitivity should be such that large audio frequency voltages need not be applied to it to give satisfactory volume. But the sensitivity of the speaker is not so important as some of its other qualities, as it can be compensated for to some extent by increased amplification if necessary. Also, of course, its proportions and shape must be such as to give it a pleasing appearance.

When alternating current flows through the primary of the audio transformer, of course it is limited in value by the effect of the winding. This wire naturally has a pretty high resistance and besides this the effect of the larger number of turns causes a high electrical weight or inductance. The combination of resistance and inductance is called the "impedance." The higher this is in value the greater the voltage required to force current through the windings. The plate circuit of the tube itself also has an impedance which in the average tube will have a value of about 10,000 ohms.

Getting the Right Audio Transformer

It is a well known fact in audio transformer design that the best quality can be obtained only by making the ratio of the impedance of the transformer primary to the plate impedance of the tube as high as possible for all frequencies between 100 and 10,000 cycles. This means high voltage amplification. With the loud speaker, however, a different condition obtains. Here we are changing the audio frequency *power* in the plate circuit of the last tube into sound energy. It is not a question of *voltage* as it is between tubes.

It can be shown by figures that if we have a system like a generator supplying energy to an external resistance, which may be an electric light, maximum power will be delivered to such an external resistance (lamp) when its resistance is equal to the internal resistance of the generator. If the external

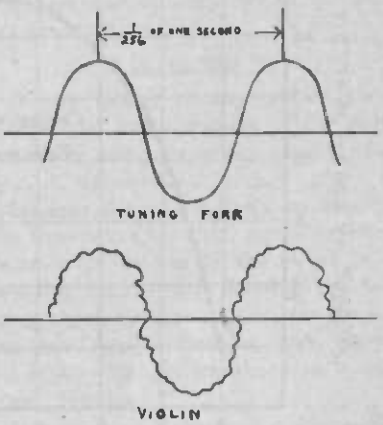


Fig. 1. How Some Horns Treat Waves

resistance is made either greater or less than that of the generating system, then the power delivered to it will be less than it was when they were equal. The curve in Fig. 2 shows the variation in power delivered to an external resistance when the plate impedance of the tube is 10,000 ohms and the generated voltage in the circuit is 10 volts. Notice that the power is greatest when the external resistance is 10,000 ohms—the same as that of the tube.

With the loud speaker we have a similar condition. We are putting energy into an external circuit (horn) in the form of audio energy, and when the amount thus expended is equal to the energy spent in the plate resistance of the tube we have obtained the maximum possible transfer. Some of the energy which goes into the loud speaker, (in fact, we might say with more accuracy, most of it) does not reappear as sound energy but is wasted in losses in the loud speaker itself. Our problem then con-

sists first in obtaining maximum transfer of energy at all frequencies into the loud speaker, and second, at the same time effecting its conversion into sound as efficiently as possible.

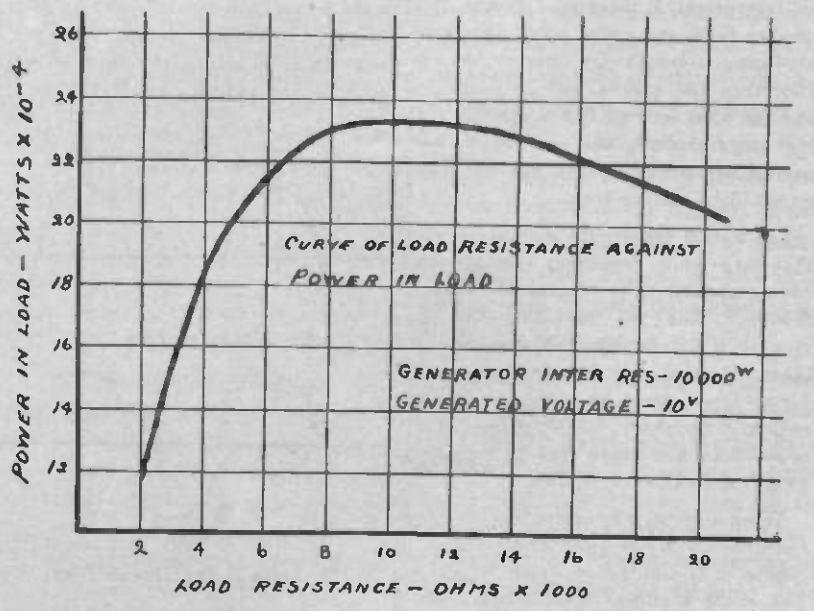
Current in Step with Voltage

Let us consider the first part of the problem just stated, namely that we wish to have maximum transfer of energy into the loud speaker at all frequencies (all different notes). This energy is represented electrically by the product of the voltage applied to the loud speaker multiplied by the current through it. That is, energy = voltage × current. This holds true, however, only when the current is in phase (in step) with the voltage. In most cases where the current runs through a coil the inductance or electrical weight causes the current to lag behind the voltage in its oscillations. That is, the highest value of current occurs a fraction of a second after the maximum voltage as the two vibrate up and down. If the current is out of step with the pressure then the equation just given will be corrected to read energy =voltage × part or component of current which is in step.

This shows that the larger we make this power component of the current the greater will be the power we put into the loud speaker. So if we can by some means or other develop a reproducing system which will keep the current and voltage in phase at all frequencies in the loud speaker, we shall have a horn that is taking all the power possible.

Of course, we must observe the other point already mentioned that the impedance of the horn must equal that of the plate circuit of the last amplifier tube.

A first consideration of this question might lead you to think that it would be utterly impossible to keep the current and voltage in phase, or anything approaching that condition in a piece of apparatus that has as much inductance as a loud speaker, but such is not the case.



How to Keep Them Together

Let us take a telephone receiver or a loud speaker and see how it acts when giving out various tones. The voltage we shall keep constant but the frequency will vary. We shall find that at one particular freqency (tone) we shall get much more sound output than we did at all the others. This vibration speed is the natural frequency of the diaphragm and the same effect will be noticed at multiples of this one to a less extent. That is, if the natural time of vibration should happen to be such as to make midde C (256 cycles) particularly loud then C in the octave above this, 512 vibrations, would also stand out louder than the rest. The same would apply to the next C, 1,024, although not quite to such an extent. If the inductance of the receiver is then measured at this fundamental frequency of the diaphragm, it will be found that it has dropped to a surprisingly low value and may even be too small to be measured accurately. When such action occurs it is called a point of resonance. It is really the same thing as what happens in your tuner when you adjust the variable condenser or variometer to the wave length you want to pick up. To all intents and purposes then, the unit at this frequency has no inductance but acts like a pure resistance and absorbs the maximum power.

If then we could make such a resonance point occur at all frequencies instead of just one and its multiples, and so give the same output at all frequencies, we should have approached at least the perfection we desire.

You Can't Change the Diaphragm

It is the diaphragm or vibrating disk in the speaker which actually makes the sound vibrations in the air and you can't change this very much to make it resonant at more than a few tones. So modern design brings into play the resonant properties of horns in an attempt to make the sound output the same at all frequencies. Every horn or instrument of that type has a certain natural period of its own, which depends chiefly upon its length,—the longer the horn the lower its natural period or note. And like the diaphragm mentioned above it has resonant points at harmonics or multiples (like twice, three times, etc.), of its natural period. If instead of using the loud speaker unit by itself we could attach a horn to it such that the resonant points of the horn would coincide with the points where the unit was not resonant, then the net result would be that we should have a combination that would respond equally to all the frequencies of both the horn and the diaphragm. It can be seen therefore that if the number of resonant points in the horn is great enough and they are sufficiently broad to fill up the hollows in the sound output where the diaphragm is non-resonant or nearly so, then the best results will follow. In that case we shall have a fairly uniform sound output over the frequency or tone range present in speech and music, and more power will go into the production of sound energy.

Long or Short Horns

The natural period of the diaphragm used may vary with the general types of loud speakers, from four or five hundred

cycles to eight hundred cycles, depending on the make. If we wish to fill up the non-resonant points of such a diaphragm by the method just outlined, it would seem that we should have to use a horn of great length in order that we might get sufficient output at the lower frequencies and also so that the resonant points of the harmonics might be sufficiently close together to give the desired result. Certain other considerations enter into the matter so that it is frequently possible to secure very uniform sound outputs with horns of very moderate lengths. It can be easily seen, however, that the characteristics of the unit and horn must be such that they complement each other if the best results are to be secured and that the fact that a unit works well with one horn does not necessarily mean that it will work well with some other.

It is a comparatively easy matter to produce a loud speaker which will give fairly good results in the middle register, but to produce one which will give uniform results over the range from 100 to 10,000 cycles is a different matter.

Can It Say Mississippi?

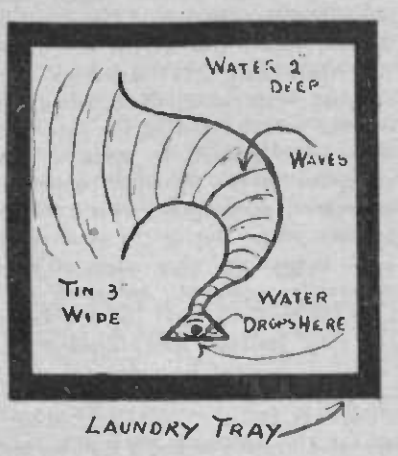
This represents the number of notes from the lowest C on the piano up to beyond the highest. The upper ones are not usually used in music but do come into ordinary speech, particularly in sounding the letter "S."

Like the audio transformer, the horn which gives satisfactory operation on low notes will usually give poor results on the high frequencies and vice versa. It is in the reproduction of high and low frequencies where the real merits of a loud speaker begin to show up. The prospective purchaser may find one type which makes a piano sound like a piano and appears natural on speech, but it sometimes happens that even such a horn is not very intelligible on speech due to an absence of the higher frequencies. The reverse is also true, that a loud speaker that reproduces violin and flute music well and makes an "s" sound like an "s" usually does not have enough of the lower frequencies in its output to give naturalness to speech or organ music.

Shape of the Horn

The actual shape of the horn also has an effect on the quality of its output. Sometimes, in going around a corner, the sound waves will interfere with each other. Some idea of the way that it works can be obtained from a simple experiment. Get a strip of ordinary sheet tin about three inches wide and long enough to represent the sides of the horn you wish to test. Fill a large flat-bottom tank with water two inches deep. An ordinary laundry tray makes a good tank for this purpose, although a kitchen sink with a piece of rubber over the drain pipe will do. Bend the sheet of tin to the outline of the horn as shown in Fig. 3, Then dip a piece of cloth in the water and squeeze it over the base of the horn in such a way that the drops fall right at the spot where the diaphragm would be.

You will see that a series of waves or ripples will be formed which if it were not for the tin walls would spread out in circles. The horn wall changes this so that the waves follow the outline and go out in a way similar to that of sound waves leaving a loud speaker. By bending the tin into various shapes, it is possible to try the effect which this has on the signals.



It is Hard to Pick a Good One

The loud speakers on the market which even attempt to reproduce the full musical range of frequencies mentioned above are few and these few are still further handicapped from general recognition of their qualtities by the large number of cheap and poorly constructed reproducers which convince the would-be purchaser with a taste for music that radio reproduction is far from good. This is an unfortunate condition, since the popularity of radio with discriminating purchasers stands or falls upon the quality of reproduction of the loud speaker.

THREE DEGREES IN THE FRAT

The development of radio in the last three years has divided its growth into three distinct classes, all of which combine to make one big radio fraternity. The word "fraternity" is used because an interest in any one of the three establishes a common ground for fellowship.

These three distinctions may be applied to other fields too. They are classed generally under the headings—mildly interested, technically inclined, and "hobby riders." Translated into radio terms, these mean, (1) the owners of factory-built receiving sets, (2) experimental listeners and (3) the amateurs who not only receive by radio, but transmit as well.

How to Get In

If you belong to any one of these groups, you are a member of the radio fraternity, but your ability to hold your own in conversation with a group of radio fans depends entirely on whether you have taken the first, second or third degree. To be merely the owner of a receiving set, without knowing the first thing about its construction, admits you into the circle. However, you cannot get farther without knowing how to talk about "hook-ups."

In order to get the most out of radio, if you seek more than the ordinary entertainment and educational advantages, it is necessary to go through all of these stages. The amateur telegraph game represents the limit that can be reached short of becoming a professional operator. Amateur radio, when you have mastered the code and a certain amount of technical knowledge, admits you to the greatest thrills in radio, the exchange of personal messages over distances limited only by the world itself.

NOW THREE MILLION RADIOS

The latest estimate of the number of radio sets in the United States puts the figure at three million. These are giving entertainment and instruction to at least ten million listeners. About two-thirds of this number use storage batteries and the corresponding tubes, while nine hundred thousand employ the newer type of dry cell equipment. One hundred thousand are crystal sets, which cannot receive more than ten or twenty miles.

How Radio Inspectors Protect You

The Bureau of Navigation Tells of Ship's Radio.—Report by Commissioner D. B. Carson

COVERING in detail the many phases of the operations of the bureau of Navigation, Commissioner D. B. Carson in his annual report to Secretary of Commerce, Herbert Hoover, made public recently, emphasizes the phenominal growth of radio and the need of adequate laws to provide for future developments in this field.

Although co-operation has enabled the Supervisory Radio Office of the Bureau of Navigation to operate under existing law without serious hardship to anyone, the Commissioner states that a more defined program is desirable.

"It seems probable," he says, "that broadcasting is firmly established as a public necessity. It may be considered as indispensable in the average home as the telephone. The success achieved in the United States has encouraged many other countries to utilize this important means of establishing direct contact with the public."

Paying for Programs

The question of who will pay for broadcasting in the opinion of Mr. Carson does not appear to require immediate consideration.

"The public will probably continue to contribute liberally through cost of equipment purchased. At present there does not appear to be a better way of distributing the cost. On the other hand, such stations must have considerable advertising value justifying the expense of operation where owners are not benefited through sales of radio apparatus."

The amateur wireless operators (hams) are searching for new things in radio, and they must be given new fields to explore if their interest is to be held. They have succeeded in talking way across the continent, and have found that they can exchange conversations with European stations on short wave lengths. In view of their past achievement it seems proper that they be given a few narrow working and experimental wave length channels below 100 meters to encourage further development.

Declaring that safe navigation of merchant vessels depends largely upon efficient radio equipment, Commissioner Carson reports that at the end of the year there were 2,741 American ships equipped with radio, not including government vessels. During the year there were 7,721 inspections made so that protection to the traveling public will be assured, as compared with 6,933 the previous year. During the same period 1,577 inspections were made of ships voluntarily equipped, compared with 1,124 the previous year; and 974 American ship stations were inspected for licenses, compared with 644 the previous year.

They Picked Up a Lot of Cash

The Bureau's service of safeguarding life and property along the Atlantic and southern seaboard, he points out, is operating without cost to the government. "During the past year the bureau's five inspection vessels turned into the Internal Revenue Bureau $50,599.36 in delinquent taxes on pleasure vessels and penalties under revenue acts, together with navigation fines imposed and the indirect effect on internal revenue collections render the service more than self-sustaining."

On 384 occasions overcrowding of passenger vessels was prevented by the bureau's inspectors. This involved the safety of 174,098 persons, as undoubtedly in each case the limit of safety would have been exceeded had the loading not been under the supervision of an inspector.

The report recommends for passage by Congress of pending vessel load-line legislation in the interest of safety, so that the commercial standing of our great fleet of ocean-going cargo steamers will not suffer by lack of governing regulations in dealing with other countries. The technicalities of this bill have been considered by a specially qualified committee of experts appointed by Secretary Hoover, and their recommendations for accepting the provisions involved were approved by the Secretary of Commerce.

SNAPPING PICTURES UNDER POWER

Photographers who have occasion to take pictures of electrical apparatus located under power lines will be interested in a recent experiment in high voltage at the Ft. Wayne Works of the General Electric Company. A report came to the engineers there that a direct short circuit in a 13,000-volt line had been caused by a photographer's flash powder, which was set off within the station.

E. A. Wagner, managing engineer, had set up a flash powder under two wires carrying 13,000-volts. These wires were separated by nine inches, a distance sufficient to make the normal potential necessary to cause an arc-over at least 90,000-volts. The flash powder was set off about four feet below the wires. This caused an absolute short circuit between the wires. The tremendous current at once tripped the main breakers in the plant. The hot gases and particles rising from the flash were ionized between the high potential wires, causing the arc-over.

Flash-lights around electrical apparatus should be placed where the rising powder or gases will not pass over or between high voltage circuits.

GET A FREE COPY

"Footlight and Lamplight," Oliver Sayler's half hour of criticism of books and plays, which is broadcast by WGBS, Gimbel Brothers, every Thursday evening at 8:30, will be sent in printed form free to all who want it. Mr. Sayles, the well-known writer and critic, in this series discusses the latest worth-while plays and books. Those who hear it over the radio may also obtain copies, without expense, by sending a stamped addressed envelope to Mr. Sayler, care of WGBS, Gimbel Brothers. "Footlight and Lamplight" is also to be distributed in the theatres where plays are running that Mr. Sayler reviews.

Talking 100 Miles to a Studio

A Studio That is Twins Supplies a Single Aerial

FEW radio fans who listen every night to the programs of Station WBZ in Springfield fully appreciate how interesting some of the unusual facts about the operating end of this station are. The listening public has had no opportunity to know some of the radio stunts which WBZ "puts over" night after night. Nor are they acquainted with a number of facts concerning the station, not only from the point of view of the operating end, but also with respect to the announcing, the studios, and its connection with the rest of the Westinghouse Electric & Manufacturing Company's broadcasting system. In a few words, some of the important features of the WBZ Station at Springfield, Mass., will be related.

Runs by Railroad Track

The Springfield broadcasting station is the only one in the world operating a studio so far removed from the transmitting apparatus. Almost all stations these days have telephone lines running all over the city in which the studio is located. The big fellows will also hook-up with other cities in the neighborhood, which may be ten or twenty miles away. By doing this they get the advantage of being able to broadcast various conventions and the like, which could not possibly be brought to the studio. But to go over 100 miles, as a regular thing, is a little unusual.

The Boston studio in the Hotel Brunswick is more than 100 miles away. See Fig. 1. Many fans are confused because of this Boston connection, but by means of a special 100-mile telephone line along the Boston & Albany Railroad tracks, the concerts and programs put on in Boston are rushed along to the broadcaster, and sent out into the air for the enjoyment of thousands of listeners. Such remote control is remarkable. Boston's best is thus given to WBZ's audience and the artists from the "City of Culture" have made their programs among the best in the country.

Has a Good Pick-up

Not only does the station maintain a studio in Boston but it has a mass of lines for outside pick-up work, running into every side of Boston's famous music halls or meeting places. The whole city is covered by them, and wherever any event of importance is happening in which the radio public will be interested, WBZ serves it out on the air.

In Springfield, this station boasts the most unique radio studio in the world, up until very recent weeks, the only one of its kind. You have seen any number of pictures of interiors where large draperies were used on the walls. These are usually necessary, as has been explained before, to prevent the echo from blurring the sound. If you have ever moved to a new house, remember how peculiar noises sounded in the bare rooms before any furniture or pictures were in place. Of course, the same thing would occur in the ordinary studio, if special pains had not been taken to prevent it.

Have You Met Cele?

But instead of using the conventional hangings, a new kind of wall covering was developed. This is called Acousto-Celetax. If you have not met any of this in your rambles, it may be explained that it is made of seaweed. It has been found that ordinary seaweed, probably owing to the fact that it is entirely covered by water, and so never has to face a strong wind, is practically not elastic at all. When the sound waves strike this material they are not reflected as they would be against a wood or plaster wall. To give stiffening to the seaweed cornstalks are used, and the whole mass is bound together with flax. In the finished form it presents a smooth, velvety touch to the hand and has rather an attractive appearance.

All musical instruments and even the human voice reproduces beautifully from this new type of radio studio, and the absence of drapes makes fire danger very small. A reception room for the waiting artists is well provided with easy chairs, and is equipped with a radio receiving set, so that the artists waiting their turn can hear how the other entertainers are getting along.

Shack for Time Signals

A special low-roofed building, called a "shack," has been provided at East Springfield for receiving the Arlington time signals, which in turn are relayed out into the air on standard frequency, 890 k.c. (337 meters), by WBZ. These time signals are picked up by most all the large factories throughout New England and master clocks are set by them. In this shack, short-wave equipment for experiment is also housed, and much of the time of the large operating staff is spent here.

The transmitting apparatus is the latest type. There is so much of it that it is assembled into three separate panels. To operate this kind of a station naturally requires a lot of power. When heavy currents are flowing they develop considerable heat in the various conductors. This same thing applies to the tubes which are used for oscillators. As a matter of fact, they are large size editions of the UV-201 which you may use in your own set. But they are so large and get so hot that it is necessary to run cold water through a jacket which surrounds the tube itself. This conducts the heat away and keeps the tube cool in the same manner that the radiator of an automobile keeps down the temperature of the engine.

The radio room atop the East Springfield Westinghouse plant also contains a special telegraphic transmitter for communication between the various Westinghouse plants over the country, and a spare broadcaster, to provide for emergencies. The antenna uses 6 wires, strung side by side. It is hung from

Continued on Page 20

Fone Fun For Fans

How They Explain It

She—"Now what are you stopping for?"

He (as car comes to a halt)—"I've lost my bearings."

She—Well, at least you are original. Most fellows run out of gas!"—*Idaho Yarn.*

The Weaker Sex

"They tell me Simpson had quite a scrap with his wife last night."

"What was wrong with him?"

"I didn't hear."

"Liquor, do you suppose?"

"No, she did him."—*American Legion Weekly.*

Proved

She—"I showed father the verses you sent me. He was pleased with them."

He—"Indeed! What did he say?"

She—"He said he was delighted to find that I wasn't going to marry a poet."

—*Vikingen (Christiania).*

Might Have Been Radio

"How long did it take your wife to learn to drive?"

"It will be ten years in September."—*The Passing Show.*

A Short Term, But Oh My.

"Hello, Mose, how long you all in jail fo'?"

"Three weeks."

"What did you do?"

"Jes' killed mah wife."

"An' you all got only three weeks?"

"Dat's all. Den dey's goin' to hang me."—*Radio Merchandising.*

A Safety Sign

"Jim, I see that your mule has U. S. branded on his right hind leg. I suppose he was an army mule and belonged to Uncle Sam."

"No. You see, we got it from nothin' 'bout no Uncle Samuel. Dat's jess a warnin'. Dat U. S. jess stands fo' Un-Safe, 'at's all."

—*Radio Merchandising.*

Perhaps They're Brothers

"Didn't I meecha coupla years ago in New Orleans?" Thus a man inoculated with so-called liquor addressed a stranger.

"No, I am sure you are mistaken. I've never been there."

"Thash funny—thought I'd metcha." After hesitation, "Guess you're right. I've never been in New Orleans, either. Musta been a coupla other fellows."

TALKING 100 MILES

Continued from Page 19

two steel, lattice-constructed, 150-feet towers on the roof of the building. The transformer room is also a spacious one, in which some experimental equipment is assembled.

Everything Twice

Two operating staffs are maintained, one at the radio room in East Springfield, and a corps of men at Boston. Two staffs of studio operators are also necessary, as well as two sets of announcers, one at the Hotel Kimball studio, Springfield, Mass., and another at the Hotel Brunswick studio, Boston. Two program directors have plenty to do, one stationed in Springfield and the other at Boston.

The station also has to have two program bookers, whose entire time is given to arranging the numbers and engaging artists for the WBZ programs

It may seem like an easy matter to keep these two studios working smoothly together. It is not as easy as it looks. Have you noticed how many stations say, "One minute, please," and then wait half an hour (or so it seems)? That happens when there is only a single studio and one director to get his talent together. How many more chances there are when the tubes are separated by 100 miles! And yet, you will find that usually only a second separates the signing off of the director in Springfield and the "signing on" by Boston.

Do Their Own Printing

A printing room to get ready the publicity releases is a necessity also. Every popular station has to send out its programs to the various newspapers all through the country. This information printed on so-called "clip sheets" carrying stories and programs of the station, are mailed to every large city and town in the country, reaching 1200 newspapers and magazines.

There are many other interesting points, but the last to be mentioned is the consistently long range of the station. Its longest confirmed reception was in New Zealand, some 12,000 miles away from the transmitter. This point is almost half way around the globe from Springfield. Undoubtedly radio waves went both east and west to get there and met at the receiving aerial. It will be remembered that one-fourteenth (1/14) of a second is all that is needed for a program to snap half way around the world. This station is heard every night in every State of the Union and every Canadian province. Within recent months the fan mail has brought in from 25 to 50 letters, each from the British Isles, Belgium and France. WBZ gets in to Central Europe with consistent success.

The Westinghouse broadcasting system spans the entire country, and in times of national events the whole nation can be covered with a radio broadcast, with WBZ at Springfield, Mass., KDKA at Pittsburgh, Pa., KYW at Chicago, Ill., and KFKX at Hastings, Neb. They are equipped with short wave apparatus and inter-communication to effect a national radio service of excellence is a reality.

MAKING 8 = 50

"The Smallest Symphony Orchestra," otherwise known to millions of music-lovers as Bernard Levitow's Hotel Commodore Orchestra, presents a Sunday Evening Concert every week from station WJY. During each concert it is estimated that more than one hundred dollars is placed in jeopardy throughout the country. Within the past few weeks of the broadcasting of the popular orchestra a surprising number of letters asking information as to the number of musicians under Mr. Levitow's baton is responsible for the estimate. Twenty or thirty wagers of ten cents to 15 dollars are settled by the answers each week.

One of the queer tricks of radio is the illusion of vast numbers produced by a few instruments advantageously placed before the microphone. During the three years of WJZ and WJY broadcasting by Levitow's Orchestra they have learned the peculiar demands of the "mike", and that, coupled with the special arrangements made of the great classics by Mr. Levitow, make the eight men seem like sixty to the listeners.

American Radio Relay League

COUNT THEM—ELEVEN

While broadcast listeners have been busily engaged in listening for European stations, the original DX men—amateur radio telegraph operators—have been just as intent in their efforts to communicate with foreign amateurs. They were the first to show an interest in international radio, and they continue to make and break records with unfailing enthusiasm.

Unlike the listening fans who turn their dials in the hope of getting fragments now and then from a faraway musical program, the amateurs go out for what they think is bigger game—personal communication through the medium of the International code. There is no special test period for them as there are now so many foreign operators that they can be picked up every night. The American Radio Relay League is receiving reports of this nature constantly.

Denmark's First Message

For example, the other night D. C. S. Comstock, an amateur radio operator of East Hartford, Conn., was tuning in on his set and he heard a strange call which he identified as a Danish station, the first to communicate with this country. Comstock received a message for the A. R. R. L., as follows. "Greetings from the first Danish amateur across." Hiram Percy Maxim, president of the A. R. R. L. replied through Mr. Comstock with this message: "Sincere congratulations. Hope that we communicate often."

With the addition of Denmark, there are eleven foreign countries whose amateurs have communicated with operators in North America. In many of these countries the development of amateur radio has been inspired by the work of U. S. and Canadian hams. The list is as follows: England, France, Italy, Holland, Scotland, Denmark, Australia, New Zealand, Mexico, Argentina and Chile.

HE WINS THE PANAMA

Amateur radio telegraph signals, starting from the Pacific coast, have succeeded in reaching nearly the tip of the South American continent, according to an announcement of the American Radio Relay League. A message from Maurice E. McCreery, manager of the League's Pacific Division, states that four western amateurs have communicated in both directions with an amateur radio station in Chile.

Many western operators, who helped to keep in contact with the McMillan Arctic expedition in the Far North, are now enthusiastic in their desire to get in touch with amateurs in some of the South American countries. This new interest in the chance of frequent contact with brother operators in the Latin American field is credited to the unusual success of the recent Pan American radio tests.

He Spoiled That "Chilly" Joke

The first amateur to work the Chilean station, according to McCreery, was Glen A. Litten of Orange, Cal., while the others were McCreery himself, whose station is in Los Angles, Willian L. Williams of Pomona, Cal., and Robert W. Kennedy of Riverside, Cal. These men are credited with having made the best South American records since the work with Argentina.

Amateurs in Chile have wanted to pick up operators in the United States for a long while, and a prominent experimenter of that country recently announced that he would give a genuine Chilean hat to the North American who turned the trick. It is expected this hat will be given to Litten in the near future.

SENDING FROM THE BIG SHOW

One of the big attractions at the Chicago Radio Show, held at the Chicago Coliseum, was the exhibit given by E. T. Flewelling of amateur station 9XBG, who set up his station for broadcasting and handling messages for visitors.

The most unique feature of the experimental station was the fact that the entire equipment, from the current supply to the antenna and counterpoise was located entirely in the building. The transmitter was a 100 watt set, broadcasting on 3,750 k. c. (80 meters), and operated entirely from power supplied from storage batteries.

SHE TALKED TO 250 STATIONS

L. W. Eberle, Acting Secretary of the Navy, has given out an interesting report from the Commanding Officer of the U. S. S. Shenandoah on the ship's transcontinental flight. In it he stated that radio communication had been established with nearly 250 amateur and commercial stations in thirty-nine states. The ship was never entirely out of communication with some station on the short wave, he said, even in the remote section of the southwest. The announcement was made in a letter to Hiram P. Maxim, President of the American Radio Relay League of Hartford, Conn. It reads:

"No mention has been made so far of the great assistance rendered by the hundreds of amateur stations throughout the United States who relieved the Shenandoah of a great amount of work that would otherwise have been necessary on the high-power set. This work was conducted over the extra-short wave transmitter and, although in several instances communication was not entirely satisfactory, due to fading, etc., it was found that there were enough stations so that good signals could almost always be exchanged over the short waves. The amateur stations worked are so numerous that we cannot mention each one, but it may be stated that satisfactory communication was carried on for about eighteen hours out of twenty-four during each day. Even while flying over the mountains and deserts of New Mexico and Arizona, it was possible to keep up the conversation.

"During the flight the Shenandoah flew over twenty-five states and the District of Columbia. The states flown over are as follows: New Jersey, Delaware, Maryland, Virginia, North Carolina, South Carolina, Georgia, Alabama, Mississippi, Louisiana, Texas, New Mexico, Arizona, California, Oregon, Washington, Arkansas, Missouri, Tennessee, Kentucky, Illinois, Indiana, Ohio, West Virginia, and Pennsylvania. Approximately 250 amateurs and commercial stations were worked in thirty-nine different states, and also in Mexico and Canada.

Chicago Puts It Across

Highlights on The Biggest Radio Show in History

By CAL HARRIS

THE report of the Third Annual Chicago Radio Show, which has just been made public, proves that this season's exposition was by far the most successful ever held in this country, not even barring the recent Radio World's Fair in New York City. The total attendance here for six days (173,000) almost equalled that of the Gotham show for seven days (175,000).

The wholesale business transacted by the 239 exhibitors here was very large. They booked over $6,500,000.00 worth of orders.

Who Says Radio is a Fad?

Strange to say, most of the business was done by the younger and smaller concerns, since fourteen nationally known manufacturers went in to the exposition oversold for 1924-1925. This was due principally to the large number of orders which they took at the First Radio World's Fair, and consequently were unable to accept any new business at the Coliseum.

They Had to be Locked Out

The enthusiasm displayed by the exhibitors and patrons of the big show was extraordinary. The intense interest was sustained right up to the closing night, which was just as lively as the opening day. Several times during the week the Management was forced temporarily to discontinue ticket selling because of the crowded condition of the huge hall, and when the curtain was rung down at midnight on Sunday the Coliseum was still packed to the doors.

The smoothness with which the enormous spectacle was carried off was indeed amazing. The manufacturers, who exhibited, showed their deep appreciation of the good work of the management, by subscribing right away for four fifths of all the available exhibiting space in the Second Radio World's Fair, which will be held in New York next September. Signed applications for 148 booths in next year's show were presented to General Manager Kerr, with appropriate ceremonies, on the third day of the exhibition.

Close to 5,000 jobbers and dealers from all parts of the world attended this year. The mammoth hall was almost as crowded during the daily "Wholesale Buyers' Hours," from 11 A. M. to 1 P. M., as it was when the doors were open to the general public.

$2000.00 From West Australia

The DX Instrument Company, Harrisburg, Pa., won the Silver Cup awarded to the exhibitor securing an order from the most distant point from Chicago. This company sold a bill of $2,000 to the Australian Radio Corporation, Perth, West Australia. The runner-up in this unique competition was the Westinghouse Union Battery Company, Swissvale, Pa., who landed a good sized order from John Chambers, Ltd., Hobart, Tasmania. Another case was the Utah Products Company, Salt Lake City, who booked an order from a Melbourne, Australia concern; while the J. T. Boone Corporation, Detroit, sold considerable equipment to the United Distributers, Ltd., Sydney, Australia. Orders numbering 984 were entered from European countries and close to 1,400 orders were taken from dealers in Mexico, Central and South America.

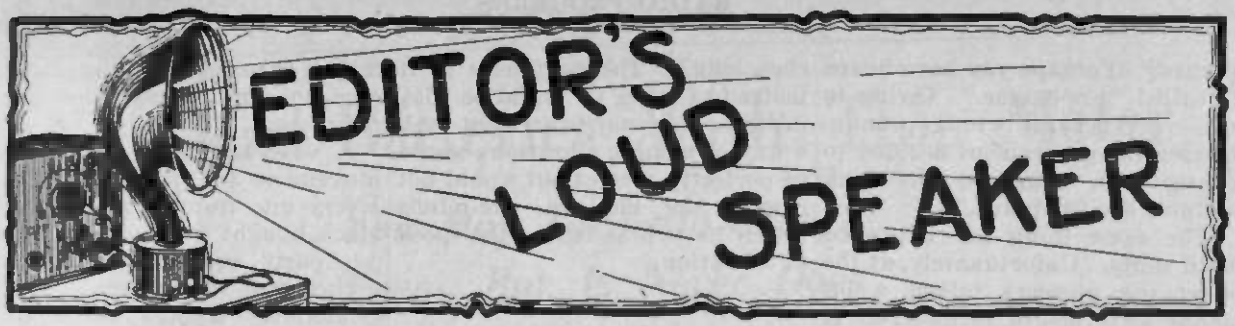
Several unusual features were introduced in the "New Inventions Section" and the "Foreign Exhibits," which, together with the famous Flewelling Short Wave Broadcasting Station 9XBG, attracted many thousands to the second floor of the South Annex.

Who Carried off The Cups?

Three handsome silver cups and one "Honorable Mention" were awarded for inventions. They went to; Miss Gail Savage, Brooklyn, N. Y., in recognition of her combined Amplifier and Loud Speaker; The Celotex Company, Chicago, for the superior qualities of Acousti-Celotex for acoustical control of sound; and Paul B. Armstrong, Chicago, because of the excellence of his "Armstrong speaker." Oscar Ryan of Chicago was given an "Honorable Mention," on his "Ryan Diaphragm."

One outstanding feature of the show was the appearance of Miss Edith Bennett, the young American concert star, who was acclaimed "The World's Finest Radio Singer" by a special jury of radio-musical experts. Miss Bennett was one of the "Guests of Honor" at the Exposition, which she officially opened and closed, assisted by George D. Hay, "The Solemn Old Judge" of Station WLS, who was recently nationally elected "America's Most Popular Announcer." On the final night the pretty soprano was presented with a Silver Cup and a Gold Medal on behalf of the Exhibitors and Management.

In an interview General Manager Kerr said: "The extraordinary success which has attended the New York and Chicago shows has convinced me that radio is one of the most important industries of the age. Because of the unlimited possibilities of the new science and the rapid advances which are being made almost daily in every branch of it, I feel positive that interest in radio will increase rather than diminish during the next decade. It will soon be on the same plane with the Automobile Industry, unless I am badly mistaken, and radio will play even a more important part in the lives of the people of all countries.



THOSE CHRISTMAS LISTS

If you are like the average American about this time you will be seen some afternoon dashing wildly about in the shopping district, with packages of peculiar shape and size under your arm. Of course. no one will be able to guess they are to be Christmas presents.

Or perhaps you are one of those calm and collected individuals who did your shopping in November and look down with a supercilious smile on the careless mortals who have let their shopping go until the last minute. If you happen to remember that there are several of your friends who have not been provided with suitable presents, it will be well to recall that something in the radio line is welcomed by almost everybody these days.

Most Sets Can Be Improved

If your fortunate friend does not happen to own a radio at all there is a choice of a great many models starting with a crystal set at $2.00 or $3.00 and running the entire range up to $425.00 for a built-in superheterodyne. So many people already have instruments that you can very likely consider some improvement which can be applied to the set which he already has. A good extra pair of phones always comes in handy. Then there is the low loss condenser. There are mighty few sets more than six months old which could not be improved quite a bit by substituting some of the modern types for the style of condenser which was in use up until recently.

The aerial is another point of attack. If your friend used bare copper wire a year or more ago, it is more than likely it will have corroded rather badly by this time and a new length of aerial wire will be welcomed to substitute for the old one. Some of the newer forms which use a large number of small wires which are insulated one from the other, will likely improve his reception.

The Best Gift of All

But perhaps there is someone in the office who has the latest thing in the way of equipment, to whom you wish to give an especially nice present. We can suggest just the thing—it is a year's subscription to RADIO PROGRESS. For your son, who is getting to the age where he likes to understand why his instrument operates, nothing will be more appreciated than a year's subscription to RADIO PROGRESS. Then there is your Aunt Jane, who lives in California. You will want something which will interest her, as she likes to keep up with the world. For her, the best thing undoubtedly would be a year's subscription to RADIO PROGRESS.

Perhaps you have noticed a kind of sameness to the Christmas shopping list. As a matter of fact, you will find that you can use RADIO PROGRESS as a present to almost any one of your friends, man or woman, who seems to be unprovided for. The reason is that it is written particularly for people who are intelligent and interested in radio, but do not have a very great amount of technical engineering experience. For any such you will find that it is hard to think up a gift which will have so great interest throughout the entire year at such a small expense. For your benefit we are printing a subscription blank, which you can use conveniently.

USING SPEEDS, NOT METERS

As any new art develops you will notice a change in the names which are in common use. Get out an old automobile magazine and you will see that they talk a lot about "horseless carriages." Another line where a change is now going on is that of flying. A few years ago you spoke of "aero-

planes." Perhaps you have heard it called "a-re-oplane." Owing to this very general wrong pronunciation the government decided to change the name to the much simpler one "airplane."

The same thing has happened with radio. Unfortunately, at the start the pioneers talked a lot about wave length in meters. If one is going to talk about lengths, it is an advantage to talk in meters rather than yards, since all the world, except England and United States, uses that unit. And furthermore, a meter is divided into 100 parts instead of 36, just as a dollar is divided into 100 cents. But it is unfortunate that the rating of stations was expressed in length at all. It is hard for any one, even an experienced engineer, to get much of a picture in his imagination when you talk about 360 meters.

We All Know Vibrations

Everyone has seen the pendulum of a clock swing back and forth. If we say that is goes once a second, even a child grasps the idea immediately. When you hear a watch ticking you naturally mention that it goes five times a second. The lowest tones of a big organ cause the air to vibrate so slowly that you can almost feel as well as hear the tone. It will have a frequency of twenty cycles a second. As we go up the scale we find that the ordinary city lighting current, which is furnished for your electric lights, vibrates up and down with a speed of sixty cycles. Another step takes us to middle C as played on a piano. This oscillates back and forth 256 times a second. All these various vibrations are rated in times (cycles) a second. And as such they are easy for any one to understand.

Suppose instead we used the corresponding length to explain what we were talking about. Instead of saying the clock pendulum went once a second, we would note that the pendulum length is 39 and a fraction inches long. Instead of calling the note middle C we would say "the note of a string 27⅜ inches long." The next note to it instead of being D, would be 26⅝ inches. It is easy to see that such a way of naming vibrations would be perfectly correct but would not convey the idea to our minds nearly as well as telling the speed of vibration.

Meters in Broadcasting

The same thing holds true when we talk about the sending station. If you tune to a transmitter which oscillates just one million times a second, then it will happen to send out a wave length of 300 meters. But the essential part is the speed of vibration. Then why reckon this in a way, which, while correct, still is misleading and hard to understand. 360 meters happens to be the length caused by 833,000 cycles. Since it is more convenient to leave off all those zeros, we call it 833 kilocycles, or, shorter still, 833 k.c.

There is another advantage in forgetting the meters. The last Radio Conference in Washington has assigned a lot of new frequencies and these are just 10 k.c. apart, that is, they run something like this: 1150, 1160, 1170, etc. When these are translated into meters it makes them come out at peculiar figures and besides this the number of meters difference between one and the next is not always the same but keeps varying.

The Government Recommends It

Because of these various advantages the government recommends that all station ratings should be given in speeds of vibration, (k.c.) instead of meters. For that reason, in the future we shall print the k.c. of each broadcaster in our articles and follow it in parenthesis by the meters, until the time comes when everyone talks in kilocycles instead of meters.

SETS BEATING PARTS

It is interesting to watch the general tendencies in a new line like radio. This year has seen a strong leaning of the public towards buying complete sets rather than parts. This can be seen in almost any good sized radio store.

A year ago there was a great movement to "Roll your own." Every one from banker to bootblack bought a lot of miscellaneous parts and hooked them together into what he called a set. Sometimes it was one. More often it could be called a musical instrument only by courtesy, and a good deal of courtesy at that. Sometimes the more tubes and the greater the complication of the hook-up, the poorer the signals came through.

"Stick to Your Last"

The advice to the shoemaker, "Stick to your last," seems to apply pretty well to radio building. If you are the sort of person who has driven an automobile for several years, yet doesn't know what the clutch clutches, or why the radiator radiates, then don't try to build your own radio set. But if you are mechanically or electrically inclined, so that you know something about how and why an automobile runs, you should be able to put together a receiving set which will work very well indeed. Even if you do not build your own set, you may be interested in knowing how and why it works. You probably did not make your own auto, but you are interested in the details of its operation.

We believe that the tendency for those who are not electrically inclined to buy complete sets is a good one. There is not much chance for such a person to make any startling discoveries in the art.

He will, on the whole, be much better pleased with a factory built instrument. Those on the other hand who delight in making things, and in seeing what makes the wheels go around, will continue to get a great deal of satisfaction out of building their own sets, and may make some worth while discovery.

No Dead Batteries With This Meter

You May Forget to Charge Them, But It Never Does

By VANCE.

LAST night we went to call on our friends, the Jones. Mr. Jones has recently bought one of those wonderful sets, which pick up stations 3,000 miles away, rain or shine. We were naturally very much interested to have him show how it worked, but when he pulled out the battery switch, the tubes lit up with a dull, sickening glow. The battery was dead.

This sort of thing happens so often that there has been some inquiry for a device which would give warning in time, so that such a calamity may be avoided. Of course, a hydrometer, when used on a storage battery, gives a pretty good indication of the amount of charge, provided that everything inside the battery is normal. That is, the hydrometer does not measure the charge itself at all.

What the Hydrometer Tests

As a matter of fact, what the hydrometer does is to weigh the liquid. A cubic foot of water weighs 62½ lbs. When the hydrometer reads 1.2 it means that the weight of one cubic foot of the electrolyte weighs 1.2 x 62½, or 75 lbs. Similarly, if it reads 1.3, it indicates

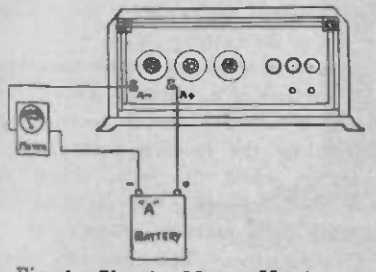


Fig. 1. Simple Meter Hook-up

that the liquid is 1-3/10 times as heavy as water. That is all the hydrometer knows—just a comparison of weights.

It is found by experience that when a battery is charged and discharged the liquid around the plates changes its weight. When fully charged the liquid is heavy, and when discharged it gets a great deal lighter. Taking advantage of this fact we say that when it weighs a certain amount (1.3 times the weight of water) then the plates are fully charged. This is probably true for we assume that nothing has gone wrong with the battery, and by the same token, when the ratio has dropped to 1.15, then we assume that the battery is fully discharged.

Fooling the Hydrometer

To show how unreliable these readings are, unless the battery is in good shape, you can try this experiment. Charge a battery up until it will take no more and the hydrometer reads about 1.300. Now dump out some of the solution and replace with water. The reading will be much lower, say 1.150, which on the scale is completely empty. The hydrometer reads this, but you will find that the battery plates are charged just as full as before—no change has taken place in them.

This is a trick known to some unscrupulous service stations. If you take your battery to such a place they may need a new rental for themselves. It is a simple matter to take your battery, which is really fully charged, into a back room and replace some of the liquid with water. You can then read the hydrometer yourself and see that the battery would not take a charge. When you have bought a new one, it is easy for them to put the acid back again, and, presto! they have another rental battery on their shelves. Your only protection against such practices is to trade with reputable service stations.

You Can't Fool This Meter

There is another type of instrument which can not be fooled in any such way. It is the Amperehour meter. An Ampere hour (abbreviated to A. H.) you will remember, is equal to one ampere flowing for one hour. Thus five amperes for six hours, or fifteen amperes for two hours, both give thirty ampere hours. The ordinary size of "A" battery used in lighting vacuum tube filaments is rated at 90 A. H. This will give an output of one ampere for ninety hours, two for forty-five, etc. The ampere hour

Fig. 2. Notice Two Pointers

meter measures this quantity so that at a glance you can tell the number which has been taken out of the battery. When it is put on charge this meter gradually shows less and less as the hand creeps up to the "full" or zero position. When the battery is discharging the hand travels in the opposite direction and, if you are using say 5 amperes, will indicate five at the end of the first hour. ten at the second, etc.

This convenient and accurate means of checking the condition of his batteries is now given the radio owner by the development of a radio-battery meter, by the Sangamo Electric Company. This meter operates on the same principle as other Amperehour Meters made by this company, which are used extensively on commercial and industrial storage-battery applications of all kinds. It is of

simple construction and may be relied upon to record accurately for years.

To appreciate fully the value of such a meter, just recall the great inconvenience and messiness which attends the taking of hydrometer readings. It is because of this nuisance that the radio owner, being human, neglects to check his batteries each day with the result that he often finds them down and out as we have described. Even when taken, hydrometer readings should be corrected for temperature, height of electrolyte and the amount of acid lost by spilling, gassing or combining with the sediment in the bottom of the jar.

Fig. 3. This is Part That Spins Around

Don't Run Down Cellar

The connections of this instrument are seen in Fig. 1. It is really unnecessary to draw such a hook-up because it is so simple. The meter is cut into the main line, running directly from the battery. If your battery is in the cellar it is convenient to put the meter upstairs on the wall near the set. Then it is unnecessary to go down stairs at all to check it until the instrument upstairs tells you to.

A photograph of the meter itself appears in Fig. 2. Notice that there are two pointers or hands on the face of the dial. One of them is black and turns to the right or left depending on whether current is leaving or entering the battery as just described. When the meter is first installed the other hand, colored red, is set to the position showing the capacity of the battery. If this happens to be a 100 ampere hour unit, the red hand will be pushed down to 100 as Fig. 2 shows. It stays there indefinitely without any further movement.

When the Pointers Get Together

When you light up your tubes, by turning the filament switch, the black pointer immediately gets busy and crawls around to the right indicating the ampere hours, as they leave the storage battery. When you snap off the radio set, the pointer stops again. This action continues until the black hand reaches the red one. That means it is time to charge your cells again. Of course, a battery getting empty is not quite like a gas tank running dry on your auto. When that happens you can't run the machine another foot until you replenish the supply.

The action of a storage battery is more like the way your tire acts. When the pressure in it drops to say 45 lbs., it is time to give it another dose of air. But if you neglect to do so you can run it a great deal farther without noticing any particular happening. Of course, you realize all the time that in running a tire with the pressure too low you are shortening its life considerably, although you will not know about it until several months later. In the same way if you continue to work your radio very much after the black hand has passed the red one you will not see anything especial occur, but you will know you are shortening the life of your battery.

It Knows When it is Full

In the olden days it was said that many a man did not know when he was full. But this meter has a switch inside the case and knows when the battery is full since at that point this switch is closed. By connecting up a circuit breaker to the switch the operation of cutting off the battery from charge can be accomplished automatically. This applies to those insulations where the battery is charged at home. This switch, of course, need not be used unless the automatic feature is wanted. The fact that the black hand points to "full" shows that the charge has been on long enough.

Here an apparent difficulty is seen. No battery is 100% efficient. If you put in 100 A. H. all you can get out is 95 when the battery is new and with an old one the output may drop off to 90 or 80. How is our meter going to take care of such a case. If it tells us to shut off the charge when we put in only as much as was taken out, then eventually the battery will starve to death from lack of current.

Caring for the Leaks

Concealed in the body in the instrument is a little device which takes care of this leakage of energy. When the battery is on discharge the meter reads accurately the number of ampere hours which flow out. But when the current is reversed on "charge" a small amount of resistance is cut into the recording circuit so that a small extra percentage of current must reach the battery beyond what is shown by the meter dial. This device for regulating the amount of extra current on charge can be adjusted to give ten to twenty percent overcharge, as is thought desirable for the condition of age of the battery.

It may be of interest to see the general construction of a mercury meter. It is called a mercury meter because after assembling the moving parts inside a chamber, which fits quite closely, the disk and shaft (Fig. 3) are floated by pouring in a quantity of pure mercury or quick silver. This has two advantages. In the first place it serves as a contact for carrying the current from the stationary part, where it enters, across to the movable part. In many direct current instruments, you will find small contacts, or brushes, which rub against the shaft as it turns. These brushes carry the current into and out of the rotor. Naturally, they have the

disadvantage that they cause a lot of rubbing friction and furthermore they are apt to wear and cause a change in the accuracy of the meter. When mercury is used to conduct a current you will see that the friction between it and a moving shaft, is nearly zero. Besides this, the mercury never wears out and so does not have to be renewed.

A Disk That Has No Weight

Of course, the disk and shaft really weigh something, but as far as the bearings are concerned, their weight is practically zero. This is because the mercury floats the moving parts to such an extent that the pressure of the rotor is not down at all, but 1/10 of an ounce up. Just think, you could send ten times the weight of the whole moving element on its bearings through the mails for two cents.

The rotor is assembled inside an insulating case, as shown in Fig. 4. Since the disk can not be seen (it is submerged in mercury) a little counter weight is fastened to the top of the shaft. A white line on this counter weight can be seen to revolve when the meter is in motion. A window is left in its face so that the counter weight can be seen from the outside.

Powerful horseshoe magnets are used as a field to operate the mechanism. These magnets are removed from Fig. 4, but the round bosses where they go can easily be seen.

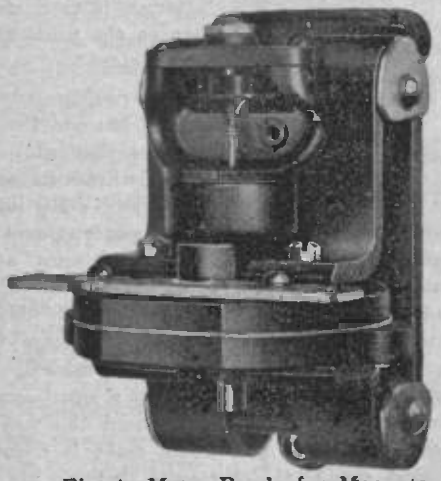


Fig. 4. Meter Ready for Magnets

Resetting the Meter

Referring once more to Fig. 2 you will see in the lower left hand corner a projecting handle. This is used to reset the meter needle in the rare cases when something unusual requires a special charge. For instance, suppose a tool were accidentally dropped across the battery terminals, thus short circuiting it. If this short circuit were left on long enough, the battery would certainly need recharging, but since none of this current had gone through the meter, the latter would not indicate properly that a recharge was needed. In such a case the key would be used to change the meter needle to correspond with the correct condition of the battery.

BROADCAST BILL AT THE CRACKERBOX CLUB

At the Crackerbox Club
When the gang meets each night
They discuss everything
From a flea to a fight.

If a radio theme
Is engrossing the crowd,
Broadcast Bill has his say,
And he says it out loud.

He has studied each quirk
Of a radio set
And he knows all the stations,
The best ones to get.

He's a popular chap
And the members agree
That they like him the best
(The reason you'll see).

—By Del.

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Dec. 1, 1924. RADIO PROGRESS.

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. Why are the coils of a neutrodyne put at such an unusual angle?

Answer. If the coils were set straight up and down as you might naturally think was the most obvious way of mounting them, then you would find that each coil sent considerable magnetism right through the center of its neighboring coil. The result of such an effect would be that each step of radio frequency amplification would have a feedback or regenerative action on the step before it. This would cause the set to break into radio frequency oscillations, which would be shown perhaps by squeals, or, if not, at any rate by bad distortion of the signals. It is found by experiment that if these coils are tipped at the correct angle, then the magnetism from one will cross its neighbor not along its axis, but just at right angles. In this case the magnetic flux will have no effect on the neighboring coil, since there is no part of it which has any tendency or component either up or down through the winding. It should be stated, however, that the angle at which the coils are set, is correct only for a definite distance between units and if this distance is altered very much you will find that the set is no longer neutralized.

Question. How many arms should there be in a spider web coil?

Answer. The number of arms does not make very much difference in the operation of the unit except for one thing. That is, there must be an odd number of spokes. This odd number is required so that as the wire goes around it will pass first on one side and then the other of any given spoke. With an *even* number you will find that if it stops on top of a certain one, then when it has come around one turn more it is still on top of the same spoke. With an *odd* number on the other hand, if it starts on top, the next turn will be underneath, and next to that on top again

The more spokes there are in the coil the nearer will be the aproach of the turns to being circles. Thus with only seven slots the winding is quite noticeably not round. With say twenty-one, the wire turns are apparently circular. However, the larger number of spokes means considerably more trouble and labor in winding. For this reason a compromise is usually made and thirteen is quite a common number. This gives a satisfactory shape to the coil, and yet does not require too much time in winding on the layer.

Question. How can I stop my set from radiating?

Answer. There is nothing which can be added to a radiating set to cut down this feature, which annoys the neighbors so much, short of adding another tube. If you are willing to put on one step of radio frequency, then this can be made if properly designed, to act like a turn-stile and allow energy to flow one way, but not the reverse. There was recently a prize contest conducted by one of the radio publications and although many devices were submitted for test, it was found that not one of them was any use whatsoever, except the extra stage of radio frequency ahead of the detector.

To be sure, there are a number of things which will reduce the radiation, but they all cut down the signal which you want in the same proportion. For instance, by putting resistance in some part of the circuit, it is easily possible to cut the radiation down to half. Unfortunately, the music is reduced to half also. If you have a radiating set, the best thing to do to operate it, if you do not want to go to the expense of the extra tube, is to be sure that you keep the tickler turned down low enough so that it does not cause the detector to oscillate. Then you will not disturb your neighbors.

Question. I have a WD-11 tube detector which seems to work a great deal better on 16 volts of "B" battery rather than on the usual 22½. How can this be explained?

Answer. The only difference between the UV-200 and the old UV-201 lay in the fact that while the latter had as perfect a vacuum as possible (a hard tube) the UV-200 intentionally contains a very small amount of air. This gives a better detector action through the tube, but has the disadvantage that it makes it considerably critical as to the amount of voltage to be used on the plate. Undoubtedly your WD-11 tube also has a small amount of air left in it, although this was by accident. This would make it a soft tube and would require that you use a lower voltage on the plate than normal. Such a tube will give unusual volume on a local station, but does not always pick up distance as well as it might.

Question. I see talk of inspecting an aerial. Just what is meant by this?

Answer. If your aerial has been up long enough, and if it is made of bare copper wire, then the probability is that is has become covered on the outside with more or less corrosion. This is caused by the oxygen in the air combining with the copper to form copper oxide. This oxide is not a good conductor of electricity as the copper was before it became corroded. Since the high frequency currents travel almost entirely in the outside layer, or skin of the wire (so-called skin effect) you will see that a poor conductor at this point will cause the resistance of the aerial to increase. There is no remedy for such a corroded wire short of taking it down and discarding it. In its place we recommend using an insulated wire preferably one which has enamel insulation.

Question. How does it happen that there have suddenly appeared so many different kind of vacuum tubes on the market.

Answer. The chief reason is that some of the basic patents on tubes have just expired. As you know a patent is given for seventeen years, and during that time no one else is allowed to make either for himself or any one else any products which conflicts with its claims. Even if you are able to make a very important improvement on the device patented, while you may patent your improvement, still you can not manufacture it provided you must make the original article at the same time. Now that the expiration date for the basic idea has passed, there are a good many manufacturers rushing into the market with their tubes. Some of these are good, but some are quite inferior.

Question. Why is the word sometimes spelled "Antennae"?

Answer. This spelling is intended to be that of the Latin plural for antenna. It is affected by the kind of people who say, "An history." The best English spelling for the word is "Antennas," and we advise all those who do not wish to appear affected to adopt it. In this connection we might also point out that we say that such and such a program was *broadcast* yesterday, not that it was *broadcasted*.

New Products of Interest

A SELF-CLEANING SOCKET

In these days it is rare to find anything really new in vacuum tube sockets. There are so very many on the market that it would seem that every possible idea had been developed long ago. However, there just appeared a new style made by Crosley, which has some rather interesting points.

The material used contains hard rubber with enough filler to give a strong, rigid construction. The unusual features of this socket are, first that no screws are used in assembling the springs and second that peculiar shape of the springs. It has been found that in a great many cases ordinary sockets, in which the springs are held on by screws and nuts, will reach the purchaser in a condition which will require adjustment before using. In one manufacturing plant we know that the regular rule for sockets is that the first operation shall be tightening up the nuts and screws, which have become loose in shipment.

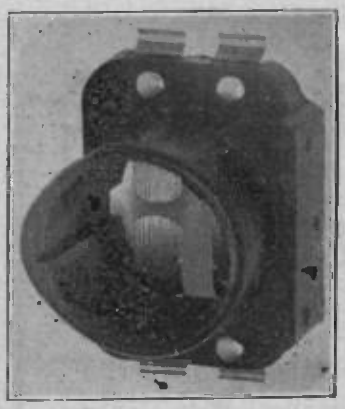

Fig. 1. Always Clean Contacts

In this particular model the spring contacts are well riveted in to the base which prevents any chance of their working loose under vibration. This feature can be clearly seen from the illustration, Fig. 1. Notice also that the springs are unusually wide and have several corrugations, or saw teeth cut into the end. The reason for these is found in the fact that many times the tips of the prongs in the base of the vacuum tube become corroded. These prongs have the lead-in wires soldered to their ends, and so the actual contact metal between spring and tip is composed of solder. The serrated ends of the springs act like a file and clean the oxide or tarnish off the ends of the prongs whenever the vacuum tube is inserted in the socket. In this way there is no danger of a poor contact between base and tube.

DISCOURAGING FOR THE LIAR

You all have met the radio romancer, who can get coast-to-coast reception every night, and who often times hears Cuba on a night when they do not run. By the same token it often happens that some of your choicest records are doubted by your friends, who cannot get the results which you do.

If so, you will no doubt be interested in a new idea which is being pushed by several companies. The picture, which is shown here, illustrates the product of the Phenix Box and Label Company, of Kansas City, Mo. The idea is to write to the distant station which you have just heard, (enclosing a reply envelope), and give enough of the program to prove that you actually did pick it up. In return they will send you, no charge, one of their poster-stickers. Three samples of these are shown in Fig. 1. Each sending station has its own particular stamp. Most of these are printed in blue and yellow and carry the slogan of the station as well as its call letters and a picture which fits the station.

When you paste such a stamp in your album, it proves to your friends that you really have heard enough of the program to identify the station without any chance of mistake. This is very different from thinking that you had Mexico City because words sounded like Spanish.

Fig. 2. This Proves You Heard Them

These stamps or stickers are not for sale and can be obtained only from the broadcasters themselves on proof of hearing the program. The albums are sold at 20c each by most of the sending stations and by the manufacturers.