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In This Issue:

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PUBLISHED TWICE A MONTH

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RADIO APPARATUS

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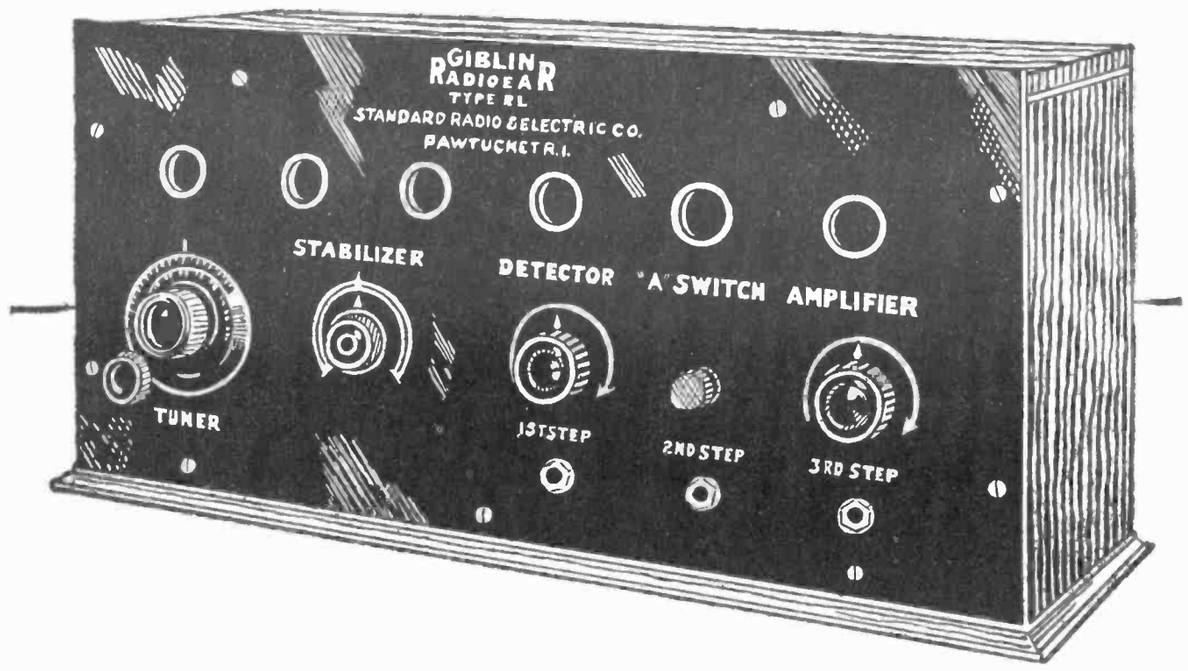
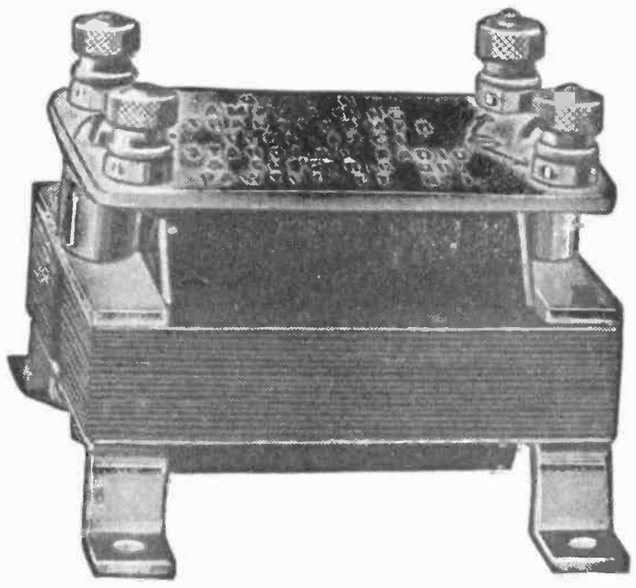


The set comprises two stages of radio frequency amplification, a detector and three stages of audio frequency amplification. The parts are mounted on a sub-base to which a Bakelite panel is attached. It is enclosed in a handsome solid mahogany cabinet.



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RADIO PROGRESS

HORACE V. S. TAYLOR, EDITOR

Volume 1 Number 22

Contents for

FEBRUARY 1, 1925

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WHY YOU WANT THE NEXT ISSUE

Nine-tenths of the sets use vacuum tubes. Do you know how they are made? A very interesting story comparing the five different styles is told by Bernard in **"How Vacuum Tubes Are Made."**

If you are interested in building a very successful radio frequency set, which is easy to control, you will want to read the construction article, **"Building the New Deresnadyne,"** by Marx.

Various rectifiers are on the market which charge the "A" battery, and some by an attachment will also fill up a storage "B." Most of such devices must be disconnected from the set while charging, or else there is danger of burning out the tubes. The "A"-"B" charger which has just been placed on the market will take care of both batteries and need not ever be disconnected from the set.

Your set will receive various wave lengths at the same time. That is why it is not as selective as you might wish. If this band were reduced you could cut out more interference. Goldsmith discusses this in, **"Chopping a Slice of Vibrations."**

Do you know the real difference between a volt and an ampere? Would you recognize a microfarad if you saw one? You will be introduced to all these electrical names by Taylor, in, **"Have You Met a Volt or Ampere?"**

RADIO PROGRESS

"ALWAYS ABREAST OF THE TIMES"

Vol. 1, No. 22 FEBRUARY 1, 1925 15c PER COPY, $3 PER YEAR

How to Wire Your Hook-Up

Kinks that Sharpen Tuning and Increase Your Range

By HORACE V. S. TAYLOR

THERE are two big problems in building a radio set. The first of these is what sort of a hook-up to use. Of course, part of this last question is answered at once by your bank roll. We do not advise building an eight tube superheterodyne if you have only $7.50 to spend on parts.

But after you have got some idea of the number of tubes you are going to have, there is still the question of which way to connect them. If you have followed the advance of radio for the last year or two you will know that there are a few good hook-ups and about 3952 variations on them which are not as good as the original. There are some very good reasons for the magazines continuing to publish a lot of foolish circuits.

Why the New Hook-ups?

One of them is that the public wants a lot of new hook-ups and so the radio editor sits down in his private office and tears off a few. Another excellent reason for the new schemes is that many of the editorial writers are heads of companies manufacturing sets, and it is a very inexpensive way of advertising to crack up your own set in the article which you write and then collect money for it from the publisher.

When you have finally made up your mind what kind of a set you mean to build there is still the question of putting in the wire. In a general way this may be obtained from published details in the better radio journals. For instance, see the "Hook-up Number" of RADIO PROGRESS (January 15, 1925) containing fifteen worth-while hook-ups which have been in use for a long while and have been found by the radio fans to produce good results.

Laying Out the Parts

Such diagrams usually do not show the exact location of every unit. As a matter of fact, it is probably better that

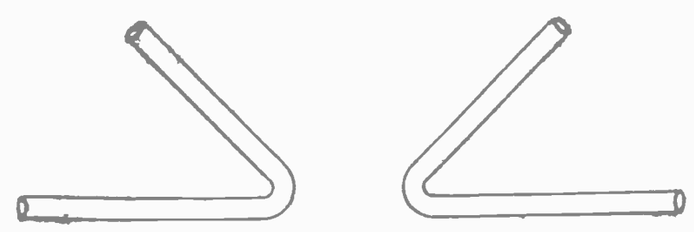

Fig. 1. Sharp Bends in Arrester

they do not. If you are building your set it is for one of two reasons. Either you are doing it for the pleasure and enjoyment which you get from "rolling your own," or else you wish to save money and so assembled it yourself instead of paying a factory to do that work.

If you are going into this construction work for the pleasure of creating something, then there is infinitely more satisfaction in arranging the parts and laying out the connections and units, than there is of making a Chinese copy of some other person's design. And if you do it to cut down the cost, it will be much cheaper to follow a general plan or hook-up than it is to copy line by line and wire the diagram drawn by some interested person who has parts to sell.

How the Units Vary

Take for instance, such a simple thing as an audio transformer. Some manufacturers bring the leads out at the side and some at the top. The primary connections will be at the left in some makes, while in others they will be located at the front and rear. It is impossible in making a sketch of the wiring of a set to show exactly how these leads go unless the particular brand of transformer is specified. And in following such a diagram the builder must buy the same kind of unit if he wishes the leads to be correct. That is where the factory man with an axe to grind gets in his deadly work. He will show a picture of a transformer with the primary leads at the bottom and the secondary at the top and tell you to buy "Blink's Best Bargain" transformer. Since you are following this construction you will have to invest in Blinks, even though it may not be a very good unit.

The best way out of this difficulty is to use hook-ups which show that one side of the primary of the transformer goes to the plate of the detector tube and the other side to the "B" battery. This information should be enough for you. You are now ready to put on your thinking cap and knowing that a straight line is the shortest distance between two points you are ready to run a wire as described.

Knowing How in Wiring

If you decide to follow this "intelligent" method, rather than the "copycat" scheme, it will be well for you to know some of the tricks of the trade and the wiring kinks, which will add miles to the range of your set.

In the first place, it is necessary to use lots of wire in a wireless set. There is a choice of bare, spaghetti covered or ordinary insulated conductor for hooking-up the various parts. Furthermore if you wish to use insulated wire there is a choice between the solid copper center and the stranded or braided

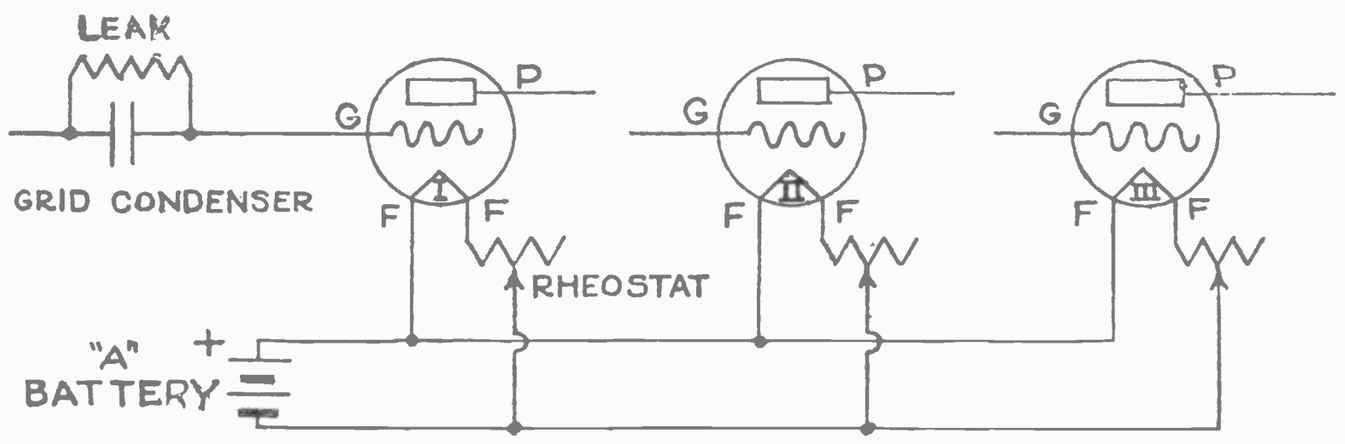

Fig. 2. Individual Rheostats Control Each Tube

cable, which is quite flexible. After you have done considerable wiring on a set you will agree with the manufacturers that solid wire is the only thing to consider. It will stay put when you have once bent it to shape, whereas the stranded cables are so very flexible and easily bent, that they quickly lose their shape and flop all around the set.

Whether to use insulated wire or not is a problem. Cotton covered magnet wire makes a very good connection. Some people object to it for one reason or another, but when you think that all your coils are wound of this material, it seems foolish to claim that a few extra inches in addition to the several yards in the coil will make any electrical difference in the set.

Busbar For Looks

The chief objection to ordinary magnet wire is that it is not very stiff. Of course, you can get such conductors up to very large sizes, but they are not usually used and are quite difficult to obtain. It is a better proposition to use a stiff heavier wire like busbar. This stays put and also looks very much better than the flimsy stuff which will not keep a straight line. When you are buying such busbar it is well to bend a piece in your fingers. If it is too stiff it means that the copper in it is not pure, and the resistance will be higher than it should be. Also it is difficult to make nice looking bends if the wire is too hard.

There is a choice of either round or square wire. The round is considerably easier to work with as no attention has to be paid to prevent twisting. For that reason many builders are using this style. A tin coating is a good thing on the outside of the bar, as it makes soldering very much easier. Of course, such a conductor has somewhat higher resistance because the high frequency travels mostly in the outside surface, (skin effect). The resistance of the connections is so low, however, that even if it were doubled it would still be lost in the shuffle.

The tinning on the wires makes solder stick fairly readily and so aids in making good joints. According to Hoyle, no soldering flux should be used, except resin. There are, however, two or

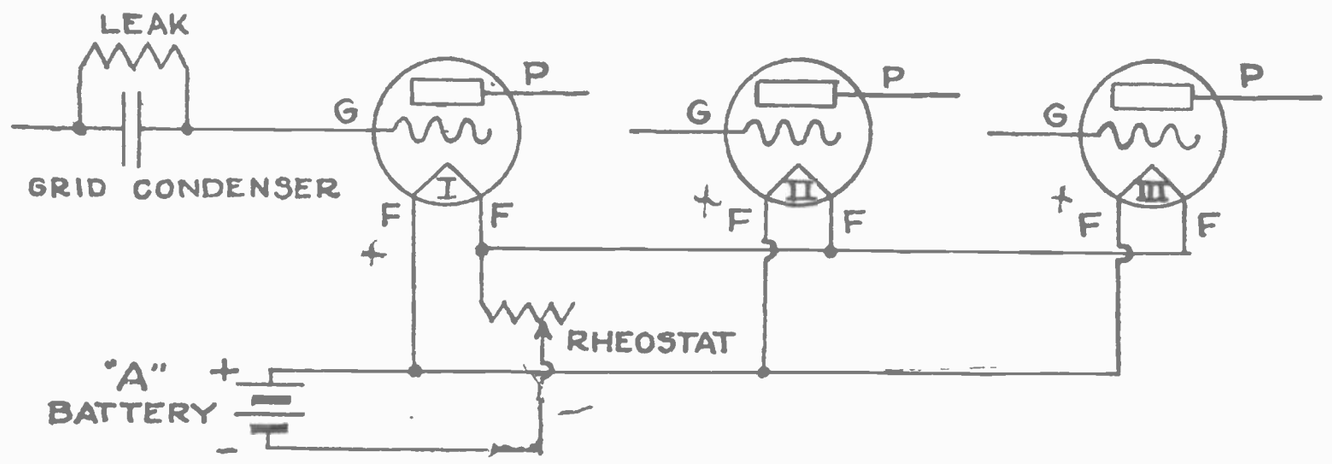

Fig. 3. One Rheostat Does the Work of Three

course, you can get such conductors up to very large sizes, but they are not usually used and are quite difficult to obtain. It is a better proposition to use a stiff heavier wire like busbar. This three liquid fluxes on the market which are powerful enough so that you can solder to iron or steel and yet are really non-corrosive. As a test a bunch of No. 40 copper wire (which is much finer than an ordinary hair) can be dipped into the flux and allowed to dry for weeks and still show no corroding. With such a flux it is safe to speed up the operation of soldering.

Care should be taken that neither flux or resin flows over a surface which is supposed to be an insulator. For instance, it would be very bad to allow any flux, no matter how non-corrosive, to get on the insulation of a low loss condenser. Such a substance is partly conducting and would act like a high resistance short circuit between rotor and stator plates. The condenser would be "low loss" no longer.

Bending the Wire

Another well advertised point is that sharp bends in a wire are dangerous. This is all wrong. If you use a pressure of 75,000 or 100,000 volts, you will find that points or sharp bends allow such a concentration of pressure that

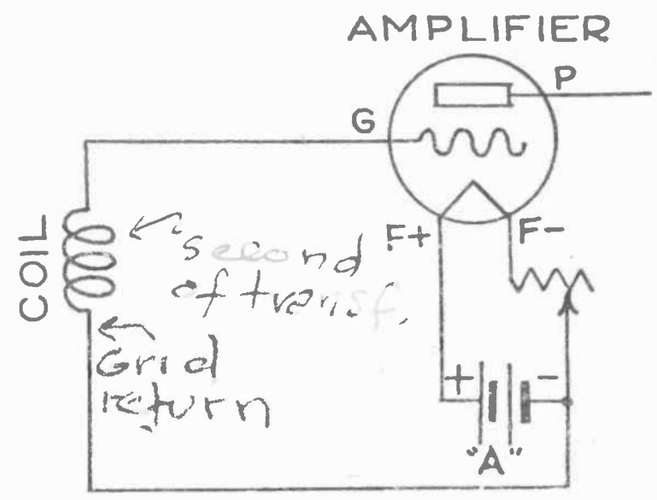

Fig. 4. Amplifier Grid Return

electrical leakage into the air will occur. Such high voltage power line will sometimes at night be seen to give off a bluish haze at sharp points or bends on the wire. For these tremendous pressures, it is necessary to use large radius curves.

When we come to the radio set with pressures under 100 volts, (under 1/1000th of a volt for radio frequency currents) then such effects absolutely do not exist. The sharpest needle point will not cause any losses at all.

When a fire engine is pumping water at high pressure through a fire hose, spectators are usually warned to keep away. If the hose should burst the high pressure might injure them. On the other hand, when a child is blowing soap bubbles it is foolish to think that the pressure through the pipe as he blows is likely to do any damage.

The same thing applies to the difference in pressure between 100,000 volts and 100 volts. The moral is bend your wire just as sharply as you like to make a good looking job.

Horn Gap Arrester

This principle of sharp bends is used in one of the simplest lightning arresters. Two large copper wires and bent sharply into horns as shown in Fig. 1. One of these is connected to the high voltage line, which will carry energy

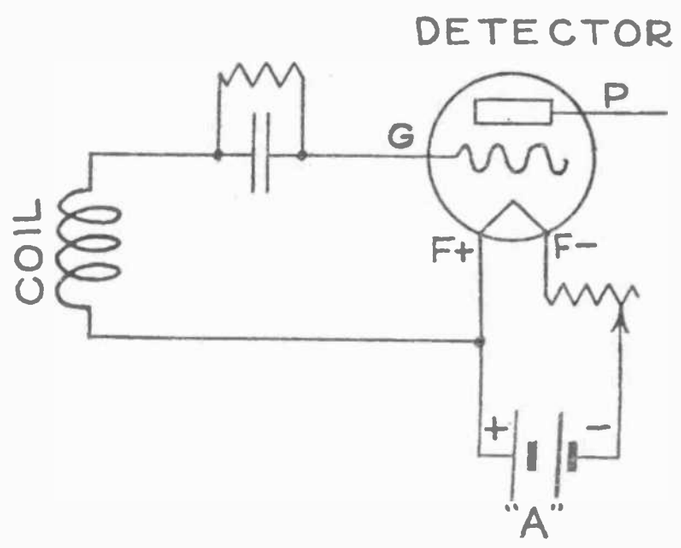

Fig. 5. Return of Detector

for perhaps hundreds of miles and the other is grounded. The spacing between the two horns is made great enough so that with ordinary voltages on the line no current passes. However, if a stroke of lightning should occur, so that the pressure increases to a point which might damage the line, then an arc will strike across the gap to the grounded terminal and this will pass the surge of pressure safely to ground without breaking down the insulation of any electrical apparatus.

The sloping, or upper part of the horn, is used to break the arc after it has been formed. Hot air tends to rise as you know when you examine an ordinary chimney. The powerful current jumping across the horns heats the air and this rising breeze blows the arc up the wire and so keeps increasing the length of the arc until it gets so long that it breaks and so is extinguished. But as already explained such an effect occurs only when the pressures are thousands of times greater than what you find on a radio set.

Omitting the Rheostat

Next let us take up the question of how many rheostats to use. Many diagrams, particularly the older ones, show as many of these units as there are tubes. Of course, such a hook-up will work perfectly, but you have considerable complication and expense in the wiring and also the set becomes so much harder to operate. The first tubes that came on the market a few years ago were very critical in their adjustments and were not at all uniform. That meant that each particular one had to have its own special voltage if it were to give the best results. Of course, in such a case individual control was necessary. The modern tubes on the other hand, are very much better. They are now built in such a way that there is a large factor of safety in the operation. An amplifier tube, designed for five volts, will work well all the way from four to six. Of course, when the pressure is run up above the rating, it shortens the life considerably, so it is an advantage not to exceed this figure. However, the potential may be dropped off by as much as 20% without causing any serious loss in the reception. With such a wide latitude it seems foolish to talk about the need for vernier rheostats on amplifiers.

A soft detector tube like the UV-200, is somewhat more critical. Even here, however, a variation of 10% may be endured without any trouble being heard in picking up the program. Since the latitude for the amplifier is so very broad, exceeding that of the detector, it is certain that when the latter has a rheostat adjustment which makes the voltage fall within the detector range, it will certainly be inside the correct amplifier band.

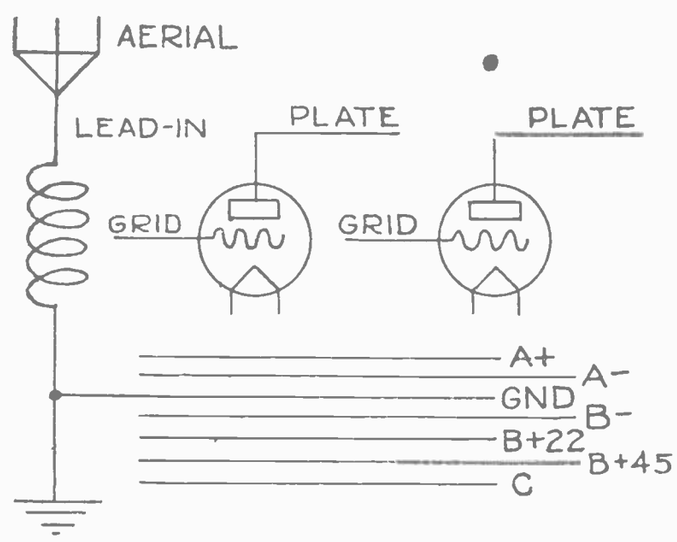

Fig. 6. These Wires Are Bunched

Changing the Hook-up

For that reason it is well to change a hook-up which calls for so many rheostats. Fig. 2, shows a typical wiring diagram for a three tube set using three rheostats. The grid and plate connections are not shown, as this discussion will apply to *any* kind of a set. Notice that the rheostats are shown in the negative side of the "A" battery. This is the better method of connecting them in case they are all used. However, if your hook-up shows them in the positive side the method of cutting their number down to one will be just the same. Fig 3 shows how the filaments are re-connected, so that they

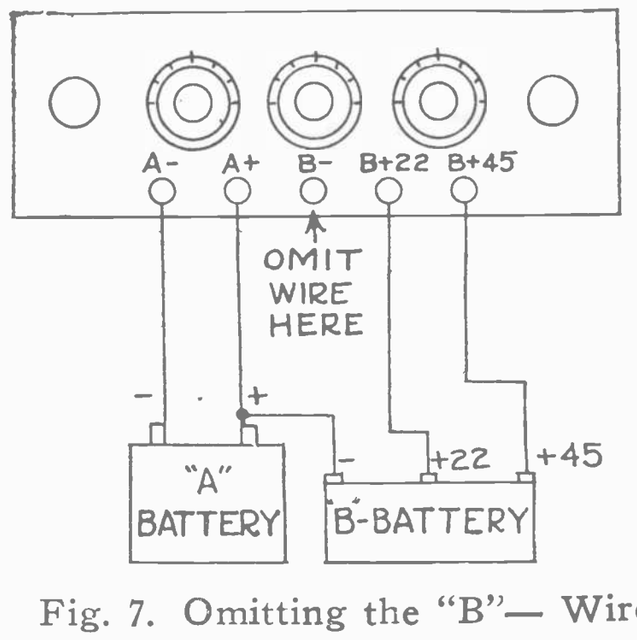

Fig. 7. Omitting the "B"— Wire

will all be controlled by a single unit. Here again this unit is in the negative line.

This is so that the proper grid or bias voltage may be applied to the amplifiers by connecting the grid return, which is one of the output terminals direct to the "A" minus. This allows the — voltage drop through the rheostat to be impressed on the grid.

The connections for this re-design are very simple. First hook-up the "A" battery, rheostat and detector tube in the usual way. If your set is already wired, then there will be no change so far. Now run wires from each of the other tubes so that the filaments of all three are connected together. It does not make any difference whether the terminal, which is sometimes marked F+ on the socket is actually the plus or not. In other words, the filament terminal, which is at the right of the grid, may be either plus or minus without effecting the operation of the tube.

No Laziness Here

By this connection you will see that one rheostat does the work of three. So you have saved two of these units, a lot of wiring, and also made the set so much easier to operate. The brightness

Continued on Page 29

Portraits of Popular Performers

Mrs. Smith and the Consul

her picture. Mrs. Edna M. Smith, of Springfield Gardens, Long Island, received first honors in the international broadcasting test by turning in verified reports of reception from Aberdeen, Paris, and Madrid several times on the loud speaker. Radio Broadcast, conductors of the test, announced her as winner of the silver cup. She used a five tube Freed-Eiseman Neutrodyne. The illustration shows Consul-General Alejandro Berea, of Spain, presenting her with the trophy.

A Different Kind

"Yes, ma'am, we keep can-openers," said the on-the-spot hardware merchant. "Here's one that's the best on the market. My wife uses the same kind for opening all her tomato cans."

"But, I don't want to open tomato cans," came the objecting voice of the inquirer. "I want to open California fruit cans."—*Good Hardware.*

THEY STOP WHEN YOU WANT MORE

"The Radio Franks" are past masters of close harmony. They have achieved national fame through their appearances before the microphone. They are giving short programs of new songs from WJZ on Wednesday evenings. The Franks—Messrs. Wright and Bessinger—are strong believers in the "short and sweet" rule for radio performers; their programs are never more than fifteen minutes long. The wisdom of their policy is evident to any radio fan who has heard them, for they always say goodbye when the audience wants more—and their next appearance is eagerly awaited. Also, with but fifteen minutes on the air, the songsters present only the cream of their songs, and never have to repeat old ones to fill up the time. Their study of "radio technique" is worthwhile, as is proved by their popularity. Their radio fame recently headlined them for two weeks at the Mark Strand Theatre, New York City.

CHAMPION FANESS OF U. S. A.

If the man who shines in broadcast listening is a fan we presume that the champion woman listener would be called a faness. At any rate, here is

One Half Hour's Entertainment in 15 Minutes

Silencing the Ether Squeals

The Engineers Wanted a Regenerative Set Without the Squeals

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

WHEN the last notes of a broadcast song die out, silence should follow. The charm of the piece and the pleasure of listening will both be reduced if during the "one moment, please," you hear undesired signals of any sort. Some of the causes of such unwelcome noises are man-made, and may even come from nearby receiving sets. It may seem odd, to the beginner, that other radios should be blamed for some kinds of interference, yet such is the case. As you know, there are conditions when many popular types of receivers are also feeble transmitters and may cause such interference. A discussion of this effect and of its complete and successful remedy is therefore of real interest to every broadcast listener.

The type of receiver which may squeal is known as the regenerative set and is very widely used. You can tell it by its "tickler" or "intensity" control handle, or the like. By turning this dial the signals become louder and louder as the tickler coupling or setting is increased until, finally, there is distortion of quality and then a howling or squealing note.

Playing Its Own Tune

If, when the tickler handle is adjusted so that this squealing or twittering note is produced from some station, the tuning handle is turned, then the notes heard go up and down the scale in a curious way. First a high note is heard, and as the tuning handle is slowly rotated, this drops gradually to a low tone and then fades into silence. Continuing to turn the tuning handle then brings in a low note again, which rises continually in pitch as the tuning handle is rotated until it is too high and shrill to be heard. When this effect is produced, the receiver is said to be in an "oscillating condition," and is, in fact, a feeble transmitter. All regenerative receivers have this same characteristic to some extent, whether they are of the single-circuit or of the two-circuit type.

The only style of regenerative receiver which, under no circumstances, causes interference with neighboring receivers is one which is guaranteed to be "non-radiating" by a reliable manufacturer. The internal adjustment of such receivers, as obtained from the factory, should not be disturbed by the listener. You might therefore ask, why do we use regenerative receivers? There are three excellent reasons:

Varying the Volume

1. Regeneration (or control of loudness by means of a "tickler" coil) is a very simple and extremely effective method of getting enormous amplification easily. It is also a good method of controlling the loudness of the signal. The economy in tubes thus realized is a point, too.

2. A regenerative receiver used with an antenna of proper size, and having the feedback tuned well up the scale, is very selective and reduces interference from other stations.

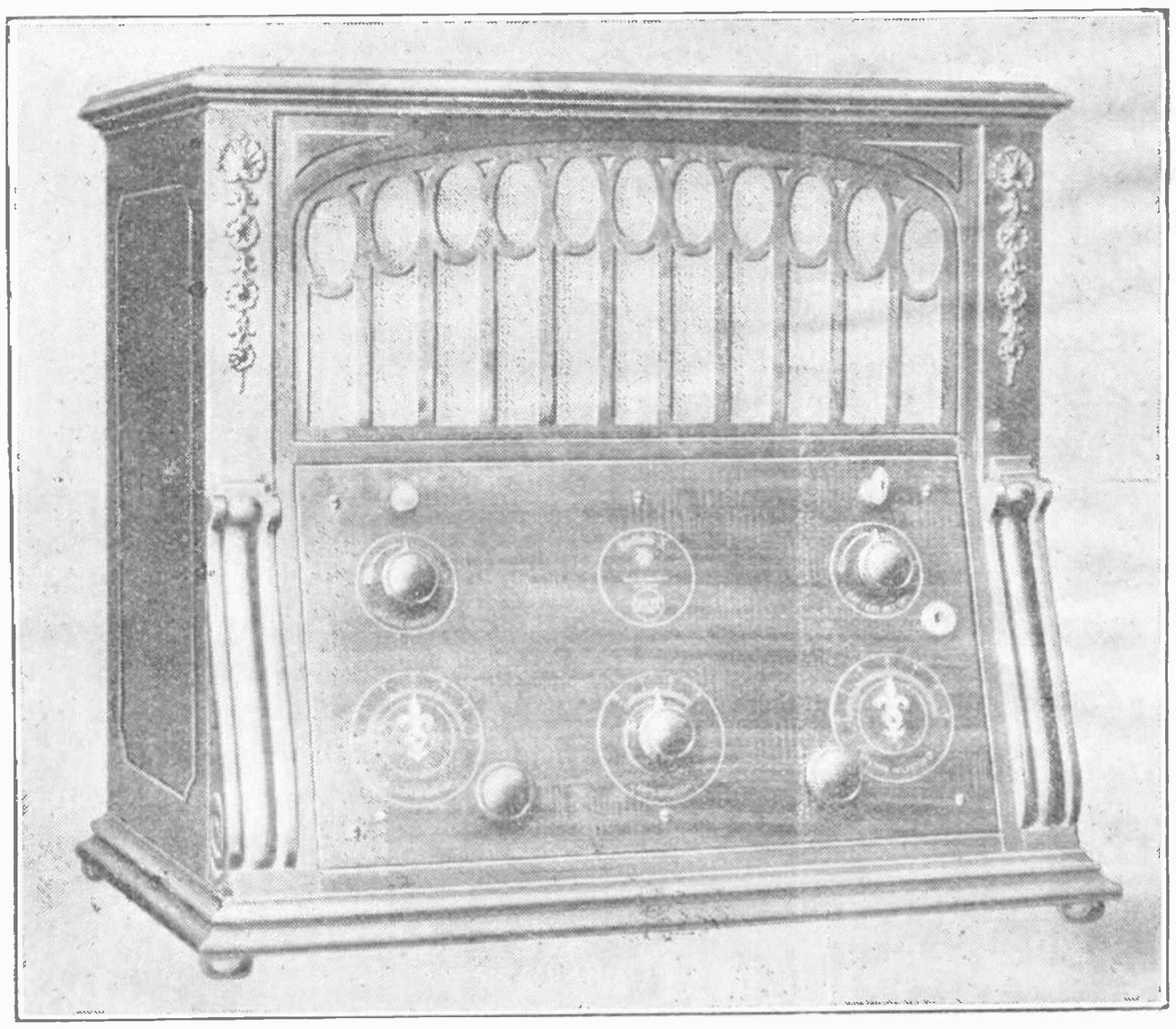

Fig. 1. A Non-Squeal Regenerative Set

3. Picking-up unknown stations is much easier, because all you need to do is to turn the tickler handle up its scale past the point where you hear the faint click (which indicates that the set is in oscillating condition) and then rotate the tunng handle. Every sending station will then be heard, even if no

speech or music is being transmitted, as a twittering note or "birdie," as it is popularly called.

Hunting the Birdies

This is a great convenience. In fact, it is so tempting a convenience that it gives rise to most of the trouble in connection with regenerative sets. For it is just in this oscillating condition that the receiver acts as a transmitter, (except for real non-radiating receivers)

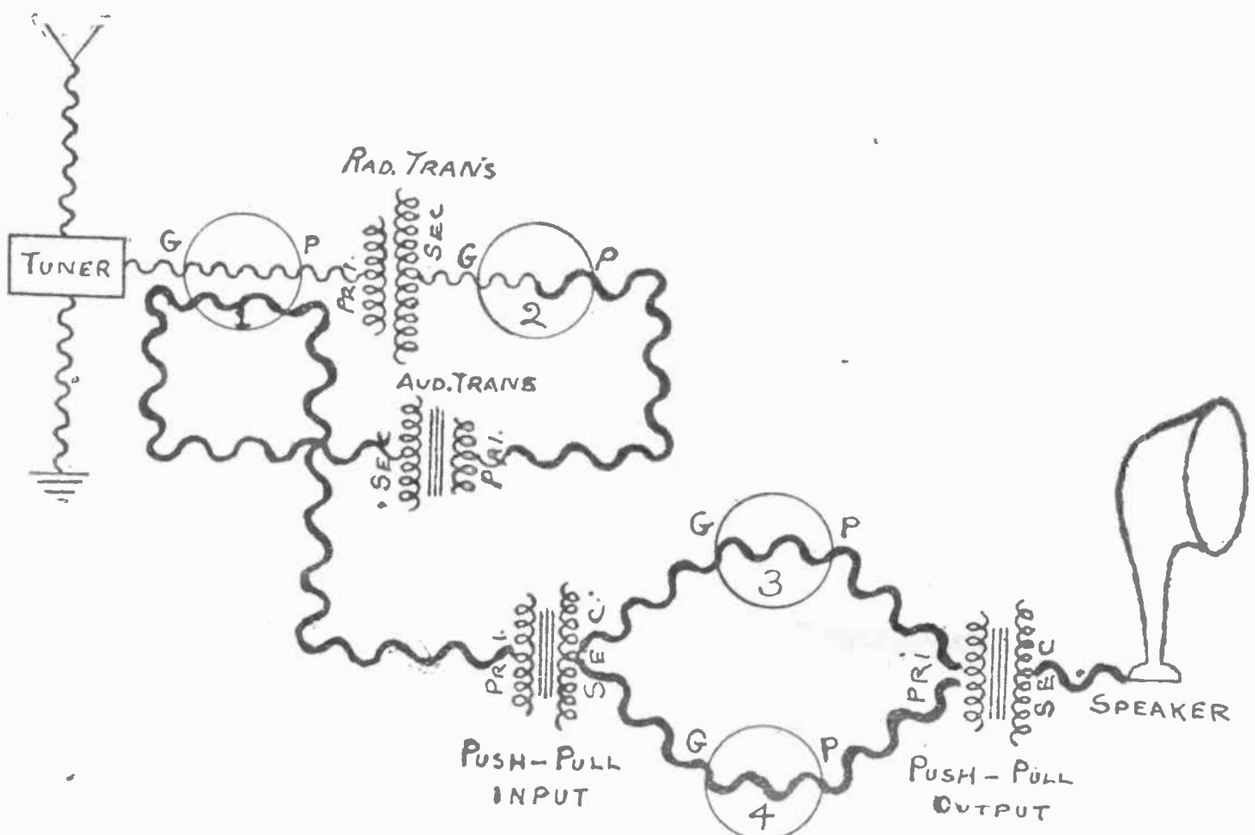

Fig. 2. Main Circuit in Four-Tube Set

and interferes with the neighbors. Otherwise stated, every time you hear the "birdie," which shows you have picked up a station, the chances are that you are causing the same squeal in all your neighbors' sets, and thus interfering with their enjoyment.

This unnecessary interference is particularly bad when the listener is working with signals which are weak and sometimes fade out. Every time the music fades, everyone with a radiating regenerative receiver is likely to bring the feedback up a little further and so accidentally gets his set into the oscillating condition. The resulting noise from the interference of all the sets in the neighborhood sounds like a bird shop at feeding time and spoils any broadcast concert.

Those who continue to use radiating regenerative sets should follow these suggestions:

Don't Let It Spill

1. Do not try to squeeze the last ounce of signal out of your set by bringing the tickler up to so critical and unstable an adjustment that it is liable at any moment to "spill over" into the oscillating conditions, thus causing the squeals which interfere with others. Be content with a reasonable signal with the tickler below the critical point.

2. Do not use such a radio on a very large antenna, and in congested city neighborhoods use the smallest possible aerial which will give local signals satisfactorily. Run your antenna as far away from all others as possible; and, where it crosses other ones, let it do so at right angles.

3. Get out of the habit of "fishing" for unknown signals all evening with the set in the oscillating condition. This may amuse you, but it spoils the enjoyment of everyone else and is not fair. If possible, pick-up all signals with the tickler below the critical point at which the faint click or a squeal shows you that the set is oscillating. (When using a non-radiating regenerative receiver, these three rules may be disregarded safely.)

Satisfying the Engineers

For years, radio engineers have been working at the problem of producing a harmless regenerative receiver; that is, a radio which would have all the great advantages of the usual regeneration and yet could not interfere with the neighbors, and was if possible, even more selective than the best of the previous one or two circuit regenerative sets. In other words, they wanted to keep the tremendous amplification which the tickler or intensity control can give; they wanted to get very high selectivity so as to be able to get complete separation of signals from local stations and to enjoy some distant stations through local broadcasting; they demanded the easy way of picking-up unknown stations by means of the "birdie" or twittering note; and they insisted that the neighboring receivers should not be interfered with no matter what the user of such a set did with his dials.

All these difficult requirements have been fully met in the new receiver, Radiola X, which is shown in Fig. 1, and which employs a circuit which has been appropriately termed "regenoflex."

The way in which the problem of avoiding interference has been solved in the regenoflex circuit is by the use of a "barrier tube" between the antenna circuit and the circuit which contains the tickler adjustment and which might therefore cause feeble transmission from the set. This barrier acts as a practically perfect trap. It lets the incoming signals pass from the antenna through it to the tickler (or secondary) connections, but it will not permit anything to go through it in the reverse direction from the tickler circuit back to the aerial.

An illustration of the way the radio vibrations travel through this set is shown in Fig. 2. This diagram appeared in the December 1 issue of RADIO PROGRESS. As was explained there in the article, "Tracing Signals Through the Regenoflex" the radio frequency waves are amplified through Tube 1, and reduced to audio frequency by Tube 2. The audio waves are looped back again through Tube 1 by reflex action and then passed to a push pull amplifier in Tubes 3 and 4. Tube 1 is the buffer referred to.

A Golden Rule Receiver

Thus, no matter what is done in this latter secondary circuit, the antenna itself remains unaffected, there is no radiation from the receiver, and the enjoyment of the neighbors is not troubled. This is accordingly a "Golden Rule" radio in every sense. By careful design of the regenoflex circuit, this receiver becomes more sensitive, much more selective, and just as convenient as the usual regenerative receiver, but without any possibility of causing local interference. Stations can be picked up by the squeal with the secondary circuit in

Continued on Page 28

A Radio Forecast for 1925

Using the Past Progress to Predict the Future

YOU are probably wondering how much the radio improvements expected during the coming year will affect your receiver. One of the first questions that occurs to a person who buys a radio seems to be, "How long before my set will be obsolete?" A brief review of the developments of the past year gives a good basis for a 1925 radio forecast.

The outstanding radio events of 1924 were the pictures transmitted across the Atlantic; the development of high frequency sending; and Marconi's beam or directional transmitter. Two methods of radio photography were demonstrated, the Jenkins and Ranger systems. Improvements may be expected during the coming year, not only in the transmission of photographs but in the evolution of radio moving pictures. However, it is hardly expected that the World's Series of 1925 will be seen in homes throughout America by radio. This is an event for future research. This field gives more channels in the ether, and so, relieves congestion and interference. It has been discovered that much less power is required when high speed oscillations are used.

Marconi Dooms Arcs

Marconi's beam transmitter employs fast vibrations, from 3,000 to 10,000 k. c. It reflects the waves in a definite direction just as the reflector of a lamp or lighthouse concentrates light and flashes a beam instead of spreading it in all directions. Marconi predicts that the powerful slow speed wireless telegraph stations now using alternators and arcs will soon be succeeded by high frequency beam transmitters, which conserve energy.

During November signals transmitted on a 6,000 k. c., wave from a low power station in Australia were successfully received in England.

During the last few days trials have been successful from Poldhu, Wales, with Canada, the United States, Brazil, Argentina, Australia, and, for the first time, with Bombay, India, and Cape Town South Africa. The power used was 15 kilowatts. The results fully confirmed expectations.

Low Power Will Reach England

It is claimed that the information gained will render possible the installation of comparatively low-power stations capable of establishing and maintaining commercial services by day and night between England and the most distant parts of the globe.

The low cost of the system, both in capital and running expenses, compared with that of the existing type of stations, should cut the telegraph rates for all long distance communications, besides making direct communication with some of the smaller outposts of the world commercially profitable.

Sparks Are Being Discarded

There is less trouble from interference now than a year ago. Many of the old spark sets are being replaced by vacuum tube transmitters, which do not interfere with broadcast listeners. It is understood that new installations will continue to be made throughout 1925, so that the code interference from spark sets will not be a great annoyance.

There are more toll stations "on the air" now than a year ago. These stations receive pay for broadcasting indirect advertising material. There is much more advertising matter vibrating the ether to-day than last year.

Chicago Won't Pay New York

It was the opinion of many last year that a fund would be necessary to pay radio entertainers. Several funds have been started for individual stations, but they have all been abandoned because of insurmountable difficulties . The contributions were returned to the subscribers. It is apparent that a fund for an individual station cannot be successful. It is still believed by many that such a fund is necessary to get the best of talent for broadcasting. It may be that a plan will be developed which will take care of all stations in the metropolitan district. Chicago might have another fund and Philadelphia another, but there would be little to be gained for Chicago listeners contributing to a New York fund.

The elimination of static and transmission of power by radio are problems to be solved by time. Progress along these lines may be made in 1925.

Pullman Phones Coming

Radio on trains is a phase of reception that much can be expected from during the new year. Tests made on the Twentieth Century in receiving election returns lead to the prediction that Pullman seats will soon be equipped with headsets so that passengers can hear radio entertainment.

The practicability of receiving messages by radio on a transcontinental, non-stop train is now being tested on the Golden State Limited.

The greatest service radio broadcasting rendered during 1924 was the election returns. It was estimated that the election return audience was the largest that ever tapped the ether. The inauguration of President Coolidge, March 4, will undoubtedly be the outstanding radio broadcast of 1925.

27 Stations Send Same Thing

Interconnection of a chain of stations by land wires has been urged by Secretary Hoover to give national distribution to important events. Twenty-seven stations scattered throughout the country broadcast Presidents Coolidge's speech on election eve and demonstrated that such a system was feasible. Undoubtedly more broadcasting on a national scale will be done in 1925, and especially the Presidential inauguration ceremonies.

Much can be expected in short wave transcontinental relaying during 1925. The new Denver station KOA is in a good position to relay programs sent from New york, Schenectady, Pittsburgh and Hastings, Nebraska, over the Rockies to KGO, Oakland, California, for rebroadcasting. It is also possible for WRC, Washington, and WBZ, Springfield, to pick-up the New York broadcast and send it over the South and New England.

1924 Not Out of Style

The past year brought no revolutionary radio receiving circuits. This shows that radio is becoming stabilized. There have, however, been many improvements in design and workmanship in the sets of 1924. It is not likely that anyone who bought a set in 1924 will find it obsolete at the end of 1925. New improvements can be expected during the coming year. The super-heterodyne made its first appearance as a commercial product in the Spring of 1924. The original super-heterodyne model will be improved, refined and made more compact before many months pass in 1925. It will be portable.

The trend now seems to be for complete sets rather than parts. This fact may lead the radio business from the many small radio shops to the music stores. People are not assembling as many sets at home as they did one or two years ago. This is attributed to the fact that complete receivers are less expensive than they were at first and, furthermore, they can now be purchased on time payments. There will be more combination radio-phonograph sets in operation at this time next year than there are to-day.

Batteries Getting Unpopular

One of the greatest improvements that will come in 1925 will be alternating current filament and plate supply devices, which permit the use of the house lighting current in place of batteries. Radio sets will then be connected to the lamp socket just as an electric iron or toaster. Some of the new sets may have the current supply apparatus incorporated within the cabinet.

It is expected that a radio "talk-bridge" will be working across the Atlantic before 1925 closes. It is understood that the installation is complete on this side of the sea and the station at Rugby, England, will be working early in 1925. This will enable a person in New York to pick-up the telephone receiver and ask for a number in London, or on board a ship at sea, just as a long-distance phone call is made. The rate for a three-minute chat will undoubtedly be much higher than a three-minute telephone conversation between New York and Chicago.

By Day or Night

Marconi anticipates the early arrival of the day when the practical range of broadcasting will be increased enormously; and American stations for instance, will be heard in England with clearness and regularity during the day, instead of only late at night, as at present. It is also quite reasonable to expect, that it will soon be possible for an important speech to be broadcast even to the most distant parts of the world, whether it is made during the hours of daylight or darkness.

The radio industry has grown rapidly in 1924. Sales this winter are calculated to be 300 per cent. greater than last season. It is estimated that to-day there are close to 5,000,000 receiving sets in the United States; 1,000,00 in England and 100,000 in Canada. The Department of Agriculture estimates there are 375,000 receivers on farms, which is an increase of 155 per cent. in a year.

The industry is more stabilized than it was a year ago. The great crowds that attended the radio shows in New York, Chicago, Boston and Buffalo this Fall indicated clearly that radio has gained thousands of new followers since January, 1924.

Half a Billion Dollars

As broadcasting has widened its scope and gained more followers, so has the radio industry developed. The business has grown in four years to a sales volume of $115,000,000 in 1923, and the Copper and Brass Research Association, after a survey of the radio field, estimates that the business of the radio industry for 1924 will reach the $300,000,000 mark, and within two or three years sales will reach the $500,000,000 mark.

A vacuum tube manufacturer estimates that sales of tubes alone for the present year will total in excess of $50,000,000, while one of the leading parts manufacturers thinks that as much as $250,000,000 will be spent for radio parts and sets. Sales of dry cells and batteries are placed at $45,000,000.

According to figures compiled by the American Radio Association, a survey made by that organization reveals that there are more than 3,000 manufacturers of radio supplies in the United States, ranging from the manufacturers of complete sets and tubes to coils and other parts.

An Army of 250,000

There are about 1,000 distributors and 27,000 retailers. More than 250,000 persons are connected directly or indirectly with the manufacture and distribution of radio supplies. Judging from the volume of business done so far this year, it is calculated that the business will aggregate $300,000,000 for the year 1924.

There are now 550 broadcasting stations in the United States and close to a total of 1,000 broadcasting stations in the world; 18,000 amateur transmitters in the United States and about 16,000 ship and shore commercial stations.

Their Last Sign-off

Since November, 1920, there have been a total of 1,180 radiophone stations, 630 of which have stopped broadcasting. In 1922, 642 stations opened and 95 stopped before the end of that year. In 1923, 250 stations opened and before the year closed 299 out of the total in operation discontinued broadcasting. Up to December 1, 1924, 250 new stations had opened and 239 had signed-off for the last time.

For years ago the radio industry was not considered of sufficient importance to give it an individual classification in the field of buisness. It was grouped under electrical products, along with electrical toys. When broadcasting started many hailed it as a fad. To-day it is considered one of the first forty industries of the United States, and the sales of radio equipment are not likely to reach a saturation point for at least ten years to come.

Business in radio circles during the past Summer has shown an increase of 50 per cent.

Continued on Page 15

Taking Portraits of Heart Beats

Method May Help Doctor to Save Your Life Some Day

By OLIVER D. ARNOLD

RADIO broadcasting started out as pure entertainment. Then it took in education and one of the recent offshoots from it has reached a point where it is helpful in saving life. This refers to the pictures of the condition of a person's heart.

We all know how important the heart action is in telling the doctor what may be wrong in a case of sickness. Do you remember the old family physician when he came on a visit? He would say, "Let me look at your tongue and feel of your pulse." The more modern doctor carries a fever thermometer to take your temperature and a stethescope to listen to your heart action.

Can You Describe a Noise?

But there are two serious objections to the the stethescope. This is a little instrument, you will remember, with a diaphragm like that of a phonograph and two ear tubes attached through which the doctor listens to the noises in the patient's chest as he presses the diaphragm against his body. In the first place it is impossible to make any record of the sounds he hears, so that he can not record the progress of the disease from day to day. With the temperature he makes a note of the thermometer reading, and jots down the point on a chart, so that at a glance anyone can tell the progress of the fever. The best he can do is to try to recall what that noise sounded like a week ago and compare it mentally with what he hears to-day.

The second drawback to this method is that one person can not describe a sound to another in such a way that he will understand what is meant. For instance, try to describe how a dog barks; to do this you will naturally try to imitate the dog and say "Bow-wow" or "Woof-woof." But this is not describing it, it is trying to make the same noise yourself. How would you imitate the beating of a heart, or the gurgling of the blood through a leaky valve so that a physician could understand it?

Try it on the Dog First

This is a serious objection in a medical school or in the hospital where the young doctors are trained. In order to teach the students the symptoms of a certain disease it is only necessary to give them a lecture or text book describing how the patient's temperature will vary. But the heart action must be heard as shown by an actual case. Otherwise, the students will not be able to recognize those particular sounds when they hear them.

This may have some strange results. For instance, in a certain hospital recently the teacher was lecturing about a certain rare sickness. which always proved fatal. We forget the name, but let us call it Jameston's Disease. Owing to lack of a subject the lecturer was unable to illustrate the peculiar heart action which was to be heard. The next day by a coincidence, a man suffering from this trouble was brought into the

Fig. 1. Patient is Sending Station, Transmitting Waves

hospital. Imagine his horror that when he heard one young doctor call out to another, "How fortunate that this chap is dying of "Jameston's Disease."

Don't Need Sick Patient Now

This new invention has changed all this. It is no longer required that a patient be dug up who happens to have the particular malady in question before being able to give the students enough information about the heart action so that they will be able to recognize it when they meet in their practice. A written record of this most important function of the body is given, which may be referred to and compared one with another.

Besides this, there is the advantage which a doctor has in being able to refer in later years to text books on the subject. When one of his patients is taken sick with something out of the ordinary, he naturally consults his medical volumes to find out the symptoms of trouble which he thinks the person has. This is easy as regards fever temperature, appearance of face, appetite, etc. But until now no information at all definite could be given as regards the sounds the heart gave out when heard through a stethescope. The new method which makes a record not of the sounds, but of the action itself, will be available in the doctor's reference books and so can be immediately looked up.

The Heart a Power House

Such a vital organ in the body has naturally been compared to a great many different things. In calling it a power house the analogy is not strained since it is found that the heart actually does generate electrical currents every time it beats. These currents can be read by suitable electric meters. Of course, the voltage is very small, but it is enough so that when passed through a radio amplifying set, it may be heard in a telephone or better still, may be made to leave a printed record of itself.

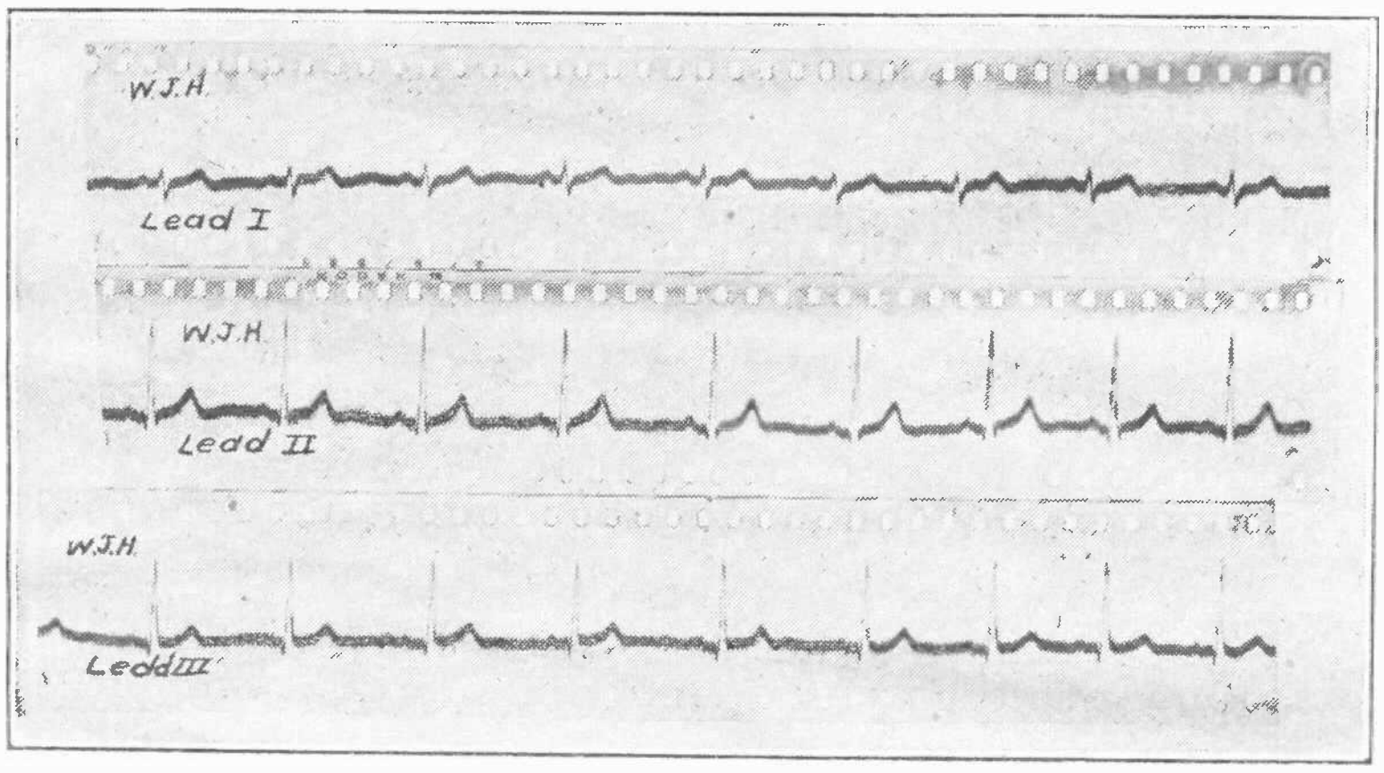

Fig. 2. Movie Film of Heart's Wave Length

It has further been discovered that this voltage is not steady like that given out by an "A" battery, but fluctuates like the radio waves coming in from the air. Furthermore, the "tune" which the heart plays is very different in different diseases and each particular style of vibration is even more characteristic of some particular disease than is the sound which may be heard coming from the patient's chest.

Picking up the Current

The electricity which the heart generates is revealed by voltages which appear at the patient's arms and legs. Since the heart lies in the upper part of the body, it is found that the voltage change is greatest between the two arms, and between each arm and either one of the legs. This means that three records are needed (1), left to right arm; (2), left arm to leg; (3), right arm to leg. See Fig. 1. A physician who has a record of these three will be in a position to tell immediately whether that heart action was normal, and if not he can classify the disease causing the irregularity.

These voltages, while they are quite definite, still are very small, and this is where radio comes in. By feeding these pressures to a special three step amplifier the wave form given out by the heart is kept unchanged in shape, but is magnified tremendously. It is just the same action which you get when you add two steps of audio amplification to the detector of your receiving set.

Making the Picture

If a pair of phones is plugged in on this amplified current, then the heart throbs can be heard quite loudly. That is a great improvement over the past method, since a whole roomful of students can hear the sounds from a single patient at the same time. But what is wanted is a record which may be referred to later. To get it in this shape, use is made of an oscillograph.

This instrument is used to make a picture on a photographic film of any electrical wave which is fed to it. The main part of this instrument is a very light coil, which turns between the poles of a powerful magnet. The more current which is passed through the coil, the farther it deflects. In this respect it is quite similar to the ammeter needle on the dash board of an automobile. When the battery is charging eight amperes the needle turns one inch, but when sixteen amperes flow, it deflects two inches. The same idea holds with this small coil except that it works on a very small fraction of an ampere.

This Pointer Has no Weight

You know that if an automobile happens to strike a rough road and starts jouncing back and forth, it is apt to set the ammeter needle swinging, since the latter has some weight, although it is naturally made as light as possible. Suppose a very rapid vibration were to be measured. Then the weight of the pointer would slow it down considerably and so reduce the accuracy of the indication. To get around this difficulty a weightless pointer is used. This is a beam of light.

Mounted on the center of the coil is a tiny mirror, smaller than the head of a pin. A powerful electric lamp shines through a slit and the beam of light is focused on this tiny mirror. Of course, this pencil of light is reflected and causes a spot on the film which is held in front. When a current passes through the coil it turns the mirror and

this changes the position of the spot of light.

Do you remember when you were at school some of the children would get a looking glass and putting it in the sun would shoot the light in the eyes of people as they passed by? The oscillograph does the same thing except that it always points to the same place, for the same amount of current. While this spot is oscillating back and forth on the film according to the wave which is being received, the film is made to move lengthwise by clock work. Combining the lengthwise motion of the film and the back and forth vibration of the light from the mirror gives a wavy line called an "Oscillogram."

Taken on Movie Film

The record is made on a movie film. Three samples are shown in Fig. 2. You can see the holes along the edge of the film which are used by the clock work to drive it forward at a constant rate of speed. The black wavy line has been traced out by the light reflected from the tiny mirror as it wabbles back and forth. A high peak in this line means that at that instant the heart of the patient gave a beat and of course the higher it is the more powerful was the electrical impulse.

Fig. 2 shows the voltage variation as described above, (1) arm to arm; (2) left arm to leg; (3) right arm to leg. The record as shown was of a person in normal health. In disease all three records would be distorted and the particular shape of wave motion would be different with each separate kind of disease which affected the heart. Troubles like halitosis will not show up.

Apparatus Required

The instrument which accomplishes these results is pictured in Fig. 3. At the left we see the oscillagraph which makes the wavy line. At the lower part of this may be observed one of the wheels which drives the film. Of course, this instrument is encased in a light-proof tin box so that the film may not be spoiled by the light.

Next to this observe the three vacuum tubes. These are UV201-A tubes just like those which perhaps you use in your set. The control apparatus used for adjustment appears at the right. This whole mechanism is supported on the bakelite panel which fits into the cabinet which appears in Fig. 1. The lower case in this picture contains the batteries. The storage form must be used in this case, not only to light the filaments, but also to supply the necessary current for the electric bulb which gives the light to be reflected by the tiny vibrating mirror.

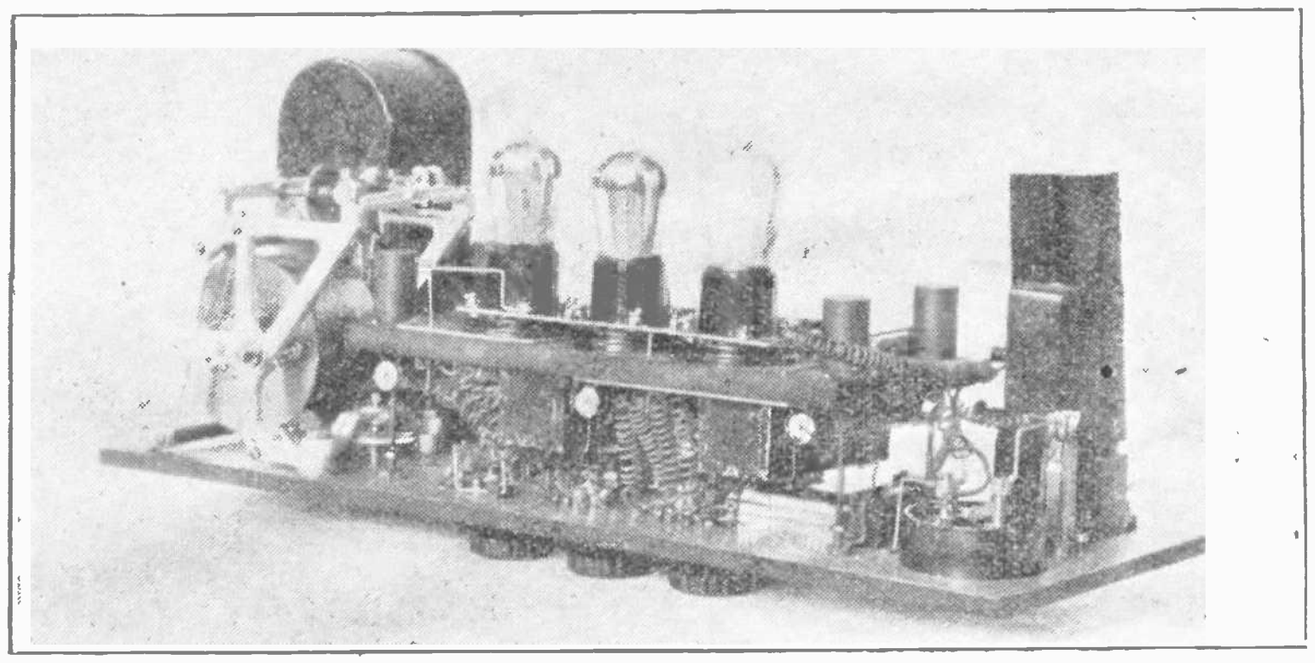

Fig. 3. Combines Movie Camera and Receiving Set

The Doctor Can Carry It

Although the upper case is fairly bulky, it is not very heavy, and the two boxes may be carried by a physician right to the door of his patient. This is quite an advantage, as it allows the heart action record to be taken of patients who are not in a hospital. As the device is entirely self-contained all he has to do on arrival is to open it up, snap the electrodes on arms and leg, turn up the filaments, and push the button.

Then the next day and the next when this operation is repeated he will not have to scratch his head and try to recall how this patient, among all his others, was doing as regards the noises of his heart. He merely pulls out the film for the day before and, holding it to the light, notices immediately that the pulse is more regular and the disease is subsiding.

FORECAST OF 1925

Continued from Page 12

Hoover Swamped with Stations

The number of stations is on the increase, so much so that Secretary Hoover has abandoned the plan suggested by the third national radio conference to allocate new wave lengths. He is in hopes that some of the stations will stop broadcasting during the coming year, and if such is the case the interference problem may be automatically solved. There are now eighty-eight class B stations. The end of 1924 finds many of the stations increasing power to 1,500 watts and some wanting to go as high as 5,000 watts.

Several leaders in the industry have suggested super-power broadcasting stations radiating 50 kilowatts and higher. Definite plans regarding the construction of such a station are likely to be announced before the close of 1925.

Only Nine Got Across

International broadcasting is not much further advanced than it was at the beginning of the year. Only fragments of waves from nine American stations out of 550 were heard in England during the international tests in November and several of them used eight and ten kilowatts. Reception of European stations on this side of the Atlantic was nothing spectacular. Until super-power stations are built international broadcasting is not likely to amount to much.

A survey of radio to-day shows that the industry is just getting under way and the volume of business next year and for years to come will be ever increasing. Radio renders public service, entertainment and education. Its possibilities are unlimited. International broadcasting, super-power, radio moving pictures are developments that can be foreseen. They will open new field and create tremendous interests in listening and seeing through the air.

New Rules for Sending Stations

Department of Commerce Issues Orders to Amateurs

A NEW set of regulations governing amateurs who send out code has just been issued by the Department of Commerce under Secretary Hoover at Washington. These relate to the frequency or wave length of transmission and to such other things as the power supply, quiet hours to be observed, and special licenses.

The new frequencies allowed cover a wider range than before permitted. From 1,500 to 2,000 kilocycles (200 to 150 meters), from 3,500 to 4,000 kc. (85.7 to 75 meters), from 7,000 to 8,000 kc. (42.8 to 37.5 meters), 14,000 to 16,000 (21.4 to 18.7), and 56,000 to 64,000 kc. (5.35 to 4.69 meters) are allocated to amateur stations. Notice that in this new requirement the frequency expressed in kilocycles (thousands of oscillations per second) comes out in round numbers, while the same thing expressed in meters of wave length are decimals. That explains why such apparently unusual figures are taken for the wave length. The band from 2,730 to 2,860 kc. (110 to 105 meters) has been withdrawn.

Spark Sets Are Discouraged

Amateur spark transmitters produce bad interference and consequently cause many complaints. Owners of such transmitters must abandon their use as early as possible and adopt a better system. Until such change is made they will be permitted in the wave length band between 170 and 180 meters, and should have a decrement not exceeding 1/10.

The decrement is a measure of the broadness of tuning of the waves. This new figure is only half what used to be allowed (2/10), and so the amount of interference caused even near this band will be only half what it formerly was.

Phone and ICW Transmitters

Phone and ICW (Interrupted Continuous Wave) transmitters will be permitted in the band from 170 and 180 meters. ICW is defined as the type of wave produced by mechanically interrupting one or more of the radio frequency circuits. CW (Continuous Wave) transmitters will be permitted in all of the bands mentioned above.

Amateur stations must use circuits loosely coupled to the radiating system, or devices that will produce equivalent effects to minimize key thumps, harmonics and plate supply modulations, except in cases where loops are used as radiators. Conductive coupling, even though loose, will not be permitted.

No restrictions will be imposed on the character of the power supply, provided the emitted wave is sharp.

Quiet Hours

Amateur stations when using frequencies of 1,500 to 2,000 kc. (wave lengths between 200 and 150 meters) are required to observe a silent period from 8 to 10:30 p. m. daily, standard time, and on Sundays while church services are being broadcast. Such stations, when using frequencies higher than 3,500 kc. (wave lengths below 85 meters), and having a pure continuous wave or where a full wave rectification is employed, are not required to observe a silent period, provided no interference is caused to other service.

Licenses issued for amateur stations will authorize the use of any or all of the wave lengths allocated for amateur use, providing the transmitter meets the requirements of the above regulations. No alteration in the apparatus will be permitted which results in changing the character of the emitted wave except under authority granted by the Supervisor of Radio.

May Call Up Yachts

Amateur stations are not allowed to communicate with commercial or government stations unless authorized by the Secretary of Commerce, except in an emergency or for testing purposes. This restriction does not apply to communication with small pleasure craft, such as yachts and motor boats which may have difficulty in establishing communication with commercial or government stations.

There being no further need for special amateur licenses, owners of stations holding such licenses will be permitted to continue the use of their "Z" calls under regular amateur station licenses. No new "Z" calls will be issued.

DEAD 167 HOURS

Probably the shortest direct-wire connection ever used by a broadcasting station is employed for one hour every week and is less than five hundred yards in length. The wire connects the Beaux Arts Club, on West 40th Street, New York, with Station WJZ, on West 42nd Street; both places are between 5th and 6th Avenues. Every Friday evening at 10:30 the brief stretch of wire comes to life and carries the dance music by the Beaux Arts Orchestra to the station until 11:30; for the other 167 hours of the week it lies asleep, bending its short self around three sides of tiny Stearns Square.

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12 HUMIDORS BY RADIO SHOWER

Irving Vermilya, operater of the "one-man" broadcast station, WBBG, at Mattapoisett, Mass., has been made the recipient of a tobacco shower by his appreciative radio audience. Mr. Vermilya, who is the New England Division Manager of the American Radio Relay League, announced over the air recently that he was a pipe smoker and enjoyed a particular brand of tobacco. It must have been a good radio night, for ever since his mail has been filled with cans and humidors of all sizes and shapes.

Mr. Vermilya is now glad that among his New Year's resolutions there is no reference to smoking. The last count revealed that he had received 137 cans and twelve humidors.

Is Radio Strangling Theatres?

Is It a Hangman's Noose, or a Fostering Angel?

By "STEVE" TRUMBULL, Announcer of Station KYW

THESE are the questions which everyone is asking nowadays, particularly since the recent concerts given by famous Victor and Metropolitan Opera artists.

Ever since the year 1, science has never made a stride forward without an accompaniment of cries of alarm from those unable to see past the period of readjustment.

Radio is no exception. In the case of the ether wave, it was the theatre that raised the loudest wail. Here was indeed cause for alarm. First the motion picture with its "10, 20 and 30c." Now this new radio, with absolutely free entertainment.

"It's ruin," said the managers of the opera houses, "What chance have we with our $3 a seat attractions? What will become of us?"

Fans Flock to Box Office

But the theatres are still running on. Likewise radio. The past two years have seen amazing adjustments. Theatrical managers have ceased to protest. Today they utilize radio, and get results of which they never dreamed. They are giving the radio fans the best of entertainment, and the radio fans are turning out to be the best bunch of box office patrons in the world.

These statements come from the recent experiences of KYW at Chicago, with the theatres of that city. The directors of this station made their first try for an entire play, from the stage, with the arrival in Chicago of Anne Nichols' well-known gold mine, "Abie's Irish Rose." The manager of the attraction was approached with the proposition.

Who Will Pay for Free Stuff?

"What?" he exclaimed, "Broadcast the entire play? Who will pay money to see it, after they have heard it?"

The manager was reminded that people paid money to see plays that

Fig. 1. Miss Claiborne Foster and Allan Dinehart in "Applesauce."

they had read, and studied; that the station had broadcast entire operas, with beneficial results at the box office. The argument was long, but consent was finally given, and "Abie" in his entirety was placed on the air.

The rest of the story is contained in the letter received a few days later, on the stationery of the Studebaker theatre, where 'Abie' was playing—and still is playing. Here is a copy of the letter:

"KYW, Chicago, Ill.,

"Gentlemen:—

"Never in my twenty years' experience as a Chicago theatre manager has any one feature helped patronage like the broadcasting of 'Abie's Irish Rose' from the Studebaker stage last Tuesday evening.

2,800 Hearers Will See

"By actual count at the box office, 2,876 persons mentioned they had heard 'Abie' over the radio when purchasing tickets. And all this number 48 hours after the actual broadcasting. Two box offices were kept open from 8:30 a. m. until 11:30 p. m. At one time lines of eager purchasers reached from the box office to the Auditorium hotel, 200 feet from the theatre.

"Letters were received from all parts of the country. One man came to the theatre with a telegram from New York in which the sender said he had heard 'Abie' over the radio. He wanted two seats for a week-end performance.

Two Girls at 2 O'Clock

"The telephone has been ringing constantly, radio fans making inquiry as to when they could purchase tickets. On the night of the broadcasting two girls answered phone calls until 2 o'clock in the morning.

"I believe that you should know these facts and I am sending this letter without solicitation from anyone.

"Miss Anne Nichols, author of the play, heard the performance in her New York apartment. In a telegram she asked me to express her thanks.

"So we both join in thanking KYW and its engineers for the splendid way in which 'Abie's Irish Rose' was broadcast.

"Sincerely,
(Signed) THOMAS P. GOZZOLA,
Manager."

"Applesauce" Big Air Hit

"Wildflower," a musical comedy, was the next play to be broadcast. Then came "Applesauce," still playing at the La Salle theatre.

In this play, Miss Claiborne Foster and Allan Dinehart scored a great hit in their performance as broadcast. Our photograph Fig. 1 shows these two popular performers as they appear in the play. Many radio fans who otherwise would never have seen them went to the performance after hearing them over the air.

The news of the things that radio could do for the theatre had traveled about among the box office czars. H. N. Holde, manager of "White Cargo" was quite willing to let his show go on the air. When Walter C. Evans, chief engineer of the station went to the theatre to try out the best location for the microphones, he was given every cooperation.

One of the other managers had said, "don't let those microphones show." Mr. Holde said, "Put them where you can get the best results, whether they are visible to the audience or not. The audience won't mind,—they will enjoy the novelty."

Swinging Hidden Over Head

The microphones were placed in the hanging lantern, above the actors heads, and in the center of the stage. The results were the best ever obtained in stage broadcasting.

The fans liked it. Hundreds of letters have been reecived at the station. They were from Chicagoans, from farmers throughout the Middle West, there were letters from the blind, letters from hospitals and sanitariums.

Gladys Frazin, the only woman in the cast of the play, was handed a pile of letters. She read them carefully.

The Human Side of It

"I'm glad we were able to do it," she said, "I was a little dubious at first. I didn't know much about this broadcasting. I've been too busy in the theatre to find out its possibilities.

"Aside from the practical side, the added attention it brings to the show —just think of the hundreds of people who were entertained who could not, otherwise, know the play, these shut-ins, these blind people, these people in hospitals. I'd like to entertain these people often. Maybe I can."

When Victor Said "No"

A little different angle on this problem has been seen recently in connection with the Victor artists performances. Up to a short while ago none of the singers who make records for the Victor Company had ever broadcast their voices. This was for two reasons; in the first place, they had some doubt as to the ability of radio to reproduce their concerts in a way which would do them credit. But even more powerful than this was the fact that their contract with this company forbade their giving any such a performance.

However, the technique of broadcasting has advanced so far that there is no more question of its being able to do the best singers justice. And now the Victor Company has caught the vision and sees that broadcasting their records will help to sell them. So every two weeks on Thursdays a half dozen big stations are sending out to an audience estimated at 6,000,000 listeners the sweet strains of music from the Metropolitan headliners.

Then the People Stayed at Home

The first reaction of the public to these superconcerts was striking. The first night when McCormack and Bori sang the theatres in the East reported that a large part of their regular patrons stayed at home. The S. R. O. (standing room only) signs were taken down off the doors of even the most popular theatres. The ticket scalpers ceased to scalp and as a result the theatre managers tore their hair.

In spite of this, there is little doubt but what such broadcasting will increase rather than reduce the revenue of the theatre. The people who will postpone going out in the evening so that they may hear the best in music are the very ones who will be attracted to the good productions which the theatres have to offer. If they don't go on Thursday night then they will go on Friday or Tuesday.

When New Things Are Old

In addition to this, it is most likely that a good part of the reason for the sudden falling off on the one night was due to the novelty of the thing. It was something that had never been done before and everyone wanted to know what it would be like. When the newness has worn off conditions will return to normal again. In other words the people of New York are not very different from those of Chicago.

53 Acres of Testing Aerial

How Some Disputed Antenna are Being Cleared up

SO much is being said these days about receiving sets that you perhaps lose sight of the fact that broadcasters still have a few problems of their own. These questions effect your set, since the best receiver can't pick up better programs than what are actually in the air. If a singer with a wonderful voice pours out liquid tones into the microphone, and the aerial censors her music by cutting out all the rich overtones, then your radio can't guess at how her notes sounded and fill in the harmonics itself.

That is why you will be interested in the large scale experiment with different styles of aerial and various lengths of wire and kinds of insulator, etc., which are now being carried on. The improvement which is being made will appear in the music you get a little later on.

A Giant Sending Laboratory

Steel towers and wooden masts, interconnected by wires and anchored in solid concrete or by cable, are sprouting up all over the field in which the General Electric Company is erecting a giant radio transmitter laboratory. Among the masts, which hold a variety of antenna systems, are large and small buildings in which radio specialists will solve some of the problems of radio transmission.

The fifty-three-acre laboratory is located six miles south of the city of Schenectady, the home of WGY. In these testing rooms the engineers will endeavor to find means of improving transmission quality and reliability, and will test theories of static and fading, in the hope that these twin terrors of radio listeners may be banished.

What Causes Fading

The general idea of fading has been explained in these columns before. When the radio waves from the sending aerial travel up into the sky, they strike a layer of air which has such a low pressure (owing to the height above the earth) that it becomes conducting. This is called the Heaviside layer, and it has the property of reflecting the waves like a mirror. The receiving set in your house picks up these oscillations reflected from this mirror.

But other waves from the same station are coming along the ground to you as shown in Fig. 1. When the two waves from the earth and sky happen to be in phase (in step) so that they add together you get loud signals. When the mirror layer happens to shift because of air currents or the like so that the two waves are out of phase, then they neutralize each other or subtract and the signal fades away. However, there are a great many points about this theory which require further investigation. These are being looked into and tested out from this laboratory.

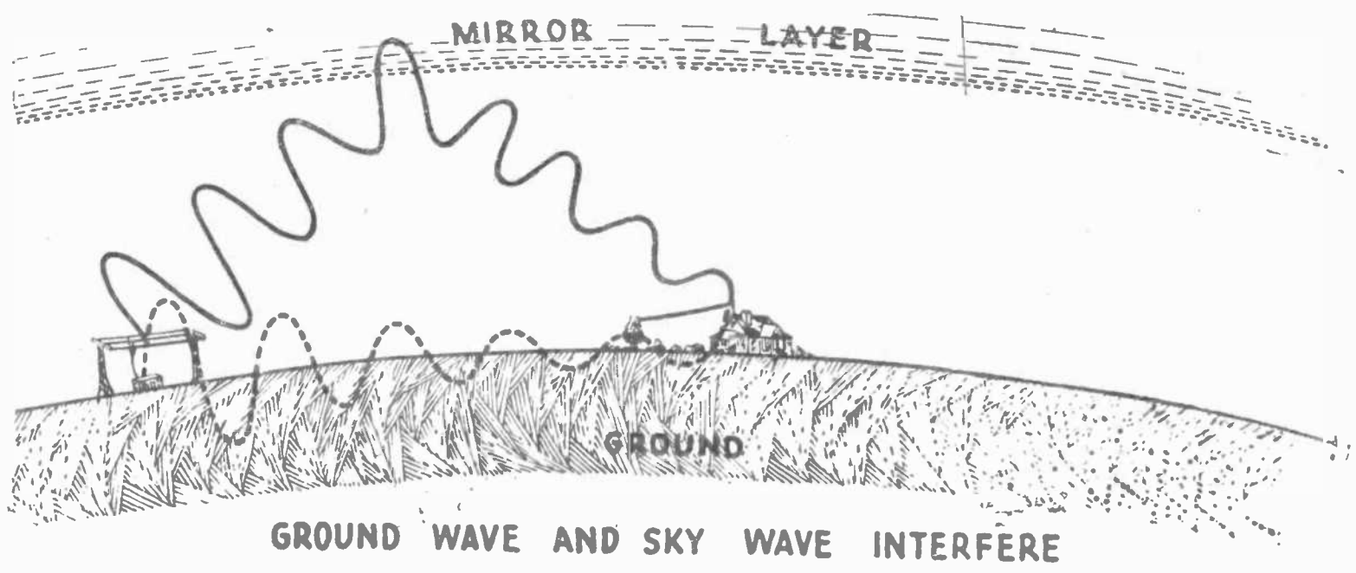


Fig. 1. Fading is Explained Here

Steel Towers of Two Heights

The antenna structures include three towers 300 feet high arranged in the form of a triangle. Fig. 2 shows the arrangement. From these steel masts almost any type of antenna may be strung capable of operation between 600 and 3,000 meters. A fourth steel tower, 150 feet high, may be connected to any of the trio of masts for work on wavelengths from 200 to 600 meters.

The reason the lower tower must be used for the ordinary frequency of broadcasting is this. The aerial vibrates with electrical waves just the same way as a violin string does with sound waves. Of course a high note is made by a short string. The ordinary band of wave lengths for broadcasting is from 200 to a little over 500 meters, which corresponds with 1500 to 600 kc. (kilocycles). This is a high speed of vibration compared with 100 kc., the equivalent of 3000 meters. The kilocycle you will remember is 1000 vibrations per second.

Now if you should see a man trying to play a high note on the violin, and he tried to use a string two or three yards long, you would know that he did not understand that a high note required a short string. In the same way the high oscillation speed of the broadcast band of frequencies (vibration speeds) needs a comparatively short aerial. If the towers three hundred feet high were used for this purpose, the lead-in alone to get to the top of the tower would be altogether too long not counting any length of flat aerial at all. So a 150-foot tower supports the antenna for telephone experiments.

Masts Musts be of Wood

In addition to the steel tower there are numerous wooden masts (Fig. 3) for antenna systems for experimentation on wave lengths from 15 to 200 meters.

These short wave lenghths are given out by oscillations at 2000 to 150 kc. respectively. Such very high speeds of vibration cause severe eddy current losses in any piece of metal within several hundred feet. If the aerial for these high frequency tests were supported on steel poles then the efficiency would be very low because of the absorption. Wooden masts overcome this trouble as no currents will flow through dry wood.

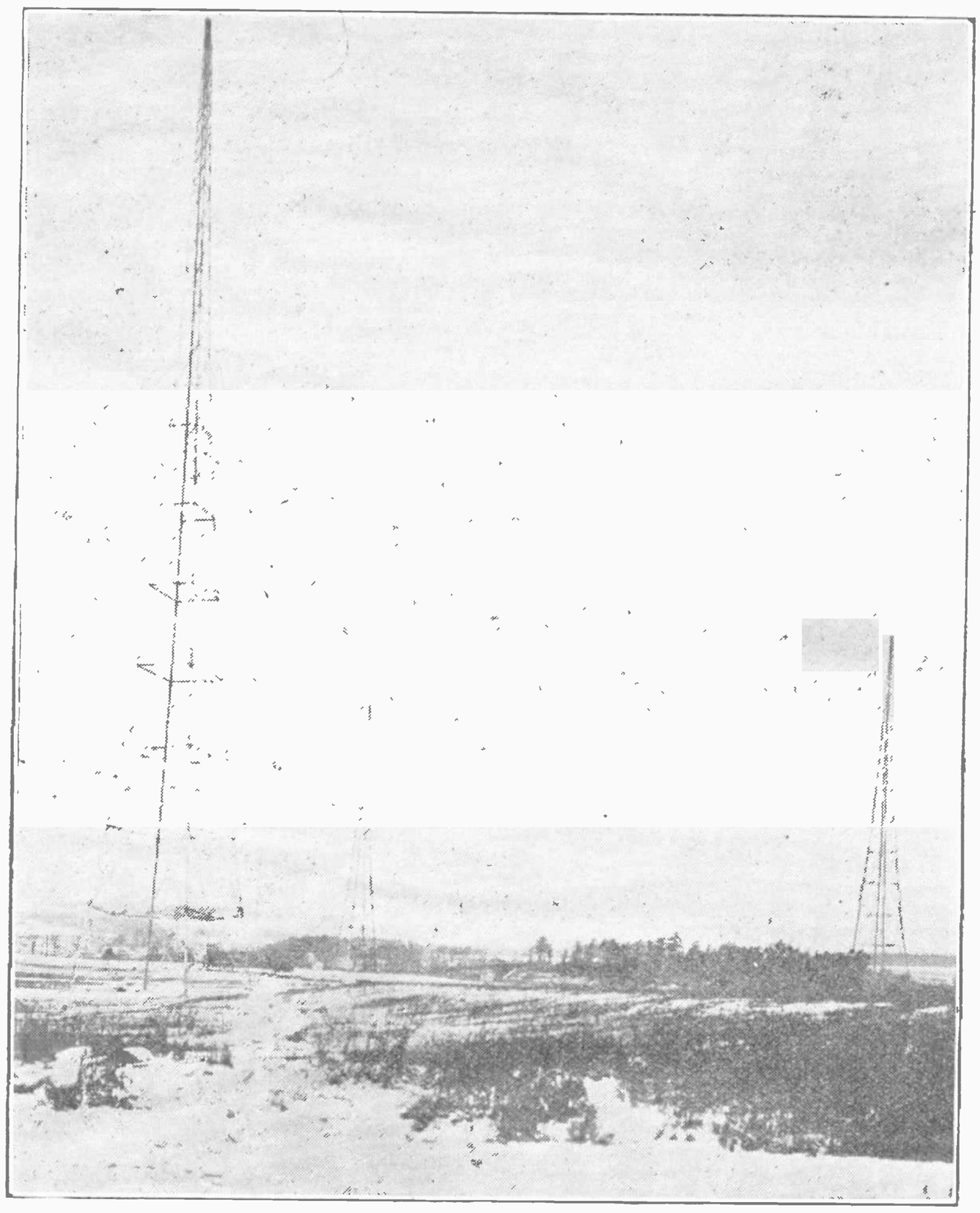


Fig. 2. These Steel Towers, 300 Feet High, for Code Transmission

In the largest building, constructed of steel and brick, will be housed the main power plant. Space is provided for two more experimental transmitters.

The power plant includes a number of high-power rectifiers for converting the alternating current supply fom the city electric wires into direct current with a maximum pressure of 30,000 volts. In addition to the rectifiers there will be direct current and alternating current machines for filament energy, biasing and for low powered amplifier operation.

The generator supplying the filament takes the place of the ordinary "A" battery, while a low pressure machine is substituted for the "C" battery for giving the proper grid bias on the vacuum tubes.

Room for 100 KW Outfit

The space allotted for the two experimental transmitters is sufficient for equipment rated at a maximum of from 50 to 100 kilowatts. The power building also includes a dark room for the development of oscillograph films.

6. Such an oscillogram is shown on page 14 of this issue. A room is provided for a fully equipped storage battery plant. Here also is located a central pumping system which provides circulating water for all transmitters. This water supply is used for the water-cooled power tubes.

The main power house is connected by cable for the transfer of power to several smaller buildings constructed of wood. These buildings will be used for the development of particular types of transmitters and must be located a distance from other equipment. Very small buildings are located at the foot of the steel towers and in these will be housed the tuning systems for particular types of antennas.

The method of tuning is to connect in series with the aerial, a coil or condenser of the proper values. A coil decreases the speed rate of vibration while a condenser speeds it up.

Perhaps You Have a Laboratory

Due to their familiarity with receiving equipment most people interested in radio think of an experimental radio laboratory as a room in which radio receivers, associated circuits and apparatus are developed. In fact, many amateurs, experimentally inclined have, on a small scale, a receiving laboratory of their own.

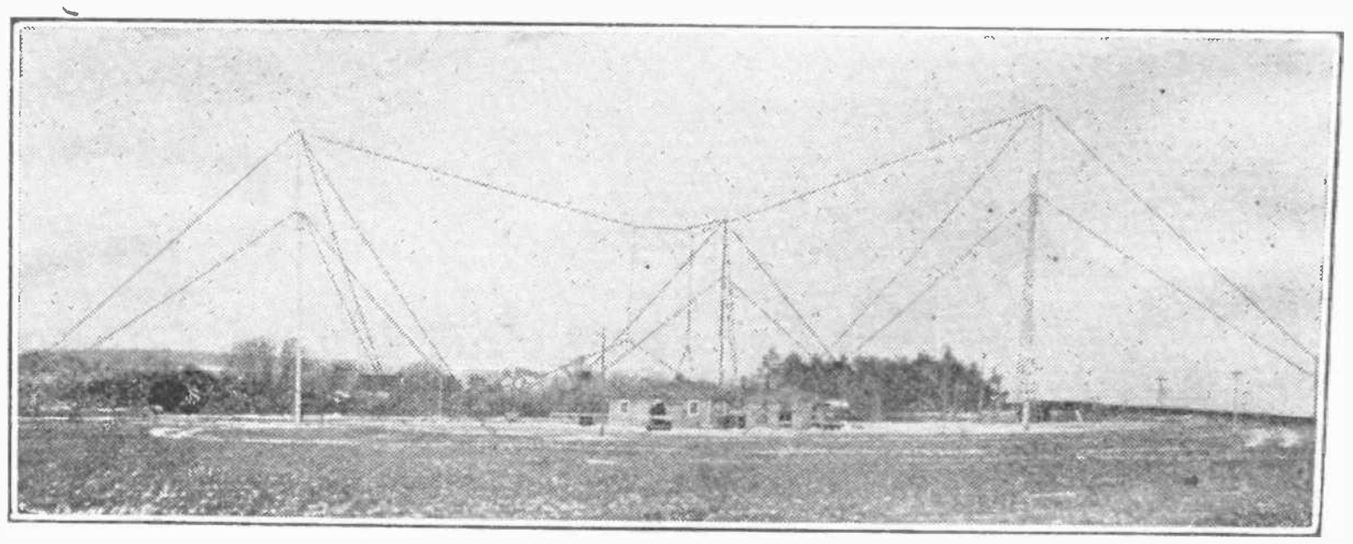


Fig. 3. These Masts Must be Made of Wood

In general, most people, due to lack of contact with transmitting equipment,

do not realize that radio transmitters are just as important as receivers. The research and design of these two lines, while quite different, are still dependent on each other. Experimental transmitter work, especially if high power is to be used, cannot be done by the amateur on account of the space and equipment required. The cost of establishing and maintaining and testing transmitting plant is beyond the purse of any except a large company.

As Big as a House

In the receiving laboratory the engineers test out the various unit parts which make up a radio receiver. They study the characteristics of the tubes for each piece of apparatus to make sure that each part can do its own work well. Ordinarily such a receiver laboratory might take up the space of an ordinary house.

In a transmitter laboratory the engineers are interested in such features as converting of the ordinary 110-volt lighting current to 15,000 or 20,000 volts direct current. They must study means of changing this direct current into radio frequency oscillations. In so doing the efficiency of each part is of vital importance. This is especially true if the transmitter is to have an output

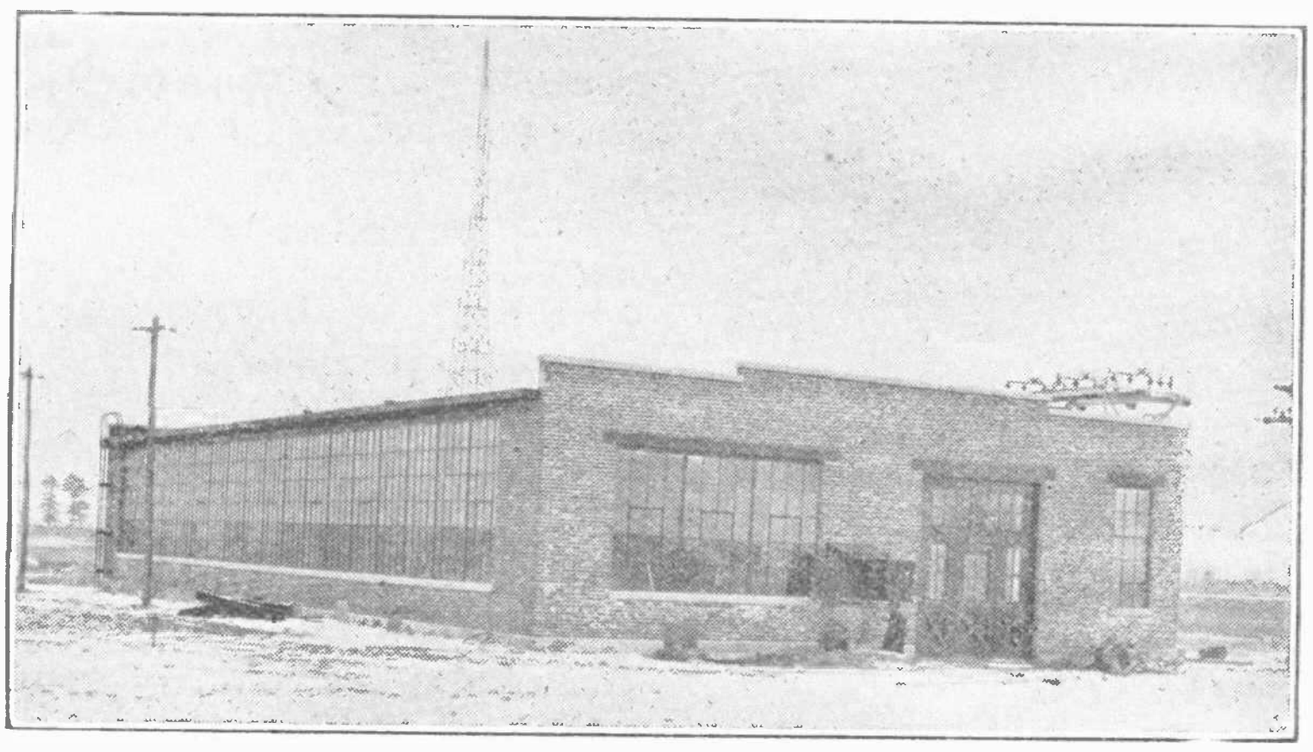


Fig. 4. Power House Will Take Up to 100,000 Watts

above 10 kilowatts. New means must be found for holding the radio frequency supply constant.

When Fading is Not Fading

If it should vary then the frequency (wave length) of the sending would change and so when you were sharply tuned to say 360 meters you would no longer be able to pick up 361 or 362, which was at that instant going on in the air. It would thus appear like fading to a sharp tuned radio.

Again, the engineers must study continuously the problem of modulation whereby the audio frequency energy may be accurately and efficiently superimposed upon the radio frequency energy. These are but a few of the problems the transmitter engineer must study and when it is appreciated that he may be dealing with transmitters up to 100 kilowatts in power (for code sending) some idea is gained of the size of the plant that must be placed at his disposal.

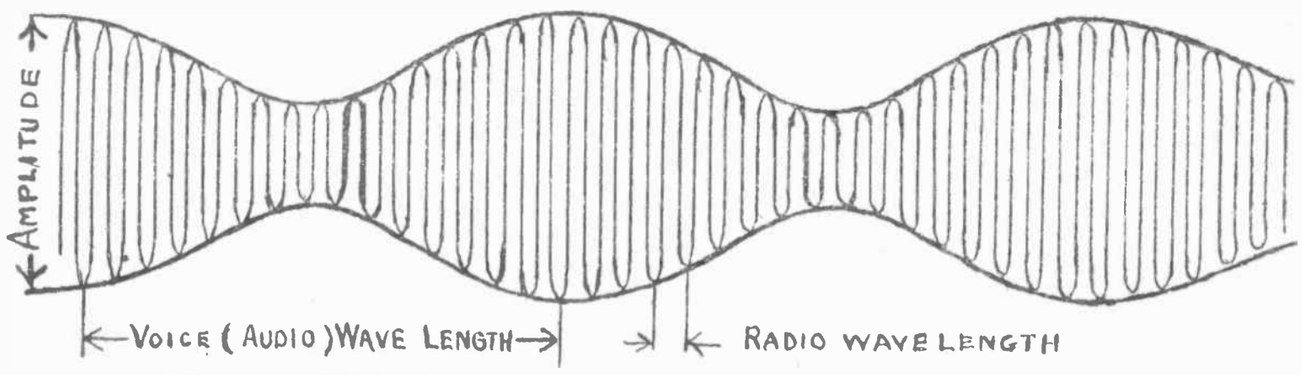


Fig. 5. This is the Modulated Wave Put on Aerial

What Modulation Does

The difference between the carrier wave as given by the oscillator and the same wave as it is modulated is shown in Fig. 5. The original vibration was a ripple with the peaks all of the same height but after the audio vibration had been impressed on it the appearance is as shown.

Besides transmitter circuits and their equipment, the radio engineer must also make a study of the propagation of electro-magnetic waves, how they travel through space. That is he must determine theoretically, if possible, and then check these results by experimental tests, which frequencies are most desirable for any given type of service. He must find out the power required to cover any given distance under any specified condition. In this case he must work very closely with the receiving engineers who tell him the number of micro-volts per meter necessary at the receiver to produce the desired signal.

Aerial One Yard Long

Micro-volts are millionths of one volt and the reason they are expressed as "per meter" is this. A long aerial naturally picks up more energy out of the air than a short one and so to get a fair comparison the signal strength is referred to the amount that would be picked up by an aerial only 1 meter (1.1 yard) long.

This work requires very elaborate and complicated antenna structures since the transmitter engineer must have available antennas for practically all wavelengths.

It is for the purpose of carrying on this intensive work in transmission development that the General Electric Company is erecting its great laboratory near Schenectady.

GOOD NEWS FOR JAZZ HOUNDS

Those who like to have the tickles in their toes will be very glad to hear that the Waldorf Astoria Concert Orchestra, has resumed their Sunday evening Radio Concerts, from station WJZ. These will run all winter.

American Radio Relay League

GETTING NEW ZEALAND BLOWS UP WORKS

Sitting up at his radio station until 5 a. m., an hour when most radio fans have gone to sleep after the usual period of DX hunting, R. B. Bourne, of West Hartford, Conn., was rewarded by hearing the call of an amateur in faraway New Zealand. In great excitement, he reached for the key of his transmitter and pounded an answer in the International code. In a moment he was listening again and heard the New Zealand Ham acknowledge his call.

Half an hour later, he stood looking at the remains of what had been a first class station; in his enthusiasm over making the contact, Bourne had used all the power available with the result that an explosion occurred, which wrecked the station. The accident happened as Bourne was in the act of sending a message addressed to his brother, Rolf Bourne, in Singapore. He expected the message would be relayed by amateur radio to Australia, from which point it would be forwarded by mail to its destination.

The temporary loss of the station was compensated for, in his opinion, by the half hour in which he had been able to maintain reliable communication with the New Zealander. He is the second amateur in Connecticut to "work" that country. The operator with whom Bourne had conversed was Frank Bell of Waihemo, one of the most successful New Zealand amateurs. His call, 4AA, has been heard in England and France, as well as widely distributed sections of the United States and Canada.

In addition to the New Zealand work, Bourne has communicated with eight amateurs in Great Britain and three in France. Both operators are members of the American Radio Relay League.

LET THE WIRES BLOW DOWN

In order to demonstrate the value of amateur radio forwarding news dispatches in time of emergency, when communication by wire is cut off, sixty-eight messages addressed to as many newspapers were started recently from New York City over the routes of the American Radio Relay League.

These messages were addressed to the member papers of the North American Newspaper Alliance, whose subscribers are distributed all over the United States and Canada. After leaving the offices of the N. A. N. A., in New York, the dispatches were transmitted by E. M. Glaser of Brooklyn, N. Y.

One of the messages as received by T. E. Graves of Cambridge, Mass., and delivered to the "Boston Post" read: "Thanksgiving greetings from the North American Newspaper Alliance via American Radio Relay League. Here is an example how radio can serve you when communication lines fail."

SANTA BROADCASTS IN MISSOURI

It was a few days before Christmas, when N. D. Chasnoff, amateur radio operator of Sedalia, Mo., received a telephone message from a neighbor, asking him if he would please act in the role of a radio Santa Claus for the other's children.

As he had been operating his radiophone transmitter for some time that evening, Chasnoff fully expected that the strange voice at the other end of the wire was going to make a complaint. Far from that, however, the neighbor was very cordial. He said that he had heard Chasnoff's phone and it had suggested an idea.

It appeared that he had listened to Old Santa's jovial talks from several different broadcast stations, but none of these were quite personal enough to suit him. He thought that Chasnoff would make as good a Santa as the rest, and he wished to observe the effects of personal messages.

He gave the names of the children over the telephone and suggested generally what he should say to them. The radiophone owner, who had enjoyed all kinds of experiences through his connection with the American Radio Relay League, thought this was the best yet and carried out his part to the letter.

The children, listening at their father's receiver, soon heard Santa addressing each one of them personally. He named over the various gifts that he was going to bring, being so accurate that the young listeners were astonished and went to bed with a new faith in the spirit of Christmas.

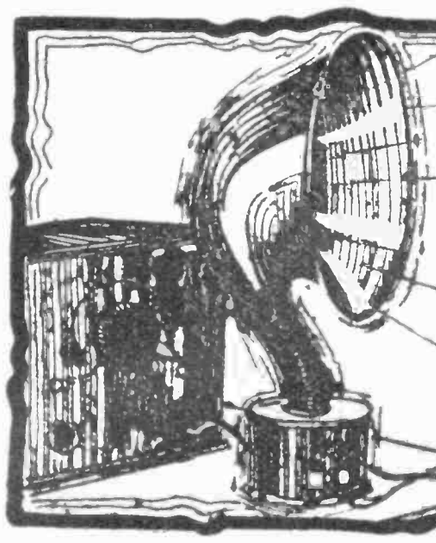
SNOWS DON'T SCARE BERGMAN

With the arrival of winter storms throughout the northern states, railroads are depending more and more on radio to aid them in dispatching train service when communication by ordinary methods becomes impossible. When all other means fail, radio is practically certain of getting through to the desired points with a minimum amount of delay.

Amateur radio scored again recently when G. W. Bergman, owner and operator of station 9CA, at Dwight, Ill., handled important messages for the Chicago and Alton Railroad. Due to the heavy snow, the railroad telegraph lines were down, so Bergman was asked to establish communication between Dwight and Chicago. Station 9CA got on the air immediately, but was unable to raise any Chicago stations. He managed finally to relay some messages through 9AZN, the station of A. D. Sanial in La Crosse, Wis.

By this means, Bergman got into communication with R. H. G. Mathews, Central Division Manager, the American Radio Relay League, who warned local amateurs to listen for Bergman's signals. He also asked the Chicago broadcast stations WEBH, WGN and KYW to have their listeners notify amateurs to get in touch with 9CA.

In a short time, 9CA raised 9AAW and 9BE, the stations of W. E. Schweitzer and M. H. Romberg, both of Chicago, and the traffic for the Chicago and Alton was then handled direct from Dwight to Chicago by means of amateur radio telegraphy.



EDITOR'S LOUD SPEAKER

THE DOOR WITH TEN LOCKS

Some housewives are timid and much afraid of burglars. They may perhaps use two locks on their doors. Others go still farther and add a bolt and hasp besides. It always seems a question whether a burglar forced to break in a door will find it much harder to do it whether there are one or ten locks on it.

It always seems to us that an extra large number of locks made it so much harder for those who wanted to use the door without helping in keeping out intruders. And in the same way those radio sets which bristle with knobs and switches would appear to make it so much harder to pick up the particular waves which were wanted without making it any easier to keep out the unwanted disturbances.

In springing this idea on a class of radio students the other day one of the scholars objected and said that he thought the romance and enjoyment of radio would largely disappear if the number of controls was reduced. However, he was asked whether he had ever raised a fuss because on his phonograph there was only two handles, one to turn it on and the other to adjust the speed. He had to admit that he had always been contented with it, even though there were no knobs to change the number of teeth in the gears and no switch to vary the color of the paint.

When you get right down to it, it does seem a little unnecessary to have more than a few handles. We have seen fellows that for every new station which they tried to pick up, would go through a lot of motions in adjusting this and that. When you remember that the only difference between the waves of any two broadcasting stations is that one sends out its oscillations quicker than another, then you will be in a better position to see the point.

Of course, the waves, once they have left the aerial, all travel at the same speed—that is, 186,000 miles per second—which is more than seven times around the earth at the equator during the tick of a clock. What is meant is that a station like WEAF (New York) or KYW (Chicago) has a slow speed of vibration, while KDKA oscillates back and forth many thousand times per second faster.

You can get the idea of this if you will watch the conductor of an orchestra as he plays different kinds of pieces. He sways his baton back and forth, and the violins and saxaphones, and all the rest of the instruments keep step with him. When he is playing a funeral march, the stick sways back and forth at a slow tempo. This is like WEAF. The next is a jazz piece, and he speeds up his stick so that the vibrations are very much quicker, like KDKA. Of course, the music travels through the air just as fast in either case.

Now suppose you want to dance, and you like a quick fox trot. You have a lot of records for the victrola, and you pick out a good snappy piece and turn it on. If you find that the music is too slow to keep in time with the quick stepping crowd, there is only one thing you need to change, and that is the speed of vibration in order to bring it up to the faster time. If you do this by adjusting six or eight different handles it seems like a big waste of gray matter to pick out how to change each one to get that simple result.

Now getting back to our radio set. The *only* difference between the two stations mentioned above is the oscillation speed. This is often rated in wave length, but that is a poorer way of expressing the same thing. If we have the radio set adjusted inside so that it naturally keeps step with the fast waves from Pittsburg, then it will not keep time with any other city. If we wish to switch to the program coming in from New York, then we must slow down the mechanism inside (by adjusting our condenser or coil) so that it now keeps time with the New York vibrations.

Notice that there is nothing else at all which has to be adjusted—just the time of the radio waves. If you find that making a certain change in a circuit will allow it to keep step with one thousand kilocycles (kc.) per second, then *any* station which vibrates at that speed will come in best with that particular setting. That is why it is foolish to adjust this knob and that handle and the other tap switch when picking up different stations on different nights which have the same frequency or wave length. Once you have found the best adjustment for a certain wave, stick to it.

Of course, if your receiver has two or three different tuned circuits, it will require the same sort of change in each one. You may also want some kind of volume control. But the point we are making is that to look wise while you change your audio frequency amplifier rheostats to bring in different wave lengths will cause a laugh from any on-looker who understands the theory of the thing.

SHOWING OFF A SET

When your Friend Bill comes in to see you of an evening, you naturally want to impress him with the beauty, efficiency, and general goodness of the new radio set you have just acquired. What is more natural than for you to fish around to pick up the Coast or Cuba, or anybody who is two or three thousand miles away?

That is, we assume that you are a radio fan of some months or years standing, and that you have been bitten with the radio bug to such an extent that you like to hear the distant places. If Friend Bill happens to belong to the same class, he will appreciate your efforts and, even if you hear a very faint voice singing a song, the words of which you can't get and which is badly interrupted by outside noises, he will still think it is wonderful, provided the call letters which the station signs, belongs to a station far away.

But there is one very different class of people who are listening to radio at the present time. Instead of wanting to pick up unheard of places, they are much more interested in getting a program through which is clear and easily understood. They have the peculiarity that when the comedian springs a joke they want to hear it, and want to catch the point. To them the fact that the station is one that the neighbors can't get does not make up for the fact that they missed the laugh.

Such a person can warm up to a new set only if the flow of music is smooth and uninterrupted. Even if the place from which the program comes is only a few hundred miles away, it sounds just as sweet in his ears. You can pick him out usually by carelessly dropping a few call letters like KDKA, or WGY, which practically every fan in the country knows. If he immediately laughs in a derisive way and says that he hears that station on one bulb with his aerial off, then you will know that you are dealing with a real DX (distance) hound and you must spin your dials with the greatest nicety and pick up the faintest whisper from the air to satisfy him.

If, on the other hand, when you mention KDKA, he thinks it is a four-letter word meaning crazy, you immediately should drop the dial twisting and tune to some old standby in the same or the next state and then leave the dials there all night. The fact that it is the same station will not be any disadvantage from his point of view; as long as the concert comes in so he can hear every note he will think you have a wonderful set. You see there *are* people who will go to a concert at the opera house and stay there for two hours to hear the music without insisting on getting up at the end of ten minutes and going to some other show.

SAVAGES WERE TERRIFIED

The eclipse which occured last week was noteworthy in more ways than one. Astronomers tell us that we must wait from 300 to 2000 years before another one like it will happen in the United States. Probably few of us will be alive at that time.

In the olden days the savages thought the Day of Judgment (or what corresponded with it) had certainly come. Mark Twain's "Connecticut Yankee at King Arthur's Court" explains how the hero was about to be executed when a timely eclipse scared the natives so much that they naturally let him off, and so it saved his life.

Owing to the surprising accuracy with which scientists are able to predict future motions of the sun and planets, it is possible to foretell an eclipse hundreds of thousands of years ahead. We are for that reason no longer terrified by such a sudden change from day to night. But while eclipses of one kind or another are occurring somewhere on the earth every eighteen years, the records show that previous ones have not enjoyed the great popularity that this one did.

Undoubtedly the thing that took the popular fancy most was the experiments which were made in radio transmission. Of course, the observatories with their big telescopes were on hand to take photographs of the sun's corona and also to measure the reflections of the light from stars. This latter was as a check on Einstein's theory, which has been accepted by many, but not all, of the prominent scientists.

This reason would not hold for most of the people who were interested. So much has been said about the difference between transmission of radio waves at different times of the day and night, that most every one is glad to know a little bit more about this question. The large number of people who tested out this theory is surprising. Undoubtedly more were busy on scientific experiments at that time than there have ever been before in the history of the world.

Although nothing very startling was observed in the way of radio transmission, still this is not a disappointment, since the facts which the radio engineers were after were not expected to be very exciting. To get at the results of a large scale test like this needs the reports of thousands of observers and it will take some little time to record all the various data sent by the amateur experimenters. The full report will not be published for some little time, but when it is given out it will undoubtedly throw considerable light on the way that radio waves travel and on the effect which the sun has upon transmission.

Build Your Own Charger

Telling How You Can Make a Tungar Battery Charger

By C. WILLIAM RADOS, IBFA

THE report on radio for the last year shows that more than two-thirds of the sets use storage batteries. All such batteries must be charged every few weeks. But besides this, there are a good many sets using 199 and DW tubes (designed for dry batteries) which have substituted one or two storage cells. This improves the operation because the rheostat does not have to be juggled in order to keep the proper voltage on the filament.

A storage battery charger is really an essential for all such receiving sets using storage batteries, as it will keep them charged at small cost and bother. The Tungar charger is one of the best of these, and is easy to build. It is also foolproof and economical. Before attempting to make your own, you should understand how it works.

A One-Way Bulb

A low pressure (6 volts) direct current is needed to charge a storage battery.

The difference between direct current (DC) and alternating current (AC) is this. Direct current flows steadily like a river, and when this is fed to a battery, it gradually fills it up or charges it. AC, on the other hand, first flows

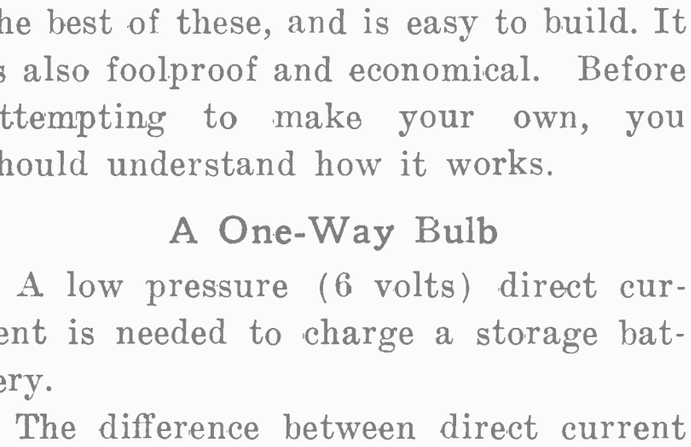


Fig. 1. Alternating Current Waves

one way and then reverses the other. A picture of this condition is shown in Fig. 1. Distances from left to right represent time, and up and down is the amount of current. Notice that every half inch (which represents 1-60 of a second) the curve repeats itself over and over again. First current runs into the battery as shown by the plus sign, and

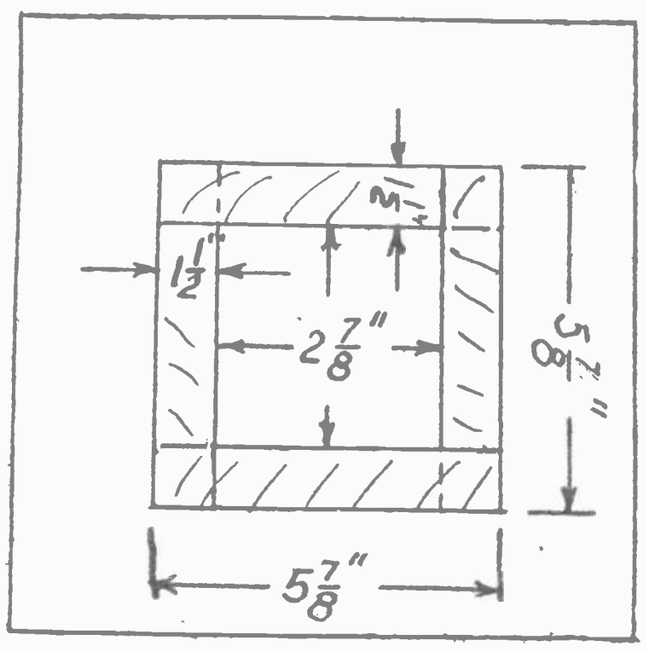


Fig. 2. Laying Out Iron Core

an instant later it runs out again, as told by the minus sign. This does no good to the battery as it empties it just as rapidly as it fills it.

To get direct current from alternating, the house current is reduced or stepped down from 110 volts through a small transformer, and then passed through the tungar valve. As the tungar is a *one way* bulb, it produces a pulsating direct current which is then fed to the storage battery, as shown.

Cutting Off the Discharge

The lower half of Fig. 1 shows what the rectifier does. It cuts off all the — loops by opening the circuit at that instant. The dotted loops in this figure show the ones which would be added if both sides of the wave were used. This requires two bulbs, however, and so it is usually not done. In such a case the suppressed half waves do not flow at all, and so are not registered on your electric light meter.

The bulb works on the same principle as your radio vacuum tube, but has no grid and is more sturdily built. The filament is heavy tungsten, the plate is of graphite, and these elements are enclosed in a large strong glass bulb filled with argon, an inert gas. Hence the name, tungar (tungsten, argon).

Shooting Into Space

When the filament is lighted, it throws off particles of negative electricity or electrons, which shoot out into the gaseous space. Negative electricity is attracted by positive or a positively charged electrode. For 60-cycle supply (the ordinary kind) the plate is connected sixty times a second to a positive pulse of electricity.

During these half waves the current flows into the battery. Then when the current reverses the electrons are no longer attracted to the plate, and so no current flows. Since the electrons themselves *are* the current, when they stop the circuit is disconnected for an instant. Thus the electricity which has flowed into the battery is not taken out again by the negative wave.

Like Automobile Valve

This action is just like that of a piston working in a cylinder like an auto-

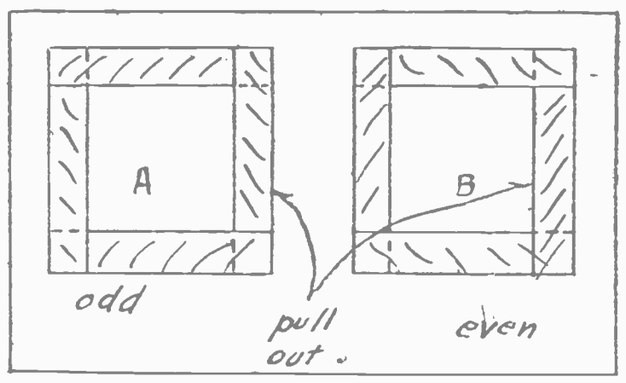


Fig. 3. Every Other Layer Changes

mobile engine. The gasoline is sucked in through the valve port on the down stroke. When the piston comes up again it would blow the gas back again, but

the inlet valve has closed which prevents this undesirable action. Instead of a valve operated by a cam, the rectifier uses the electrons to give a one way motion.

Since the electrons flowing from the filaments to the plate are *negative*, the direction of flow of *positive* current is in the opposite direction. That is, the filament is the positive, and is to be connected (through the coil) to the plus sign of the battery.

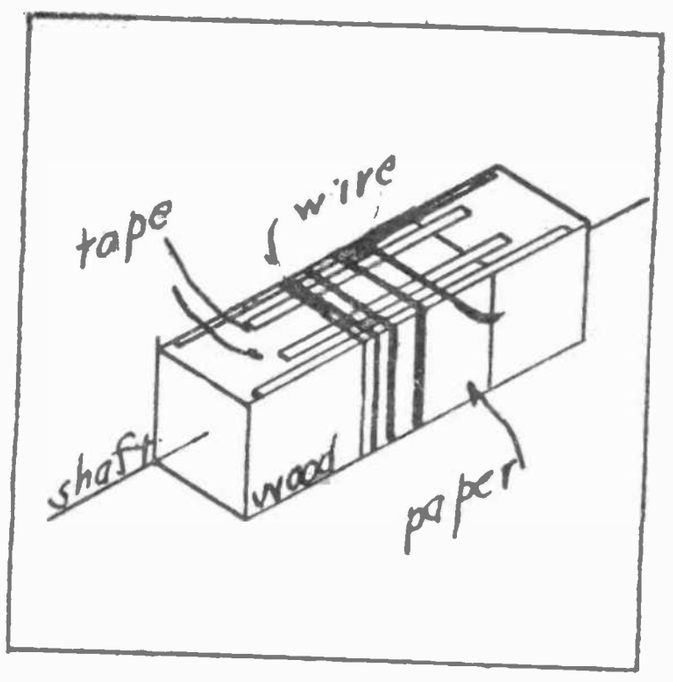


Fig. 4. Tying the First Layer

Two Sizes Are Built

There are two sizes of tungar bulbs available on the market, the 2 and 5 ampere tubes. These cost four and eight dollars respectively. Details for construction of rectifiers to use either will be given. The parts necessary are a transformer, a fuse block, a switch and socket.

The transformer is the only part which has to be made, as the rest of the parts can be bought cheaply. The core is mad of transformer iron No. 28 gauge. The electric light company's service station is the best place to find this and get it cheaply. About five pounds of iron will be sufficient. Stove pipe iron should not be used, as it is a poorer iron electrically and so more of it will be necessary. The transformer will draw more current and be heavier also. Do not cut the core iron by hand, but take it to a tin shop and have the squaring shears used. Good joints cannot be made in the core, unless the pieces of iron are carefully cut. All pieces are of the same dimensions which are 1½" x 5⅞". See that the tinsmith cuts them all exactly alike.

Shellac on One Side Only

The pieces of iron should be insulated one from another in order to keep down the heat developed by eddy currents in the transformer. The rust and scale on the iron is sufficient to insulate the laminations in most cases. If you are in doubt, however, shellac one side of each piece with thin shellac and allow to dry thoroughly before assembly.

In assembling laminations the joint or crack between one piece and the next lies first one way and then the other. This is shown in Fig. 3. Layers 1, 3, 5, etc., have the crack as at A, while layers 2, 4, etc., are like B. The only difference you will notice is at the corners.

As the core is square, it is easy to build up. Fig. 2 shows how the core should be put together. Use a corner of a box to bank up the laminations. Be sure that the joints are well made. Stack the iron to a height of 1½ inches all around. Wind the three sides indicated in Fig. 3, with friction tape. Wind the tape (one layer only) as tightly as possible and hammer up the joints with a mallet or rawhide hammer. One side of the core is then pulled out, after assembly, to allow the windings to be slipped on.

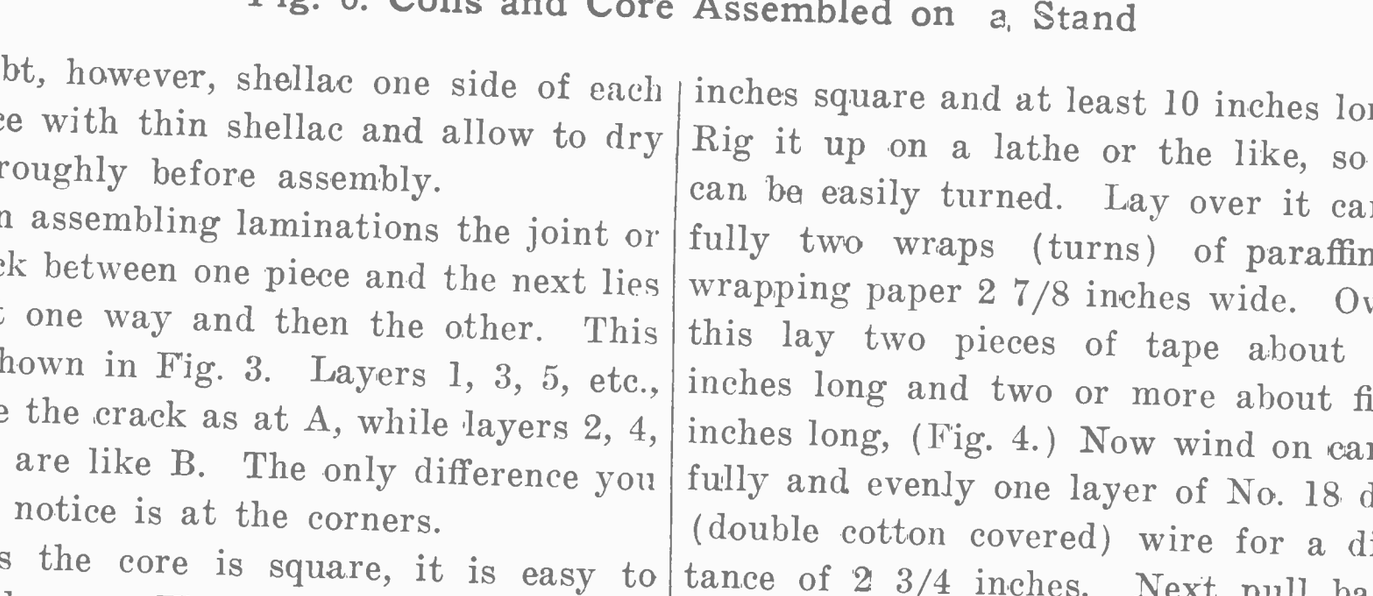


Fig. 6. Coils and Core Assembled on a Stand

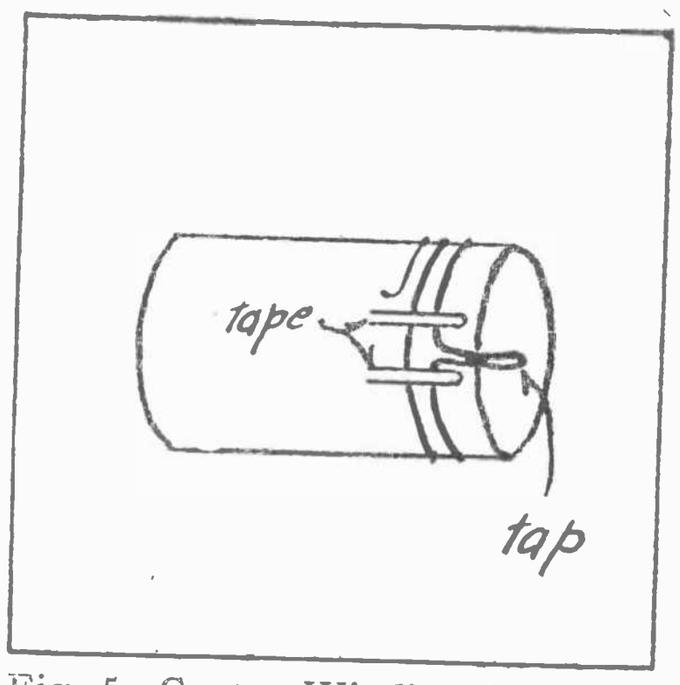


Fig. 5. Center Winding Has Tap

Winding the Primary

Obtain a piece of hard wood 1 3/4 inches square and at least 10 inches long. Rig it up on a lathe or the like, so it can be easily turned. Lay over it carefully two wraps (turns) of paraffined wrapping paper 2 7/8 inches wide. Over this lay two pieces of tape about 12 inches long and two or more about five inches long, (Fig. 4.) Now wind on carefully and evenly one layer of No. 18 dcc (double cotton covered) wire for a distance of 2 3/4 inches. Next pull back over the winding the four short ends of tape and lay them over the wires so that they will hold the ends of the first layer in place. When the second layer is put on, it will hold the tape in place and so keep the coil in shape. The long tapes are left until the winding is finished.

Continue this process until 550 turns are on, putting down a layer of paper for every other turn layer of wire. A revolution counter is a very handy thing to have here. The 550 turn winding is the primary which connects to the 110-volt house current. The filament winding is placed directly over the primary, with 2 wraps of paraffined between. It consists of ten turns of a conductor consisting of two No. 12 dcc wires. Lay the wires side by side and do not twist them while winding. A tap is taken out at five turns (both wires). The tap is merely a long loop in the wire from the winding to the terminal post. Pieces of tape, one on either side of the tap (Fig. 5), are placed so as to hold the winding in place. These tapes are pulled back over the wires and held as explained

above. Allow about one foot for good measure as the tap can be cut off afterwards if it is too long.

This filament winding carries about thirteen amperes (at 2 volts) which is a large current, so the winding should be well made as per directions with well-fastened ends. There are three terminals, the two ends and the tap. All of the winding must be carefully done, watching for kinks, breaks, and short circuits. If the insulation of the wire should wear off so that two adjacent turns touch, it will cause a short circuit. This will make a one-turn secondary in which a very large current will flow, burning out the wire and so rendering the whole transformer useless. These precautions apply to all findings which will carry house current.

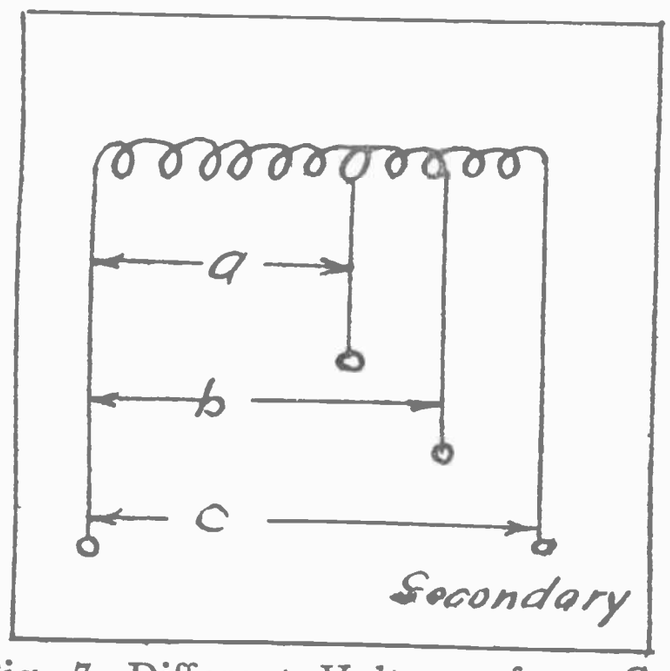


Fig. 7. Different Voltages from Coil

Finishing the Primary Coil

When the primary and filament windings are finished, lay over them several layers of Empire cloth (varnished cambric) and tape the leads or put spaghetti over them. Now slip the entire coil off the wooden form and tape, starting inside. A single layer is enough, as room must be left for the core inside. Give the entire coil a good coat of electral paint (black) and place in a warm place to dry.

The other coil called the secondary will be wound in a similar fashion over the wooden form again. It consists of 180 turns of No. 12 dcc. tapped at 75 and 110 turns. The leads from both ends are brought out. These taps give respectively 15 volts, 22 volts and 36 volts. This coil is slipped off the wooden form, taped, painted, and dryed. Then when both coils are thoroughly dry, they are slipped on the iron core. The secondary goes on one core leg and the other coil, consisting of the primary and filament windings, goes on the opposite leg. Then

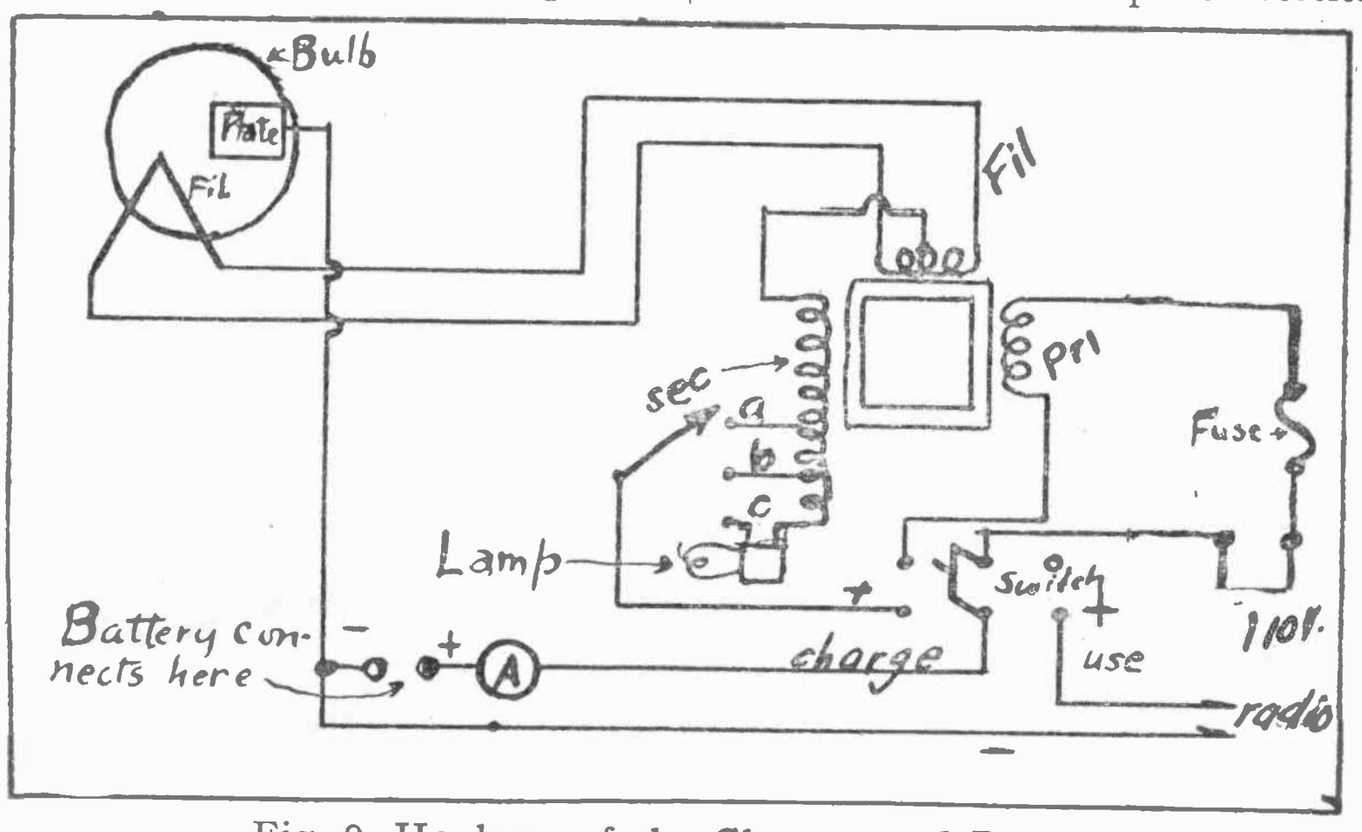


Fig. 9. Hook-up of the Charger and Battery

the fourth side of the core is added and the whole transformer is fastened securely by means of angle irons to a base. A good coat of insulating black paint is given to the whole transformer.

Mount the transformer vertically as per sketch, (figure 6) which will allow maximum circulation of air. Obtain a piece of bakelite, radion rubber, or the like, 2 inches x 6 inches and use it for a terminal strip fastening it to the core, so that there will be plenty of room behind for changes or repairs. Mark each lead and terminal with white paint so that it is easy to decipher, as even the

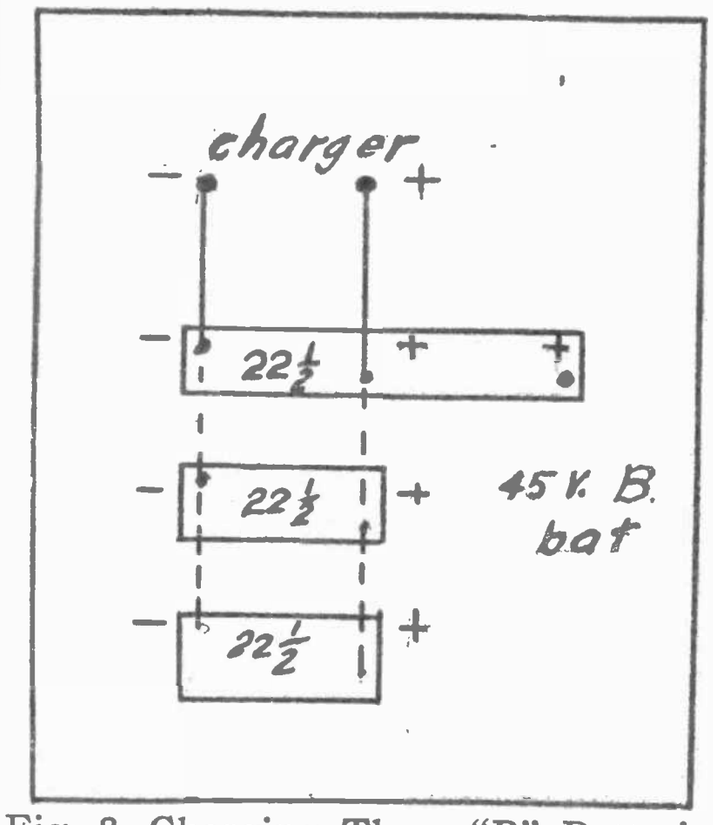


Fig. 8. Charging Three "B" Batteries

builder will forget after a while which terminal is which.

Bulb Has 3 Terminals

A mogul socket (obtainable at any electricians) is necessary for the tungar bulb to screw into. A piece of brass rod or stiff bus bar is placed vertically alongside the bulb to make the connection at the top with the plate terminal. The bulb has three terminals, two for the filament and one for the plate. The latter connection is at the top of the bulb, and is made by a clip. The two filament connections are made when the bulb is screwed in the socket, like an ordinary electric lamp.

Five Ampere Bulb

The dimensions, diagram, etc., as given above are for the five-ampere tungar bulb. The secondary was tapped at 75 and 110 turns. See Fig. 7. The turns and voltages corresponding to the letters are: "A," 75 turns, 15 volts; "B," 110 turns, 22 volts; "C," 180 turns, 36 volts.

This means that tap "A" or "B" will be used for charging the "A" battery while the tap "C" giving about 36 volts will be just right to charge the "B" battery with. Only 22-volt "B" batteries can be charged in this fashion as the pressure is not great enough to charge a larger battery. If you have a 45 or 90-volt battery it can be connected as Fig. 8. If the battery cannot be broken up, that is, separated into two or more 22-volt units, it will be necessary to charge one unit at a time as shown. If the battery can be divided into 22-volt sections, however, the units should be all connected in parallel as indicated by the dotted lines.

When starting the "B" battery charge,

Continued on Page 28

Fone Fun For Fans

Secret of Success

"What is the secret of success?" asked the Sphinx.

"Take pains," said the window.

"Push," said the button.

"Always keep cool," said the ice.

"Never lose your head," said the barrel.

"Be up-to-date," said the calendar.

"Make light of everything," said the fire.

"Do a driving business," said the hammer.

"Aspire to greater things," said the nutmeg.

"Find a good thing and stick to it," said the glue.—*Blackwell, Okla., Buckshot.*

Fable of the Unusual Cop

Once there was a traffic cop who was kind and considerate, and who never failed, when the engine died on the street, to come over and say, "That's too bad. But don't get excited. Take your time getting her out. The people behind don't mind."

That copper died from being kissed so much by motorists.—*Motor Age.*

The Educated Static

What we can't understand about the radio is how the static knows you have company that night.—*Roanoke World News.*

An Advertising Cow

Little Jane was walking in the country with her mother.

"Gracious!" exclaimed mother, "what is that noise?"

"Oh, that's a cow mooing—trying to sell her milk," said Jane.—*The Progressive Grocer.*

Time to Cheer

Steamboat Captain (who has just fallen overboard)—"Don't stand there like a dumbell. Give a yell, can't you?"

College Stude Deckhand—"Certainly, sir, Rah! Rah! Rah! Rah! Captain!"—*Denver Clarion.*

Succeeded Only Too Well

We knew a cashier who wished to be one of the 400 and now he is No. 387.—*Santa Barbara News.*

BUILD YOUR OWN CHARGER

Continued from Page 27

put a 50-watt, 110-volt lamp in series as per Fig. 9.

This will limit the current to about 1/10 of an ampere which is right for the ordinary "B" battery. If two blocks are connected in parallel then this current may be doubled by using a 100-watt lamp. If this is not done the current will be lowered and the charge will take so much longer, no other disadvantage except the time will be experienced. Such a small current as this cannot be read on the ordinary meter. The length of time necessary to charge your "B" battery can be found by trial. Measure the voltage with a volt meter or battery tester and when the reading is unchanged over a period of two hours you will know that it is full. One night's charge every two or three weeks is usually about right.

If the battery gases violently (gets hot) then the lamp is too big and a lower watt size should be used. The battery will gas slowly even on normal charge. Two 6-volt "A" batteries may be connected in series, or one 12-volt "A" may be charged from tap 6. Always remember that the charging pressure must be several volts above that of the battery it is charging. The positive pole must also be connected to the positive post of the charger.

The complete circuit for the five-ampere tungar charger is given in Fig. 9. Once wired up in this fashion, it is only necessary to throw the switch to left or to right to have the battery on charge or discharge respectively. The rectifier is started and stopped automatically by the same switch. The meter is an automobile type of 0-15 charge and discharge. They are very cheap (use a Ford model at about $1.50) and are a necessity. The fuse is rated at 10 amperes.

SILENCING THE ETHER SQUEALS

Continued from Page 10

the oscillating condition, but without the danger of troubling anyone. So for the first time all the convenience and powerful amplification of the usual regenerative set can be fully used by the listener without the risk of bothering other people.

Broadcasting depends, for its full usefulness, on freedom from interference caused by other broadcast listeners. This is particularly important where receiving sets are crowded closely together. It also requires very sensitive, highly selective, and conveniently operated receivers which will give high quality of tone. Consequently a receiver such as this, using the new circuit, is a real step forward, and is truly a valuable contribution to art.

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. To pick up some stations, I have to turn the variable condenser entirely out, so that the plates are separated. Does that mean that the coil or condenser should be changed, and should it be made larger or smaller.

Answer. If the capacity has to be turned as low as possible (to zero on the scale) it means that the coil is too big. Usually fifty turns on a 3½-inch tube or sixty turns on a 3-inch tube with wire about No. 22 or No. 24, will be found plenty big enough. By taking off ten to twenty turns from your coil you will have to adjust the condenser so that the plates interlock or mesh part way to pick up the same station. This will give you room to turn it down to get the higher frequency (lower wave length) stations.

HOW TO WIRE YOUR HOOK-UP

Continued from Page 7

of all the tubes will rise and fall together and if one is right, they are all correct. The rheostat may get fairly hot, since it does all the work, but unless it reaches a temperature where it will carbonize a piece of tissue paper, there will be no trouble on this account.

Fig. 4 shows better how the grid return from the amplifier must be connected to get the best results. The plate circuit does not appear, since it has nothing to do with this connection. The coil attached to the grid will be the secondary of the transformer. This will represent a step of either radio or audio amplification.

The end of the secondary opposite the grid is called "the grid return." It is shown connected to the "A" minus and separated from the negative end of the filament by the rheostat. That is how the drop in voltage is applied to the grid.

Such a connection is not right for a detector. No negative bias is needed here. The grid return from the detector (Fig. 5.) comes from the coil, which will be the secondary of a radio frequency transformer provided such is used ahead of the detector, or else it will be the stator of a variocoupler, which is used as the tuner. This grid return is not run to the "A"— but to the *plus* terminal of the filament. This connection is correct for every kind of tube in any hook-up. That is why it is better to use it, and then if later on you want to change the kind of tube you use for detector it can be done without any alteration of the hook-up.

Those Parallel Wires

All directions say that wires in a radio should not be run parallel and close together. This is wrong as applied to some of the leads. Wires which carry radio frequency which oscillates about one million times per second (1000 kc.), should be kept away from other metal as if they are close together they act like plates of a condenser and a lot of the energy is lost. But the direct current lines, like the "A" and "B" battery wires and the low frequency or audio conductors are not affected by these small capacities.

Indeed in many hook-ups you will see a large capacity like a .1 mfd. condenser connected between certain pairs of these wires. How foolish to increase this capacity to a large amount and then make sure it is as low as possible. Fig. 6 shows a grouping of all the wires, which may be run parallel and so that they all but touch without causing any trouble at all. But notice, that the aerial and the grid and plate connections are kept far away from them.

Omitting the "B" Minus Lead

The negative side of the "B" battery will work equally well when connected to either the plus or minus side of the "A" battery. But when hooked-up to the "A"+ the voltage on the plate will be slightly greater than when the "A"— is used. For that reason it is usually shown with a wire connecting "A"+ and "B"—. Such a connection may be made outside the set, if the two batteries are placed together on the floor. Run a short wire as shown in Fig. 7, and then the "B"— lead may be omitted entirely. Two pairs of lamp cord will then take the place of five wires running to the batteries. Of course, if only two terminals of the "B" battery are used instead of three as shown, then three wires will do the entire trick.

New Products of Unusual Interest

A LOUD SPEAKER IN YOUR PHONOGRAPH

There are a good many attachments on the market for changing a phonograph or Victrola into a loud speaker for the radio set. As far as we know, with one exception, they are all alike in principle. They consist of a single head phone with the customary magnets and diaphragm. This unit is slipped on the end of the tone arm in place of the reproducer. Of course, such a scheme is a good one and ordinarily gives results which are quite satisfactory.

The one exception just mentioned is the Dulce-Tone. This makes use of an entirely different principle. It consists

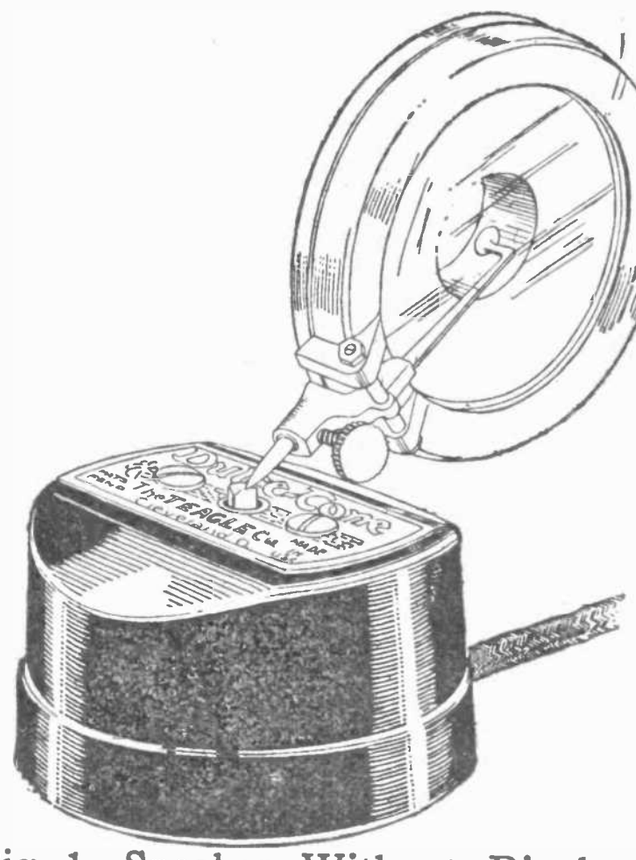


Fig 1. Speaker Without Diaphragm

of a steel framework something like the letter "E" turned over on its back.

The outside or "U" part of the steel is a permanent magnet. The center leg or tongue has a coil wound very loosely around it, which is connected to the output jack from the loud speaker. The varying currents in this coil make the tongue more or less magnetic, depending on the music coming in. This tongue is made quite flexible, so that the upper end is attracted by one pole of the permanent magnet and repelled by the other when the current through the coil is positive and this motion is reversed when the current reverses. In this way, the flexible tongue vibrates back and forth inside the coil. It does not strike, owing to the looseness of the fit between it and the coil.

The upper end of the tongue has a little groove cut in it, and in this groove is rested the end of their producer needle of the phonograph. As the tongue oscillates back and forth with the music it carries the end of the needle with it in just the same way that a record would have made it vibrate. Of course, the needle carries the diaphragm of the reproducer with it and that makes the music through the horn.

Notice that no diaphragm is used in the Dulce-Tone. This unit merely replaces the record and lets the reproducer make its own music, just as usual. This has two advantages—in the first place, since the reproducer has been designed by the phonograph manufacturers to go with the particular horn of your machine, there is no doubt, but that it fits better than any similar unit made to go with *every* phonograph. Besides this, it is not necessary to remove any part of your machine to play the radio. No record is put on the turn table, but in its place is laid this new unit. When you want to shift to a record again, merely pick up the attachment. Fig. 1 shows it in position. It gives a loud and sweet tone.

A NO-DRILL LEAD-IN

In installing the aerial there is usually trouble in getting the lead-in through the window. Some people have drilled the frame and inserted a porcelain tube in the hole. This makes an easy method of bringing the wire indoors, but has some drawbacks.

First and foremost it ruins the appearance of the window sash. The landlord will certainly make a howl when he sees it. Besides this it prevents the window from going up and down, and this is awkward on a hot summer day. If you have a long drill the side of the wall may have a hole put through it, which will not obstruct the opening of the window. This is apt to cause a leak in a hard thunder shower.

To get away from these difficulties a special lead-in strap has been made by the Electrad Company. This is built of a strip of thin copper with a spring connection clip at each end. Heavy insulation is wrapped around the center of the strap and over this is placed a strip of stout webbing. The strap is placed on the window sill, as shown in the illustration, Fig. 2, and the window is closed, the sill resting on the insulated part.

There is always space enough around a sash to allow this very thin lead-in to pass under the sash without obstructing its movement.

It is a difficult matter to solder connections in an aerial system and, unless the joints are soldered or are well

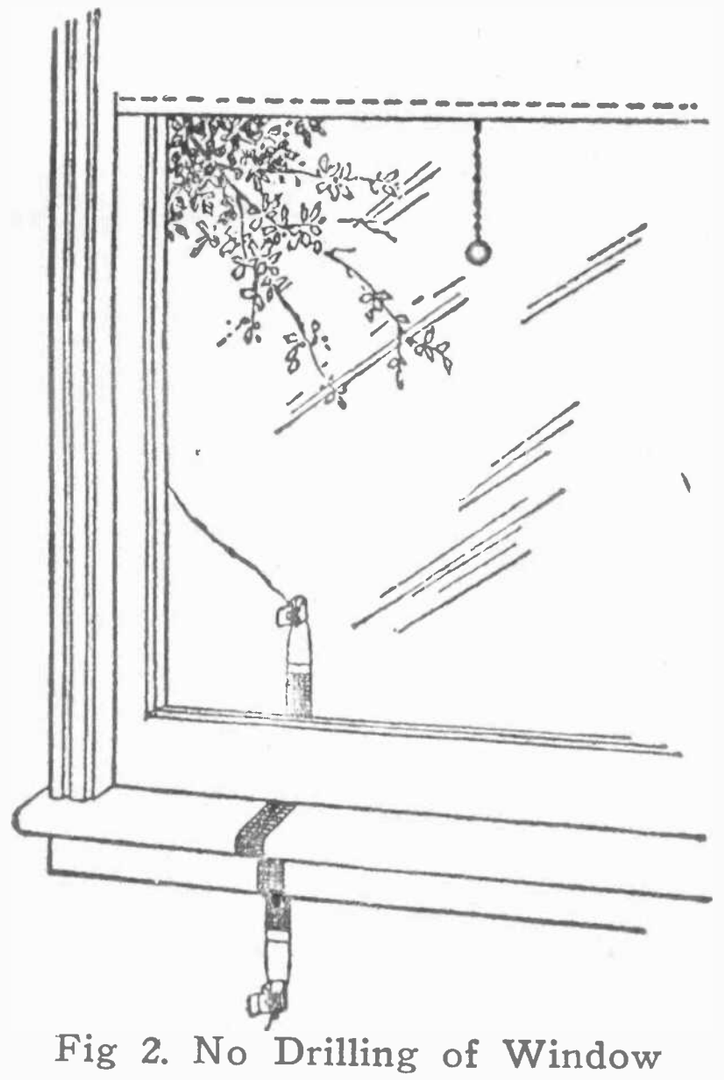


Fig 2. No Drilling of Window

made, they soon corrode when exposed to the atmosphere. The lead-in wire may be fastened directly to the clip, and the wire to the set, fastened on the other end.

It is often better to place a lead-in at the top of the upper sash, where it will be out of the way and there will be no danger of disturbing it by opening the window. It is better protected from the weather in this manner and the lead-in does not show in front of the window. This labor-saver lightens the task of erecting an aerial and makes a more efficient insulation. It has gained the favor of the landlords because its use does not in any way spoil the appearance of the woodwork of the building.

UNITED STATES BROADCASTING STATIONS ARRANGED ALPHABETICALLY BY CALL LETTERS

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

	W.L.	K.C.	W.P.
KDKA—Westinghouse Elec. & Mfg. Co., East Pittsburgh	326-	920-	1000
KDPM—Westinghouse Elec. & Mfg. Co., Cleveland, O.	270-	1110-	500
KDPT—Southern Electrical Co., San Diego, Cal.	244-	1230-	100
KDYM—Savoy Theatre, San Diego, Cal.	280-	1070-	100
KDYQ—Oregon Institute of Technology, Portland, Ore.	360-	834-	100
KDZB—Frank E. Seifert, Bakersfield, Cal.	240-	1250-	100
KDZE—The Rhodes Co., Seattle, Wash.	270-	1110-	100
KDZF—Auto. Club of So. Cal., Los Angeles, Cal.	278-	1080-	500
KFAB—Buick Auto Co., Lincoln, Neb.	240-	1250-	200
KFAD—McArthur Bros. Mercantile Co., Phoenix, Ariz.	360-	908-	100
KFAE—State College of Washington, Pullman, Wash.	330-	910-	500
KFAF—Western Radio Corp., Denver, Col.	360-	833-	500
KFAJ—University of Colorado, Boulder, Col.	360-	833-	100
KFAQ—City of San Jose, San Jose, Cal.	360-	833-	250
KFAR—Studio Lighting Service Co., Hollywood, Cal.	227-	1320-	100
*KFAU—Boise High School, Boise, Idaho.	275-	1090-	500
KFBB—F. A. Buttrey & Co., Havre, Mont.	275-	1090-	100
KFBG—Search Light Publishing Co., Fort Worth, Tex.	254-	1180-	100
KFBK—Kimball-Upson Co., Sacramento, Cal.	283-	1060-	100
*KFCF—Frank A. Moore, Walla Walla, Wash.	256-	1170-	100
KFCL—Los Angeles Union Stockyards, Los Angeles, Cal.	236-	1270-	500
KFCM—Richmond Radio Shop, Richmond, Cal.	244-	1220-	100
KFCZ—Omaha Central High School, Omaha, Neb.	259-	1160-	100
KFDH—University of Arizona, Tucson, Ariz.	268-	1120-	150
KFDM—Magnolia Petroleum Co., Beaumont, Texas	306-	980-	500
KFDX—Frst Baptist Church, Shreveport, La.	250-	1200-	100
KFDY—So. Dakota State College, Brookings, So. Dakota	273-	1100-	100
KFEL—Winner Radio Corp., Denver, Col.	254-	1180-	100
KFEQ—J. L. Scroggin, Oak, Neb.	268-	1120-	100
KFEX—Augsburg Seminary, Minneapolis, Minn.	261-	1150-	100
*KFFV—Graceland College, Lamoni, Iowa.	250-	1200-	100
KFFY—Louisiana College, Alexandria, La.	275-	1090-	100
*KFGC—Louisiana State Univ., Baton Rouge, La.	268-	1120-	100
KFGD—Chickasha Radio & Elec. Co.	248-	1195-	200
KFGH—Leland Stanford Jr. Univ., Stanford Univ., Cal.	273-	1100-	250
KFGJ—Mo. Natl. Guard, 138th Infantry, St. Louis, Mo.	265-	1130-	100
KFGX—First Presbyterian Church, Orange, Tex.	250-	1200-	500
KFHD—Utz Elec. Shop Co., St. Joseph, Mo.	226-	1365-	100
KFHJ—Fallon & Co., Santa Barbara, Cal.	360-	833-	100
KFHR—Star Elec. & Radio Co., Seattle, Wash.	263-	1140-	100
KFI—Earle C. Anthony, Inc., Los Angeles, Cal.	469-	640-	1500
*KFIF—Benson Polytechnic Institute, Portland, Ore.	248-	1210-	100
KFIX—R. C., Jesus Christ of L. D.Stas., Ind'p'nd'n'e,Mo.	268-	1120-	250
KFIZ—D'ly C'm'nw'h & S. Radio C'p., Fond d'L'c, Wis.	273-	1100-	100
KFJC—Seattle Post Intellegencer, Seattle, Wash.	270-	1110-	100
KFJF—National Radio Mfg. Co., Oklahoma, Okla.	261-	1150-	225
KFJK—Delano Radio & Electric Co., Bristow, Okla.	233-	1290-	100
KFJM—University of N. Dakota, Grand Forks, N. Dak.	280-	1070-	100
KFKB—Brinkley-Jones Hospital Assn., Milford, Kans.	286-	1070-	500
KFKQ—Conway Radio Laboratories, Conway, Ark.	250-	1200-	100
*KFKU—Univ. of Kansas, Lawrence, Kansas.	275-	1090-	500
KFKX—Westinghouse Elec. & Mfg. Co., Hastings, Neb.	285-	880-	1000
KFLE—National Education Service, Denver, Col.	268-	1110-	100
KFLR—Korber Wirelss Station, Albuquerque, N. Mexico.	254-	1180-	100
KFLZ—Atlantic Automobile Club, Atlantic, Ia.	273-	1098-	100
KFLV—Swedish Evang. Mission Church, Rockford, Ill.	229-	1310-	100
KFMX—Carleton College, Northfield, Minn.	283-	1071-	500
KFNF—Henry Field Seed Co., Shenandoah, Iowa.	266-	1145-	500
KFOA—The Rhodes Co., Seattle, Wash.	454-	660-	500
KFOC—First Christian Church, Whittier, Cal.	236-	1290-	100
KFON—Echophone Radio Shop, Long Beach, Cal.	234-	1290-	100
KFOU—Hommel Mfg. Co., Richmond, Cal.	254-	1180-	100
KFOX—Technical High School, Omaha, Neb.	248-	1210-	100
KFOZ—Taft Radio Co., Hollywood, Cal.	240-	1250-	250
KFPG—Garretson & Dennis, Los Angeles, Cal.	238-	1260-	100
KFPL—C. C. Baxter, Dublin, Texas.	252-	1190-	100
KFPR—L. A. County Forestry Dept., Los Angeles, Cal.	231-	1300-	500
KFPT—The Deseret News, Salt Lake City, Utah.	360-	833-	500
KFPX—First Presbyterian Church, Pine Bluff, Ark.	242-	1240-	100
KFPY—Symons Investment Co., Spokane, Wash.	283-	1060-	100
*KFQC—Kidd Brothers Radio Shop, Tait, Cal.	231-	1300-	100
KFQD—Chovin Supply Co., Anchorage, Alaska.	280-	1070-	100
KFQI—Thomas H. Ince Corp., Culver City, Cal.	234-	1280-	100
KFQM—Texas Highway Bulletin, Austin, Texas.	268-	1120-	100
KFQU—W. Riker, Holy City, Cal.	234-	1280-	100
KFQV—Omaha Grain Exchange, Omaha, Neb.	231-	1300-	100
KFQX—Alfred M. Hubbard, Seattle, Wash.	233-	1290-	500
KFRA—Marvin S. Olsen, Carver, Minn.	240-	1250-	100
KFRB—Hall Brothers, Beeville, Texas.	248-	1210-	250
KFRN—United Churches of Olympia, Olympia, Wash.	220-	1360-	100
KFSG—Echo Park Evangelistic Ass'n, Los Angeles, Cal.	278-	1069-	500
*KFUM—W. D. Corley, Colorado Springs, Col.	242-	1240-	100
*KFUO—Concordia Theological Seminary, St. Louis, Mo.	549-	546-	500
*KGO—General Electric Co., Oakland, Cal.	312-	960-	1500
KGU—Marion A. Mulreny, Honolulu, Hawaii.	360-	833-	500
KGW—Portland Morning Oregonian, Portland, Ore.	492-	610-	500
KHJ—Times-Mirror Co., Los Angeles, Cal.	395-	760-	500
KHQ—Louis Wasmer, Seattle, Wash.	360-	833-	100
KJR—Northwes' Radio Service Co., Seattle, Wash.	270-	1110-	100
*KJS—Bible Institute of Los Angeles, Los Angeles, Cal.	252-	1190-	500
KLS—Warner Brothers, Oakland, Cal.	360-	833-	250
KLX—Tribune Publishing Co., Oakland, Cal.	508-	590-	500
KLZ—Reynolds Radio Co., Denver, Col.	283-	1060-	500
KNT—Grays Harbor Radio Co., Aberdeen, Wash.	263-	1140-	250
KNV—Radio Supply Co., Los Angeles, Cal.	256-	1188-	100
KNX—Los Angeles Express, Los Angeles, Cal.	337-	890-	500
KOA—General Electric Co., Denver, Col.	323-	930-	1500
KOB—N. M. C. of Agri. & Mech. Arts. State Col., N. M.	360-	833-	500
*KOP—Detroit Police Dept., Detroit, Mich.	278-	1090-	500
KPO—Hale Bros., San Francisco, Cal.	422-	710-	500
KQV—Doubleday-Hill Electric Co., Pittsburgh, Pa.	275-	1090-	500
*KSAC—Kansas Agri. Col., Manhattan, Kansas.	341-	880-	500
KSD—Post Dispatch, St. Louis, Mo.	545-	550-	500
*KTHS—New Arlington Hotel, Hot Springs, Ark.	375-	800-	500
KTW—First Presbyterian Church, Seattle, Wash.	360-	833-	750
KUO—Examiner Printing Co., San Francisco, Cal.	360-	833-	150
KUS—City Dye Works & Laundry Co., L. Angeles, Cal.	360-	833-	100
KUVQ—Kreetan Co., Johnswood Drummond Island, Mich.	450-	666-	1000
KWG—Portable Wireless Tel. Co., Stockton, Cal.	360-	833-	100
KWH—Los Angeles Examiner, Los Angeles, Cal.	360-	833-	500
KYQ—Electric Shop, Honolulu, Hawaii.	270-	1110-	100
KYW—Westinghouse Elec. & Mfg. Co., Chicago, Ill.	535-	560-	1500
KZM—Western Radio Institute, Oakland, Cal.	360-	833-	100
KZKZ—Electrical Supply Co., Manila, P. I.	270-	1110-	100
KZN—The Desert News, Salt Lake City, Utah.	360-	834-	500
*KZRQ—Far Eastern Radio, Inc., Manila, P. I.	222-	1360-	500
*KZUY—F. Johnson Elser, Manila, P. I.	370-	812-	500
WAAB—Valdemar Jensen, New Orleans, La.	268-	1120-	100
WAAC—Tulane University, New Orleans, La.	360-	833-	400
WAAF—Chicago Daily, Drovers Journal, Chicago, Ill.	278-	1080-	200
WAAM—I. R. Nelson Co., Newark, N. J.	263-	1140-	250
*WAAW—Omaha Grain Exchange, Omaha, Neb.	278-	1080-	500
WAAZ—Hollister-Miller Motor Co., Emporia, Kans.	360-	833-	100
WABE—Y. M. C. A., Washington, D. C.	283-	1060-	100
WABI—Bangor Ry. & Elec. Co., Bangor, Me.	240-	1250-	100
WABL—Conn. Agri. College, Storrs, Conn.	283-	1060-	100
WABM—F. E. Doherty Auto. & R'dio Co., Saginaw, M.	254-	1180-	100
*WABO—Rochester, N. Y.	278-	1080-	100
WABT—Holliday-Hall Elec. Engineers, Washington, Pa.	252-	1190-	100
WABU—Victor Talking Machine Co., Camden, N. J.	225-	1330-	100
WAHG—A. H. Grebe & Co., Richmond Hill, N. Y.	316-	950-	500
WBAA—Purdue University, West Lafayette, Ind.	283-	1060-	250
WBAD—Sterling Electric Co., Minneapolis, Minn.	360-	833-	100
WBAK—Penn. State Dept. of Police, Harrisburg, Pa.	400-	750-	500
WBAN—Wireless Phone Corp., Paterson, N. J.	244-	1230-	100
WBAP—Wortham-Carter Pub. Co., Fort Worth, Tex.	476-	630-	1000
WBAV—Erner & Hopkins Co., Columbus, Ohio.	390-	770-	500
WBAW—Marietta College, Marietta, Ohio.	246-	1220-	250
*WBAX—John H. Stenger, Jr., Wilkes-Barre, Pa.	256-	1170-	100
WBAY—American Tel. & Tel. Co., New York, N. Y.	492-	610-	500
WBBF—Georgia School of Technology, Atlanta, Ga.	270-	1110-	500
WBBG—Irving Vermilya, Mattapoisett, Mass.	248-	1210-	500
WBBL—Grace Covenant Church, Richmond, Va.	283-	1060-	100
WBBM—H. Leslie Atlass, Chicago, Ill.	226-	1330-	200
WBBR—Peoples' Pulpit Ass'n, Roseville, N. Y.	244-	1230-	100
*WBCN—Foster & McDonnell, Chicago, Ill.	266-	1130-	500
WBN—Ott Radio, Inc., La Crosse, Wis.	244-	1230-	500
WBR—Penn. State Police, Butler, Pa.	286-	1050-	250
WBS—D. W. May, Inc., Newark, N. J.	360-	833-	100
WBT—Southern Radio Corp., Charlotte, N. C.	360-	833-	500
WBU—City of Chicago, Chicago, Ill.	286-	1050-	500
*WBZ—Westinghouse Elec. & Mfg. Co., Springfield, Mass.	327-	890-	1500
WCAD—St. Lawrence University, Canton, N. Y.	263-	1140-	250
WCAE—Kaufmann & Baer Co., Pittsburgh, Pa.	461-	650-	500
*WCAH—Entrekin Electric Co., Columbus, Ohio.	266-	1130-	200
WCAJ—Nebraska Wesleyan Univ., Univ. Place, Neb.	280-	1070-	500
WCAL—St. Olaf College, Northfield, Minn.	360-	833-	500
WCAP—Chesapeake & Potomac Tel. Co., Washingt'n, D. C.	469-	640-	500
*WCAR—Alamo Radio Elec. Co., San Antonio, Texas.	263-	1140-	100
WCAS—W. H. Dunwoody Ind. Inst., Minneapolis, Minn.	280-	1220-	100
WCAT—S. Dakota State Sch. of Mines, Rapid City, S. D.	240-	1250-	100
WCAU—Durham & Co., Philadelphia, Pa.	278-	1080-	500
WCAX—Univ. of Vermont, Burlington, Vt.	360-	834-	100
WCAY—Milwaukee Civic Broad. Assn., Milwaukee, Wis.	266-	1130-	250
WCBC—Univ. of Michigan, Ann Arbor, Mich.	229-	1310-	200
WCBD—Wilbur G. Voliva, Zion, Ill.	345-	870-	500
*WCBI—Nicoll, Duncan & Rush, Bemis, Texas.	226-	1330-	150
WCBN—Chicago, Ill.	266-		500
WCBQ—First Baptist Church, Nashville, Tenn.	236-	1270-	100
WCBT—Clark University, Worcester, Mass.	238-	1260-	250
WCCO—Washburn-Crosby Co., Minneapolis, Minn.	417-	720-	500
*WCK—Stix, Baer & Fuller Dry Goods Co., St. Louis, Mo.	273-	1100-	100
WCX—Detroit Free Press, Detroit, Mich.	517-	580-	500
WCKB—E. Richard Hall, St. Petersburg, Fla.	266-	1130-	500
WCM—Texas Mkts. & Warehouse, Dept., Austin, Tex.	268-	1120-	250
WDAE—Tampa Daily Times, Tampa, Fla.	273-	1100-	250
WDAF—Kansas City Star, Kansas City, Mo.	411-	730-	500
WDAG—J. Laurance Martin, Amarillo, Texas.	263-	1140-	100
WDAH—Trinity Methodist Church, El Paso, Texas.	268-	1120-	100
WDAR—Lit Brothers, Philadelphia, Pa.	395-	760-	500
WDAU—Slocum & Kilburn, New Bedford, Mass.	360-	833-	100
WDAX—First National Bank, Centerville, Iowa.	360-	833-	100
*WDBE—Gilham, Schoen Electric Co., Atlanta, Ga.	278-	1080-	100
WDBH—C. T. Sherer, Co., Worcester, Mass.	268-	1120-	100
WDBR—Tremont Temple Baptist Church, Boston, Mass.	256-	1170-	100
WDBY—North Shore Cong. Church, Chicago, Ill.	258-	1160-	500
*WDWF—D. W. Flint, Providence, R. I.	441-		500
WEAA—Frank D. Fallon, Flint, Mich.	234-	1280-	100

	W.L.	K.C.	W.P.
*WEAF—Amer. Tel. & Tel, Co., New York, N.	492-	610-	2000
*WEAH—Wichita Board of Trade, Wichita, Kas	268-	1120-	100
*WEAI—Cornell University, Ithaca, N. Y	254-	1180-	500
*WEAJ—Univ. of S. Dakota, Vermillion, S. Dakota	278-	1080-	100
WEAM—Borough of N. Plainfield, N. Plainfield, N. J	261-	1150-	250
WEAN—Shepard Co., Providence, R. I	273-	1100-	100
WEAO—Ohio State University, Columbus, Ohio	360-	834-	500
WEAP—Mobile Radio Co., Mobile Ala	263-	1140-	100
WEAS—Hecht Co., Washington, D. C	360-	833-	100
WEAU—Davidson Bros. Co., Sioux City, Iowa	275-	1090-	100
WEAY—Iris Theatre, Houston, Texas	360-	833-	500
WEB—Benson Radio Co., St. Louis, Mo	273-	1130-	500
WEBH—Edgewater Beach Hotel Co., Chicago, Ill	370-	810-	1000
WEBJ—Third Avenue Ry. Co., New York, N. Y	273-	1100-	500
WEBL—R. C. A. United States (portable)	226-	1330-	100
WEBW—Beloit College, Beloit, Wis	268-	1120-	500
*WEEI—Edison Elec. Ill'm'n't'g Co., Boston, Mass	405-	990-	500
*WEMC—Emmanuel Missionary Col., Berrien Springs, Mich	268-	1120-	500
WEV—Hurlburt-Still Electric Co., Houston, Texas	263-	1140-	100
WEW—St. Louis University, St. Louis, Mo	280-	1070-	100
WFAA—Dallas News & Dallas Journal, Dallas, Tex	476-	630-	500
WFAB—Carl F. Woese, Syracuse, N. Y	234-	1280-	100
WFAN—Hutchinson. Elec. Serv. Co., Hutchinson, Minn	286-	1050-	100
WFAV—Univ. of Nebraska, Dept. of E. Eng., Lincoln, Neb	261-	1250-	250
WFBB—Eureka College, Eureka, Ill	261-	1250-	150
*WFBG—William F. Gable Co., Altoona, Pa	278-	1080-	100
WFBH—Concourse Radio Corp., New York, N. Y	273-	1100-	500
WFBI—Galvin Radio Supply Co., Camden, N J	236-	1270-	100
WFBK—Dartmouth College, Hanover, N. H	256-	1170-	100
*WFBL—Onondaga Hotel, Syracuse, N. Y	252-	1190-	100
WFBM—Merchants Heat & Light Co., Indianapolis, Ind	268-	1120-	250
WFBN—Radio Sales & Service Co., Bridgewater, Mass	226-	1330-	200
WFBR—5th Infantry, Maryland, N. G., Baltimore, Md	254-	1180-	100
WFBW—Ainsworth-Gates Radio Co., Cincinnati, Ohio	309-	970-	750
*WFBY—U. S. Army, Fort Benj. Harrison, Ind	258-	1160-	100
WFI—Strawbridge & Clothier, Philadelphia, Pa	395-	760-	500
WGAQ—Youree Hotel, 406 Market St., Shreveport, La	263-	1140-	100
WGAY—Northwestern Radio Co., Madison, Wis	360-	833-	100
WGAZ—South Bend Tribune, South Bend, Ind	275-	1090-	250
*WGBB—Harry H. Carman, Freeport, N. Y	244-	1240-	100
*WGBG—Breitenbach's Radio Shop, Thrifton, Va	226-	1330-	100
WGBS—Gimbel Brothers, New York, N. Y	316-	950-	1000
WGI—Am. R'dio & Res'ch Corp., Medf'd Hillside, Mass	360-	833-	100
WGL—Thomas F. J. Rowlett, Philadelphia, Pa	360-	833-	500
WGN—Drake Hotel (Whitestone Co.), Chicago, Ill	370-	710-	1000
WGR—Federal Manufacturing Co., Buffalo, N. Y	319-	940-	750
*WGY—General Electric Co., Schenectady, N. Y	380-	790-	1500
WHA—University of Wisconsin, Madison, Wis	275-	1090-	500
WHAA—State Univ. of Iowa, Iowa City, Iowa	484-	620-	500
*WHAD—Marquette University, Milwaukee, Wis	275-	1090-	500
WHAG—University of Cincinnati, Ohio	233-	1290-	100
*WHAM—University of Rochester, Rochester, N. Y	278-	1080-	100
WHAR—Seaside Hotel, Atlantic City, N. J	275-	1090-	200
WHAS—Courier-Journal & Louisville Times, Louisville, Ky	400-	750-	500
WHAV—Wilmington Elec. Spec. Co., Wilmington, Del	266-	1130-	100
WHAZ—Rensselaer Polytechnic Institute, Troy, N. Y	380-	790-	500
WHB—Sweeney School Co., Kansas City, Mo	411-	730-	500
WHK—Radiovex Co., Cleveland, Ohio	283-	1060-	100
WHN—Loew's State Theatre Bldg., New York, N. Y	360-	833-	500
WHO—Bankers Life Co., Des Moines, Iowa	526-	570-	500
WHQ—E. M. Tellefson, Mackinac Island, Mich	300-	999-	200
WIAC—Galveston Tribune, Galveston, Texas	360-	833-	100
WIAD—Howard R. Miller, Philadelphia, Pa	234-	1180-	100
WIAK—Journal-Stockman Co., Omaha, Neb	278-	1080-	250
WIAR—Paducah Evening Sun, Paducah, Ky	360-	833-	100
WIAS—Home Electric Co., Burlington, Iowa	283-	1060-	100
WIK—K. L. Electric Co., McKeesport, Pa	234-	1280-	100
WIP—Gimbel Brothers, Philadelphia, Pa	508-	590-	500
WJAB—American Electric Co., Lincoln, Neb	229-	1310-	100
*WJAD—Jackson's Radio Eng. Laboratories, Waco, Tex	353-	850-	500
*WJAG—Norfolk Daily News, Norfolk, Neb	270-	1110-	250
*WJAN—Peoria Star, Peoria, Ill	273-	1100-	100
WJAR—The Outlet Co., Providence, R. I	360-	833-	500
*WJAS—Pittsburgh Radio Supply House, Pittsburgh, Pa	275-	1090-	500
WJAX—Union Trust Co., Cleveland, Ohio	390-	770-	500
WJAZ—Zenith Radio Corp., Chicago, Ill. (portable)	268-	1120-	100
WJH—Wm. P. Boyer Co., Washington, D. C	273-	1100-	100
WJJD—Supreme Lodge Moose, Mooseheart, Ill	278-	1080-	500
WJY—R. C. A., New York, N. Y	405-	660-	500
WJZ—Broadcast Central, New York, N. Y	454-	660-	500
WKAA—H. F. Parr, Cedar Rapids, Iowa	278-	1080-	100
WKAF—W. S. Radio Supply Co., Wichita Falls, Tex	360-	833-	100
WKAQ—Radio Corp. of Porto Rico, San Juan, P. R	360-	833-	500
WKAR—Michigan Agr. College, E. Lansing, Mich	280-	1070-	500
WKY—WKY Radio Shop, Oklahoma, Okla	360-	833-	500
WLAG—Cutting & Radio Wash. Corp., Minneapolis, Minn	417-	720-	500
WLAH—Samuel Woodworth, Syracuse, N. Y	360-	834-	500
WLAL—Naylor Electric Co., Tulsa, Okla	360-	833-	100
WLAN—Putnam Hardware Co., Houlton, Me	283-	1060-	250
WLAW—Police Dept., New York City, N. Y	360-	834-	500
WLBL—Wisconsin Dept. of Markets, Stevens Pt., Wis	278-	1080-	500
WLS—Sears, Roebuck & Co., Chicago, Ill	345-	870-	500
WLW—Crosley Radio Corp., Cincinnati, O	423-	710-	1000
WMAC—Clive B. Meredith, Cazenovia, N. Y	275-	1090-	100
*WMAF—Round Hills Radio Corp., Dartmouth, Mass	349-	833-	500
WMAH—General Supply Co., Lincoln, Neb	254-	1180-	100
WMAK—Norton Laboratories, Lockport, N. Y	273-	1100-	500
WMAP—Utility Battery Service, Easton, Pa	246-	1220-	150
WMAQ—Chicago Daily News, Chicago, Ill	448-	670-	500
WMAT—Paramount Radio Corp., Duluth, Minn	226-	1130-	250
WSY—Alabama Polytechnic Institute, Auburn, Ala	250-	1200-	500
WMAY—Kingshighway Presbytern Church, St. Louis, Mo	280-	1070-	100
WMAZ—Mercer University, Macon, Ga	261-	1150-	100
WMC—"Commercial Appeal," Memphis, Tenn	500-	600-	500
WMH—Ainsworth-Gates Radio Co., Cincinnati, Ohio	309-	970-	750
WMU—Doubleday-Hill Elec. Co., Washington, D. C	261-	1150-	100
*WNAC—Shepard Stores, Boston, Mass	280-	1070-	100
WNAD—University of Oklahoma, Norman, Okla	254-	1180-	100
*WNAP—Wittenberg College, Springfield, Ohio	248-	1210-	100
WNAT—Lenning Brothers Co., Philadelphia, Pa	250-	1200-	100
WNAX—Dakota Radio Apparatus Co., Yankton, S. D	244-	1230-	100
WNYC—City of New York, New York, N. Y	526-	570-	1000
WOAC—Pagan Organ Co., Lima, Ohio	265-	1130-	150
WOAI—Southern Equipment Co., San Antonio, Tex	384-	780-	500
WOAL—William E. Woods, Webster Groves, Mo	229-	1310-	100
WOAN—Vaughn Conserv't'y Music, Lawrenceb'rg, Tenn	360-	833-	200
WOAR—Henry P. Lundskow, Kenosha, Wis	229-	1310-	100
WOAV—Penn. Nat'l Guard, 2d Bat., 112th Inf., Erie, Pa	242-	1240-	100
WOAW—Woodmen of the World, Omaha, Neb	526-	570-	500
WOAX—Franklyn J. Wolff, Trenton, N. J	240-	1250-	500
WOI—Iowa State College, Ames, Iowa	360-	833-	500
WOO—John Wanamaker, Philadelphia, Pa	508-	590-	500
WOQ—Unity School of Christianity, Kansas City, Mo	278-	1080-	500
WOR—L. Bamberger & Co., Newark, N. J	405-	740-	500
WOS—Mo. State Marketing Bureau, Jefferson City, Mo	441-	680-	500
*WPSC—Pennsylvania State College, State Colege, Pa	261-	1150-	500
WPAC—Donaldson Radio Co., Okmulgee, Okla	360-	833-	100
WPAH—Wisconsin Dept. of Markets, Waupaca, Wis	360-	833-	500
WPAJ—New Haven, Conn	268-	1120-	100
*WPAK—North Dakota Agri. Col., Agri. College, N. D	275-	1090-	250
WPAL—Avery & Loeb Elec. Co., Columbus, Ohio	286-	1050-	100
WPAM—Auerbach & Guettel, Topeka, Kansas	275-	1090-	100
*WPAZ—John R. Koch (Dr.), Charleston, W. Va	268-	1120-	100
WQAA—Horace A. Beale, Jr., Parkesburg, Pa	220-	1360-	500
WQAC—E. B. Gish, Amarillo, Texas	234-	1280-	100
WQAM—Electrical Equipment Co., Miami, Fla	268-	1120-	100
WQAN—Scranton Times, Scranton, Pa	250-	1120-	100
WQAO—Calvary Baptist Church, New York, N. Y	360-	833-	100
WQAQ—Abilene Daily Reporter, Abilene, Tex	360-	833-	100
*WQAS—Prince-Walter Co., Lowell, Mass	251-	1190-	100
WQJ—Calument Rainbo Broadcasting Co., Chicago, Ill	448-	670-	500
WRAL—No. States Power Co., St. Croix Falls, Wis	248-	1210-	100
WRAM—Lombard College, Galesburg, Ill	244-	1230-	250
*WRAV—Antioch College, Yellow Springs, Ohio	263-	1140-	100
WRAX—Flexon's Garage, Gloucester City, N. J	268-	1120-	100
WRBC—Immanuel Lutheran Church, Valparaiso, Ind	278-	1080-	500
WRC—Radio Corp. of America, Washington, D. C	469-	640-	500
WREO—Reo Motor Car Co., Lansing, Mich	288-	1040-	500
WRK—Doren Bros. Electric Co., Hamilton, Ohio	270-	1110-	200
WRL—Union College, Schenectady, N. Y	360-	833-	500
WRM—University of Illinois, Urbana, Ill	273-	1100-	500
*WRR—Dallas, Texas	261-	1150-	200
WRW—Tarrytown Radio Research Lab., Tarrytown, N. Y	273-	1100-	500
WSAB—State Teachers College, Cape Girardeau, Mo	275-	1090-	100
WSAC—Clemson Agri. Col., Clemson College, S. C	360-	833-	500
WSAD—J. A. Foster Co., Providence, R. I	261-	1150-	100
WSAH—A. G. Leonard, Jr., Chicago, Ill	248-	1210-	500
WSAI—U. S. Playing Card Co., Cincinnati, Ohio	309-	970-	1000
WSAJ—Grove City College, Grove City, Pa	254-	1180-	250
WSAP—7th Day Adventist Church, New York, N. Y	263-	1140-	250
WSAR—Doughty & Welch Elec. Co., Fall River, Mass	254-	1181-	100
WSAV—Clifford W. Vick Radio Const. Co., Houston, Tex	360-	833-	100
WSAY—Chamber of Commerce, Port Chester, N. Y	233-	1304-	100
WSAX—Chicago Radio Laboratory, Chicago, Ill	448-	670-	1000
WSB—Atlanta Journal, Atlanta, Ga	428-	700-	500
WSK—Reiss Steamship Co., Sheboygan, Wis	300-	999-	1000
WSL—J. & M. Electric Co., Utica, N. Y	273-	1100-	100
WSOE—School of Eng. of Milwaukee, Milwaukee, Wis	246-	1220-	100
WSY—Alabama Power Co., Birmingham, Ala	360-	833-	500
WTAB—Fall River Daily Hearld, Fall River, Mass	248-	1130-	100
*WTAC—Pennsylvania Traffic Co., Johnstown, Pa	209-	1430-	150
WTAM—The Willard Storage Battery Co., Cleveland, O	489-	770-	1500
WTAN—Orndorff Radio Shop, Mattoon, Ill	240-	1250-	100
WTAQ—S. H. Van Gorden & Son, Ossea, Wis	254-	1180-	100
WTAR—Reliance Electric Co., Norfolk, Va	261-	1150-	100
WTAS—Charles E. Erbstein, Elgin, Ill., near	286-	1050-	500
WTAT—Edison Electric Illum. Co., Boston, Mass	246-	1220-	100
WTAW—Agri. & Mech. College, College Station, Texas	270-	1110-	250
*WTAY—Oak Leaves Broadcasting Station, Oak Park, Ill	250-	1200-	500
WTG—Kansas State Agri. Col., Manhattan, Kas	485-	620-	1000
WWAD—Wright & Wright, Inc., Philadelphia, Pa	250-	1200-	500
WWAE—Alamo Ball Room Joliet, Ill	242-	1240-	500
WWAF—Galvin Radio Sup. Co., Camden, N. J	236-	1260-	500
WWAO—Michigan College of Mines, Houghton, Mich	244-	1230-	250
*WWI—Ford Motor Co., Dearborn, Mich	266-	1130-	500
WWJ—Detroit News, Detroit, Mich	517-	580-	500
WWL—Loyola University, New Orleans, La	268-	1120-	100

* Alterations and corrections.

Radio Dealers!

Practically every Radio Fan who comes into your store will subscribe to RADIO PROGRESS, if you will keep a few copies on your counter. Those who won't subscribe will at least buy a single copy.

Why not ring up some of this business on your Cash Register? We will help you and will put you in touch with our distributor in your territory.

You'll be surprised when you discover how big an item this business will amount to in the course of a year. And you take absolutely no risk, nor do you have to invest a single cent of capital.

GET ABOARD! Send us your name and address to-day.

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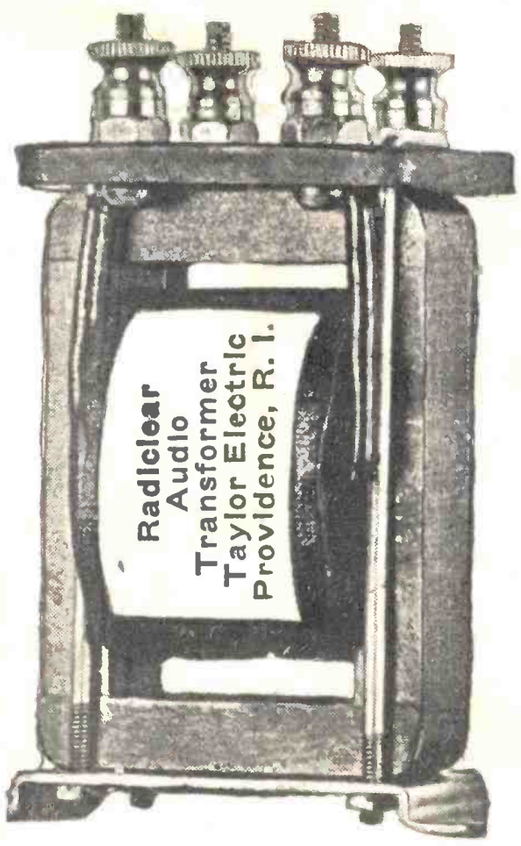
Happiness for $6.00 a Step!

Of course we mean one step of amplification. If you have a one or two-tube set you no doubt enjoy it, but it is nothing now compared with what it will be after you add one step of our RADICLEAR amplification. Instead of straining your ears to catch the murmur of that distant station, you will find that it comes in loud and clear.

Of course, any transformer will give increased loudness. Most of them also cause a lot of noise or distortion. The RADICLEAR transformer is noted for the fact that it never plays a tune of its own but reproduces only the program which the detector feeds to it.



One reason for the clear tone of the RADICLEAR is the measured air gap in the iron. Other units by interlacing the sheets or laminations get variable magnetic resistance. In our product the leaves are not interlaced, but are butted against each other with a measured air gap. The result is that the usual falling off in the tone of high and low notes is not found in this instrument.

The transformer itself sells for $3.95 postpaid.

If you want the entire kit, containing everything needed to add one step of audio to your set, the price is only $6.00. The kit contains the famous RADICLEAR transformer, socket, rheostat, four-spring jack, "B" battery binding post, and wire for the whole job. Use the blank for happiness.

The Taylor Electric Company,
1206 Broad Street,
Providence, R. I.

Please send me the following by parcel post. (Mark which one you want.)

Radiclear Audio Transformer @ $3.95
Amplifier Kit for.....tube @ $6.00
Audion Crystal @ 25c.
Gold Plated Cat Whisker @ 15c.

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

☐ Send them to me C. O. D. I will pay the above price plus postage. (Indicate which way you wish to pay.)

Name.....

Address.....

TAYLOR ELECTRIC CO.

1206 Broad Street

Providence, R. I.