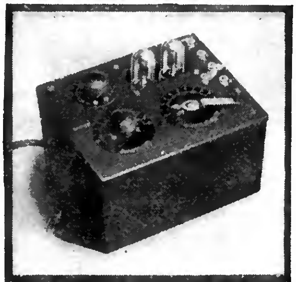
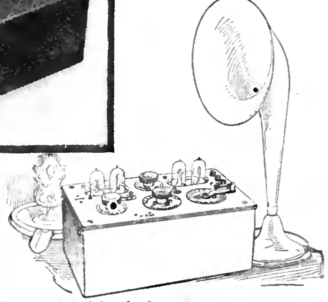
There's a Radiola for every purse

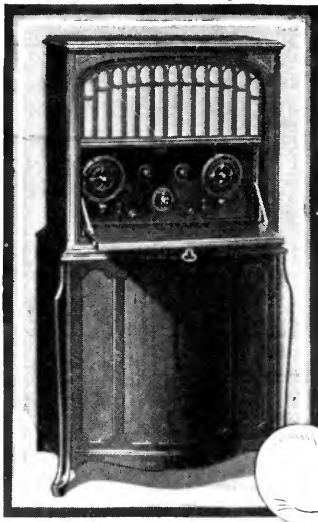
New and Revolutionary Radio Achievements in the new Radiolas



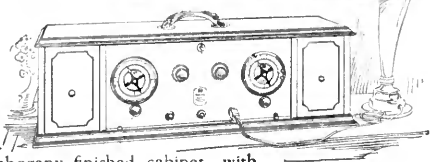
Radiola III, an improved two tube receiver of antenna type, sensitive and selective. *Complete* with two WD-11 Radiotrons and headphones (everything except batteries and antenna) . . . $35.



Radiola III-a, which is Radiola III and its balanced amplifier complete in one cabinet; including four WD-11 Radiotrons, headphones, and Radiola Loudspeaker (either type FH or UZ 1320.) Everything except antenna and batteries $100



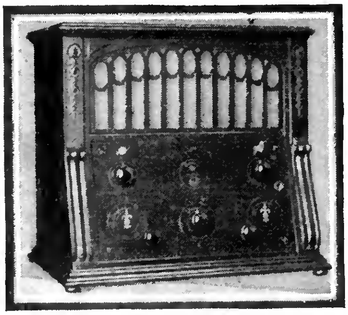
Radiola Super-VIII —an improved Super-Heterodyne. Selective and non-radiating. With *no antenna*, and no ground connection, it receives far distant stations, even while local ones are operating. Loudspeaker built in. *Complete* with six UV-199 Radiotrons — everything except batteries . . . . $425.



Radiola Super-Heterodyne, same as Super VIII but semi-portable in mahogany finished cabinet, with Radiola Loudspeaker. With six UV199 Radiotrons, but without batteries . . . . $286.

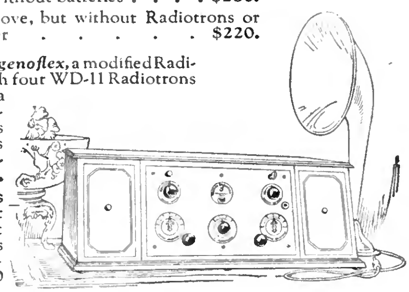
Same as above, but without Radiotrons or Loudspeaker . . . . . . $220.

Radiola X—selective and non-radiating. Remarkable for distance reception. Built-in type loudspeaker. Complete with four WD-11 Radiotrons—everything except batteries and antenna. $245.



Radiola Regenoflex, a modified Radiola X. With four WD-11 Radiotrons and Radiola Loudspeaker but less batteries and antenna . $206.

Same as above, but without Radiotrons and Loudspeaker $150



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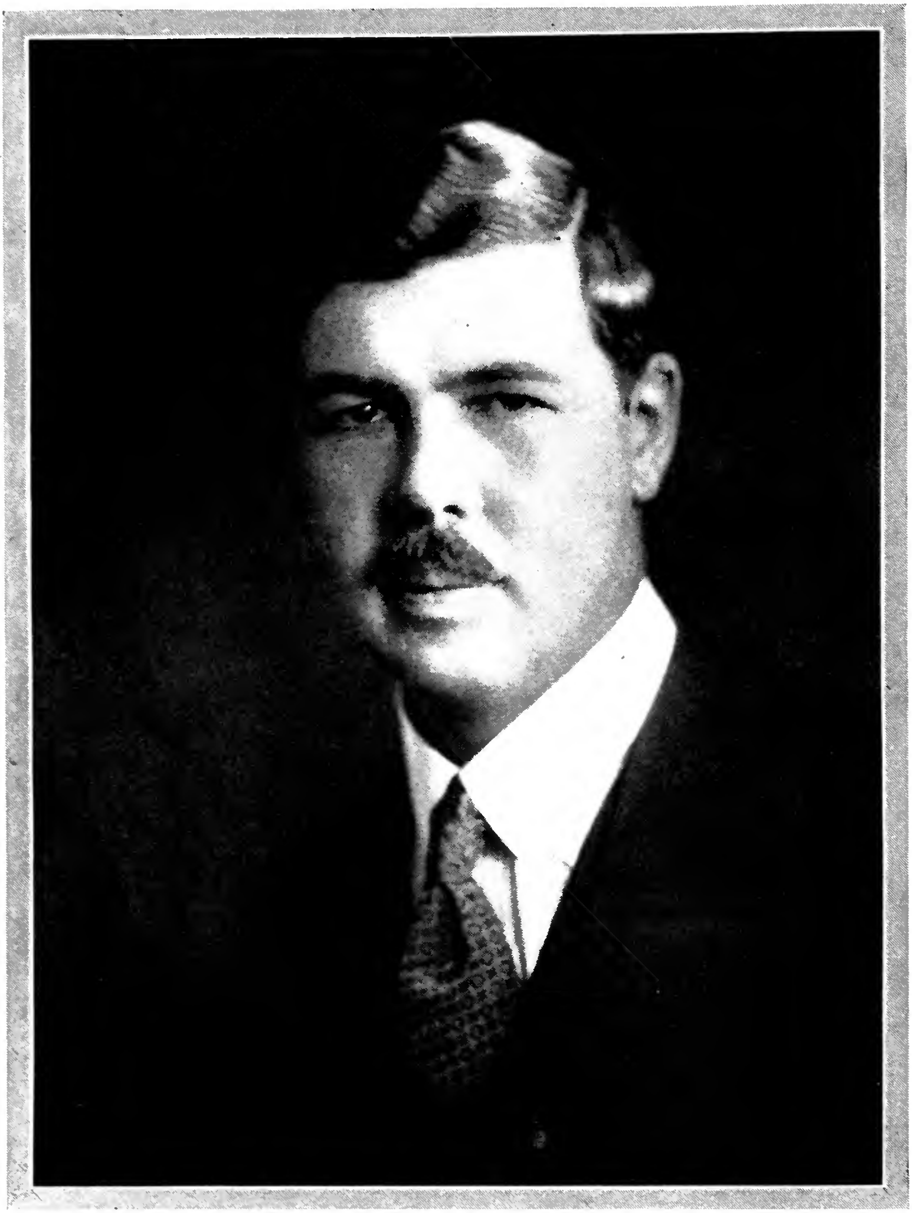

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LOUIS ALAN HAZELTINE

Who patented the neutrodyne circuit. He is Professor and head of the Department of Electrical Engineering at Stevens Institute of Technology at Hoboken, New Jersey

RADIO BROADCAST

Vol. 4 No. 6 April, 1924

C Q D

The Story of the First Sea Rescue by Radio as Told by Jack Binns Who Became a Radio Hero in the Old Days when Radio Was Wireless and a Ten-Inch Spark Coil and a Magnetic Detector Was the Ultimate in Apparatus

By ALFRED M. CADDELL

Serious accidents on passenger liners at sea are rare enough these days. Just stop for a moment and see if you can remember when the last great disaster at sea occurred. The war years should not be counted, for the sinking of the *Lusitania*, for example, was not due to faulty navigation or the luck o' the sea.

The fact is that radio has so aided navigation that real accidents simply don't happen. Every big vessel is in constant touch with both shores of the ocean during the entire passage, the ship's chronometers are corrected twice daily by radio time signals, and the radio compass guides the big ships in time of fog or heavy weather. The shore radio compass is available on almost every coast for every ship, small or large.

We have grown to take radio almost for granted, as far as its use in marine telegraphy goes. The public expects great things of the radio now—and isn't disappointed. But it was not so long ago that the radio waves had to prove their usefulness. Then, even the big ships boasted but one operator who could be at his set only a part of the day. Sets would not send very far, and the apparatus was not too dependable. The public, if it gave much consideration to radio at all, was somewhat skeptical.

But when radio saved the lives of thousands at sea in January, 1909, when Jack Binns at the key of the *Republic*, sent out distress calls which gave him the aid of the land station nearest him and the many ships around the scene of the disaster, Americans began to feel that maybe this radio thing had something to it after all.

Jack Binns has given me this fascinating story of the *Republic* himself, exactly as it happened.—A. M. C.

IT WAS four o'clock Saturday morning, January 23, 1909. The steamship *Republic*, in command of Captain Inman Sealby, had left New York for Liverpool at five o'clock the evening before, with 1,600 passengers on board. Jack Binns was the one wireless operator on the ship. Almost immediately upon clearing Sandy Hook the ship had run into a thick fog bank, and the automatic fog-horn was set going. Binns was kept busy at the key until midnight, sending and receiving commercial messages, and exchanging "location" reports with other ships and stations on shore. And then he turned into his bunk for the night.

Like all ship operators Binns went to sleep with a more or less alert mind. All went well until eight bells, and then——

Awakened by the sudden change in the fog signals, Binns sat upright on the edge of his bunk, and listened. One second, two seconds, three——

A tremor ran throughout the ship. There was terrific crashing. Rushing from his bunk into the operating room which was situated on the aft-port side of the ship, he peered out through the darkness.

Crumpled up like the bellows of a concertina, the lower part of the colliding ship's bow had hit the *Republic* full and square in her engine room compartment while the upper part, plowing its way through the cabins on the deck, hung over it, a menacing mountain of twisted steel. The roof of the wireless cabin collapsed; part of the cabin itself was wrenched away.

A strong current was running, swinging the colliding ship and the *Republic* around and twisting her davits, stanchions and beams. The telephone between the wireless cabin and the bridge was destroyed. At a glance—it all happened at once, it seemed—Binns took in the situation. He was standing between life and death. Unlike many others on the ship his intelligence was not numbed. He got into action.

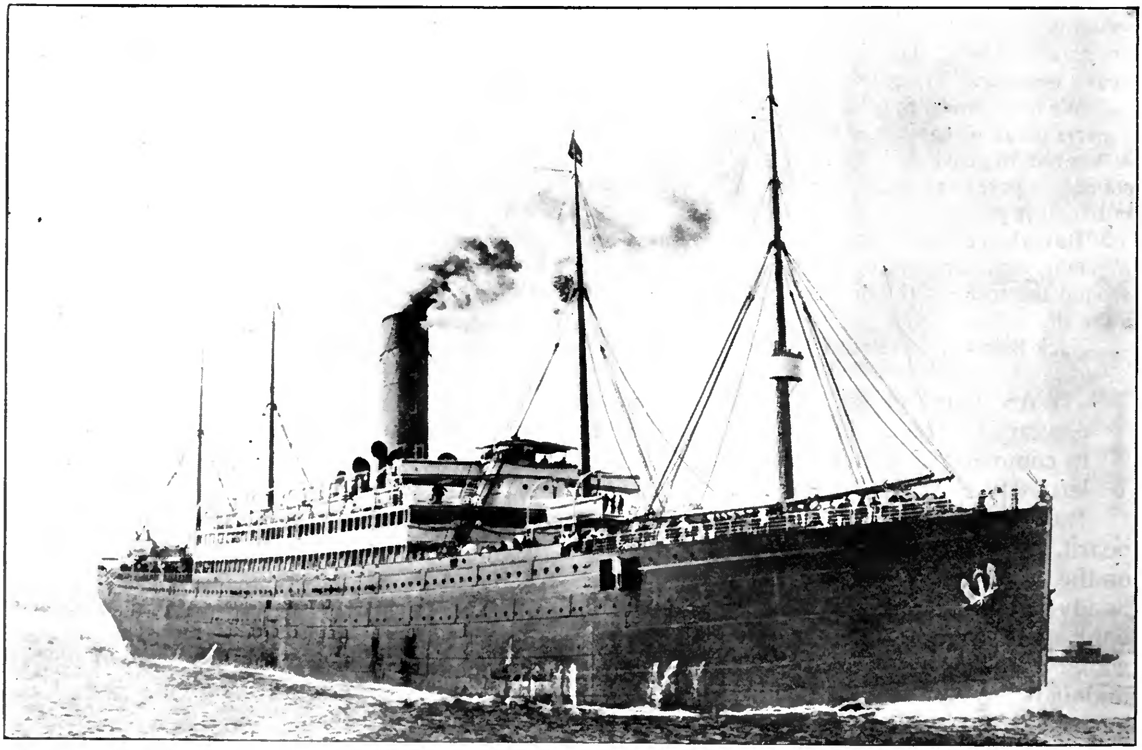
Was his wireless set in working order? Was the antenna intact?

"The system we used at that time enabled me to find out very quickly," said Mr. Binns, when the writer interviewed him in his office at the New York *Tribune*. "I had a transmitting apparatus consisting of a ten-inch spark coil which was run from the ship's lighting mains and could be used either for untuned sending at the natural period of the aerial or with a tuned circuit which was an inductance and condenser of Leyden jars. On the other hand, my receiving equipment consisted of a magnetic detector with a Franklin tuner which was one of the new pieces of apparatus of that day. But, judged from present standards, that tuner was very crude.

"We were transmitting with what is known as plain antenna, and unless the antenna was up and thoroughly insulated, it was impossible to get a spark. I had just time enough to work the key and find out that the antenna was still up when the lights went out. All the machinery of the ship, including the generators, had been almost immediately put out of commission.

"I had jumped to the key immediately—I think that not more than three seconds had elapsed since the vessel had struck us. Although I had a vague idea what had happened, I didn't know the exact details. What I did know was enough. As the vessels were swung around by the current I saw my cabin being ripped away.

"When the ship's lighting current went off,



THE "REPUBLIC"

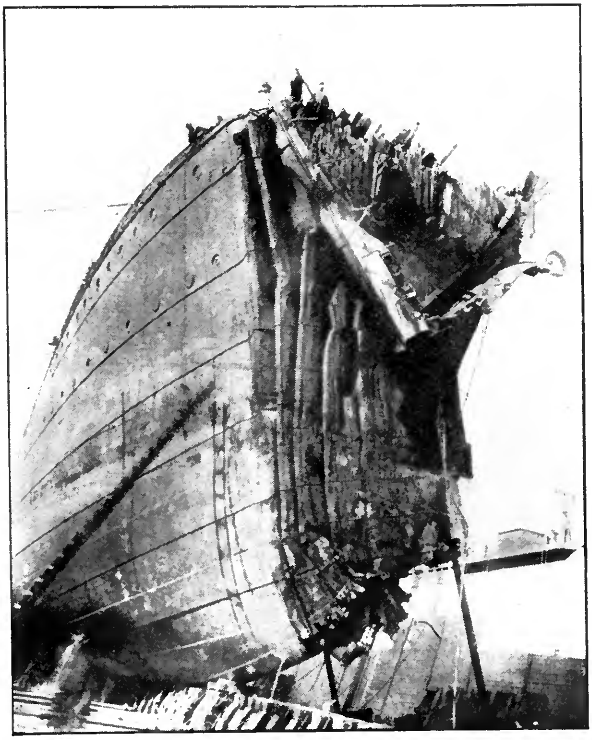
Which was the scene of the radio drama in which Jack Binns was the chief actor one exciting day in January, 1909

I changed over to our storage batteries for transmission power. We carried these batteries as an emergency reserve. When we used the batteries to operate the spark coils, our range was limited to approximately sixty miles. It was still dark and foggy. The air was biting cold. I put on as many clothes as I could find, bundled an overcoat around me, and began sending out CQD, which at that time was the distress call.

C Q D

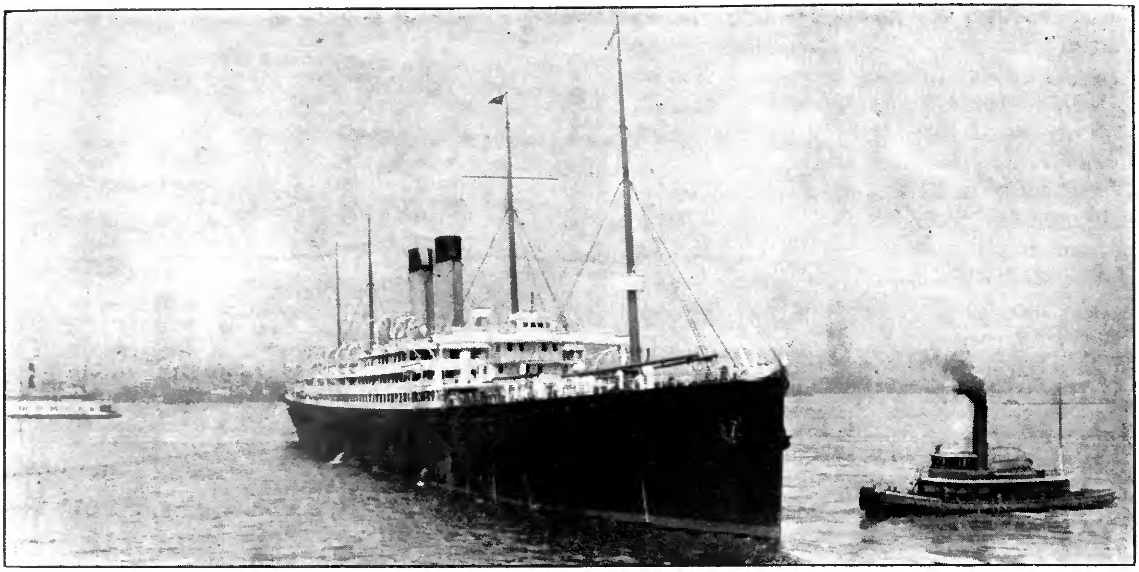
THERE was little on the air at that time of the night. We were, as I found out later, about sixty miles away from the Siasconsett station on Nantucket Island, just on the verge of communication with the shore and that was all. It seems that Jack Irwin, the man on watch at Siasconsett, had had a very quiet night and had dozed off to sleep. As a result his fire had died down and presently he began to feel uncomfortably cold. He woke up with a start so suddenly, in fact, that he became wide awake. He was just in the act of putting on more coal when he heard my call. He dropped the coal, jumped over to the key and replied instantly. I told him we were in distress, that two vessels were in distress, that I did not know at that moment where we were, nor the extent of the damage to either one of us, but told him I would get the information from the bridge as rapidly as possible, and asked him to keep everybody off the air until I could get the information through. However, I had no sooner sent this message than I received word from Captain Sealby, giving the damage done by the collision and the position of the ship. When I conveyed this message to Siasconsett, Irwin immediately sent out a general distress call. The steamship *Baltic* of the White Star Line was the first to answer the call.

"During this time we were drifting. The captain had absolutely no control of the ship. We had found the vessel which struck us, and learned that it was the Italian steamship *Florida* with immigrants bound for New



WHAT HAPPENED TO THE "FLORIDA"
This is all that remained of her bow after the collision. This photograph was taken in a Brooklyn dock

JACK BINNS
Photographed in 1908 in his uniform of an English Marconi ship operator



THE "BALTIC"
Which aided in the first radio rescue

York. She had not suffered as much as the *Republic*, and it was decided to put all of our passengers and crew on board her. Her engines were undamaged and the ship was controllable. But transferring the passengers from the *Republic* was not an easy task, for the *Florida* was a very small ship and had nearly 2,000 passengers on board, the majority of them being refugees from the earthquake at Messina, in Italy. The captain of the Italian ship, a young man by name of Ruspini, handled the situation from his end with a surprising degree of coolness.

"About noon of that day—which was Saturday—the *Baltic* was within ten miles of the *Republic*. I could tell by the strength of her signals, although at that time we had no means of knowing definitely how far away any particular station or ship was, and I had to rely on the sensitiveness of my ears to arrive at that conclusion.

EIGHTEEN HOURS CONSTANT DUTY AT THE KEY

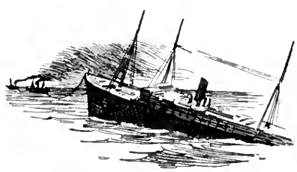
THE fog had, if anything, grown worse than it was at 4.00 o'clock that morning—and of course the *Baltic* had to reduce speed for fear of running into us before she could check her speed. From twelve o'clock until six in the afternoon I remained constantly at the key trying, in conjunction with the officers of both ships, to get the *Baltic* alongside. To accomplish this we exploded detonating bombs and fired sky rockets. When one ship exploded bombs, the officers on the other would try to learn approximately the direction from which the sound came. We were doing this all afternoon on both ships, but although we were within an approximate radius of ten miles of each other, none of the explosions had been heard.

"Six o'clock came and it was still foggy and dark. Presently we had reduced the number of our bombs to where each of us had only one left. According to our soundings, we were aware that the *Republic* had been sinking steadily at a rate of about one foot an hour. Unlike the sound of the voice or other noise, wireless of course was not directional, and inasmuch as we had no electrical means of determining the exact location of each other we might just as well have been a thousand miles apart.

"At this point we checked up, carefully with each other the time on our chronometers. Each ship carried three chronometers, the mean average of which was taken as the accurate time. As soon as we had checked up on that it was decided that the *Republic* should fire her last bomb at a certain precise second, and they would listen very attentively to hear it. That second arrived, and Boom! went the bomb. But it proved in vain—they did not hear it. It looked like a forlorn hope. The *Republic* was gradually sinking, night had come upon us, the *Florida* was floating somewhere in the neighborhood fearfully crowded with four thousand passengers and crew aboard that small ship. What were we to do?

"We made arrangements for the *Baltic* to explode her last bomb, and then I went forward on the bridge. By this time there were only eight on board the *Republic*. We had plenty of time, so seven of us formed ourselves in a circle with our faces outward while the quartermaster stood by the chronometer. He was to indicate to us by moving his arm upward the exact second the explosion of the last *Baltic* bomb was to take place. He raised his arm and—we listened.

"An operator's sense of hearing undoubtedly becomes more acute than another person's because of his constant training in straining his ears for faint code signals. Somehow or other, within about five seconds after the quartermaster had raised his arm, I heard very faintly what I thought might be the sound of a bomb. I turned to the third officer who stood next to me and he said he thought he had heard it too, although he wasn't exactly sure. It had been prearranged that none of us were to move in case we heard the sound, this in order that we could check the direction and get our bearings on the *Baltic*. Consequently, the officers took a bearing on the direction the sound came from, according to the third officer's and my own sense of hearing, and then I went back to the operating cabin to transmit steering directions to the *Baltic*, based on those bearings. We cautioned them to come very slowly because of our helplessness.



"Had we really heard the *Baltic's* last bomb? Were the steering directions I had just transmitted going to bring her alongside? Those were tense moments.

"In about fifteen minutes we heard the fog horn of the *Baltic*. The last bomb really had been heard beyond all doubt.

"'You are proceeding on the right course,' was the message that I then sent the *Baltic*. 'We can now hear your fog horn. Come very cautiously as we have no lights.'

"And then, fifteen minutes later I heard a tremendous cheer. I knew of course that it couldn't come from the members on our own ship, as there were only eight of us. I looked out of the cabin. There was the *Baltic* coming up right alongside of us. Her passengers had lined the decks to keep a sharp lookout for us.

"It was then a little after seven o'clock Saturday evening. It had taken fifteen hours of the most trying and intensive work to bring the *Baltic* alongside during the dense dark fog, and considering the crude apparatus we had at that time I have always considered it a great achievement, for a more difficult set of circumstances could hardly be imagined.

"After our officers conferred with Captain Ransom of the *Baltic*, she proceeded to where the *Florida* lay, as Captain Sealby felt very anxious about the safety of his passengers, especially since the *Florida* was badly damaged and excessively overloaded.

"Just about this time the fog suddenly lifted and the weather turned into a nasty driving rain. The *Baltic* found the *Florida* and the combined crews of the ships immediately set about transferring all the *Republic's* and *Florida's* passengers to her own decks. Throughout the night in the cold, drenching rain these crews labored transferring 4,000 passengers through a dangerous long rolling swell. Thus within the short space of twenty-four hours there had been two major transfers of passengers at sea, and all accomplished without loss of human life.

And when daylight broke the next morning, Sunday, there was one of the greatest concourses of ships ever seen on the seas. Everywhere, as far as the eye could see were ships. Every liner and every cargo boat equipped with wireless that happened to be within a three hundred mile radius of the disaster, overhearing the exchange of messages between the *Baltic* and *Republic* had gathered around and stood by ready to be of whatever assistance they could. It was a fine testimonial to the value of wireless. Shortly after daybreak the *Baltic* proceeded to New York and the *Florida* also proceeded at slow speed, convoyed by two or three other ships that were standing by. And then relief ships cared for the badly damaged *Republic*.

"During all this time, of course, the *Republic*, had been slowly sinking, and it was decided to tow her into the shallow waters off Nantucket. Two revenue cutters, the *Gresham* and *Seneca*, thereupon took line on the bow of the *Republic* in tandem fashion, and the Anchor Line *Furnessia* tied up on the stern to act as a rudder for the disabled ship. All available means were taken to keep her afloat. The tow started at ten o'clock Sunday morning and continued until seven o'clock Sunday night, but no actual progress had been made, for although the revenue cutters pulled her forward, a cross current was running against them at practically the same speed, so that all four ships virtually stood still.

"Finally the *Furnessia* cast off, for the stern of the *Republic* was under water. The water was already beginning to creep into my cabin and while I was wondering whether I should go forward or wait until the captain sent for me, the third officer came aft and said the captain had issued orders to get ready to abandon the ship and that I was to come forward. I didn't hesitate about that. The rest of the officers were there and we tried to persuade Captain Sealby to abandon the ship with us. But he refused to do so. Instead he asked for a volunteer to stay with him. Everyone volunteered. Captain Sealby then chose Second Officer Williams on account of his being the senior unmarried man in the group and also because Williams knew the Morse code and could signal with a lantern.

"At this time the *Republic* was attached to the *Gresham* by a steel hawser. As soon as we put off in the Captain's gig we pulled over to the *Gresham*, told the captain of that ship the condition of the *Republic*, and asked him to pay out a nine-inch rope hawser and stand by, ready to cut the rope hawser as soon as he got a signal from the bridge of the *Republic* that the ship was about to go under. It had been previously agreed that Captain Sealby was to flash a blue Coston light when that moment did arrive. This the captain of the *Gresham* did. He stationed a man with an ax over the hawser, with instructions to cut it the moment he saw the blue light. We stayed off in the life boat waiting for developments and holding ourselves ready to go to the rescue of Sealby and Williams the moment the ship went down.

"Fortunately there were four or five other ships in the vicinity watching the proceedings. Each one played its searchlight on the *Republic*. By the aid of the many searchlights the two lone figures could be seen pacing to and fro on the uptilted bridge. And then came the signal of the blue light. Then we saw one of the men jump on to the rat-lines of the foremast, climb up to the top of the mast and wait. The other man ran forward, climbed up on the rail, and taking one last long look at the little cabin on the bridge turned and dove forty feet into the sea.

"For one minute more the bow of the *Republic* trembled above the waves and then sank.

"We rowed over to the spot where it went down. The light of each observing ship was trained upon the spot. Fortunately a quiet sea was running at the time, but even so it was most difficult to see very far from the open boat as the lights, intercepted by the crests of the waves, threw darkened shadows over most of the surrounding waters. We grew very anxious about Captain Sealby and Mr. Williams, for certainly no man could long survive the cold of those wintry waters.

"For twenty minutes we rowed around, earnestly but yet aimlessly, for we did not know where to go. On all sides we saw the glaring searchlights—but nowhere could we discern any sign of life in the sea. I don't think any more sorrowful moment ever came into the lives of the men in that open boat, not to mention those on the nearby ships, for Captain Sealby and Second Officer Williams had nobly upheld the tradition of the sea. But the length of time did not diminish our hopes.

"This collision at sea had indeed brought forth a series of climaxes. First the wireless apparatus, crude as it was, had brought Siasconsett to our aid; the very last bomb that the *Baltic* had came within an ace of being in vain, and now——

"Suddenly, to our right, from out the murky blackness of the waters of the sea, a revolver shot rang out. We pulled over in that direction immediately, and there we found Captain Sealby hanging on to a floating crate, so nearly exhausted that he had had just sufficient strength to pull the trigger of his revolver. 'Williams over there', he said, 'Get him.'

But we pulled the captain in then and there, and then rowed in the direction he had indicated. And sure enough we found Williams too, clinging to a hatch cover that had floated off the *Republic* when she went down."

It was fitting *denouement* to one of the greatest near-tragedies of the sea. And a tragedy indeed it would have been had it not been for wireless and an operator who had initiative, skill, and the fortitude to stick to his post for 48 hours without eating or sleeping.

Jack Binns was born in Lincolnshire, England, in 1884. Early in his teens, he became interested in the electrical sciences and attended the technical school of the Great Eastern Railway, where he obtained a thorough grounding in electricity and learned the Morse telegraphic code. About that time Marconi, having made his bow to the scientific world, was developing a company over in England. Binns made application for a position as operator and was quickly accepted. He became connected with the Belgian Marconi Company and was sent to sea on a German ship.

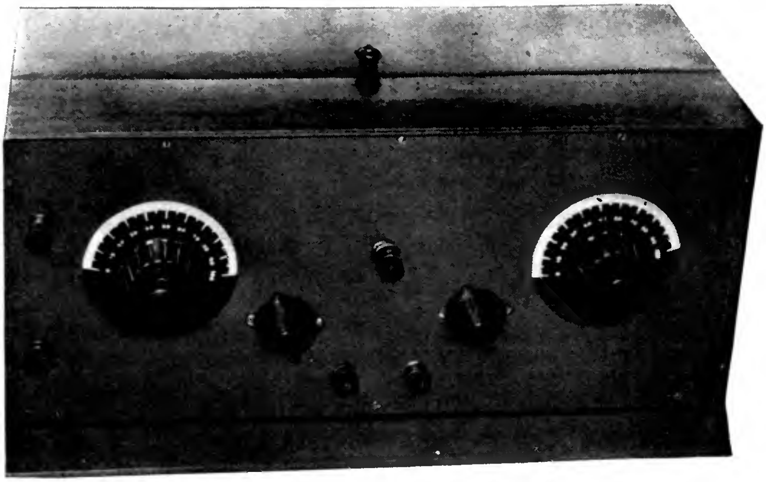
LT. MAYNARD, JACK BINNS, AND DANIEL FROHMAN

In 1920, ready to bombard New York with "broadsides" on the Actor's Fund

At that time there was competition between the Marconi system and the Slaby-Arco system, a German system in use on German ships, but the Marconi organization was better developed and they won out. About twenty operators were picked for service on German ships, Binns among them, and during his connection with that company he did considerable experimental work, chiefly in long distance reception from the so-called high power stations at that time—the Poldhu and Cape Cod stations. This experimental work took him not only across the Atlantic but up around Spitzbergen in the Arctic Ocean and down in the tropics on this side of the Atlantic, through the Caribbean Sea and along the northern coast of South America, all of which work was in addition to regular trips made as operator on German ships.

About 1907 there was a great deal of agitation in Germany over the presence of foreign operators on board German vessels, who included not only Englishmen but Americans, Italians, Belgians, Danes, and even one Icelander. Consequently, in June, 1908, the German Government notified La Compagnie de Télégraphie Sans Fil (Belgian Marconi Company) that all foreign operators would have to be replaced with German operators by the end of July that year. In August of that year, the German Government precipitated the second Morocco crisis. In its order, the German Government bluntly stated that in the event of war with Great Britain or any other European power the foreign operator on board a German ship would undoubtedly refuse to notify the commander of the fact that war had broken out and consequently those ships would be captured by enemy cruisers. Therefore, Binns was among the operators replaced, and after one or two shifts to various positions with the Marconi company, was assigned to the steamship *Republic* which post he had held for a period of three months.

During the war years, he became so proficient in flying that he was engaged as instructor in the Canadian Flying Corps, and made his headquarters at Toronto. Here he taught not only piloting, but instructed aviators in radio and the code. Radio indeed has been the outstanding feature of his life's work. He was one of the first to prove its value in an emergency at sea. He was one of the organizers of the New York Newspaper Club, and is now the Radio Editor of The New York *Tribune*.



FRONT VIEW OF THE COMPLETED SET

This outfit can be built for less than $50, uses a 201-A and UV-199 tube, is surprisingly efficient in operation and easy to build

A Knock-Out Two-Tube Set

Combining the Advantages of Tuned Radio-Frequency Amplification, Audio-Frequency Amplification, the Neutrodyne Principle, Regeneration, and Reflexing and Loud Speaker Operation—All *Without Radiation*

By WALTER VAN B. ROBERTS

The set described costs less than $50 for parts, including tubes and batteries; is fairly easy to make, and as Mr. Roberts says, will equal the performance of far more elaborate and expensive sets. This set is another of the series built under the direction of RADIO BROADCAST, the first of which was the "Knock-Out One-Tube Reflex," described in our November, 1923, number which we are printing on page 496 of this issue.

If the reader has the parts and has built the one-tube set described last November, it will cost him about $10 more for the additional parts necessary for this set.

We are rushing the information on this set to our readers, and that explains why we do not show a panel lay-out. Next month, we will publish a complete "how-to-make-it" article on this new receiver.—THE EDITOR.

THE circuit to be described is only one of many possible applications of the method which is used to obtain radio-frequency amplification without any tendency toward regeneration. This method is closely related to the ordinary neutrodyning system, but has the advantage that the coupling between primary and secondary of the radio-frequency transformer may be varied, thus allowing the maximum possible amplification over a large range of wavelengths.

The method employed by the writer for overcoming oscillation in the radio-frequency amplifier consists in winding the primary with a *pair* of wires, thus forming two separate windings coupled as tightly together as is physically possible. One of these windings is used as the primary in the ordinary fashion. The other one is used only to prevent regeneration. Fig. 1 shows the arrangement schematically. S is the secondary, P the primary, and N the neutralizing winding. The capacity C should be exactly equal to the capacity between the grid and plate of the tube together with the socket and leads. Whatever alternating voltage exists on the plate must be due to alternating magnetic flux linking P. But the same flux also links the similar winding N, which is connected the other way around, and hence, acting through C, produces an effect on the grid which is equal and opposite to that produced by P acting through the grid-plate capacity of the tube. Thus the net "feed back" or tendency to regenerate is completely neutralized (the coils P and S being of course set at such an angle with the coils in the grid circuit that there is no magnetic feed back) *whatever sort of secondary is used, however loosely it is coupled, and however it is tuned.*

If a transformer has a tuned secondary of low resistance, the coupling between primary and secondary should be varied with the wavelength in order to keep the amplification at its maximum value. Practically, however, it will be found sufficient to have two or three different degrees of coupling—for instance, primary and secondary as close together as possible for the long wave range, and about one inch apart for the short wave range.

> The outstanding features of this circuit:
> 1. It will run an hour or so a day for several months on four dry cells.
> 2. It will operate a loud speaker well enough for all ordinary purposes.
> 3. It does not radiate and cause squeals in the neighbors' receiving sets.
> 4. It offers a better combination of sensitivity, selectivity, and quality for the *total* cost than any other circuit the writer has ever used.

USING REGENERATION INTELLIGENTLY

IF A transformer has a tuned secondary, the lower the resistance of the secondary is, the greater the voltage amplification will be, and the looser the best value of coupling. The easiest way to obtain a very low effective resistance is to employ regeneration in the tube to which the secondary is connected. The use of regeneration in this way will help most when the secondary is loosely coupled to its primary, and the set is then much more selective. By making this tube oscillate, signals are easily picked up by the squeals—the reason that the set is non-radiating is that if the capacity C of Fig. 1 is adjusted just right and there is no magnetic feed-back to the antenna, then no oscillations can get back from the oscillating tube through the amplifying tube to the antenna. The neighbors, bless 'em, won't hear any squeals.

Fig. 2 shows the complete circuit, while Fig. 3 shows a simplification which is very satisfactory for strong signals, especially if great selectivity is not needed. Regeneration is omitted in the simplified circuit and all couplings are left fixed at a good average value so that only the two variable condensers are used in operating the receiver. Different methods of connecting the antenna to the set are shown in Figs. 2 and 3. The method of Fig. 3 is simpler but a slight hum is likely to be heard if there is alternating current supply in the house.

LOW COST AND HIGH COMPARATIVE PERFORMANCE

THIS total cost is very little compared to what most sets giving comparable results would come to after all batteries and tubes are included. To keep down the cost and to make it easier to build, the set is laid out on a flat board 2 feet by 1 foot. There is room for interesting experimental work in arranging this set behind a panel, and making the layout very compact. Results were more important at first than symmetry of construction.

WINDING THE COILS

COILS A, S, N, P, and T (the tickler) are all wound on the same size cardboard spiderweb coil forms. These are 5 inches outer diameter and have 13 teeth each 1$\frac{7}{16}$ inches long. Coils A, S, and T are all wound with No. 22 wire, going over two teeth, then under two, etc. There are 30 turns on A, a small loop being twisted in the wire at every fifth turn.

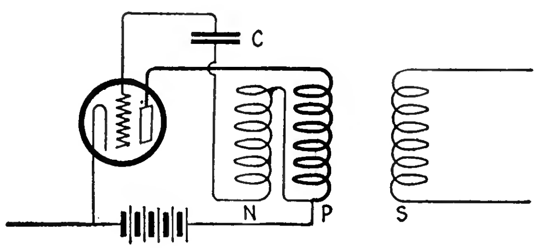


FIG. 1

Fundamental circuit of the method of winding the radio-frequency transformer for this set. N is the primary neutralizing winding and C the neutralizing capacity to balance the effect of the capacity between the grid and plate of the tube

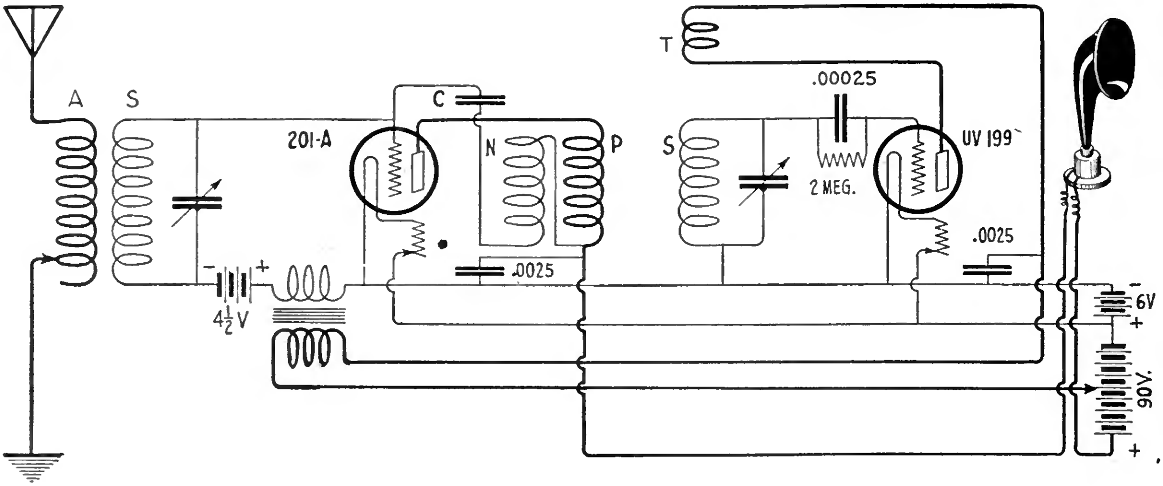


FIG. 2
The complete circuit of the Knock-Out Two Tube Set. This circuit is recommended over the simplified arrangement shown in Fig. 3

The insulation is scraped off these loops and contact is made by a voltmeter clip. S has 45 turns. Both of the coils "S" should be connected so that the lead from the inner turn goes to the grid. T should have 20 turns, or even less if oscillations occur too easily.

The tickler must of course be connected the right way around to get oscillations at all, and this is most easily discovered by experiment. Windings N and P are wound simultaneously on the same spider web form by winding with a pair of No. 26 wires, treating the pair exactly like one wire. In this case wind over one tooth, then under one tooth etc., going around 22 times. There are then two separate windings each of 22 turns. Connect the outer terminal of one of these windings to the inner terminal of the other.

The remaining pair of terminals go to the plate and to the capacity C and it makes no difference which goes to which. This self balancing primary of the three winding transformer is the novel feature of the receiver and to it is undoubtedly due the improvement over similar reflex circuits using other types of radio frequency transformers. The photograph shows how magnetic coupling between coils A and S at one end of the board and coils N, P, S, and T at the other end is avoided by setting them at right angles. The tickler is mounted on the end of a strip of wood that can be slid in and out between a pair of narrow guide strips. The coil containing windings N and P is not arranged to slide, but by loosening up the single screw that fixes its position, it can be set up close to coil S or backed away about an inch and a half. The same arrangement is used for coil A. Both of the coils S are fixed in position.

USING THE NEUTRALIZER

THE capacity C shown in the photograph consists of two pieces of copper about the size of a penny separated by a sheet of mica. A piece of paper would do just as well, as the only purpose of the material between the pieces of copper is to prevent their touching, which would short circuit the B battery. Adjustment can then be made by sliding one piece of copper sideways. Another way of getting the capacity C is to have a couple of inches of bus bar stick out from the grid terminal, and slide a piece of spaghetti over it, the spaghetti being wrapped around on the outside with the wire coming from the neutralizing winding. The best way, however, to obtain the capacity C is to buy a little one-plate variable condenser, the plate being about 1½ or 2 inches in diameter.

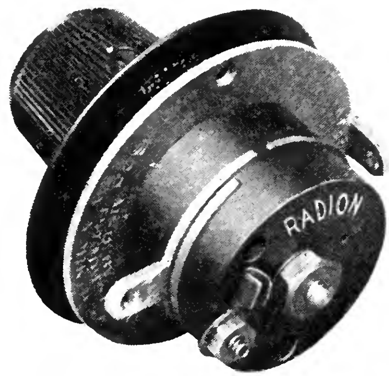
The capacity C has to be considerably greater than in the usual neutrodyne arrangement. The adjustment of this capacity to exactly the correct value is of great importance for two reasons. First, to make the set non-radiating, and secondly, to make the operation of the two tuning condensers completely independent of each other. The ordinary way of getting the proper balance with the filament of the first tube unlighted is impossible because the phones are in its plate circuit.

A simpler way is to make the second tube oscillate by pushing the tickler coil up, then pick up the carrier wave of some transmitting station by the squeal, and then adjust the capacity C. When the correct adjustment is obtained, it will be found that varying the setting of the antenna circuit condenser will not affect the pitch of the squeal from the carrier wave, but only its intensity. This proves that the antenna circuit is not coupled in any way to the oscillating circuit, and hence no oscillations can be produced in the antenna.

If the non-regenerative circuit of Fig. 3 is used, the adjustment of capacity C is even simpler—it is merely varied until a value is found such that the set cannot be made to squeal by any combination of settings of the two tuning condensers. It should be noted that too much neutralizing capacity will cause regeneration just as readily as too little.

GENERAL NOTES

IN ANY given set, it is advisable for the user to try connecting the grid return of the detector tube to the + side of the filament. This sometimes gives better results. Also, the best value of the voltage for the B battery should be found by experiment, although $22\frac{1}{2}$ volts will usually do about as well as any.

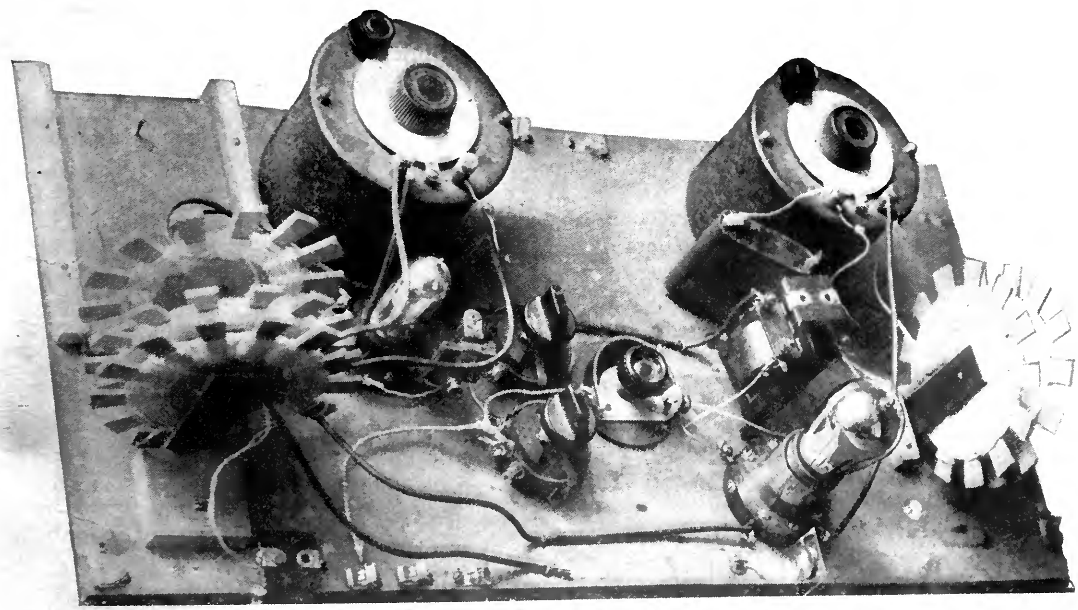


A NEUTRALIZING CONDENSER
Which may be used in place of the two penny-size pieces of copper suggested for the neutralizing capacity for the first tube

A good long antenna of low resistance is of much more importance in this set than in an ordinary regenerative set, because the resistance of the antenna circuit is not wiped out by regeneration. The ground lead should be firmly clamped or well soldered, and the antenna wire made of copper.

WHAT THIS SET HAS DONE

AFTER the set is working at its best, the results should be noticeably better than can be had from a first class single circuit regenerative receiver with one stage of audio ampli-



THE LABORATORY MODEL
Worked out by Mr. Roberts. With this simple layout, he was able to tune-in Havana on a loud speaker while Newark was operating, and WJAZ while WJZ was on the air. His experiments were conducted at Princeton, N. J.

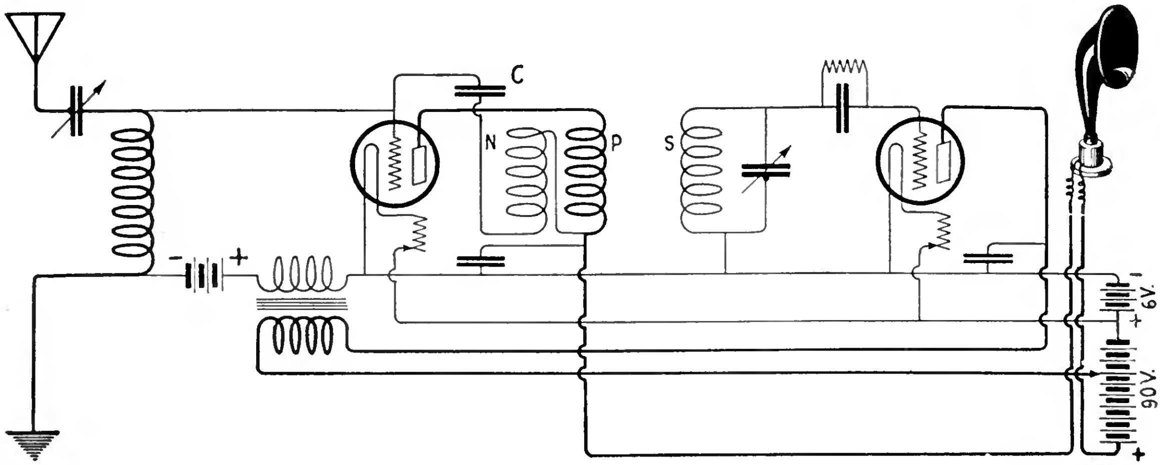


FIG. 3

A simplified circuit which may be used. The number of tuning controls is reduced to the two variable condensers. But the results obtained from the circuit shown in Fig. 2 are far superior to those secured from this circuit, although its adjustment is not quite so simple

fication. The selectivity should be better than that of a three-circuit regenerative receiver, and the tuning easier and less critical. The outfit shown in the photograph has been tried out against two well known makes of neutrodyne and gives about the same results (only one stage of audio being used in the neutrodyne sets, of course.) Using a single wire antenna 150 ft. long and about 20 ft. high located in Princeton, N. J., WJAZ in Chicago was heard on a Western Electric 10D loud speaker without any interference from WJZ. PWX, Havana, was heard on the loud speaker while WOR, about 35 miles away, was working. These stations are too close together in wavelength to be separated completely, but the selectivity of the set was such that PWX was only slightly less loud than WOR.

The parts that have to be bought and the approximate list prices are as follows:

Two General Radio .0005 mfd. geared condensers ("table mounting") (or other good condensers)	$12.00
One Amertran audio frequency transformer	7.00
One UV 201-A or C-301-A or DV-2 vacuum tube and socket	5.75
One 6-ohm rheostat	1.00
One UV-199 or C-299 or DV-1 vacuum tube and socket	5.75
One 60-ohm rheostat (or two 30 ohm rheostats in series)	1.00
Two .0025 Micadon condensers	.70
One .00025 Micadon condenser with clips for grid leak	.45
One 2-megohm grid leak	.75
One 4½-volt flashlight battery	.50
Four dry cells	1.60
90 volts B battery	7.00
Five 5 and 10 Cent Store spider web coil forms (these may be made at home without difficulty)	.25
Screws, wire, wood, etc., about	1.50
Total	$45.25

(Loud Speaker is not listed due to wide variation in prices)

Man-Made Static

What Causes Interference to Radio Receivers—Some Easy Methods of Locating the Cause of the Trouble—and How to Stop it

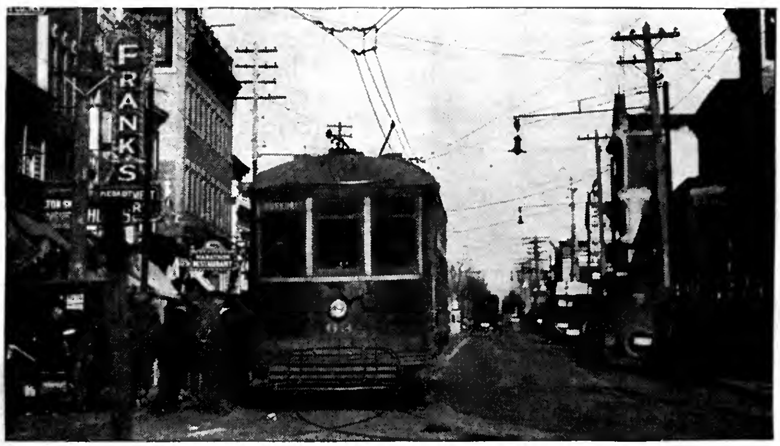
By A. F. VAN DYCK

Engineer, Technical Division, Radio Corporation of America

THE term "static" has been used, more and more commonly, to name the cause of many noises which are heard in radio receivers, and which sound like scratching, frying, clicking, or grinding. The word static is short for "static electricity." Real static electricity, or electrical charges deposited on the antenna, cause a very small part of the whole disturbance, and radio experts label all the causes of such interference as "atmospherics." However "static" seems to be a more usable and popular word, perhaps because it sounds so much like the short, sharp, vicious thing it stands for.

Now there is static and static—static caused by phenomena of nature, and that caused by electrical disturbances due to man's own agencies. It is the purpose of th s article to point out and describe examples of one kind of interference which is very common in broadcast reception, and which is quite mysterious in many of its manifestations. This form is often called "inductive interference." There are a great many industrial and other applications of electricity in use, and everyone of them can, under certain conditions, become a radio transmitter in effect, and send out radio waves which will cause interference with the signals from radio broadcasting stations. Since the noise produced by such sources sounds very much like static, and yet is caused by human agencies, it is often called "man-made" static.

> **"What Is that Scratching Noise?"**
>
> Well, if you are morally certain it doesn't come from your receiver itself, you have every right to be suspicious of almost everything electrical about you which might possibly be out of order.
>
> Mr. Van Dyck shows that in actual practise, the interference comes from a few sources and that, by the exercise of a little intelligence, the trouble may be eliminated, and all be made again serene on the radio horizon.
>
> —THE EDITOR.



LITTLE BURSTS OF "STATIC"

Are often caused when the trolley of this surface car makes sparks in following the wire. "Static" of this sort is not particularly bothersome, because of its short duration

WHERE THE TROUBLE COMES FROM

IN MANY localities, man-made static causes far worse interference than does nature's own static. Fortunately, man-made static can always be eliminated, while nature's cannot by any means now known. The most difficult part of the process of elimination of man-made static is locating its source.

Some causes of "Man-made Static":

Class 1. Power Circuits
- (a) Lines
- (b) Insulators
- (c) Lightning arrestors (on power lines).
- (d) Transformers
- (e) Generators and motors

Class 2. Industrial Applications
- (a) Arc lights
- (b) Telephone and telegraph lines
- (c) Telephone ringers
- (d) Street cars and electric railroads
- (e) Factory motors
- (f) Store motors and barber shop appliances
- (g) Smoke and dust precipitators
- (h) Electric flashing signs

Class 3. Household Appliances
- (a) Door bells
- (b) Light switching
- (c) Sewing machines
- (d) Vacuum cleaners
- (e) Flat irons
- (f) Electric refrigerators
- (g) Dish washing machines
- (h) Kitchen mixers
- (i) Violet Ray outfits
- (j) Heater pads.

Class 4. Miscellaneous
- (a) X-Ray machines
- (b) Storage battery chargers
- (c) Electric elevators
- (d) Annunciator systems
- (e) Automobiles
- (f) Stationary gas engines
- (g) Tickers
- (h) Dentists' motors

PASSING ELECTRIC TRAINS

Often annoy the broadcast listener who blames radio in general for the resulting "scratchy" noise in his receiver. A faulty contact-shoe on one car of a train can cause considerable, although not serious, trouble

The list given above contains only devices which actually have been reported as causing interference Many other similar ones, although not mentioned in this list, may cause interference in other cases. Of course, some of these causes are more frequent offenders than others. Certain ones in the list have been reported hundreds of times, others but a few times, and a few but once.

If all electrical circuits and devices were always kept in perfect order, radio receivers would have but little interference. The following devices are exceptions, that is, these devices cause interference even when they are in perfect order.

Class 1. Lightning arrestors on power lines.

Class 2. Telephone ringers
Street cars
Motors (of some types).
Smoke and Dust Precipitators

Class 3. Door bells
Light switching
Various motor driven devices
Violet Ray outfits

Class 4. X-Ray machines
Storage battery chargers
Electric elevators
Annunciator systems
Gas engines with electric ignition

The devices which appear in the first list and not in the second, cause interference only when they are not in perfect condition. It is therefore possible to eliminate the interference from such devices merely by putting them in perfect condition.

It is also possible to eliminate in part the interference caused by devices mentioned in the second list, but it is usually difficult and requires study by an expert, or someone who has had previous experiences with that form of interference.

THINGS WHICH MAY CAUSE INTERFERENCE IF OUT OF ORDER

LET us consider now those appliances which cause interference to radio because they are not in perfect order. First on the list are power lines, together with the insulators on the lines. It can be said, as a general proposition, that power lines are the cause of most "interference" in radio reception. This is not remarkable if one considers the great power of the energy which is transmitted over most electrical lines, and the very tiny power which is required to operate sensitive radio receivers. An electric power line needs to radiate only a ridiculously small part of its power to create very strong interference with radio.

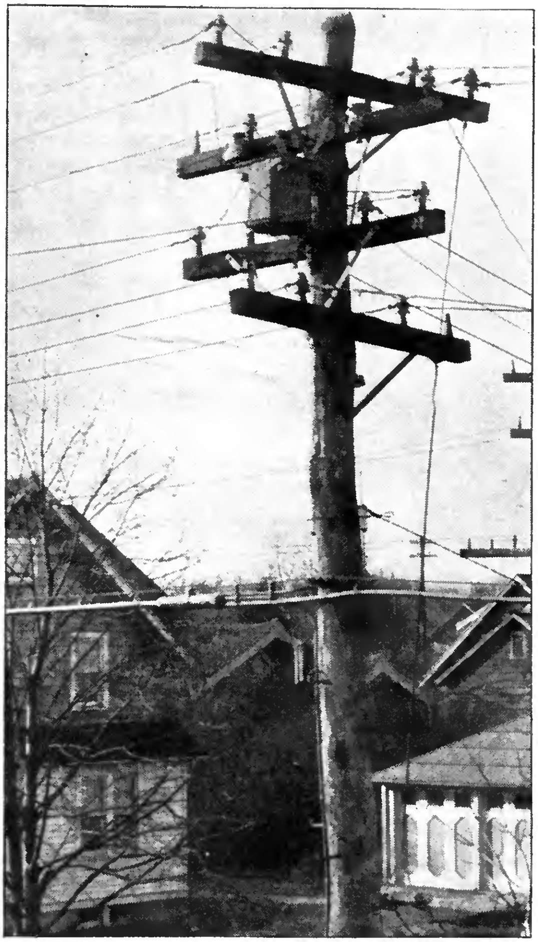
How does the electricity carried by power lines differ from that which operates radio receivers? An understanding of this difference is essential before one can intelligently try to locate any case of interference.

The power carried by electric transmission lines is either direct current, flowing always in the same direction around its circuit, or it is alternating current of low frequency, "alternating" in direction around its circuit twenty-five or sixty times each second (called 25 or 60 cycle power). Both of these two forms of electricity are harmless to radio, provided the antenna and receiver are at least fifteen or twenty feet away from the power wires, and provided the power lines and all of the electrical devices connected to the lines are in normal condition, and none of the devices are of Class 2, as listed above.

WHEN AND WHY A POWER LINE INTERFERES

TO OPERATE a radio receiver at a distance, we must have electrical alternations of *very high* frequency, thousands of cycles per second at least, because electricity operating at such frequencies sets up waves which can travel without wires. Therefore, to cause waves of the same nature as radio waves, and thereby cause interference with *real* radio signals, the electrical power on transmission lines at low frequency must be changed to high frequency. Here is how that happens.

Whenever an electric circuit makes a spark, either by a bad contact between any two parts of the circuit, or by the use of a voltage high enough to jump a gap between two parts (like the ignition spark plug), high frequency currents are generated. In fact, this method of generating high frequency currents (a spark caused by high voltage of the ordinary sort) was the one used in all the early radio transmitters, and is still used in some, although better ways are now known. So whenever any electric circuit causes a spark, radio waves are generated. The wavelength, or frequency, of these waves depends upon the electrical characteristics of the circuit. The wiring of the circuit forms an antenna and the distance over which the disturbance can be heard therefore depends upon the size and form of the wiring of the circuit.

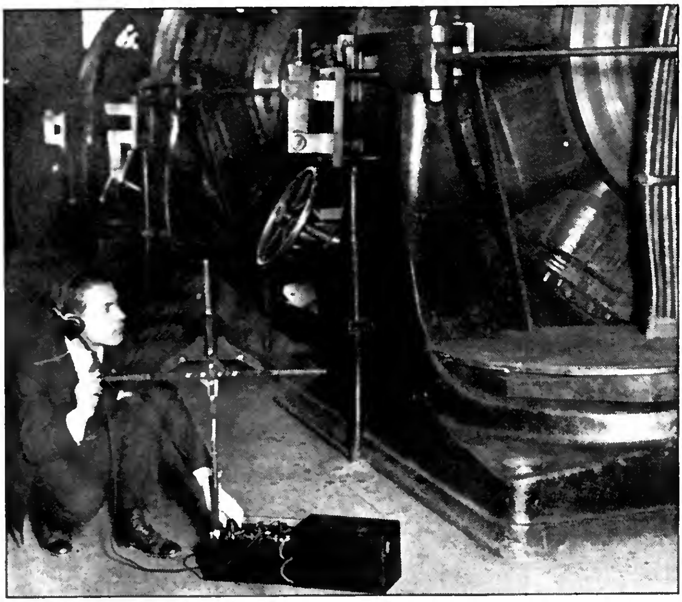


A POOR CONNECTION

Inside the metal case of this lighting transformer could make broadcasting reception in this neighborhood very difficult. And if one of these power wires were scraping its insultation bare against a tree, or if there were a leaky insulator on this pole cross-arm, unpleasant local interference would also be set up

The electric power line itself does not produce interference with radio, unless in some part of it there develops a bad contact or other means of creating a spark. The spark may be so small as to be invisible to the eye, and yet create disturbance. And whenever there is interference from this source, it can be removed by locating the spark and either removing it, or in some way preventing the spark from sending out radio waves.

Sparking can develop on power lines in many ways. The most common way is through "leaky" insulators, that is, ones which do not give perfect insulation, and allow the power to creep off in tiny jumps. Troublesome radio interference is often due to power wires



LARGE MOTORS AND GENERATORS

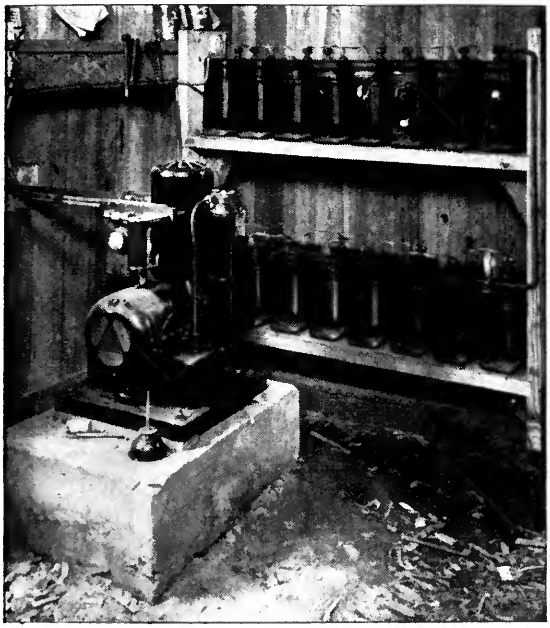
Frequently set up interference for the broadcast listener. Sparking commutators on motors and collector rings on generators are responsible. This difficulty is not usually hard for the power house to remedy. The operator with the loop receiver is verifying the cause of the trouble

touching tree branches. Also many cases have been traced to the distributing transformers, which are usually mounted on poles in the center of the neighborhood they serve. These unfaithful transformers develop defective internal insulation, poor contact at their terminals, etc.

HOW TO FIND THE INTERFERENCE

IT IS often difficult to locate the exact spot of such power line interference, because the antenna formed by the lines is extensive and the interference therefore heard over a large area. To locate the trouble, that section where it is worst can be found by listening to it on ordinary receivers at various locations, and when the area has been localized to a particular section, a direction finding set with loop aerial must be employed. This set should not be too sensitive, as the increase in loudness as one gets nearer to the trouble (which is more apparent on an insensitive receiver), is also a useful indication, in addition to the direction. Power companies are usually glad to coöperate in removing such interference, particularly since it is an indication of a fault on their system which is wasting power, and which may grow worse until it finally results in interruption of the power service. The radio receiver, in fact, can be made use of by power companies as an effective method for locating line faults.

Generators and motors are somewhat different from power lines in that they may give interference while operating in a condition which is satisfactory from the mechanical and commercial point of view. Ordinarily, interference from machines is due to their commutators or slip rings, because sparks occur at these points. The sparks, just as described before, generate radio frequency currents, and the wiring to the machine acts as an antenna system radiating the waves. Obviously, the first step in eliminating this interference is to stop the sparking on the machine, or at least to reduce it as much as possible. It can not be stopped completely in all cases, as a certain small amount of sparking can not be avoided in most machines. However, the commutator should be clean and smooth, the brushes in good condition and properly set, and the machine not overloaded. In extreme cases with direct current machinery, and where the expense may be justified, the interference can be stopped by putting large "choke" coils in the wires connecting the machine with the power line. These must be put right at the machine terminals and must, of course, be capable of carrying the full current of the machine. The low voltage winding of a proper size transformer will often make a suitable "choke". In some cases, connecting large condensers (having a few microfarads capacity) directly across the terminals of the machine alleviates interference, but this method is not always effective. When condensers are thus used, they should be insulated to stand at least twice the voltage of the line. The use of choke coils has been successful in many cases of interference from small motors, such as dentists' motors, and those used in dictaphones, cash registers, household appliances, etc. With small motors, the choke coils may consist of "honeycomb" type coils. The size of coil must be chosen to suit the particular case, and is usually a size between 500 and 1500 turns. The larger the coil the better it is for reduction of interference, but if the supply line is



FARM CHARGING OUTFITS
Can make trouble for the broadcast listener. The usual cause is badly sparking brushes on the dynamo

alternating current, it can not be too large or it keeps too much line voltage away from the motor, thereby causing the motor to run slowly, or otherwise affecting its operation.

ONE CASE IN POINT

LOCATING interference of the sort which has been described above, becomes a good deal of a sporting proposition, with plenty of opportunity for clever detective work and systematic experimenting. In one instance which has been reported, a broadcast listener who had good reception conditions for over a year, returned from his summer vacation to find that reception was quite impossible on account of terrific "interference." This noise was continuous and appeared to be from a power line. Whenever an interference is on continuously day and night, it is fairly safe deduction that it is due to some power line itself, because devices fed from a line are switched off and on at least occasionally. So this listener concentrated on the power lines in his neighborhood, and first asked all his neighbors if any changes had been made during his absence. One neighbor recalled having seen linemen at work upon a certain transformer. Inasmuch as the interference was loudest near this transformer, it seemed logical to suspect this device. Inquiries to the power company revealed that the wood pole upon which the transformer was mounted, had needed replacement, and the transformer had therefore been taken from the old pole and mounted on the new one. This made the trail seem warmer, and the radio listener asked the power company to make examination of the transformer. The inspection was made, and in fact a second one, when it was found that one connection on the internal terminal block. of the transformer had not been soldered. As soon as this was soldered the interference ceased completely.

THE STRANGE CASE OF THE HEATING PAD

A RADIO dealer installed a very good radio receiver in a certain home, and it performed properly with satisfactory service for a period of several weeks. One day, however, the dealer received complaint of trouble. He investigated and found a bad case of interference which, after several days' observation, was noticed to be continuous except for an occasional short "silent" period. The quiet periods were erratic in time of occurrence although always in daytime, usually morning. The dealer

A WASHING MACHINE MOTOR
Such as the one shown here may produce enough "static" in radio receiver installed in the same house or very near by to spoil the incoming concerts. Remedy: clean the motor commutator and clean and adjust the motor brushes

looked for the source of the trouble and finally found it, but his success came only after a week of careful and logical work. The first tests, made with the coöperation of the power company, and by cutting off power in one section at a time, showed that the trouble originated in one certain small section. Further tests of the same sort showed that it came only when a certain transformer in this section was connected. Now it had been noticed every time the voltage was removed from the line during these tests that not only did the interference stop, but it did not start again until almost exactly ten minutes time after the power was turned on. It seemed quite reasonable to believe, therefore, as soon as the source had been narrowed down to one transformer, that this transformer became defective in some way after the power had been on long enough to heat it up to a certain temperature. So the power company went to the trouble of replacing the transformer with a new one. But, ten minutes after the new transformer was turned on, the interference came on as strong as ever. This was conclusive evidence that the trouble was not in the transformer but was somewhere on the lines going from the transformer, which as is usual, fed quite a number of houses in the neighborhood. When he tried a radio receiver with a loop antenna, he soon localized the trouble as coming from one particular house which was several hundred feet from the nearest radio receiver. When the main switch in this house was opened the interference stopped all over the section. Further systematic search in this house seemed to indicate that the porch light was the guilty device and so it was taken apart and examined—but the noise continued even when the porch light wiring was disconnected. Then a member of the household remembered that there was a baseboard outlet in a front room on the second floor which was probably connected to the porch light wiring. Examination of this outlet revealed that it was used practically continuously for an electric heater pad in the bed of an invalid. When this heater pad was disconnected, the noise stopped. Ten minutes after this heater was plugged in, the noise would start. A variable contact in the heater element of the pad partially opened the electric circuit and therefore caused sparking, when it became hot. It took ten minutes for the pad to heat up to the temperature which caused the sparking.

IT ISN'T HARD TO FIND THE TROUBLE

THE incident just given has been described in detail because it shows the sort of detective work which is usually necessary in order to locate inductive interference. Expert radio knowledge is an advantage, and familiarity with electrical practice a still greater benefit in "shooting trouble," but the chief requisites to successful locating of inductive interference are common sense and the ability to see what experiments are most likely to give useful information, and second, to interpret the results of the experiments.

A Power Company Cuts Out "Static"

One Lineman with a Loop Receiver Replaces Many Men and Saves Repair Costs, Current, and the Temper of the Broadcast Listener

By EARL C. McCAIN

ON THE 66,000 volt Arkansas Valley power transmission line of the Southern Colorado Power Company between Pueblo and La Junta, Colorado, there are 28,530 insulators. And each insulator has to be inspected frequently so that the high tension current will not stray from its copper path.

No doubt you are asking yourself what this has to do with radio. Well, it has just this to do with those who nightly listen to the voice of the broadcaster. Large power lines which "leak" current are certain to produce static in every radio receiver in the vicinity. The sound will almost always be continuous, and if the leak is bad enough, and your receiver is near enough the source of the trouble, you are going to have a pretty hard time of it. Distant stations simply can't be "pulled in" through the local artificial "static," and the more amplification you use, the louder it will come in.

Those who live in cities and those who don't, often encounter receiving trouble from this source. All that is necessary is for you to be near a leaky power line.

The power companies don't like leaky lines any better than an irate broadcast listener does, for if the leak is sizeable, they are going to lose current, and in losing current, money.

George W. Hammill, superintendent of the Arkansas Valley transmission lines of the Southern Colorado Power Company, has had great success using a radio receiving set equipped with a loop antenna to detect faulty insulators and leaks of greater or less magnitude on the lines under his control.

A fairly sensitive loop receiver is quite directional, and the Power Company trouble shooters go out with their Ford and loop receiver, skim along the road and can note down each and every pole where there is trouble, without even leaving the car. It is perfectly possible for a lineman to inspect the line at a speed of sixty miles an hour, as far as the accuracy of the test is concerned. The loop receiving tester set has never shown a leakage without closer inspection revealing a broken insulator, and it has never passed a broken insulator without revealing it by sound. The officials of the Southern Colorado Power Company say they are very well satisfied with this method of testing and will use it on all their lines.

Insulators are subject to damage or failure from three sources: mechanical stresses, such as being struck by bullets or stones; electrical stresses, such as lightning or other excess voltage surges, and atmospheric stresses, due to sudden variations in the temperature. Any of these causes break the insulators and permit leakage of current, often sufficient to interfere with service and compel a shutting off of the power until the fault can be repaired.

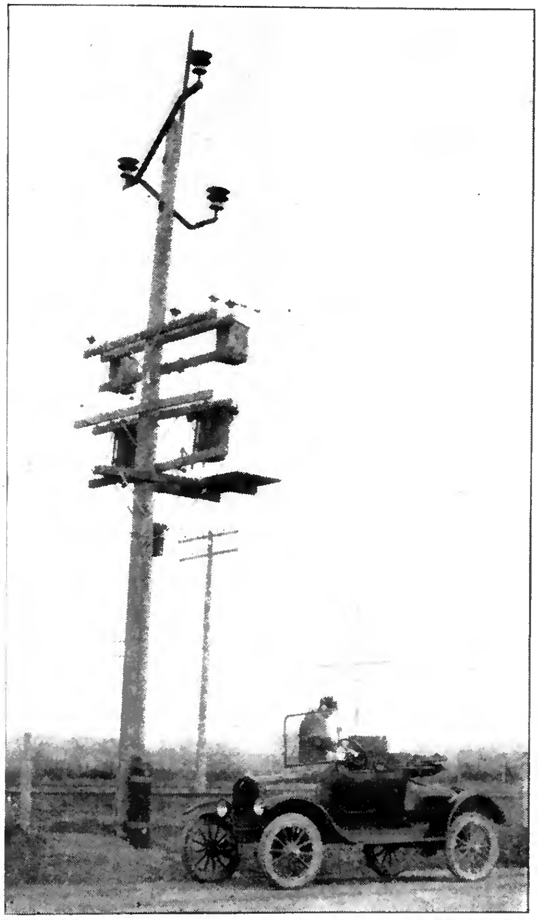
In most cases, this trouble occurs at the top of the insulator, where it cannot be seen even when a lineman has climbed the pole. The use of field glasses sometimes helps to detect insulator breaks, yet even the glasses often fail to show the smaller breaks. In such cases, the only solution is to determine the approximate location of the leak, install a relay contrivance to carry the current past a certain point, and carefully go over all the poles in that area.

E. F. Stone, superintendent of power lines for the Southern Colorado Power Company, says: "While many experiments have been made to determine means of locating insulator leakage, this is the most satisfactory of all. I believe this method is infallible, and power companies throughout the United States in the very near future will undoubtedly adopt this means of testing their lines."

Radio Clubs Can Help

We do not see why local radio clubs can't have a trouble squad equipped with a loop receiver to do electrical detective work on "power-line static" in the way described in this article.

By proper coöperation between the radio club amateurs, the broadcast listener, and the power companies, it would seem that radio life could be made more liveable for everybody.
—The Editor.



TESTING A TRANSFORMER

One lineman with this car and loop receiving set can inspect a 66,000 volt power line with 28,530 insulators where it took many linemen at a total cost of $6,000 for salaries and replacements under the old system

A RADIO EQUIPPED CAR

Ready for a transcontinental trip these four men plan. Camping and cooking gear and the dog are stowed neatly on the side of the car. The receiving set will help them while away many a dull evening when they are camped along the roadside

The March of Radio

Real Information on the Size of Radio Audiences

THREE well known Chicago stations recently called on their audience to send in votes as to the type of program they wanted, and the number of letters received furnishes some clue to the size of the radio audience of to-day. We are told that one station alone received 170,699 letters, a truly remarkable figure. Starting with this known quantity, the statisticians of the stations, ever enthusiastic and optimistic, calculated the audience of this station as 8,534,950—"some audience," as we say in our crude modern parlance.

Now how did they arrive at this astounding figure? Our guess is something like this. Let us say that accurate statistics show that of all the children born, 50 per cent. of them reach the age of twenty. Therefore, we say, as a mother codfish lays 9,000,000 eggs, 4,500,000 mature cod will be the offspring of each effort the codfish makes to perpetuate her species. Naturally the question is asked—what has the mortality among children got to do with codfish and the obvious answer is—nothing. By such logic however do our broadcast managers reach their fearful and wonderful results.

If a business man sends out circular letters, he receives a certain number of replies; by considering enough of such cases we arrive at the conclusion that in answer to circular letters perhaps 2 per cent. of replies may be expected. For other types of circularization perhaps a different return may be expected. For example, in the annual election of officers for our national engineering societies (carried out by mail) about one member out of four takes the trouble to send in a vote. From consideration of cases of this sort, the managers of the broadcast stations came to the conclusion that for every letter they got from the unseen audience there were at least fifty listening. On this basis the number of letters received, multiplied by fifty, gives the size of the audience.

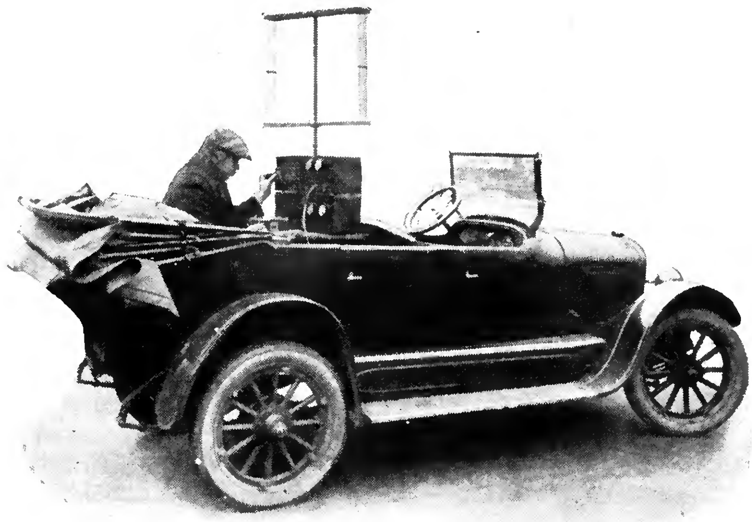
This is a most flagrant example of misapplied methods. The number of replies received bears no more relation to the known figures of letter circularization than does the mortality of humans to that of codfish. From what we know of the appreciation of radio programs from the high class stations, we imagine that not only one out of fifty would answer such an inquiry as the Chicago stations sent out, but probably more likely one out of five. Using the one to five proportion gives a radio audience of about 800,000 for one station. Even this figure, arrived at by reasonably conservative calculation, is enough to stagger any one used to treating figures with more respect than do the radio publicity men.

Radio Maps for New York City and Washington

THE radio surveyors of whom we have spoken several times lately have just finished maps of New York and Washington, and their surrounding country. Their signal-measuring apparatus, mounted in an automobile, has made hundreds of measurements which, properly plotted on a map of the district, enables them to draw a radio map looking much like the relief maps of our physical geography days. By drawing lines through the points of equal signal strength, a map is obtained which resembles exactly the topographic maps put out by the geological department of the government. Instead of signifying points of equal height however, these radio contour maps show points of equal signal strength.

With the aid of one of these radio maps, our imagination, if at all active, can follow very closely the radio waves as they tumble and twist their way over the earth's broken surface. Behind mountain ranges we find but little signal, it having been absorbed by the hills; along sandy, moist country the signals travel straight, with the regular motion of rollers hundreds of miles out at sea; over the cities the progress of the waves resembles that of the ocean rollers as they approach a rocky shelving shore. Here their direction of travel changes and twists, the waves reflected from rocks and shore meet head on at some places producing extra turbulence while at others, perhaps behind a projecting rocky ledge, the water is still. No waves at all penetrate here—it is a dead region in so far as wave motion is concerned.

But perhaps further behind this rocky ledge, the waves which have been climbing shoreward twist around and meet, thus destroying the "wave shadow" the ledge has set up. So it is with radio waves; absorbed as they travel over the cities' squares, piled high with steel structures which absorb the waves' energy, radio dead spots are found. But farther along the same course, in the same direction from the station, the waves from the two sides of the city pour some of their energy into the shadow space to such an extent that the signals actually get louder with increasing distance from the station. So it would be with water waves dashing against a small island; a boat resting in the lee of the island would find no wave motion, at all, but if allowed to drift with the wind, away from the protecting shore, the ocean soon becomes rough and turbulent due mostly to the waves which have passed around the island on either side; they spread into the waveless region to destroy its calm.



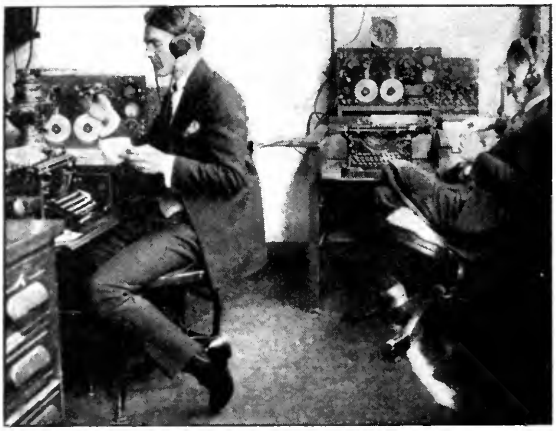
MAKING A RADIO MAP

With a special loop receiver equipped to make particularly accurate measurements the operator measures very carefully the signal strength of the station at various points. The radio map we printed in March of New York, was an equipment of this kind

You should get a radio map of your city as soon as you can; it may well be that the comparatively poor reception you are able to get is due to the fact that you are in a dead zone; your friend a short distance away, who boasts of the superiority of his reception, may have unknowingly picked out a very active radio spot for his residence. Perhaps in the future the landlords will talk of the radio features of their location as well as the exposure and other things we now hear about.

Is the Radio Corporation a Bad Trust?

IN OUR last issue we gave a résumé of the Federal Trade Commission's report on the situation in the radio industry. The findings showed conclusively that a stringent monopoly existed in the radio field. In the report no recommendations were made as to how the situation should be remedied because the report requested by Congress was to give the facts only. But soon after the report was issued, the Trade Commission started court action to have the Corporation expose its alleged monopolistic workings.



WHERE THE "SHENANDOAH" GOT HELP

A corner in the office of Naval communications, Washington. These naval radio operators control NAA, Arlington, and NAL, Washington Navy Yard. When the Navy dirigible *Shenandoah* recently broke away from her mooring mast at Lakehurst, N. J., and fought high winds for nine hours, these two operators were in close touch with the runaway airship

The complaint specifies certain acts of the members of the Corporation which, in its opinion, were carried out "for the purpose of, and with the effect of, restraining competition and creating a monopoly in the manufacture, purchase, and sale in interstate commerce, of radio devices and apparatus, and other electrical devices and apparatus, as in domestic and transoceanic radio communication and broadcasting." The acts referred to are grouped under five headings.

The Corporation:

1. Acquired collectively patents covering all devices used in all branches of radio, and pooled their rights to manufacture, use, and sell, radio devices and then allotted certain of the rights exclusively to certain respondents.
2. Granted to the Radio Corporation of America the exclusive right to sell the devices controlled, and required the Radio Corporation to restrict its purchases to certain respondents.
3. Restricted the competition of certain respondents in the fields occupied by other respondents.
4. Attempted to restrict the use of apparatus in the radio art manufactured and sold under patents controlled by the respondents.
5. Acquired existing essential equipment for transoceanic communication and refused to supply to others necessary equipment for such communication and also excluded others from the transoceanic field by preferential contracts.

Now from what we know of radio it seems quite likely that the Radio Corporation has done practically all these things. Whether the actions have been carried out in such a manner as to warrant legal steps to dissolve the Corporation is not so certain. Government officials were present when the plans of incorporation and program of activities were made up and, undoubtedly, high legal talent has passed upon the legality of the plans of the radio trust which apparently comes dangerously near an infringement of law. Since the Federal Trade Commission has been so unsuccessful in many of its previous suits, the Radio Corporation is probably not much disturbed by their attempt to use the big stick.

Should the Corporation be haled into court and made to bring in books showing its activities, its financial schemes, its manufacturing and selling campaigns, etc., with costs of production and sales, the radio public would get much interesting information on the vacuum tube situation. What is the manufacturing cost of an ordinary triode, and what is the proper selling cost when reasonable profits and development charges have been cared for? In the old days of the De Forest audion, when hand work was the rule and tubes were turned out by the dozen, we can see that the proper selling price might have been the five or six dollars we had to pay even then for the audion. But now when tubes are machine made, and almost four million a year produced, can the reasonable cost to the public be the same as it was in the early audion days? We know of course about "development costs," the research laboratories must be well repaid for the time and material spent in developing the present tubes and for research into future improvements. We also know that patents have been well paid for in certain instances, and we know that a high depreciation must be charged off on machinery and auxiliary apparatus used in making types of tubes which may be superseded to-morrow.

Granting this, should the public be obliged to pay five dollars for a triode whose actual manufacturing cost we venture to guess, does not exceed fifty cents at the outside? How much does the Radio Corporation take for its share, since the tubes nominally go through its channels? How much may the dealer keep for storing the tubes on his shelves a day or two and then passing them out over the counter? This information would be a very welcome outcome of any possible court action arising from the Trade Commission's complaint against the Radio Corporation.

Is there a monopoly in the manufacture of triodes? The answer is—Yes. Is this an illegal situation, one which warrants government interference with threats of prosecution if the trust is not dissolved at once? No—certainly not. The reason is because the government itself grants the monopoly. This point must be borne in mind by those who, disgusted with high prices, would give unlicensed manufacturers the right to manufacture triodes in spite of the patent situation.

A patent is an out-and-out monopoly granted to the inventor for seventeen years, as a reward for those diligent labors which have brought into being a new and useful device. Theoretically he can hold up the public for any price he decides to charge and he is doing nothing illegal. And if some company buys the invention the monopoly becomes theirs, legally, and they legally have the right to charge any price the traffic will bear. So that this "trust" situation, in so far as it affects the average listener-in, has no illegal aspects at all.

It frequently seems that this patent law itself is eminently unfair to inventors and prospective inventors, but it is not evident that any change would relieve the situation. This invention game has no second and third prizes; no matter how much such prizes may seem to be deserved.

We will say that A discovers, accidentally, how to make the audion oscillate, at ten o'clock on a Monday morning. He gets his idea certified by a notary so as to have an authentic record and in time files a patent application. On the same day, in another part of the country, B finishes a series of carefully planned experiments and succeeds, at eleven o'clock on the same Monday morning that his years' work is rewarded—the audion will oscillate. So he files a patent application and soon finds himself in interference with A. When the case is heard, A of course is decided to be the inventor and B gets nothing, although he is really a much cleverer and more capable experimenter than A. Such situations, apparently unfair, probably exist in most of the pathways along which striving man progresses.

Argentina's New Station

RECENTLY there was opened a high power radio telegraph station at Monte Grande near Buenos Aires, Argentina. Messages of greeting were sent from the station to the rulers in The United States, Great Britain, France and Germany, the reason for the international greeting being the fact that the station is owned and operated jointly by the radio companies of these four countries. Although ownership is nominally vested in an Argentine corporation, the Transradio Internacional, this company is owned by the Radio Corporation of America, the Marconi Company, the Compagnie Générale de Télégraphie sans Fils and the Telefunken Company. Separate stations had been begun by the German and American companies when it was decided to pool interests and let in the other two radio concerns.

"BEHIND THE SCENES AT A BROADCASTING STATION"

Eight young artists resting after their juvenile program recently broadcast from WOR, Newark. The microphone was not on the air during the ice cream eating

The station will communicate directly with the United States and Europe with probably the same reliability as the Radio Corporation's present transatlantic links have shown. The cost of this station is about five million dollars, according to the report, so it is evident that a considerable radio traffic with South America must be built up if the station is to prove a profitable venture. This is another commercial bond south of the equator.

New Standard Wavelength Stations

IN ADDITION to the stations we have recently cited, the Bureau of Standards now feels that the following stations have been holding to their specified wavelength with sufficient constancy to warrant mention as secondary standards of frequency. WWJ at 580 kilocycles has a greatest deviation of 0.2 per cent. and an average deviation of 0.1 per cent.; WCAP at 640 kc with a greatest deviation of 0.3 per cent. and an average of 0.1 per cent.; WOS at 680 kc with a maximum deviation of 0.2 per cent. and an average deviation of 0 per cent.; WSB at 700 kc has a greatest deviation of 0.3 per cent. and an average deviation of 0.2 per cent. These are in addition to WGY at 790 kc and KDKA at 920 kc.

With a few more stations well distributed throughout the broadcasting band, the accurate calibration of a receiving set will soon be a very simple matter.

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LADY TERRINGTON, ANOTHER WOMAN MEMBER OF PARLIAMENT

Who was recently elected for Wycombe, Bucks, listening to what must be quite entrancing radio signals

Keeping Close to Employees

IN A transcontinental railways system it is evident that those responsible for the detailed operation and maintenance of the equipment cannot but feel very far away from the executive officers, whom they perhaps never see, and hear of only occasionally through company bulletins. Feeling that a closer connection between the President of the road, and the men who do the work, will be beneficial to employees and road alike, Sir Henry Thornton, for some years a railway executive in the United States, but now President of the Canadian National Railways, has announced his intention to make it possible for a radio receiving set to be in the home of every one of his employees. The sets are not to be given away, but are to be purchased by the railway and sold to the employees at cost, with long time payments allowed.

It is his idea to broadcast from some central station (or several if necessary) his ideas regarding improvements in the operation of the roads as well as in the working and living conditions of the employees. It seems quite likely that information about the road and its aims and prospects, delivered by word of mouth of the President, will prove of much more interest to the operatives than the printed bulletins, often thrown away before being read.

And of course the fact that the receiving sets are perfectly good for bringing in entertainment of various kinds, as well as the talks of the road's President, will make him try to say something of real interest to his listeners—otherwise his voice will be dissipated over Canada's waste spaces without reaching the ears of a single employee.

The scheme has received quite favorable comment from the press and its results will be awaited with interest by other enterprises which are organized along the same line as is the railroad.

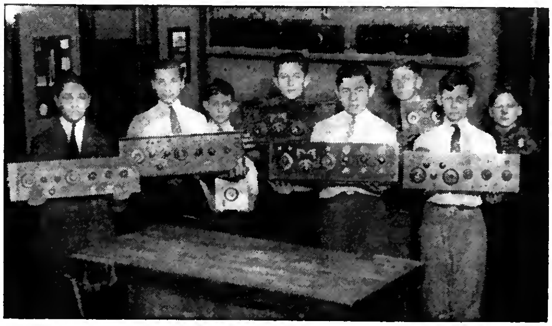
Down to the Deeps with Sets

TWO or three items appearing recently add to our knowledge of the laws by which radio waves travel. At Bisbee, Arizona, a group of radio enthusiasts descended 1,400 feet in the Junction mine with radio receiving sets "to see what they could see."

A radio wave does not stop at the surface of the earth, but penetrates into the surface according to a law well known to radio engineers. The penetration of the radiation into the earth is very much the same as the penetration of a beam of light into a fog, or the penetration of "cold" into the earth as the winter comes on. How far does a light penetrate into a fog? Evidently no definite distance. It gradually gets weaker and weaker as the distance into the fog increases. Furthermore the beam will surely penetrate much farther into one of our fogs, than if it has to force its way through one of London's "black" fogs. Similarly, the radio waves penetrate better into a dry non-conducting earth than they would into moist earth, or earth containing coal veins, or veins of conducting ores.

At the same time the experimenters in Arizona were getting signals 1,400 feet in the earth, others in a tunnel under the Hudson River were elated because they got signals 100 feet below the river's surface. This was perhaps a more remarkable example of radio's travel than the other because the river is salt water (a comparatively good conductor) and the waves had to penetrate the cast iron casing of the tunnel besides.

Neither of these occurrences violate the known principles of radio transmission, but rather confirm them. If one listens to the radio signal received in a submarine as she



RADIO CRAFTSMEN IN SCHOOL
Boys of Public School No. 6, New York, with radio sets they built themselves

submerges, antenna and all, and gradually goes lower the intensity of signal falls off just about as the beam from an arc lamp falls off as we penetrate a dense fog.

No Political Broadcasting in England

ONE of the ancient customs of the English Government was called to our attention by recent press dispatches announcing that the King's speech to Parliament was not to be broadcast. This speech is prepared not at all by the King, but by the party to which the Government's affairs are temporarily entrusted; the King is however allowed to read it as though it were one of his own composition. How many boys in school wish that this King's privilege of using some one else's ideas might be extended throughout our democratic school system!

Now, as the speech has nothing to do with the King himself, but is really political propaganda for the party in power, the Cabinet, which had previously ruled that the broadcasting of political speeches in England was not to be allowed, decided that the King's speech might not be broadcast. Surely no one needs to fear the power of the King in this labor-controlled, democratic, monarchy; his officials even deny him the privilege of broadcasting the

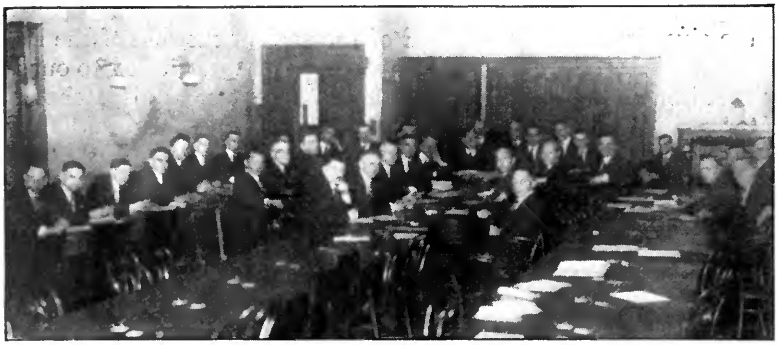
BOY SCOUTS CONTROLLED WJZ FOR A DAY
In their campaign for one thousand new Scout leaders in Greater New York. The boys announced and managed the station themselves. The group is examining the oscillograph, the instrument which enables the control operator to "see" what the station is sending, and so to check the quality of the broadcasting

speech which they themselves have written for him.

Spark Interference

IF THERE is one source of annoyance more disturbing than another in broadcast reception it is that due to spark stations sending code. Of all the irritating and exasperating experiences we have suffered, the hoarse, rasping dots and dashes caused by the ordinarily musical note of the spark station interfering with the carrier wave of the broadcast concert is the worst. And many times it seems as though the spark operator must be actually asleep on his key. Again we can almost hear his sardonic laughter as he pictures to himself the hundreds of thousands of broadcast listeners, each of whom would like nothing better at the moment than to drop him to the floor of his cabin with a gleefully administered tap from a black jack.

Now these spark signals really shouldn't be so disturbing because a 500 kilocycle signal (600 meters) is far enough away from most broadcast frequencies so that but little interference should be experienced except by those who are very near the spark station. But most of the trouble doesn't come from this spark signal frequency. For some reason better known to others than to us, many spark sets near New York Harbor are operated on a frequency of 666 kilocycles (450 meters), right in the middle of the broadcast band.



THE NEW YORK CONFERENCE

Which recently met at the call of Arthur Batcheller, Supervisor of Radio, second district, to decide how to reduce interference to broadcast listeners from ships and coastal radio stations. It was decided to eliminate the use of 450 meters, a wavelength in the very middle of the broadcast band, for ship and shore communication. Four representatives from Canada attended the conference

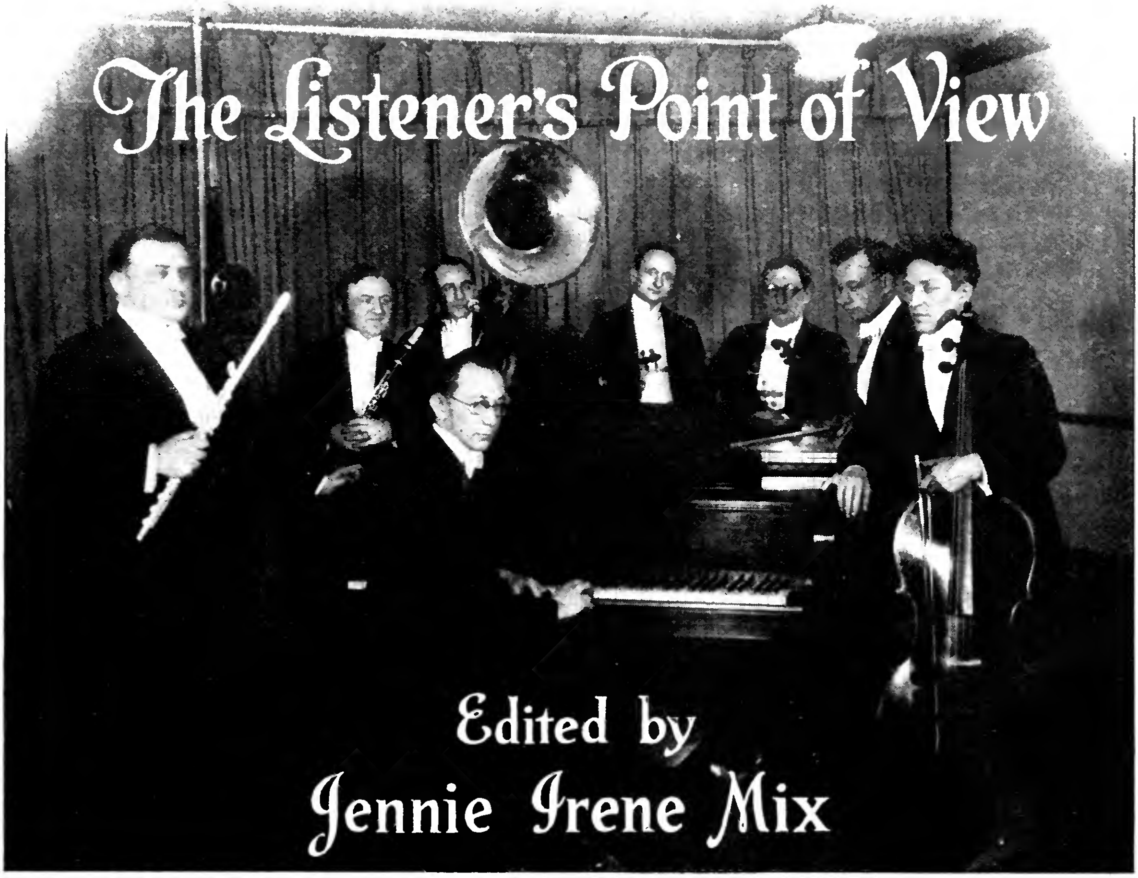
At a recent meeting of radio experts in New York representing the U. S. Department of Commerce, the Canadian Government, and the commercial radio companies, it was agreed that spark transmission should be done away with as soon as practicable (perhaps within a year) and that the 666 kilocycle frequency should not be used at all by ships in American waters. This is a most admirable achievement, and we are sure the radio public is much indebted to those responsible for the inauguration of this change in ship radio traffic.

Radio Cures Tubercular Patients

WE HAVE heard of cases of the deaf being made to hear by radio—we have heard of radio being used in the delivery room of a hospital, in place of anaesthesia successfully to dull the pain Nature inflicts, but even then, we were astonished to read a report from a reputable physician that radio was curing his tubercular patients. Was it short waves or long waves? Were they applied internally or externally, or what was the scheme? we asked ourselves. Well, it all turns out to be very simple. The greatest enemy to the health of the tubercular patient is nervousness and worry. He of equable temperament can rest quietly and let Nature mend the destroyed tissues, but the nervous and irritable patient has practically no chance whatsoever. Now, lying in a hospital 24 hours a day, seven days a week, waiting to get better is not conducive to the elimination of worry.

The wise doctor has found that the radio concerts are so much appreciated by his patients, are so much anticipated and looked forward to, that tuberculosis is forgotten. Quiet untroubled rest follows and then Nature steps in to do her share in the reconstruction task. We cannot contradict this doctor's report that here radio is actually curing tuberculosis.

The Listener's Point of View



Edited by Jennie Irene Mix

THE DETROIT NEWS ORCHESTRA

Every week day from 3:00 to 3:30 P. M. you can hear, via radio, a concert by this orchestra of eight men from the Detroit Symphony Orchestra. Every man is a virtuoso on his instrument. From left to right they are: Otto E. Krueger, flute and conductor; William Herrick, clarinet; Valbert Coffey, piano and viola; Eugene Braunsdorf, sousaphone; Maurice Warner, Herman Goldstein and Roy Hancock, violins, and Frederick Broeder, 'cellist

WHEN this prodigy they call "Broadcast Music" first came into existence, it was adopted by a thousand foster parents, nursed by millions of eager admirers. Now, after but three years, some of these foster parents have cast the prodigy aside as too expensive a protégé. Others, and their name is legion, have so spoiled the youngster, permitting him to perform his tricks for anybody and everybody regardless of the company into which it throws him, that many who were once his friends will no longer have anything to do with him. They fail to see that his shortcomings and defects are due to wrong guidance rather than to himself.

Have you ever stopped to think of that, you who are daily sending out music through the radio to millions of listeners?

By Way of Introduction

The impulse that leads one to brush up on his Shakespeare before going to see a Sothern and Marlowe or a Jane Cowl interpretation of one of Shakespeare's plays; or that creates sale for librettos before an opera, is at one with the impulse that has prompted this new department. As the ranks of those who listen to symphony orchestras, operas, and all the varied forms of musical entertainment have increased a thousandfold overnight, as it were, so, we believe, there will be a similar increase of interest among our readers in whatever this department may have to tell of the best in broadcast music. Miss Mix has been writing interestingly and authoritatively, in newspapers and magazines, about music for many years.—THE EDITOR.

All the influence ever exerted by all the musicians who have ever lived, and by all their interpreters, is as nothing when placed against the influence exerted by broadcast music since it came into existence some three and a half years ago as a regular means of entertainment for the public.

And no one seems to know exactly what to do with it. Every hour of every day it is serving as a medium through which is disseminated an incredible amount of trash, even a small portion of which is enough to vitiate public taste. On the other hand, during this short existence, it has brought good music, sometimes even the greatest music, to hundreds of thousands, yes, millions, who otherwise could never hear such music at all.

What is to be the future of this musical giant that can penetrate in an instant to every nook and corner of the earth? This is a question so far from solution at the present time that to attempt an answer would be but a waste of words.

But to watch developments—to do what can be done to regulate this force for the pleasure and enlightenment of those brought into touch with it, and to make of it a constructive force —this is going to be to all who try it, one of the most interesting and fascinating experiences among the thousand and one interesting and fascinating experiences constantly available in this life.

ELEANOR MCLELLAN

The first one to give instruction over the radio regarding the production of the singing voice

Can Voice Lessons Be Given Over the Radio?

ELEANOR McLellan, the first person ever to try it, says, "Yes."

She has given a number of such lessons through the broadcasting station, WJZ, Aeolian Hall, New York. The returns in letters have been such that she knows that many listeners all over the country not only were interested in what she had to say but understood what she was aiming to make clear to them.

"Of course, I do not think that one can develop a pupil into a singer through radio lessons," she said, when asked at her New York studio to talk about her broadcasting experrience. "But there are certain laws," she went on, "governing the correct production of the singing voice that can be explained by radio to those who are anxious to learn these fundamental principles.

"I talked to these unseen students about the correct action of the breath and illustrated this point by explaining many incorrect ways of using it as taught to-day. Then I told them about the right adjustment of the palate and tongue and lips, how to get this adjustment and what happens to the tone when the opposite action is used. In making such points as these I could not but wonder how I was 'getting it across,' to drop into the vernacular. I confess I was astonished, when the letters began to pour in, to find that my radio listeners had listened with greater intentness to what I had to say and had comprehended it more fully than the majority of studio students.

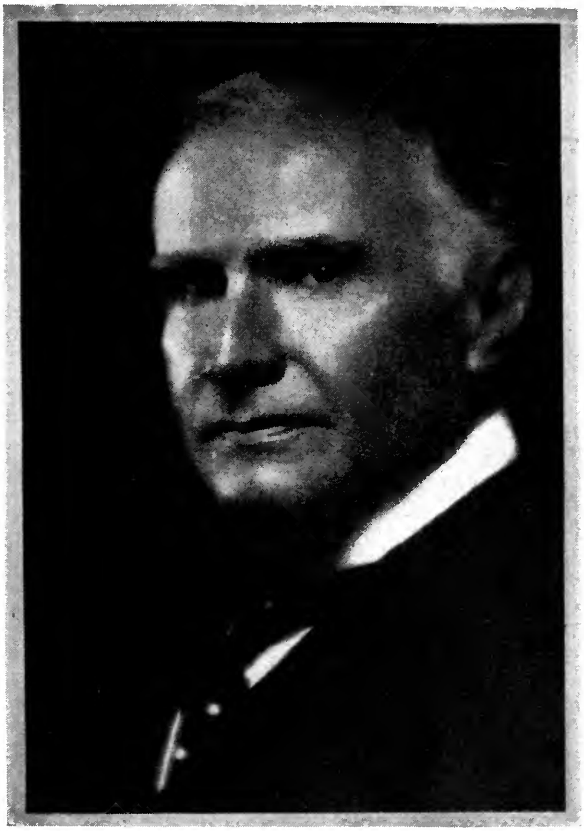
"The reason for this must be that only a person definitely interested in the production of the singing voice would have the patience to listen to instruction on this subject from a teacher who is invisible, and distant from one mile to three thousand or more. As for me, I never thought, once I began to talk, of distance between my listeners and myself. On the contrary, the complete silence gave me an unconscious impression of an intent audience.

I should judge from my own experience that all one needs in talking over the radio to get rid of a feeling that no one is listening, is the use of imagination.

"Yes, I am unqualifiedly in favor of using the radio as a means of bringing the best in music to every section of the country. I am not at all in sympathy with the idea entertained by some that if an artist is heard over the radio he will not be in demand for appearances in person in these same localities. To me there is about as much sense in saying that if an artist has sung once in a town, no matter how well he is liked, he will never get a chance to sing there again. And then, too, there is the universal human quality of wanting to see what one has heard something about.

"Even more, there is the benefit to the artist in the encouragement and inspiration that come to him from the response by letter after he has been heard by a radio audience. And let me assure you that every artist, no matter how great, always feels the need of appreciative recognition. It heartens flagging enthusiasm, turns discouragement into ambition. The artist who sings or plays for radio listeners will realize as he never could realize otherwise, that the people capable of appreciating his art are in numbers far beyond what he had before thought possible."

A further proof that there are plenty of radio listeners who want to learn as well as be entertained is found in the fact that Miss McLellan has received many letters asking that she read for her radio audiences portion of her book, *Voice Education*, published by Harper and Brothers and now being translated into French. The object of the requests is that while she reads she should stop when the opportunity occurs and give illustrations of the points brought out.



WALTER DAMROSCH

Are there enough people in this country interested in good music to justify broadcasting it? Ask Mr. Damrosch. His reply will be in the affirmative. His recent talks with illustrations at the piano on the Beethoven Symphonies, given at Carnegie Hall, N. Y. before subscribers to the Beethoven Cycle of concerts by the New York Symphony orchestra of which he is director, were broadcast from station WEAF

What a Negro Spiritual Really Is

IT GOES without saying that those who made a special effort to hear the program of Negro spirituals recently put on by KDKA as a dinner hour entertainment will be shocked to learn that, according to John Powell, they are not Negro spirituals at all.

Many, in addition to being shocked, will be resentful at this bald contradiction by Powell of a long-cherished belief. But as this composer-pianist, whose fame is international, is considered the leading authority in this country on Negro music it is well to give some heed to what he has to say about it.

He tells us that Negro music is seldom heard by the white man, and that these spirituals with which we are all so familiar and which the Negroes themselves sing for us with such fervor, are simply old hymn tunes modified and distorted by Negro rhythms. This is even true of the Stephen Foster melodies which are much nearer kin to German folk song than to Negro music.

As he was born and raised in "old Virginny," and still lives there when not on concert tours, Powell knows well what he is talking about. Three years ago when he toured Europe and

England as soloist with Walter Damrosch and his New York Symphony orchestra, Mr. Powell created what was no less than a sensation with performances of his "Negro Rhapsodie" for piano and orchestra. This "Rhapsodie" is generally conceded to be a remarkable interpretation of Negro moods in addition to being mighty good music just as music.

Perhaps sometime Mr. Powell will "tell the world" via radio something more as to why Negro spirituals are not Negro spirituals. He ought to, considering the fact that he has shot a hole straight through a cherished popular belief. All those who listened to that KDKA program should demand that he explain his position to them fully.

How about it, John Powell? Come, it's up to you.

Medlies

SPEAKING of radio, Ossip Gabrilowitsch, famed equally as orchestra conductor and pianist, said a few days ago:

"I seem to be the only man living who has never 'listened in.' Always when I tried to something interfered. Either that thing you call static got in my way, or I had to get away to that place you call station. Yes, I know that eight men of my orchestra, the Detroit Symphony, play a daily program for radio, and that the concerts we give for children are broadcast. But I—alas! Yet wait! I'll listen in soon, then I'll tell you how it impressed me—this broadcasting of music—and you can tell the readers of your magazine."

To which the "Listener's Point of View" conductor replied: "If you really do want to 'listen in' I won't have to wait long. You look like a man who can do what he wants when he wants to."

JOHN POWELL

Composer—Pianist. Ask this noted American musician what he thinks about Negro spirituals, and he will very likely reply in that charming Southern drawl of his and with that characteristic twinkle in his eyes: "Are you talkin' about the Negro spirituals what am, or the Negro spirituals what ain't? It must be the ones what ain't for I reckon you've never heard the ones what am."

Expecting the announcer at a broadcasting station to get all the titles of the program right is probably asking more than any tongue can tell.

Names of authors, books, titles of lectures. Scientific terms, musical names and terms—

Which reminds us.

There's an announcer at a certain well known broadcasting station whose mind must dwell more on the delights of fishing than the delights of music. Whenever a soloist is a bass he pronounces the word in a way to make the listener want to ask:

"Black or striped?"

The word "bass"—not the fishing variety—again reminds us.

Because the tones of the double basses in an orchestra cannot be heard by radio owing to the low rate of vibrations, the parts written for this instrument are played by many broadcasting orchestras on the sousaphone.

A sousaphone, be it explained, is a huge brass horn which was made for and first used by John Philip Sousa in order that the foundation tones of his band might be deeper and more evenly balanced. It is said that the idea of the instrument originated with him.

While the sousaphone cannot, of course, produce a tone resembling the instrument it replaces in broadcasting, it serves an invaluable purpose, so say those who use it, by filling in the harmony as nearly as possible as originally written for the double bass, and it keeps the tone of the orchestra better adjusted than could otherwise be the case with these important stringed instruments out of commission.

After having seen a sousaphone, one cannot but wonder how any man can find breath enough to keep it going, or how, once it gets to going, it can be kept from drowning out all the other instruments with which it is associated.

OSSIP GABRILOWITSCH

Those of you who have not heard him conduct the Detroit Symphony Orchestra have probably heard him in recital. For he is equally famous as conductor and pianist. When it comes to the radio, however he's—well—see what he has to say about it elsewhere in this department

Who Will Pay For Broadcasting?

AN AMBITIOUS experiment is being conducted in New York to see if the listener is not, after all, willing to pay for the very best musical talent in broadcasting. The "Radio Music Fund Committee," as they have called themselves, was formed with Clarence H. Mackay, Felix M. Warburg, Frederick A. Juillard, and A. D. Wilt, Jr. as members, and the Central Union Trust Company, 80 Broadway, New York City as depositary for the funds.

The plan, as announced, is to appeal to radio listeners to send in contributions, direct to the bank, of $1 or more, to allow the Committee to engage the best musical talent—symphony orchestras and individual artists—to broadcast. The Committee announce that all of the funds received will go directly to pay the artists and that none of the contributions will be used to pay for administration expenses.

Station WEAF of the American Telephone and Telegraph Company, 195 Broadway, New York City, was selected by this committee for the experiment, because, the Committee announced, "of the superior quality of their broadcasting."

There is some doubt whether the artists the radio public is eager to hear can be secured for broadcasting, since most of them are recording phonograph artists, and there is a clause in many contracts, made by phonograph companies which prohibits these artists from broadcasting.

The plan, at present, is by no means national in scope, and we are in some doubt whether it is wise to restrict the application of this fund to pay for the services of artists from one station alone. What are the managers of stations in Illinois, Texas, Nebraska, and California going to say to this?

We are by no means sure that now is the time to start a program of payment for broadcasting, because it will mean an additional burden on the broadcasters and many stations are already wondering where the money for them to continue is to be raised. The difficulty is a national one, and decidedly not local. Since contributions to this fund are invited, nationally, how are listeners at great distances from New York going to feel about the extreme localization of the disbursing of their money?

Why You Should Have a Wavemeter

And How You May Build it from a Few Parts, Easily Secured and Assembled as Well as Directions for its Use as a Wave Trap and a Tuned Radio-Frequency Amplifier

By GEORGE J. ELTZ, JR.
Manager, Radio Department, Manhattan Electrical Supply Company

IT HAS been wisely stated that the development of a science can be gauged by the accuracy with which the quantities used in the science can be measured. Practically, the advance of the science, and the accuracy of its physical measurements go hand in hand, one reacting directly upon the other. In no particular branch of science has this been more strongly borne out than in radio.

Probably the first instrument developed and one which has been but slightly modified since its inception was the wavemeter. Although radio has advanced most rapidly, the operation of the wavemeter is, perhaps, the most valuable of the radio engineeer's measuring instruments.

Every radio set, whether it be a transmitting set or a receiving set, consists essentially of a combination of inductances and capacities so arranged that by their combined action, resonant circuits are created. These circuits are acted on by the incoming signal in the case of the receiving set and fix the frequency of transmission in the case of the transmitting set. The wavemeter also consists of an inductance and capacity suitably combined to resonate or tune over a band of wavelengths, which may be altered at will.

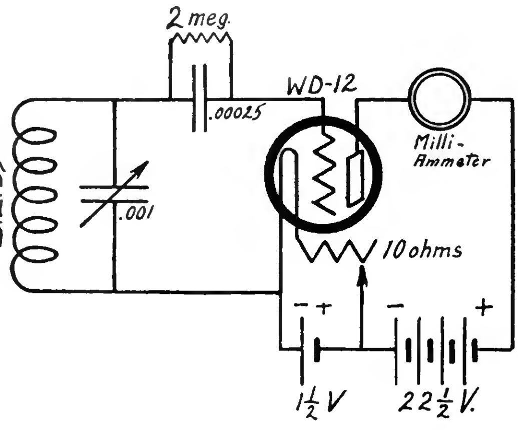


FIG. 1

Typical wavemeter circuit for detection. The tube used may be either UV–200, UV–201–A, WD–11 or–12, or UV–199 and corresponding Cunningham types. A WD–12 or UV–199 tube is most convenient as it permits dry battery use throughout. In the latter case, however, the A voltage should be increased to 3

TWO TYPES OF WAVEMETERS

WAVEMETERS may, in general, be divided into two classes. First there is the precision wavemeter, designed and constructed to give extremely accurate readings which can be duplicated any number of times. Second, wavemeters giving readings of fair accuracy whose calibration change slightly in use. The construction of the precision wavemeter is difficult and expensive to undertake. The condensers and coils used must be made with great care and must be mounted in such a manner that their physical dimensions will not change with temperature or use over long periods of time. They must also be constructed so that there will be no variation in the electrical characteristics with temperature. Precision wavemeters are of interest only to the scientific investigator who has considerable means at his disposal and who is interested in extremely accurate measurements.

THE CONDENSER

FOR general measurement work, the ordinary wavemeter constructed of good standard parts is entirely satisfactory. Practically any good variable condenser of approximately .001 mfd. capacity is suitable for use in a wavemeter. The one requirement, which the condenser must meet is that it be one which will not change its capacity with use. This means that the mechanical supports and the construction of the plates must be rigid, so that there will be no shifting of the plates if the condenser is accidentally dropped or otherwise abused. Any number of condensers can be bought which meet this requirement. In addition, it is advisable, although not absolutely necessary, that the resistance of the condenser be low at the frequencies at which it is to be used. If this requirement is met, the wavemeter will give more sharply defined resonant points than would otherwise be the case. Condensers provided with a movable plate vernier or other means of fine adjustment utilizing an extra plate, are not recommended for this service as they require two readings for each wavelength setting. If a vernier adjustment is desired, and sometimes this is desirable, the vernier should take the form of a small vernier knob attached to the dial of the condenser.

THE COILS

THE coils used in the wavemeter should be strongly constructed, and should not change their size or shape with temperature or with use. Coils either of the form wound type (duo-lateral coils) or coils wound on hard wood or bakelite forms are suitable for wavemeter construction. Perhaps the most convenient type of construction for the amateur is that employing the form wound coils, such as duo-lateral, De Forest, Remler or Curkoid coils. This type of construction is particularly good since it permits the easy construction of a wavemeter covering a wide wavelength or frequency range. The manufacturers of these coils have constructed a number of coils which are designed to cover the entire wavelength band when used in combination with a .001 mfd. variable condenser. If the coils are mounted on plugs, it is a simple matter to cover any particular wavelength band with great convenience.

MEASURING THE WAVE OF A TRANSMITTER

IN FIG. 1 is shown the circuit of a wavemeter designed to measure the wavelength of transmitting or receiving sets. This wavemeter consists of one duo-lateral coil suitably fitted with a plug shunted directly by the .001 mfd. variable condenser. Connected as shown in the diagram is a vacuum tube. This vacuum tube serves as an indicator to show when the wavemeter is in resonance or tune with transmitting or receiving set. In the case of a transmitting set, resonance is indicated by a deflection of the meter from the position at which it would rest if the transmitter were not operating. The wavemeter should be placed a considerable distance from the transmitter when the measurement is taken in order to permit of accurate measurement. When a wavemeter of this character is connected as shown in Fig. 3, it can also be used to indicate the wavelength at which any regenerative or radio-frequency receiver is operating. In the case of a regenerative receiver the receiving set must be placed in an oscillating condition before any indication will be received on the wavemeter. The same oscillating condition must be obtained with the radio frequency receiver. The condition of oscillation of a radio-frequency receiver can, of course, be easily obtained by the manipulation of the potentiometer.

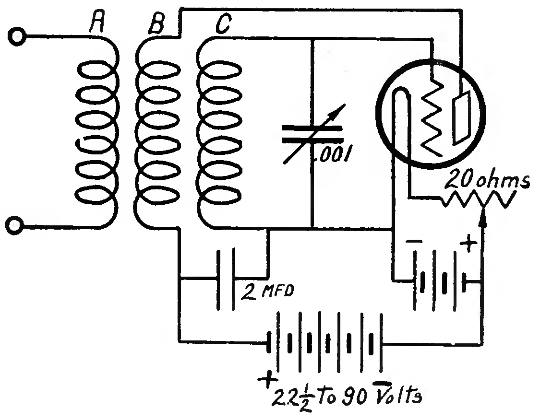


FIG. 2
Typical wavemeter circuit for the generation of oscillations. The use of a UV-201-A or WE-216-A tube is recommended although dry battery tubes will work

In Fig. 2 is shown the circuit connections for a wavemeter designed to create oscillations of a known frequency. This wavemeter utilizes the same coils and condensers used in the wavemeter of Fig. 1. Two coils are added—one a feed-back coil—the other a pick-up coil for use in transferring the energy from the wavemeter over to the circuit where it is desired. Coil C, together with the variable condenser, determines the frequency at which the wavemeter will oscillate. Coil B, the feed-back coil, serves to create the oscillation, the frequency of which is determined by coil C and the variable condenser. Coil A, which can be of the size of coil B, must be varied for best results as the frequency is changed. The same size coil will cover quite a wavelength band; but as the wavelength increases it is necessary to increase the size of coil A if any appreciable amount of energy is required for the measurement.

In constructing either of the wavemeters shown, dry battery or storage battery vacuum tubes can be used. The wavemeter in Fig. 1 will operate satisfactorily with any type vacuum tube. The wavemeter shown in Fig.

2 will operate satisfactorily with all tubes except soft detector tubes, such as the UV-200; but will work best with UV-201-A or Western Electric 216-A tubes. The use of WD-12 tubes in the wavemeter shown in Fig. 1 and a small size B battery permits the construction of a very neat self-contained wavemeter of small dimensions. The milliammeter used should have a range of from 0 to 5 milliamperes.

SIMPLE METHODS OF CALIBRATION

MOST experimenters and amateurs, who are sufficiently interested to construct a wavemeter, understand its general principles of construction and use, but are puzzled to find a suitable means of calibration. The establishment of broadcasting stations and the accuracy with which the wavelength or frequency of the broadcasting station is set, has solved this problem. The accurate calibration of a wavemeter from a reading obtained on even one broadcasting station is now possible, provided, of course, that the broadcasting station chosen is one of the larger size broadcasting stations, which has had its frequency or wavelength carefully fixed.

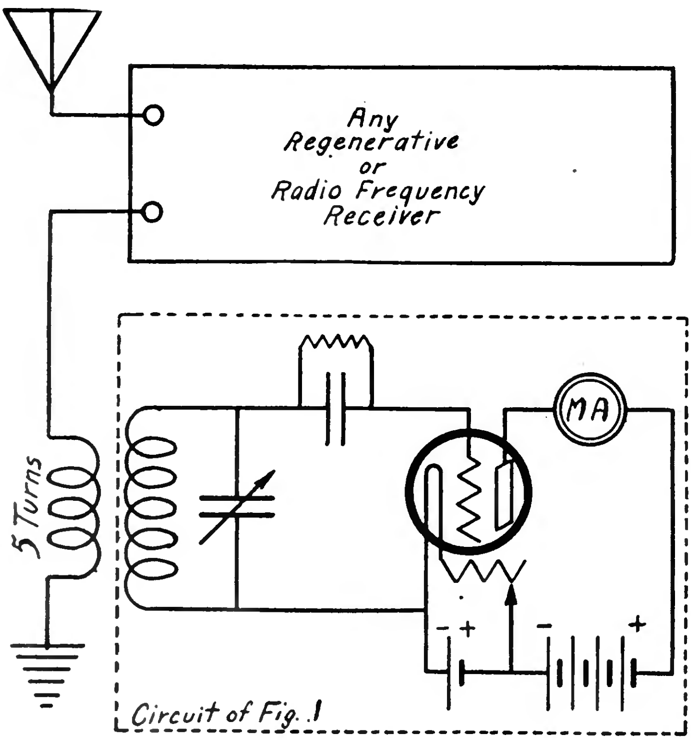


FIG. 3
Method of connection for calibration of receiving set using circuit of Fig. 1. Also method of calibration of wavemeter circuit. Here the wavemeter is shown within the dotted lines

Before going into the method of calibration it may be advisable to explain briefly the relation between frequency and wavelength. The electro-magnetic disturbance in the ether travels through the ether at the same speed as light, namely, 300,000,000 meters per second. The frequency of oscillation does not affect the speed at which the disturbance travels through the ether, so that all waves, regardless of length, travel the same distance in the same time. This being the case the amount of space transversed by a single cycle of the electrical disturbance can be obtained by dividing the number of cycles per second into the distance traveled per second. If a radio set transmits at a frequency of 50,000 cycles, or as it is now more commonly called 50 kilocycles, the distance traveled by one cycle will be 50,000 divided into 300,000,000 or 6,000 meters. Conversely, if the wavelength of a station is given, by dividing the wavelength in meters into 300,000,000 the frequency of the electrical disturbance can be determined. The wavelength and frequency are, therefore, dependent entirely on one another.

With the facts above in mind, consider what means there are available for calibration using frequencies or wavelengths known to be associated with the various broadcasting stations. Take for example, station WEAF of the American Telephone & Telegraph Company, located in New York City and operated on a wavelength of 492 meters or 610 kilocycles. Assume we desire to calibrate the meter shown in Fig. 1. Couple the wavemeter circuit as shown in Fig. 3 to a regenerative receiving set. Tune the receiving set to station WEAF very carefully. This is best accomplished by causing the receiver to oscillate strongly and then adjusting to the exact point where the howl between the frequency of the broadcasting station and the frequency of the receiver disappears. This is commonly known as the point of zero-beat. Allow the receiver to oscillate strongly on this adjustment, tune carefully with the condenser on the wavemeter until a deflection of the milliammeter is obtained.

Make a note of the reading of the dial at which this deflection is obtained, marking the reading as corresponding to 492 meters. Repeat this same process with other Class B broadcasting stations until a half a dozen different readings are obtained covering nearly the entire dial. A curve can now be plotted between these readings and the corresponding wavelengths, and the calibration of the wavemeter for intermediate wavelengths obtained from the curve.

If it is impossible to obtain more than one or two good readings on broadcasting stations whose wavelengths are known, use this method. We may use station WEAF, as an example again. Tune the receiving set as before. Carefully determine as before the point at which WEAF is obtained. This point will be around 80 degrees on the condenser dial. Decrease the capacity of the condenser in the wavemeter by turning the dial toward zero until a reading of the order of 20 is obtained. At this point, another deflection will be obtained which will be very slight and which will correspond to the second harmonic of 492 meters or 246 meters. Now, keeping the wavemeter set on 246 meters, increase the wavelength of the receiver still keeping it oscillating. At a point on the receiver dials corresponding to a wavelength of 738 meters, another deflection of the milliammeter will be obtained. The wavelength set on the wavemeter (246 meters) is then the third harmonic of the frequency of the receiver. We now have determined a new fundamental frequency (738 meters) to which the wave, meter may be tuned and also by making use of the second harmonic of 738 meters can obtain a wavemeter reading for 369 meters. By the single reading taken at 492 meters we have, therefore, obtained the following readings: 738, 492, 369, 246. These four readings alone are almost sufficient to give a good curve. The same process can be repeated for every broadcasting station obtained on the upper numerals of the condenser dial. So the complete calibration of the wavemeter is obtained. This method of calibration is very satisfactory when the setting on the original frequency is accurately made and when the frequency of the broadcasting station may be relied on. This is not in general as good a method to follow as that of choosing a number of different broadcasting stations. The liability of error by this latter means is not as great.

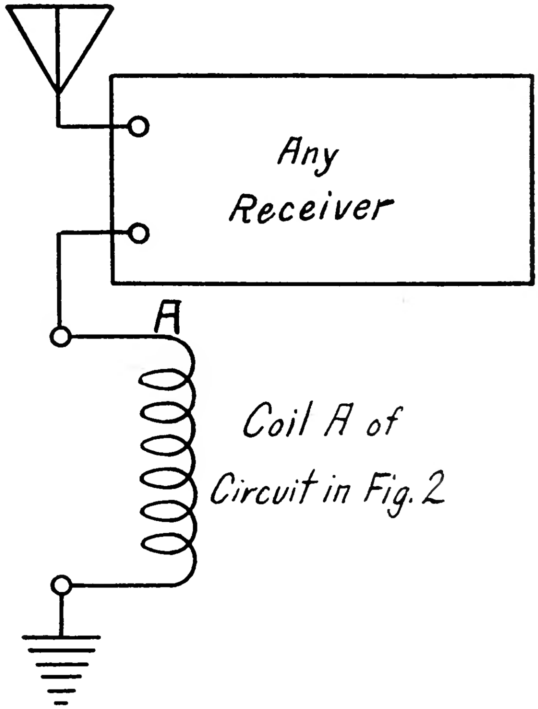


FIG. 4
How to calibrate any receiver using oscillator coil A of the wavemeter shown in Fig. 2 after the wavemeter curve has been made

If a neutrodyne receiver is used, it is not possible to use this method of calibration, and the wavemeter shown in Fig. 2 should be used. For broadcasting wavelengths, the coils should have the following values:

A, 25 turn duo-lateral
B, 25 " " "
C, 35 " " "

This wavemeter is, in effect, a small transmitting station and should be calibrated in the following manner. Adjust the receiving set accurately to the wavelength of the broadcasting station, turn on the vacuum tube in the wavemeter, and adjust the wavemeter until a squeal is heard indicating that the wavemeter is coming in resonance with the receiving set. Carefully adjust until zero-beat condition is obtained, at which point the oscillator will be exactly in resonance with the receiving set and in turn in resonance with the broadcasting station. Mark down this setting and the wavelength corresponding. Adjust until a sufficient number of readings are obtained to make a good calibration curve.

The manner in which the wavemeter should

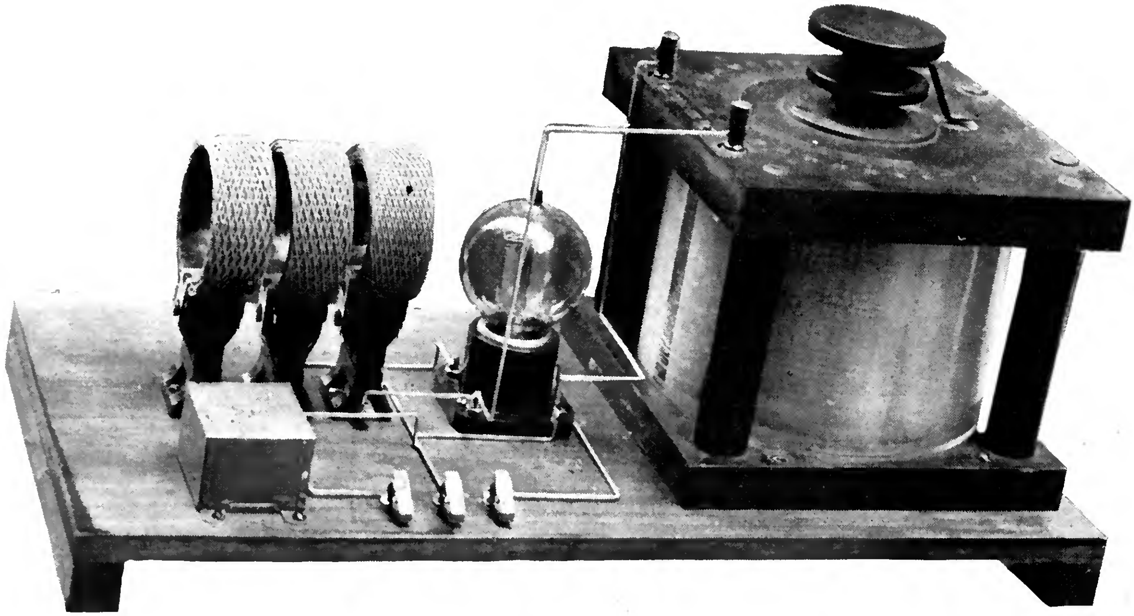


FIG. 5

This is the most convenient form of wavemeter oscillator or calibrated oscillator. This instrument covers a wave band of from 200–20,000 meters. The output may be as great as one or two watts depending on the frequency. The condenser shown is a large laboratory condenser, but any good condenser may be used

be constructed is a question of personal taste. The leads from the coils to the condenser should preferably be as short as possible; but there is no great objection to having the leads long if it is absolutely necessary. Where long leads are used, always use the same wires. Duo-lateral coils may be mounted directly on the condenser or may be mounted on a panel with the condenser underneath the panel. Three wavemeters are illustrated, showing satisfactory types of construction. The wavemeters shown using duo-lateral coils are the ones recommended, as they are most easily constructed and as all the parts necessary for their construction may be obtained from practically any good electrical or radio supply house. The manufacturers of duo-lateral coils have compiled a table showing the wavelength range covered by each coil when used as shown in either Fig. 1 or 2. A copy of this table is given. A wavemeter, such as that shown in Fig. 6, when once built up can be used to cover the entire wavelength range with good accuracy at a minimum expense.

MAKING YOUR WAVEMETER MODERN

A GREAT many wavemeters have been described in different periodicals showing a crystal detector and a telephone headset as an indication of the resonance point. A great many other meters have been shown with a high frequency buzzer as a driver or source of energy. The first wavemeter corresponds to that shown in Fig. 1 and the second to that shown in Fig. 2. Present day radio does not permit this rather crude method of detection and generation. It is recommended that by all means a vacuum tube be used in either of the manners described.

For the owner of a regenerative receiver and transmitting set the wavemeter described in Fig. 1, will perhaps, be the most useful. For the owner of a receiving set only, the wavemeter shown in Fig. 2 will be the best. Either or both of these two instruments will be of great value to the owner of a modern receiving or transmitting station, as they permit him to know definitely how his receiving set is operating and what wavelength he is transmitting on.

Modern amateur communication is carried on at wavelengths from 150 to 220 meters. Very few standard wavemeters are supplied to operate at these short wavelengths, particularly if they are also intended for use at higher waves. The method of calibration by means of harmonics outlined above is of particular value in the calibration of wavemeters designed for short wave use. The amateur and operator of a transmitting station will find this method the best he can use to calibrate his wavemeter.

A PERFECT WAVETRAP

IN ADDITION to using the wavemeter of Fig. 1 as illustrated, the instrument may be used as a wavetrap for the elimination of an interfering station. A wavetrap consists of a combination of inductance or inductances and capacities so arranged that the combination opposes the passage of any given frequency. To use the wavemeter shown in Fig. 1 as a wavetrap connect it as shown in Fig. 8 and in Fig. 9. Fig. 8 shows the connection to be made in the case of a receiver connected to an antenna. Fig. 9 shows the connection where a loop receiver is used. The operation in either case is the same. Set the condenser of the wavemeter at maximum capacity and tune the receiver in the regular manner. When the desired station is received and interference is present vary the condenser of the wavemeter and readjust the receiver. A setting will be obtained where the interference will be entirely eliminated. Sometimes in tuning it is advisable to short circuit the condenser of the wavemeter. A test will readily determine if this is necessary. Be sure in

FIG. 6

Wavemeter constructed of form wound duo-lateral or similar coil and variable condenser. This wavemeter will cover any range by changing the size of the coils. The proper size coil to use is shown in the table given below

WAVELENGTH RANGE OF VARIOUS DUO-LATERAL COILS

		No. 200A 3 Plate		No. 200B 5 Plate		No. 200C 11 Plate		No. 200D 21 Plate		No. 200E 43 Plate	
Capacity Range of Condenser in Micro-Micro Farads	Max.	49		91		208		418		877	
	Min.	7		8		10		13		21	
Coil Numbers		Wave Lengths in Meters		Wave Lengths in Meters		Wave Length in Meters		Wave Length in Meters		Wave Length in Meters	
		Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
U S or M S 25.		75	105	75	130	75	180	120	245	120	355
U S or M S 35.		105	145	105	175	105	245	160	335	160	480
U S or M S 50.		145	205	145	250	150	355	220	485	220	690
U S or M S 75.		195	290	200	365	210	520	340	715	340	1020
U S or M S 100.		250	380	255	475	260	675	430	930	430	1330
U S or M S 150.		335	550	340	705	355	1020	680	1410	680	2060
U S or M S 200.		435	730	445	935	465	1359	900	1880	900	2700
U S or M S 249.		535	910	560	1170	575	1700	1100	2370	1100	3410
U S or M S 300.		680	1120	690	1430	720	2140	1400	2870	1400	4120
U S or M S 400.		830	1450	870	1880	890	2750	1800	3830	1800	5500
U S or M S 500.		1050	1840	1080	2390	1120	3430	2300	4870	2300	7000
U S or M S 600.		1270	2200	1300	2840	1360	4130	2800	5700	2800	8200
U S or M S 750.		1600	2760	1680	3570	1710	5100	3500	7200	3500	10400
U S or M S 1000.		2090	3660	2140	4750	2240	6900	4700	9600	4700	13800
U S or M S 1250.		2570	4670	2640	6000	2770	8900	6000	12500	6000	18000
U S or M S 1500.		3320	5800	3400	7500	3570	11000	7500	15400	7500	22100

NOTE—In making calculations of the 21- and 43-plate condensers a minimum capacity of 100 micro-micro farads has been assumed which includes the capacity of accessories in the circuit

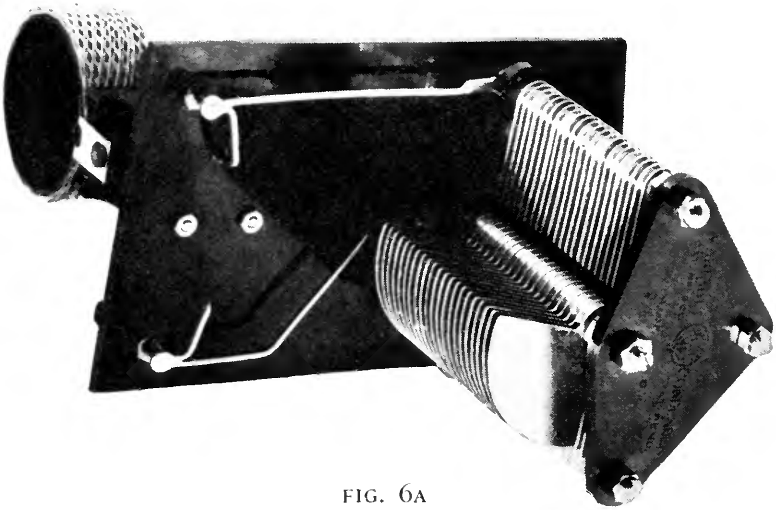


FIG. 6A
Rear view of Fig. 6

searching for new stations that the wavemeter, when used as a wave trap is not tuned in such a manner that it interferes with the reception of that station.

A STAGE OF TUNED R. F.

IN ADDITION to the use of the wavemeter, of Fig. 1 as a wave trap, it may also be used as a stage of tuned radio frequency amplification in front of the receiver. The connections to accomplish this vary slightly with each receiving set, but in general, if the circuit shown in Fig. 10 is followed, good results will be obtained. When using the wavemeter as a stage of tuned radio frequency use only amplifier tubes and omit the grid condenser and leak. The use of a potentiometer on the grid return of the wavemeter is not always necessary, but is shown to make the set complete.

The output coil is shown in Fig. 9 as a 35 turn duo-lateral or similar coil. The input coil is variable between 25 and 50 turns, the exact value of this coil cannot be given as it will vary with the receiver. The small fixed condenser shown in series with this coil may be omitted if the receiver is of the three-circuit regenerative type and has a variable condenser already in series with the coupler primary. In general, the coupling between the output and input coils is very loose. As a matter of fact the input coil may be entirely eliminated and the primary of the coupler used instead. Long leads may also be used in the output coil, and coupling obtained directly with the set by placing the coil near the inductance in the grid circuit of the receiver. For this purpose the use of $1\frac{1}{2}$ volt or 3 volt dry battery tubes is recommended as well as the use of individual A and B batteries for the radio frequency amplifier, thus making any changes in the wiring of your regular receiver unnecessary.

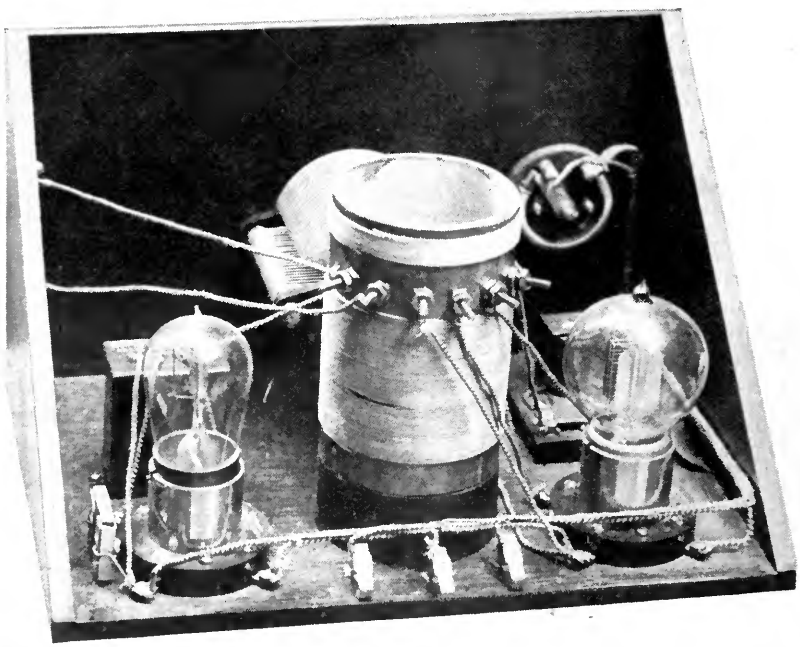


FIG. 7
Experimental type of wavemeter oscillator. The large coil is used as an oscillator, the smaller coil is a modulator creating an audible note. This type is not as convenient to construct as that shown in Figs. 5 and 6. This oscillator is made for use on a measuring bridge. It covers a wavelength band of 200 to 600 meters

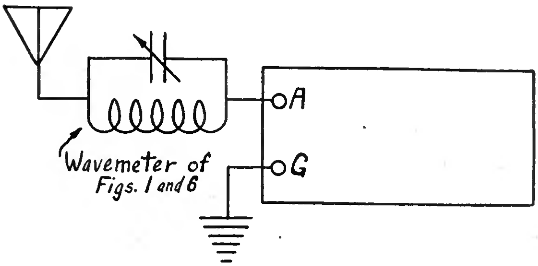


FIG. 8
Connection of wavemeter circuit of Fig. 1 as a wavetrap. The meter vacuum tube circuit is omitted in this case

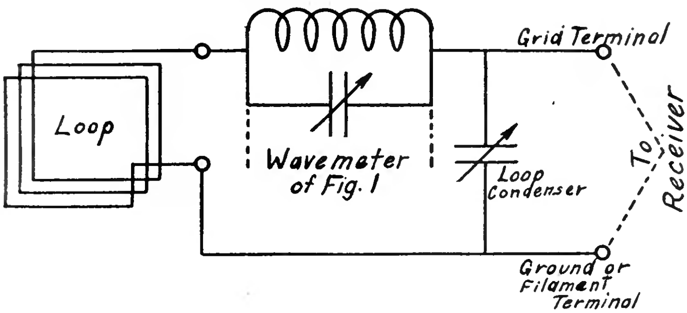


FIG. 9
Connection of wavemeter circuit in Fig. 1 as wave trap in loop receiver. The vacuum tube circuit is omitted as indicated by the dotted lines

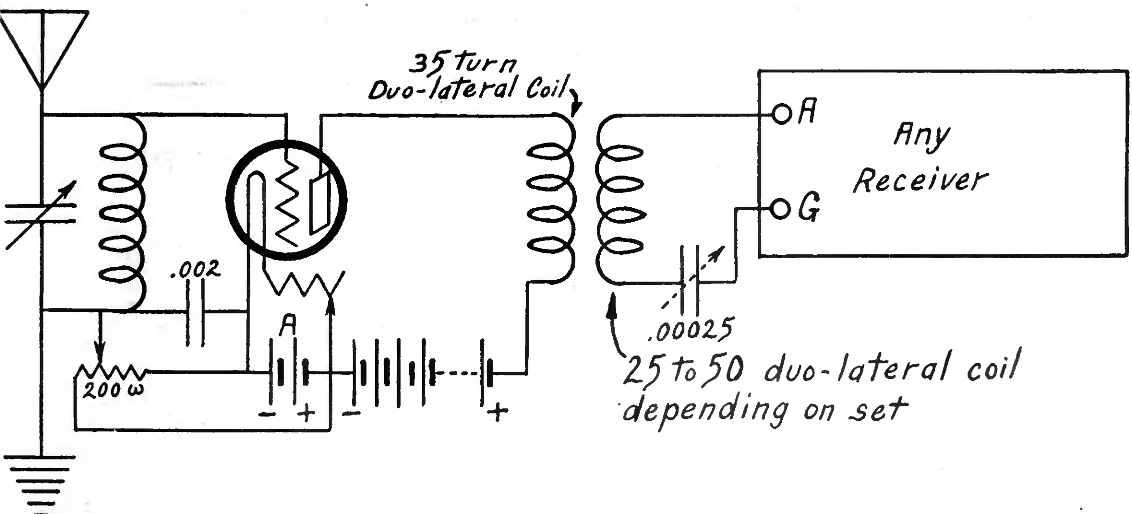
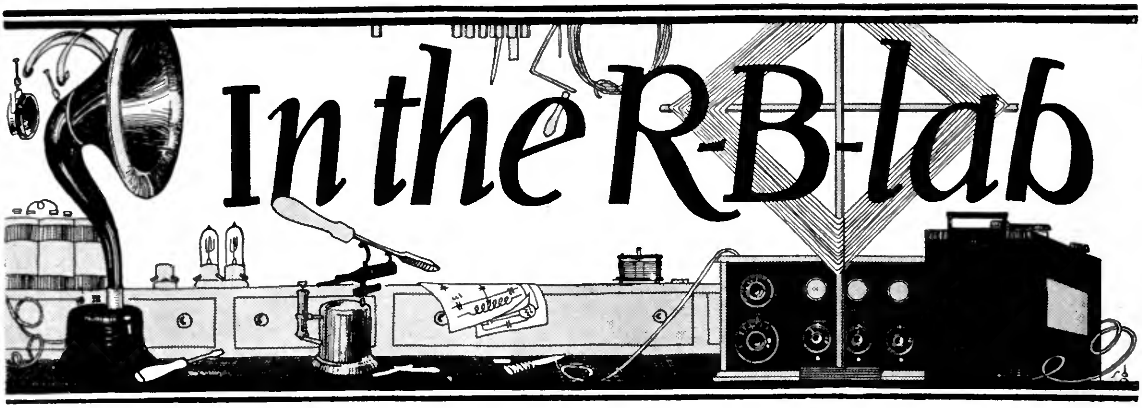


FIG. 10
By the addition of the units shown here the wavemeter of Fig. 1 may be used as one stage of tuned radio-frequency amplification with any receiver. The .00025 condenser may be variable, as shown by the dotted arrow



The "lab" department has been inaugurated by Radio Broadcast in order that its readers may benefit from the many experiments which are necessarily carried on by the makers of this magazine in their endeavor to publish only "fact articles" backed by their personal observations.

ERRATA

The following diagrams have appeared in recent issues of Radio Broadcast, with slight errors in the indicated connections.

January: Page 260, Single-tube reflex plus one stage of audio: A connection should be made between the ground and negative side of the A battery.

February: Page 305, "The Best Inverse Duplex Circuit We Have Yet Seen." The telephone receivers, or loud speaker should be connected in the plate lead of the second tube, just below the connection of the .001 condenser.

February: Page 326, "The Fundamental Circuit." A connection should be made between the ground and the negative of the A battery.

THE SODION TUBE AND OUR "KNOCK-OUT" REFLEX

NO CIRCUIT ever published by Radio Broadcast has aroused such interest among its readers as the one-tube reflex set originally described in the November number. Stimulated by suggestions from the hundreds of readers who have written to us concerning this circuit, and by our own enthusiasm for this remarkable little set, this department has not given it up as devoid of further improvement and research. The use of the Ballantine Varioformer, in place of the home-wound T2, described in the January Lab. and the reflex plus two stages of audio amplification, in our February number, are the result of our continued investigation. And now we have some more good news.

DETECTION AND REFLEX CIRCUITS

THE problem of detection in reflex circuits is one of the most serious involved in the design of such apparatus. As we have had occasion to state before, the three-element vacuum tube with its oscillating proclivities, complicates a reflex circuit to such an extent as to render this form of detection undesirable. This has left the crystal as the most satisfactory detecting medium, and the one which has been used, almost altogether, in commercial types of reflex apparatus.

The Sodion tube, however, being a stable and non-oscillating detector, will immediately suggest itself to the reflex experimenter as a detector. The R. B. Lab experienced little difficulty in adapting this new tube to the erstwhile single-tube reflex.

The Sodion detecting circuit is a simple one, and it was illustrated fundamentally in the Lab department for last month. The input and output circuits are similar to those of the standard tube, and Fig. 1 shows the manner in which the Sodion bulb is substituted for the crystal detector.

The output of the R.F. tube is impressed, through the transformer T2, on to the collector circuit (C), (analogous to a grid circuit in a regular tube), of the Sodion tube. The output of the Sodion tube, like that of the usual audion, is a varying plate current, and this is sent through the primary of the reflex audio transformer. The final amplified output, through the telephone receivers, is taken, as usual, from the plate circuit of the first and conventional bulb.

T1 and T2 are wound on 2½ inch tubes, the secondaries being wound first, with the primaries on top of them, an insulating layer of paper being placed between. The secondary of T1 consists of sixty turns of wire, and that of T2, of forty turns. The primary of T1 has sixteen turns, and that of T2 thirty-six turns. C1 is a 17-plate variable condenser, and C2 a 43-plate condenser. T3 is any good make of audio amplifying transformer with a ratio of about four or five to one—such as the Pacent or Amertran.

The critical reader will observe that the specifications for T2 and C2 differ somewhat from those described in the November Radio Broadcast for the original crystal set. These changes have been made in consideration of certain characteristics of the Sodion tube (as outlined in this department last month). The Sodion tube works best, and is most selective, when the input has comparatively few turns of wire, the required wave range being secured by boosting with a high capacity condenser. For this reason, the Sodion detecting circuit is not

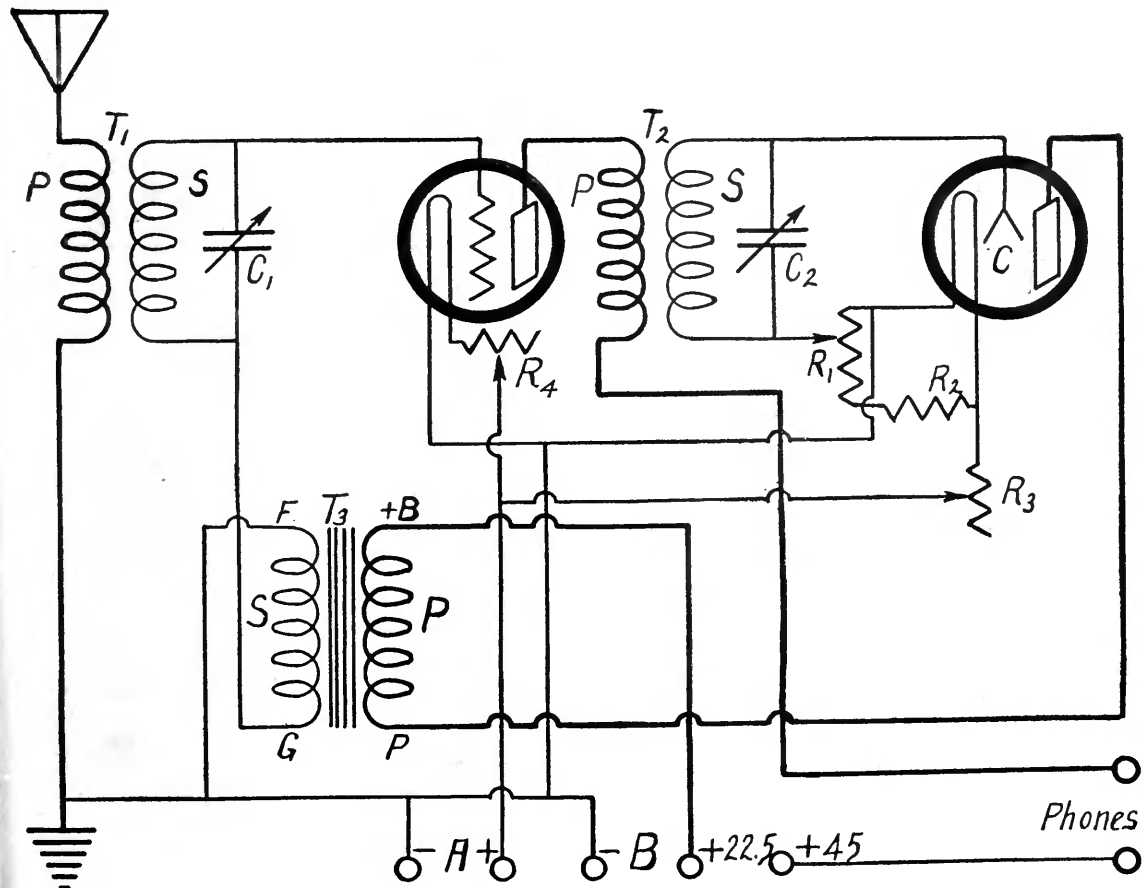


FIG. 1
The "knock-out" reflex circuit with the Sodion tube for detector

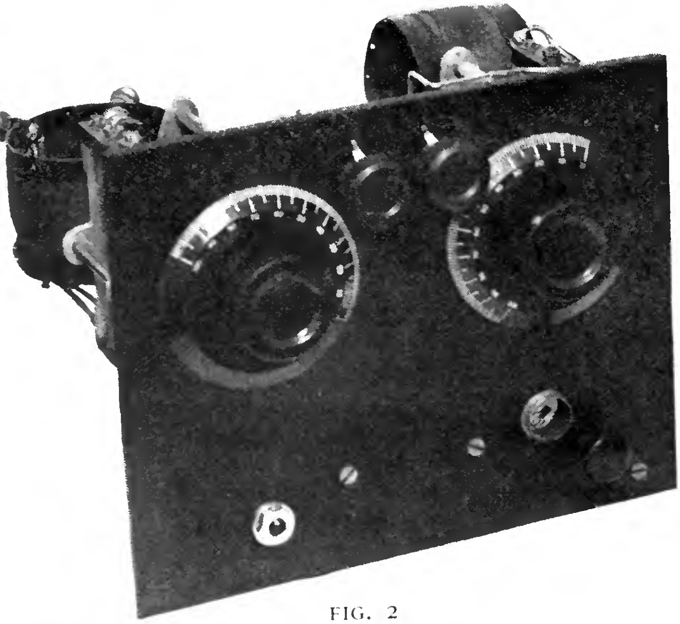


FIG. 2
The original reflex set plus the Sodion tube. Note the two small knobs, rheostat, and potentiometer, in the upper center

well adapted to the reflex set with the Ballantine Varioformer (where no C2 capacity is used at all) as described in the January Radio Broadcast. It will, however, work sufficiently well with the windings and capacity described in November, to justify the change from crystal to the Sodion tube, if the experimenter cares to alter slightly his set already made. Directions for doing this will be given a little later on.

Returning to Fig. 1: R1 and R2 may be a single resistance, a standard potentiometer of about three hundred and fifty ohms. But, as the required variation of resistance is generally confined to a comparatively small ohmage on the negative side of the potentiometer, the Connecticut Telephone and Electric Company, Meriden, Connecticut, has designed two resistances, a variable and a fixed one, respectively R1 and R2. The variable resistance costs $1.00, and the fixed unit $.30.

R3 and R4 are rheostats, and, if the set is made up especially for the Sodion tube, it is suggested that they be of thirty ohms resistance each. This will make possible the correct filament voltages, on each tube, from a common filament source.

The plate potential for the Sodion Tube is 22.5 volts.

The Sodion tube can, of course, be applied to any reflex circuit as described above. The principle of the low input impedance should merely be carried in mind, and some form of a variocoupler, with a variable condenser across the secondary, substituted for the final output R. F. transformer.

ADDING THE SODION TUBE TO THE OLD CRYSTAL REFLEX SET

If you have built up a set according to original description which appeared in November, the Sodion tube detector may be added to it in accordance with the circuit of Fig. 1, and as shown in Figs. 2, and 3,

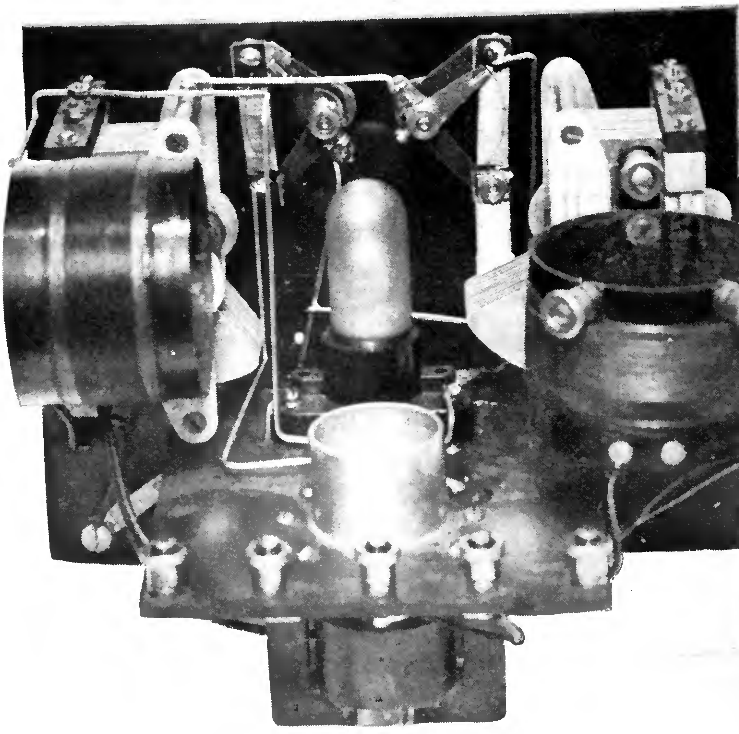


FIG. 3
Showing the back of panel work necessary to adapt the Sodion tube to the single tube reflex

In this case, the reader is advised to buy not merely the Connecticut Company's potentiometer units but also their Sodion filament rheostat. These resistances are most easily mounted in the remaining free space on the panel, and they are uniform in appearance. The socket of the Sodion tube is mounted on the shelf holding the standard tube, placing it close up to the panel.

The only necessary circuit changes are those connections to the secondary of T2 and to the primary of T3. An additional binding post may be added for the 22.5-volt tap for the Sodion tube. The crystal detector is, of course, completely eliminated from the circuit.

FIXED CRYSTALS AND THE ONE-TUBE REFLEX

THE use of the Sodion tube, as described in the preceding article, by no means makes obsolete the crystal detector in this circuit. There are many to whom the simplicity and economy of crystal detection will continue to appeal, in fact we use it with great regularity and satisfaction. Readers in this category, who may at present be experiencing difficulty with crystal detection, should not resort to the Sodion tube before thoroughly examining the possibilities of their present system.

Ninety per cent. of the troubles which have bothered the comparatively few interested enthusiasts who have not been able to make this set function properly, have been due to faulty crystal detection. The symptoms of such troubles are as follows:

Oscillation, as evidenced by the reception of a variable beat-note of the transmitting radiophone.

Squealing.

Equal or better detection when the cat-whisker of the detector is lifted from the crystal.

These difficulties may be instantly and permanently remedied by the use of an efficient fixed crystal, such as the Erla, manufactured by the Electrical Research Laboratories, 2515 Michigan Avenue, Chicago, Ill., and the Pyratek, made by the Erisman Laboratories, Washington Heights Building, New York City. These fixed crystals will be supplied by the

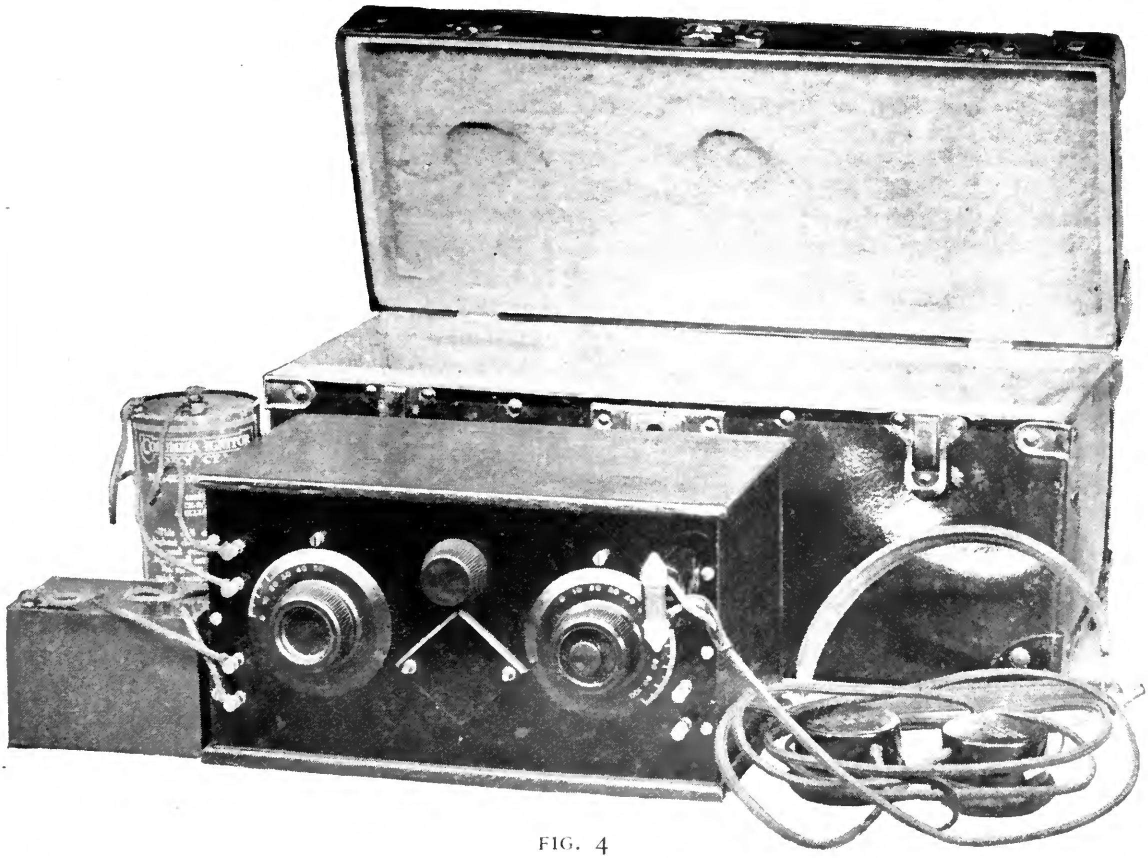


FIG. 4
The ideal automobile radio equipment

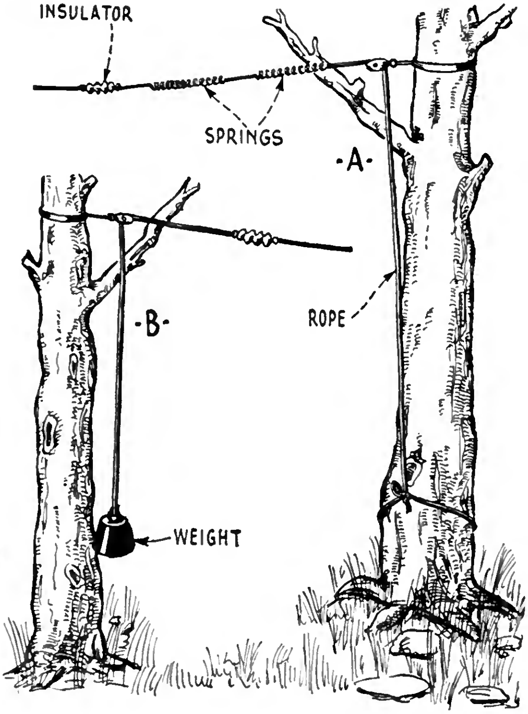


FIG. 5
Two methods of compensating for the sway of tree antenna moorings

manufacturers, if the reader is unable to obtain them from a local dealer, for $1.00 and $1.25 respectively.

THE PORTABLE SET AND THE AUTOMOBILE

Photos by C. H. BROWN

WITH the coming of spring, and all that this season means to the motorist, the portable set, in its adaptation to the automobile, takes on considerable significance. But, as in all things (particularly in radio!) there is a right and wrong way of combining these two interests.

The wrong way is to throw the old set, with the necessary additional equipment (excepting those parts you forget) into the tonneau, cramp yourself by operating it on the running board or rear seat, and finally returning home minus a pair of 'phones, or a bulb—left a monument to inefficiency and lack of system—at your temporary location.

Fig. 4 tells the other story—how to derive unadulterated enjoyment from the orderly combination of two enthusiasms.

The set, in the first place, should be constructed purposely for automobile use. It is preferably a simple installation, sturdily built, with the fewest number of parts to shake loose and give rise to difficulties. For this reason, the single tube reflex is ideal. Certainly, if the enthusiast is one of these genuine motorists, who scorn the state-roads and suburban boulevards, a plurality of tubes is to be frowned upon.

A carrying case should be provided for the set, partitioned so as to hold the receiver firmly, and leave sufficient room for 'phones, aerial and connection wire, B and A batteries. This last may be dispensed with if it is desired to utilize the automobile storage battery.

The carrying case should not be bought to fit the set, but rather the set built to fit whatever size and shape case the experimenter may have on hand or can easily procure. The set and the parts should fit it snugly, and it is a good idea to cushion, with quilting, the top and sides. Fig. 4 shows the ideal portable equipment.

The antenna may be strung from the car to the branch of a tree, while either a nearby wire fence, all wires bridged, or a single long bare copper wire laid on the ground beneath the antenna, makes a fairly good ground. With some sets, the frame of the car makes an excellent counterpoise (ground substitute).

HANGING YOUR ANTENNA TO TREES

By S. OLIVER

HAVING one end of my antenna fastened to the top of a large tree, I found that whenever the wind blew very hard, the tree would sway and often break the antenna.

To remedy this, I obtained three ordinary screen door springs (any similar springs will do) and fastened them, end to end. One end of the springs was fastened to my antenna insulator, and the other to a rope which ran through a small pulley in the tree-top and then down to the ground. The pulley makes it possible to adjust the tension of the aerial from the ground. The springs are strong enough so that I may pull the antenna wire quite taut, while still leaving sufficient elasticity for stretching with the movement of the tree in the wind. This arrangement is shown in Fig. 5A.

(Another idea, in some respects superior to that suggested by Mr. Oliver, has been employed by the editor of this department, not only to compensate for the swinging of tree moorings, but as a general convenience for automatically regulating the tautness of the antenna, regardless of rope shrinkage, expansion, etc. Figure 5 B, explains this system, which merely consists of running the rope or mooring end of the aerial through a pulley to a weight, which the writer found most conveniently made up of two or three sash-weights from a window An antenna, moored in this manner, may be left for months without even so slight an inspection as an anxious glance.)

MAKING TRANSFORMERS FOR THE SUPER-HETERODYNE

IN THE development of the super-heterodyne, several designers deemed it expedient to get away from the long wave transformers designed to cover a wide band of frequencies in favor of another type for which certain advantages are claimed. This type requires no iron in its core nor does it require tuning. Its fundamental frequency is comparatively high, and it will not permit audio-frequency disturbances to pass through the radio stages.

A wooden spool $2\frac{1}{2}$ ″ in diameter with two slots $\frac{3}{16}$″ wide separated by $\frac{1}{8}$″ and with a base diameter of $\frac{3}{4}$″ is the winding form used for the windings. In the interstage transformers.the primaries are wound with 800 turns of No. 32 DSC wire, and the secondaries with 1,000 turns of the same wire. The input transformer differs only in having its primary winding reduced to 300 turns so that with the .0005 condenser across this winding it resonates at approximately 2,400 meters.

The outside primary lead is run to the plate, the outside secondary to the grid. The inside primary goes to the B battery and the inside secondary to the stabilizer arm. The input transformer is used to feed from the first detector into the first R. F. tube.

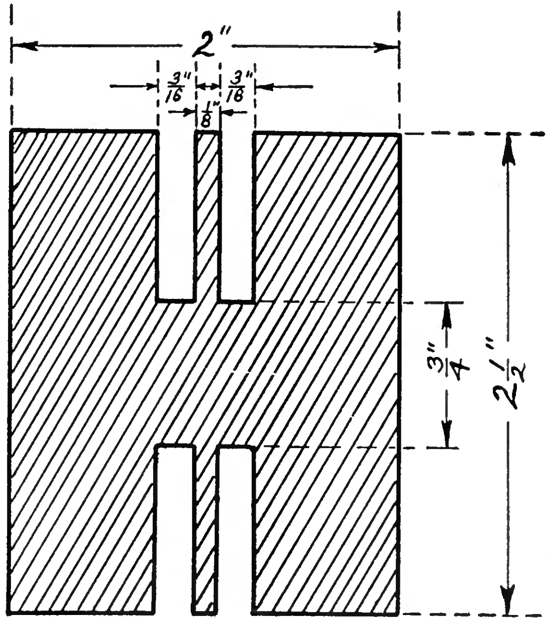


FIG. 6
Working drawing for the home-made super-heterodyne transformer

THE MEASUREMENT OF RADIO FREQUENCY VOLTAGE AND TESTING OF RADIO FREQUENCY TRANSFORMERS

By W. VAN B. ROBERTS

A WELL known method of measuring the alternating voltage (at any frequency) applied to the grid of a vacuum tube is shown in Fig. 7. In the absence of any A. C. input it will be found that the plate current can be reduced practically to zero by sliding the potentiometer contact sufficiently far over to the negative side. The voltmeter then reads the value of the negative grid potential that is just sufficient to shut off all plate current. Call this value V_1. (V_1 is approximately equal to the plate battery voltage divided by the amplification constant of the tube). If, however, alternating voltage is applied to the grid in addition to the direct voltage of the potentiometer, the mil-ammeter in the plate circuit will show some current. This is because one half of the A. C. voltage cycle reduces the instantaneous value of the grid potential below the value V_1 that was found necessary to shut off the plate current. By increasing the voltmeter reading by sliding the potentiometer contact farther to the left, the grid potential may be made so negative that the alternating voltage is at no time sufficient to bring the instantaneous value below the critical value V_1. Call V_2 the voltmeter reading that is just sufficient to shut off the plate current in spite of the alternating voltage. Then $V_2 - V_1$ is the maximum instantaneous value of the alternating voltage applied to the grid, or the peak value, or the amplitude, as it is variously called.

Fig. 8 shows a complete circuit for measuring the voltage amplification per stage of an amplifier coupled by means of the transformer T. The oscillator supplies the radio frequency voltage to the first tube. This supply can be shut off by closing switch S_1. The double pole double throw switch S_2 is arranged so that when thrown to the right the mil-ammeter measures the current in the plate circuit of the first tube, and vice versa. The procedure is as follows:

Close S_1 and throw S_2 to the right and put the plug in the left hand jack. Adjust the voltage of the flashlight battery F and the potentiometer P until the mil-ammeter read-

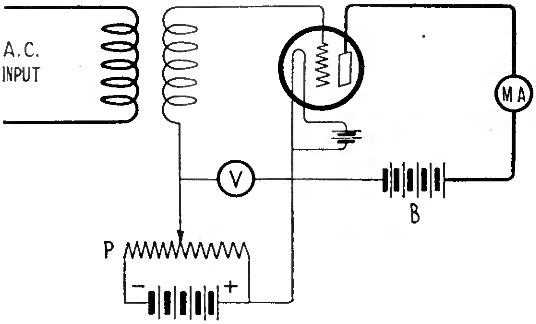


FIG. 7
Circuit showing method for measuring the alternating voltage applied to the grid of a tube

ing is just reduced to zero, or practically zero. Count the number of cells of F that are required and reckon 1.5 volts per cell and add to this the voltmeter reading. The result is V_1. Then open switch S_1 and make the coupling between coils L_2 and L_3 sufficient so that the voltage V_2 required to shut off the plate current is a couple of volts greater than V_1. The difference, $V_2 - V_1$ is the A. C. voltage applied to the grid of tube No. 1.

Next, throw S_2 to the left and put the plug in the right hand jack and measure the grid potentials required to shut off the plate current of tube No. 2 with switch S_1 closed and then with it open. The difference is the A. C. voltage on the grid of tube No. 2. This, divided by the A. C. voltage applied to tube No 1, gives the voltage amplification per stage at the frequency and B and C battery voltages used.

The curve showing the amplification at various frequencies can be made by going through this whole process a number of times at different frequencies.

If the transformer is for use at the frequencies employed in broadcasting, the oscillator frequency can be calibrated by putting a pair of phones in its plate circuit and using it as a receiving set loosely coupled to an antenna and noting the condenser readings for various stations of known frequency. If the transformer is for lower frequencies, honeycomb coils can be used in the oscillator, which are of known inductance, the approximate number of mil-henries is usually marked on the label. If a General Radio Co. variable condenser is used, the approximate number of micro-micro-farads is marked on the dial, and the frequency can be calculated approximately from the formula frequency (in kilocycles) =

$$\frac{5{,}000}{\sqrt{\text{No. of milhenries x No. of micro-microfarads.}}}$$

In using this measuring circuit great care must be taken never to have switch S_2 closed unless it is certain that there is plenty of negative potential on the grid to keep the plate current down to a value low enough not to harm the mil-ammeter. A mil-ammeter that shows a large deflection on one mil-ampere is necessary. In particular, remember to open switch

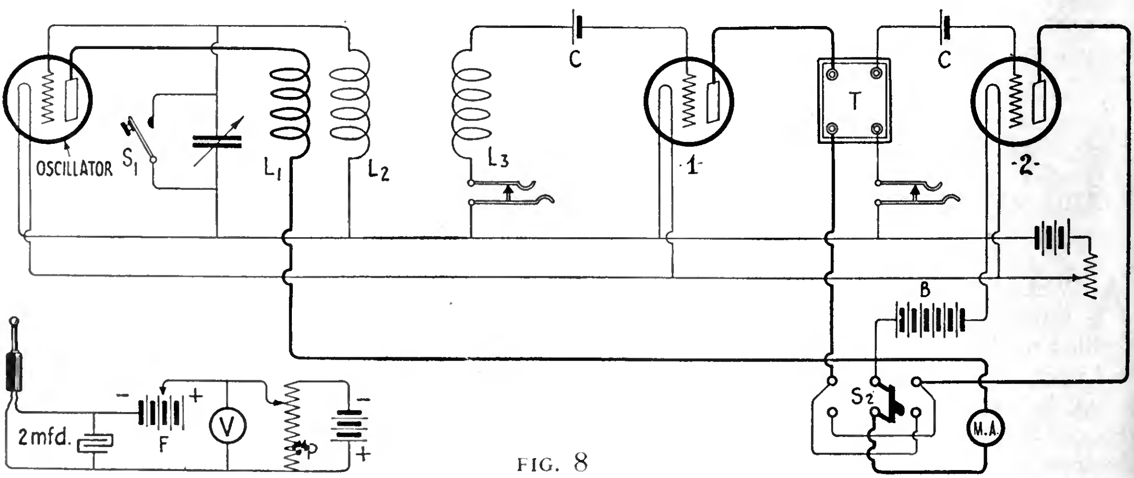


FIG. 8
Complete circuit showing how to measure the voltage amplication per stage of an amplifier coupled by the transformer T

S_2 when changing taps on the battery F. Coil L_3 needs only to be big enough to pick up a couple of volts from the oscillator. For broadcast frequencies, a DL 50 will do, but for lower frequencies a larger coil should be used. The reason the battery F is not put across the potentiometer so that the voltmeter could read the whole voltage directly is that the resistance of the potentiometer is so low that too much current would be drawn from the flashlight cells for their good. A few six inch dry cells form the potentiometer battery and the potentiometer is only necessary to give a continuous variation of voltage between taps on F. The 2 mfd. condenser is a radio frequency by-pass.

BUILDING YOUR OWN LAB

Radio Broadcast's suggestion for this month's addition to the growing laboratory, is an electric soldering iron. Such a tool, really *indispensable* to fine radio-craftsmanship, will cost from $2.50 to $6.00, depending on the quality. We strongly advise against a compromise with price when buying tools. Cheap electric soldering irons, more often than not, have serious faults such as slow heating and over-heating, and after use develop additional troubles, burning out, short-circuiting, etc. An excellent iron, such as that illustrated in Fig. 9 can be bought for about four dollars. A small iron is generally preferable to a larger one.

The electric iron is so vastly superior to the old fashioned externally heated type, that the experimenter who is still racing back and forth between his work bench and the gas stove, is still driving a prairie schooner in these days of airplanes and motor-cars. A good electric soldering iron gives a constant heat of the correct soldering temperature, insuring a perfect flow of metal and weld at every joint. The electric iron permits soldering in cramped places inaccessible to the ordinary iron because of its bulk, made necessary for the retention of heat.

FIG. 9
An excellent electric soldering iron costing about four dollars

Only the owner of an electric iron can truly appreciate the actual handicap under which he labored with the old style, inefficient and sooty tool

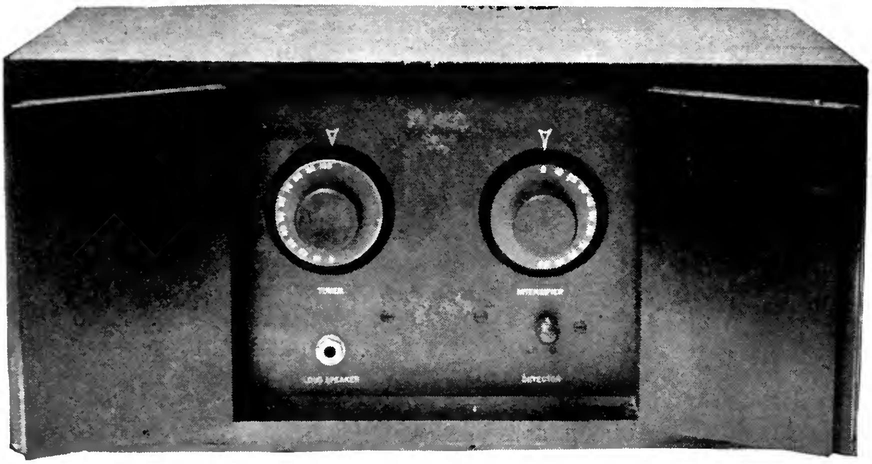
HOW TO USE THE SUPER-HETERODYNE ON 100 METERS

The super-heterodyne which was described in Radio Broadcast in January may be used for 100-meter reception by a change of the oscillator coupler and loop.

The grid winding of the oscillator coupler should be decreased to 10 turns and the plate winding cut down to 15 turns. It will then be necessary to tune the oscillator with the condenser in shunt with the grid coil only; instead of in shunt with the grid and plate coils as is shown in the original diagram for 200 to 600 meter work. The coupling coil would remain about 15 turns, while the loop would probably have to be decreased to between 4 to 6 turns for operation to get down to 100 meters.

Then, too, it is possible to receive on 100 meters without making any changes whatever in the receiver itself. By using a two or three turn loop the capacity of the loop tuning condenser will be found low enough to function satisfactorily well below 100 meters. It is then but necessary to tune the oscillator to a harmonic of the incoming signal. Reception by this method is very satisfactory and for waves below 100 meters both the loop and heterodyne dials will be set somewhere between zero and fifteen.

"How to Build a Resistance-Coupled Audio-Frequency Amplifier" will be one of the articles in the May number which you will want to read. Besides being a very quiet amplifier, the resistance-coupled type is quite inexpensive to build. The article will be complete with diagrams and specifications



THE COMPLETE OUTFIT

Everything including the A and B batteries may be placed in an attractive cabinet. Some idea of the simplicity of operation may be had from a glance at the panel

How to Make a One-tube Reflex Set That's a "Knock-Out"

Described in a Most Comprehensive Manner, with Complete Instructions for Building and Operating It. It Should Operate a Loud-Speaker over a Crystal Range and It Is not a "Blooper"

By Kenneth Harkness

This article first saw the light of day in our November, 1923, number. Since that time we have designed and described various modifications of this fundamental circuit and several new developments are in the fire. As soon as the results we obtain are satisfactory these sets will be described. In this number there are two modifications of the receiver described below. Both are impr[illegible]ements. By confining our efforts to a single fundamental idea it is possible to provide our readers wi[illegible] reliable data on receivers *without making it necessary to discard any material previously purchased.*

We have had so many letters from enthusiastic supporters of this receiver and so many requests for extra copies of the November number that we feel that its reprinting will fill a rapidly growing need. The boiled-down digest of our readers' comment shows very plainly that the receiver really is what we have called it—a knock-out.—THE EDITOR.

WE HAVE often heard of one-tube receivers that will actuate a loud speaker, but seldom do we have the experience of listening to such a performance; and in radio—hearing is believing—so we are justly skeptical of these "wonder sets."

Indeed, the super-regenerative "flivver" receiver was the first loud-speaking one-tube set* we had occasion to witness in actual operation, and although it made a remarkable showing in reproducing local stations, distant reception appeared impossible and some rather complicated knob and dial juggling was required in the process of tuning.

Immediately after the super-regenerative craze died down, we were deluged with hashed-up versions of revivified and rejuvenated but nevertheless ancient reflex circuits; but until recently we were still looking for a demonstration of a one-tube set that would make a loud speaker "percolate."

For this reason we spent many days and nights in an effort to produce such a single-tube receiver. Our work has resulted in an outfit that is simple and inexpensive to build, easy to install and operate as well as being compact

*See "Operating a Loud Speaker on One Tube Without Batteries" in RADIO BROADCAST for June, 1923.

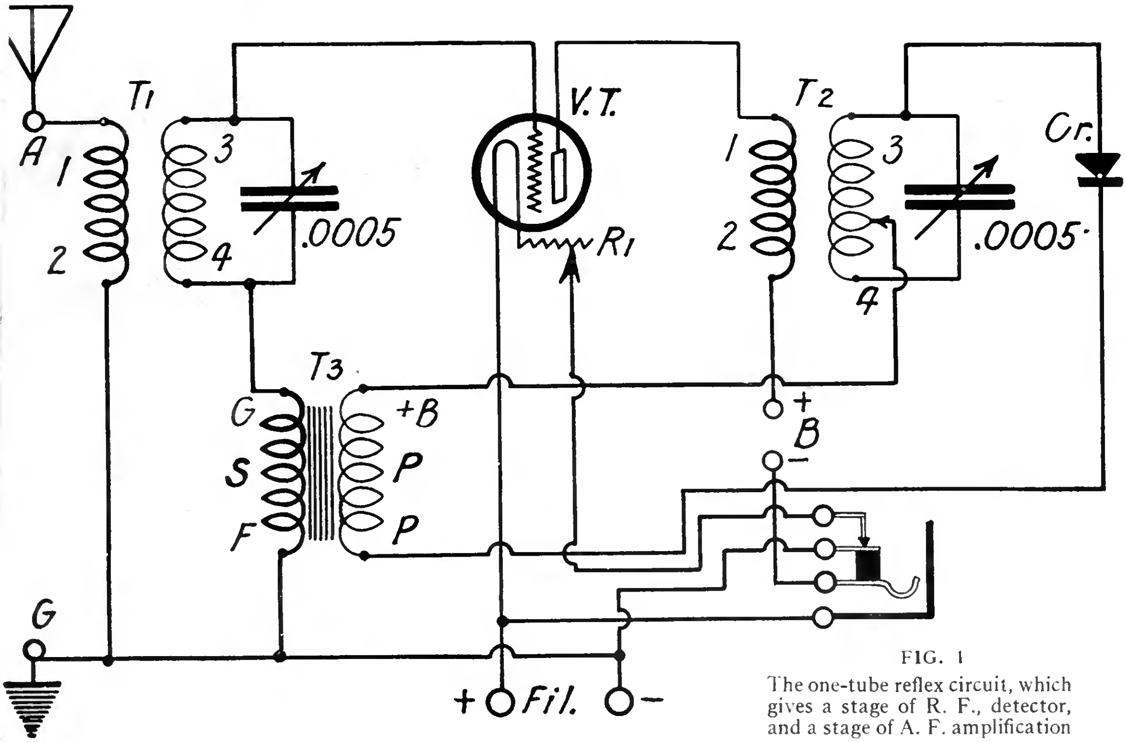


FIG. 1
The one-tube reflex circuit, which gives a stage of R. F., detector, and a stage of A. F. amplification

and portable. It will function with any kind of receiving tube now on the market and will operate a loud speaker over distances about equal to those it is possible to hear with the telephones on an ordinary crystal receiver. When used with a headset it is capable of very long distance reception, extremely sharp tuning, and exceptionally clear reproduction of speech and music.

The receiver is essentially a one-tube reflex outfit, but involves certain modifications that make for efficiency, sensitivity, volume, clarity, and ease of control. It is:

Efficient—because the one tube is made to do double duty and because an improved circuit with correct constants is employed.

Sensitive—because a stage of *tuned* radio-frequency amplification is provided before the *tuned* detector circuit.

Volume—because a stage of audio-frequency amplification is used to amplify the rectified impulses and because *both* the radio-frequency amplifying and rectifying circuits are *tuned*—giving maximum amplification with corresponding selectivity.

Clear—because a crystal is used for rectification: and because, when properly adjusted, the vacuum tube does not oscillate and the howling and squealing so noticeable in regenerative receivers is totally absent.

So far, not so bad, eh?

METHOD OF PREVENTING SELF-OSCILLATION

ORDINARILY in a reflex circuit the tendency toward self-oscillation is so great that a potentiometer or similar device must be employed to impress a positive charge on the grid so that the resultant grid current will prevent self-oscillation.* In a plain radio-frequency amplifier this would be quite satisfactory, but when it is desired to use the same tube for audio-frequency amplification it is necessary to operate the grid at a *negative* potential or else the A. F. amplification will be *nil!* It is evident then that reflex systems utilizing a potentiometer stabilizer are out of the question.

We could employ reversed inductive or capacitive feed-back to balance the self-oscillations, but each of these systems has certain disadvantages; especially in a circuit having a variable resistance element such as a mineral rectifier.† The adjustment would necessarily be tricky and unstable.

*See "Radio-Frequency Amplification Without Distortion or Reradiation," RADIO BROADCAST for July, 1923, page 214.

†Several fixed crystals, such as the Erla and Pyratek have been used in the R. B. Lab with great satisfaction.

The method of preventing self-oscillation in the receiver to be described is not new, but, to the best of our knowledge, its application and dual functioning are original.

Briefly, if the grid and plate circuits of a vacuum tube are adjusted to the same frequency, even though they are not in inductive relation, the inter-element capacity of the vacuum tube is large enough to feed back sufficient energy to produce self-oscillation. If a third and independent circuit is closely coupled to either the plate or grid circuit and this independent circuit is tuned, it will cause a reduction in the amplitude of the local oscillations, and if the initial amplitude is *not too great,* the reduction will be effective in preventing self-oscillation. Further, the energy in the independent third circuit may be fed into a rectifying device, the damping effect of which will still further aid in preventing undesirable self-oscillation.

The practical application of this system may be noted in Fig. 1. The primary coil of transformer T2 is in close inductive relation to the tuned secondary circuit—which latter functions in the dual rôle of the *independent third circuit* and the *tuned detector input.*

The rest of the circuit is standard, but every endeavor has been made to reduce the number of controls without decreasing efficiency. Thus, the antenna circuit is made slightly aperiodic (i.e., requires no tuning over the range covered by the secondary); the filament circuit is "made" or "broken" by the automatic filament control jack, and a ballast resistance is used in place of an adjustable rheostat; the plate winding of T2 is sufficient to allow good transformation without direct tuning of the plate circuit; the grid and detector inductances are fairly widely separated and at right angles to each other so there is a minimum of inductive feed-back.

SIMPLE DESIGN AFFORDS EASY CONSTRUCTION

AN AMATEUR should have little difficulty in constructing a receiver of this type as the photographs afford constructional details which may be readily understood, even by the newcomer in the radio game.

In the top view, Fig. 2, the disposition of

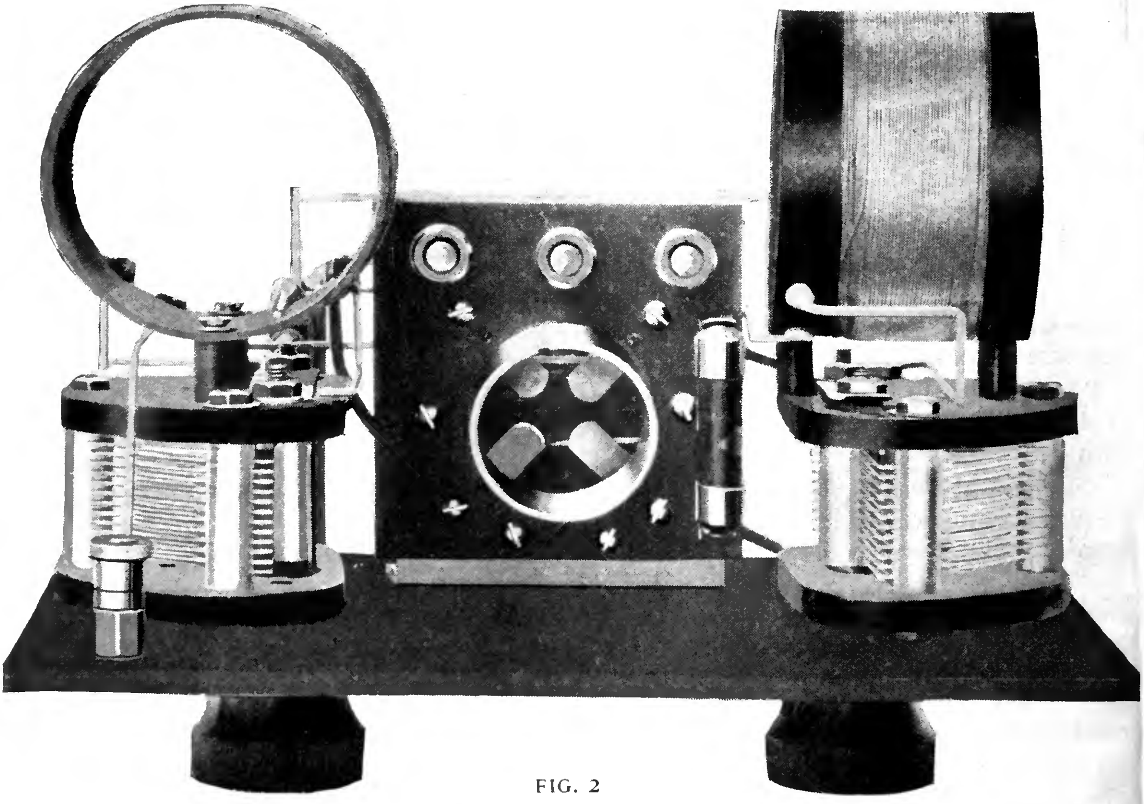


FIG. 2

This is how the receiver looks from above. Note that the two transformers (T1 at the left, T2 at the right) are mounted at right angles to each other parts is clearly shown. The transformer mounted behind the left hand condenser constitutes, with the condenser, the tuned antenna, grid, radio-frequency transformer unit T1; at the right hand side is mounted the plate-detector, audio-frequency transformer unit (T2).

An "Amperite" or other fixed resistance is mounted at the right side and battery terminals in the rear of the socket strip.

In the front view, on page 496, may be seen the controlling knob of a mechanical crystal detector illustrated in Fig. 3. This detector has proved its excellence as to ease and stability of adjustment, two factors of prime importance which should be looked for in selecting this item; but any good crystal detector may be used.

The entire set is mounted within a special cabinet with provision for separate battery compartments. The top and center panels of the cabinet are hinged to allow access to the tubes and tuning controls. When closed, the instrument is completely protected from dust and injury.

Close study should be given the photograph of the empty cabinet, Fig. 4, which shows the proper measurements. It is advisable to secure all the material necessary before starting the actual assembly of this receiver.

LIST OF MATERIALS REQUIRED

1 Audio-frequency transformer, $4\frac{1}{2}$ to 1 ratio
1 Panel-mounting crystal detector, mechanical adjustment preferred
2 Special tuned radio-frequency transformers, utilizing—
  2 .0004 mfd. variable condensers
  2 $\frac{1}{16}''$ Formica forms, $2''$ long and $2\frac{5}{8}''$ dia.
  $\frac{1}{8}$ lb. No. 28 cotton and silk insulated wire
  2 $8''$ strips of $1''$ cambric cloth

FIG. 3

A small French crystal detector which is gaining popularity in this country. Few are available at present, but they are to be marketed in quantities shortly. The cat-whisker and crystal are completely enclosed. Adjustment is accomplished by rotating the small knob shown at the right

  8 Switch points and 8 hexagon brass $\frac{6}{32}$ nuts for terminals
  4 $\frac{3}{4}''$ mounting pillars and 4 $1''$ $\frac{6}{32}$ round head machine screws for attaching the transformers to the condensers
  2 dials to fit condenser shafts
1 Front panel $7\frac{1}{2}''$ high, $9''$ long and $\frac{3}{16}''$ thick
1 Sub-panel with spun-in socket $3\frac{1}{2}''$ x $5''$ x $\frac{3}{16}''$
1 $1''$ Brass angle $3\frac{1}{2}''$ long, $\frac{3}{16}''$ stock
1 Automatic filament-control jack. Micarta insulation
5 Binding posts, $\frac{6}{32}$ screws
2 Spring mountings for Amperite or fixed resistance
4 Feet of bus bar
2 Feet of No. 23 bare copper wire
2 Feet of small flexible cambric tubing
8 $\frac{3}{8}''$ $\frac{6}{32}$ round head machine screws
8 $\frac{3}{8}''$ $\frac{6}{32}$ flat head machine screws
1 Vacuum tube, preferably a UV–201–A or C–301–A
1 45- or 90-volt B battery
1 A battery of 6 volts, either storage battery or dry cells
1 Headset or loud speaker

ANTENNA EQUIPMENT

Either 1 light-socket antenna attachment or
  200 Feet No. 12 rubber-covered copper wire
3 $5''$ glazed porcelain corrugated insulators
1 Lead-in insulator
1 Lightning arrester (not necessary when antenna attachment is used.)

CABINET MATERIAL

4 pieces $7\frac{1}{2}''$ x $8\frac{1}{2}''$ x $\frac{1}{2}''$
1 Base $9\frac{1}{2}''$ x $18''$ x $\frac{1}{2}''$
1 Top piece $2\frac{1}{2}''$ x $18''$ x $\frac{1}{2}''$
1 Cover $7''$ x $18''$ x $\frac{1}{2}''$
2 Doors $4\frac{1}{2}''$ x $7\frac{1}{2}''$ x $\frac{1}{2}''$
2 Front pieces $7\frac{1}{2}''$ x $4\frac{1}{2}''$ x $\frac{1}{2}''$

THE TUNED R. F. TRANSFORMER UNITS

SPECIAL care should be observed in constructing, *or purchasing (if you do not care to build them)*, the tuned radio-frequency transformer units, as successful operation is greatly dependent upon them. For this reason exact specifications are given, and it would be well to employ similar material, follow the same constructional lines, and make all connections in accordance with instructions if duplication of the results mentioned above is expected.

Procure $\frac{1}{8}$-lb. of number 28 single cotton (under) and single silk (upper) insulated soft-drawn copper wire and two formica forms $\frac{1}{16}$ inch thick, 2 inches long and $2\frac{5}{8}$ inches in diameter.

Number 28, S.C.S.S. wire is chosen because it combines highest efficiency with exceptionally neat appearance. The double covering provides good spacing between the metallic conductors. The white cotton protective layer affords good insulation, while the silk layer is pleasing in appearance and does not allow the shellac to gather and harden between turns. The usual effect of increased distributed capacity resulting from the use of shellac or other dope

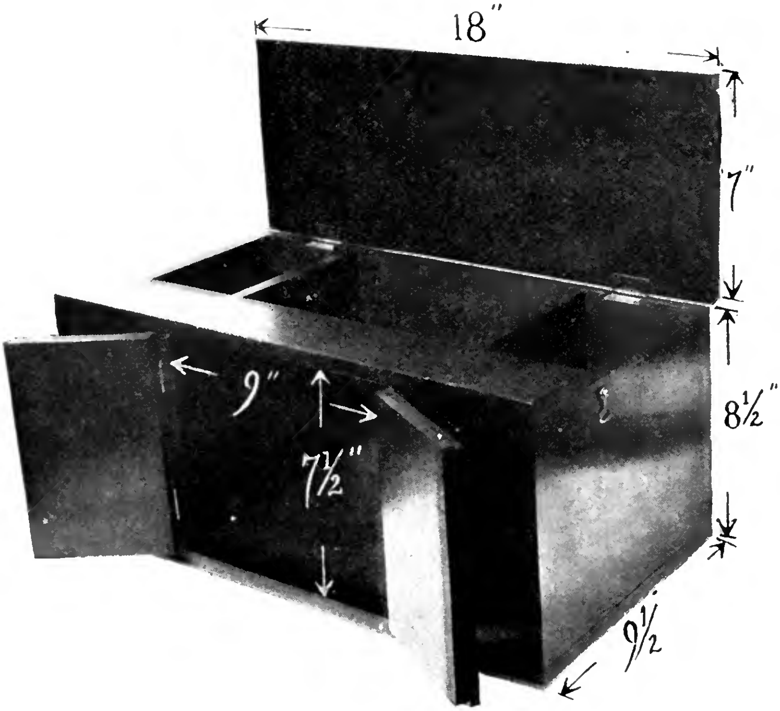


FIG. 4
The receiver slides into the middle compartment, the side sections being provided for the A and B batteries. If the constructor of the set prefers not to make the cabinet, it may be bought for a reasonable sum

on ordinary cotton covered wire is thus reduced. It is interesting to note that when coils, especially cotton covered, are not treated with some form of moisture-resisting material, a relatively great amount of moisture will be absorbed, the insulation between turns is materially reduced, and this fairly low-resistance shunt across the coil is extremely detrimental to sharp tuning.

The particular size wire is chosen because with it a relatively small length of wire is required for any given inductance and in addition the value of capacity between turns and therefore the total value of distributed capacity is lower than would be the case with heavier wire.

MAKING TRANSFORMER T1

ONE of the two Formica forms (see list of materials) should be provided with four terminals and two mounting screw holes, made with a No. 27 drill. The terminals are situated ¾" apart, ¼" from one edge. The mounting holes are ¼" from each edge on a line parallel to the axis and between the two center terminals. The terminals may consist of switch points with the heads outside and hexagon brass nuts clamping them to the form inside. The projecting pieces of the screws are cut off and solder flowed over the nut to prevent loosening. Small holes to pass the wire should be drilled near terminals 1 and 3 (Fig. 1).

The secondary coil is wound on the form first; starting at terminal No. 3 to which the wire is soldered, 60 turns are placed evenly and tightly; the end of the wire is brought through the form at a point opposite terminal No. 4 and soldered to that terminal.

A one-inch strip of cambric cloth or other flexible sheet insulating material is wrapped over the secondary and held in place with glue.

The primary, of 15 turns, is wound on the insulating material, spaced in the center and in the same direction as the secondary.

The beginning is soldered to terminal No. 1 and the end of the coil is brought through the form at a point opposite No. 2 and soldered to that terminal.

The entire form may be given a light coat of thin shellac, collodion or airplane "dope" leaving only the terminal heads untouched for soldering. When throughly dry the transformer is mounted on its condenser—one method of accomplishing this is shown in Fig. 2. Two holes 1½" apart may be drilled and tapped for $\frac{6}{32}$ thread in the end plate of the variable condenser. Two $\frac{6}{32}$ machine screws and small brass pillars are used to support the transformer away from the condenser. The arrangement should be similiar to the illustration in order to retain short leads.

MAKING TRANSFORMER T2

THIS transformer is constructed in a manner similiar to T1 with the difference that the primary (top coil) has 35 turns.

Referring to the diagram, Fig. 1, it will be seen that there are *five* connections to T2; the fifth connection is a center tap on the secondary and should be used only if the receiver is to be operated in the vicinity of an interfering station. Otherwise this tap should *not* be provided as it reduces signal strength, although at the same time increasing selectivity because the damping effect of the crystal rectifier is effective over only half the inductance; if a vacuum tube detector were used, the value of this connection would be nil, the grid-filament resistance being so high. Although the volume would be diminished, selectivity would be neither greater nor less.

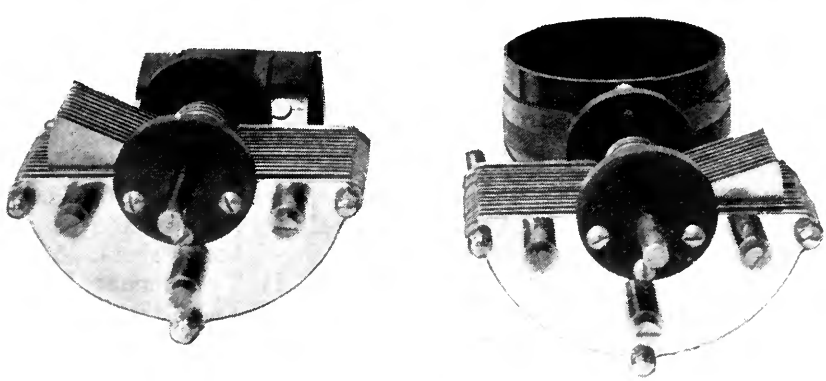


FIG. 5
The tuning units T2 and T1 (left to right)

In most cases the lead from the positive B terminal of the primary of T3 will be connected to terminal No. 4 of T2 rather than to the tap.

Only a very light coat of dope or shellac should be placed on the primary of No. 2 as it is desired to keep the distributed capacity very low.

In mounting, T2 should be placed on its condenser at right angles to that of T1. Fig. 5 shows the correct arrangement which should be followed.

The photographs of the back of the complete receiver (Figs. 2 and 6) indicate that the variable condensers face each other; this is not good practice because the dials must then be of different types, one reading left hand and one right hand. Therefore, in the panel layout, Fig. 7, and in the photograph of T1 and T2 (Fig. 5) corrections have been made so that both condensers are mounted in the same manner and both dials may be of the same type. All stated dimensions have been checked and corrected so that the drawings may be followed with perfect assurance that everything will fit.

These special transformer units, both T1 and T2, may be purchased if the constructor wishes to save time and labor. They are priced at about $6.00 each.

THE VACUUM TUBE STRIP

THE vacuum tube socket is "spun" into a sub-panel $3\frac{1}{2}''$ x $5''$ x $\frac{3}{16}''$ on which are located the filament resistance mounting clips, binding posts, audio-frequency transformer and mounting bracket, but single sockets made for panel mounting may be purchased for about $1.50 and the assembly of the sub-panel will then be up to the ingenuity of the constructor himself. Figs. 10, 11, and 12 will help to show the proper arrangement of parts.

In assembling, care should be taken that the audio-frequency transformer is placed with its grid terminal adjacent to T1; the plate terminal will then be close to T2 so all leads may be made very short.

Four binding posts are located on this sub-panel as indicated in the drawing Fig. 8. This is the correct method in contrast to the photographs which show a receiver with a slightly different wiring system.

Special attention should be given the springs of the tube socket as "dead" tension will in time cause a great deal of difficulty, chiefly characterized by noisy and spasmodic operation.

THE FRONT PANEL

THIS should be of Bakelite, Formica, or Radion, $9''$ long, $7\frac{1}{2}''$ high and $\frac{3}{16}$ to $\frac{1}{4}''$ thick. Bakelite or Formica should be sanded or grained on both sides, but Radion should retain its original finish. The panel is drilled in accordance with the front panel layout, Fig. 7, but the position of holes may be changed to suit any condensers.

ASSEMBLY

AT ABOUT this stage in the manufacture of a home made receiver, the amateur workshop, whether it be a real shop, the kitchen, parlor, or attic, has assumed an air of congested indecisiveness that hardly bespeaks the usually tidy habits of the constructor; coils, tools, condensers, dirt, sockets, wire, binding posts, solder, and some more dirt and tools are indiscriminately mixed and thrown about. When it comes to assembling, some of us do not stop to clean up—we merely shove the cluttered mass to one side and with a clear space of six inches go right ahead.

How much better it would be if we were to stop for a few moments, clear up the dirt, put away unnecessary material, and leave before us only the essential parts for immediate progress. Surely the orderly surroundings would tend to create that orderliness of mind which enables better and more accurate work. Let's try it. We should have before us on an otherwise clear table the following parts:

1 T2 transformer unit.
1 T1 transformer unit.
1 Sub-panel with binding posts, tube socket, A. F. transformer, and resistance mounting clip in place.
1 Crystal detector.
1 Single-circuit automatic filament-control jack.
1 Front panel, drilled and sanded.
Also a screw driver and 3 $\frac{6}{32}$ flat-head machine screws $\frac{3}{8}''$ long.

The vacuum tube strip is mounted first by threading two screws into the angle bracket (Fig. 9, and at the right in Fig. 10). The heads should be just flush with the panel. T1 is mounted to the left of the socket strip, T2 to the right (from the front). All screws should be driven with a firm and equal pressure in order to avoid unnecessary strain on the condenser shafts.

The aerial binding post is placed in the upper left-hand corner of the panel—this is arranged so connection is made from the rear, obviating an unsightly lead-in. The crystal detector and jack are mounted last; the frame of the jack should be facing down. As the final step

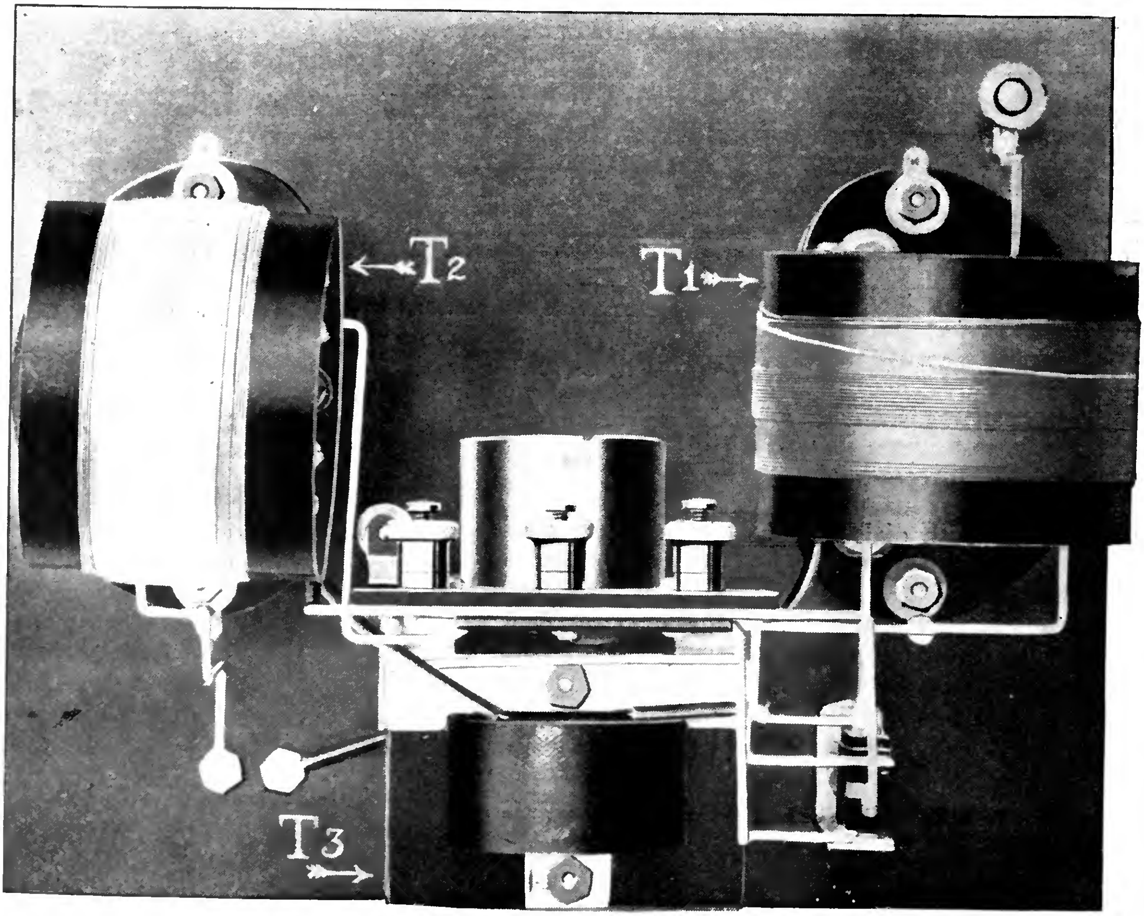


FIG. 6
The receiver as seen from the rear

in assembling, the dials are placed upon the condenser shafts and so arranged that the movable plates are all "in" when the indicating mark on the panel is in line with the highest mark on the dial.

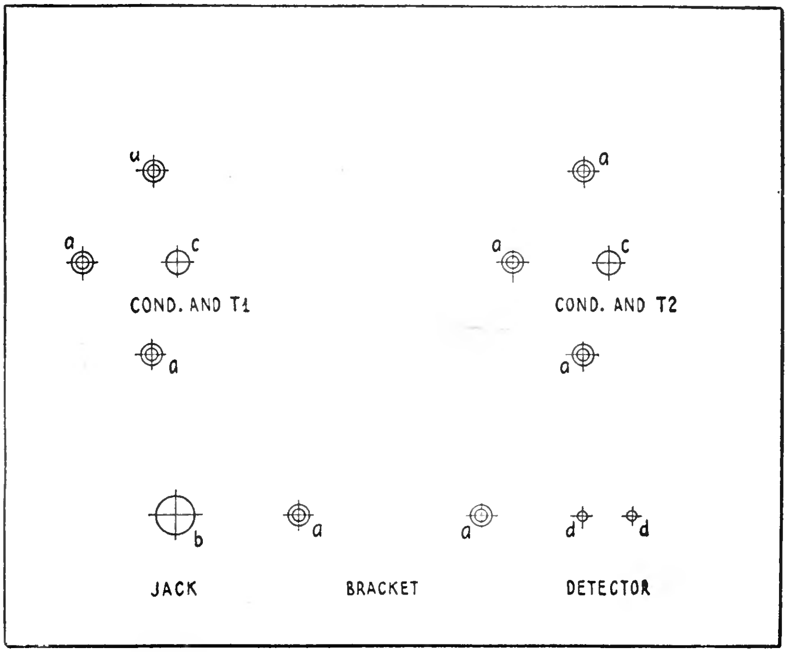


FIG. 7

This plan is $\frac{4}{9}$ the actual size of the panel. For *a* holes, use No. 27 drill and countersink the holes to fit flat-head screws; for *b*, use No. 27 drill; for *c*, use $\frac{5}{16}''$ drill; for *d*, use $\frac{9}{16}''$ drill

NOTES ON WIRING

AGAIN there is need for a clear space, the proper tools, and, if possible, some experience. As every joint must be soldered, a soldering iron is quite essential. So also is a pair of $\frac{1}{4}''$ flat nose pliers, a clean rag and bus bar wire. "50–50" bar solder is splendid, and soldering paste may be used if difficulty is experienced with rosin flux, though the excess should be removed with a little alcohol, after the soldering is completed.

Although each of us has his own way of doing things, the generally acknowledged method of wiring may be condensed in the following seven points:

1—Solder all joints. Soldering to a lug and screwing the lug to a terminal does not constitute a solder joint—the wire should be soldered direct to the terminal.

2—Flow the solder in all joints so they are perfectly smooth when cold. This requires a properly heated and tinned iron with sufficient flux.

3—Do not be too sparing in the use of flux, but immediately after soldering remove all traces of paste—with scrupulous care.

4—Use square tinned bus bar wire wherever possible.

5—Make 90° bends and run stiff connections only vertically and horizontally.

6—Wires more than a few inches in length should be run against the panel or other insulating support—they should not be left unprotected in space.

7—When soldering a wire to a terminal, aim the wire toward the center of the terminal—do not solder it to the side.

Wire the filament circuit first; the positive A battery terminal runs direct to one filament contact while the negative A battery terminal goes through the automatic filament control jack break and the "Amperite" mounting (R1) to the other filament contact, thus completing this circuit.

The transformers are connected as follows:

T1—No. 1 to the aerial binding post; No. 2 to the negative A battery terminal; No. 3 to the stationary plates of the variable condenser and then to the grid spring of the tube socket; No. 4 to the rotary plates of the variable condenser and to the "G" terminal of the secondary of the audio-frequency transformer, T3.

T2—No. 1 to the plate contact of the tube socket; No. 2 to the positive B battery binding post. No. 3 to the stationary plates of its variable condenser and to either terminal of the crystal detector; No. 4 to the positive B terminal of the primary of T3 and the rotary plates of the condenser.

T3—"F" to negative A battery terminal; P to the other side of crystal detector. Connecting the negative B battery binding post to the long curved spring of the jack completes the circuit and the receiver is finished!

RESISTANCE STRIPS FOR DIFFERENT TUBES

"AMPERITES" or automatic ballast resistances may be purchased in two types; one (PT) for power tubes—that is, tubes drawing 1 ampere; the other (1A) for ¼-ampere tubes such as the WD–11, WD–12, all the "C" tubes and UV–201-A. The resistance of both types varies with the current in such a manner that light fluctuations above and below the normal battery voltage do not produce a corresponding change in filament current. This property of varying resistance is the chief asset and, strange to say, the greatest drawback of this type of ballast resistance. For, when a battery is applied to a circuit containing a fixed resistance (such as the filament of a vacuum tube) and a varying resistance such as an "Amperite" the initial current is governed solely by the sum of the value of the fixed resistance and the Amperite—when "cold." And, unfortunately, the resistance of an Amperite is much lower when "cold" than when heated by passage of current—therefore the initial current is in excess of the proper value and is quite harmful to the filament of a tube.

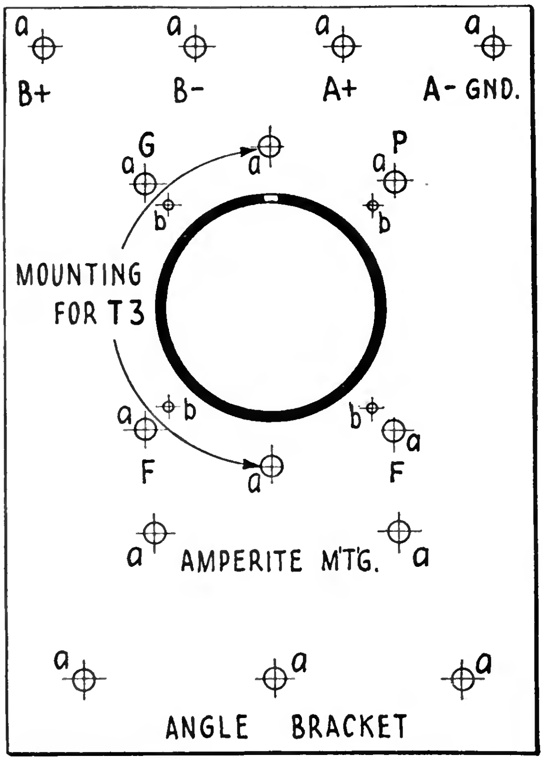


FIG. 8

Plan for the sub-panel. This is in correct proportion, but less than actual size (1½). For *a* holes, use No. 27 drill; for *b* holes, use No. 52 drill

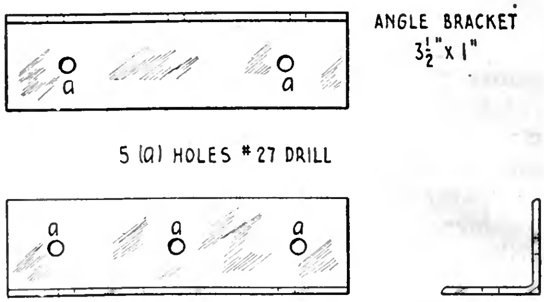


FIG. 9

This is the bracket (half actual size) that fastens the sub-panel to the main panel

For this reason and also because ballast resistances are not made for all types of tubes, we have for some time been using fixed wire resistance strips which may be slipped into the regular mounting. They are easily made, and with the proper length and size wire may have any value of resistance.

The first few were made from portions of the resistance element of a regular 6-ohm rheostat. Each portion was 2″ in length and utilized the resistance wire salvaged from the rheostats.

A much neater job can be made however if ⅜″ insulating rod cut into 2″ strips is fitted with two metal end pieces and wound with the resistance wire, both ends of which are soldered to the end pieces. The rod should be threaded so the wire will not slip and short circuit adjacent turns. Small thumb tacks or similiar devices have been employed as connecting end terminals.

It is necessary to know or determine the resistance per unit length of wire in order that the proper amount may be employed to offer the correct resistance.

Having selected a type of tube and the A battery voltage, reference to the table will enable selection of the proper resistance strip. Thus, if a UV–199 with 4.5 volts "A" are chosen, a strip of 30 ohms should be inserted in the sub-panel clips; a WD–11, WD–12, or W. E. "N" tube with a single dry cell will require a 2-ohm resistance, and so on.

Choice of tubes and batteries rests with the constructor; personally we prefer a UV–201–A with 4 series dry cells or a 6-volt storage battery. However, the UV–199 with 3 series dry cells very nearly equals the UV–201–A and is much more pratical for dry cell operation. The

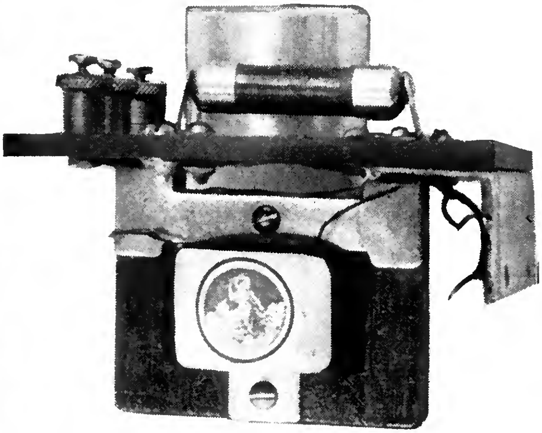


FIG. 10
The sub-base from the left

WD–11, WD–12, and W.E. "N" tubes are of the single dry cell type; they operate quite well, but it has been our experience that they come through very irregularly—some being good and others quite the opposite. The B battery voltage may vary from 45 to 90 although with this receiver as much as 300 volts has been applied to the plate of a UV–201–A; the resultant volume being comparable to the output of a single-tube super-regenerative receiver.

The following table shows the value of resistance for use with different A battery potentials on various tubes in order to restrict the current to a point slightly below the normal consumption rate.

TUBE	BATT. VOLTAGE (Representing 1, 2 and 3 storage cells and 1, 2, 3, and 4 dry cells.)	RESISTANCE	CURRENT
UV–201–A	6.0	6.0	.23
UV–201–A	4.5	0.*	.22
UV–201–A	4.0	0.*	.20
WD–12 or –11	1.5	2.0	.23
WD–12 or –11	2.0	4.1	.23
UV–199	3.0	0.*	.06
UV–199	4.0	18.0	.06
UV–199	4.5	30.0	.06
UV–199	6.0	55.0	.06
UV–201	6.0	1.5	.92

THE CABINET

THIS may be readily constructed at home if one is at all handy with wood working tools. Otherwise, it should be purchased.

The left-hand battery compartment is for the filament heating source, and the right-hand compartment for the plate battery. Sufficient room is allowed to accommodate medium size B batteries and full size A dry cells without crowding.

The panel is set back in its compartment 2″ and is held in place with four flat head $\frac{3}{4}$″ wood screws driven into corner blocks $\frac{3}{4}$″ square and 2″ long.

Finish is optional, but a dull gloss seems to be popular.

THE AERIAL

PARTICULAR care should be taken in the design of the aerial as, for best results, the resistance should be low. We advise a single-wire aerial, 100′ to 150′ in length, at least 20′ above surrounding objects. The lead-in may be a continuation of the aerial wire and should be brought away at right angles to the horizontal portion. Glazed porcelain insulators are doubltess best for a small receiving system and should be used at all points of suspension.

In the event that an aerial cannot conveniently be employed, reception may be effected with a ground connection alone. This usually will give equal if not better results than a small aerial. The ground should be connected to the aerial terminal and the receiver tuned in the usual manner. Several grounds should be tried—the best type appears to be

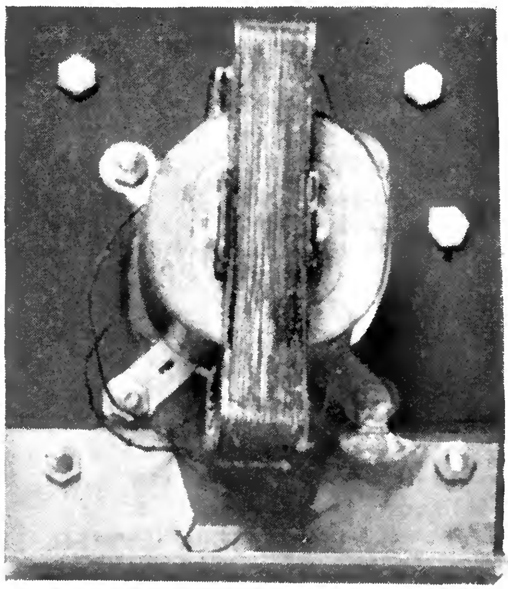


FIG. 11
The sub-base from below

*Direct short. May be made like other resistance strips' but has only a copper wire joining the end terminals.

one in which a rather long lead runs to a distant ground; this is, in effect, a grounded aerial with the receiver connected to the free end. The lighting system may be employed in a similar manner through use of an "antenna attachment"—if results are satisfactory the more or less cumbersome aerial may be dispensed with.

INSTALLATION

(A) Connect both A and B batteries to their respective binding posts—care being taken to have the polarity correct. Use number 18 or heavier rubber-covered stranded wire and keep all leads short and direct.

(B) Insert the vacuum tube and Amperite in their sockets and ascertain that positive contact is assured; it would be well to bend up the socket springs slightly in order that they may exert considerable force upon the vacuum tube pins.

(C) Connect a suitable ground to the negative A binding post and an aerial such as described above to the aerial binding post.

OPERATION

(A) Place the output plug in the jack; the vacuum tube should light instantly.

(B) Set both dials to the same point and adjust the crystal detector until a fairly strong "click" is heard.

(C) Slowly vary both dials between maximum and minimum position, maintaining them in approximately equal relation to each other.

(D) When a station is heard, turn the grid variable condenser and center it for stronger response, following this by adjusting the detector for better results.

(E) Further manipulation of the crystal for the most "sensitive" adjustment will improve both the quantity and quality of reception.

(F) With an average antenna, both dials will nearly coincide for any wavelength. No difficulty will be experienced in tuning both circuits to the same resonant frequency, as clicks (from crystal adjustment) are heard only when the grid and detector circuits are in

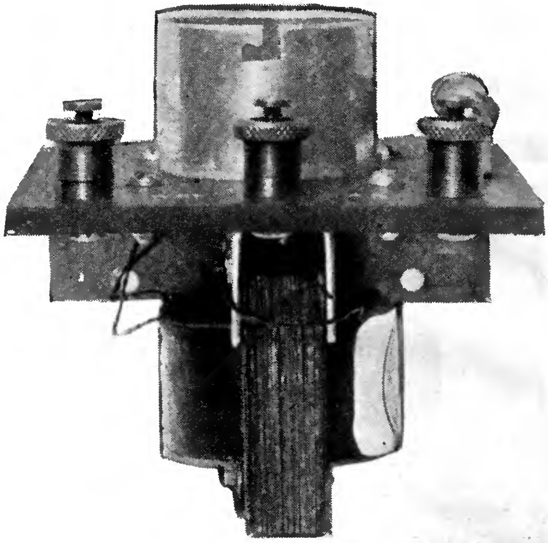


FIG. 12
The sub-base from the rear

tune with each other; being loudest when the circuits are exactly in resonance.

(G) When the crystal contact is "off," the receiver may oscillate, especially if headphones are used while tuning. There are a few methods of stopping this, but as it is rarely annoying special precautions are not necessary.

(H) On strong signals, the condenser in the crystal detector circuit is not very critical, but it has a well defined maximum resonant peak which may be passed over if this control is varied too rapidly.

(I) It is the *combination* of controls that makes for selectivity, and both are quite critical on weak stations.

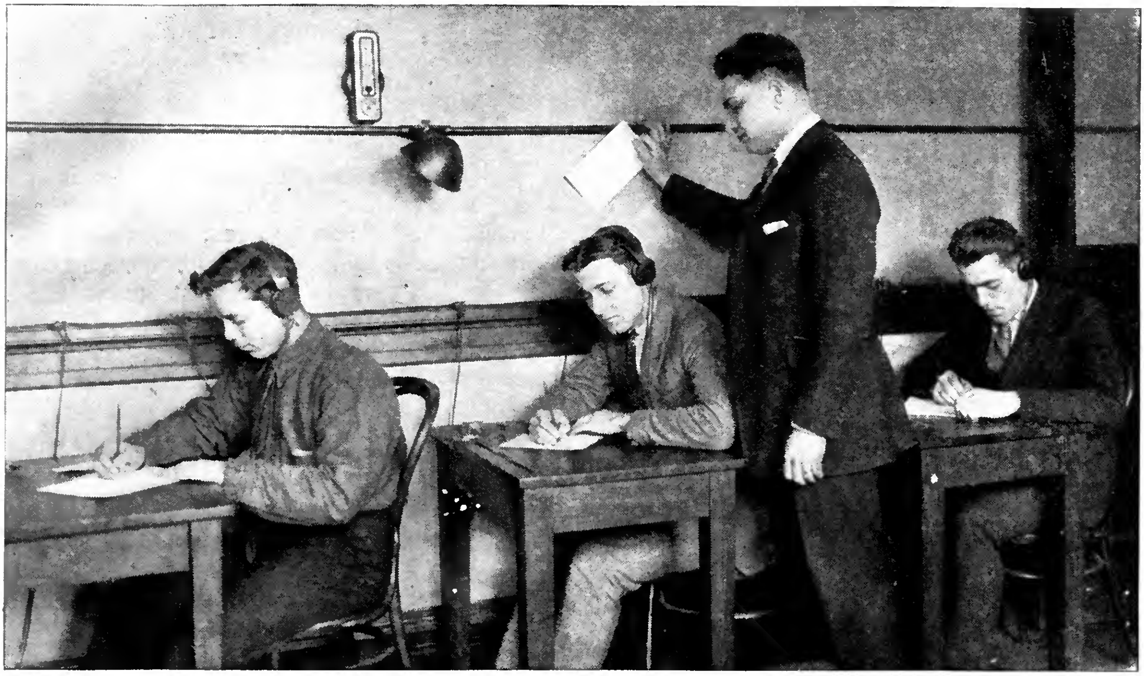
(J) The crystal adjustment is important not only for strength and clarity of signals but also for selectivity.

(K) On a stiff piece of manila paper provide three columns to record:

(1) Stations call letters, (2) T1 dial settings and (3) T2 dial settings. This record may be permanently placed on the inside of the cover (under transparant celluloid, for example) and referred to when the program of a certain station is to be tuned in.

IMPORTANT NOTICE

For the broadcasting wavelength range we have found that variable condensers from .00029 to .0004 are preferable to .0005, but if you already have .0005 they will do very well. The coils described as T1 and T2 may be made by securing two 60-turn duolateral or honeycomb coils and winding the necessary number of turns for the primaries right on the outside edge. Arrangements have been made with several manufacturers to supply any of the parts by mail, if your local dealer cannot supply you.—THE EDITOR.



TAKING THE CODE EXAMINATION AT NEW YORK

Embryo operators in the office of the radio inspector copying the Omnigraph. The code examination must be passed before the second part—the theoretical—can be taken

Why Some Applicants for Operators' Licenses Fail

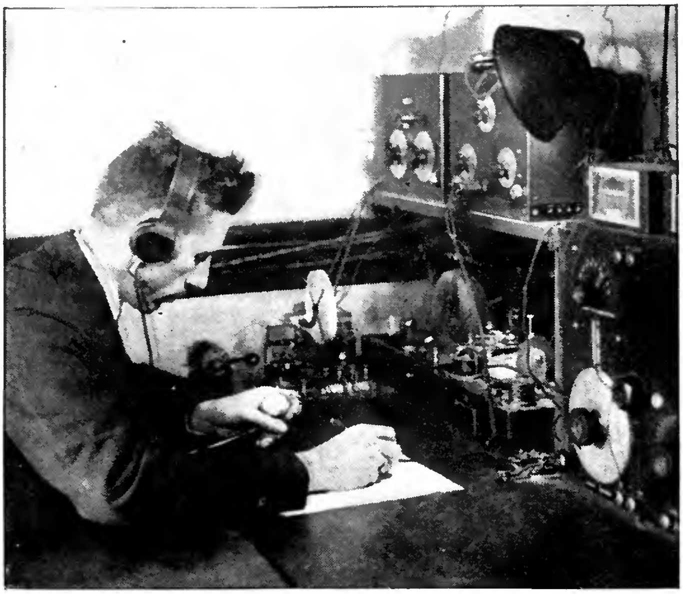
By HOWARD S. PYLE

Assistant U. S. Radio Inspector, Eighth District

IN GLANCING over the results of recent examinations for radio operators' licenses, held by the writer in several large cities, a considerable number of failures were noted. This suggested an analysis of the probable causes for these failures and a determination on the part of the writer to offer his findings in an effort to bring about a more general understanding of how such examinations are given. Many possible failures may perhaps become successes, if the applicant profits by the mistakes of others.

Suppose we consider the various grades of licenses issued by the U. S. Department of Commerce and set forth briefly the qualifications required for each, taking up the probable causes for failure as we go along. Skipping the cargo grade (almost never issued), the lowest class of operating license is the Amateur Second Grade. This is the only class of license issued without a personal examination. It is in reality only a temporary permit, issued for a period of one year, or, as stated on the form, until the applicant has been duly examined. Such license permits the operation of an amateur radio station at a point remote from a radio inspection office or from any of the points on the usual itinerary of a radio inspector. Where such licenses are issued, cards are always mailed to licensees, telling them when a radio inspector is to be in their vicinity, and informing them of the date and place of examination. It is then expected that all holders of Amateur Second Grade certificates will present themselves for examination. Failure to appear for such personal examination results in the cancellation of the Second Grade license. It is realized, of course, that circumstances may actually prevent attendance of a few holders of the temporary certificate, and if satisfactory evidence is furnished to the Supervisor of Radio in the district controlling the examination that attendance was impossible, the licensee is excused, but he must appear at the next scheduled examination.

An applicant appearing for personal examination, who has held a Second Grade Amateur operator's license, has exactly the same standing as a man appearing for his first license. Rather than credit him with a few points for experience gained through operation of an amateur station, he is given an opportunity to demonstrate his superior knowledge and skill over the inexperienced man by what he writes on his technical examination.



CHARLES T. MANNING
Conducting a code examination with the Omnigraph at New York. All code tests for licenses last for five minutes

THE AMATEUR FIRST GRADE LICENSE

NOW for the Amateur First Grade license: The amateur holding the First Grade operator's license has been personally examined by a representative of the Government and his knowledge has been found sufficient to warrant the issue of a more permanent grade of license than the second grade, which is only a temporary permit.

The code speed test is run first in conducting an examination of an applicant for an operator's license of any grade. The code ability of the applicant must be determined before he is allowed to take the test on "theory." Should he fail to attain the prescribed code speed, he is then dismissed and his papers filed in the district headquarters. Since he has failed, he cannot present himself for re-examination until three months have elapsed. The same penalty is inflicted if the applicant fails to pass his theoretical examination.

THE OMNIGRAPH IS NOT AN "INFERNAL-MACHINE"

THE characters comprising the Continental telegraph code, arranged to form sentences, words, and phrases, are transmitted automatically by a spring motor device known as the Omnigraph. This instrument reproduces the characters of the Continental code perfectly on a high-pitched buzzer. It is often contended that the machine-like transmissions of the Omnigraph are unnatural and not true to the usual type of manual sending to which applicants are accustomed. This is true, to a certain extent. The automatic transmission is perfect, whereas hand sending is a bit erratic and always individual. The use of an automatic device, however, enables an accurate, even speed to be maintained and eliminates any possible chance of error. The writer much prefers to copy the even precise transmissions of the Omnigraph or of an automatic tape transmitter than most styles of hand sending. The adverse sentiment toward the Omnigraph however, has often frightened applicants for radio operator licenses. They are led to believe that it is a horrible instrument of torture—an infernal machine that simply cannot be copied. When the applicant comes up for his code examination he is frequently nervous and loses some control over his faculties and is unable to concentrate on the buzzer properly. So, one of the main reasons for failure is nervousness induced by fear of the Omnigraph.

We have digressed from our subject of Amateur First Grade licenses somewhat, and gone into generalities, but it is well, since a fear


The United States of America
NUMBER 32173
DEPARTMENT OF COMMERCE
BUREAU OF NAVIGATION
LICENSE
RADIO OPERATOR, AMATEUR FIRST GRADE
This is to certify that Ray G. Leonard has been examined and shown to have a knowledge of the adjustment and operation of apparatus and of the regulations of the Radiotelegraphic Convention and the Acts of Congress in so far as they relate to interference with radio communication and impose certain duties on all grades of operators sufficient to entitle him to a license, and he is hereby licensed as required by law Radio Operator, Amateur First Grade for two years.
The candidate was examined and shown to have knowledge (excellent or good) in the following additional subjects:
(a) general adjustment, operation and care of apparatus: Good
(b) transmitting and sound reading Continental Morse at a speed of 10 words a minute
(c) general knowledge of international regulations and Acts of Congress to regulate radio communication: Good
Arthur Batcheller (Examining Officer) Oath of Secrecy executed
U.S. Supervisor of Radio (Title) — Notary Public
HERBERT HOOVER, Secretary of Commerce
D. B. CARSON, Commissioner of Navigation
Place New York, N.Y. Date December 13th 1923
1 Excellent or good 2 Insert good

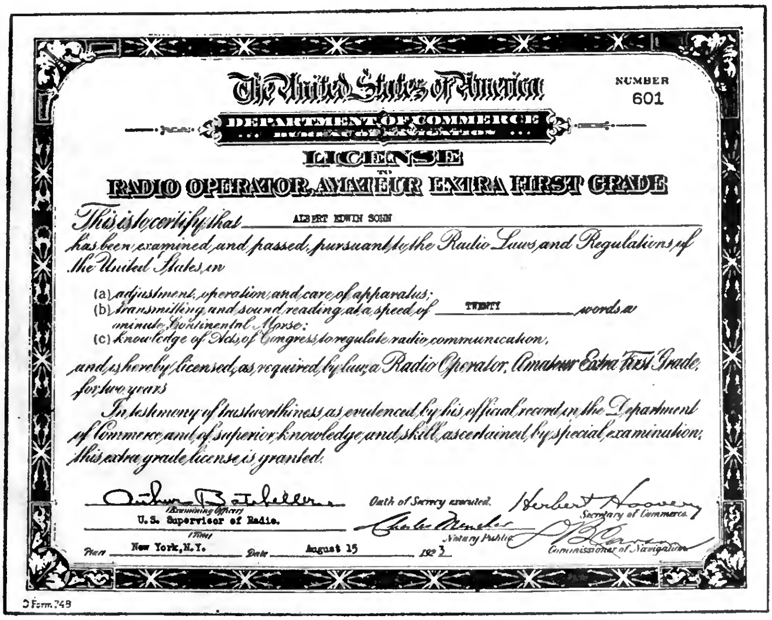
AN AMATEUR FIRST GRADE LICENSE

of the automatic transmitter is evident among all classes of applicants. A man who can copy five words a minute faster than the required speed when actually operating a radio station, can come successfully through the code transmission. He should not attempt the examination unless he has this "safety margin."

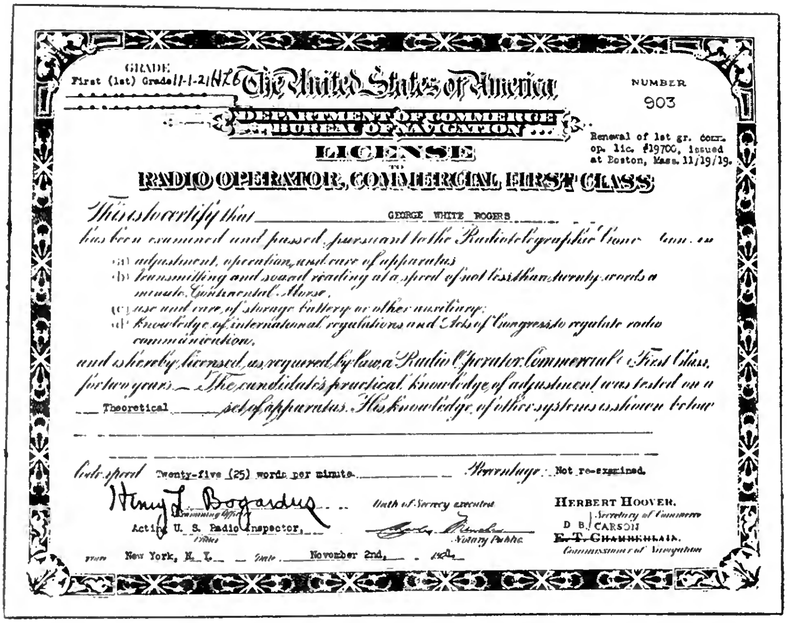
The code speed prescribed in the examination for Amateur First Grade operator's license is ten words per minute, and, counting five letters, numerals and other characters to a word as in the commercial tests. To pass such a test the applicant must receive successfully fifty consecutive letters (ten words) from a group of two hundred and fifty characters transmitted. This, in reality, gives five opportunities to make the required transcription. The same opportunity is offered in the commercial tests.

Ordinarily, few amateurs who can successfully copy ten words a minute fail in their theoretical examination. During the period the applicant has been learning the code, he mingles with his brother amateurs, visits their stations, and takes part in their conversations. In this way, he naturally acquires a fair knowledge of amateur equipment which is of great assistance to him in his examination.

The theoretical questions presented in an amateur examination take into consideration only the applicant's own station, or the station he proposes to operate. If he is reasonably well versed in the functioning of his apparatus, he will experience no difficulty. Few applicants fail the technical examination for the Amateur First Grade license, but almost invariably, those who do, fall down miserably on the questions regarding the radio communication laws and regulations. Apparently little or no attention is paid to the study of the laws. A copy of the Radio Communication Laws of the United States is readily obtainable by remitting fifteen cents in currency—


The United States of America
NUMBER 601
DEPARTMENT OF COMMERCE
BUREAU OF NAVIGATION
LICENSE
RADIO OPERATOR, AMATEUR EXTRA FIRST GRADE
This is to certify that ALBERT EDWIN SOHN has been examined and passed, pursuant to the Radio Laws and Regulations of the United States, in
(a) adjustment, operation and care of apparatus;
(b) transmitting and sound reading at a speed of TWENTY words a minute, Continental Morse;
(c) knowledge of Acts of Congress to regulate radio communication,
and is hereby licensed, as required by law, a Radio Operator, Amateur Extra First Grade, for two years.
In testimony of trustworthiness, as evidenced by his official record in the Department of Commerce, and of superior knowledge and skill, ascertained by special examination, this extra grade license is granted.
Arthur Batcheller (Examining Officer) Oath of Secrecy executed. Herbert Hoover, Secretary of Commerce
U.S. Supervisor of Radio. (Title) — Notary Public — D. B. Carson, Commissioner of Navigation
Place New York, N.Y. Date August 15 1923
Form 749

AN AMATEUR EXTRA FIRST GRADE "TICKET"


GRADE First (1st) Grade 11-1-21 NL6 The United States of America NUMBER 903

DEPARTMENT OF COMMERCE BUREAU OF NAVIGATION

Renewal of 1st gr. com. op. lic. #19700, issued at Boston, Mass. 11/19/19.

LICENSE TO RADIO OPERATOR, COMMERCIAL FIRST CLASS

This is to certify that GEORGE WHITE ROGERS has been examined and passed, pursuant to the Radiotelegraphic Convention in

(a) adjustment, operation and care of apparatus;
(b) transmitting and sound reading at a speed of not less than twenty words a minute Continental Morse;
(c) use and care of storage battery or other auxiliary;
(d) knowledge of international regulations and Acts of Congress to regulate radio communication,

and is hereby licensed, as required by law, a Radio Operator, Commercial First Class, for two years. The candidate's practical knowledge of adjustment was tested on a Theoretical set of apparatus. His knowledge of other systems is shown below

Code speed Twenty-five (25) words per minute. Percentage Not re-examined.

Henry L. Bogardus, Examining Officer. Acting U. S. Radio Inspector, Office. Oath of Secrecy executed. Notary Public. HERBERT HOOVER, Secretary of Commerce. D. B. CARSON, ~~E. T. CHAMBERLAIN~~, Commissioner of Navigation.

Place New York, N. Y. Date November 2nd, 1921.

A COMMERCIAL FIRST CLASS, FIRST GRADE LICENSE

Ship and coast station operators must have a license of this class, grade one or two

THE AMATEUR EXTRA FIRST GRADE LICENSE

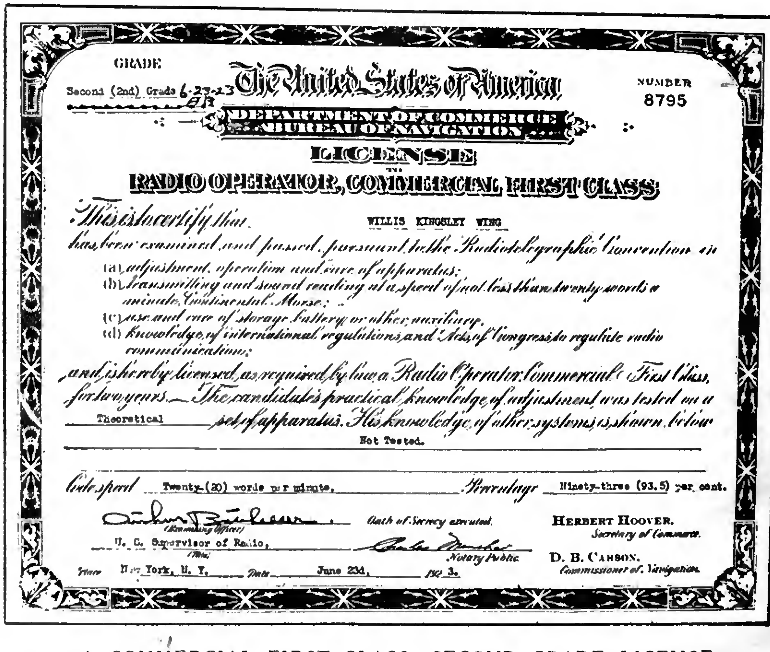
THE Amateur Extra First Grade operator's license has recently been made available. This certificate was created at the request of representative amateurs of the country and represents a special award of merit to deserving amateur operators who are capable of meeting the requirements. A code speed, of twenty words a minute must be attained, and the applicant must have held an operator's license of some other grade for a period of two years before he is eligible for the Extra First Grade certificate. Perhaps the most important requirement is that the applicant must never have been penalized for any infraction of the radio regulations (as for instance, sending during quiet hours).

The theoretical examination for this grade of license deals with amateur continuous-wave

not stamps—to the Superintendent of Documents, Government Printing Office, Washington, D. C. A copy of General Letter No. 252, setting forth the recent regulations governing amateur stations should also be secured from a district Supervisor of Radio. For the latter, no charge is made.

Study both publications thoroughly before you take the examination. It is well to familiarize yourself with the entire contents of the communication laws, paying particular attention, of course, to the sections devoted to amateur stations and operators. Learn the various penalties prescribed for violations.

When an amateur applicant can copy fourteen or fifteen words a minute at his station and is familiar with the functioning of his equipment, and has conscientiously studied the radio communication laws, he may be reasonably sure of success in his examination.


GRADE Second (2nd) Grade 6-23-23 The United States of America NUMBER 8795

DEPARTMENT OF COMMERCE BUREAU OF NAVIGATION

LICENSE TO RADIO OPERATOR, COMMERCIAL FIRST CLASS

This is to certify that WILLIS KINGSLEY WING has been examined and passed, pursuant to the Radiotelegraphic Convention in

(a) adjustment, operation and care of apparatus;
(b) transmitting and sound reading at a speed of not less than twenty words a minute Continental Morse;
(c) use and care of storage battery or other auxiliary;
(d) knowledge of international regulations and Acts of Congress to regulate radio communication;

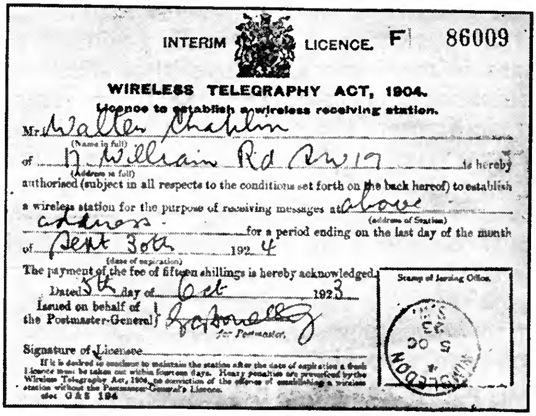
and is hereby licensed, as required by law, a Radio Operator, Commercial First Class, for two years. The candidate's practical knowledge of adjustment was tested on a Theoretical set of apparatus. His knowledge of other systems is shown below Not Tested.

Code speed Twenty (20) words per minute. Percentage Ninety-three (93.5) per cent.

Examining Officer. U. S. Supervisor of Radio, Office. Oath of Secrecy executed. Notary Public. HERBERT HOOVER, Secretary of Commerce. D. B. CARSON, Commissioner of Navigation.

Place New York, N. Y. Date June 23d, 1923.

A COMMERCIAL FIRST CLASS, SECOND GRADE LICENSE equipment exclusively, with a number of questions concerning the Department of Commerce radio regulations. If the applicant has a good working knowledge of amateur CW transmitters and receivers, he can ordinarily pass this examination. Inasmuch as comparatively few Extra First Grade licenses have been issued as yet, it is impossible to analyze reasons for possible failure at this time.



INTERIM LICENCE. F 86009

WIRELESS TELEGRAPHY ACT, 1904.

Licence to establish a wireless receiving station.

Mr. Walter Chaplin (Name in full)

of 17 William Rd NW17 (Address in full) is hereby authorised (subject in all respects to the conditions set forth on the back hereof) to establish a wireless station for the purpose of receiving messages at above (address of Station) for a period ending on the last day of the month of Sept 30th (date of expiration) 1924

The payment of the fee of fifteen shillings is hereby acknowledged.

Dated 5th day of Oct 1923

Issued on behalf of the Postmaster-General — for Postmaster.

Stamp of Issuing Office.

Signature of Licensee

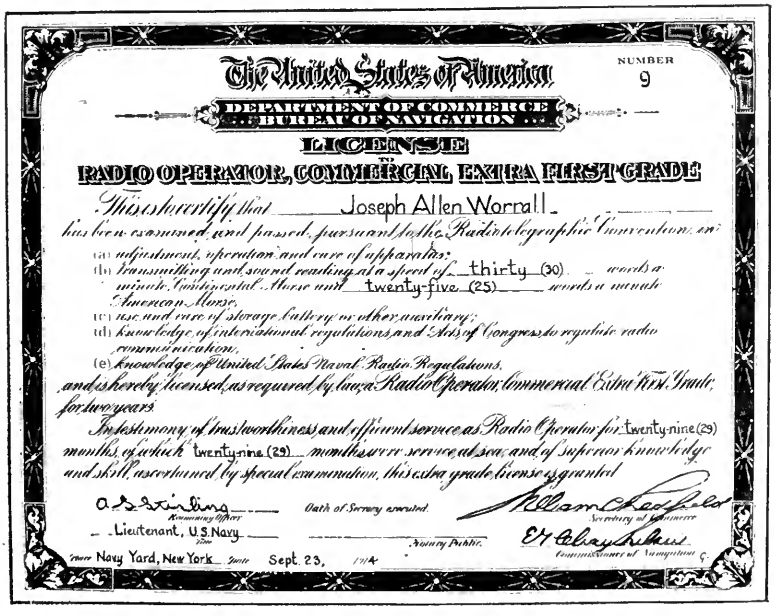
AN ENGLISH LISTENER'S LICENSE

Each listener must be licensed in England and it costs 15 shillings

COMMERCIAL LICENSES: SECOND GRADE, THIRD CLASS

WE PASS now into the commercial grades of licenses. The lowest of this class is the Commercial Second Grade, Third Class. Holders of such certificates may serve as operators only in a restricted class of station—those not engaged in General Public Service communication, such as broadcasting stations and limited point-to-point stations.

The code speed required for this grade of license is twelve words a minute. An applicant successfully passing such a code test is then given a theoretical examination covering moddern spark transmitting equipment as used in marine service; suitable receiving equipment; common radio measurements; storage batteries; motor-generators, and radio communication laws and regulations. Passing the code test and failing to pass the theoretical examination can be attributed to one or more of the following reasons: the applicant has been unfamiliar with the apparatus and circuits of a modern shipboard radio transmitter. The questions were answered too briefly or only in part; he was unfamiliar with the care and construction of the storage-battery; he had insufficient knowledge of motor-generator equipment; or he had no clear idea of radio communication regulations and penalties invoked for violations. A large number of failures are due to the last-mentioned question, while almost as great a number can be attributed to the applicant's inability to sketch in detail the complete circuits of a modern shipboard radio installation. All the above-mentioned points require a large amount of study and application to make the student thoroughly prepared for examination.



The United States of America — NUMBER 9

DEPARTMENT OF COMMERCE
BUREAU OF NAVIGATION

LICENSE
TO
RADIO OPERATOR, COMMERCIAL EXTRA FIRST GRADE

This is to certify that Joseph Allen Worrall has been examined and passed, pursuant to the Radiotelegraphic Convention, in:

(a) adjustment, operation and care of apparatus;
(b) transmitting and sound reading at a speed of thirty (30) words a minute Continental Morse and twenty-five (25) words a minute American Morse;
(c) use and care of storage battery or other auxiliary;
(d) knowledge of international regulations and Acts of Congress to regulate radio communication;
(e) knowledge of United States Naval Radio Regulations,

and is hereby licensed, as required by law, a Radio Operator, Commercial Extra First Grade, for two years.

In testimony of trustworthiness and efficient service as Radio Operator for twenty-nine (29) months, of which twenty-nine (29) months were service at sea, and of superior knowledge and skill ascertained by special examination, this extra grade license is granted.

Oath of Secrecy executed.

Examining Officer — Lieutenant, U.S. Navy

Secretary of Commerce

Notary Public.

Commissioner of Navigation

Navy Yard, New York, Sept. 23, 1924

EXCELSIOR

The highest grade license issued by the Government—the Extra First Grade Commercial. Only a few of these have been issued

COMMERCIAL FIRST GRADE, THIRD CLASS

THE next step above the second grade commercial license is known as the Commercial First Grade, Third Class license. The holder of such a certificate is eligible to any position in the radio operating field; he may operate at any class of station—marine or broadcast—coastal or inland. He is required to attain a speed of twenty words a minute and pass a more comprehensive theoretical examination than that required for a second grade license. He must have a knowledge of several types of spark transmitters as well as a working knowledge of undamped wave generators. His knowledge of receiving equipment must comprise receivers suitable for use in both damped and undamped wave reception. A more extensive knowledge of storage batteries and motor-generators is called for; as well as a good understanding of the communication laws and the method of handling radio traffic. The causes for failure to obtain this grade of license are practically identical with those set forth under our discussion of the second commercial class. We might add one more point here, which would be equally applicable to all classes: carelessness in reading the questions, with consequent misinterpretation of the information called for. This, naturally enough, is no excuse and will not serve to pull you through what would ordinarily be a below-passing grade.

A system of grading commercial licenses according to experience is now in effect. The holder of a First Grade, Third Class commercial license, may have it raised to the First Grade, Second Class when his service record on the reverse of his license form shows six months satisfactory service on a General Public Service station, as attested to by the signatures of the master, manager, or superintendent of his employing companies. Similarly, when twelve months of such service can be proven by proper evidence, and a code speed of twenty-five words a minute attained, an applicant will have the status of his license raised to that of Commercial First Grade, First Class.

One additional grade of license is issued. It is known as the Commercial Extra First Grade. This is the highest grade license it is possible to obtain and is issued as a testimony of efficient and trustworthy service as radio operator, and an acknowledgment of superior knowledge and skill, as ascertained by a special examination. A code speed of thirty words a minute in the Continental code, and twenty-five words a minute in American Morse is required, in addition to the special theoretical examination covering all types of radio equipment in use to-day.

Few of these licenses have been issued, and no data is available from which to construct possible causes for failure in this class.

IN GENERAL

IT MAY be said that failure to pass license examinations is due often to carelessness, the omission of some vital part in a circuit diagram, or the total omission of one or more of the sub-questions. Neatness is taken into consideration as well—your writing should be legible to the examining officer. He is forced to give you no credit for what cannot be deciphered. The use of pencil is permitted in all examinations, but only one side of the paper should be used. Attention to the instructions at the head of the question sheets may save errors.

An effort has been made in the foregoing paragraphs to clear up, in the minds of the aspirants to radio operator licenses, several misunderstandings that have existed in the past, and to remove the shroud of mystery that has apparently encircled such examinations. It is believed that an outline of the general requirements for the various grades of radio operator licenses, will enable the student to prepare himself more intelligently and to concentrate more readily on the more vital points of the examinations.

A Beginner's C. W. Transmitter

PART V

Various Circuits and What They Mean

By ZEH BOUCK

IT IS inevitable that the majority of broadcast enthusiasts, at some time, and with more or less seriousness, consider the possibility of installing transmitting apparatus. They are very few who do not acknowledge the lure of radio intercommunication, whose fascination far exceeds that of passive listening. This is particularly true of our younger enthusiasts to whom the toy telegraphs and the tin can telephones of back-yard days are not very distant memories. But radio communication is a far more serious thing, involving infinitely deeper considerations, than a baking soda tin and a piece of string; and the experimenter, young or old, who enters upon this side of the game precipitately, injures not merely himself but the entire citizen radio world.

Mr. Carl Dreher, in his recent articles in this magazine dealing with the relation of the amateur to the broadcast enthusiast, has ably demonstrated the crucial situation with which citizen radiodom is confronted. There exists between these two factions considerable friction, a general rubbing of fur in the wrong direction, caused, chiefly by misunderstanding on the part of the BCL (broadcast listener). This feeling is certainly aggravated by a host of inexperienced amateurs, who are, however, *no less a thorn in the side of the experienced citizen operator*. These, the nation's radio experts acknowledge as a genuine asset. This lamentably large group of inexperienced operators, which has grown to really tragic proportions in the last two years, has undoubtedly recruited, and continues to recruit its members from the ranks of the broadcast enthusiasts.

Our reader should therefore think more than twice before engaging a venture in which his lack of experience will gain him the active antagonism of the true blue amateur (upon whom his intercommunicative pleasure largely depends) and of his former friends among the broadcast enthusiasts. He will be the fabled crow in the feathers of the dove, unaccepted and scorned by the crows and doves of genuine plumage.

> In his introduction to the accompanying article, Mr. Bouck has touched lightly but well on the amateur situation in its relation to the newcomer and the increasing number of transmitting stations. Mr. Bouck himself is a radio amateur, one of the most prominent in the East, and his ideas, are the result of many years of experience and observation.
>
> It is suggested that our readers who are genuinely interested in building and operating a transmitter send to the Government Printing Office, Washington, D. C., for a copy of *Radio Communication Laws of The United States* and *The International Radio Convention*, which can be obtained for fifteen cents each. Knowledge of the contents of this book is essential to pass the government examination and the securing of a license, which, of course, must be had before one can transmit on even the simplest of apparatus. We regard this as one of the best "How to Make It" articles ever published in this or any other radio magazine.—THE EDITOR.

THE OPERATOR HIMSELF

THE first consideration of the prospective operator should be his own ability. The requirements need not be treated in detail, for one item alone implies proficiency in all others. *The amateur should not touch a key, on other than a practice set, or a transmitting microphone, until he can send and receive twenty words a minute with ease.* This means months of constant practice—a half-year of code copying which almost invariably brings with it a knowledge of amateur ethics and traditions, the method of handling traffic, an appreciation of concise calling and signing—in short, a theoretical and practical knowledge of radio.

HIS FIRST SET

THE transmitting equipment with which our amateur

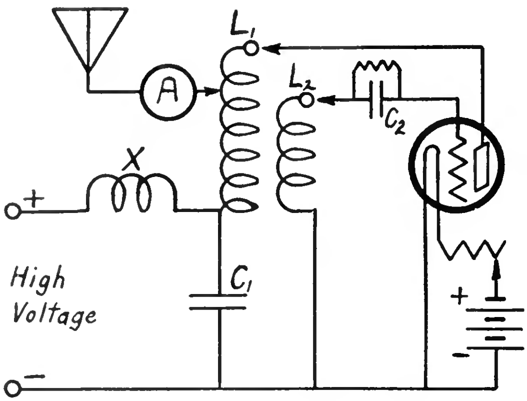


FIG. 1
The Fundamental Circuit

makes his *début* must meet several exacting requirements. It must, in the first place, cause a minimum of QRM (interference) to the other amateurs, and none at all on broadcasting waves. This immediately eliminates all forms of spark transmitters such as the induction coil, which, because of its economy and simplicity, appeals to the budding operator. Likewise, excepting in the most isolated radio districts, all forms of I. C. W. (interrupted continuous wave, accomplished by the use of buzzer, chopper etc.), poorly rectified and filtered alternating current, and the radio telephone are frowned upon. This leaves us only pure continuous wave transmission, which, however, is the most efficient form of radio communication known, and which makes possible fairly long distance transmission on the low power apparatus to which the beginner is necessarily limited. Also, the operator of apparatus of this type finds the warmest welcome "on the air" from his more experienced brothers. A comparatively inexperienced operator with pure C. W. is tolerated, even welcomed, where, with a less sharply tuned transmitter, he would certainly be most unpopular.

Simplicity and cost are other considerations which quite decisively eliminate the motor-generator with its elaborate filter and high power apparatus. Only the B battery is now left to us as the source of plate voltage. So the ideal beginner's set resolves itself into the following:

A B-battery C. W. set, operating from the amplifying plate potential from the receiving set, using an amplifying tube as an oscillator, built entirely of easily procured and cheap receiving parts (excepting the "radiation" meter).

THE IDEAL BEGINNER'S SET

FIG. 2 is the front view of a C. W. transmitter built according to the conditions outlined above. Fig. 1 shows the fundamental circuit, which, in the category of various types of oscillators, is the tickler feed-back system with inductive grid coupling.

L 1, the combined plate and antenna coil, is wound on a three and a half inch diameter tube with forty turns of wire, tapped every two turns. No. 18 annunciator is a convenient wire to use. The simplest manner of tapping,

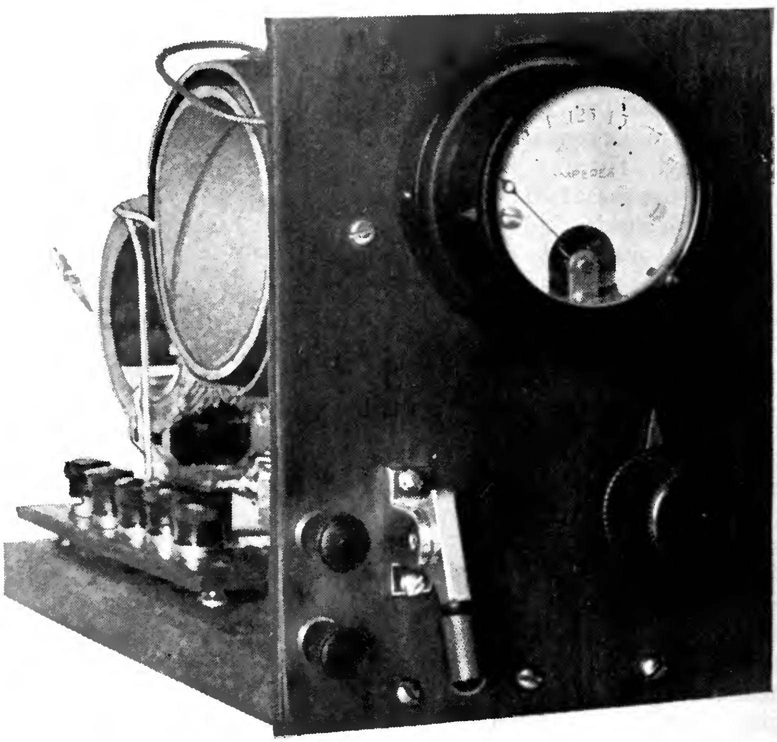


FIG. 2
The ideal beginner's C. W. transmitter which has a daylight range of about five miles and can be built for less than $20

and that employed by the writer in building this set is to twist the wire into a half-inch projection every other turn, staggering the taps in a progression of four so that clip connections can later be made without crowding. When the inductance is completely wound, the insulation is burned from the taps. They are then given a tightening twist, scraped clean, and tinned with solder. L2, the grid coupling coil, or tickler, is wound on a three-inch tube with the same size wire. Twenty turns are wound, tapping at 10, 12, 14, 16, 18 and 20 turns. The taps on L2 are brought through the tubing, and the ultimate connections are made from the inside. This permits L2 to fit, without forcing, inside of L1.

C1, though a by-pass capacity for the greater part, will vary between .0005 mfd. and .002 mfd. for various wavelength adjustments. C2 is a grid condenser, .0005 mfd. capacity (some times greater) shunted by a leak, the resistance of which varies inversely with the plate voltage. With voltages in the neighborhood of one hundred, it may be as high as $\frac{1}{2}$ megohm, while with transmitting tubes, and on plate potentials in excess of three hundred and fifty volts, the resistance is often as low as five thousand ohms.

A is a "radiation" ammeter. X is a high frequency choke-coil, generally about two hundred turns of wire on a three-inch winding form.

THE SPECIFIC CIRCUIT

THE more experienced enthusiast can easily follow the circuit given in Fig. 1, adapting it to his individual requirements and wishes. The circuit exactly as employed in the set to be described, is shown in Fig. 3.

L1 and L2 are wound as described for the general circuit. The tubes on which the two coils are wound are each four inches long. If No. 18 annunciator wire is used, the forty turns on L1 will cover exactly three inches, leaving a half inch margin on each side. In the center of the half inch margins, that is, $\frac{1}{4}$ inch in from each edge, holes, passing an $\frac{8}{32}$ machine screw, are drilled or punched. Later, these holes facilitate the fastening of brackets which support the inductances on the panel.

X, the radio frequency choke, is a honeycomb, size DL200. (Incidently, this coil is not necessary to produce oscillations in this circuit, but its presence permits the regulation of wavelength by condenser C, by preventing the short-circuiting of this capacity through the plate source.)

C is a .0015 mfd. Micadon. Under some conditions, a different capacity, within the limits mentioned in describing the fundamental circuit, may be desirable.

A is a "radiation" meter reading from zero to 250 milliamperes. In the particular meter the writer used, approximately this range was secured by removing the shunt resistance from a higher range meter.

R is a six-ohm rheostat, which is about right for all six-volt tubes when used for transmitting.

A grid condenser was originally provided on the base of the transmitting set, but it was found undesirable on most tubes when the set was operated on voltages below one hundred and fifty, so, in the photographs it is shown shorted over. It is not shown at all in the specific circuit.

The tube may be almost any hard amplifier. The UV-201-A works nicely, though best results were obtained with a Western Electric J tube, or VT-1.

S is the antenna change-over switch. In the upper or transmitting position, the antenna is connected to the transmitter, and the filament lighted. In the down position, the antenna is thrown to the receiving set, and the filament circuit to the transmitting tube is broken. This switch may be any type that performs a double-pole, double-throw function. It may be an anti-capacity key, or a telephone cam switch such as used by the author. The anti-

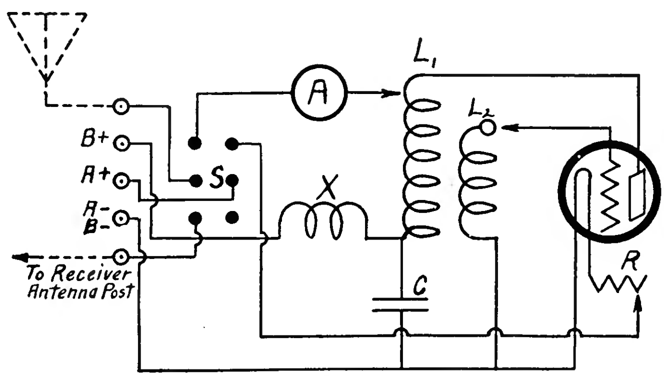


FIG. 3
The exact circuit used in the set

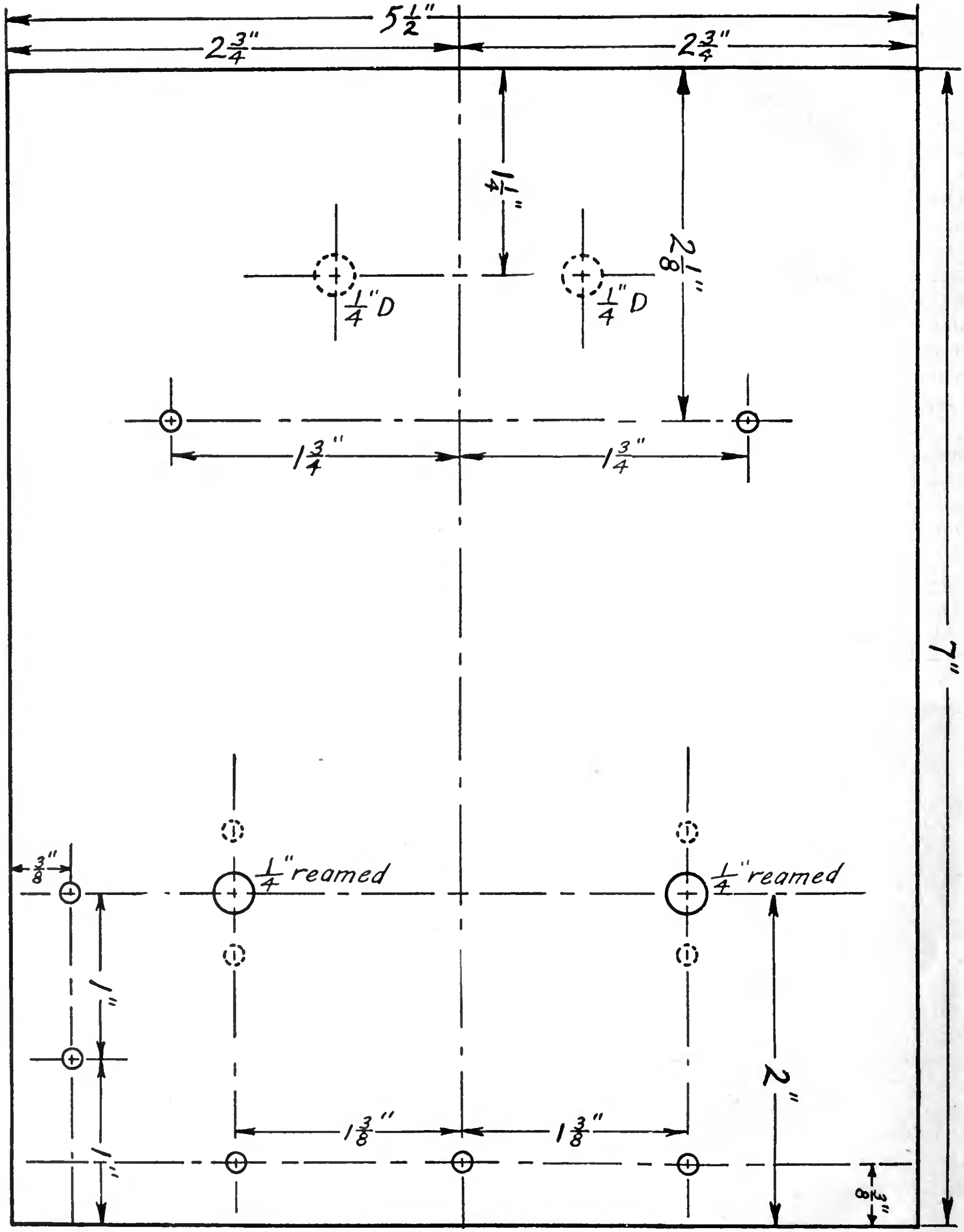


FIG. 4
The working drawing of the panel

capacity key is most easily obtained in large cities from any well stocked radio store, while in rural districts, the reader will have little difficulty in securing one of the telephone type from the company's local representative.

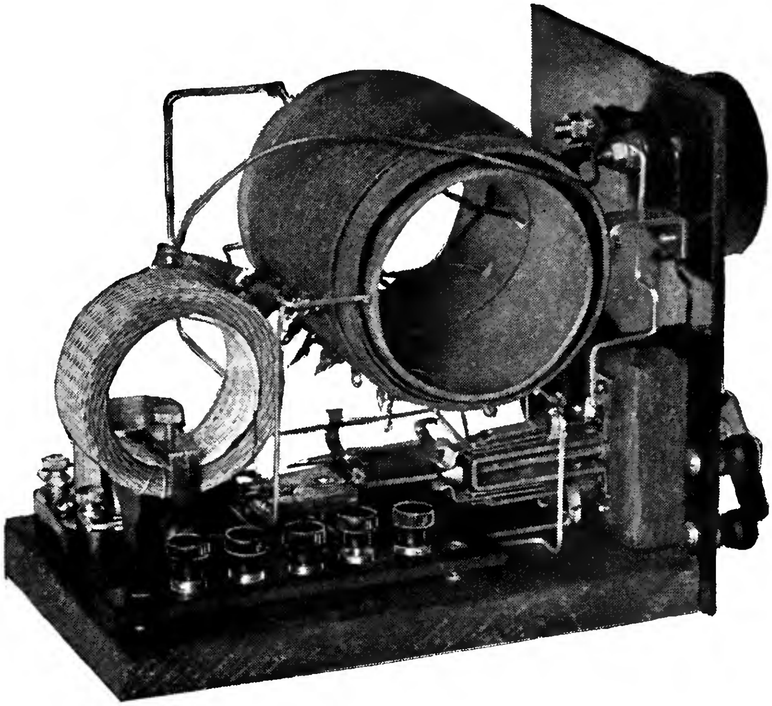


FIG. 5
The completed set from the left, rear

It will be observed that, in the specific circuit, no connections are indicated for the negative B battery or ground. This is because these connections are already effected through the writer's receiving set, a Grebe CR3, in which the positive of the filament in grounded and the negative B battery, of course, connected to the filament battery. Similar circumstances will be found in almost all receivers. Trace your circuit, and if you find the filament battery grounded, no similar connection should be made on your transmitter. If the A battery is not grounded, the negative terminal should be connected to the ground, through a switch for breaking the connection if it broadens the tuning while receiving, or otherwise complicates reception.

CONSTRUCTING THE SET

FIGS. 2, 5, and 6 show the completed transmitter as seen from different views. The panel is of hard-rubber, 5½ inches by 7 inches, a working drawing of which is shown in Fig. 4. All holes, excepting those designated as odd sizes, are drilled to pass a No. 8 screw. Two binding-posts are shown on the main panel, which are provided for making a front connection to the transmitting key if desired. If used, these posts are placed between the plate of the tube and the inductance. In the set the writer built, it was found more convenient to connect the key in the plus high voltage lead before it reached the positive B terminal on the transmitter. Incidentally, it is always a good idea, in view of possible later changes and expansion, to provide two extra binding-posts on any experimental apparatus.

The send-receive switch is on the left hand side of the panel, and the rheostat knob on the right.

The wooden base is ¾ of an inch thick, 5¼ inches wide and 9 inches long. The photographs, Figs. 5 and 6 show the placing of the various parts.

The honeycomb coil is mounted by drilling a small hole (passing a No. 8 screw) and forcing the single prong into it.

The binding-post strip is five inches long, ¾ inch wide, with the posts spaced ¾ inch between centers. This strip is cut from the same sheet of rubber as the front panel, originally a 7″ by 10″ standard panel which is carried by all dealers. A hack-saw, with a long blade, is used for cutting the hard-rubber. This is best accomplished by laying the panel flat on the table, cutting it as a slice of bread is halved in making a sandwich. This gives a much smoother and straighter edge than if you saw the material as you would a plank of wood.

After the binding-posts have been mounted, an inch and a half length of bus-bar wire is soldered to the nut or screw of each post. The strip is then screwed down to the base, two nuts taken from a dry cell, being used as washers to raise the connection strip ⅜ of an inch above the base. Connections are now made to the posts by soldering to the projecting stumps of wire.

All connections, excepting the direct leads to the inductances, are made as soon as the base instruments, the rheostat and change-over switch have been mounted.

When these have been completed (trace them and make sure that they are correct) the coils are mounted by means of the small brackets, fastened to L1, and which are illustrated in Figs. 5 and 6. These brackets are made from $\frac{3}{32}$ inch brass strips, two inches long, and bent over $\frac{1}{2}$ inch in from each end. The two holes were drilled and tapped to take an $\frac{8}{32}$ machine screw. If more convenient, they may be drilled to pass the screw and a nut used for holding.

The Cost

The following is a list of parts required for building the set itself, and the approximate cost which the reader may expect to pay:

1 7" x 10" panel	$ .85
1 Socket	.75
1 Change-over switch	1.00
1 Six-ohm rheostat	1.00
7 Binding-posts	.35
1 "Radiation" meter	5.00
8 Lengths of bus-bar wire	.32
1 Lb. annunciator wire	.90
Cardboard tubing	.40
1 Micadon condenser	.40
1 DL200 honeycomb coil	1.85
Total	$ 12.82

The lower connection to L1, that to the condenser C, is the only permanent connection to the inductances made before the transmitter is tuned. Flexible leads are provided for completing the circuit with test connections. The lead from the ammeter to the inductance is furnished with a clip for change of wavelength even after the set is permanently installed.

TUNING AND OPERATION

THE set is best tuned by observing the antenna current as indicated by the meter, and by listening to the transmitter on your own oscillating receiver. In doing this, the antenna is of course disconnected from the receiving set, by being thrown over, through the switch S, to the transmitter. Therefore, if you are using a single circuit receiver, connect a grid condenser, without leak, across the receiving antenna and ground binding-posts for the test.

Place the antenna clip on the 6th tap from the bottom, and connect the lead from the plate to the upper end of the coil. Now connect the lower end of the grid coil to the negative filament, and the tap at the 18th turn, to the grid. Slip L2 inside of L1, and light the transmitting filament quite bright. Make your receiving set oscillate, and tune, around 200 meters, for a beat note from the transmitter. If none is heard, reverse the connections to the grid coil.

Once the transmitting set is oscillating, it remains only to adjust it so that it oscillates most powerfully at the desired wave (between 150 meters and 200 meters). This is accomplished by varying the plate and grid taps and soldering the leads at the most efficient adjustment. In the majority of cases, and with the average antenna, the plate tap will be kept

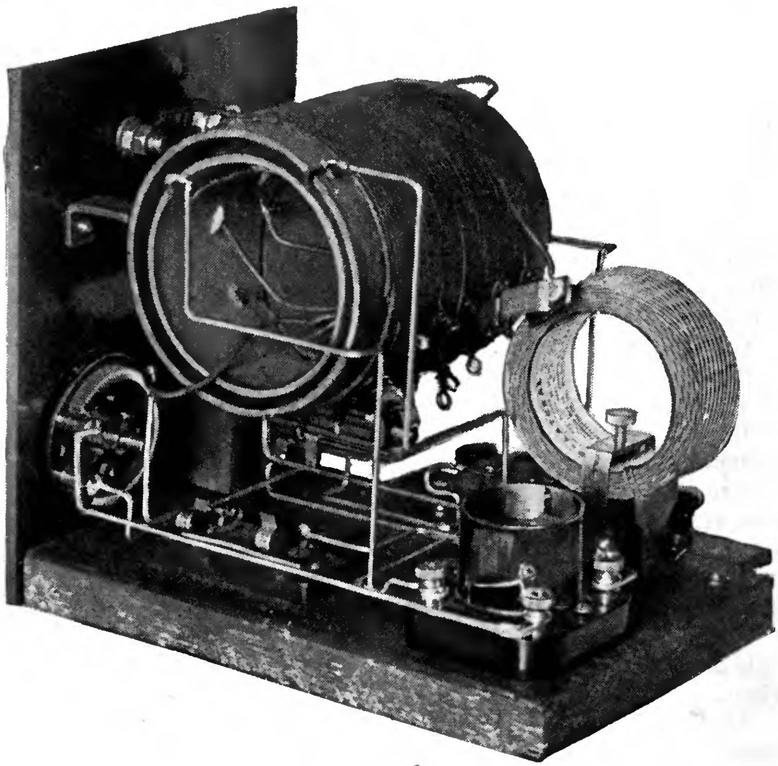


FIG. 6

Another rear view. Most of the wiring is completed before the inductances are mounted at the upper end of the coil, and the grid tap at number 16 or 18. The antenna connection should be kept at about tap 6 or 8. If your antenna is more than 75 feet long, an antenna series condenser should be employed, and connected between the meter and the change-over switch. Size .0005 mfd. will be about right. During tuning, the wavelength can be checked continually on the receiving set.

The antenna current with this transmitter, using from 90 to 150 volts on the plate, will vary with the tubes and aerial systems. In some cases it may be in the neighborhood of only 20 milliamperes, while in others it may rise to $\frac{1}{10}$ of an ampere. When the antenna current is very low (which does *not* necessarily mean that you are radiating very little power), the antenna meter, with its slight movement, will be an indication only that the set is working, and will be of little assistance in tuning. In this case, adjustments must be made at the transmitter while listening for the most powerful beat in the receivers.

It is thus evident that the "radiation" meter is not altogether a necessity, and may be dispensed with by the experimenter if he desires. It is, however, very useful, and adds to the appearance of the transmitter.

RANGE

THE distance which this set will transmit depends on so many things, antenna, ground, location, tube, voltage, etc., that only a most general statement can be made. The author knows of similar sets which have freaked actual long distance transmission in excess of three hundred miles. The writer has personally found the set here photographed and described superior, in several instances, to a $\frac{1}{4}$ kilowatt spark transmitter. The average experimenter should experience no difficulty in working stations five miles away in daylight.

Supplemental List of Broadcasting Stations in the United States

LICENSED FROM JANUARY 19 TO FEBRUARY 15 INCLUSIVE

CALL SIGNAL	STATION	FREQUENCY (Kilocycles)	WAVE-LENGTH	POWER WATTS
KDZE	Seattle, Wash.	1110	270	100
KFJQ	Grand Forks, N. D.	1070	280	5
KFNC	Corsicana, Texas	1280	234	20
KFNF	Shenandoah, Iowa	1130	266	500
KFNH	Springfield, Mo.	1270	236	20
KFNJ	Warrensburg, Mo.	1280	234	50
KFNL	Paso Robles, Calif.	1250	240	10
KFNV	Santa Rosa, Calif.	1280	234	5
KFNX	Peabody, Kansas	1250	240	10
KFNY	Helena, Montana	1150	261	5
KGO	Oakland, Calif	960	312	1000
WBBJ	W. Palm Beach, Fla.	1160	258	50
WBBK	Pittsburgh, Pa.	1180	254	10
WBBM	Lincoln, Ill.	1330	226	200
WBBN	Wilmington, N. C.	1090	275	10
WBBC	Rogers, Michigan	1200	250	500
WBBP	Petoskey, Mich.	1220	246	10
WBBQ	Pawtucket, R. I.	1190	252	50
WBBR	Rossville, New York	1230	244	500
WBBT	Philadelphia, Pa.	1280	234	5
WBBU	Monmouth, Ill.	1340	224	10
WBBV	Johnstown, Pa.	1210	248	5
WDM	Washington, D. C.	1280	234	50
WMAW	Wahpeton, N. D.	1180	254	50

LIST OF BROADCASTING STATIONS DELETED JANUARY 1 TO JANUARY 31

CALL	STATION	CALL	STATION
KFAV	Venice, Calif.	WABC	Anderson, Ind.
KFCD	Salem, Ore.	WABJ	South Bend, Ind.
KFCK	Colorado Springs, Col.	WBAW	Marietta, Ohio
KFDU	Lincoln, Neb.	WDAX	Centerville, Iowa
KFIB	St. Louis, Mo.	WGAY	Madison, Wis.
KFIK	Gladbrook, Iowa	WJAB	Lincoln, Neb.
KFIY	Seattle, Wash.	WKAW	Beloit, Wis.
KFJD	Greeley, Colorado	WLAN	Houlton, Maine
KFKH	Lakeside, Colorado	WLAT	Burlington, Iowa
WAAZ	Emporia, Kansas	WOAJ	Parsons, Kansas

How to Go About Buying a Set

Where to Go—How Much to Go With—What to Ask for When You Get There—and What to Do With the Unfamiliar Thing When You Get It

By WILLIAM H. CARY, Jr.

LONG before the saying, "Well begun is half done" was translated from the original (whatever that was) into the English language, people must have appreciated pretty thoroughly that "ill begun is underdone"—i. e., half-baked. And nowhere is this fact more evident to-day than in the gentle art (with a small "a" for a change) of broadcast receiving. Self appointed Radio Experts, cheap parts which refuse to "percolate," loud speakers operated at maximum volume (and maximum distortion), columns of text about "new" circuits ground out because the public expects a new circuit every week or so—these are the sad results of poor beginnings, of the construction without instruction which has done do much to make the word "radio" connote "nuisance," in many quarters.

For Those About to Plunge

Hereby hangs a tale, a tale for the would-be, will-be, broadcast listener, who naturally enough at first, does not know what he needs in the way of receiving apparatus, nor how and where to acquire it, nor what he ought to pay. This article is an explanation of the fundamentals that should be understood by any one who is thinking of getting "a radio." Otherwise stated: if you know, in a general way, what you're "out for," this article will help you to know what you're "in for."

Next month, in an article: "Home Remedies for Indisposed Receivers," Mr. Cary will tell what to do with the ready-made set when it won't work.—THE EDITOR

But, since "it is not in our stars, but in ourselves, that we are thus or thus," and since thousands of people every evening are deriving a real pleasure from their radio sets, those who lack experience in radio may in a measure make up for their lack by entering the game armed with the few plain facts.

For the sake of argument (and, paradoxically, hoping to avoid it), all people may be divided into four general groups:

1. Those who know *nothing* and care *nothing* about radio,
2. Those who know *nothing* and care *something* about radio,
3. Those who know *something* and care *something* about radio,
4. Those who know *something* and care *nothing* about radio.

The first group is by no means hopeless: many will be stimulated to active interest; but probably few of them will chance to read these words. The second group, those who know nothing about radio but are interested, is a very large one. Perhaps you are in it. If so, it is for you that this is written. The group includes those who will grasp the principles quickly when once introduced to broadcast receiving, as well as those who—being busy, clumsy, very old, or very young (not so often this, however!) need repeated simple instructions. The third class—those already in the game—need not be content with the simple fare of this article: other wholesome food is provided for them elsewhere in the magazine.

As for the last group—those who have gone through the mill and come out radio-electrically dead—their present apathy or haughty indifference toward radio may be due to the fact that they owned sets which didn't work, or which brought in programs of a kind or quality which did not suit them, or they heard a rush of noises, reminiscent of music, at a friend's house or at a radio store. This, of course, is too bad. So much might be said—and repeatedly is—on both sides!

SUPPOSE YOU ARE A NEWCOMER

LET us suppose, that although you are a rank newcomer to the listening-in game, you are ready and willing to give it a fair trial. Let us suppose, also, that you are *buying* a set, not making it.

First of all, it is well to establish the *price range* you are willing to consider *for the set and* *all accessories.* Comparatively few receiving sets are sold to-day complete. The "set" sold over the counter is a box full of tuning apparatus, sockets for the vacuum tubes, and a certain amount of other parts and wiring. Batteries, tubes, or head-phones do not come with it. To many, this state of affairs may seem like buying a phonograph spring in its case, for a certain price, then shopping around to pick up the crank, the record disk, and the horn, at added trouble and expense. The condition is evidently handed down from the days—not so long ago—when most of the people interested in amateur radio were electrical experimenters first and listeners second. In another year, we shall probably see many more receiving sets sold complete, so that you can pay one price, take the stuff home, and find everything present or accounted for.

"WELL, HOW MUCH DOES A GOOD RADIO COST?"

"HOW MUCH DOES A GOOD RADIO COST?"

"HOW much does a good radio cost?"

O, question how often asked and how utterly unanswerable! Unanswerable, that is, until you have determined the *distance range* of the required set, and the *volume of sound* that it will be expected to produce.

Although it is a bit difficult to submit very definite prices, the table below is drawn up to give you a general idea of the cost of broadcast receivers and their effectiveness.

This is all very approximate, and does not take into consideration the *de luxe* sets, which are distinguished either by many stages of amplification, or by luxurious cabinet work, or both.

If you can make a visit to the receiving sets of several of your acquaintances, and see what results they give and at what outlay, it will be well worth your while. There is perhaps no better course of procedure for the uninitiated than to hear a satisfactory set at a friend's house, get one like it, and have the friend help install it—or more important still, have him go over its installation and adjustment with you after it is "hooked up."

THE CRYSTAL SET

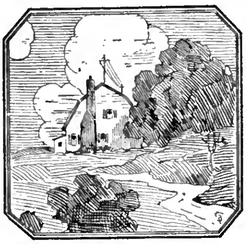
IF YOU are within 15 or 20 miles of a broadcasting station, and do not insist on getting stations farther away than that, a crystal receiver may fill your needs. It requires no batteries, so that the up-keep is practically nothing. You will need the following apparatus:

Type of Set	*Mileage Range*	*Volume Sufficient for*	*Price* (including everything needed)
Crystal	up to 20	headphones only	$10 to $25
One-tube	up to 750	headphones only	50 to 125
Two-tube	up to 1000	loud speaker on local stations	75 to 175
Three-tube and all other sets	up to 1500	loud speaker on all but very distant stations	100 to 500

Crystal receiving set
Head-phones
50 to 125 feet of bare copper wire (solid or stranded) any size from about No. 14 to No. 22.
2 small antenna insulators (hard rubber or porcelain or glass).
Some insulated wire (No. 14 is good) to connect "ground" terminal on set with radiator or water-pipe.
Ground clamp, for fastening ground wire to radiator or water-pipe.
"Lightning arrester" or safety device (at any radio store).

In case you are very near a broadcasting station—so near that the signals from it are clear and loud—you might as well replace your adjustable crystal with a permanent one. Several kinds are on the market. They may cut down the volume a little, but are a source of great satisfaction in that they do away with the bother of keeping the crystal in adjustment.

As for the tools needed to install the crystal set, or practically any other type of set, only three are needed: jack-knife—screw-driver—pliers.



THE SINGLE-TUBE RECEIVER

WARNING! Please keep off the single-circuit grass! These single-circuit regenerative sets (and lo, there are many in the land,) when operated act as little transmitting stations, sending out radio waves of their own which cause squeals in the phones or loud speakers of your neighbors. "Reflex," "neutrodyne," "three-circuit," and other types of sets are available which do not cause this interference.

For a single-tube receiver, you will need the following materials:

Receiving set (generally with both tuning and detecting apparatus mounted in the same cabinet).
A–battery. (For WD–11 or WD–12 tube) A single $1\frac{1}{2}$-volt dry cell.
(For UV–199 tube). Two dry cells, $1\frac{1}{2}$-volt.
(For UV–200 or C–300 tube). A six-volt storage battery
B–battery. One $22\frac{1}{2}$-volt dry battery (on sale at stores handling radio supplies).
Headphones and phone-plug (for connecting phones in the receiving circuit.
1 vacuum tube (see under A–battery).
Antenna wire, insulators, lightning arrester, ground wire, and ground clamp as listed under requirements for the crystal set.

THE RECEIVER USING TWO OR MORE TUBES

IF YOU want more volume than the single-tube set will give you—and especially if you wish to use a loud speaker instead of phones, you should go shopping with the following list:

Receiving set and amplifying unit (generally included in the same cabinet with the tuning and detecting apparatus)
A–battery. (For WD–11 or WD–12 tubes). A $1\frac{1}{2}$-volt dry cell for each tube used (this is only approximately correct. See article, "Dry Cells and WD–11 Tubes," in RADIO BROADCAST for July, 1923).
(For UV–199 tubes). Two or three $1\frac{1}{2}$-volt dry cells for 2 tubes. Three $1\frac{1}{2}$-volt dry cells for 3 or more tubes (the idea is to supply 3 volts to each of the tube filaments. Two cells connected in series will do this, or 3 in series when sufficient resistance (rheostat) is in the circuit).
(For UV–200, UV–201–A, C–300, or C–301–A tubes). A 6-volt, No. 80- to 120-ampere-hour storage battery.
B–battery. 2 to 5 $22\frac{1}{2}$–volt dry batteries (Three are generally sufficient for 2- and 3-tube sets).
Headphones and phone-plug. (If two or more pairs of phones are to be used, one of several makes of multiplugs or phone blocks should be purchased.)
Vacuum tubes. (See under A–battery.)
Antenna wire, insulators, lightning arrester, ground wire, and ground clamp as listed under requirements for crystal set.

In all fairness, it must be said at this point that these parts and accessories "certainly do add up." Suppose, for example, you see a 3-tube set advertised in a store window for \$70. "Fine!" you exclaim, "\$70 is about what I'm willing to pay to receive all this broadcasting that's going on nowadays." And you go in and look at the set and handle the knobs and peek inside and tell the salesman to wrap it up. He gives you the package and \$30 change from your hundred-spot, but—you have not bought a phonograph, which needs only a few needles and records to make it immediately useful. Let us determine, approximately, what your total initial expense for this \$70, 3-tube receiver will be (using dry cells for your A battery, not a storage battery.) Of course these prices will not hold everywhere, but you want to know what comes with your \$70 cabinet.

The set	\$ 70.00
A–battery (3 dry cells)	1.50
B–battery (3 $22\frac{1}{2}$-volt batteries	9.00
1 pair head phones	6.00
Loud speaker	20.00
Plug for head phones	.75
Plug for loud speaker	.75
3 UV–199's	15.00
3 adapters for UV–199's	2.25
Antenna wire	.75
Insulators	.20
Lightning arrester	2.00
Ground wire	.20
Ground clamp	.10
Total	\$128.50

"DON'T EXPECT TO HEAR HAWAII THE FIRST TIME YOU TOUCH THE DIALS"

WHAT TO DO WHEN YOU'VE BOUGHT THE RECEIVER

SOME of you will discover suitable apparatus at prices lower than those given above. Others may have to pay more: but the list shows that the cost does indeed, add up. It is well to know the worst. Rest assured that the writer's idea is not to spread disappointment over this intriguing sport called radio, but rather to forestall it.

Once you have acquired all the apparatus you need for your set, and have got your treasure safely home, you will very likely be keen to do the work of installation yourself. If you are lucky enough to receive printed directions with your outfit —many manufacturers supply them, but some still don't—you will do well to study them until you have thoroughly in mind what you are supposed to do. It isn't hard: the binding posts are generally marked, and so are the B battery terminals. The set may not produce music the first minute you get all the connections made, but what of it? Few sets do. Not that there is anything wrong with them, but a bit of experience is needed to determine the best battery voltages, and the proper positions of the dials for good volume without distortion.

WHO SHOULD INSTALL THE SET

TIME will be saved, perhaps, if you have someone install your set who has done similar work before. A friend who is already "in the know," or a man from a radio store, can do the job with neatness and dispatch. But do not call up your electrician and say you want him to install your set. That is, not if he is only a lighting man. Electricians have in many cases taken up radio successfully, but because a man is familiar with lighting installations, it does not follow that he would be any better than yourself in installing your radio set. In fact, he might be worse, because he'd be less willing to disclose his lack of knowledge.

Why Radio Waves Travel—and How

WHAT MAKES THE WHEELS GO 'ROUND: II

What Antenna Is Best for Receiving, What for Sending—Clear Explanation of More Radio Terms

By WALTER VAN B. ROBERTS, B.S., E.E., A.M.

This series is written distinctly for the enthusiast—the man of good intellect, but untrained along electrical lines—who would like to know all about the workings of his receiving set. Not that this brief discussion pretends to completeness; it is merely intended as a stepping stone to put the reader in a position where he can profitably read the more complete treatments of different branches of the subject.

Simple mathematics is used, but only after a qualitative discussion of the subject has been made. —W. VAN B. R.

This article is the second of a series on "What Makes the Wheels Go 'Round." The first appeared in the March, 1924, RADIO BROADCAST. You can start this series now, since every article is a complete unit.—THE EDITOR.

WHEN high frequency alternating current flows in an antenna, energy is radiated (cf No. 7, article I, RADIO BROADCAST, March) in the form of radio waves in the "ether." We shall continue the custom of speaking of radio waves in the ether regardless of whether there "really is" an ether or not. A wave motion is the state of affairs when any quantity at a given point in space varies periodically with the time and also at any given instant varies periodically in space. A series of water waves satisfies this definition. The height of the water is the quantity that varies. If we watch the water level on an upright stick it will be observed to go up and down as the waves pass. At a given point the height of the water varies periodically with the time. On the other hand if we take a photograph to get the condition of the water at a given instant we see a periodic variation of height along the direction in which the waves are moving, hence at the given instant the height varies periodically in space.

19. LIGHT, RADIO, AND X-RAYS

IN THE case of radio waves we have two quantities, the electric field strength and the magnetic field strength, both of them varying in the fashion described above. Radio waves are merely a special case of electro-magnetic waves. Electro-magnetic waves of wavelength (measured from "crest" to "crest") of a few meters up to thousands are classified as radio waves. Those of wavelengths in the neighborhood of one ten thousandth of an inch are heat waves, those of about 2.8 hundred thousandths of an inch are red light, those of about 1.6 hundred thousandths of an inch are violet light (all other colors coming in between these values) while the still shorter ones are the ultra violet and X-rays. All of these waves move through empty space, or air, with the same speed, that of light, or 300 million meters (186,000 miles) per second.

20. IS THERE AN ETHER?

NOW the electric field strength at a given point in space is merely a number that tells us the force that would act upon a unit charge of electricity (say one electron), placed at that point. And the magnetic field strength at a point is the force that would act upon a unit magnetic pole at that point. In fact the whole conception of these terms is due to the desire of the early physicists to invent some unseen mechanism that would explain the observed fact that forces are sometimes exerted upon bits of electricity for no apparent reason. And the ether is the imaginary substance that acts directly on electricity. Certain stresses and strains in this ether are identified with the electric and the magnetic field strengths. In one sense then, if the ether itself is merely a convenient figment of the imagination, then waves in the ether are, equally, not "really" existent. But if radio waves are considered only as waves in the mere *numbers* that measure the real forces that would act upon real electrons, then the existence of these waves does not require any ether. Whatever view we take of the nature of what we call waves in the ether, they certainly produce a very real effect when they hit a good receiving set.

21. THE EARTH AS A CONDUCTOR

IF THE earth were a perfectly conducting surface, the direction of the electric field in radio waves would be vertical, while the direction of the magnetic field would be horizontal, and perpendicular to the direction of motion of the waves. As a matter of fact the resistance of the earth's surface causes the electric field to tip forward somewhat, like a man starting to run. This same sort of thing can be seen in the waves on the sea shore. When they get to shallow water the friction against the bottom holds back the water from below and the upper part goes ahead, leaning forward until the wave "breaks."

22. ANTENNAS: OPEN AND CLOSED

MERELY for the purpose of convenience, we will divide antennas into two classes, closed or loop or coil antenna and open or condenser antenna. This is because it is slightly easier to explain the working of loop antennas in terms of magnetic waves, while the open antenna fits in better with the idea of waves of electric field strength. The working of either kind of antenna can be explained in terms of either the electric or the magnetic waves, for these two are merely two different aspects of the same thing: the radio waves. In the last analysis, radio waves can always be detected in two and only two ways: (1) an electric charge placed in their path will tend to oscillate up and down: to ride on the waves so to speak, and (2) a magnetic pole (if there is any such thing) would be affected the same way, only sideways. It can be shown that these two effects are not independent; either of them necessitates the other. If then the magnetic wave is an inseparable companion of the electric wave and can't explain anything that the electric wave alone will not explain, the question may well be asked, why do we take the trouble to imagine it? The only answer is that on the whole it is easier to invent this wave and assign properties to it and then reason about it than it would be to reason everything out from the idea of electric force alone. Fig. 7 is a representation of the way we imagine the radio waves split up into the two components.

23. LOOP ANTENNAS

THE working of a transformer is usually explained by saying that current flowing in the primary sets up an alternating magnetic field which in turn causes the current in the secondary. This is the simplest way to explain the operation of a loop antenna too, the only difference being that the alternating magnetic field that causes the current in the loop comes along in the form of waves. The number of volts induced in a loop by the passage of radio waves is $\pi\sqrt{2Hf}\,nA \times 10^{-8}$ where H is the amplitude of the magnetic wave, f is the frequency, n the number of turns on the loop and A its area. This is on the assumption that the plane of the loop is vertical and perpendicular to the direction of the magnetic field, that is, pointing toward the transmitting station. If rotated about a vertical axis a quarter of a turn, no voltage will be induced at all. This feature is the most important advantage of a loop, for two stations using exactly the same wavelength may still be separated (provided that they do not lie in the same direction) by simply turning the loop at right angles to the one that is to be cut out. The other may not

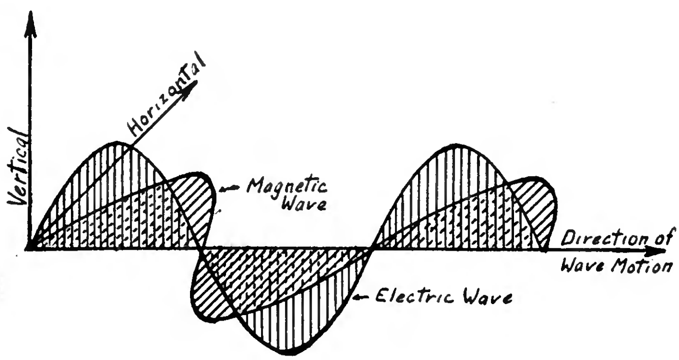


FIG. 7
How radio waves are theoretically imagined to split into magnetic and electric components

be heard as loudly then as if the loop were turned straight toward it, but it will be much louder than the interfering station.

24. OPEN ANTENNAS

THE simplest case of an open antenna is a vertical wire. The waves of electric force hitting it cause the electricity in the wire to oscillate up and down. The voltage picked up by such an antenna would be proportional to the electric field strength and to the height of the wire. But as mentioned before, the electric waves are likely to come in with a considerable tip forward. Hence signals will be better received from a particular direction if we tip the wire away from that direction. This is approximately realized by making the antenna in the shape of an "inverted L." That is, a vertical section with a horizontal extension at the top. This will receive best stations lying farthest from the horizontal part.

25. GROUND CONNECTION

IT IS usually desirable to couple the receiving set to the part of the antenna that has the most current in it. If a simple vertical wire, this would be the middle. Or, if an inverted L is used, a similar section may be connected as shown in Fig. 8 so that the vertical part all has comparatively large current in it and the receiving set can be located at the bottom. The section below the receiving set is called a counterpoise and is rarely used for receiving as it may be replaced by a connection to ground. The ground connection like the counterpoise, "gives the electricity some place to go" after passing through the receiving set and thus makes possible a good flow of current through the set. When a ground is used it is worth the trouble to make it a good one. The simplest is a connection to a water pipe by solder or a screw clamp squeezing a bright wire against a well scraped section of pipe.

26. LOOPS VS. OUTDOOR ANTENNAS

HIGH outdoor open antennas are used at transmitting stations to get large amounts of power into the ether. At the receiving end, loops are coming into greater and greater use as the transmitting stations get more powerful, and will probably ultimately be used almost exclusively on account of the small space required, ease of installation, portability, lack of necessity to safeguard against lightning, and

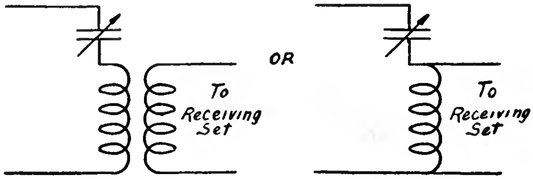


FIG. 8
The receiving set is coupled to the part of the antenna where the current is greatest

the improvement of the ratio of signal strength to interfering noises due to their pronounced directional quality.

27. RADIATION RESISTANCE

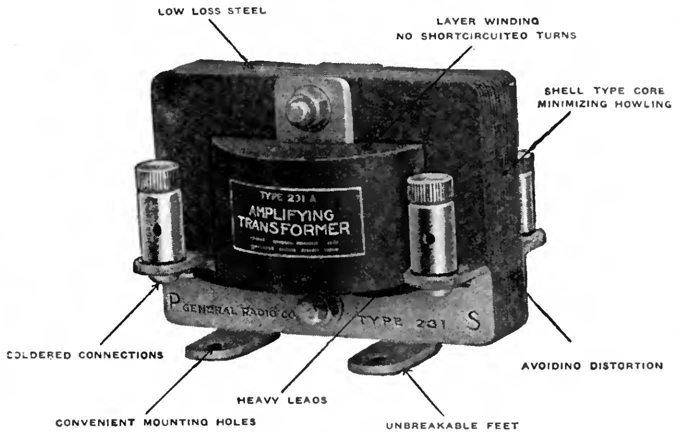
AN ANTENNA can be defined as any circuit that will radiate energy in the form of radio waves when radio frequency current flows in it. Or, it is any circuit in which radio frequency current is caused by radio waves. Now if energy is radiated from a circuit, it has to be supplied by the mechanism that produces the alternating current in the circuit. Furthermore, the rate at which energy is radiated is proportional to the square of the alternating current, which is exactly the same law that governs the dissipation of energy in a resistance. In one case the energy goes out as radio waves, in the other case it changes into heat. From the point of view of the source of the alternating current there is no difference between the two. Hence it is natural to speak of the "radiation resistance" of an antenna, meaning the amount of ordinary or "ohmic" resistance that would absorb the power that actually goes out into the ether. It is obviously important to have as little "ohmic" resistance in an antenna as possible, for we are not interested in heating the antenna wires. The ratio of the radiation resistance to the total resistance (the radiation resistance plus the "ohmic" resistance) of an antenna is the efficiency, or the percentage of the total energy (supplied by the source of the current) that is radiated as ether waves.

28. ANTENNA EFFICIENCY

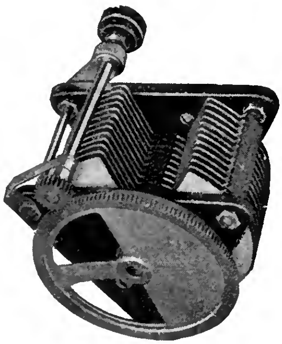
EVEN if a receiving antenna had no resistance at all, the current produced in it by incoming radio waves would not be greater than a certain amount, for if it were greater than that amount the antenna would be radiating energy faster than it is receiving it. This is as impossible as it would be to have a mirror

Amplification— undistorted

"*Products of Proven Merit*"



Type 231-A. Audio F. A. Transformer



Type 247-H Condenser
Price $5.00

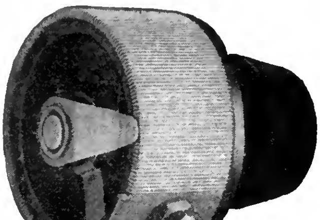
The efficiency of a broadcast receiver is often destroyed by poor amplification—due to inferior transformers.

In buying transformers be sure to look well into the electrical and mechanical features, as well as appearance and price.

The features which have gained the GENERAL RADIO CO. Type 231-A Transformer its enviable position as a leader among Transformers are:

Low loss steel used in its core construction.
Layer winding prevents short circuiting of turns.
Air gaps in core avoid distortion.
Unbreakable feet with convenient mounting holes, make installation easier.
Soldered connections eliminate losses from poor contacts.

Not only has this Transformer a high amplification factor but the amplification is nearly uniform throughout the entire audio range, making it ***best for all stages.***



Type 301 Rheostat
Price $1.25

Turns Ratio 3.7 to 1. Impedance Ratio 10 to 1.

PRICE - - - - - - - $5.00

Carried in stock by all good radio dealers.

Write TO-DAY for Instructive Folder—"Quality Amplification" and Bulletin 917-B

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reflecting more light than falls upon it. This leads to the remarkable conclusion that in case of an antenna having no ohmic resistance the current produced may be independent of the size of the antenna. For although the voltage produced by the incoming waves may be greater in a large antenna, yet the radiation resistance is also enough greater to limit the current to the same value as that produced in a smaller antenna. Of course in actual practice we never can obtain an antenna with no ohmic resistance, for the wires must have *some* resistance even if very thick, and the receiving set connected to the antenna introduces resistance too. But this line of thought accounts for two observed facts that might seem puzzling. The first is that a good loop antenna tuned with a condenser of low insulation losses will pick up signals much better than would be expected from comparing its size with that of a large outdoor antenna. The other fact is that a regenerative receiver will work almost as well on a short, low antenna as on a much larger one. In both cases the smaller antenna shows up well on account of having a high efficiency, or ratio of radiation resistance to total resistance.

To carry the thing to purely theoretical extremes, a single electron "tuned" by an imaginary spring to oscillate freely in space at the same frequency as the incoming waves, would absorb and re-radiate as much energy as comes in on a wave front comparable in size with the wavelength of the incoming waves.

What Our Readers Write Us

A New Idea

THE very novelty and originality of the "construction idea" in the letter below should inspire many a reader to go out and put up a new antenna himself.

Editor, Radio Broadcast,
Doubleday, Page & Co.,
Garden City, L. I.

Dear Sir:

In putting up an antenna wire this week, it was necessary to attach one end to the branch of a tree, and it was almost impossible to climb this tree. The way we solved the problem might be of interest to somebody else.

I put a screw in a golf ball, and attached a string to the screw, then tied the other end of the string to my wire and took a mashie and drove the golf ball over the tree. Then, by hauling on the end of the string, the wire was drawn across the branch in the proper position—I think it took three strokes—no doubt one would be par.

Clyde Martin
High Point, N. C.

Radio and the Domestic Life

NO ONE would be bromidic enough to say that radio has contributed much to the stability of the American home. That statement is, however, true. Rightly used, it brings something to every member of the domestic democracy. But radio can be misused, and even before this interesting letter came in, listening-in on the domestic circuits, we had heard scattered reports of "radio divorces," and faint hints of "incompatibility of temperament"—apparently because of differing convictions about radio and how it should be used.

Editor, Radio Broadcast,
Doubleday, Page & Co.,
Garden City, L. I.
Dear Sir:

No one denies the benefits of "radio culture". And since the craze for wireless has spread with even greater speed than an epidemic, and unlike an epidemic, been welcomed with joyful acclamation; high and low, rich and poor have hastened to the nearest carpenter, plumber, and electrician for the makin's.

The mysterious nomenclature of the science has invaded our speech so that we "stand-by," "sign off," "tune-in" or "fade out" without a qualm of a conscience hitherto devoted to pure English.

The most maddening, the most humiliating of all the jargon connected with the use of an active radio set is the warning "sh-ssh" of the interested operator. And so I rise to remark that we are slowly but

★

MAGNAVOX

THE name Magnavox on a Radio Reproducer stands for the most careful workmanship, highest quality of material and also for a fundamental operating principle utterly distinct from that of ordinary "loud speakers."

The base of the new model Magnavox Reproducer R3, showing tone control

Important features now offered in Magnavox Radio—the Reproducer Supreme

THE Magnavox electro-dynamic principle obviates the need of any mechanical adjustment to regulate the air-gap or change the position of moving parts. This famous principle of operation permits the use of an electrical tone control.

This control directly affects the character of the electrical circuit which creates the sound, controlling the sensitivity of the instrument and also its volume of reproduction.

Moreover, this electrical control produces a great saving of current (already reduced in the new R3 and R2 to a maximum of .6 ampere) for, by its action, the current value can be reduced to a minimum of .1 ampere.

The new Magnavox electro-dynamic Radio Reproducers R3 and R2, in fact, are equipped with the first true sound controlling device ever designed. See them at your dealers and write us for catalog.

THE MAGNAVOX COMPANY
OAKLAND, CALIF.
New York Office: 370 Seventh Ave.
Perkins Electric Limited, Toronto, Montreal, Winnipeg, *Canadian Distributors*

4R

surely becoming a nation of the speakers and the speechless. The art of conversation is doomed to desuetude, and our eager college boys will flock to courses in after dinner speaking and announcing, while their sisters assiduously devote themselves to bed-time stories in the hope of sometime broadcasting their melodious tones and attractive personality to the wide world.

There is not an hour in the twenty-four when the average receiving set can not reach out its electrical fingers and clutch a jazz orchestra, a pipe organ, Grand Opera, a talk on How to Cook Fish, or a bed-time story, out of the ether; to say nothing of the tremulo sopranos, soulful contraltos, and jovial basso profundos, wrestling with the "Rosary," "The Road to Mandalay," or "Pale Hands."

Now all of this outside entertainment insinuating its charms into the average family life around the evening lamp has a strong tendency to discourage family discussion, helping Betty with her home work, checking up the grocery account—all of which are necessary to maintain peace and balance in the family life and exchequer.

But when the head of the family is tuning-in and whistles are flying thick and fast, each signalling a station clamoring to be heard, a deathlike silence must prevail in the family circle. To break in on an announcement is a positive crime! And so the prattle of the children is hushed, necessary questions are answered in stealthy whispers, for if we all become too boisterous, father, with a muttered blessing, grabs the head-phones, shuts off the loud speaker and retires into his shell literally speaking. Then mother and the children, properly subdued and shown their place in the scheme of things, wait humbly until the station is successfully captured, when they are allowed to hear the results.

So, instead of discussing the League of Nations, Jim's need for a pair of shoes or a spanking, we all sit speechless while a symphony concert gives place to a market report, and that in turn, to an after-dinner speech from the annual banquet of the Laundrymen's Association—then, a jazz band, with its reiterated tom-tom—one scene from a play now running at the Regent, but not now appearing to arrive anywhere—truly a hodge-podge of information, amusement, and moral suasion. And all punctuated with whistles, groans, static, and fading.

One of the most important of radio developments is the radio widow. When the children are in bed, the local station finished with its program, father goes fishing for those elusive long distance stations, which ought to be heard, but somehow, never are. Wife sits mum, consoling herself with a book, or solitaire, having at least the chill comfort of his physical presence, though his soul go marching on.

Bess B. Harris
Belle Vernon, Penna

Two Good Announcers

THE discussion about announcers and announcing is still going on. Every broadcast listener seems to have his favorite station and favorite announcer. The following letter contains some interesting observations.

Editor, Radio Broadcast,
Doubleday, Page & Co.,
Garden City, L. I.

Dear Sir:

I have a radio log of about 130 stations, some as far distant as 2,500 miles away. The best two announcers I have heard are those at WSB and WOS. Some stations I have listened to played as many as five numbers without an announcement.

And very often when receiving from faint and far-distant stations, the station fades before the announcer gives the call letters, for so many give them so infrequently.

W. R. Mottes,
Coopersburg, Penna.

"Seeing" the Broadcaster

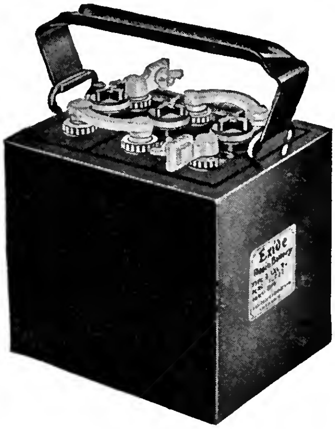
Editor, Radio Broadcast,
Doubleday, Page & Co.,
Garden City, L. I.

Dear Sir:

Here is a suggestion which may interest other broadcast listeners, of whom nearly every one subscribes to one or more radio publications (if he doesn't, he should). The writer has a scrap book with clippings and illustrations of the stations he has heard, which adds at least 50 per cent. to the enjoyment of the reception, as you are literally "seeing the broadcaster" and his station while you are enjoying his program.

Charles C. Drake,
Detroit, Michigan.

A complete revised list of Broadcasting stations in the United States will appear in the May number



"A" Battery for six-volt tubes

When is a battery *cheap?*

A BATTERY that allows your soloist to be accompanied by a noise like a thunderstorm is never a cheap battery; because it's certain that you will be dissatisfied and soon supplant it with a good battery.

Obviously, a battery that does not last long is not a cheap battery.

The battery that is really cheap is the one that gives perfect service and gives it a long time; one that does not have to be recharged too frequently—a silent, long-lasting battery, steady and dependable.

Because they give such good service and such long service, you will find Exide Radio Batteries cheap in the true sense of the word. They may cost you more than some to start with, but long life and freedom from repairs make the last cost low. And the added enjoyment you get from your set, through clarity and lack of needless bother, will be priceless.

In replacing a worn-out battery or when buying a new set, be good to yourself and get an Exide.

Complete line of Exides for radio

There is a complete line of Exide Radio Batteries—batteries that give uniform filament current over a long period of discharge.

Apart from the 12-cell "B" battery there are three "A" batteries for whatever type tube you use. The Exide for 6-volt tubes gives full-powered, ungrudging service. It has extra-heavy plates and requires only occasional recharging. It comes in four sizes, of 25, 50, 100 and 150 ampere hours capacity.

The Exides for low-voltage tubes are midgets in size but giants in power. The 2-volt battery weighs only five pounds, has a single cell, and will heat the filament of WD-11 or other quarter-ampere tube for approximately 96 hours. The 4-volt "A" battery has 2 cells and will light the filament of UV-199 tube for 200 hours.

The dominant battery

On sea and on land the Exide plays an important role in the industrial life of the nation. In marine radio, Exide Batteries provide an indispensable store of emergency current. A majority of all government and commercial radio plants are equipped with Exides.

Exide Radio Batteries are sold by radio dealers and Exide Service Stations everywhere. Ask your dealer for booklets describing in detail the complete line of Exide Radio Batteries. Or write direct to us.

Exide ★

RADIO BATTERIES

THE ELECTRIC STORAGE BATTERY COMPANY, PHILADELPHIA

In Canada, Exide Batteries of Canada, Limited, 133-157 Dufferin Street, Toronto

★ Tested and approved by RADIO BROADCAST ★

The Grid

QUESTIONS AND ANSWERS

The Grid is a Question and Answer Department maintained especially for the radio amateurs. Full answers will be given wherever possible. In answering questions, those of a like nature will be grouped together and answered by one article. Every effort will be made to keep the answers simple and direct, yet fully self-explanatory. Questions should be addressed to Editor, "The Grid," RADIO BROADCAST, Garden City, N. Y.

ABOUT YOUR GRID LETTERS

Judging from the rapidly increasing demands made upon this section, it is performing a valuable service—but it is getting to be a very serious problem.

As a general rule replies to letters addressed to the GRID require the drawing of a diagram or two and a considerable amount of research. Similar service, if purchased elsewhere, would cost a very tidy sum. We are pleased to offer this service to our readers without charge but feel that it is up to our readers to coöperate with us to the extent of sending, with their requests for information, a self-addressed, stamped envelope. Unless our request is complied with the GRID will be unable to consider these inquiries.—THE EDITOR.

REGENERATION AND SQUEALING

My receiver recently developed the unpleasant habit of howling as it went into and out of oscillation. And now, it howls even when a few degrees below the oscillating point. This makes it impossible to secure maximum regeneration on signals. Can you suggest a remedy?

A. T. T., New Bedford, Mass.

THE trouble which our correspondent describes, becoming evident in a receiver which formerly functioned satisfactorily, and on which no changes have been made, is generally due to B battery deterioration—particularly of the cells between the negative terminal and the detector tap. The B battery detector voltage should be readjusted, or, if hopelessly gone, a new battery substituted. This latter course is, perhaps, the better one, for readjustments afford only a temporary relief, and reception, from then until the battery becomes altogether useless in a week or so, is likely to be marred by microphonic scratches and other annoyances.

A similar squealing often accompanies the changing of the circuit or tube. In most cases it can be remedied by readjusting the plate voltage as described, though sometimes it is necessary to vary the grid condenser and leak.

A tube should go into and out of oscillation quietly. There should be no squealing at the critical point, nor should there be a loud "plop" as the tube "spills over." Also, the tube should enter and come out of the oscillating state at practically the same reading on the regeneration control dial.

TUNING THE SINGLE CIRCUIT TUNER

I have a singie circuit tuner, and it has recently been called to my attention that this receiver is the cause of the whistling and squealing that mars the concerts every night. I have been advised to dispose of this set, or make it over into the non-interferring variety for the good of radio. I understand perfectly that this is the right thing to do, but, at present, I am not in the financial position to invest in new apparatus, and I feel that there are many other fans desiring to do the right thing, who are in a position similar to mine.

Is it not possible to tune these single circuit receivers in such a manner that they will cause much less interference than they do at present?

O. A. R., New York City

YES. Much can be done in the way of tuning reform to ameliorate the whistles and squeals that make enjoyable receiving impossible in congested radio districts.

This interference is caused by tuning when the receiver is oscillating. Tuning in this manner simplifies the finding of elusive stations, for the moment the wave of a broadcasting station is crossed the beat-note, or squeal, is heard. Then by a careful juggling of the controls around this whistle, the program of the station can be brought in. However, this system of tuning is a help, only in the angling for distant stations, and local stations can be tuned in more easily when the receiver is not oscillating. Moreover, as it is impossible to receive distant stations on a single circuit receiver, when the local broadcasters are transmitting, there is absolutely no reason for this interference from oscillating receivers, which constantly mars local programs. No operator who permits his single circuit receiver to oscillate during the transmission of local broadcasting gains anything in doing so, in fact he loses, and at the same time ruins the programs for hundreds of others.

In tuning for local stations, first set your regeneration control so that the set will not oscillate over the broadcasting wavelength range. It may be necessary to reduce the detector filament slightly to do this. Now tune for your station with the wavelength control. When you

hear it, bring up regeneration slowly, varying the wavelength control slightly and at the same time to compensate for the detuning caused by regeneration. Bring regeneration up to just below the oscillating point. If it "spills over" little or no harm is done, for the chance is that the local oscillations, so perfectly is the set tuned at this point, will "lock" with the oscillations of the transmitting station, and a zero beat, or no sound, will be the result. Squealing, if any, will be but momentary.

If the air is to be cleared of this squealing, which has become a serious drawback to radio, every owner of a regenerative receiver must coöperate. It does no good to complain of the other fellow. If, for the time being, you must use a single circuit or any type of oscillating receiver, tune it as directed above, and then, as soon as circumstances permit, change to a non-oscillating set.

Use Grid Bias Only When Necessary

After reading the very interesting article by Mr. Rider in the February Radio Broadcast, *I built a bias battery into my two stage amplifier as he directed. Amplification had always been quite satisfactory, but, from reading his article, I hoped that the C battery would improve it. The results, however, have been just the opposite; the signals are now distorted. I have traced the connections, and everything is quite correct, the negative side of the battery running to the grid.*

What is wrong?

A. C. O., Albany, N. Y.

The difficulty in this case is that no C battery was needed. The grids were being operated at their most efficient potential in the original circuit, and, of course, any variation from this normal condition, on either the plus or minus side, would result in distortion.

A C-battery should never be used, except as a corrective measure—when there is something wrong with the amplifier, and then make sure that the difficulty is such that it may be remedied by a C battery. If your amplifier is working well, do not use a bias battery. The chances are that it will distort and weaken signals.

The Knock-Out Reflex on 200 Meters

I built one of your Knock-out reflex sets, and must say that it is all that you claim for it. However, I experience difficulty in getting down to 200 meters. Can you explain this?

A. B., Schenectady, N. Y.

On antennas of the average size (under 120 feet), the experimenter should experience no difficulty in tuning down to 200 meters with the reflex set. However there is little to be gained by doing so, for 200 meters and the immediate neighborhood is the hunting ground of the amateur transmitting stations, which carry on 90 per cent. of their traffic and intercommunication on continuous waves. To receive this, an oscillating receiver is necessary, and the one tube reflex does not oscillate.

If it is desired to use this set for 200 meter reception, on other than phone and damped waves, some form of external oscillator should be employed. The experimenter might build up a small local oscillator such as that described in recent issues of Radio Broadcast for the super-heterodyne. This would use only the two oscillator coils (eliminating the pick-up coil), which should be placed near to the single tube reflex set.

Of course, any oscillating receiver, close to the reflex, may be used for producing the local heterodyning oscillations; but this is rather inefficient, for probably better results would be secured using the oscillating receiver directly for reception.

The Super and the Special Transformer

In the articles on the super-heterodyne receiver which you have recently published by Messrs. Eltz and Haynes, I notice what appears to me to be two rather fundamental differences. I should like your advice concerning them.

Each writer, in addition to the standard transformers in the intermediate frequency amplifier, designates a special transformer which tunes considerably sharper than the conventional amplifying transformers, and which apparently acts as a filter.

Mr. Eltz uses this transformer in the last intermediate stage, while Mr. Haynes uses it in the first intermediate stage. Is there any difference?—and is one system better than the other?

H. M., Detroit, Mich.

The two circuits to which our correspondent refers may be found, that by Mr. Eltz on page 72 of the November Radio Broadcast, and that by Mr. Haynes, on page 212 of the January Radio Broadcast.

As H. M. suggests, these special transformers are often designated as "filter transformers." They are so designed that they tune very sharply, excluding all but a very narrow band of desired frequencies. If placed in the final stage of intermediate frequency amplification, it is supposed to prevent all amplified impulses, excepting the tuned signal, from going through to the detector. In the first stage it permits only the tuned signal to pass on to the amplifier. This latter system, advocated by Mr. Haynes, is the most desirable for the following considerations.

In the first place, there is no sense in amplifying strays or side frequencies that are not going to be detected or used. It is, theoretically, a useless expenditure of energy. In the second place, if these strays are permitted to pass through the amplifier, by the time they reach the filter, or special transformer, they will be so amplified that some of them will force their way through and be detected.

Condenser Plates and Capacities

Some circuits describe condensers by the number of plates, while others designate the capacity in microfarads. It is often difficult for the novice to reconcile these specifications, particularly when it is desired to compare circuits.

Will you please tell me the relation of the number of plates to the capacity of the condenser?

J. A. B., Chicago.

The only correct way of specifying the size condenser to be used in a circuit is by the capacity in microfarads. It is the specific capacity that is desired, and this varies, in the number of plates, for different makes of condensers. Naming the number of plates is only approximate. Very often an inexperienced experimenter will refuse a 23-plate condenser because the builder of a set specified 21 plates, when the capacity in each case was the same, .0005 mfd.

Condensers (variable) are built up in the following popular and standard capacities: .00025 mfd., 0005 mfd., .001 mfd., and .0015 mfd. Condensers with these maximum capacities have, approximately, the following number of plates (in the order given for the above capacities). 11 plates, 23 plates, 43 plates and 65 plates.

Super-service

Wide-awake radio fans prepare for clear reception of all programs by keeping the storage battery full-powered with the Tungar. For super-service the Tungar is used to recharge both radio and auto batteries. The result is longer battery life and more "pep"—plus convenience.

In homes with electricity Tungar recharges the run-down radio or auto battery overnight at a saving.

Sold by Electrical, Auto-accessory and Radio dealers.

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Tungar is one of the many scientific achievements contributed by the G-E Research Laboratories toward the wonderful development of electricity in America.

Tungar Battery Charger operates on Alternating Current. Prices, east of the Rockies (60 cycle Outfits)—2 ampere complete, $18.00; 5 ampere complete, $28.00. Special attachment for charging 12 or 24 cell "B" Storage Battery $3.00. Special attachment for charging 2 or 4 volt "A" Storage Battery $1.25. Both attachments fit either Tungar.

Tungar

REG. U.S. PAT. OFF.

BATTERY CHARGER

Tungar—a registered trade mark—is found only on the genuine. Look for it on the name plate.

Merchandise Department
General Electric Company
Bridgeport, Connecticut

GENERAL ELECTRIC

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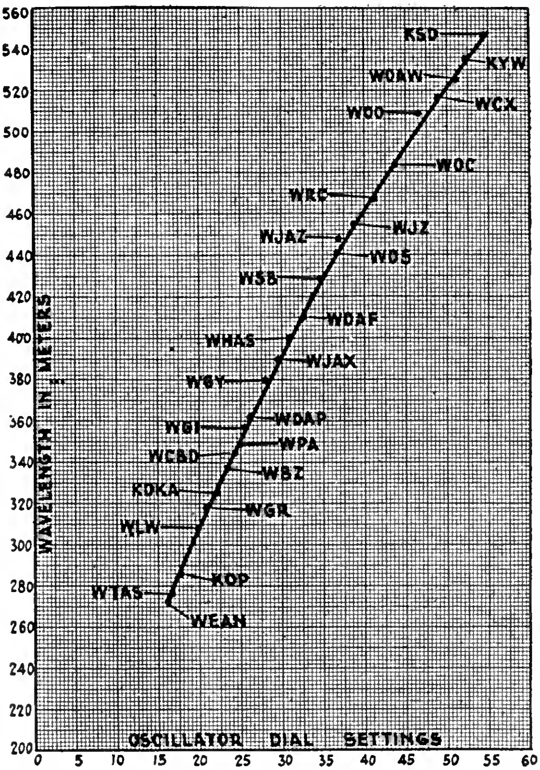


Oscillator Dial Settings for the Haynes Super-Heterodyne

Oscillator Dial Settings on the Haynes "Super"

Can you give me an idea of the approximate oscillator dial settings for various broadcasting stations for the Haynes super-heterodyne as described in January Radio Broadcast?

N. T. M., Marietta, Ohio.

We are glad to print a graph showing actual oscillator dial settings for 26 broadcasters whose wavelength settings are over the complete broadcast wavelength band.

This graph was omitted from Haynes' "Shooting Trouble in the Super" in the March Radio Broadcast.

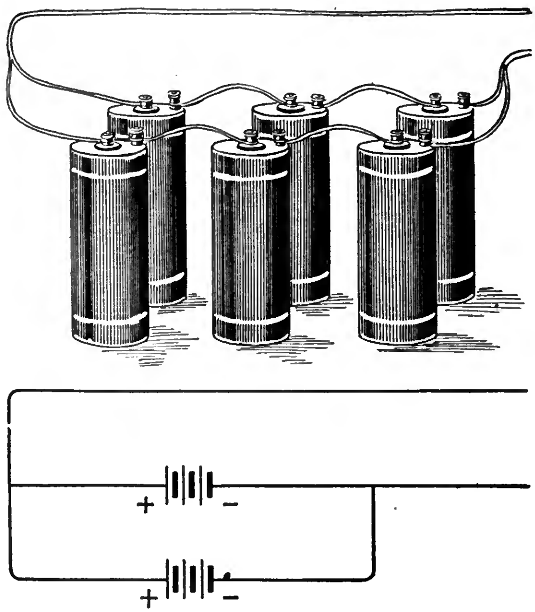
Series Parallel Connection for Dry Cells

Will you please let me know if I can connect six dry cells in the manner which I have shown for use with the UV-199 tube, without blowing out my tubes? It seems to me that six batteries would give six times one and a half volts, or nine volts, which is twice too much for these tubes.

J. G. H., Hershly, Pa.

Yes, the cells may be connected in the manner which you indicate, and no harm whatever will be done to the tubes. This connection is known as "series-parallel." Connecting a series of three cells in parallel with a series of three cells, halves the resistance of the complete battery, making it possible to draw twice the current from it. And, inversely, dividing the current consumed between the two banks of three cells each, this arrangement makes the battery last about twice as long as three cells used alone.

The voltage is equal only to that of a single bank.



Dry cells connected in series parallel

Making Reflex Sets Selective

The "knock-out" 3-tube set I built from the directions published in your February number is working marvels with a single exception. My station is within a short distance of WJAZ and I find it difficult to hear the New York stations when WJAZ is working—in other words, how may I improve my selectivity?

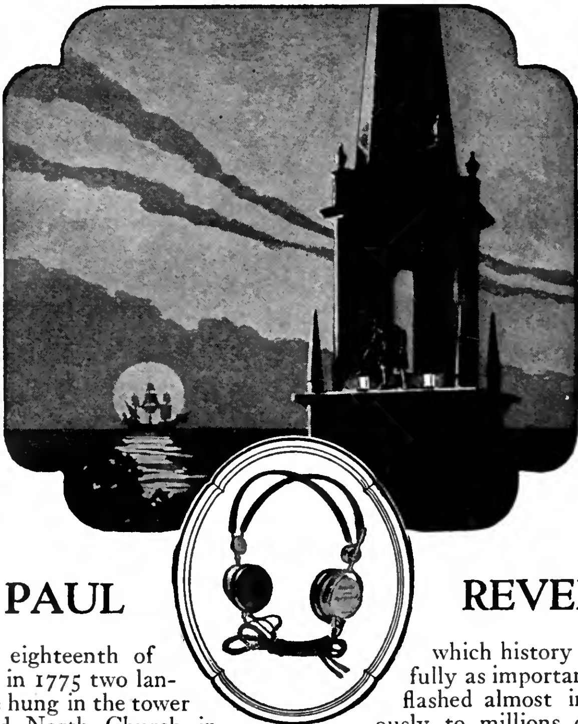
L. J. R., Chicago, Ill.

When interference from a local station is experienced, it is usually advisable to purchase or build a wave trap. A very good one was described in Radio Broadcast for November, 1923.

Another simple and generally effective method of sharpening tuning is the use of a second aerial, commonly called a "counterpoise." A single wire between 50 and 100 feet in length and just high enough above ground to be out of the way and insulated in the same fashion as the regular aerial is used in place of the ordinary ground wire. The counterpoise may be run in any direction and at any angle with relation to the antenna. In apartment houses, the counterpoise may be strung around the picture moulding of one or two rooms. When a counterpoise is used, the ordinary ground connection is not connected to the receiver but the lead from the counterpoise is taken to the ground post and more volume may be had by using a wire about 150 feet long in the main antenna.

DX PRIZE CONTESTANTS

Must have their entry-reports in the mails by midnight, March 23 to qualify according to the terms of the contest, printed on page 420 of* RADIO BROADCAST *for March. No station may be logged more than once



PAUL REVERE

ON the eighteenth of April in 1775 two lanterns were hung in the tower of the Old North Church in Boston signaling to Paul Rever in Charlestown the movement of the hostile troops. Thus began the famous ride which will always live in our history.

Paul Revere's broadcasting, although romantic and spectacular, seems crude to us to-day. The death of a president, an earthquake in far-off Japan, and many other instances which history may deem fully as important are now flashed almost instantaneously to millions of homes.

Only one key is necessary to gain access to this wonderland of Radio. The key is satisfactory receiving apparatus.

HOLTZER-CABOT Headphones and Loud Speakers enable your receiving set to give its utmost in sensitiveness, volume and quality.

The fullest enjoyment of Radio is yours if you own HOLTZER-CABOT equipment.

Holtzer-Cabot Loud Speaker,	**$25.00**
Loud Speaker Phonograph Attachment,	**10.00**
No. 2 Universal Headphones,	**9.50**
No. 4 National Headphones,	**6.00**

Write for booklets explaining how the exclusive features of these instruments enable you to enjoy the wonders of Radio

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Among Our Authors

HUGO A. WEISS, who is responsible for our cover this month, is the artist who originated "Dr. Mu" who "needs no introduction" to readers of radio advertising.

ALFRED M. CADDELL is a writer on radio whose name is not unfamiliar to readers of this magazine. He is pretty certain to be found wherever radio men gather in New York.

WALTER VAN B. ROBERTS is radio researching at the Palmer Physical Laboratories at Princeton University. His remarkable article this month on a "Knock-Out Two-Tube Receiver" is the result of his latest experiments.

A. F. VAN DYCK

ARTHUR F. VAN DYCK after leaving Yale in 1911 as an electrical engineer has followed radio ever since the old United Wireless days when transmitters were "a thing of beauty and a noise forever." He is now a research engineer with the Radio Corporation and says, "I am married and have two children. See my family once in a while, thus upholding the traditions of those engaged in radio work. I expect to live to see radio a household necessity."

E. C. McCAIN

EARL C. McCAIN is a newspaper man in Pueblo, Colorado and writes that nothing can compare with the sport of driving about the foothill ranches of Colorado. "I first camped in the woods when I was fourteen," says he.

J. H. MORECROFT, whose editorial "March of Radio" is a monthly feature of this magazine, is Professor of Electrical Engineering at Columbia University. He has recently been honored by election to the Presidency of the Institute of Radio Engineers.

JENNIE IRENE MIX was the music critic of the *Pittsburgh Post* from 1904 to 1918 and since that time has been a free-lance writer and has traveled extensively in this country covering important musical events. "I am greatly interested in the drama," writes Miss Mix, "—when it is good. I am not a club woman. I could never understand mathematics or politics."

GEORGE J. ELTZ, JR. is a native of New York City and one of the old radio guard. He had one of the first amateur radio sets in the city. He is now manager of the radio sales department for the Manhattan Electrical Supply Company.

HOWARD S. PYLE is one of the radio inspectors at the Detroit office of the Radio Service, Department of Commerce, and much of his time is spent trying to keep things running smoothly with broadcast stations, amateur operators, ship operators and land stations in the 8th District. He has been a ship and naval operator, manufacturer, and engineer.

W. H. CARY, JR.

WILLIAM H. CARY, JR. for many months helped guide the destinies of RADIO BROADCAST and is now traveling in England and on the continent. "Bill" is full of quaint expressions and fairly radiates personality—which is entirely proper for a radio man. He has several more articles in his kit-bag which will appear in succeeding numbers.

INDEX

(*Illustrated Articles. Editorials in Italics)

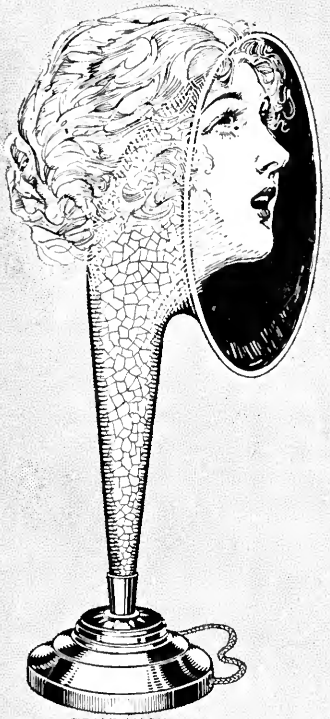
PORTRAITS

(*Portraits in "The March of Radio")

AUTHORS

Atlas

TRADE MARK



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NATURAL

THE Atlas Radio REPRODUCTION of the artist's performance brings the studio into your home.

Write for Booklet "A" Complete **$25**

Atlas Loud Speaker Unit

With phonograph coupling	$13.50
Without phonograph coupling	$12.50

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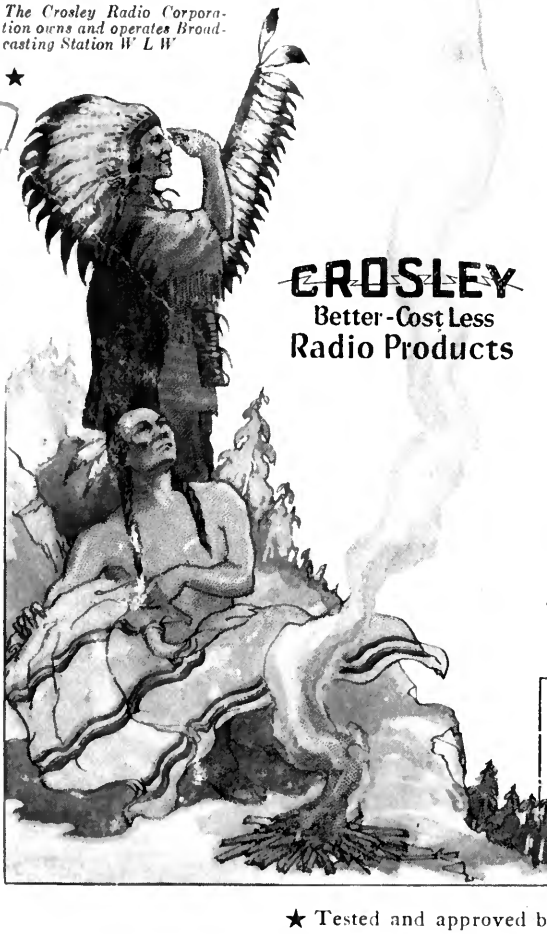
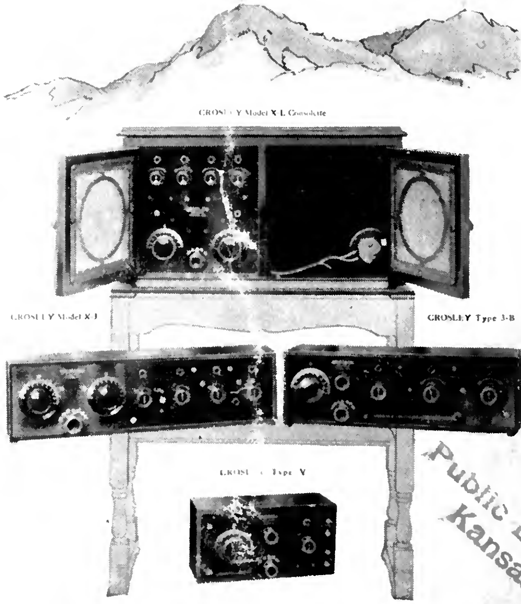
The SIGNAL FIRE *of* TODAY

PIONEERS of the old West were amazed to see how quickly the Indians learned of their presence. The advance of a wagon train was known days ahead. Even a lone trader was known long before he arrived in the Indian camp. Eventually the pioneers learned that the savages had a highly perfected signal code. From mountain top the signal fire blazed its message at night, or by day sent up its smoke in columns, wreaths, puffs—white smoke, black smoke—it carried a story far and wide. Gone are the signal fires. Scattered are the tribes. Today the Westerner in remotest places receives his message by Radio—the Modern Signal Fire.

The Crosley Radio Corporation owns and operates Broadcasting Station W L W

★





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Better-Cost Less
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A one tube regenerative set, licensed under the Armstrong U. S. Patent No. 1 113,149. Actual performances of this little receiver have proven a revelation to the radio world.

CROSLEY TYPE 3-B PRICE $42.00

This 3 tube regenerative receiver licensed under Armstrong U. S. Patent No. 1,113,149 combines the Crosley Type V and the Crosley two stage amplifier. It has consistently out-performed sets costing a great deal more.

CROSLEY MODEL X-J PRICE $55.00

A four tube radio frequency set combining one stage of Tuned Radio Frequency Amplification, a Detector and two stages of Audio Frequency Amplification. At bringing in distant stations we believe no instrument can equal it. Local Interference is easily and quickly tuned out.

CROSLEY MODEL X-L Consolette PRICE $120.00

A duplicate of the Model X-J except for the arrangement and mounting into a beautiful mahogany cabinet with the addition of a built in loud speaker. Space is provided in the cabinet for housing the necessary batteries. A special mahogany stand as illustrated in outline for the Model X-L may be had for $25 extra.

Crosley Instruments Are Sold By Best Dealers Everywhere

Write for Complete Catalogue which fully describes the Crosley line of regenerative and radio frequency receivers and parts.

THE CROSLEY RADIO CORPORATION

POWEL CROSLEY, JR., President

Formerly

The Precision Equipment Company and Crosley Manufacturing Company

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