RADIO BROADCAST

Vol. 4 No. 2 December, 1923

The March of Radio

DID RADIO FAIL AT POINT ARGUELLO?

THE disastrous accident to our destroyer fleet off the Pacific coast at Santa Barbara is apparently to be closely connected with the radio bearings sent out by the compass station at Point Arguello. It seems that there had been another accident in the same vicinity shortly before the destroyers went aground, and that the air was full of radio inquiries regarding the bearings of fog-bound ships. It would appear from the testimony so far elicited that the radio compass bearings given to the destroyer fleet were correct, but did not seem to be to the navigating officer and that he therefore used his own judgment as to when to change the course of the fleet, instead of relying implicitly on the radio bearings.

Perhaps, in the long run, it would be better if this were the true story of the disaster; for if it should prove that the radio compass bearings as given out by the Point Arguello station were incorrect, our faith would be shaken in the reliability of one of the most important contributions of radio to navigation. Ships without number are daily shaping their courses by radio bearings when they approach port in a fog, or when for other reasons the normal aids to navigation seem not sufficient, and it would indeed be serious should it develop that the bearings given by this service should suddenly become unreliable, especially without the suspicion of the operator in charge.

Radio compass stations do not directly give the correct bearings, as is well known; each station, after it is installed, and periodically thereafter, must be calibrated; that is, its errors in the different directions must be measured and kept on record in front of the operator. On getting the ship's apparent bearing, the operator must immediately consult his chart of corrections before sending back to the ship its true bearing.

These corrections to the apparent bearing depend upon the direction of the coast line, presence of inland water, disposition of the transmitting antenna, etc., and may be expected to change whenever any of the large electrical conducting bodies in the vicinity of the radio compass are moved. It appears that some alteration was made in the transmitting station the day the accident occurred, and, while it is not at all likely, it is still possible that the calibration of the station was actually at fault when the destroyers were wrecked. Fortunately it will be easily possible to find this out by measuring the errors of the station with and without the changes in the transmitting antenna, to which some have ascribed the trouble. At all events, the radio compass itself must emerge from the inquiry with its reliability absolutely unquestioned.





BACK FROM FRANCE

Dr. Lee de Forest recently returned to this country with Mrs. de Forest and their young daughter. He is reported to have brought with him some important developments in the field of radio

"Quality First" In Radio Reception

THE fact that many people spend a great deal of time arguing about, and striving after, what they really won't want when they get it, is a generally acknowledged but scarcely appreciated trait of human character. As a matter of fact, what many of us seem to want is determined largely by the practices of the uninspired majority, and by the fear that a departure from the prevailing fashion would leave us uncomfortably spot-lighted before that harsh censor, Public Opinion. The trouble is, that having once expressed not what we think but what has been thought for us, these expressions create habits which are exercised repeatedly in response to certain stimuli from without.

Take this matter of radio receiving, for example. We all know broadcast listeners who will tell us, in answer to our inquiry as to the health of their receiving set, "Oh, it's working fine. With two stages of audio and a loud speaker, you can hear it way out on the street." Then, if they ask us whether our own apparatus can create a disturbance of equal volume, and we mildly reply that we are not out for a long-distance record on sound waves but that we do pull in stations as clear as a bell, so that it's a real treat to sit down and. . . . "Well," they break in, "You'll have to go some to get any more kick out of three tubes than I do. . . ."

"Kick" is the word; but the horseshoe that comes with the hoof is likely to fly off and hit the neighbors.

It may be more frank than wise to state that, of the scores of occasions when we have listened-in at the homes of our acquaintances, on only five or ten per cent. of them have we heard music of an intelligent quantity and intelligible quality—such as to make us glad to listen to it *as music*, not as something *comparatively* good for a radio set. In some cases, to be sure, the receiver or loud speaker is at fault, but often it is not: the owner is merely suffering from a maximum-loudness complex, or else he hasn't had enough practice in clearing up the signals to be expert at it.

We are aware that this departure from the ways of complacent satisfaction may raise a storm of protest among many good citizens. Each indignant one will declare that *his* results are exceptional. Perhaps; but let him secure a real musician, who knows nothing about radio, plant him in front of his loud speaker, and see how long he will be satisfied to listen to the music, as he would for several hours at a time at a concert or an opera. Another test for our above-mentioned indignant one (in case he gets a defective musician): let him go forth unto the music hall and hear a good instrumental or vocal concert; let him shut his eyes and think of the clearness and the quality of the music in comparison with what pours out of his loud speaker at home. His broadcast listener's pride may say, "I get music almost as clearly as that on my own set"; but the still small voice within him is likely to come back, "*Yes*, you do—*not!*"

It seems to us that an injustice is done when sets are "forced" for greater volume than is necessary, or when the operator does not bother to learn a few of the fine (though not difficult) points of good tuning. He is being satisfied with a low standard in a high art; he

is blaming the announcers and artists for the harsh quality of their voices when a slight turn of a rheostat and readjustment of the tuning dials would "clear up the signal" wonderfully. "Why do they let people with such awful voices sing and talk over the radio?" asks the non-radio guest. Sometimes the voices are pretty bad; but often they are made so at the receiving end. Isn't it absurd—and unfair—to distort the music of fine artists?

The tendency toward "quantity first" hits at the whole radio game. If you ask any one not in the radio fraternity why he (or she) doesn't own a radio receiver, he (or she) is likely to assume a "The-very-idea!" expression and reply, "Pay so-and-so dollars to hear what comes out of the funnel down at Rackett's Electrical Store? Not much! If that's radio, . . . etc., etc." And, if we reassure this non-believer that everyone acknowledges Rackett's output to be terrible, and that anyone who had read the article, "Shall We Have Music or Noise?" in the September, 1922, number of RADIO BROADCAST could have nothing but shudders of disgust for such sounds, the come-back may chant this familiar strain:

"Well, I'm going to wait until this radio thing settles down, until they get it so you can turn just one little gadget and be sure of hearing any station you want. . . ."

Some day, surely, this agreeable condition will come to pass. But think of the fun that thousands of watchful waiters are missing in the meantime! Yes, *fun*. Yes, *missing*; because, with a good (not necessarily expensive) outfit, and a little practice in fine tuning, the novice can bring into his home the varied programs of speech and music with a clearness and quality gratifying to even the most finicky. He will then be automatically elected to the S. Q. F. R. R.—the Society for Quality First in Radio Reception—where the privileges of membership are many, and the dues are figured not in dollars, but in sense.



A TREAT FOR FRENCH BROADCAST LISTENERS

Mme. Georgette Leblanc, former wife of the Belgian author, Maurice Maeterlinck, giving a talk on the American moving picture, at station "Radiola" in Paris. Left to right: Jacques Catelain, Mme. Leblanc, Robert Tabius (Secretary-General of the Société Française Radioélectrique), and Marcel L'Herbier, film director of Mme. Leblanc



THE AMERICAN RADIO RELAY LEAGUE BANQUET—
Every radio district in the U. S. was represented. There were delegates from Canada, and one from France. The convention was



—AT THE SECOND NATIONAL CONVENTION, IN CHICAGO

a great success and indicated a very keen interest in the brass-pounding, night-owl type of radio—a veritable tribute to Hamdom. Were you there?

The Coming Super-Heterodyne

MOST experimenters have been much disappointed with the behavior of the super-regenerative sets they have built or heard. They undoubtedly do produce undreamed-of amplification, but they are generally so noisy and the quality is so poor, that no great enthusiasm for them exists to-day. We do not believe this achievement of Armstrong's is in the same class with the two other schemes for which he was responsible—the straight regenerative set and the super-heterodyne.

When once asked by some of his amateur friends how he regarded the relative merits of his two "super" schemes the inventor expressed the idea that the super-heterodyne was the Rolls-Royce receiver, whereas the super-regenerative set might be likened to the flivver—a lot for your money. Now although we might prefer Rolls-Royce cars to the creations of Henry Ford, most of us are probably doomed to fliv through life, if we don't walk. If all of us could become wealthy, or the cost of the best cars could be decreased 90 per cent., then Fords would be in danger of going out of style. It seems that the price of the "Rolls-Royce receiver" is bound to fall. At least two factors are at work to cut down its cost and maintanence, and still another development, mentioned below, will make the super-heterodyne more popular, as this type of receiver will be necessary to get satisfactory results; we refer to short-wave transmission.

The super-heterodyne, it will be remembered, has one high-frequency circuit, tuned to the signal frequency, at the input end. Supplied also to this input circuit is the power from a local oscillator which combined with the signal frequency, gives a beat frequency of about 50,000 cycles. On this 50,000-cycle current is superimposed the voice frequency which was originally on the signal frequency. This 50,000 cycle, voice-modulated current is then sent through about four amplifier tubes, which in the early receivers were resistance coupled,



A SUPER IN AN AUTO

It has been successfully employed by Mr. Tuhill of Garden City, Long Island. The machine is of experimental character, hence the many controls. A super-heterodyne with but two tuning controls was illustrated and described in RADIO BROADCAST last month



HIS INVENTION SENDS SYMBOLS THROUGH THE AIR

C. Francis Jenkins, Washington inventor, has developed apparatus which government experts have declared should revolutionize wire and wireless telegraphy in the Orient. It photographs the original message, transmits it, and reproduces an exact duplicate of it at the receiving end

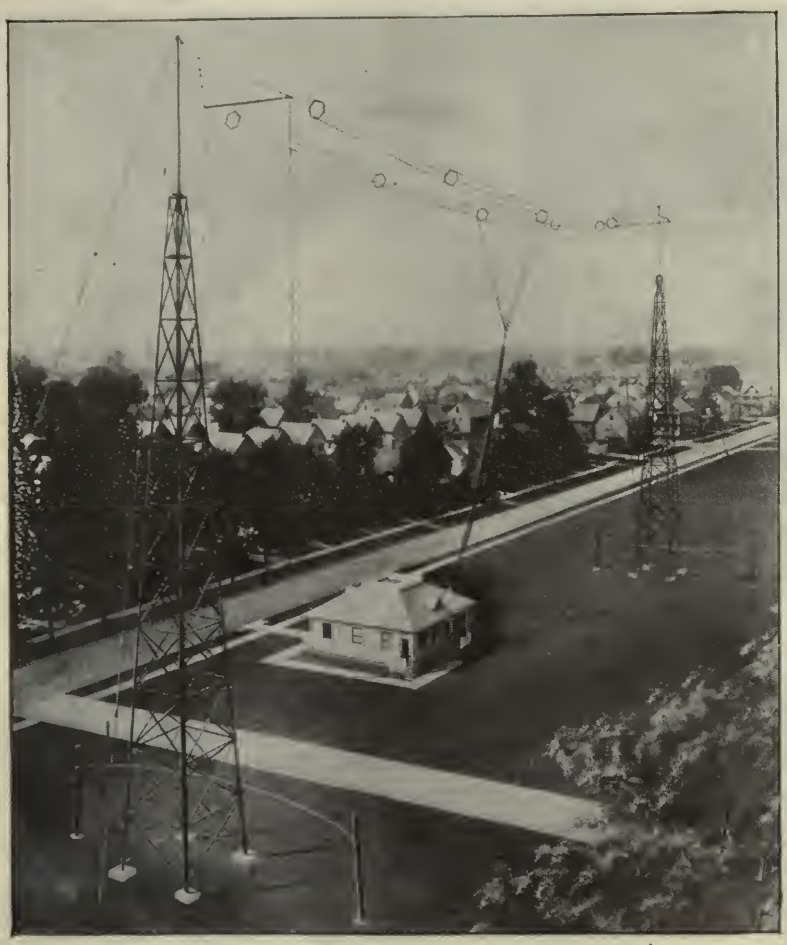
instead of transformer coupled as might be expected. The 50,000 cycle current is then sent into a detector, from which voice-frequency current comes out, to be increased perhaps with one stage of audio-frequency amplification. Evidently the scheme requires quite an outlay of tubes, generally from six to eight.

Now resistance coupling has two drawbacks, as compared to transformer coupling; it does not give much amplification per stage and it amplifies all frequencies very nearly alike. As we gradually learn more about high-frequency currents, we are able to design and build better radio apparatus, and this is true of 50,000 cycle transformers. By using transformers, instead of resistance, for coupling in the intermediate-frequency tubes, we do away with at least one of the required amplifier tubes and possibly two. Moreover, pulses and noises have much of their energy at other than 50,000 cycles, and as the transformer coupling may be quite selective, the amplification with transformers should have less interference than when resistance coupling is used.

Another factor which favors the development of the super-heterodyne is the unipotential cathode tube, mentioned above. The battery expense, which is high for the ordinary "super," is done away with altogether if such alternating current filament tubes are used. And if short-wave transmission comes into more general use, as seems quite likely, then still more does the super-heterodyne take on the appearance of the future universal favorite.

A Storage Battery Broadcasting Station

HOW many new things applied science actually forces us to learn! Developments which, ten years ago, were absorbing the interest and efforts of perhaps a dozen experts or research men, are now the subjects of conversation by the layman, forced on his attention because they continually intrude upon his daily round of work and pleasure. How many people we find to-day who are vitally interested in the proper mixture of air and gasoline vapor to get the maximum



WTAM, RUN FROM STORAGE BATTERIES

This 1,000-watt broadcasting station, built and operated by the Willard Storage Battery Company, has recently opened up in Cleveland, Ohio. It sends on a wavelength of 390 meters

power from the explosion! How many people have had their concepts of the boundary of the earth's atmosphere clarified and put into quite definite form by the newspaper items to the effect that "Macready had reached the ceiling," that the air was so thin and cold at the height of seven miles that a gasoline engine could not properly function! We learn applied science of this sort nowadays without effort; or rather, it is absorbed, not learned.

Not many years ago, the idea that the current which the ordinary continuous-current generator delivers is not exactly uniform, or "smooth," was of interest only to a few telephone experts who were trying to make their long-distance lines more quiet. The very term "commutator hum" meant nothing at all, even to most technically trained men. Yet to-day the twelve-year-old boy, tuning in on some broadcasting station before the program has commenced, announces—"Yep, I've got 'em, 'cause that's their commutator hum."

And his idea is right. As the commutator, with its hundreds of segments, revolves at high speed, a slight disturbance is set up every time a segment breaks its connection with the brush which serves to carry the current to its load—vacuum tubes or what not. In the ordinary generator there are set up each second about one thousand of these disturbances which travel out into the wires connected to the generator; these disturbances communicate themselves to the modulator tubes of the broadcasting set and so the characteristic commutator hum is heard even before the modulator is excited at all by its microphone circuit. Very little experience is necessary to recognize some of the broadcasting stations by the quality of this hum; in fact it is even possible for the engineer familiar with the behavior of electrical machinery to tell by this hum whether or not the operator of the station is giving his generators proper care.

In a well designed modulator circuit this commutator hum is largely suppressed by suitable "filters"—combinations of coils, resistances, and condensers. It is reduced to such a low limit that it is inaudible during the program, except in the pianissimo passages.

A new station has just been granted a license, and put into operation, in the radiation of which the commutator hum will be entirely absent—for the very good reason that there is no commutator in the station. The Willard Storage Battery Company has started broadcasting from its station WTAM, where all power requirements for oscillators, modula-

tors, amplifiers, etc., are furnished by their well known storage batteries. About 1,400 full-size storage cells, all connected in series, are required to give the high voltage power for the plate circuits of the oscillators and modulators, and other batteries are used for the filaments, control circuits, etc. The station is at a good distance from other disturbing factors, such as trolley systems, so that when the microphone of the modulating system is short-circuited the transmission should be completely quiet. The only way to hear the station when its oscillators are putting current into the antenna and the modulators are silent will be to set up oscillations in the receiving circuit so as to get the beat note.

From the description of the station it should prove a real addition to the list of high class broadcasters.

Radio Hazards and Insurance Rates

WE HAVE at hand a very interesting report on the hazards of radio, the report having been compiled by a committee organized for the purpose of investigating them by the National Safety Council, an organization serving the insurance companies of the country.

Considering the great number of receiving sets which have been put into operation during the last year or two, the report says, "the number of accidents has been very small." The principal hazards of radio are then enumerated. It turns out that they have very little to do with radio itself. "Collapse of antenna masts, due to insufficient guying" (the same thing happens to clothes poles), accidents due to "climbing in unfamiliar places" (small boys have always done that before the days of radio), "gasses from storage batteries", and "putting nails instead of fuses in the lighting wires," are among the risks noted. Evidently the use of the modern receiving set does not necessitate any of these risks.

A year or so ago we went on record as saying that the installation of the ordinary small, low, antenna used for receiving would add but little to the risk of fire from lightning, especially if a proper arrester was put in. Such now seems to be the accepted fact, as the report continues:

"Generally speaking, fire insurance companies will not be affected adversely by the installation of radio receiving sets, even with an outdoor antenna. It is suggested, however, that those who wish to make certain of this point, call up their insurance broker, who will either give a verbal consent to the addition or will issue a radio permit endorsement for the fire insurance policy *without extra charges or change of rate.*"

If there is no change of rate in the fire insurance we may rest assured that there is mighty small risk incurred by the installation of our receiving sets!

The Broadcasting of News by the Daily Papers

THE few newspapers which have installed broadcasting stations have not, up to the present time, used them in a way which we believe will become customary a few years hence.

It would be worth while for the wide-awake



A FEW OF THE 1,400 BATTERIES THAT SUPPLY THE JUICE FOR WTAM
Station of the Willard Storage Battery Company in Cleveland, Ohio

program manager to notice how many men, on their way to or from work, read their daily papers; they scan the headlines hurriedly and note whatever topics are interesting to them. They do not then throw away the paper, but keep it for further perusal when more leisure is available, and the items which are then first read are those which were headlined in such a way as to attract attention during the first cursory examination. That is, a man does not use the headlines primarily to get the news from the paper, but to determine what columns are worth reading. The front page is what sells the newspaper, and the headlines are the selling agents.

Now, if this is so, why should not an enterprising newspaper take ten minutes a day in the evening when most people are at home, to put the important news items of the day on the air. They don't because, so the skeptics say, if the people already have the news via radio they won't bother to read a paper. This is certainly not so; if the radio news items are properly worded, they will convey not only news but also the impression that it is well worth while to buy the paper to get the rest of the facts.



This use of radio, putting real news on the air, is as yet practically untouched, although it is probably one of radio's most promising fields. The possibilities of the service were apparent in New York City recently when practically every paper had to suspend publication because of an unexpected strike in the press rooms. Had the radio news service been developed, the principal news items of the day would have been disseminated almost as well as if the pressmen had not walked out. And we are perfectly sure that this radio news service, instead of cutting down the circulation of the newspaper carrying it on, would rather augment it—that is, if the items selected comprised the really worthwhile news of the day, the kind of items used for the headlines of the successful paper.

No Confirmation of Marconi's Sunset Line

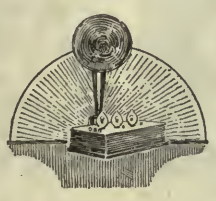
MARCONI'S early attempts to depict signal strength were, of course, very crude and unreliable. The only measuring instrument he had was the ear, and this is probably the most deceptive organ for making measurements that we have. In the laboratory we frequently test students to find out what, if any, conception of signal strength the average man has. It is remarkable how divergent the opinions are. We make a certain signal, of certain strength, and ask the student to record, in his memory, how strong the signal is. Then we increase the signal to perhaps five times its former strength and ask the question —How strong is this signal compared to the previous one? Man has never used his ear to estimate strengths of sounds as he has trained his eye to measure distances, so no wonder the opinions are so divergent. A given class will report strengths ranging from perhaps 25 per cent. stronger to 100 times as loud, for the signal actually five times as loud. It is astonishing how infantile in ability the ear is in this special task, to which it has never been trained.

It is no wonder then that Marconi's results, in which he showed a definite decrease in signal strength whenever the sunset line, or sunrise line, was between the communicating stations, were frequently questioned. During the last year or two, remarkable progress has been made in the technique of testing the strength of radio signals. At the Naval Research Laboratory, Doctor Austin has been making measurements of signal strengths from transatlantic stations over long periods of time, and his results show definitely the great difference between winter and summer transmission of radio waves. When the recent successful attempt was made to telephone across the Atlantic, through the combined facilities of the Radio Corporation and the Western Electric Company, it was at once evident that here was a good opportunity to get much needed information on the variation of signal strength.

With accurate measuring apparatus, signal strength measurements were made every hour over long periods of time. The great difference between day time and night time signals, with which every radio listener is acquainted, was measured day after day. The average of many readings gives a night time signal eighteen times as loud as the day time signal. The loud signals are obtained only when darkness exists over the whole path the waves have to travel; this is a small fraction of the day during the long summer days, as compared with about eight hours of good transmission in the winter months.

The results show a regular decrease in

strength lasting about four hours, the time taken for the sunrise line to sweep across the Atlantic from east to west, and a corresponding rise in strength as the sunset line follows it, about 12 hours later. When the sunset or sunrise lines are between the two stations, however, there is no excessive drop in signal such as Marconi found. The decrease in strength seems to be directly proportional to the amount of daylight between the two stations. Throughout the day the signal strength is very uniform, and low, lower than when the sunset or sunrise line is between the stations. For the wavelengths used in these tests, then, Marconi's two dead periods do not exist. However, this is not conclusive evidence that Marconi was wrong, because these same tests showed no appreciable fading, whereas every one of us is convinced that such a phenomenon does actually occur, and to a marked degree. It will be necessary to get much more data on radio wave transmission before we can begin to formulate the laws in accordance with which our radio signals travel.



British Radio Policy

IT WAS a foregone conclusion that any solution of the radio problem in England must be one which would link together all the high-powered stations, not only in the United Kingdom, but in all the colonies and dominions across the seas. It seemed at first that the Marconi Company and the Government would proceed separately, with possibly also other interests operating in the radio field, but a despatch from our London Consul indicates that private and government interests have been pooled. An agreement has been reached between the Post Office Department and the Marconi Company, and tentatively with the Eastern Telegraph Company, to operate their stations as a single system. This will obviate the necessity of duplication of stations and will unquestionably result in less interference than would otherwise occur. According to an announcement of the Department of Commerce, it is the opinion in England that:

"The agreement reached by the Post Office with the Marconi Company is believed to be unique in the history of telegraph operation. The telegraph services of the empire are to be conducted by the wireless pool, consisting at present of the Marconi Company and the Post Office, although it seems certain that the Eastern Telegraph Company will be taken in at a later date should its plans for stations in India and China meet with success. The wireless stations necessary for the proposed imperial service will be furnished in certain agreed proportions by the two parties to the contract, the company furnishing two stations in the first instance and the Government one. The position of the Government in the communication field is greatly strengthened by the consummation of this agreement and it is probable that the approaching coördination of land telegraph, international radio, and submarine cables will form a world wide system of communications for the British Empire that will result in very effective government control of the whole field."

Where is the Alternating Current Filament Tube?

ABOUT eight years ago, one of the well known writers on radio matters pointed out some of the advantages to be gained by completely changing the design of vacuum tubes. Instead of getting the electrons from a hot filament they were to be obtained from a thimble, which itself was to be heated by a tungsten filament inside the thimble. The detecting efficiency and amplifying power were much better, and other advantages, not so evident at the time, were to be gained by introducing this change in tube construction. Alternating-current power might be used for heating the filament and still the sixty-cycle hum would not be bothersome, as it is to a prohibitive extent with the ordinary form of tube when operated on the ordinary house wiring system.

Of course, it is generally easier to suggest an improved tube and make laboratory models than to get such a tube into successful commercial production; the placing of any device on the market must necessarily lag appreciably behind the first experimental models. In this case it was about six years before the new type of tube could be manufactured in a satisfactory manner, even though a great research laboratory had been working on the task. About a year ago, Doctor Hull, one of the best known research men of the General Electric Company, read an interesting paper before the Institute



A TRULY PORTABLE RECEIVER

Exhibited at the 2nd annual Radio Exposition held in New York in October. This five-tube receiver is an example of excellent wiring and design. It was entered in the amateur contest by Mr. Sidney Kasindorf

of Radio Engineers, telling of his work in this field, which had culminated in the production of a satisfactory alternating-current filament tube, or uni-potential cathode tube, as they were first called. The newly developed thoriated tungsten which his laboratory had developed was just what was needed to build the thimble for this new tube.

The early experimenters had been obliged to use tungsten itself for the thimble, and this construction required such a high temperature for the heating filament that after a few hours' use (sometimes after a few minutes only) the filament was burned out and a new one had to be inserted and the tube re-evacuated. The XL metal (thoriated tungsten) gives off electrons freely at low enough temperatures so that the heating element, the enclosed tungsten filament, need not be operated at such destructive temperatures as was necessary at first.

In Doctor Hull's paper the characteristics of the new tube were unreservedly praised; it seemed to be the most remarkable advance in tube construction since the grid was first introduced by De Forest. As the author of the paper stated at the time—it made at once possible a receiving set which employed no batteries at all: radio-frequency amplifier, detector, and audio-frequency amplifier could all be run from the electric power wires with which practically every house is equipped. The alternating-current power could be used for the plate circuit as well as for the filaments. It seemed that, from the standpoint of its power supply, the perfect receiving set was at hand.

We have waited over a year now for these new uni-potential cathode tubes. Because of patent agreements they can be put out only through the Radio Corporation, so our gentle inquiries are herewith directed to the home of World Wide Radio.

Canadian Trading Post Men and Engineers To Have Their Concerts

THERE are many trading posts in the northern part of Canada which are completely cut off from the rest of humanity during the long Arctic winter. The Hudson Bay Company, it seems, intends to try to reduce the monotony of its factors' lonely existence by installing receiving sets, hoping that radio entertainment will be tuned in from Southern Canada and the United States. Two of the Company's trading ships, we are informed, are carrying Westinghouse receiving sets far above the Arctic Circle, to try out the scheme this winter. If radio broadcasts can be received satisfactorily so far north, probably all the Hudson Bay Company's posts will be fitted with sets for next winter. The ships steaming north have reported so far that New England stations are received very well; but as the ships will soon be ice-bound we shall not hear of the performance of the Arctic sets until they return to civilization next spring.

We learn also that the engineers mapping northwest Canada are now using radio to keep in touch with their bases and for entertainment. These engineers, whose object it is to lessen the number and area of the blank white spaces on the government's maps, have previously been completely out of touch with the world for months at a time. The only news they received was by Indians and trappers who passed the news along by word of mouth. With the modern compact field sets, however,

the engineers keep in touch with home although they are often half a summer's journey away. In these two cases radio is proving a most important and useful contribution of applied science, to those who have needed it badly.

Demonstrating Radio at the Fairs

THE national Chamber of Commerce, of whose activities we have made frequent mention, has recently been urging on the radio manufacturers the great possibilities of the county fair as the medium through which they could get in touch with prospective customers from the farming districts. It is an indisputable fact that the farmers of the country can profitably absorb a great number of radio receivers; and the fairs are the proper place to demonstrate the "profitably" part of the above statement, as one is generally in the mood to be shown when at a fair.

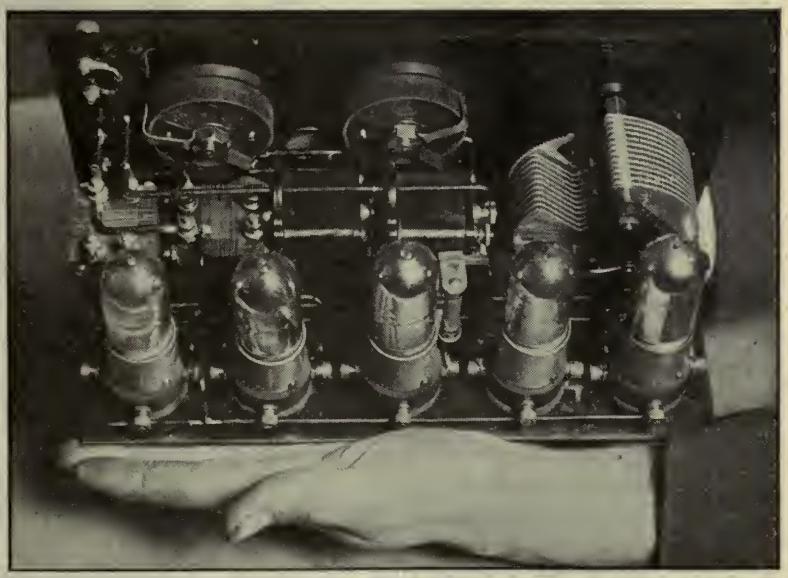
The manufacturer of good radio apparatus can well afford to send their representatives to these fairs to demonstrate the possibilities of radio as a source of useful information. Surely the market reports and weather predictions must be of importance to the farmers of the country, or the Government would not be sending them out.

We hope, however, that the demonstrators do not try to outdo the vendors of tin horns, squawkers, and unlubricated farm machinery, as must have been the case last month with a radio dealer we know quite well. To his summer camp he took his radio and loud speaker, partly for his own amusement and partly to boom business among those who might be summering in his neighborhood. One of our neighbors had a camp close to that of the dealer, and he came back this fall with sentiments that could not be called friendly to radio. When will some of our dealers understand the prospective buyer's reaction to such performances and profit by the knowledge?

More About Short-wave Transmission

THE more we think of short waves for radio transmission, the more the idea appeals. The work of Franklin and Marconi in England, and of the Westinghouse Company and the Bureau of Standards in this country, prove beyond doubt the feasibility of employing a range of frequencies at present used by no one. The amateur is apparently of the opinion that 3,000 kilocycles (100 meters) and higher is not a useful range for him, but actual experiments show this range to be perfectly workable, and it must therefore soon be used by some one or other. The experiments of the Westinghouse Company in using 3,000 kilocycles for re-broadcasting, is, according to report, proving very successful.

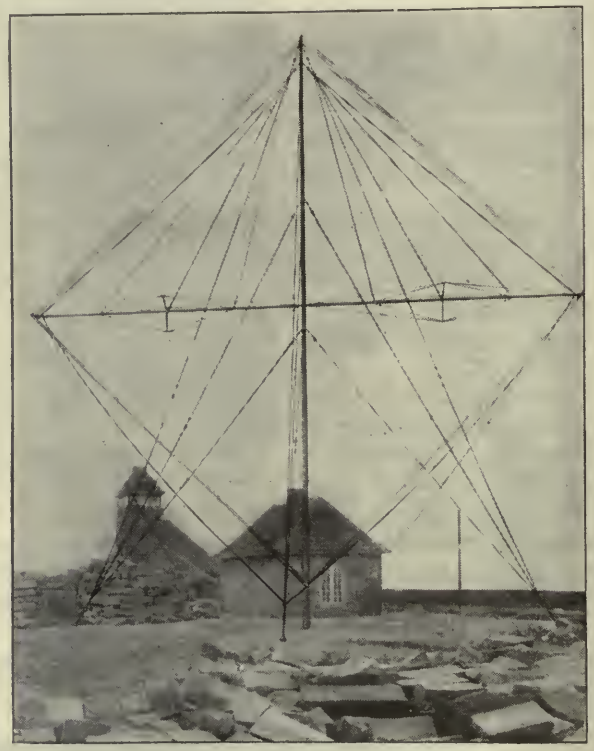
Suppose we grant that for the time being it is not practical to use waves of less than 50 meters, except for rather short distances. The Bureau of Standards has shown this to be far from the truth, but as the range is undoubtedly not large, we will consider only the range between 50 meters and 100 meters, that is a frequency range from 3,000 kc to 6,000 kc. If we allow a frequency band of 20,000 cycles between adjacent channels, this unused high-frequency band will permit the non-interfering operation of 150 channels. *This is six times as many channels as are to-day available for all our broadcasting*, if we allow the same separation of channels. Just think of it, these 150



THE INTERIOR OF MR. KASINDORF'S SET

channels would be so far apart that the beat note between the two stations closest together in the series would be inaudible!

What is the draw-back? Well, it is not possible to send a great deal of power at these high frequencies, but the question at once arises, Is it necessary to send a deal of power? And the answer is: It depends upon the kind of receiving set used. A radio-frequency amplifier for a 6,000 kc current would be difficult, if not impossible to build; but here the super-heterodyne comes to the rescue. It seems that 50 watts, at 50 meters, with a good super-heterodyne receiver, might well be better than 5,000 watts at 500 meters with the ordinary receiver. We think the future of broadcasting will be the brighter in proportion as more work is done toward the development of short-wave transmission.



THE RECEIVING STATION AT BORNHOLM

Employs this monster loop held in place by a tall mast and many guy wires. It is part of a radio link something like the one we have been operating between Catalina Island and the mainland

The Copenhagen-Bornholm Radio Link

FOLLOWING the example of the American Telephone & Telegraph Company in its installation of the radio telephone link to Catalina Island, Denmark has just started to use the radio equipment which puts Copenhagen in touch with Denmark's island, Bornholm, about 100 miles out in the Baltic Sea. The radio link is arranged for two-way communication and is installed in the regular duplex fashion: at each end of the channel is a transmitting station and a few miles away from this is the receiving station.

We are led to believe that Poulsen arcs are used for generating the high-frequency power. If this is so, it would seem that the station is far behind modern practice, for water-cooled triodes are now generally used for installations of this kind. While we have in America several Poulsen arcs operating satisfactorily in transatlantic stations or for spans of a thousands miles or more, an arc would hardly be considered as suitable as a tube outfit for the few kilowatts needed in the Denmark radio link.

It is anticipated that the Copenhagen station will soon be in telephone communication with Berlin, as tests have already indicated that the transmitting apparatus is sufficiently powerful to operate such a channel.

Firpo's Admirers Quickly Hear of His Defeat

THE excitement-loving South Americans who hoped their Pampas bull would bring back to them the world's approbation as its hardest and most accurate hitter naturally wanted to hear of Firpo's progress toward the championship as quickly as possible. The Radio Corporation's channel to Argentine was given the task of carrying the message, and we are informed by the corporation, that a word description of the battle was broadcasted in South America with only fifteen seconds lag. Fifteen seconds after Firpo had Dempsey hanging through the ropes, the fight fans of his native country had the news, and were probably much more excited over it than was Firpo himself.

The natural question which occurs to one is: What were the radio waves doing during that fifteen seconds? Their 6,000 mile journey to the southern hemisphere should take only one thirtieth of a second. And that is all the radio

waves did take. The rest of the time was spent in translating words into telegraphic code and then back into words again. We are not equipped to carry on telephone conversation with South America as yet, but there is a reliable telegraph channel in operation, which was used on this occasion. The description of the fight was sent by telephone to a despatcher in the receiving room of Radio Central; here it was immediately changed to telegraphic code and punched on a tape; the tape was at once put into the automatic key which actuates the huge Alexanderson alternators and so the code was flashed to Argentine. Here the code was changed to words by an operator, who at once sent it out through a local broadcasting station.

Of course that is not quite as satisfactory as if the Buenos Aires friends of Firpo could have heard the punches and the cheers, as we did, but still, to get the news of the fight, 6,000 miles away, only fifteen seconds after the event, shows that we are making progress in communication.

Makers of Neutrodyne Sets Already in a Patent Fight

WE MENTIONED in these columns some time ago the ingenious circuit developed by Professor Hazeltine, employing a principle which had not hitherto been put to practical use in receiving sets. It is not a simple matter to build a good radio-frequency amplifier, and the Hazeltine method for neutralizing the capacity coupling in the tubes permitted increased stability and reliability. The Independent Radio Manufacturers, an organization of the better known radio manufacturers not connected with the Radio Corporation, have been building and marketing these neutrodyne sets and have apparently found a good market for them.

It now appears that the Radio Corporation, through its associated company, the General Electric Company, had in its archives a patent which it believes covers the ideas involved in Hazeltine's patent, and the Corporation naturally started suit to stop the manufacture and sale of the neutrodyne sets.

Although the suit is brought against the F. A. D. Andrea Company, it will be defended by the Independent Manufacturers Association, which has been informed by their eminent counsel, Penny, Davis, Marvin and Edwards that there is a valid defense against the Radio Corporation's suit. We sincerely hope that such is the fact, because it would be extremely unfortunate for the progress of radio if the Radio Corporation should acquire too monopolistic a control over its development. Healthy competition is absolutely necessary if the public is to be properly served in the radio field.

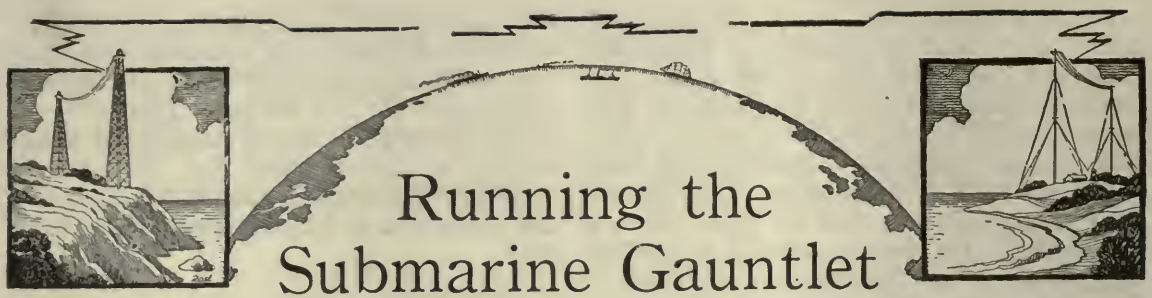
Some Excellent Radio Health Talks

THE American Red Cross goes about its work of human service, and leaves the shouting to others. The organization's Boston Metropolitan Chapter has just published the 38 five- to ten-minute practical talks on health, written by Mr. Henry Copley Greene with the coöperation of many eminent medical men and women of Massachusetts, and broadcasted by Mr. Greene from WGI, the "Amrad" Station at Medford Hillside, Mass. In an introductory note to the book, which is called "Listen In," Dr. Richard C. Cabot, of the Harvard Medical School, says:

> The outstanding merit of Mr. Greene's book is that it is never dull, yet never sensational. Most health books are very unhealthy and very dull. They paint countless "dangers" which the average man runs with impunity every day, because they are not dangerous. . . . But this book is interesting, and so far as I know, most of it is true. If you begin it, you will probably read it through, and remember much of it. There are extraordinarily few exploded theories in it; and there is a great deal of sensible advice—even exhilarating advice here and there. This. . . . is a remarkable achievement.

Among the topics which were broadcasted are: "When to Call the Doctor," "A Fair Chance for Mothers and Babies," "Keep a Good Heart," "Fresh Air and How to Get it," "That Tired Feeling," "Medical Bunk," "Steer Clear of Tuberculosis," and "Cleanliness." Although these talks have been heard by WGI's large audience, they deserve to be known more widely. We are glad to express our own appreciation of this fine service of the Red Cross, and to announce that those who wish copies of "Listen In" can obtain them at twenty-five cents each, post paid, from the Department of Health Service, American Red Cross, 73 Newbury St., Boston 17, Mass.

J. H. M.



Running the Submarine Gauntlet With a Cargo of "Gas"

The War-time Experiences of a Radio Operator on the Ill-fated Tanker, *Joseph Cudahy*. Incidents, Humorous and Otherwise, Touching on German Tactics, Getting Out an SOS Under Difficulties, and Three Days in an Open Boat

By HAYDN P. ROBERTS, EX.–U. S. N.

BOOM Z-Z-Z-Z-Z-Z-Z—— POP! SUBMARINE! GENERAL QUARTERS!"

The ship seemed to become suddenly alive. Bells clanged, orders were shouted, and the gunner's mates rushed from all directions to the guns. To those of the crew who had been to sea before, the clanging of the warning bell generally meant that "Some fool had sighted a floating spar or the like," but the sound of a gun added a touch of reality that made even the "old boys" stop and take a look.



As I was not on duty in the radio room, I had been basking in the sun on deck with the ship's doctor, playing jazz records on a small but seaworthy phonograph.

About a quarter of a mile ahead of us was a Greek ship which had lost the convoy on account of her inferior speed, and although she was faster than we, decided to keep us company on the trip over, for she liked the looks of our "3-inchers," in comparison with her "1-pounders" (known to the gobs as "Pea-Shooters"). We called her the "Wop" and it was from the "Wop" that the "BOOM! Z-Z-Z-Z-Z-Z-Z—— POP!" came.

At first we thought it was target practice, but when we saw her stacks begin to belch black smoke and saw her change her course ninety degrees and make off at top speed (nine knots per), we realized that she had seen something. Our guns were by this time all manned, but we had not sighted anything to shoot at.

"BOOM! Z-Z-Z-Z-Z-Z-Z—— POP!" Again the "Wop's" pea-shooter flung its charge of shrapnel, which even if it had reached its mark, would have been as dangerous as raindrops on a window-pane. This time the aim was good, and after the shell had exploded and the black smoke had lifted, we were able to sight an enemy sub's periscope, which rapidly rose above the surface, the gunners getting into action while the decks were still awash. The "Wop" left us to do the fighting and seemed in a hurry as she steamed away from the scene. By this time the sub had sighted us, and since we looked like bigger game, opened fire. My curiosity kept me out on deck until two shots had been fired. Then, upon the arrival of a messenger from the Captain with orders for a distress signal, I went into the wireless coop and relieved the operator on duty.

My dreams were at last realized: I was actually in charge of the radio on a steamer while in action with the enemy. I had for eight years been hitting a radio key, waiting for this chance. It was much more interesting than merely being shipwrecked or disabled.

We were about 350 miles southeast of Newfoundland, and carried a cargo of 96-test gasoline destined for aeroplanes in France. Three and a half million gallons of it, and a quarter-kilowatt radio set to try to call for help with. It was not especially comforting to think that if a single German shell found its mark we would stir up quite a little commotion for Father Neptune.



THE SEAWORTHY PHONOGRAPH FURNISHING JAZZ
From a photo taken at Hoboken, N. J. just before "Smoky Joe" sailed on her last voyage

Closed up in a four-by-six radio shack, sending SOS as fast as my "fist" would permit, and ducking every time I heard a shot, was the way I spent the next five minutes. One radio man had thoughtfully brought me a life-preserver, but I hastily told him that in this case a life-preserver to be of real use would have to be a balloon. No radio man was ever so exasperated as I was at that time, when the signals from St. Johns, Newfoundland, came roaring into my phones and the land station could not hear even a squeak from our little quarter-kilowatt. However, in the midst of all this, I noticed that the shelling had ceased. This did not comfort me, for on a previous occasion a sub had quit shelling in order to get into position for torpedoing. I had made up my mind that this was the case, and was awaiting the crash which would mean that a torpedo had found its mark, when one of the gunners joyously informed me that we had hit the sub on the ninth shot and had either disabled or destroyed her, for she had submerged following an exploding shell. This was almost too good to believe, but the fact remains that we saw no more of Heinie and whether the sub sank or just submerged worried us very little.

After a few remarks on what *might* have happened, the crew returned to their duties, or to their card games or phonograph, and thus ended the first chapter of our trip.

We had left Hoboken, New Jersey, four hours after the convoy, having been delayed in getting water, and when clear of the harbor all that we saw of our convoy was some smoke on the horizon. In fact, this was all we ever saw of it, for it was a 9½-knotter, and we—the U.S.A.C.T. *Joseph Cudahy*, otherwise known as "The Pride of the Atlantic" and also as "Smoky Joe"—could make eight whole knots when we hung weights on the safety valve and all the firemen worked overtime. We were bound for La Pallice, France, with a cargo worth three times as much as the ship in figures and twenty times as much as the ship in our opinion. She was a typical old "tanker," with a flat bottom and no bilge keels. When she hit a sea, she sailed farther sideways than forward. She carried a tall, lanky, ugly smokestack far aft, and her lines were far from beautiful. She was manned by forty-four civilians and twenty-two navy men (including gun crew and radio crew). It was a rare and motley bunch: there were hoboes, land-lubbers, old sailors, new sailors ("hard-boiled" and "soft-cracked"), doctors, lawyers, editors, and college graduates. They were out for an experience. Believe me, they got it.

The different types of men on board presented a wonderful opportunity for the study of human nature, and it was interesting to note how each man acted while under fire for the first time. There was, for instance, Clark, known as "Sparks" one of the radio operators, a typical cowpuncher from Arizona. At the first warning of danger his face gleamed with a smile from ear to ear, and he came prancing down the deck hollering, "Gee Chief, ain't this great!" Then there was the assistant engineer, who always delighted in telling us of his little farm and family and how this would be his last trip across, whose dream of coming home again seemed to have been shattered when the general alarm signal sounded. His expression became tense, and with a ghostly look he watched everything that happened with concern.

There was the Captain, a big, burly Dane, who had weathered the fiercest storms and had been to sea all his life. There was the Chief

Gunner's Mate, who immediately took upon himself the full responsibility of "getting" the sub, calmly directing the action of the navy gun crew as though it were target practice.

There were the seamen, a crew of hardened men used to all sorts of dangers, watching everything that took place with intense interest. The most interesting of these, however, were the gunners' mates on the gun platform, pushing shells into the guns as quickly as possible, getting the range, and firing with a determination—"One, two, check, fire," etc., until they finally reached their mark on the ninth shot. Then there were a number of others who ran about the deck wrapped in life preservers, ready for the call to the life boats and in everyone's way.

Soon rumors of trickery on the part of the submarine captain started about the ship, to the effect that the sub had submerged only to follow us and get us in the dark. Although none of the gun crew would believe such a thing possible, a sharp lookout was kept aft until dusk that evening, and the glasses were turned upon any conceivable object until it had faded out of sight. However, the night passed quietly, and dawn the next morning found us steaming ahead at our eight knots per, on our way to France.



As the days passed, the signals from American stations became weaker, and many died out altogether, until only the old faithful government station at Arlington, Va. (NAA) could be heard. We then began to pick up weak signals from European stations, and succeeded in getting our weather reports and time signals from Eiffel Tower, France, before we lost Arlington's signals, thus having continuous weather and time service all the way across. As soon as signals from Spain, France, and the Azores began to come in, we got dozens of submarine warnings. We nailed up on the radio room wall a large map of the Bay of Biscay, and began to put crosses on all positions where submarines or mines were reported. The map soon was a mass of crosses. The Captain at first tried to take a course which would avoid these points of danger, but they came in so thick and fast that he was unable to do so. After dotting up his map all over the Bay of Biscay, he decided to head straight for our destination, for one course looked just as safe or just as dangerous as another.



As we approached the coast of Spain we had our next bit of excitement. One night, about midnight, the general alarm signal sounded, and everyone was up and out on deck immediately. Dead ahead of our ship was sighted a large steam schooner, directly in our path. We instantly changed our course to avoid a collision, and at the same time, smoke belched out of her stacks, and she started to steam away at top speed. It was evident that she had not been in motion until she had sighted us. She had stayed in her position for a few moments before moving, to hide a submarine which was trying to submerge quickly under cover of the large ship. Our guns were immediately trained on the submarine before she had completely submerged, however, and we covered her without the least trouble, being probably not more than two hundred yards from her.

In maneuvering to avoid a collision she had to expose the submarine before it had actually submerged. The gunners' fingers were itching to fire, for they could have destroyed the sub with one shot, but the innocent-looking "sail-" boat without doubt had large guns concealed and could have put us under without the least effort. For this reason, the Chief Gunner's Mate told the gunners not to fire as long as we were not fired upon. The commander of that large mysterious ship must have had the same line of reasoning that we did. He was satisfied to let us alone as long as we let her alone. We thought that just as soon as the sub had fully submerged we might be followed and destroyed, but the enemy undoubtedly knew that at her first shot our wireless would have shrieked out a call for help, and three or four speedy destroyers would be on their way to comb the bay for this raider. However, we kept a double lookout the rest of the night, and very few of us got any more sleep.

The next morning we received a radiogram from a Portuguese station, which warned us

that there were two subs operating in our vicinity, and that we were also approaching the dreaded mine fields north of Spain. We had been "zig-zagging" now for two days and nights, for we were in the "war zone" which Germany had marked off as forbidden territory for neutral ships. Our chart of sub and mine warnings was pretty well covered up. I regret that I was not able to save it and reproduce it here. We were now going through a most hazardous part of our journey, with the chances of encountering both mines and subs. A mine is the worst engine of destruction, so we tried to keep as far as possible out of this district even to the extent of taking more chances with the subs. A mine gives you no warning, no opportunity to fight or maneuver; it's just there, and when you hit it, goodbye. For two solid days and nights six men kept their eyes glued to the water in front of them, reporting every conceivable object. The shining glare of the water made many of them sick with headaches. The ship would be instantly turned out of her course for a log or stick or any floating object whatsoever. The crew whose quarters were to the extreme forward part of the ship slept on cots back in the fantail these nights, although even this would have been little protection to them had we hit a mine with the cargo we carried.

We were greatly relieved when we had passed the north coast of Spain and were practically out of the mine territory. We were now approaching La Pallice, France. The day before we sighted the French shore there came another sub warning which showed us that a sub was operating right at the mouth of this harbor, but this didn't worry us much, for we felt sure that by the time we reached that point we would have some form of protection, such as a destroyer or patrol boat. We finally sighted shore about nine in the morning, but as yet had seen no signs of a patrol. A message was sent to the commander of the port, asking that a pilot be sent to meet us immediately. The message was received and acknowledged by the station at Nantes, and we steamed along at half speed for hours waiting for a pilot, right in the location which was reported to us as being dangerous. In addition we flew our pilot signals at the mast-head. Soon we sighted an observation balloon, which surely must have sighted us and reported, but still we saw no escort. The balloon was equipped with radio, and we expected that we would now get our pilot. Three hours later the Captain decided not to stop the ship in dangerous waters, and proceeded to find the harbor with the aid of his chart. We took frequent soundings, but knew nothing about the channels. At any rate, it was comforting to know that if anything did happen now we could easily swim ashore. Sighting a row of piers ahead, we picked out a likely looking one and started for it. In the distance were two American and French destroyers at anchor and numerous other ships. While proceeding slowly, we finally saw a tiny French patrol boat approaching us at full speed. The commander was standing out on the forward deck waving his arms frantically and hollering something unintelligible at us. I finally heard him cry in his best English, "Stop, stop, stop!" I reported this to the Captain on the bridge, and we reversed our engines probably just in time to prevent our running right into a mined net, and possibly being blown up by a mine of one of our allies.



A FEW ROUNDS FOR EXERCISE
This gives some idea of the *Joseph Cudahy's* handsome appearance

It all happened so quickly that none of us

realized how close we came to being destroyed. The little Frenchman finally guided us around the nets and inside the safety zone. His boat then came alongside and we had quite a chat with the crew, for our ship's doctor was an able student of French. We found that the latest news at that time was that the Americans were rapidly advancing their battle line toward Berlin. We rested uneasily that night for none of us could get ashore, and in the morning we found that we would have to wait two weeks to get a chance to unload, so we were given orders to proceed to Pauillac, a little town on the Gironde River about thirty miles from Bordeaux.

We weighed anchor, and steamed out of the harbor and down along the coast toward Bordeaux. The scenery along the French coast was wonderful, for it was in the month of July, and we all enjoyed sailing within sight of land. When we arrived at the mouth of the Gironde River we were met by a pilot, who told us that twelve hours previous to our arrival a transport had been torpedoed right off the mouth of this river, and many soldiers had perished. Our pilot guided us up the river to a little hamlet about three miles beyond Pauillac, where there were about a dozen houses and a large tank, where we were to unload our gasoline. We dropped anchor, and within twenty minutes practically the entire naval crew were ashore.

It is with difficulty that I omit a description of many interesting experiences on shore. But there were some lively times in store for us on the high seas, and these are what I am getting at.

SURVIVORS OF JOSEPH CUDAHY REACH AMERICA

British And Greek Steamers Land 38 Members Of Crew At Atlantic Port

VESSEL TORPEDOED WITHOUT WARNING

Sixty-two Persons On Steamer Shee Unaccounted For —Second Steward Lost

An Atlantic Port, Aug. 31.—A British steamer arrived here today bringing fifteen men, said to be survivors of the American steamer Joseph Cudahy, sunk by a submarine August 17, seven hundred miles off the British coast. The men report a Greek steamer also picked up other members of their crew and they also were brought here today. Authorities here decline to deny or affirm that the men are from the Cudahy. The number of men picked up by the Greek ship could not be ascertained.

The men brought here said their ship was torpedoed without warning. Two torpedoes were fired, the first putting the wireless outfit out of order and making it impossible to send out an SOS call.

Captain Questioned

The steamer listed heavily and filled rapidly. The crew were ordered to the boats. As the men pulled away the submarine rose to the surface and [illegible] steamer.

WHAT THE PUBLIC KNEW OF IT

A clipping from a New York daily paper of August 31, 1918

I was anxious to receive our sailing orders, for our set had been sealed by the French authorities when entering the river. It was amusing to notice how they sealed our apparatus. The antenna switch was sealed half way between the sending and receiving positions, and if we had desired it would have been an easy matter to run two wires across the switch!

Off to the starboard we could see through the glasses a large amusement resort with many bathers in the water, but as we were at anchor and also "broke" we were anxious to get started for home. Finally one morning, six destroyers, two airplanes, a blimp, and a few "skeeter" chasers arrived, and we set off in a convoy of about thirty ships. We had hardly got started when submarine warnings began to come in again thick and fast. Being the slowest ship in the convoy, we soon took our place at the rear—where the subs could get an easier shot at us. Once in a while one of the destroyers would come back and give us the once-over, wondering whether or not we were moving. So did we, but the indicator showed "Full Speed Ahead."

Just before the airplanes left us they dived back and forth between our masts, or as near as the radio antenna would permit them. This was their playful way of saying, "Good-bye, you poor nuts, why don't you get a safe job like ours?" The destroyers, with their speedy lines and low rakish appearance, seemed impatient to slip away, and at dusk the "skeeters" turned, one by one, and headed back to France, after tooting a good-bye. That evening I received war news from Nantes, Lyons, and Eiffel Tower, and was glad to report to the

Captain and crew that our battle line had materially advanced since the last news. The crew were interested in these reports to the extent that they kept in touch with our progress with a large map, running a red cord through a series of pins, showing the battle line, and every morning they would gather around outside the radio room, and we would move that red line a little closer to Berlin.



THE NAVY GUN-CREW AND OTHERS
They sank the first German sub encountered; the third sank them (but they were finally rescued)

The following day we received a distress call from two United Fruit boats which were torpedoed within a few hundred yards of each other. They were about sixty miles dead ahead of us, directly on our course, and sailing east. They alternated, sending first in English and then in French. We watched to see what our destroyers would do. Soon a message was sent from the flagship in code, and three destroyers slipped away and over the horizon ahead of us at express-train speed. Eight hours later we passed the two ships at a distance of not more than two hundred yards. They had been torpedoed within a couple of minutes of each other, which must have been fast work for one submarine. They both were listing heavily to the port side. The lifeboats were all in the water, but most of the crew had already been picked up by the destroyers. There was at least one submarine in the vicinity and the destroyers were making things hot for it by dropping depth bombs all around.

The next day we heard, in wireless spurts, a thrilling and rather sickening tale. The signals were very weak—just readable. The first report told of sighting a submarine, and a little later an SOS told us that the ship was shelled. The screeching spark would stop, and then start, and each time the signals were heard there came another chapter of the episode. Then we got the report that the sub had found its mark, and the shells were taking effect. The next two reports I remember well. They were, "Sub gaining on us ship now afire have been hit returning the fire SOS SOS SOS." Then the position was given. I could picture vividly the whole battle in my mind: the ship, with stern ablaze, surpassed in speed and guns by the enemy, desperately firing her stern gun, while some of the crew worked feverishly to extinguish the blaze. I could picture that radio operator, in a two-by-four room, calling for help, and reporting the progress of the battle, not knowing at what minute he might be blown into "kingdom come." After six minutes' silence we heard the next report, "Sub submerging for torpedo attack." Then I could imagine the battle of wits, with the zigzagging to the limit and the submarine running submerged at a greater speed under water, with no opportunity for destruction by shell fire. For the next ten minutes I know I was just as concerned as the radio man on that ship. I strained to get the next radiogram. It came all too soon. "SOS SOS SOS torpille, torpille, torpedoed," then giving the position. One of our destroyers sent the SOS broadcast, but did not leave us; and I have never been able to learn whether that unfortunate crew were ever saved or not, for after this message all I heard was a few struggling signals from the ship's auxiliary set which soon died out.

From then until late in the night submarine warnings came in thick and fast. About nine o'clock in the evening several code messages were exchanged between the destroyers which then turned and left us to our fate. It seemed like a great lack of judgment to me to leave us so soon, for we were positive of two, if not more, submarines within a radius of not more than a hundred miles. After testing the generator and spark, as well as the receiving apparatus, I decided to get some sleep, and called my relief at about 1 A.M.

The next thing I remember after "hitting the hay" was lying on the deck in my room in a half stupor, and stunned.

I pulled on a pair of trousers and a shirt and ran out on deck and into the radio room. The ship had almost immediately listed heavily to starboard, and the engines had stopped. We still had juice, however, and I quickly relieved the operator on duty, who had been knocked almost senseless. The radio room was a wreck. Condenser jars were broken, the receiving set had been ripped completely from its moorings, and all the connections had been broken off. The motor generator was the only thing that held its position, but its connections were broken. A pipe from the steam heating equipment had broken in the room, and the radio apparatus was hardly visible on account of the steam.

"Sparks," the cow-punching radio man, arrived at this time and was intensely interested and pleased by the excitement. He said, "Well, Chief, this looks like the real thing!" To which I replied, "It sure does; let's get this thing working again." I replaced the broken apparatus with spare parts, and got the connections all in place once more. On pressing the key, I was pleasantly surprised at hearing a weak spark in the transmitter. "Sparks" then informed me that the antenna was lying on the steel deck, the forward mast having been broken in the middle by the force of the explosion, and carrying the antenna down, spread the wires in a hopeless mess all over the deck. I remember how glad I felt that I did not give a radio inspector in Bordeaux a spare coil of antenna wire which he tried so hard to acquire while we were in France. "Sparks" and the other radio man got out this coil and proceeded to put up an emergency one-wire antenna from the stub of the broken mast to the pilot house. One man climbed the forward mast and started fastening the wire through an insulator to the mast. The other man went to climb the midship mast, to make another connection. We had worked feverishly to repair the apparatus and to get our distress call off, and had not noticed until that time that the lifeboats had all been lowered and there was only one man aboard the ship besides ourselves that we could see.



Just then I noticed old "Pegleg," the ship's steward, a man of about fifty-five years, with a withered left leg, crawling along the deck on all fours. He had been in his room below, and probably had been injured by the torpedo. He crawled to the ship's rail and slid over. I presumed that he had jumped into the water, where the lifeboats were, but later when we took a count of the men in the boats old "Pegleg" was missing, and no one saw him after he had jumped into the water. The other man we saw on deck was running around, looking for a good place to jump to the boats. We had little time to look after his welfare, however, and went on with our work. We knew that the sub would soon appear and probably shell the ship, for she was not sinking fast.

I returned to the radio room, made the antenna connection, and began walking backward unrolling the coil of wire, and was approaching the midship mast where I was going to make the final connection when another crash occurred, blowing the stern of the ship to bits. It was a second torpedo, and hit its mark in the place it was meant for—the engine room, directly below the radio room, and also broke the bulkhead into the oil tank. For about half a minute we had a steady shower of thick heavy brown fuel oil over everything and everybody. One lifeboat had been lowered on the port side, and had not yet reached the water. It was a remarkable escape for those in it, for the torpedo passed probably not more than ten or fifteen feet directly under them, and into the ship. This lifeboat was swamped by the oil, which filled it completely, but it did not sink, and the men worked fast, and were able to bail out enough of the oil to keep her afloat. Just a few seconds before the torpedo hit, I was standing, or rather walking, directly over the spot on the deck where an eight-foot hole was blown through by the force of the explosion, but I was twenty or thirty feet from this point when it actually occurred, and was knocked down on the deck, while pieces of flying metal landed all around.

The radio man who was up the forward mast was knocked practically unconscious by the explosion, and was only saved from falling to the steel deck below by the shrouds, in which he became entangled. In less than two minutes the whole aft end of the ship had sunk, and only the empty tanks forward kept the ship from going under altogether. All the lifeboats by this time were clear of the ship. The

only thing left on the deck was a life raft, but we remembered that we had tried to float the raft for swimming purposes when in the Gironde River, and it would have been down at the bottom of that river now if it hadn't been tied to the ship with a rope that held it from sinking. The electric light in the radio room had gone out, and we knew that the generators were under water and out of commission. There was nothing left that we could do, since there was no auxiliary set, and besides, at that time, the submarine came to the surface some distance away, and began training her guns on the ship, so we slid over the side and swam to the nearest lifeboat, which was not far off, on account of having been swamped when leaving.

The sub began to pour a rain of shells into the forward part of the sinking ship, some of them coming uncomfortably close to the life boats. They didn't seem to care whether they hit us or not, but since they hit the ship every shot, after getting the range, we concluded that they were not trying to fire at the boats. After putting about twenty-five shells into the ship, the ship rose high in the air forward, as if in protest at the kind of treatment she was getting, and then slid down stern first under the water. "Smoky Joe, the Pride of the Atlantic," was no more.

I sat in the lifeboat and listened to the peculiar sound effects as the ship was being shelled. The first warning of the sub's firing was the flash at the mouth of the gun; then the black puff of smoke; then the metallic sound as the shell struck the ship; then the explosion of the shell, and after all this we then heard the dull boom of the sub's gun, which did not reach us until after the shell had exploded. It was quite an interesting study of the time it takes sound to travel.

It was not until the ship had completely disappeared below the water that the sub approached the lifeboats, for she did not trust the forward gun which was sticking up in the bow until the last minute, and was taking no chances on there being a man hidden aboard to operate it, should she come close enough to make a good target. Very cautiously the sub commander manoeuvered around us with his gun trained on us all the time. Standing in the conning tower, he watched every move we made through glasses, and finally headed straight for us. There was much excitement in the lifeboats, for we thought the undersea boat would ram us. There was other talk about taking us prisoners, and some talk of shelling us. However, just as it got within about ten yards of us it swerved around broadside alongside the Captain's boat, after passing a few yards from our boat. How he knew which boat the Captain was in was a mystery to me, for none of us had our uniforms on. After tying the Captain's boat alongside, the Hun commander began to question him in the best of English. There was hardly a bit of German accent in his voice, and he talked as though he had spent some part of his life in an English-speaking country. His voice was gruff and authoritative. His questions as near as I can remember them were as follows:



"Where is your captain?"

Capt. (After some deliberation): "Here."

"Where is your chief gunner?"

One of the crew: "Killed by the torpedo."

(At that time the Chief Gunner's Mate was in another boat.)

"Where is the radio officer?"

Mate: "He is missing."

(At that time I slid down into the bottom of the lifeboat, and was mostly under water.)

"What is the name of your ship?"

Capt.: "The *Joseph Cudahy.*"

"An American ship?"

"Yes."

"Where bound?"

"Brooklyn, New York."

"From what port?"

"La Pallice, France."

"What was your cargo?"

"Gasoline, we were light, coming back."

"You are lighter now." (At which some of the crew grinned.) "What tonnage?"

"Thirty-two fifty."

"Speed?"

"Eight knots."

"That will do."

"Our wireless was disabled. Will you send a message for help with your set?"

(At this the commander and a few men of his crew laughed heartily.)

"Would you give us a tow part of the way toward land?"

"We are not out here to tow lifeboats, but to sink ships." He then pulled the signal gong

for "full speed ahead" and as the sub motored off using the gasoline engines, on the surface, he hollered, "It is about 700 miles to the Azores, due south, go to it." At this one of our crew hollered, "Yes, and it's only 400 miles to Berlin for the Yanks, too." Luckily the Hun commander did not hear this last remark, and the fellow who made it was promptly muzzled.

One boat then put up its sail and was soon lost to us over the horizon, while the three other boats stayed together. We were all in good spirits, and sang songs and told stories. We decided to attempt to row and sail to the coast of Spain. The mate and myself knew our position, and we figured it was about 600 miles to Spain, although we told the crew it was much less. We sailed as long as there was any wind, and also took turns at the oars. At dusk we decided to have our first "meal." We had a box of crackers about the size of soda crackers, which was soldered up air-tight, and a small keg of water strapped to the bottom of the boat with metal straps, the faucet being so close to the bottom that it was immersed in oil, and it was impossible to get water out. We finally found a tin box full of face powder, and we poured this on our hands so that we could get a better grip on the oars and then used the tin for drinking purposes. This worked all right until some salt water came over the side and into the fresh water and then it was useless. The salt water didn't hurt the crackers much, for there was no salt on them originally, and they tasted better, but those that were wet were not eaten freely on account of the thirst they created.



The mate was the "chef" and we ordered our meals with all the style and elegance of a Broadway habitué. The orders came in thick and heavy, and varied from "Ham and—" to "Tenderloin steak with mushrooms," and each in turn received three crackers and a talcum powder can full of water for his order. I still have a portion of one of their crackers which I saved in the pocket of my life preserver, oil soaked and greasy, but the only souvenir.

The night was extremely cold, and as we had left our bunks in a hurry when leaving the ship, not one of us was properly clothed except "Mike," a sort of half-witted fellow who used to sleep in his clothes, and was fully dressed. He even had an overcoat. We all envied Mike, but he wouldn't part with a particle of his apparel, and could not be bribed. Money, of course, was nothing out there: you couldn't have bought a cigarette for a thousand dollars.

A man of about sixty summers sat squeezed in next to me. It was hard to tell whether he was merely shivering or crying, and further investigation showed that it was both. When he shivered, I would shiver, and the man next to me would shiver, and so it passed all around the boat soon after dark, until the whole boat seemed to be vibrating.

I shook so much that night that my muscles were stiff and sore in the morning. The oil that covered our faces and bodies became hard and sticky. Our mate had a little compass which was all we had to tell our direction by, and it was not any too accurate. As best we could we laid a course to the Spanish coast. It was out of the question to try to row near the steamship lane, because during the War it did not exist. The sea was high, but luckily there were long rolling swells with very few whitecaps. We continuously were bailing water out of the boat as it kept coming in over the side. There was about six inches freeboard, with the seventeen of us in the boat, and it took very little to throw in a pail of water.

Some of the men were injured and suffered greatly during the night from their hurts and from the cold. I am not enough of a writer to attempt to describe all that took place in the lifeboat, and some of the agony endured by certain members of the boat's crew could not be written about. It was a scene that I hope never to have to witness again.

"Mike" would "come to" about every half hour and ask me in all seriousness whether or not our ship had sunk yet, and if the Boche had taken us prisoner yet. I would tell him the truth, and he'd say, "Oh, alright, Chief, thanks." In about five minutes he would again call me, and say, "Did you get off an SOS yet?" I would inform him for about the fiftieth time that we were now in the lifeboat, and that the radio had been destroyed and no SOS had been sent, to which he would reply, "Oh, alright, Chief, thanks." The old gentleman at my right, who cried almost all night as a child would do, would then open up with his story about the little home he had just bought,

and his wife and children, and that this was to have been his last trip, because he could now pay off the mortgage and settle down. I heard this tale quite frequently during the night.

When the gray dawn appeared we discovered that we had lost another lifeboat, that of the first mate, which had drifted away from us during the night. As the sun rose, our spirits did likewise, and soon the warmth of the sun "thawed us out" and the oil softened and thinned, and although we became "well lubricated" it was a relief and a pleasure in contrast to the hard caky effect during the night. That day we all scanned the horizon for the sight of anything alive but didn't see a thing.

That evening and night I was spared the knowledge of what went on, on account of an injury I had received which relieved me of consciousness.

The third day we had all become quite accustomed to our predicament and seemed to feel better, although there was no reason for the feeling. Our water had become salty from the spray and brine which came over the side and contaminated it, and was about useless, but we still had some hardtack left. The mate, who had nerves of iron, continued to try to keep us in good spirits, and succeeded fairly well. A peculiar incident occurred that afternoon in the other lifeboat, which was full of navy men. Although practically out of food and water, they were sitting there supposedly quite contented, smoking cigars and drinking champagne! This seems rather ridiculous, but was the truth. In leaving the ship one of the men had taken with him a box or two of cigars out of the canteen and three or four bottles of champagne, which had been purchased in France.

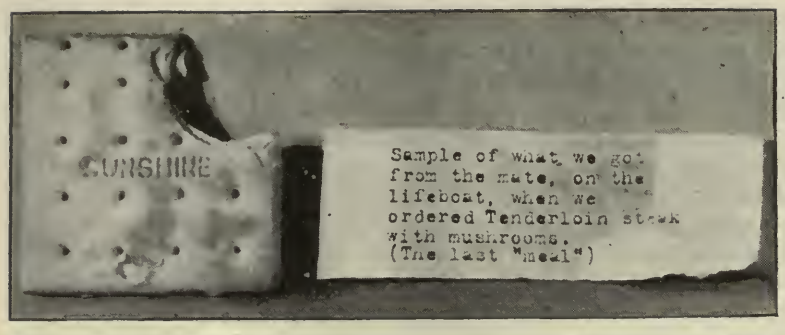
That night we tied the two lifeboats together, to avoid losing one another during the night. This night was even worse than the others, for a rather strong wind had blown up, and the sea was beginning to act up in an uneasy way. Most of us were completely soaked with water in those few parts where the oil had not made us waterproof. We continued to row and sail when the wind would allow, and the knowledge of moving—just moving, regardless of where to—made us feel considerably better than lying still. Meanwhile, we had completely run out of smokes. It was smoking that kept up our spirits as much as anything, and we were out completely.

While engaged in making and smoking some cigarettes made out of old "butts" which we gathered from the bottom of the boat and dried, there was observed to be a lot of excitement over in the other lifeboat some distance away. They were shouting and waving their arms frantically to the extent of nearly capsizing their boat. We looked out on the horizon, and there was smoke. Real honest smoke which could have come from no other source than a real honest ship. It was a sight which we had hardly hoped for. "Mike's" handkerchief was raised in the air and waved frantically, even though a ship was not in sight. Nothing but plain smoke, and miles away. The mate brought us to our senses when he informed us that we were not yet rescued, and to cut out the noise and get to work on the oars. The idea was to head off anything that might come our way, and to this end the other boat went one way, and we another, as hard as we could row. It was with the greatest delight that we saw the top masts of a ship appear over the horizon, for we then knew that she was coming our way and not just crossing the horizon. We felt wonderfully relieved but still worried lest at this critical point we should still lose out. We continued waving, but it was evident that the ship hadn't sighted us yet, for only the tops of her masts were visible, and we were so small. As she approached, we could see more and more of her masts, and finally her pilot house.



At this point she suddenly seemed to turn directly at right angles and make off in a direction away from us. The mate swallowed hard, but kept the oars going just the same, with a determination to do all that was humanly possible. It was at this time that a rocket was suggested, but it would have hardly been seen in the daylight, and the mate thought best not to take any chance of being taken for a Boche "sub."

It was most peculiar to me that out of a clear sky at this time arose a mist that thickened into a quite heavy fog, and hid the entire horizon. The day was clear, although the sun was not actually shining, but it seemed the height of misfortune that such a fog should



THE AUTHOR FOUND THIS IN THE POCKET OF HIS LIFE-PRESERVER, "AFTER IT WAS ALL OVER"

occur at this time. We continued rowing, hoping against hope that the fog would lift. We had lost sight of the other lifeboat by this time and we held our course as best we could. After about twenty minutes or a half hour of this, straining our eyes in an effort to pierce the fog, directly in front of us out of the fog appeared a tremendously large ship, traveling at slow speed, for she was gently cutting the water. She sighted us immediately, and slowed down. The ship was camouflaged heavily, and we did not know nor did we care what nationality she was. A line was thrown over, and as one of the crew grabbed it and held on, it nearly overturned us, on account of our inertia and the superior speed at which it was traveling. The mate yelled, "Let loose on that line, you damned fool, what in hell is wrong with you?" After a bit of maneuvering, we finally got alongside, and heard her Captain say, "'Urry along there, we cawnt stop 'ere long." Of course we knew that our rescuers were English, and the Captain later informed us that looking down from the bridge, seeing a huddled crowd of men, who to all appearances were black or dark brown, he never dreamed what nationality we were until the mate let loose with the above profanity, after which, he said, he knew we were Yanks.

The last man to leave the boat pulled out the bottom plug and let her sink, and there was none of us who could not climb the long ladder to the deck of the ship. However, upon stepping on board very few of us were able to walk, and we fell in a heap on the deck. It will be remembered that all the time we were in the boats we were in a sitting position, and had not been able to stretch out, and for this reason our knees refused to hold us. So we rested for some time on the big concrete deck of H. M. S. *Poleric*. In the meantime, the other lifeboat had been picked up by a Greek ship which accompanied the *Poleric*. The *Poleric* was bound for Norfolk, and arrived there safely about ten days later.

When the *Poleric* pulled into Norfolk I stole aboard a little motor boat that had come out to the ship anchored in the river, got myself smuggled safely ashore, and made arrangements for a boat to go out and take off the crew.

Upon reaching the Navy building I could not realize why a sentry wanted to stop me from interviewing the Commanding Officer until I remembered that I had on a huge long coat, baggy trousers, and a green muffler borrowed from the steward, so that I looked like anything but a naval officer. After much persuasion I finally was admitted to his sanctum, and explained matters. Upon his asking me what proof I had that I was in the Navy, I realized that I had none, and a telegram was sent to Brooklyn to verify the fact. The men of our boat were clad, many of them, in English overalls and nothing else. Yet on account of red tape and the absence of proof of our identity, and absence of our pay cards, nothing could be done for us. No clothes, money, or cigarettes were obtainable except by begging them. In this regalia, after three days' waiting, we were put aboard a passenger ship and sent to Brooklyn, where we finally got necessities. The other members of the crew who were picked up by the Greek ship landed in New York a few days later; the third ship, that of the mate, had already arrived at New York, having been picked up the second day out. The fourth boat, that of the Captain, was picked up, after being out nearly a week, by a ship going to France, which landed that crew safely back in France. The casualties were: one dead, nine wounded, and one mentally deranged.

The last I saw of "Mike" was when we arrived at Brooklyn. He said, "Did the ship go down yet, Chief?" "Yes, Mike," I answered, "but you are now safe at home. Don't worry about the ship." And he answered, "Oh, alright, Chief, thanks."



TRYING TO DECIDE WHAT TO GET

In a well-run radio store such as this one in New York, the novice is helped to buy discriminatingly. Many stores do nothing more than put their apparatus out for sale without bothering or knowing how to help the broadcast listener get the best value for his money. Some knowledge of the types of sets discussed below will help the B.C.L. to buy with his eyes open

What Kind of Receiver Shall I Buy?

What Results You May Expect from Various Types of Receivers. The Accessories Needed, and Some Idea of the Entire Cost

By ARTHUR H. LYNCH

TO HAVE or not to have: that *was* the question. People have now pretty generally decided, however, that they would like to own—eventually, if not immediately—some kind of apparatus which will bring broadcasting into their homes. Their question becomes: "How good a set can I get for the amount I am willing to spend?" When you approach a counter where radio is sold, and ask: "How much is a good radio?" you are likely to be taken aback if you are a newcomer to this radio game, by the volume of technical verbiage which the apparently simple question excites. The answer is a difficult one and is unknown to many sales people.

Without intending to be insolent, the clerk must answer the first question with several others, such as: "Do you wish a crystal set or a tube set?" "Do you wish to use an aerial or a loop?" "Do you wish to receive with headphones or a loud speaker?" And then, that all-important question: "Just how much do you care to spend?" By the time he has finished, you realize that you have let yourself in for a great deal more than you bargained for, and



A CRYSTAL RECEIVER
One of the first to be made specially for broadcast reception

feel desperately alone in a rudderless ship in a stormy sea. Perhaps the following outline may assist you and incidentally lighten the burden for the salesman.

To begin with, let us understand each other properly: You have thought of buying a radio receiving set, "a radio," to use the common term, and we want to help you to get the best for your money. We have not the time or space to tell you of the wonder machines that may be had for fifteen dollars that bring in stations fifteen hundred miles away on a loud speaker that may be heard fifteen hundred feet away. The radio millennium has not arrived, but there is plenty of pleasure to be had at a reasonable outlay. Let us proceed, then, on a dollars-and-cents basis.

WHAT THE CHEAPEST SET WILL BRING YOU

THE cheapest of receiving sets is the crystal outfit, so-called because a mineral or crystal is used as part of the receiving system. The price of a crystal broadcast receiver, complete, ranges from less than $10 to about $35. No batteries of any kind are necessary with it, and there is, therefore, no up-keep expense. With a good outside aerial, made of a single copper wire, a crystal receiver will operate with headphones on stations from fifteen to twenty-five miles away under average conditions.

If your crystal receiver is to be within less than five miles of two or more powerful broadcasting stations, it is quite likely that you will experience interference when both stations operate simultaneously: in other words, you may not be able to hear one without the other—the receiver is not "selective."

The quality of music and speech picked up with a crystal receiver from stations well within its range is usually very good, though the volume is not very great. A crystal receiver alone will *not* operate a loud speaker. Over distances in excess of one mile it will *not* work with a loop. It may be used in conjunction with a loud speaker if an amplifier is used, but the cost of an amplifier in proportion to the cost of the crystal receiver itself is so great and the results obtained so unsatisfactory that such an arrangement is not advisable.

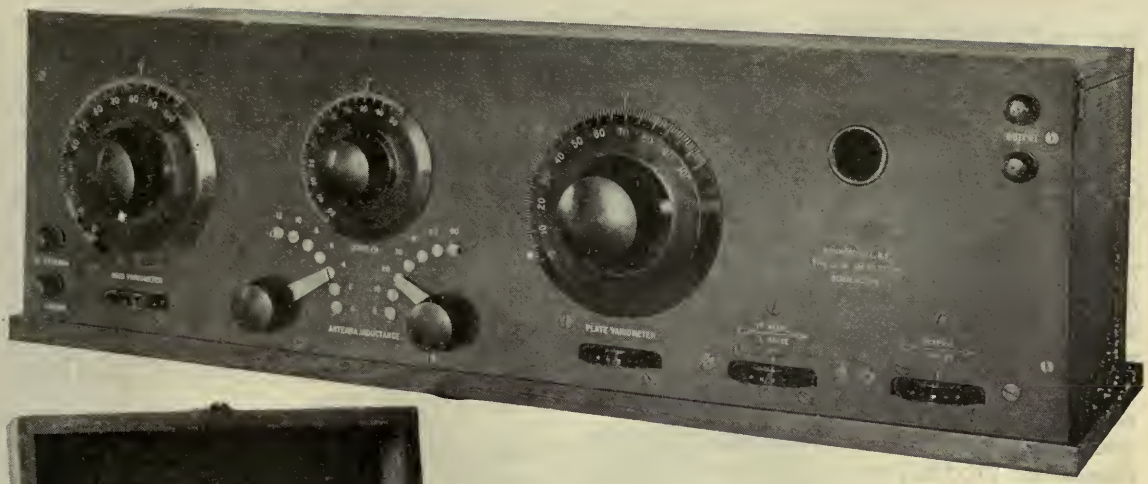
THE LAMP-SOCKET ANTENNA

ONE great radio achievement, not appreciated by most people in search of a receiver, is a little device known as an antenna attachment. It screws into an ordinary lamp socket or plugs into a base outlet. It permits the use of the electric light wires in the house as an antenna, *without using any of the electric lighting current.*

Antenna attachments of this kind may be used with nearly all makes of receivers. They make the use of an outdoor antenna unnecessary, and eliminate the necessity for the safety device required when the outdoor antenna is used. The results obtained compare very favorably with those obtained with an outside wire. Sometimes the reception is greatly improved. The radio receiver may be moved to any part of the house where there is an electric socket and put in operation in a few minutes. It may be found in using these devices that better reception is obtained in one socket than in another. The price of such attachments runs from 75 cents to $1.50. We mention this device here because it may be used with a crystal receiver.



AN ANTENNA ATTACHMENT
It is screwed into the ordinary electric light socket, permitting the use of the lighting wires as a receiving antenna





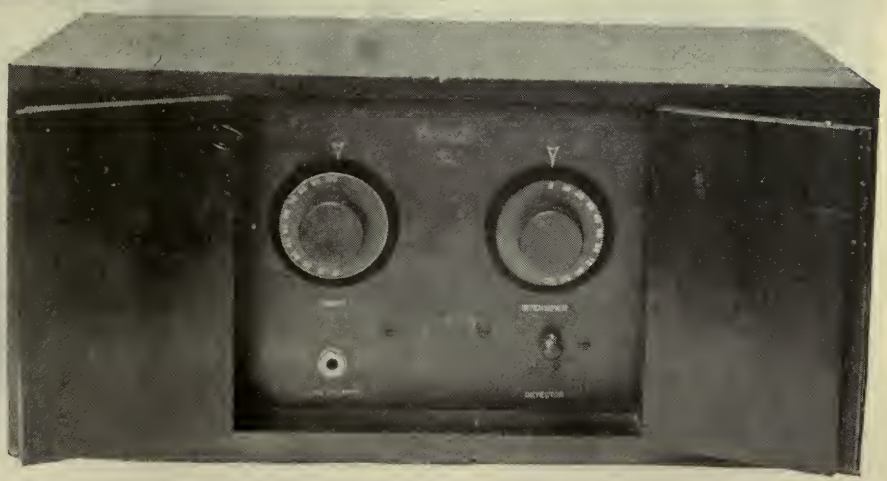
TWO SINGLE-TUBE RECEIVERS

Above is a three-circuit regenerative outfit, which permits of fine tuning; at the left is a simply-controlled single-circuit regenerative set, designed for use with a dry-cell tube

WHAT A SINGLE-TUBE SET WILL BRING YOU

THERE are many kinds of receivers employing a single tube, and most of them may be relied upon to perform in a satisfactory manner. There is little need for the prospective buyer going into a technical discussion of the relative merits of different circuits used in single-tube receivers, with one exception, and that is the so-called single-circuit regenerative receiver.

A receiver of this type in the hands of an inexperienced operator and in the hands of many an experienced operator is likely to act as a transmitter, causing howls of a most disagreeable character to be heard by other receivers in the neighborhood. If you are out in the country with no one within a mile or two of you, the single-circuit receiver may serve you



(RIGHT)

A ONE-TUBE "REFLEX" SET

It has a crystal detector, and the single tube is made to do double duty, giving one stage of radio-frequency and one stage of audio-frequency amplification

fairly well, without causing unpleasant relations with your neighbors; but if you are in the city, you will do well to procure some other outfit.

Most single-tube receivers are designed for operation with ear phones, though amplifiers may be added so as to permit the use of a loud speaker. A single-tube receiver, operated on the tuned "reflex" principle described in last month's RADIO BROADCAST will, however, operate a loud speaker over a distance of approximately twenty-five miles.

The three-circuit regenerative receiver is another satisfactory type. It is made by several reliable manufacturers and varies in price from about $100 to $225, complete with batteries, tube, phones, antenna equipment, etc. It is a great deal more selective than the single-circuit regenerative outfit but somewhat harder to tune than the reflex receiver mentioned above.

Loops are not satisfactory with these receivers, as a rule, but the antenna attachment may generally be used.

Special attention should be given the matter of accessories, especially where an amplifier is to be added later, for operating a loud speaker. A receiver with a dry-cell tube will be satisfactory for head-phone operation but where a loud speaker is to be used, it is better to figure on 6-volt tubes and a storage battery.

Single-tube receivers for dry-cell operation may be had complete for from $50 to $125. They will operate over distances up to several hundred miles under favorable conditions.

WHAT TWO TUBES WILL DO FOR YOU

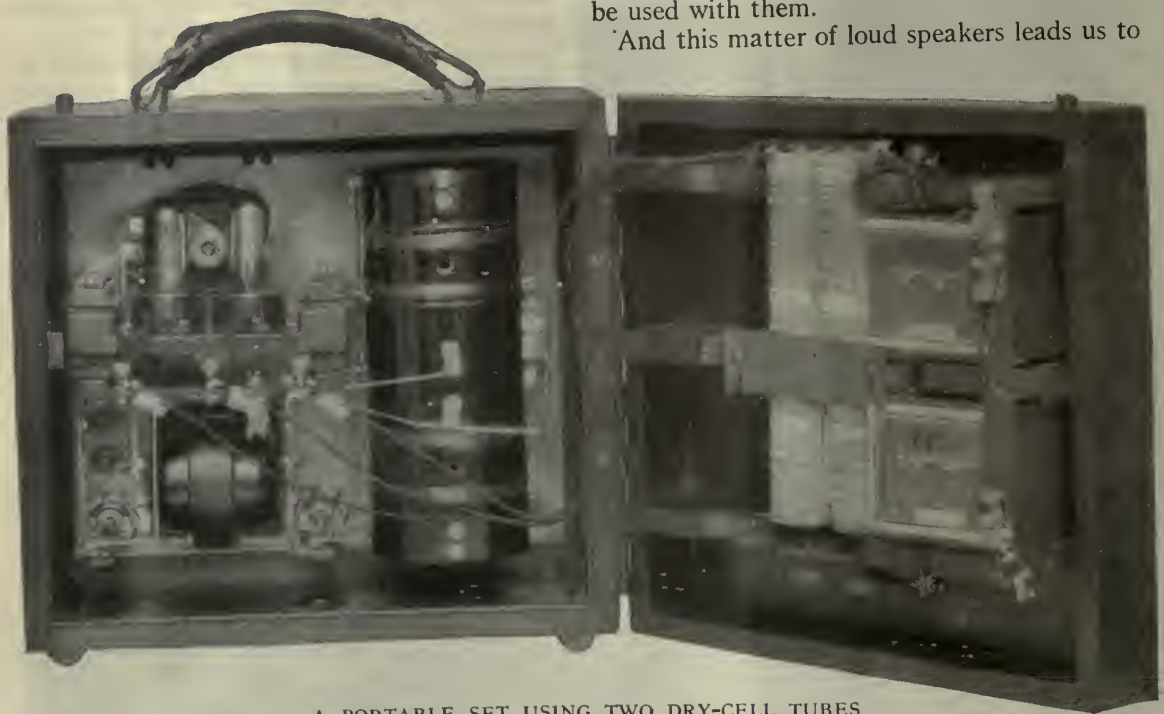
THE addition of a second tube is of value when you are within a short distance of a broadcasting station, because it will permit the use of a loud speaker. There are several two-tube outfits on the market, some of them being of the portable type.

The additional tube is used in one of two ways: either as a radio-frequency or audio-frequency amplifier. The difference lies in the fact that radio frequency (R.F.) amplification increases the range of the set but adds little to the volume, while audio-frequency (A.F.) amplification adds volume but does not increase the range. You have your choice. Under most conditions the addition of the A.F. amplification is preferable.

THEN THERE ARE THREE TUBES

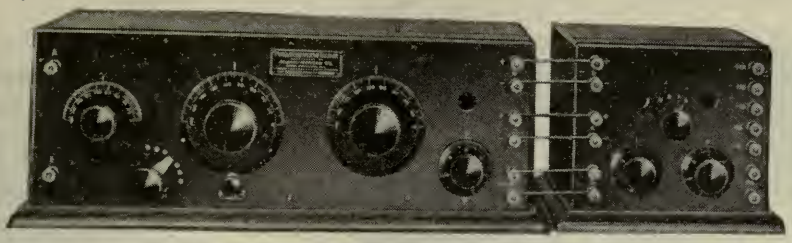
THE number of receivers employing three tubes is rapidly increasing and they are becoming popular because a loud speaker may be used with them.

And this matter of loud speakers leads us to



A PORTABLE SET USING TWO DRY-CELL TUBES

All batteries are inside the cabinet. Outside connections are necessary for antenna, ground, and head-phones



A THREE-CIRCUIT RECEIVER AND TWO-STEP AMPLIFIER
With an outdoor antenna, it will operate a loud speaker over considerable distances

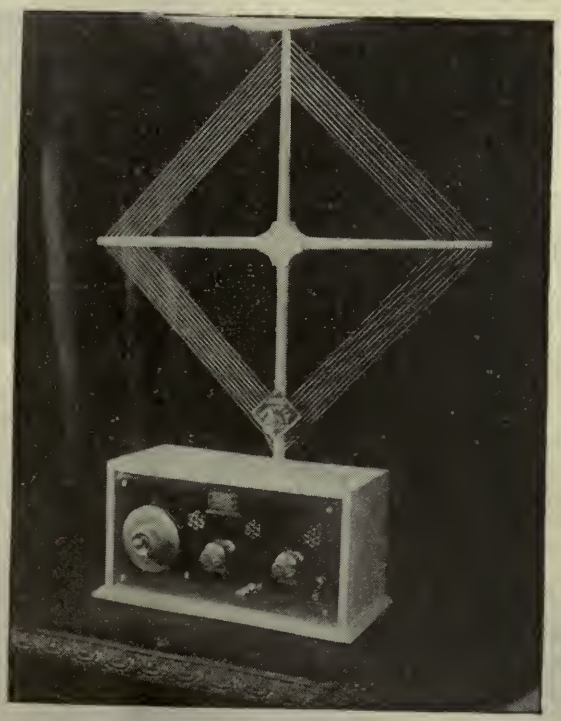
a discussion of the distance over which loud-speaker operation is practicable. That distance is materially shorter than most of the glowing accounts of radio would have you believe. There are a great many exceptions to the rule, but the rule is that few stations may be heard *clearly* on a loud speaker with a three-tube set over distances in excess of one hundred miles. Most people who find interest in distant reception would rather hear a few squawks from a 1,500-mile-distant station than a complete program from one near by.

There are some three-tube receivers made for use with an outdoor aerial that have all the accessories in a single cabinet. As a rule they operate on dry cells and sell for about $300 complete.

Less pretentious receivers may be had more cheaply but the average three-tube set for dry-cell and outside-antenna operation will cost from $85 to $150, without tubes or accessories.

There are three-tube receivers designed for operation with a loop aerial. They will operate a loud speaker over distances up to thirty or forty miles with dry cell tubes and somewhat longer distances when storage battery tubes are used. These receivers, for dry-cell operation, with all the accessories including two pairs of ear-phones and a good loud speaker, cost approximately $200. For storage-battery operation, the cost is about $15 more.

The range and volume of these receivers may be improved by the addition of a regular antenna and ground but this improvement is usually accompanied by a loss of selectivity. This type of receiver has the advantage of being easy to adjust. With three tubes and an outdoor antenna, one may feel sure of very good loud-speaker reception over fairly long distances and similar operation with a loop receiver over somewhat shorter distances.



A THREE-TUBE LOOP SET
The diamond shaped loop antenna, used in place of outdoor antenna and ground, makes for selective receiving. The Grimes "Inverse Duplex" system, giving two stages of R. F., detector, and two stages of A. F. amplification, is employed. This particular gold and ivory model, built for Marguerite Clark, the screen star, was exhibited at the New York Radio Show recently

WHAT YOU CAN GET WITH FOUR TUBES

ONE of the most popular receivers employing four tubes is built on what is called the neutrodyne principle. Such receivers are now being produced by several reliable manufacturers. The results they are producing for people who have known nothing about radio receivers heretofore seem to predict a wave of popularity for them. They have been designed for outdoor-antenna and storage-battery operation and may be used for loud-speaker operation over distances of several hundred miles. They are



A FOUR-TUBE RECEIVER
Containing all batteries in the cabinet. It uses a 20-foot antenna



"DETECTOR AND THREE AUDIO"

easy to manipulate and produce very fine tone quality. They may be had complete for about $220.

The four-tube loop receivers are extremely popular and have been so since their appearance on the market about this time last year. For operating a loud speaker on an automobile trip with dry-cell tubes they are hard to beat, and for home use they will produce ample volume for dancing, from stations comparatively far away. For dry-cell operation, the price is in the neighborhood of $225, and for storage-battery working, it is about $15 more.

Other receivers employing four tubes are usually made to include one stage of R.F. amplification which is used for increasing the range. Such receivers are very satisfactory and are less expensive than either the neutrodyne or loop outfits. As a rule, storage batteries are recommended, but they will operate with dry cells also. The price, complete, with all the accessories, two pairs of headphones and a loud speaker, for dry-cell operation, ranges from $130 to $275.

FIVE-TUBE RECEIVERS

THE addition of the fifth tube is generally for the purpose of securing reception of the best quality, rather than increasing the range, and it is successful in this respect.

SIX TUBES

BECAUSE of the improvement in vacuum tubes it is now possible to operate the filaments of six of the new tubes with less current than two of the old-style vacuum tubes would have consumed. For this reason, multi-tube receivers are making a good showing from a sales standpoint. Six-tube ones will operate over approximately the same distance with a loop antenna as any good three-tube receiver will operate with an outdoor wire or a lamp-socket antenna attachment. Because



"ONE RADIO, DETECTOR AND TWO AUDIO"

the loop aerial has the property of being directional—that is, of receiving best from points in the direction in which its edge points, it reduces interference from undesired stations. It is not necessary to have all six of the tubes operating to give maximum volume. If they are not "overloaded," or "forced," the result is likely to be a receiver capable of long-range reception with a minimum of interference and adjustment. Loop receivers of this kind are



STILL ANOTHER FOUR-TUBE RECEIVER
Combining "two radio, detector, and one audio"

not cheap but they are certainly very worth whil

THE ACCESSORIES

WITH most receivers now on sale it is necessary to procure your accessories at a price not figured in the price of the receiver. The prices for this material are about as follows:

Material for outdoor Antenna	$3.50 to $7.50
(As a rule this figure may be reduced by using an antenna attachment in place of the antenna material)	.75 to 1.50 each
Dry cells	.35 to .50 each
B batteries (22.5 volts)	1.75 to 3.00 each
Head-phones	3.75 to 12.00 a pair
Loud speaker	10.00 to 55.00
Vacuum tubes	5.00 to 6.50
Storage battery (6-volt, 80 ampere-hour)	15.00 to 26.00

IN CONCLUSION

We have tried to be conservative in telling you what you can get a receiver for, and what you may expect it to do for you. Our outline considers average results. Familiarity with your receiver will enable you to exceed this average. In making your selection it is well to beware of the man who makes wild claims for his goods, and before buying it is advisable to hear several sets in operation.

Make up your mind how much you want to spend, and look at five or six different makes of receivers within your price limit; then make your selection. If you patronize a reliable shop where standard merchandise is sold, rather than a cut-price shop, you will, as a rule, be sure of satisfaction or given your money back and very few instances have been brought to our attention where the latter has been necessary.



FOUR-TUBE NEUTRODYNE SET



ANTENNA AND GROUND EQUIPMENT

This assortment consists of heavy insulated copper wire for the ground connection, lighter insulated wire for the "lead-in," bare stranded-copper or phosphor-bronze wire for the antenna, screw-eyes, a ground clamp, insulated double-pointed tacks, a porcelain lead-in tube, a lighting arrester, and various other glazed porcelain insulators

How to Build a Neutrodyne Receiver

With a Complete List of Parts Necessary, Their Approximate Cost, Working Drawings, and Wiring Diagrams—by a Man Who has Directed the Building of these Receivers in Great Quantities

By KIMBALL HOUTON STARK

Chief Engineer, F. A. D. Andrea, Inc.

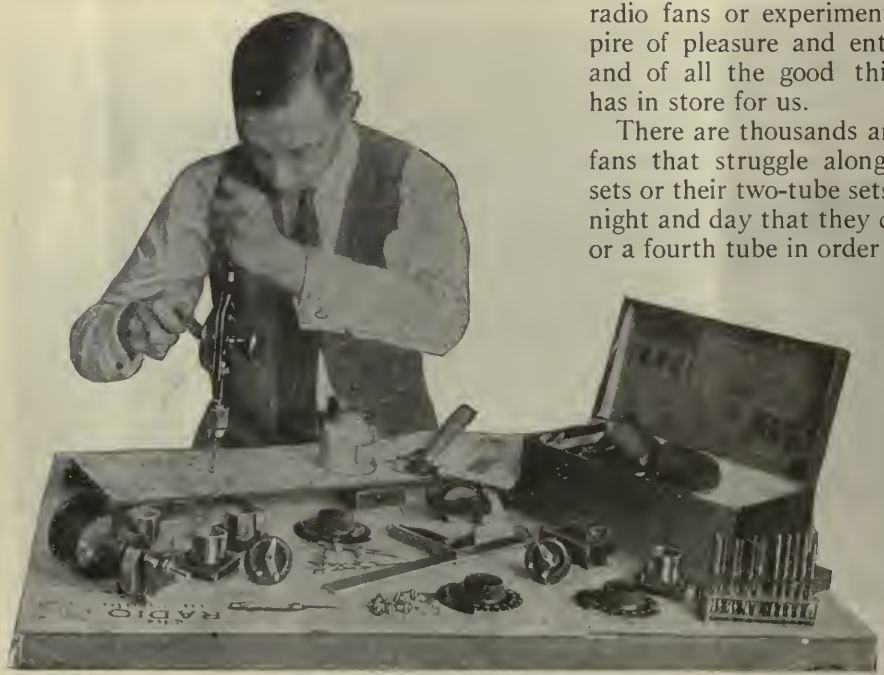
In the last two or three years, since radio became popular, probably several million radio receivers have seen the light of day. In this article, complete information is given for building a tuned radio-frequency receiver using Professor Hazeltine's now famous neutrodyne circuit. In the second article in this series the author will give detailed instructions for neutralizing the inherent vacuum-tube and stray circuit capacities. The third article will deal with practical pointers on operating the receiver, including data on loop antennas, dry-cell tube operation, etc.—THE EDITOR.

BREATHES there a man with soul so dead that he has not enthusiastically told his neighbors with ready speech and beaming eye, of his marvelous DX records the night before?

A rather funny statement was made to me the other day. The thought was presented that radio is certainly making us a nation of liars. A couple of rabid radio hounds meet at any radio store and immediately begin the discussion, infinite in detail and yet always ending with that universal topic of "How far did you get last night?" One man hears signals 1,500 miles on a two-tube super; another chap gets Los Angeles on a one-tube set; somebody else happens to think of the old days when someone told him about hearing a commercial ship station three thousand miles west of San Francisco, from New York City, using a crystal detector —and so it goes.

It seems to me the craze for distance will never die out. I don't want it to. Of all the romance, mystery, and myths that we encounter in this life and that we are told about, where can we get romance that will compare with listening-in to concerts and music and speeches from stations hundreds of miles away, from invisible cities, as it were—from an invisible empire, an empire not of radio receivers or equipment, not of listeners or radio fans or experimenters, but a vast empire of pleasure and entertainment, of music and of all the good things that this world has in store for us.

There are thousands and thousands of radio fans that struggle along with their one-tube sets or their two-tube sets who are just wishing night and day that they could add a third tube or a fourth tube in order to hear that station a few hundred miles beyond the limit of their receivers today. Some of these radio fans can afford to buy complete receivers, but the ma-



THE SET UNDER WAY

Mr. Stark is shown drilling the panel, preparatory to assembling a receiver such as he describes in this article

jority must build, or would rather build, their own.

In past years, before radio came into people's homes, a man would build a mission table, a sled for the kiddies, or possibly a model engine; and, after planning for days, what a thrill he would get when the thing was actually finished and made to "work" or serve some useful purpose! Where in the world is there anything that can compare, in giving to such people more thrills and pleasures, with the everyday use of a radio receiver, built by their own hands, that works?

To give radio experimenters dependable, authorized constructional information concerning the neutrodyne circuit receiver is the purpose of this article.

In March of this year, Professor Hazeltine revealed his developed work and introduced the neutrodyne circuit radio receiver. About July of this year, a limited number of companies licensed under Professor Hazeltine's patents were building completed receivers, utilizing the neutrodyne principle and in addition were supplying complete sets of parts suitable for neutrodyne-receiver construction.

Being in intimate touch with many people who have built neutrodyne-circuit receivers using such parts, I can assure you that to build such a receiver calls for reasonable care in construction in order to obtain maximum broadcast signal reception, but for thousands who would be painstaking, the results in the end certainly justify the expense and the pains necessary.

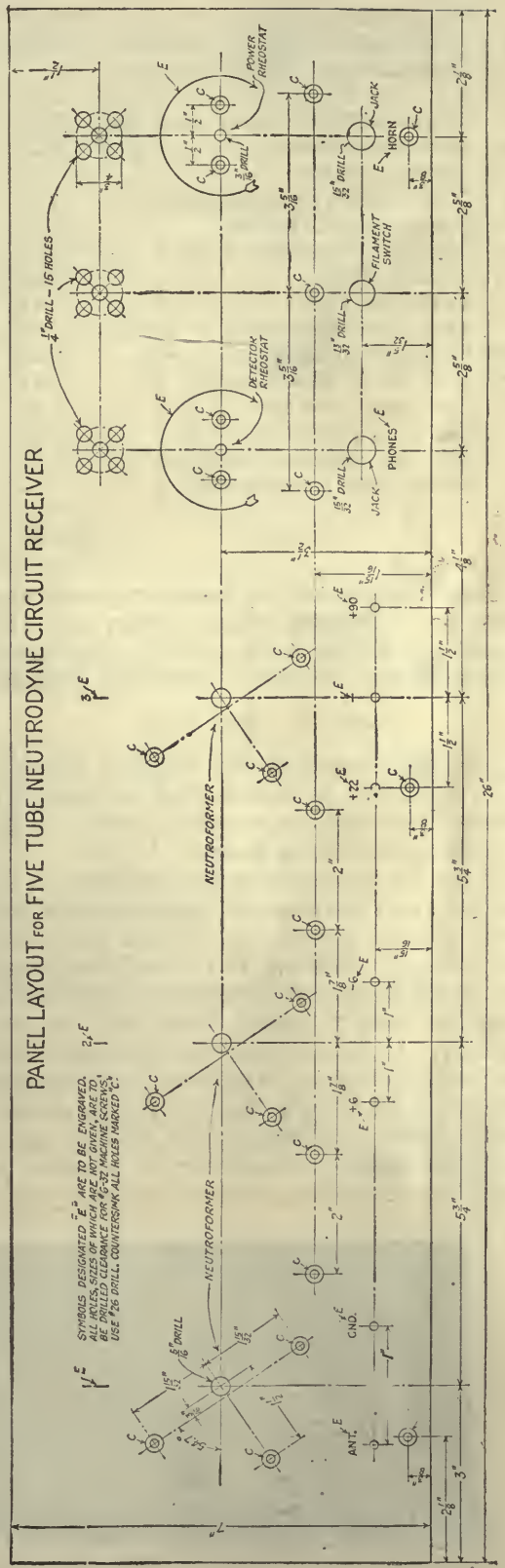


FIG. 1

LIST OF MATERIALS NECESSARY TO CONSTRUCT A FIVE-TUBE NEUTRODYNE-CIRCUIT RECEIVER

THE five-tube neutrodyne-circuit receiver to be described gives two stages of tuned radio-frequency amplification, a vacuum-tube detector and two stages of audio-frequency amplification. Such a receiver will cost approximately $65.00 for parts, and if one purchases all the additional equipment, the total cost will be approximately $150.00, including the five vacuum tubes, storage battery, B battery, phones, and antenna material.

The following list of materials must be acquired:

		APPROXIMATE PRICES
1	Panel, bakelite, 26″ x 7″ x $\frac{3}{16}$″, drilled, machined, and engraved	$ 8.00
1	Base board, oak, 26″ x 6″ x $\frac{3}{4}$″	1.00

1	Triple socket	2.70
2	Single Sockets	2.00
3	Neutroformers (tuned secondary R. F. transformers)	22.50
2	Neutrodons (neutralizing condensers)	2.50
2	Audio transformers	12.00
1	A battery switch	.75
3	Dials (verniers are unnecessary)	3.60
1	Power rheostat (2 ohms)	1.20
1	Detector tube rheostat (6 ohms)	1.25
7	Binding posts	.84
1	Radio jack, closed circuit	.75
1	Radio jack, three-spring, automatic	1.00
27ft.	Insulated tubing	2.26
27ft.	Wire No. 14, tinned copper	.25
2	Condensers, .006 mfd.	1.50
1	Grid leak, 2 megohms	.75
1	Grid leak condenser .00025 mfd.	.65
	Screws, nuts, terminals, etc.	.10
	Total	$65.60

Great care should be taken in purchasing these parts and one should obtain only the special neutrodyne parts made by authorized licensees under Professor Hazeltine's patents.

DRILLING YOUR PANEL

FOR the panel, either bakelite, formica, condensite, or radion may be used. A detailed panel drilling layout is shown in Fig. 1, all dimensions being given.

If you do not purchase the complete set of parts but only the necessary special neytrodyne parts, you will need to lay out your own panel for drilling. In doing this it will be found convenient to use dividers and a combination square in order to get all dimensions, etc., accurately. It is suggested that you purchase the complete set of parts which includes the panel with all holes drilled and the proper engraving done. By using such a finished panel in constructing your receiver it presents a mighty good appearance when finished. However, if you do drill your own panel, very great care must be taken in laying out the position of the Neutroformer mounting holes as the relationship of the Neutroformers to one another is very exact.

As shown on the drawing, Fig. 1, the Neutroformers are mounted at an angle of 54.7° from the horizontal and should this vary even one or two degrees, trouble will be experienced in properly balancing out the receiver. On the diagram, the marking is also shown for the binding posts and telephone jacks. All holes not marked with special dimensions are to be drilled clearance for 6-32 machine screws. This requires the use of a No. 26 drill.

ASSEMBLING THE PARTS ON THE PANEL

WITH our panel drilled and engraved, the next step is to assemble the various units on the panel. The rear view of the completed five-tube neutrodyne receiver is shown in Fig. 2, and from this picture one can get an idea of the general arrangement of the parts on the panel.

It will be noted that two of the sockets are placed between the Neutroformers, and that the triple-tube socket is placed on the left-hand end of the panel looking from the back. The rheostat at the extreme left end is a power rheostat controlling the filament current of the amplifier tubes and the rheostat closest to the left-hand Neutroformer controls the filament current of the detector tube. In the hole on the panel drilling layout marked "phones" is mounted a two-spring closed-circuit telephone jack. This is directly under the knob of the vernier rheostat. In the other or "horn" jack is mounted a three-spring automatic filament-control jack. The filament switch, binding posts and sockets are easily assembled in their proper position. The Neutroformers should be very securely screwed to



FIG. 2

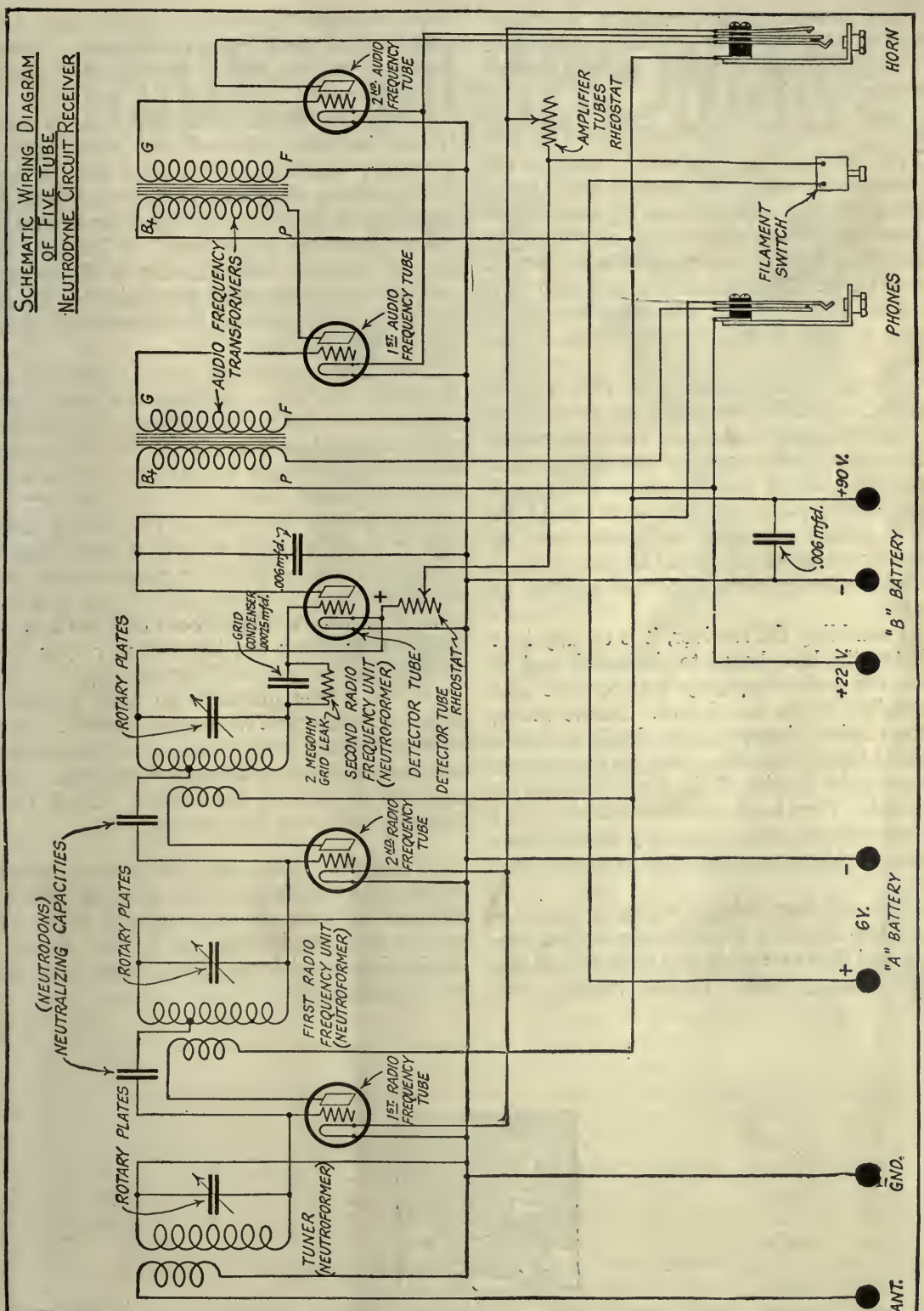

SCHEMATIC WIRING DIAGRAM
OF FIVE TUBE
NEUTRODYNE CIRCUIT RECEIVER
HORN
2ND. AUDIO FREQUENCY TUBE
AMPLIFIER TUBES RHEOSTAT
FILAMENT SWITCH
PHONES
AUDIO FREQUENCY TRANSFORMERS
1ST. AUDIO FREQUENCY TUBE
+90 V.
.006 mfd.
"B" BATTERY
+22 V.
.006 mfd.
GRID CONDENSER .00025 mfd.
2 MEGOHM GRID LEAK
SECOND RADIO FREQUENCY UNIT (NEUTROFORMER)
DETECTOR TUBE
DETECTOR TUBE RHEOSTAT
ROTARY PLATES
2ND. RADIO FREQUENCY TUBE
(NEUTRODONS) NEUTRALIZING CAPACITIES
ROTARY PLATES
FIRST RADIO FREQUENCY UNIT (NEUTROFORMER)
6 V.
"A" BATTERY
ROTARY PLATES
1ST. RADIO FREQUENCY TUBE
TUNER NEUTROFORMER
GND.
ANT.

FIG. 3

the panel in their proper position as the operation of the set would be affected if they were even slightly moved out of position during assembly and wiring.

WIRING UP THE FIVE-TUBE NEUTRODYNE SET

THE wiring of a receiver is usually the stumbling block for most of the experimenters. I have seen some of the most horrible looking jobs on neutrodyne receivers, yet when the job was properly balanced out, it worked O. K. This should not be taken as a criterion, however, and the experimenter is advised to take particular pains in wiring up his set.

Study the wiring diagram in Fig. 3 very carefully. Note in particular the polarity of the Neutroformer windings, audio-frequency transformers, and especially the connections of the Neutrodons and telephone jacks. All high-potential plate and grid leads should be kept as widely separated as possible and all wiring separated at least one half inch with as few leads running parallel to one another as possible.

In assembling the receiver, it is usually best to fasten the base board to the panel, and to fasten the audio-frequency transformers and Neutrodons to the base board. Before wiring up the receiver, however, one should unfasten the base board from the panel, as this makes it much easier to wire all the parts mounted on the panel. Then fasten the base board with its Neutrodons and audio-frequency transformers again into place to complete the wiring of these units.

It is usually best to begin wiring by connecting all the negative vacuum-tube socket terminals and then extending this same wire to the ground binding posts. In like manner, the positive filament connections can be made and the wiring of the detector tube rheostat, power rheostat, battery switch, and battery binding posts completed.

Connections to the Neutroformers come next. It will be noted that all the Neutroformer secondary windings have a small loop or tap. On the wiring diagram no connection is made to the tap of the first or left hand Neutroformer looking from the panel front. A lead is connected, however, from the tap of the second and third Neutroformers going directly to one terminal respectively of the second and third Neutrodon condenser.

The fixed condensers with capacities as shown on the wiring diagram are wired into position and need not be fastened either to the panel or base board, as the stiff No. 14 copper wire will hold them in position. After you have completed wiring up your receiver or preferably step by step as you fasten each wire in position check off with a heavy pencil on the wiring diagram the connection that you have just made. When the wiring is completed, all wires will have been checked and in addition by doing the job this way, you are doubly checking yourself for mistakes.

On the wiring diagram, no wire is shown jumping another one with a loop symbol. The plan shows each wire passing across the others and only connecting to cross wires when represented by a solid black dot. Check this carefully with your own wiring.

In the next article of this series, detailed instructions will be given for balancing out the inherent capacity of the vacuum tubes as well as the stray-circuit capacities, thereby eliminating parasitic and distorting oscillations and regeneration.



RADIO VAGABONDING



The Part that a Broadcasting Receiver Played During the First Leg of a Motor Trip Around the World*

By PETER TAYLOR

ON THE running board of our car is a rectangular box, riding underneath its muddy rough-looking waterproof cover. A passer-by might think it a supply or tool box such as any tourist might carry. However, when I remove the cover in an auto camp or in some city street, and let the front side drop to form a narrow desk, a black panel with dials is disclosed, which leads the way to music and to speech—a trip from camp far out into space. Adjoining the panel in a second compartment is a square, screen-covered opening—a loud speaker. A top lid lifts, under which are tubes and brown bakelite variometers on the rear of the panel. Sponge rubber carefully cradles the apparatus attached to the panel which is held in place at either end by rubber-covered grips. In a compartment around the throat of the horn are packed extra bulbs, a set of head-phones and a small flexible coil of antenna wire. Shelved on the end in the third section rides the 90-volt B battery, also protected by sponge rubber cushions.

It takes only a moment to put the equipment in operation: a small plug, hanging on a nickeled chain at the end of the panel, is pushed into a jack, lighting the tubes from the storage battery of the car and connecting the loud speaker to the set. The end of a wire running around three sides of the top, underneath the padding, is dropped and connected to the antenna post on the panel, or a twenty-foot wire is stretched up arm's-length to a nearby tree or other object. Now one has merely to turn the dials. The ground connection needs no attention ordinarily, since the frame of the

*The writer of this article, with his sister, Mildred Taylor, also a writer, and Blanding Sloan, friend and artist, left New York on April 26, 1923. (Their departure is shown in the photograph on page 229, RADIO BROADCAST for July.)

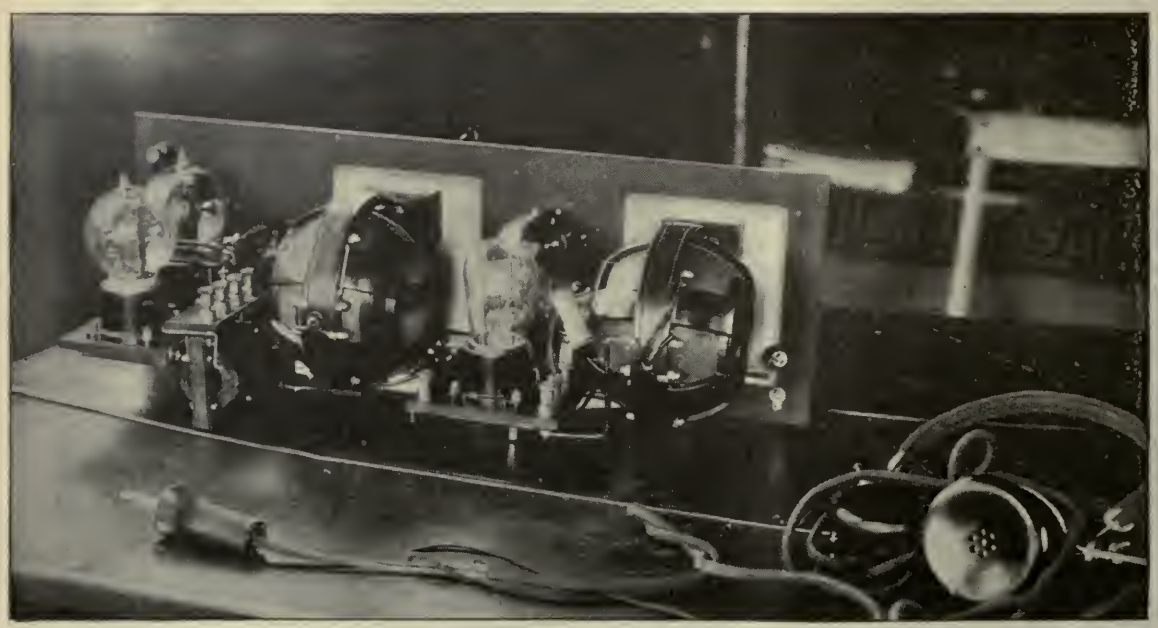
car, being connected to the storage battery, acts as a counterpoise or series capacity to earth.

This set has never failed to please me. Always it seems that the running board of a car is a very unusual place for a radio. I like the equipment not only for its beautiful construction, but because it has given me more than six thousand miles of perfect service on our zig-zag trail across the United States. It has satisfied a great many personal "radio desires."

The first tests and first impressions seem a long time ago. I smile to think how carefully I drove away from the factory after the set had been installed the day before we headed west. Every little eighth-inch bump drew my foot to the brake! Later the same evening we drove uptown in New York to find a store where I might get a leather coat. On the return along Riverside Drive my fingers itched to turn the dials of the new receiving set. Last moment preparations had left no time for previous tests. We pulled up by the curb, opened the case, and in a moment, we had music rolling out clear and loud. I thought, "All this and with so little effort!" It had seemed useless to try the outfit when driving, because of ignition interference. However, I felt sure that the motor spark could not affect such strong signals, so I started the motor to make the test. One had to stand very close to the loud speaker to hear the click, click, click of the motor spark. Nothing could have pleased me more. It meant a radio ride now and then, provided that the lighted filaments would stand the vibration. We continued down Broadway and serenaded the folks crowding from the theatres and cafes. There was not the slightest irregularity due to changes in tuning or tube vibration. This first radio ride is an experience that I shall not soon forget.

We left New York rather hurriedly the next afternoon. There was no time for system. Typewriters, camp stove, tent, suit cases, blankets, brief-cases, artists' materials and all sorts of necessary equipment were loaded in the quickest possible way. A motorcycle police escort piloted us at thirty miles an hour through the thick of traffic to the city limits, from the City Hall where Mayor Hylan had presented us with a sheepskin scroll—a letter of greeting to "fellow mayors around the world." When finally we reached the city line, the cops asked how the radio was riding. I opened the set, and finding everything all right (rather to my surprise) gave them a little concert in appreciation of the swift and thrilling ride. As we drove on, I wondered how long it would be before something broke inside the little black case.

On the way up the Hudson, I was anticipating a first night test in camp. High over the river, across from Poughkeepsie, we drove in the shiny new stakes and erected a brand new



"THE WORKS" FROM WITHIN

out-of-door house—our balloon-silk tent. It was difficult to stick to the task of camp-making with my mind on radio. I thought of the noisy New York "L" which only a few nights before was interrupting my DX work. What a contrast to this "miles from nowhere" stillness! I took my time when opening and connecting the set. Every move was a pleasure, from unlocking the outer box to lighting the tubes. I clipped a wire on the tent rod, driven two feet into the earth. An antenna wire attached to a nearby limb brought in Schenectady immediately. I raised the volume with a little turning of the dials. It was astonishingly strong. Immediately I wondered how far I could hear it. Up the river along the high bank I went. Every announcement was still coming clear after I had been walking for five minutes or more. The small loud speaker did not look equal to such volume, but it was handling it splendidly. Later, many Western and Southern broadcasting stations and messages of enthusiastic, faraway amateurs vibrated the surrounding atmosphere.



We set our watches to WJZ and then turned in. As I was falling asleep, something seemed to say. "You're really appreciating radio for the first time." Incidentally, my sister and Blanding Sloan and I became so absorbed in this new radio experience that we forgot our fire, which burned up a buffalo robe. But what's a buffalo robe between programs!

Next morning, when I paid a visit to an adjoining estate to get some water, the people told me that they had opened their windows and listened-in—five hundred feet away. Until I told them of our radio, they had thought the concert was coming from across the river at Poughkeepsie.

I had a few fears regarding the tubes. Would they hold up in the sockets, or become noisy or break? Could the set stand the continuous vibration and heavy jolts of the car on bad roads? Would some one crash into us and wreck the outfit? But at Buffalo I began to have real confidence in the equipment. Nothing of an ill nature had happened, except a little trouble from the storage battery which had been frequently low due to our lengthy stops along the road at various places. This, I remedied by installing an extra battery in parallel with the one on the car. No doubt the average tourist would not require this provision. Not having had any trouble with the equipment thus far, I began to wonder what to do with a newly purchased soldering iron. I had just left a laboratory and, after all, did really want to fix something—sometime.

During stops along the road to Buffalo, I had always thrown out an antenna wire, so that the set would not be limited. The antenna in the car top seemed valuable only for local work and for use while driving. When I did actually give the car antenna a try out, it proved to be a good competitor of the regular short line off the car. At Buffalo we listened to Schenectady while driving through the streets. The volume was excellent. Although this car antenna is a sort of modified loop, it is non-directional, due to the fact that it lies in a horizontal plane.

The Automobile Club of Buffalo, stationed far out in the country at Clarence, invited us to have dinner and to spend an evening in their big chairs before their huge log fires. Spring air was still chilly; in fact a day or so before, we had lifted our heads in the early morning to find the tent and everything else covered with snow. Steak before the open grate sounded very good. Members of the Buffalo Launch Club were holding their annual dinner there that day. We undid the wing nuts that held the radio set on the running board, pulled the plug from the electric light socket behind the case, and carried the set and the spare battery inside the club house. Schenectady gave us a good dance program, on a wire between balconies.

At Cleveland, a local station and also one from Detroit could be heard while driving up every street and boulevard. It was interesting to watch the surprised folks in trolleys, passing autos and on the street. On these rides, bridges and viaducts showed what they do with radio waves. As we passed through a viaduct, signals stopped. Bridges had a similar effect. Our camp was on the lake at Edgewater Beach. The music from Detroit and from the local station was as perfect as I have ever heard by radio. When one stood far away from the set, the Hawaiian singers with their guitars seemed to come from some pleasure boat far out in the lake rather than by radio from Detroit.

I left this camp one night for a radio ride on a boulevard running along the lake. Just as



THE TAYLOR-SLOAN PARTY AND THEIR MUCH-DECORATED CAR
The old-fashioned lantern and the globe were presented to the travelers "as a precaution against driving past China"

I made a sharp left turn to pull up on the street, the music stopped suddenly. Apparently it was a clear open space. I drove back and forth, turned around, and soon found that there were no directional effects. There was a circle of ten feet or more where signals were extremely weak. A guy wire from a pole a dozen feet away caught my eye. This was the cause of the distortion. I thought, then, of the many carelessly erected antennas that may be wholly or partially strung in just such pockets, unknown to the radio fan.

The effects of buildings, trees and mountains began to interest me, much more than when I had read of them in books. It is contrary to natural belief, but I have driven many times from densely wooded parks to open spaces and found little change in signals. However, a turn into a narrow alley may make a considerable cut in the energy received, even with only a one-story building intervening.

In drives about Cleveland where the streets were only fairly wide, there was no noticeable change in signals, although we drove for an hour in widely separated parts of the city. This selfsame experience in other cities indicates that there is scarcely an appreciable variation in energy over a fairly wide area surrounding the broadcasting station. When one is a dozen or so miles away from the source of transmission there is a gradual and easily noticeable reduction in signal strength as the distance increases.

One elderly lady in Cleveland came up and told the story of her runaway son. She went home greatly cheered when we told her we had heard by radio the news that Alexanderson's lost boy had been found by the owner of a radio set.

In Chicago, we camped for two weeks at Jackson Park. Groups of people from the artists' colony came each night for concerts and radio rides. They were somewhat mystified at first by the short antenna and the excellent quality of the music. Most of them seemed to have thought that radio sets at best are nerve racking boxes of noise. Before we had broken camp, many of them were preparing to make sets of their own.

A reporter from the *Tribune* came to see us while there. He seemed greatly interested in radio, and I decided to have a little fun. At

my request he held the bare end of a six-foot antenna wire to his ear. I tuned in a local station. He took the wire away and then touched it to his ear again. The concert stopped and started correspondingly. "Say boy," he said, "I think I would make a better antenna than a newspaper reporter."

Another night I tuned in Davenport for the artists. The sun was just going down. I was using a very short wire, and the signals were only fair. As the sun dropped below the horizon the volume of the incoming concert seemed to treble in a quarter of an hour. This was much more rapid than I had thought possible.

When we were driving along the lake one night at Jackson Park, the radio concert dropped in volume, then became noisy and irregular. At first it seemed that the tubes were breaking down. The trouble proved to be a loose wire, making and breaking contact with the antenna post behind the panel. As a temporary repair I slipped the wire under the post. Later I soldered it in place, the only time that I have used that "poor investment" iron.

While waiting for the brakes of the car to be adjusted, I tried the radio in the second story of a Chicago garage. Men were busy on all sides. The steel beams looked impregnable as far as radio was concerned. I clipped on the car antenna; and market reports from a local station came in with tremendous volume, temporarily putting an end to the work of every mechanic in the place. Some one asked how radio came through steel buildings. One of the mechanics pointed to an open window. The serious expression on the questioner's face brought a laugh from every one.

My sister gave a talk by radio at the request of one of the Chicago stations—a story of our trip by auto around the world. I remained outside and heard it from the car. It surely



THE THREE "VAGABONDS" AT WORK IN THE CHICAGO ARTISTS' COLONY

Blanding Sloan is wielding the brush, and Peter Taylor is making tests on the set to the tune of Miss Taylor's portable typewriter

did seem weird to hear one's own sister talking from the black case, and later to see her walk from the station. This is, of course, all very ordinary, but the element of wonder in it never diminishes with me.

We stopped to see Uncle Joe Cannon at his Danville Home in Illinois. Sloan made a hurried charcoal sketch of him while he talked. Over in the corner was a radio set. It struck me that radio corners are rapidly becoming one of the country's most popular, and best, institutions.

At St. Louis the tourist camp was nothing less than a small city. Every one was waiting patiently for the roads ahead to clear, there having been daily rainfall for weeks past. One night the *Post Dispatch* broadcasted the opera "Wang." The little tourist city soon gathered around our radio, enjoying the entertainment. A strange thing about the incident is that the tourist camp and the open air theatre, where the opera was produced, were only a few hundred yards apart, in the same park. If one had stood halfway between he could have heard the concert from two directions.

It would seem that the country in the region of the Mississippi has considerable effect upon radio transmission. As we approached St. Louis, everything to the east coast came in with heavy volume, slightly decreasing as we neared the river. With each following evening that we went farther west, Eastern stations gradually came in stronger, for more than a week, after which time they diminished again. I could think of nothing but the valley to account for it. What else? Weather conditions apparently were the same.

It seemed good to approach Kansas City and be through for a little while with days of mud and rain and constant ruts. On the last lap in Missouri we stopped in a little village cafe to get something to eat, and to rest for a time from the weary road. I looked at the car through the restaurant window and wondered how we were ever going to get three or four days of mud off the caravan. It was everywhere—splashed on the hood and thrown on the top. It was even piled inside, having dropped from our high boots after we had jumped out many times either to tow a fellow tourist from a mud hole or to dig a trench to guide us from a rut when passing other cars. The radio had its share of mud, too, for it is the stepping stone when one opens the car door to leave or to enter. I continued to look through the cafe window at the car, and at the



AN INSPECTION

Which revealed no indication of the set's rough journey from New York to the Kansas City camp



THE MAYOR OF KANSAS CITY LISTENS-IN ON PETER TAYLOR'S OUTFIT

Frank H. Cromwell is the first mayor to broadcast police court sessions and other municipal activities, as a means of civic education. (His story is told in August RADIO BROADCAST—"'Selling' the Public on Better City Government.") Peter Taylor, his sister, Mildred Taylor, and Blanding Sloan (in background) invited the Mayor to try out the receiving set which they are carrying on their round-the-world auto trip. At the time the picture was taken, the car had done 3000 miles without breaking a tube in the set, which is mounted in sponge rubber

farmers in blue overalls, walking past. What would they think of a concert from this automobile? I hurried out, turned on an orchestra from Kansas City and came back to listen, to watch, and to finish my dessert. I watched them crowd around the car, each one trying to get nearer. They looked at one another with expressions of surprise. We sought the road again after the concert ended. All of them seemed disappointed that the radio had stopped, even though it had been going for a long time.

That night we had to set up camp and cook supper in the rain. No one seemed to be interested in anything but sleep; but music is always good for tired bones. I draped a poncho over the open set, tuned in a flute-piano-violin concert, tied a long string to the filament plug and rolled up in a blanket, still keeping hold on the end of the string. It was surely real comfort, lying there listening to the music and the pouring rain, knowing at the same time that I did not have to get up to shut off the set. Later on, when I was nearly asleep, the concert stopped. I pulled on the string, the lights went out—and so did I.

Although I had never seen the Kansas City broadcasting stations, I had drawn layouts of their antenna systems, etc. These stations had served us faithfully, too, all the way from New York. It gives one a peculiar feeling first to hear a station when hundreds of miles away, then slowly by auto to cover the intervening gap which the radio spans in a moment. Each day the space grows less, till finally one finds himself rapping on the studio door.

From our Kansas City camp we received daily reports of road conditions by radio—an excellent service for tourists. When the report came that our route was passable, we moved on. Meantime I had taken down the equipment, and cleaned and inspected every part.

There were no loose units, wires, bolts, or anything to indicate that it had been having a rough ride on an automobile.

In our Kansas City radio drives, energy-*vs.*-distance results corresponded to those in Cleveland. Anywhere in the city signals were of the same volume whether the car was directly under the antenna or a few miles distant.

One night, while pleasure riding on the high bluffs in the northeastern part of the city, a car drove alongside us, and the folks inside smiled as they watched the lighted tubes and listened to the piano selections. Then others drove closer, soon making a rather large moving audience. We were using what one might call a folded antenna: the car top was down with the antenna inside it!

When we left Kansas City, buildings were taking on decorations for the arrival of the late President Harding on his Western tour. In the newspapers I read an article explaining the preparations for broadcasting his speech from Convention Hall through the radio station of the *Kansas City Star*. We reached Lawrence at midday. The afternoon paper announced that the President would be heard at eight o'clock in Central Park from the radio on our car. I had no hesitancy in telling the reporter that the speech would be audible for two blocks. Other work delayed us; it was after seven before we drove into the park to make a test. I did not expect that many people would come, due to the late announcement. I was uneasy as we drove in, for there were pop and ice cream stands erected in a haphazard manner, apparently awaiting some great event. It looked as though we had made a mistake on the park location which the Mayor had granted us. It came as a shock when a man in charge of one of the stands said that President Harding was going to be heard on a radio at eight o'clock. We threw up a thirty-foot line to a nearby bandstand. In a moment the Sweeney School at Kansas City came in with power to spare. It was then seven-thirty, and we had not yet eaten. We hurried to a restaurant, satisfied with our hasty test. At five minutes to eight we were back in the park again. A huge crowd of people stood there, and dozens were coming from all sides as we drove in. It was just one big unit wondering whether anything was going to happen, and if so, where the source of it was. Then it dawned on me that I was a poor sort of person not to have allowed any factor of safety on such an occasion. Up till the last moment we had driven recklessly over bumps in our haste. Suppose something had broken. Somehow I knew that it had not. The one loose wire at Chicago had not shaken my confidence in the equipment. If serious troubles were to develop, they would have done so before this, especially in Missouri, where springs broke and backbones suffered as we plowed through the muddy zig-zag ruts. We slipped the line under the antenna post. Sloan went off about a hundred feet to motion up or down on the volume. I did not want people to get too close, so I warned them that the talk would be so loud that if any one stood too near, his ears might be affected or he might be knocked down. They remained back and the volume from the loud speaker, only a foot or so above ground, was not shut off by a human screen. Finally the shouts of the audience at Convention Hall, Kansas City, died away. Our listeners gradually settled down on the grass. At first it was difficult for them to get over the unusualness of the situation: shortly



TAKING THE FROSTING OFF

before, a car had driven in, and in a moment it was sending forth the voice of the President. Soon the faces indicated that every one was listening to the speaker himself, and not to a radio set. There was great applause many times as our hearers shared the feelings of the other audience in Kansas City. When all was over, many came to see the set and expressed great surprise at the good volume and quality. I tuned in a few selections from Omaha, then drew in the wire and drove away. Since there was no road it was necessary to drop off a high curb stone. I wondered what they thought of radio as we hit the street, purposely at no slow rate.



When approaching Denver where the Rockies rise up in the distance, I wondered what these huge ranges might do with radio waves. We camped in the city at Elitch's Gardens, gave the B batteries a test and found them ready for the grave. New batteries restored the proper tuning conditions. Los Angeles came in with remarkable clearness, considering the time of year and that we were using the car top antenna. We drove high up into the mountains above Boulder on one of the following nights. A range of the Rockies, a jagged vertical wall only a few hundred feet away, rises to the sky between the camper and the west. After dinner, my sister said, "This is one of the places where I enjoy radio best." I looked at the range running to the north and to the south and tried to see the top. Things looked dubious, but I connected the car antenna, and soon we had our choice of two stations in California, equally clear. The volume on the loud speaker was the same as at Denver, thirty miles to the east in fairly open country! Even with an antenna wire only three feet long, the stations were still audible on the loud speaker. As we approached these mountains, later, stations from the East fell off very rapidly. The volume was not even half that of West Coast stations which were a shorter distance away.

One afternoon at Elitch's Gardens we parked the car in a large circle of trees and staked a rope around them as an enclosure for the car. The newspapers read, "Dempsey-Gibbons at three." A number of people had listened to our concerts previously and had inquired about radio returns of the fight. Many fans were on hand at the appointed hour, and by the time the returns began to come in, there was a large crowd. Some sat in the dirt, consideration for clothes being a minor detail. A director of a nearby theatre copied the returns and hurried them to the stage during the matinee. The scene was much like a real prize fight arena —the ropes, the crowd, perfect in every detail, except for missing towels and fighters. In this way, on another evening, we received the Willard-Firpo returns, for an enthusiastic crowd. There were many women in the audience, too, listening eagerly and cheering with the others. I wondered how many of them would have attended a real fight.

Denver, a veritable city of auto campers, gave me the impression that all America is touring. It seems we have taken on the gypsy's best heritage. Nearly every city, likewise, between New York and the West Coast has provided a public camping ground for its guests. Municipalities apparently compete with one another to see which shall leave the best impression with the traveler. Many provide shower baths, running water, cooking facilities, grocery shops, laundry facilities, swimming pools, and garage service, most of which is free or available at cost price. In my experience in all these cities of American nomads, I have been surprised to find that almost all of the travelers are radio fans when at home, but that it just had not occurred to them to take the set along, or it seemed impractical to do so. Radio is such a great pleasure while touring, I am surprised not to have found one set on the road.

There is a pretty place west of Denver called Inspiration Point, where people go at sunset to look at the blinking lights of Denver down below, and to gaze west into the mountains at the setting sun. Many times we drove up there and turned on the radio in the late evening. Folks opened the doors of their closed cars and listened. One could hear by radio the orchestra that was playing at an amusement park far below beneath the blinking lights. Some people came near and looked into the set. From the light of the tubes surprised faces stood out in the darkness as first one, then another, looked into the mysterious half-lighted cabinet. It was a real pleasure to sit there in the dark looking into the dim mountains to the west and listening to the radio—first an orchestra, and then a few Southern songs or a violin concert. One man asked me if there

were a needle and record inside the case, and even after an explanation of radio he failed to understand.

At the time of this writing, our camp is on an Indian reservation at the foot of the mountains north of Taos, N. M. A cold, clear mountain stream, the Star River, flows by, almost underneath our tent door. An Indian village is only a little walk away. It seems an unusual kindness for them to have broken for the first time an age-old rule, in allowing us "white men" to camp here. We visited the Governor of the Pueblo when we arrived, and showed him the parchment scroll. He called a council, interpreted the writing, and wrote his name with those of other mayors of the country. The Indians were afraid of the paper, at first, for they feared that they might be signing away what little land they had left. They said we might camp there. However, we chose to spend our first night in a colorfully furnished adobe house at the request of one of the Indians. The following evening the same Indian took us up a trail, which leads into the mountains where these people go to hunt, and gave us a place to camp—the best that he could find. I like it here. Every day the Indians come and visit us. A few know Spanish well, others speak good English. We converse with them as best we can in each language.



INDIAN CHILDREN LISTENING-IN
Quite as curious as their white neighbors

One Indian told me that he had picked up a piece of paper one day and read of radio for the first time. He said that he knew his thoughts would sometime bring a radio to his village. He told me he knew it was this which had brought us here. Then I understood why he had come through the crowd the first night we gave a concert in the Pueblo, and had shaken my hand in great enthusiasm, saying it was the first time he had heard radio. One night at our camp when we were listening to a Western station, he said, "California—thousand miles away," then looked first at the small wire then the set. After a while he said, "I wish I could go there, sing for my people in my Pueblo by your white man's radio." These nights remind me of similar ones in Cuba, recalling experiences when we journeyed to outlying sugar plantations and gave concerts to the people who live in straw huts.

Some of the Indians say that the white man's inventions are bad. They like them very much, but they know that with them and our ways, their colorful dances, their moonlight songs from the adobe house tops, songs for rain to grow their crops, and all their traditions, will gradually be lost. As they pass our door, some of them leading burros loaded with wood, others riding horseback to the mountains for game, they smile and call out "Bueno!" Often they stop to talk and to have a little coffee or a cigarette. I wonder at their calling us "Amigos" so few generations after the white man encroached upon their land.

Los Angeles and San Francisco are now only a few days' drive. As I look back, the country we have traveled through impresses me as one big playground for radio tourists. I regret that we are coming to the end, temporarily, of our radio rides. We shall nevertheless still have concerts from the States on our ship to Japan, at least until some Oriental station—in Peking or Calcutta—turns our dials to unaccustomed marks.

Just to Please the Wife

By HARRY IRVING SHUMWAY

Drawings by THOMAS E. MONROE

WHAT starts the thing is the Wife says to me one fair sweet morning she wants to hear some sort of a Largo by a bird named Handel and that I can do no better than trickle in town and buy one of these radios. All the neighbors have them. In fact, the first intimation a lot of the same have that their houses have chimneys on them is that they need something to hang the wires on. And so, says the Wife, if the neighbors have radios we've got to have one.

I remember the patent washing machine and the vacuum sucker and 8 or 9 water filters none of which was ever known to work, so I don't fall with a sickening thud for this latest idea.

"You are always knocking a proposition when you first see it," says the Wife. "You wouldn't ride on a trolley car when they first came out. I hate to say it, but as a cold water thrower you have Niagara Falls looking like a medicine dropper. For heaven's sake come out of the Tut Dynasty and realize the world is finding out something new every now and then. Why only yesterday, Mrs. Thumscrew-Jones told me she heard Troy, New York."

"That's no recommendation," says I. "You remember we drove through that place last summer and broke a rear spring on what they call their highway. Believe me, I don't want to hear from that place unless they send me a new spring."

"You have no poetry in your soul, no love of music," says the Wife. "With these radios we can tune in all sorts of concerts, lectures, and everything. Besides, it won't do you any good to argue because I'm going to have one anyway." The way she looks at me means plainly, "And don't you come home to-night unless you bring it with you."

Well, when they put it up to you gently like that, there's nothing you can do but do. Consequently, an hour or so later finds me looking in a store window full of things with names on them which Greek would be easy compared with. There seems to be a lot of excitement going on inside, so thinking it might be a fight or something, in I go. I get wedged into a corner with another fellow, who has lost his hat, and who is breathing like a horse that has been down the home stretch too many times.

"Where are you hurt?" I says.

"Hurt?" he asks. "I'm the luckiest guy in the world. I got one."

"Got what?" says I, wishing to humor him. Evidently he is a member of the Coo Coo League.



"NOW I CAN GET DETROIT!"

"I got a QV 1234 tube," he gleams (or figures that sound like that.) "Now I can get Detroit!"

I choke off a good reply that occurs to me and inquire mildly, "Does this radio do that to you?".

"You bet," he says. "I've been after one of these tubes for weeks. Now I can get——"

"Yes, I know. You can hear Troy or some place. What's all the fight about here?"

"There's no fight," he says. "It's always like this. Just people buying radio stuff. Haven't you got a set?"

"No, but I gotta get one that'll play Handel's Largo, or there'll be the devil to pay."

"Then take my advice, friend," he says. "Take my advice and get a regenerative two-step frequenter with a Whiffenpoof hook-up."

I bust away from this maniac whose talk has me dizzier than riding the giraffe on the merry-go-round. I elbow my way up to a counter and a young lad with a tired face stands at attention.

"Without hard names or technique," I says, "let me meet something simple in a radio set—and something cheap."

He shifts his feet and leans against the counter. "You might get a tuning coil or fix up a loose-coupler set. Then later on you could——"

"Hold on," says I. "Let's stick to the present tense. Show me this loose-coupler."

He reaches into the case and brings out an apparatus which could be part of a sewing machine, perhaps. There are a couple of spools, one with copper wire wrapped around so it couldn't come apart, and another with cloth-covered wire the shade of a pool table. Some brass rods run through it and hitch into a small post. The whole is stuck onto a board.

"All you need with this is a crystal detector and a phone block. Wire them up, hitch on your ground wire and antenna lead and you can listen to the music."

"Can I hear Troy and Detroit and Chicago?" I ask.

"Sure—if you take the machine to within twenty-five miles of those places. This outfit only sucks in the signals at a 25-mile range. Do you live near here?"

"Yes."

"'Then there's a couple of good broadcasting stations you can get without going anywhere. Later on you can make this into a regenerative tube set by adding——"

"Let's stay in low speed for now," I says. "We can graduate to something more fancy in the future. Show me how to wire this thing up and gimme the parts."

"You know about the antenna?" he asks.

"You mean how to tie a couple of chimneys together with wire?"

"Yes, you take a——"

"Wait! Draw me a picture of it and I'll follow your plan."

He gives me a book of instructions and makes a lot of diagrams on the back of an envelope and says it is so simple a child can hook it up. I think we over-estimate what our children can do. When they tell me anything is so simple a child can do it, I always know there is some darned hard technique to it or they'd never bother to hand out the child-can-do-it stuff.

Well, anyway, I take the thing home, unwrap the bundle, and step back waiting for the applause from the Wife. She stares at it with a cold eye. You would have thought I was the neighbor's old cat laying a dead mackerel on the table.

"*What* do you call *that* thing?" she asks.

"That," says I, "is a loose-coupler."

"It looks to me like an egg-beater—for ostrich eggs. What is its function?"

"Why, you said to get one. It's a radio. All we have to do is wire up a few things and presto—we have a radio."

She registers exasperation and takes in air. "You have been deceived as always," she says. "All the radios I have seen have had ambition enough to sit up. This thing is playing dead. Mrs. Thumbscrew-Jones's machine has a nice black board with dials and door bells, etc., all over it."

"Sure. That's the second stage. You get that way—I mean, that kind when the symptoms are violent. This baby I have brought home is a sort of rudimentary radio. Now let's lay off the argument and you help me spread the aerial in the breeze. Here's the sketch of it."

I lay the salesman's drawing on the table. As we live in the suburbs, the dope seems to favor a one-piece antenna about a hundred feet long.

"What's the highest place on the house which I can dig my feet into without a fall?"

"Try the sleeping porch," she says, pouring over the drawing. "This thing is simple. What's this other wire marked 'L'?"

"That's the lead-in wire. You wrap that onto the antenna and run it to the binding post on the machine."

"Simple. Now the other end of the long wire we can tie to Charlie Harding's cherry tree."

"It's an electrical wire and you can't graft currents on a cherry tree," says I, facetiously. (This was a feeble one, but you never can avoid getting them off your chest once they pop into your head.)

She pays little or no attention to me. "Get the wire ready and we'll go out."

Putting up the outside trimmings to a radio no longer excites any interest among the neighbors. Nowadays when you see a full grown prominent citizen in a Prince Albert coat and a new hat climbing a tree you don't think his mind's on a holiday or he's after reckless pub-



HE'S NOT CONSPICUOUS
Any more than if he's hanging out the washing; in fact, less

licity. You know he's putting up the family radio and he's not conspicuous any more than if he was hanging out the washing; in fact, less.

It's been many a year since I climbed anybody's cherry tree. I guess this is the first time I've ever done so without choosing my exit first. Outside of barking an old shin in a new place, no casualties result. The first end of the old antenna is up.

Next I make the sleeping porch and drop a rope down for the other end of the long wire. I hook her in place, attach the lead-in wire and run downstairs. By this time the old pulse is beating fast and I am getting as excited as a kid.

But it's no time to get excited. The more you study into radio the more you find out that calmness and deliberation are your best assets. Like, for instance, the moment when I got the axe from the cellar and was going to smash the whole business—it was wrong, and you can't tame this new science so it will eat out of your hand by such 5,000 B. C. stuff as that. But I am getting ahead of my story.

The bird who sold me the loose-coupler drew a diagram which showed how I should wire up the crystal detector, which isn't like any crystal in my acquaintances but is a glass tube with a chunk of coal or something at one end and what the guy said was a cat's whisker at the other. We owe a lot to the cat. We use his whisker to play on a radio, and on the violin we use another part of him, which I will not mention as this is an article on radio and not violins. Then this crystal gadget has to be joined to what they call a phone block. Well, what with diagrams and arguments and a half hour or so, we actually get it done. Finally I stick the phone terminals into the block and attach one end of the ground wire to the machine, while the Wife runs the other end to a faucet which we have concealed in the kitchen sink.

It is a pretty auspicious occasion, as after dinner orators say, when we slide our ears into the phones. With one hand on the throttle of the cat's whisker and the other on the slide trombone of the apparatus, I start to tune up.

The point is, you have to tickle the crystal in a sore spot with the cat's whisker, and right away you get music—in dots and dashes, which isn't music to anybody but a parent with a new-born radio.

The crystal in the present instance is the most callous one you would find in a day's walk. Finally, after a few minutes, I find the cat's whisker is becoming exhausted and we aren't getting anywhere, let alone, Troy.

The Wife says, "You let me try that and you go rehearse these wires and things."

But no—not a mew out of the cat's whisker. Finally I have an idea that the ground may not be all that should be expected. I go into the kitchen and find that the Wife has wrapped the wire onto the faucet all right, but onto the *porcelain* part of it. Even *I* know this isn't quite *à la carte*, and besides it makes it hard to turn on the water if you should ever want to. So I give her a yank (the wire, that is) and hook her around the metal pipe. Great Cats! The Wife lets out a shriek you could hear a block away and I think I have electrocuted her.

"What's the matter?" I yell, running to the scene of the accident.

"There's a band playing," she says, as pleased as Christmas. "Shhh! It must be in Los Angeles, because I can just barely hear it."

I grab the other ear phones and sure enough there's a band going fine—keeping time and everything. It's clear, but faint. So I begin to manipulate the coil.

Yes, you've guessed it. I sour the whole machine. The band disappears. I wish I could too, because the Wife takes off her phone so she can tell me a few things.

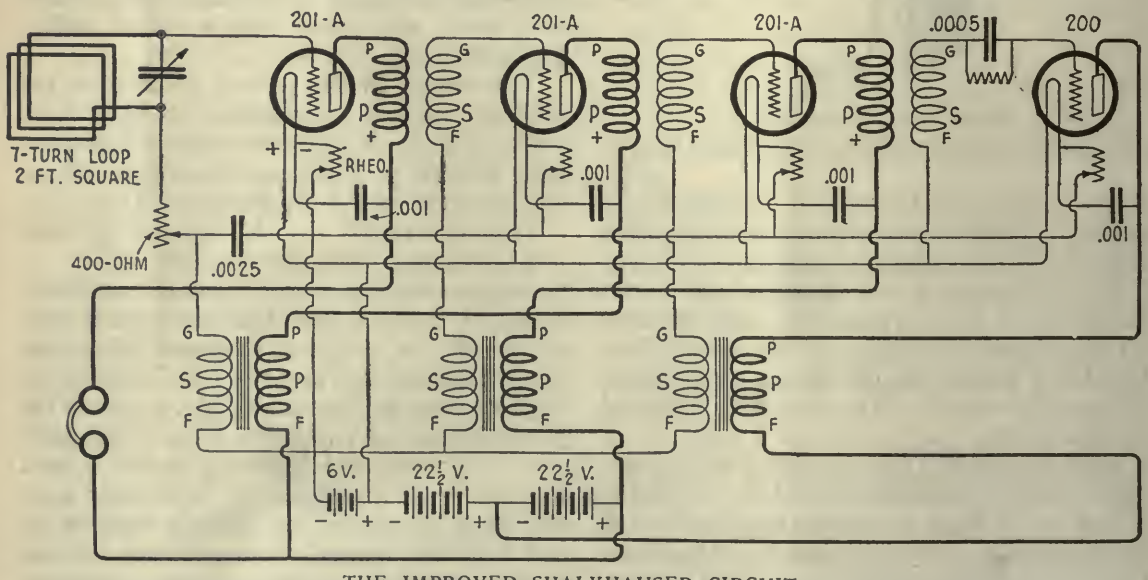
"You never *will* let well enough alone," she exclaims. "You did the same thing to the carbureter on the car. You tried to cut it lean and it took a couple of garage hounds a day to get the car breathing again. This band maybe was in London for all we know and here you've gone and got us disconnected."

Well, we fuss over that machine for the next hour without getting a single message. The cat's whisker could just as well be a feather duster.

Finally, one of the members of our family which has any sense thinks of looking in the newspaper at the broadcasting news. No wonder we aren't getting an earful! The program is scheduled to stop just about the time I knock the cat's whisker for a goal from the field!

We make a fresh start in the evening and find everything is OK. The strength isn't all that could be hoped for, but the quality is good. The next night we do better, probably the antenna gets loosened up, like a car after the first few hundred miles. I will say, it tickles me the way I can wipe a long-winded speaker right out of existence with two fingers. This is a mean but enjoyable advantage. You take an old man eighty years of age who gets his ears into a broadcast which is a bed-time story for little folks: well, you can't expect a boy of this age to curl up in glee over fairy tales. So what does he do? Why, he just tunes his way out of it and tries for the sound of some careless saxophone in another place. On the other hand, a kid seven years old may happen to get a report on market prices in the West. It's not often that a seven-year-older plays with that stuff as a hobby; so he just fools with a knob for a minute till he has tuned in the funny rabbits in the cabbage patch.

The Wife has always been a great traveler. She wants to tune in to Troy and Schenectady and other distant places. (The Los Angeles or London station, by the way, we found out is a store in the next town to us.) However, I'll admit I'm beginning to think, myself, of adding something to this set, so as to stretch it out—like making a three-bagger out of a scratch single. As I tell the Wife, if we had enough more junk to boost up the noise, we might hear PWX (Pretty Wild Xcitement) loud enough to smell the smoke from real Havana cigars.



THE IMPROVED SHALKHAUSER CIRCUIT

The circuit shown here is an improvement over the one published in our August number (page 417). It is sometimes advisable to use .001 fixed condensers across the secondaries of the audio-frequency transformers in addition to those shown here

Using What Junk You Have in Making a Super-Heterodyne

By GEORGE J. ELTZ, Jr.

Few radio enthusiasts appreciate that most of the equipment they are now using, or have on hand, may be used in building a super-heterodyne. As a rule, the only additional material necessary is a few tubes and three or four long-wave, radio-frequency transformers.

We have been making an effort to bring this receiver within the reach of those of moderate means, and have had the coöperation of a number of the foremost radio men in America. We are trying to reduce the number of tubes needed to the absolute minimum and are experimenting with various reflex arrangements. By combining the best ideas of the men who have done most with this type of receiver, we are able to pass many improvements along to our readers.

This article is a valuable addition to the information on the super-heterodyne which has already been published in RADIO BROADCAST, set forth by such authorities as Paul F. Godley, Walter Van B. Roberts and the author of this article.—THE EDITOR.

THE super-heterodyne receiver, several descriptions of which have appeared in this magazine, is coming more and more into general use, and for several good reasons, the first and most important, perhaps, being the increased selectivity which is obtained and the greater distance over which it will receive.

The construction of a super-heterodyne is not difficult, although a certain amount of care and experimenting is necessary if good results are to be obtained. This is particularly true when the "super" is to be used with a loop antenna. To some, the expense of constructing this receiver has appeared to be excessive. Unquestionably, due to the number of tubes and other accessories required, it will always cost more than many other types of sets; but when a set is to be made or bought which uses more than three tubes, the expense for the extra tubes and parts for a super-heterodyne is more than justified.

Its wavelength range is unlimited. The amplification obtained at wavelengths of 10 meters will be exactly the same as the amplification obtained at wavelengths of 10,000 meters. This is a property not possessed by any other type of receiving set and one which makes the super-heterodyne very valuable for the reception of short wavelengths.

A super-heterodyne receiver constructed in accordance with any of the diagrams shown here and used with an aerial of moderate size should give reliable reception under any but the worst conditions over distances of at least 2,000 miles. A receiver of this type used under good conditions should have an effective range of about 4,000 miles. When used with a loop antenna, the range will vary depending on the location. Loud speaker operation on a good broadcasting station should be possible over



FOR USE INSTEAD OF HONEYCOMBS

This is an ordinary variocoupler with the primary winding split to make the two oscillator coils. The secondary is used as the antenna pick-up coil

distances of at least 1,500 miles. Loop antennas, however, depend for their operation to a great extent on their position and location with reference to surrounding objects, and it is impossible to predict exactly what results will be obtained. Instances are recorded where a loop antenna has worked equally as well as a large outdoor antenna. And just as many instances can be cited to prove the opposite. In general, a small wire, either outdoors or indoors, will give better reception than the loop antenna. As each location must be treated separately, the only way to determine which type of antenna or pick-up system to use, is by experiment.

For those who are not familiar with the action of the circuit, it may be briefly stated that by its use the amplification of the incoming signal occurs at a frequency of approximately 50,000 cycles, a point at which much greater amplification per stage is obtained than if the incoming signal was amplified at the ordinary frequency. The change in frequency is accomplished by means of an independent oscillator which is part of the receiving set. This oscillator sets up a frequency differing by 50,000 cycles from the incoming signal frequency. The result is a beat-note of 50,000 cycles, and it is this beat-note which is amplified. The variations in the amplitude of the beat-note are in exact accordance with the variations in the amplitude of the original signal. Reception, consequently, is free from distortion. No regeneration is required, a fact which further insures clear reception. After the beat-note has been amplified in what is known as the intermediate-frequency amplifier, it is detected by a second detector tube, the output of which operates the telephone receivers, audio-frequency amplifier or loud speaker. Unquestionably, many more super-heterodynes would be in use to-day if it were generally known that parts of receiving sets already in use may be used in making them. With this object in mind, we shall describe several popular circuits, which, by the addition of an intermediate-frequency amplifier, will permit the conversion of the receiving set already in use into a super-heterodyne.

An ingenious amateur can modify the super-heterodyne circuit in a number of ways. Once a good intermediate-frequency amplifier is constructed, the detector may consist of either a single- or three-circuit tuner. Practically any receiving set on the market may be used for this purpose. It is recommended, however, that a three-circuit tuner be used whenever possible, since the use of a single circuit tuner will reduce to a great extent the increase in selectivity which the super-heterodyne makes possible.

How Much of This Have You on Hand?

1	3-coil mounting	
2	50-turn coils	*or* 1 short-wave variocoupler to be used in place of the coils and mounting
1	35-turn coil	
1	2-coil mounting	
2	600-turn coils	
4	.001 mfd variable condensers	
1	detector and 2-stage audio outfit	
4	additional tube sockets	
4	additional tubes	

Provided with the above, you need procure only the long-wave transformers to make a "super" of your present set.

The Intermediate-Frequency Amplifier

THE most important part of the circuit is, as can be expected, the intermediate-frequency amplifier. On the operation of this particular piece of apparatus, the success of the instrument depends. It may be constructed in several ways. The most efficient and by far the most sensitive amplifier uses radio-frequency transformers having a resonance point at about 50,000 cycles. Those manufactured by the Radio Corporation, UV-1716, are particularly efficient at 47,500 cycles. and are now being used in many super-heterodyne receivers with great success. In Fig. 1, to the left, is shown an intermediate-frequency amplifier made with these transformers. The apparatus to the right is a detector and two-stage amplifier such as is used with any ordinary receiving set.

The intermediate-frequency amplifier shown in Fig. 1 is made with a tuned input circuit, made up of two 600-turn Duo-Lateral inductances in a two-coil mounting, so that the coupling may be varied; or in some other suitable fashion which will accomplish the same purpose.

Shunted across these coils as shown in Fig. 1, are two variable condensers, each of .001 mfd. capacity. These, in combination with the 600-

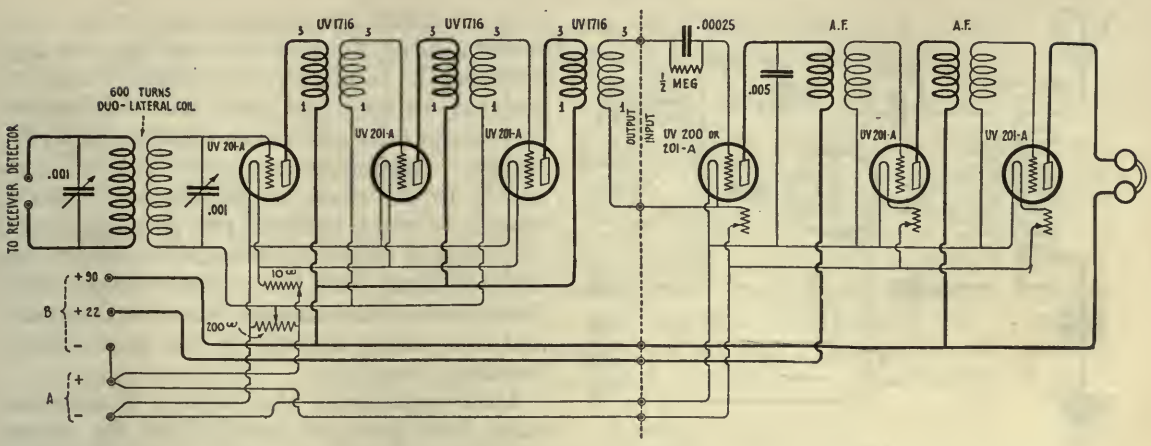


FIG. 1

Additional material required for the construction of the intermediate amplifier of the super-heterodyne is shown to the left of the dotted line. Material to the right of the dotted line is the conventional detector and two-stage audio-frequency amplifier, details of which have appeared in past issues of RADIO BROADCAST. This type of intermediate amplifier is tuned at the *input* to the amplifier by the 600-turn DL coils, shunted by .001 mfd. variable condensers

turn coils, give a frequency of about 50,000 cycles at one-half scale on the condenser. In this circuit the beat-note is tuned to resonance and amplified by the three tubes which follow. The output of the last amplifier tube is fed into the primary of the UV-1716 transformer, the secondary of which is connected to the terminals on the detector and two-stage amplifier marked grid and filament. *In making this connection it is important that the terminal marked "3" on the secondary of the UV-1716 transformer be connected to the terminal marked "grid" on the detector and two-stage amplifier. It is also important in the intermediate-frequency amplifier that the terminal on the primary of the transformer marked "3" be connected to the plate, and the terminal on the secondary marked "3" be connected to the grid.* The small condenser marked .005 mfd., shown in the plate circuit of the detector tube in the detector and two-stage amplifier, if not already present, should be connected in the position shown. The purpose of this condenser is to ground the 50,000-cycle frequency, preventing it from passing through the audio-frequency amplifier into the telephone receivers and causing oscillation of the entire amplifier.

The intermediate-frequency amplifier can be constructed without shielding, if the tubes are placed approximately 5" apart with the transformers immediately behind the tubes. If the tubes are placed with a shorter distance than 5" between their centers, the amplifier will in all probability oscillate and consequently refuse to operate properly. *If tickler terminals are provided on the detector and two-stage amplifier, the tickler terminals should be short-circuited.*

TESTING THE I. F. AMPLIFIER

THE intermediate-frequency amplifier can be tested for operation by connecting an antenna and ground to the two terminals marked "to receiver detector." By varying the condensers across both coils and making the amplifier regenerate by manipulating the potentiometer, long-wave stations will be heard. If interference is obtained from long-wave stations, shielding the two coils and condensers connected to the first tube of the amplifier will eliminate this trouble.

CONVERTING A STANDARD THREE-CIRCUIT RECEIVER

FIG. 2 shows the manner in which a regenerative receiver using two variometers and a variocoupler must be altered to be used in connection with a super-heterodyne. In Fig. 2 the receiver is shown without external oscillator. The beat note must be obtained by causing oscillation to occur in the regenerative receiver. On short waves this is readily accomplished, but on wavelengths of 500 meters or above, this method is not so good as the one shown in Fig. 3. This diagram shows the same three-circuit regenerative receiver, provided with an external oscillator. The external oscillator is coupled by means of a three-coil Honeycomb mounting to the regenerative receiver proper. Coupling is accomplished by means of the 15-turn Duo-Lateral coil, shown

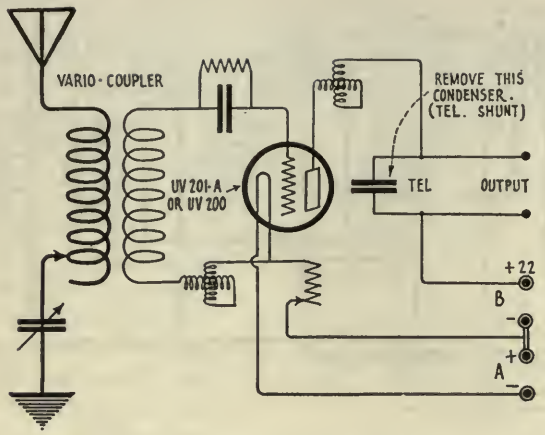


FIG. 2

Three-circuit regenerative receiver operated in conjunction with intermediate amplifier shown in Fig. 1. No oscillator tube is used, as the detector in the regenerative set operates as both oscillator and detector

in the lower left hand corner of the circuit diagram. The oscillator consists of two coils, one being a 35-turn Duo-Lateral, shunted with a variable condenser of .001 mfd. capacity in the grid circuit and a tickler coil of 25 turns in the plate circuit. Both these coils, when once set, need not be adjusted. The coupling of the 15-turn coil to the 25-turn coil must be varied. The same A and B battery may be used on all tubes in the set.

The circuit shown in Fig. 3 uses regeneration on the first detector tube. If this is used carefully, excellent results will be obtained. If the detector tube is made to regenerate too strongly, the customary amount of distortion present in a regenerative receiver will occur.

CONTINUOUS WAVE RECEPTION

C. W. may be heard with this receiver by causing the regenerative circuit to oscillate slightly, thus setting up a beat note between the incoming frequency and the frequency of the oscillator itself. This is of advantage for amateur relay work. It is rather difficult to obtain this setting. In constructing the oscillator, care should be taken to see that no long lead wires are used between the various coils and condensers making up the circuit. The condenser marked .005 mfd connected to the plate circuit of the oscillator, should be right next to the coil, as shown. The purpose of this condenser is to prevent the high-frequency from the oscillator leaking back through the wires coming from the B battery and thus acting directly on the intermediate-frequency amplifier.

Most signals on the shorter wavelengths come from amateur stations, and the almost universal use of C. W. makes it necessary that a receiving set be suitable for this type of reception.

USING AN OSCILLATOR FOR C. W.

IN FIG. 4 is shown a method of heterodyning by means of which reception of C. W. is simplified. In this circuit an extra tube is used, which, in combination with the coils shown in the diagram, forms an oscillator differ-

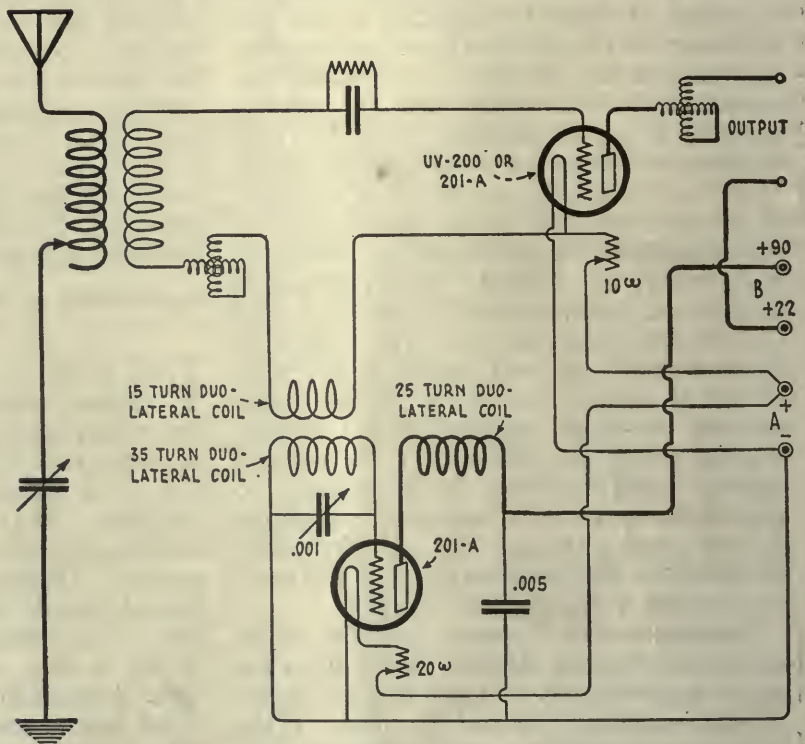


FIG. 3

Three-circuit regenerative tuner with oscillator. The first detector tube is regenerative, the oscillator tube uses the same A and B batteries as the intermediate amplifier. If regeneration is not desired, the variometer in the plate circuit may be taken out or shorted. This precaution is advisable in learning to operate the receiver

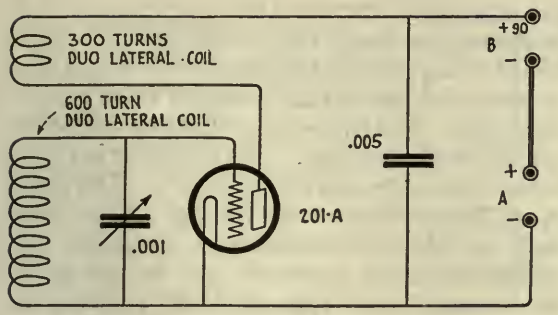


FIG. 4

Extra oscillator for simplifying the reception of C. W. This oscillator is adjusted to give a beat note of proper frequency with the incoming signal. It is placed near the intermediate oscillator, and need not be closely coupled. The same batteries may be used to operate it, however. It may be made very compact by using a UV-199 tube and flashlight cells

ing in frequency from the tuner of the intermediate-frequency amplifier by 1,000 or 2,000 cycles. This oscillator, in combination with the intermediate-frequency amplifier, sets up a beat-note which is unvarying in tone whenever C. W. passes through the intermediate-frequency amplifier. This method of reception does away with the trouble of setting the beat note frequency necessary with regenerative receivers and still retains all the advantage of the super-heterodyne. In Fig. 5 is shown another method of accomplishing the same result. This method is not quite so satisfactory as that just described. Of course, C. W. may also be received by causing the intermediate frequency amplifier to oscillate. The oscillation of the intermediate-frequency amplifier can generally be obtained by the manipulation of the potentiometer. The sensitivity of the receiver will be impaired to a certain extent, however, if this method is used.

AN I. F. AMPLIFIER OF IMPROVED TYPE

THE type of intermediate-frequency amplifier just described uses standard parts, and as far as efficiency is concerned is satisfactory. It may be improved, however, to some extent. One of the chief drawbacks of this type of intermediate- requency amplifier is the fact that tube noises and B battery noises are amplified and passed on by each stage of amplification. In addition, it is al-

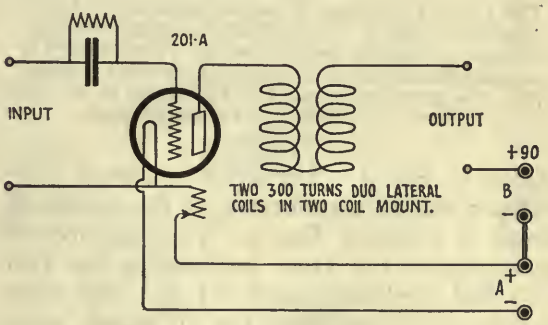


FIG. 5

Connection to second detector of amplifier shown in Fig. 4, to permit reception of C. W. The two coils shown act as a variometer to tune the plate circuit of the second detector

most always necessary to shield the two large coils used on the input. In Fig. 6 is shown an intermediate-frequency amplifier constructed along the same general lines as the amplifier shown in Fig. 1, but with the tuned circuit on the output side of the amplifier. The tuned circuit used in this amplifier may be the same as that used on the input of the amplifier,

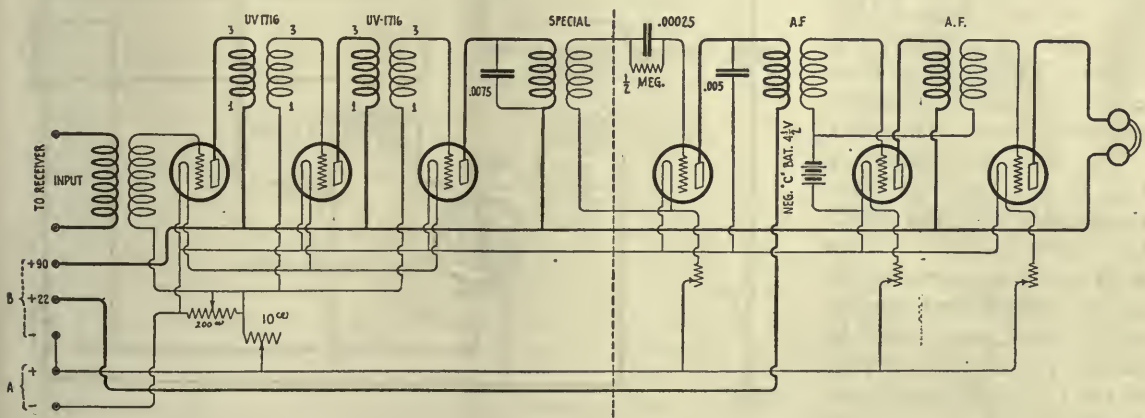


FIG. 6

Intermediate-frequency amplifier with tuned output circuit. Material to the left of the dotted line is extra equipment necessary. Materia! on the right of the dotted line is the regular detector and two-stage audio-frequency amplifier

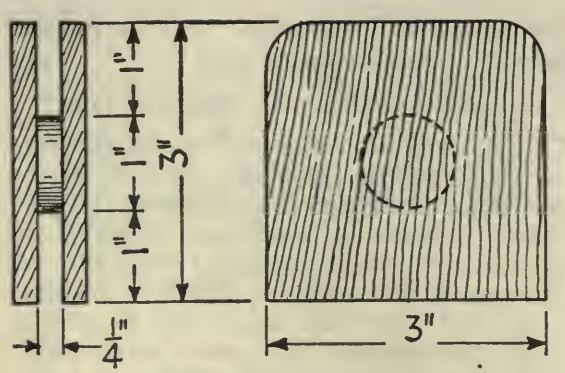


FIG. 7

This special transformer is used as indicated in Fig. 6 (marked "special"). The walls of this transformer may be made of bakelite or hard rubber. The primary is wound with 200 turns of No. 29 S. C. C. and is separated from the secondary, which has 1500 turns of No. 36 D. S. C., by several layers of empire cloth

shown in Fig. 1. Preferably it should consist of a special transformer, an illustration of which is given in Fig. 7. This transformer accomplishes the same purpose as the two coils and condensers used in Fig. 1 and when used properly overcomes the difficulties mentioned above. Although the transformer must be constructed specially, the added simplicity and saving in cost is well worth the trouble. The same care in shielding must be taken with this amplifier as with the amplifier shown in Fig. 1. A conventional detector and two-stage amplifier may be used, a small condenser being inserted in the position shown. For good quality, a negative C battery, if not already present in the audio-frequency amplifier should be inserted.

The amplifier shown in Fig. 6 can be used interchangeably with the amplifier shown in Fig. 1. When used with a regenerative receiver, a small fixed condenser of .00025 mfd. should be placed across the primary of the UV-1716 transformer on the input side of the amplifier. This small condenser acts as a by-pass for the regenerative action of the receiver. In Fig. 8 is shown the connection which should be followed in hooking-up the amplifier of Fig. 6 to a regenerative receiver consisting of three honeycomb coils. Two three-coil mountings will be required for this purpose. The oscillator in Fig. 8 is the same as the one used in Fig. 3. The same A and B batteries are used throughout. In case only one three-coil mounting is available, the coils used in the oscillator may be wound on an insulated tube approximately 3 inches in diameter. The coupling between the 15-turn coil and the 35-turn coil should be variable in any case.

OPERATING ON A LOOP

FIG 9 shows the connection to be followed when using the super-heterodyne with a loop antenna. Here the first detector circuit is not made regenerative. This eliminates one adjustment and the possibility of introducing distortion by means of regeneration in the first detector. Of course, the signals obtained by the use of a loop antenna will not be so strong as they would if an antenna were used, but

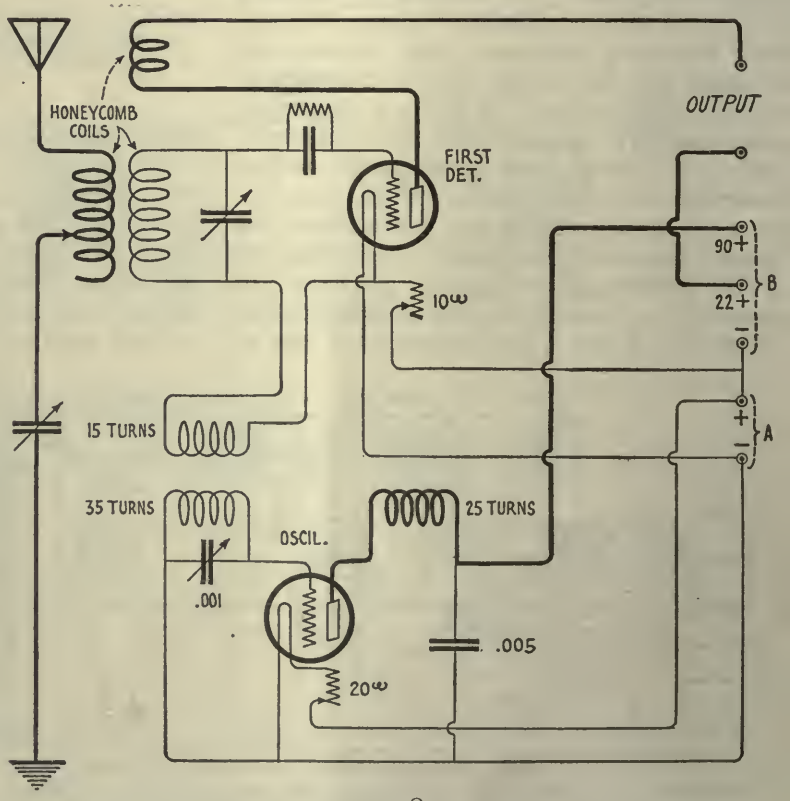
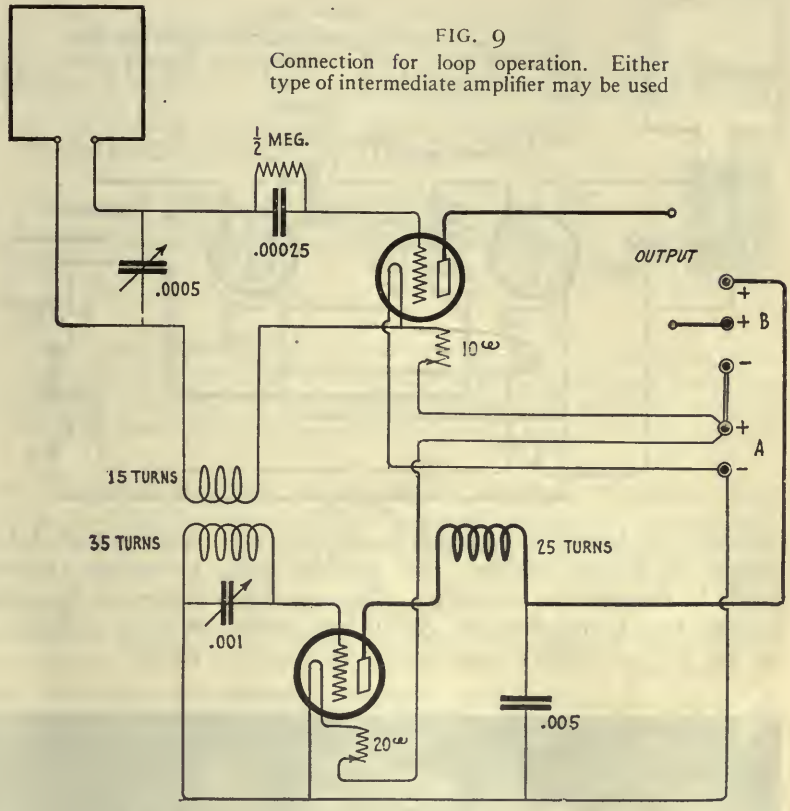


FIG. 8

Feed-back circuit regenerative receiver with extra oscillator. This may be used with either type of intermediate amplifier

less interference is likely to be experienced. Either of the intermediate-frequency amplifiers shown may be used, although preference should be given to the amplifier shown in Fig. 4.

FIG. 9
Connection for loop operation. Either type of intermediate amplifier may be used



USING AN ANTENNA

THE super-heterodyne receiver, while it has been generally used with a loop antenna, can be satisfactorily used with an outdoor antenna or a small indoor aerial. It is extremely selective; but when used with an outdoor antenna it is generally necessary to operate the receiving set connected with the antenna, with extremely loose coupling. If the coupling between the receiving set and antenna is too close, the selectivity of the first detector tube will naturally be destroyed and most of the tuning will have to be done by means of the oscillator. Even when this is the case, the selectivity of the receiver will be considerably greater than the selectivity of the ordinary receiving set. For this reason, it is not generally advisable to use a single-circuit receiving set as a means of coupling to the antenna and it is an easy matter to provide the set with binding posts to allow either method to be employed. If a small antenna is used, such as a short indoor wire, the single-circuit receiver will operate satisfactorily. No changes need be made in the grid circuit of the single-circuit receiver, the plate circuit being treated exactly as shown in the diagram for the two-circuit receivers illustrated in Figs. 2, 3, and 7.

Although most of the diagrams given show regeneration in the first detector circuit, this is not absolutely necessary. Regeneration does, it is true, improve the sensitivity of the receiver to a considerable extent but the introduction of distortion which is bound to occur when regeneration is present, argues against it. If the super-heterodyne receiver is used with a loop antenna, regeneration may readily be obtained by placing a variometer in the plate circuit of the first detector. Practically any variometer of standard manufacture will be suitable for this purpose.

A great many modifications of the super-heterodyne will probably occur to the ingenious amateur. The first detector tube may be replaced by a crystal detector when the receiver is used in connection with an antenna. (When used with a loop antenna, the first detector must be a vacuum tube.) Whether used with an antenna or loop, the second detector may be replaced by a crystal detector and good results obtained. In using a crystal detector as a second detector, be sure to pick out a crystal which will stand a considerable amount of energy without burning out. The amount of signal obtained from the three stages preceding, is sufficiently great to cause most detectors to burn out, necessitating constant adjustment.

Fig. 10 shows another modification of the super-heterodyne which works satisfactorily, although the number of controls is increased. This circuit shows one stage of radio frequency amplification before the first detector. Due to the characteristics of the radio frequency transformer employed, the sensitivity of the receiver will vary at different wave-

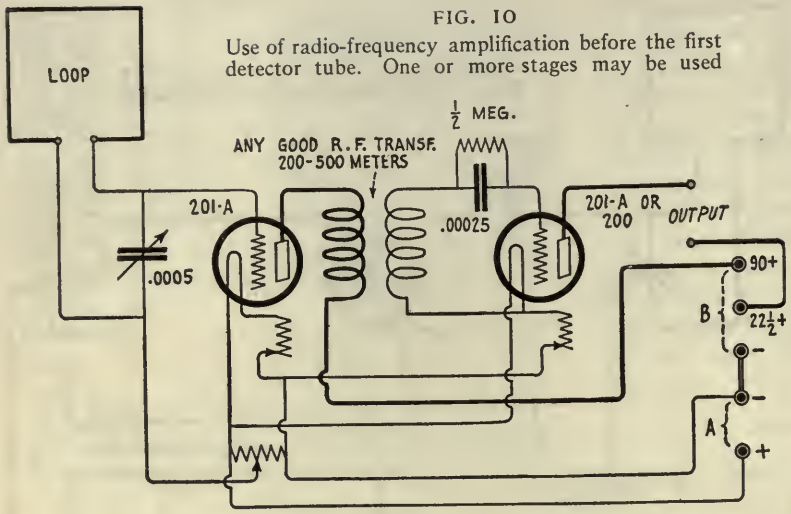


FIG. 10

Use of radio-frequency amplification before the first detector tube. One or more stages may be used

lengths. If, however, a narrow band of wavelengths is to be received, this method will prove to be quite satisfactory. The new Ballantine tuned transformers cover the range of 200 to 600 meters quite well. Of course, one or more stages of radio frequency may be used, but as a general rule two are all that will be of advantage.

The circuits shown indicate the use of UV-201-A or C-301-A vacuum tubes. Practically any good vacuum tube may be used satisfactorily. Bear in mind, however, that when using dry-battery tubes it is necessary to insert sufficient negative C battery to bring the grids of the tubes to the right potential. In general, 3 to 4½ volts will be required. The value of B battery and A battery will depend to a large extent on the tubes used. It should not be necessary to exceed B battery voltages of 90, with a 22½- or 45-volt tap for the detector tubes.



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The Fundamentals of Loud Speaker Construction

A Technical Discussion of the Factors Which Must Be Considered in Converting Electric Current into Sound Waves

By A. NYMAN

Recent years have seen a very rapid development in loud speakers for use with radio receiving sets. In this paper, which was read at a meeting of the Radio Club of America on September 28, 1923, the writer outlines the essential features of a successful loud speaker and also some of the experimental results obtained during an investigation leading to the development of one commercially successful type of instrument.

IT HAS been found that music reproduction requires the presence of notes ranging in frequency from 25 cycles per second to 5,000 cycles per second. The quality of reproduction is affected to a large extent by the loudness of individual frequencies; hence, the necessity of bringing in each frequency at a value proportional to the original volume. It can readily be seen that the quality of the pick-up instrument or microphone, as well as the design of the transmitting and receiving systems, is of the utmost importance.

Apart from the pick-up and transmission, the following qualities are required in the loud speaker itself:

(1) Uniform intensity of sound at all frequencies from 25 cycles to 5,000 cycles.

(2) Absence of resonance points capable of responding at a frequency different from that applied or giving an excessive volume of sound when their own fundamental frequency is applied.

(3) The ability to reproduce a combination of frequencies with a volume of each frequency proportional to the input.

(4) Absence of distorting harmonics at any individual frequency applied.

(1), Uniform intensity of sound at all frequencies is particularly important in reproducing every kind of sound. For example: A weak or missing range of frequency is noticeable even to an untrained ear. However, if it is near either end of the total range, i. e., below 400 or above 3,000 cycles, an untrained ear may sometimes fail to detect this defect. Similarly, an individual missing frequency can be occasionally overlooked. A loud range distorts the quality to a considerable extent, and a loud individual note has a very unpleasant blasting effect.

(2), if overlooked, is particularly liable to give blasting or an unnatural ring to certain notes. The fundamental may be suppressed and a harmonic of an altogether different pitch come through, possibly considerably louder than the applied note.

(3), dealing with combinations of frequencies, is particularly noticeable in speech reproduction. Normal vowel sounds consist of a fundamental of rather small volume and harmonics often much larger than the fundamental. Unless the proportionality is maintained, the sound of the voice will change, giving the impression of a changed pitch; a tenor voice may sound like a bass; a soprano like a contralto, or vice versa. The higher harmonics again determine the individual characteristics of the voice. Thus, in order to recognize a person's voice, the higher harmonics up to the 20th or 30th must be included and kept at their proportional value. What is true of the voice is true of most musical instruments.

Regarding (4)—the absence of distorting harmonics at any individual frequency—certain materials have qualities which give them

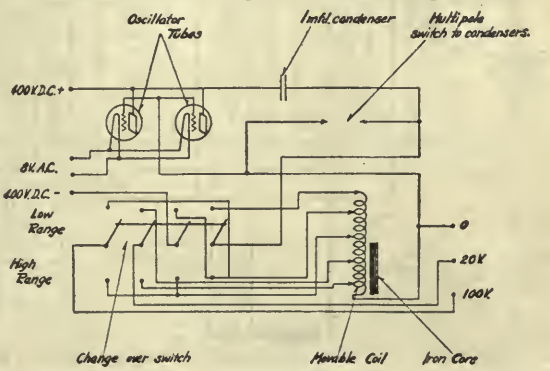


FIG. I

Oscillator designed to cover a range from 150 to 10,000 cycles

peculiar forms of vibration. Thus, the vibrations of brass are usually different from those of aluminum, wood, or micarta. This is generally due to a number of harmonics, each modifying the original note. In a loud speaker the pleasing quality and the naturalness of reproduction are dependent to a very great extent on the choice of materials, particularly of the material carrying a large amount of energy of sound.

METHODS OF TESTING LOUD SPEAKERS

THE four essential features of the loud speaker have been investigated by different test methods, partly dynamical and partly physiological; i. e., depending on aural observation.

Fig. 1 shows a diagram of an oscillator designed to cover a range from 150 to 10,000 cycles. A number of steps of condenser capacity raise the frequency about 50 to 100 per cent., while for each step the movement of an inductive coil on and off an iron core gives gradual variations of frequency. Each step of condenser is calibrated for frequency at different coil settings which are indicated on a graduated scale. The coil acts as an inductance and also as a transformer. Operating the set at 20 watts, the amount of power drawn to the loud speaker is small, giving good voltage and frequency regulation on load. In order to make the loud speaker circuit equivalent to a tube circuit, a resistance equal to the tube impedance is included in series with the loud speaker. Although the voltage on the oscillator remains fairly constant throughout the whole range, for quantitative measurements the voltage can be checked at each reading.

Fig. 2 shows the pick-up arrangement for measuring the sound from a loud speaker. A condenser transmitter pick-up is considered very close to the ideal sound-receiving instrument and has been used by many investigators as a sound standard. The pick-up of this transmitter is amplified through a resistance amplifier, precluding distortion, and the resultant current measured on a milliammeter. The last stage, containing a step-down transformer, is also used for checking the voltage at each frequency. Hence, any possibility of reduction of received current at low frequencies is balanced by a corresponding reduction of the measured value of voltage.

Sound volume tests were conducted as follows:

The oscillator was operated through the complete range at fairly constant voltage, while measurements of sound by condenser transmitter were recorded and corrected by the value of voltage measured at each frequency. This arrangement gives a complete cycle from current to current and is evidently equivalent to the cycle from sound to sound. In addition, a point is obtained at 60 cycles to determine the loudness of very low notes.

The above test gives valuable data for investigation of the uniformity of sound and of the absence of resonance points. Listening to the sound, while performing this test, makes it possible to detect any foreign noise, rattle, or sound at a different frequency from that applied.

The ability to reproduce accurately any kind of musical sound or speech can be tested best by actual music and speech reproduction. Again a condenser transmitter has been used for the pick-up of sound. A number of stages of amplification (resistance coupled) bring the current to the loud speaker, while an audibility meter is so arranged that the volume can be cut down to any suitable loudness. Repeating each note on the piano several times is one of the best means of detecting any disturbing harmonics. Each note should

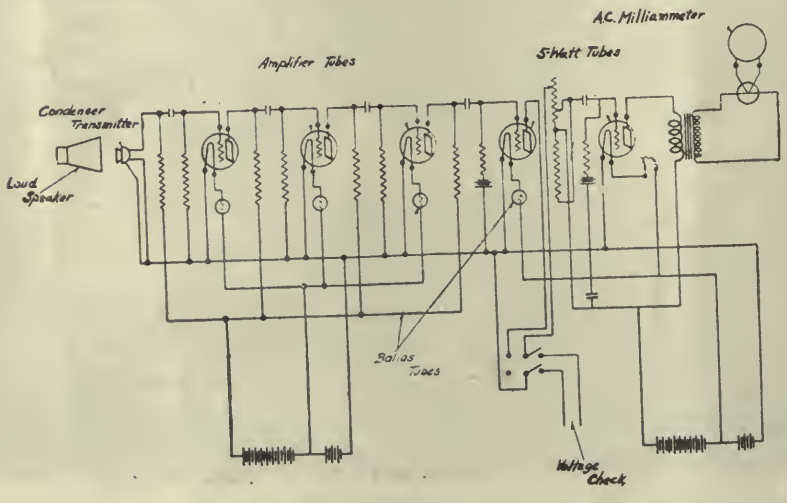


FIG. 2
Apparatus for measuring the sound from a loud speaker

come through clearly and should correspond exactly to the original piano note. Low notes in particular should be checked for the presence of the fundamental tone. Some designs of loud speakers, while giving a loud note at these pitches, are found to be completely devoid of the fundamental—the note is just the sum of all overtones.

Speech transmission over the same circuit gives a splendid test for quality and recognizability of reproduction. For proper speech reproduction the volume should be adjusted to equal, approximately, the loudness of the original speech. Of course, in a loud speaker designed for a large audience, with a special view to great volume, the speech must sound normal at the volume desired. The same loud speaker would not necessarily give natural reproduction at a lower volume.

An additional test for actual music reproduction is essential. Thus, a piano selection, a baritone solo, and a soprano solo are particularly good for detecting any faults in quality. In addition, a violin or a flute solo can be used to advantage to determine the ability of the loud speaker to reproduce the high notes naturally. The table below shows the list of tests and results that can be learned from each:

TESTS OF LOUD SPEAKERS

1. Measurement of volume (60 to 5,000 cycles) . . .	Uniformity of volume, absence of resonance points and foreign sounds
2. Musical scales on piano	Accurate reproduction of quality on each note, particularly the low notes
3. Speech . . .	Clearness of articulation. Individuality of voice
4. Piano selection .	Clearness and naturalness on abrupt tones
5. Baritone and soprano singing .	Clearness and naturalness of sustained notes
6. Flute or violin .	Reproduction of high notes
7. Speech and music	Naturalness of superimposed sounds

The last test, the combination of music and speech, is very desirable. Each possesses individual characteristics, and the ideal loud speaker would maintain them. Very often, however, the presence of music will distort the speech, and vice versa. Of course, in this latter case we could not expect the loud speaker to reproduce correctly a number of musical instruments simultaneously, although the distorting effect might not be as noticeable as in the case of speech and music.

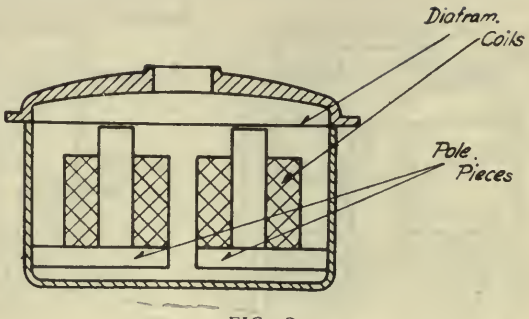


FIG. 3
Loud speaker unit operated on the same principle as the ordinary telephone receiver

THE STRUCTURE OF LOUD SPEAKERS

IN A COMPLETE loud speaker the following mechanical parts can be segregated and investigated separately:

(1) The electromagnetic structure
(2) The sound-producing element
(3) The sound-amplifying and distributing element

Figs. 3, 4, 5, and 7 show four distinct types of electromagnetic structures.

Fig. 3 shows a loud speaker operating on the same principle as an ordinary telephone receiver. It has a thin iron diaphragm held at a small distance from two magnetic pole pieces which are energized by a permanent magnet and also by two coils, one on each pole piece. The volume that can be obtained from this type of loud speaker is somewhat limited on account of the close spacing between the diaphragm and the pole pieces. Moreover, certain notes are accentuated, due to the resonance of the diaphragm. This, however, is not necessarily a defect. It is possible to overcome the resonance feature by means of a proper sound-amplifying device. The magnet in this type is often made adjustable. This permits a very close magnetic balancing of the diaphragm and a consequent improvement in quality.

Fig. 4 shows a moving-coil type of loud speaker. A circular coil is located in a round air-gap, with an iron core in the center. This air-gap is traversed by a strong magnetic field, excited by an inner coil which carries direct current, while the circular coil mentioned above carries sound-producing alternating current and is attached to the center of a dia-

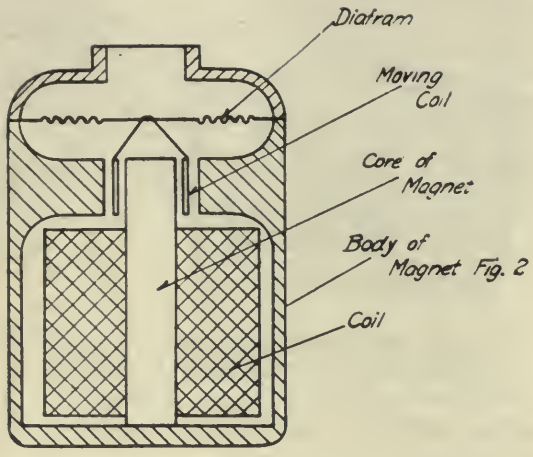


FIG. 4
The moving coil type of loud speaker

phragm. Very satisfactory results can be obtained with this type of loud speaker.

Fig. 5 shows what may be termed the enclosed-armature type. A small iron armature is located in the center of a coil and suspended by two thin piano wires. The coil is surrounded by two U-shaped pole pieces, forming two air-gaps. A permanent magnet produces magnetic flux in these air-gaps. The current in the coil causes diametrically opposite pole pieces to be energized simultaneously, which causes the armature to rock. This rocking is communicated through a thin connecting rod to the center of the diaphragm.

Fig. 6 shows the sound distribution for a loud speaker constructed on this principle. The loudness is fairly uniform over the range. The graph shows the frequency from 100 cycles to 10,000 cycles on the horizontal axis, and loudness along the vertical axis.

Fig. 7 shows the "relay type" loud speaker recently developed. Its construction is similar to that of a polarized telegraph relay. A thin iron armature is located between four pole pieces, each carrying a coil. These pole pieces are magnetized by an L-shaped magnet and the coils are connected in such a manner that diametrically opposite pole pieces exert simultaneous attraction. The armature operates through a rod on a diaphragm.

Fig. 8 gives a representative curve of this loud speaker. The range is fairly wide, while no part of it is exaggerated in volume.

In all the above structures the sound-producing element is a diaphragm. Considerable variation is possible in the design of this diaphragm. Of course, the first type requires an iron or steel diaphragm, or at least an iron center. The other types have a free choice of material. Aluminum and micarta have both been used successfully. It has been found that the quality of the loud speaker is considerably improved by proper corrugation of the diaphragm.

Figs. 9, 10, and 11 show, respectively, the variation of sound intensity with frequency for three different types of diaphragm.

Fig. 9 shows the resonance points with a very stiff small diaphragm. The lowest resonant point is at 1,500 cycles. The harmonics are at 2,900, 5,000, and 6,000 cycles, i. e., approximately in proportional 1:2:3:4. These resonance points may have been modified by the presence of the horn. The resonance points below 1,500 cycles are due to the horn.

Fig. 10 is the same relation for a fairly thin flat aluminum diaphragm. The resonance points are still very pronounced.

Fig. 11 shows the relation for a corrugated aluminum diaphragm of the same dimensions as the one used in the case of Fig. 6. Up to 3,000 cycles, the resonance points are not prominent.

Fig. 12 shows some of the types of diaphragm that have been tried. (b) and (c) have been found to give the most satisfactory results. The one marked (c) is the diaphragm whose performance is represented by the curve in Fig. 11. It has the corrugations spaced at radii bearing a ratio to each other corresponding to prime numbers. This diaphragm is based on mathematical considerations worked out by Dr. Philip Thomas.

Diaphragms (g) and (h) have the property

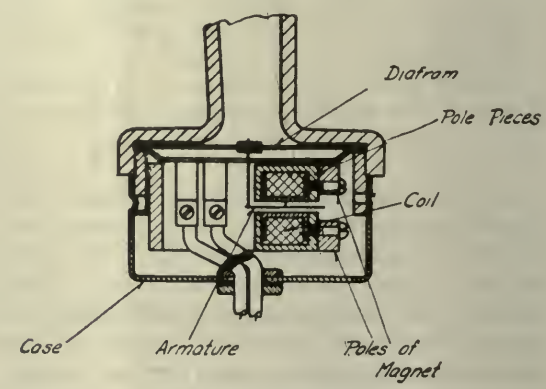


FIG. 5
The enclosed-armature type

of having the same depression from either side. Diaphragm (i) has, in addition, an identical pattern from either side, and, consequently, is less liable to buckle either one way or the other. This quality is important, as demonstrated in a succeeding paragraph.

So far only two types of sound amplifier and distributor have come into practice; namely, a horn and a large conical diaphragm. Considerable controversy ranges about the type of horn which would give the most satisfactory results. It is difficult to record the effect of horns with the method outlined above.

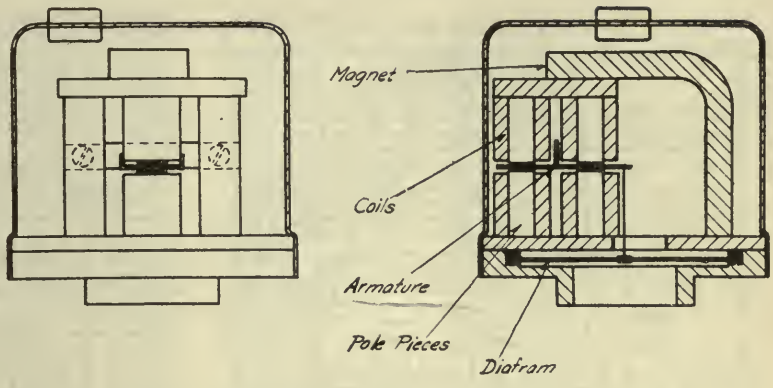


FIG. 7

Diagram of a recently developed loud speaker constructed after the fashion of the polarized telegraph relay

Speech and music are both modified considerably, depending upon the length and shape of the horn, and on the volume of the sound. A horn longer than one quarter the wavelength of the lowest pitch available gives the best reproduction. However, in practice, the length of the horn seldom exceeds three feet, approximately one fourth of the wavelength of 90 cycles, the fundamental of the horn. If the horn is shorter than one foot (270 cycles fundamental), the bass and baritone voices are likely to be distorted, since their fundamental, which is below 270 cycles, would be reduced. It has been found that a loud speaker with a magnetic balance and a horn about two feet long is capable of very good reproduction of even very low frequencies.

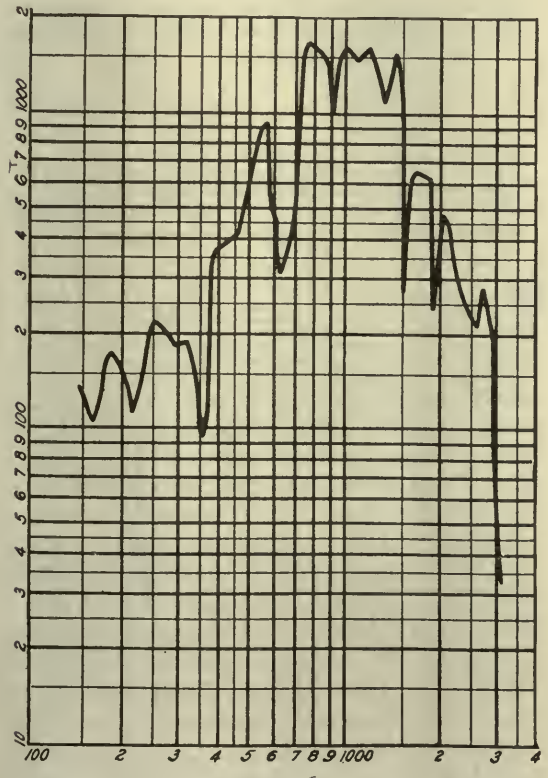


FIG. 6

Showing the sound distribution for a loud speaker of the enclosed-armature type. The horizontal axis represents the frequency, from 100 to 10,000 cycles, and the vertical axis represents loudness

Careful study has been made of materials to be used in the horn, in so far as they affect the quality of reproduction. A wood horn, or horn made of some "dead" material like hard rubber, is least likely to introduce a strange quality.

Horns of large volume carry considerable energy at resonance, which is dissipated only gradually unless the design is correct. Slow dissipation of energy would mean that some notes would be dragged out after this note had been silenced at the sending end. Aural observations give the most accurate information on horns. Experience points to the use of horns as large as possible, but designed with sufficient divergence and wide enough mouth to dissipate the energy.

Large conical diaphragms made of parchment or stiff paper have been used successfully. As a rule, it is difficult to reproduce the low range and the high range on this type of diaphragm. However, this type of sound amplifier is inherently free from resonance characteristics and therefore carries the greatest promise of future utility.

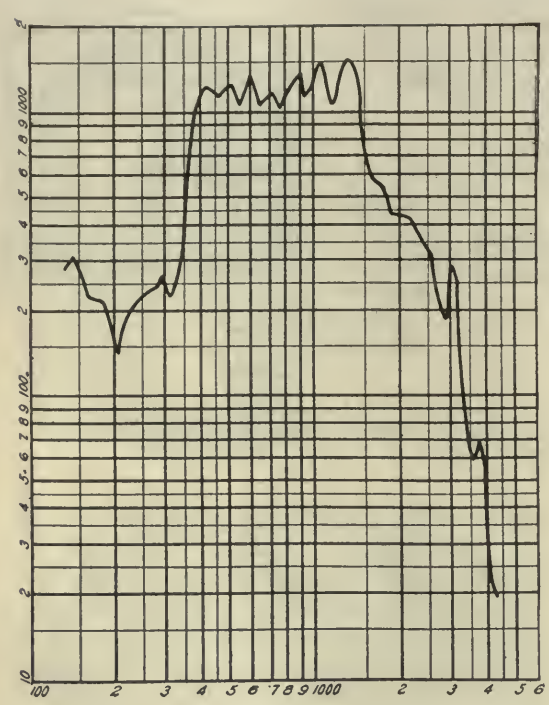


FIG. 8

The representative curve of the "relay type" loud speaker. Loudness is plotted against cycles (see Fig. 6)

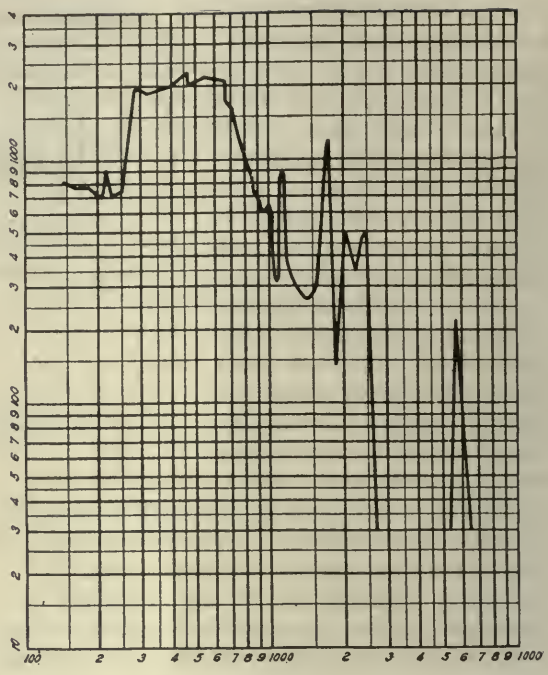


FIG. 9

Showing the variation of sound intensity (vertical axis) with frequency (horizontal axis) when a small stiff diaphragm is used

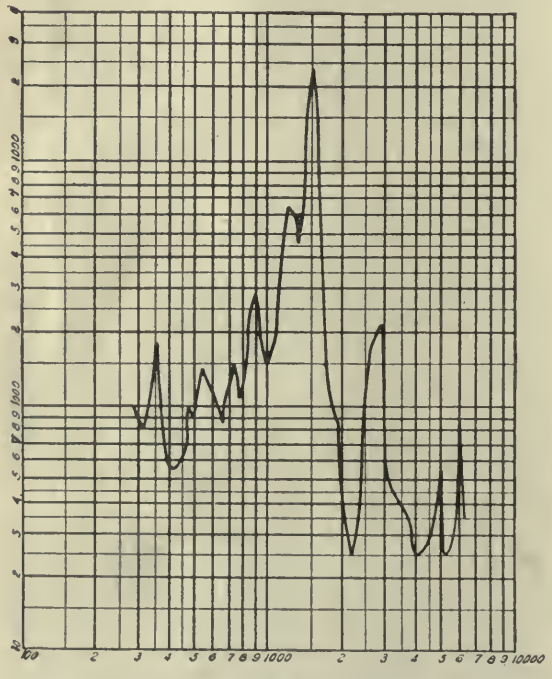


FIG. 10

Showing the same relation as in Fig. 9, but with a fairly thin, flat diaphragm

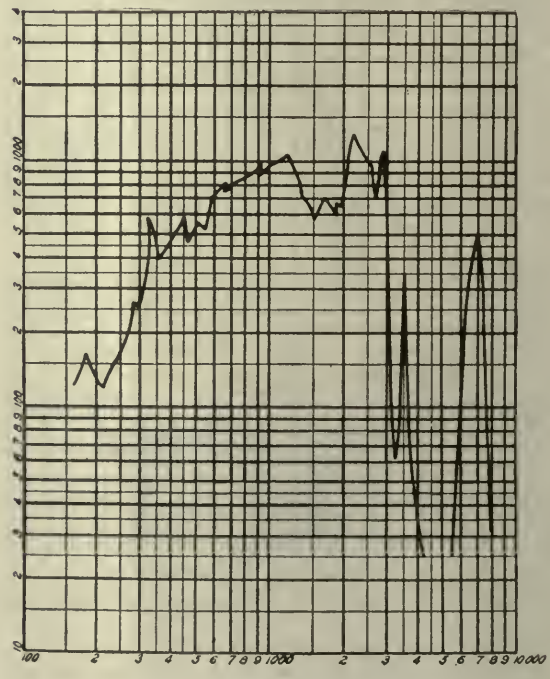


FIG. 11

Same as Fig. 9, but with corrugated aluminum diaphragm

RESONATING SYSTEMS

CONSIDERED from a mechanical standpoint, a loud speaker is invariably a complicated resonance system. Certain subdivisions of resonance, however, are possible.

1. The Mechanism as a Whole

The force of a magnetic field is in all types, except the moving coil type, counteracted by a strain in the diaphragm. In a loud speaker of the type shown in Fig. 3, that is, the telephone receiver type, this action is automatic. The diaphragm pulls down until its tension is equal to the pull of magnetic field. In the type shown in Figs. 4, 5, and 7, the normal position of the armature is such that the magnetic pull is zero. Actually, however, it is very difficult to keep the armature in this position. Generally there is a little pull one way or another, balanced by the strain in the diaphragm.

For a movement of the diaphragm, the magnetic field begins to exert a force helping this movement. If the magnetism is increased by using a stronger magnet, the force of the magnet may be made so large that it pulls the diaphragm over. Normally, a balanced condition may be obtained where very little force is required to produce a certain movement. Fig. 13 illustrates this fact. The two curves show the variation of force on the diaphragm with movement of the diaphragm, and show that, with the magnet, the diaphragm requires distinctly smaller force for the same movement.

In this way the strength of the magnet and the tension of the diaphragm determine the force for certain movements and, consequently, the resonant frequency of the whole mechanism. By adjusting the magnetism in a way to get a very close balance, this resonant frequency may be placed very low. As a rule, the damping at these low frequencies is high enough to conceal the resonance; however, the whole of the low range will be found raised. This is demonstrated in Fig. 14, showing two curves for one loud speaker, one with a .015–inch gap, and the other with a .010-inch gap. The latter had a close magnetic balance; hence, all notes and the low notes in particular are increased. These curves were taken on the relay type loud speaker. It is evident that similar adjustment is possible on all types except the moving-coil type, in which the resonance point is determined entirely by mechanical strain and the mass of moving parts.

Fig. 13 shows a bend in the curve when the magnet is in place, i. e., there is an equality in pull for the two directions of movement. This is caused by a lack of symmetry in the diaphragm equivalent to a slight dish in one direction. A diaphragm free from this dish would give a straight line characteristic. Hence the importance of the development of a diaphragm of some such type as (g), (h), or (i) of Fig. 12.

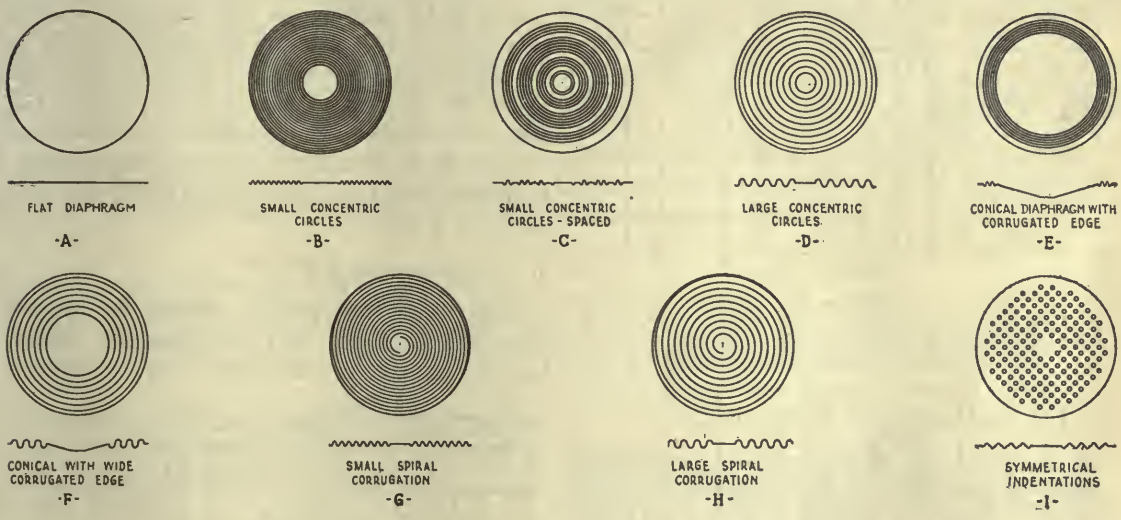


FIG. 12
Various types of loud speaker diaphragms

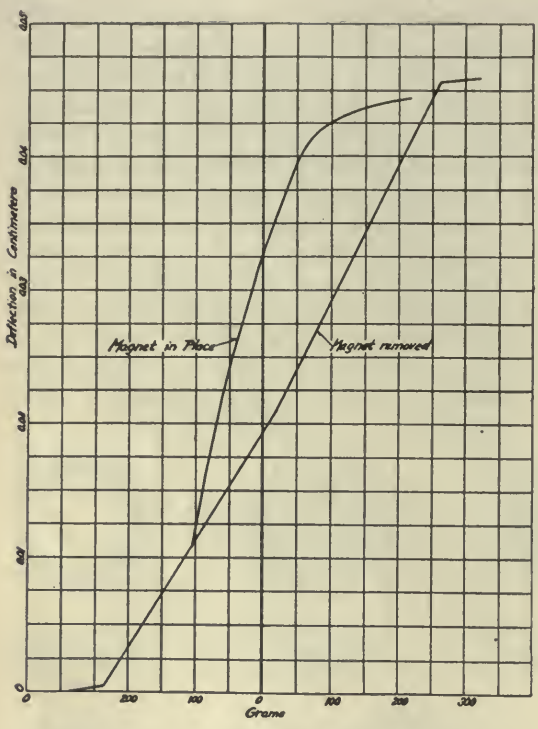


FIG. 13
Showing the effect of a permanent magnet on the movement of a diaphragm

2. *The Diaphragm and Horn*

In a foregoing paragraph the resonance points of diaphragm and horn were discussed. It must be remembered that the horn constitutes a load on the loud speaker. If it is possible to construct a load that remains constant at all frequencies, and large for a small movement of diaphragm, then the resonance of the diaphragm will be unimportant. This is one of the chief reasons of the success of large horns.

If the load due to the horn is small between its resonance points, and a resonance point of the diaphragm should occur at one of these points, the vibration may be excessive, with a resulting rattle and noise. The longer horn favors a more uniform load at different frequencies.

3. *The Armature*

The armature of a loud speaker of enclosed-armature or relay type is a strip of steel very short and stiff, but nevertheless possessing a resonance point within the audible range. It has been found that frequencies above this resonance point are difficult to reproduce. Thus, Fig. 15, made using a loud speaker with a very small stiff armature, shows a range on higher notes extending to 5,000 cycles.

Another effect of resonance of armature is the introduction of foreign notes. An example is seen in Fig. 16, showing a reduction in volume at 800 cycles. At this frequency it was observed that the note had a strange high-pitched harmonic; however, damping the armature by a piece of rubber cleared this note and brought up the volume of its fundamental. The trouble was eventually overcome by using a much stiffer armature.

4. *The Strip*

The strip supporting the armature has a resonance note, but the forces acting in it are generally very small compared with the forces in the rest of the system. Hence the effect of the strip is negligible. The only exception is in attaching the strip to supports. It seems that any looseness at this point will result in a rattle.

5. *The Connecting Rod*

The connecting rod is subject to a complicated torsional and longitudinal strain. Unless this rod is sufficiently stiff, vibrations

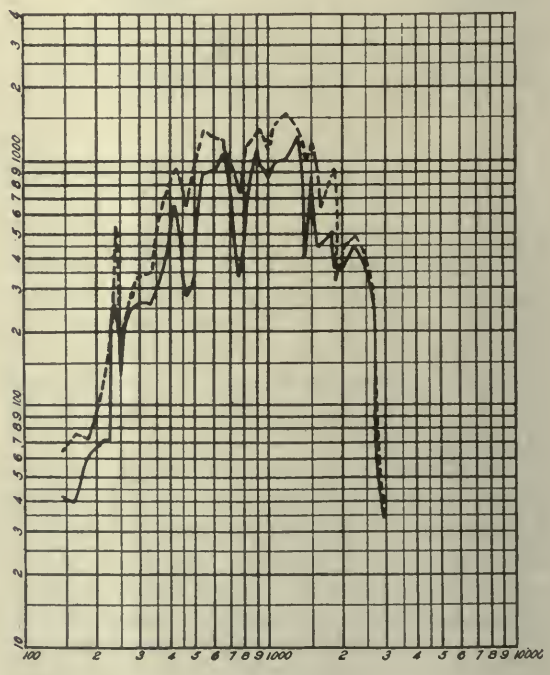


FIG. 14
Two curves taken with the same relay-type loud speaker; in one case, the gap was .015 in. (solid line), and in the other, the gap was .010 in. (dotted line)

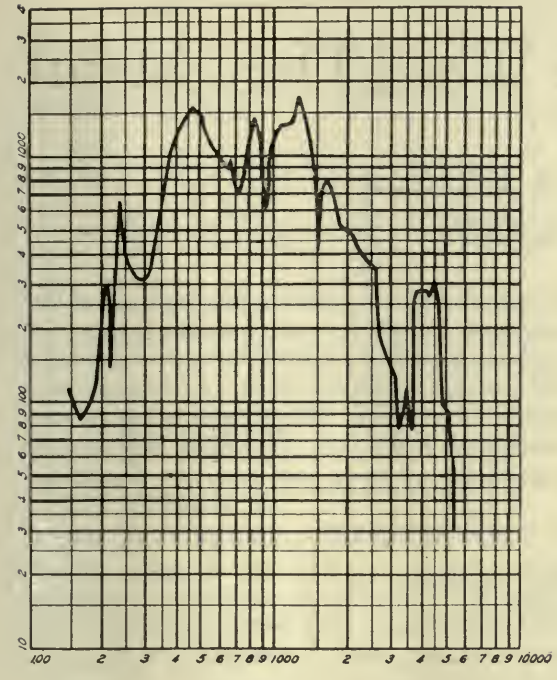


FIG. 15

Characteristic curve made with a loud speaker having a very small stiff armature. Vertical axis indicates loudness, horizontal axis indicates frequency in cycles

may be set up which introduce a foreign note at the lower frequencies and limit the sound at the higher frequencies.

CONCLUSION

IN CONCLUSION, a brief summary will be given, covering the outstanding points. The function of loud speakers is considered as that of a device for converting electric current, of frequencies ranging from 25 cycles to 5,000 cycles, into sound waves.

The essentials of this conversion are as follows:

(1) Uniform volume at all frequencies.
(2) Absence of strange sounds.
(3) The ability to reproduce a combination of frequencies correctly.

Four fundamental types of loud speakers are discussed:

(1) Receiver type.
(2) Moving-coil type.
(3) Enclosed-armature type.
(4) Relay type.

Test methods are outlined for:

(1) Measuring the volume of sound.
(2) Testing the quality of reproduction.

The effect of various parts of a loud speaker on its operation are considered, namely:

(1) The magnetic structure.
(2) The diaphragm.
(3) The horn.
(4) The details.

The art of designing a loud speaker is extremely new. The empirical work for ascertaining the effect of various factors is only in its embryo stage.

Eventually, we may expect to design a horn or a vibrating structure with the same facility as an electric motor, because a loud speaker is really an electric motor though its load is less tangible than the load of most motors.

The design of a loud speaker must be based on a scientific analysis of this load and of its reaction on the motor. This involves considerable acoustic research work, mechanical research on vibrating structures, and electrical work on the effects of vibrating parts in an electromagnetic structure.

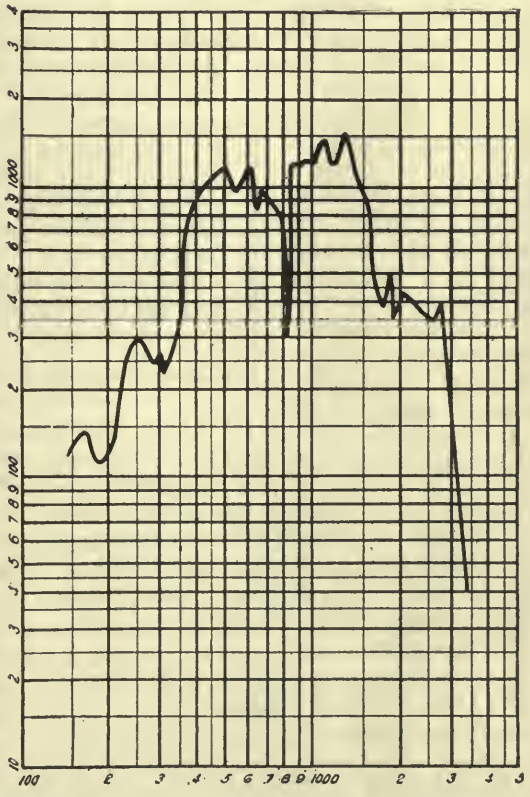


FIG. 16

In this case the armature was not stiff enough and the sound showed a reduction in volume at 800 cycles

Various Circuits and What They Mean

PART I

The Analysis of a Circuit

By ZEH BOUCK

TO UNDERSTAND thoroughly and derive the fullest benefit from any article describing a radio installation, it is essential that the reader be perfectly familiar with the symbols to which the author must necessarily resort in his description of a circuit. The interpretation of a diagram should be almost instantaneous. A cursory examination of almost any well-drawn, but unlettered and unannotated diagram, furnishes the experienced experimenter with the following information:

1. The instruments required. It should never be necessary to write to a magazine requesting a list of parts for such-and-such a circuit diagram; the parts are indicated quite plainly on the diagram.

2. The functioning of each instrument, i.e., the whys and wherefores of each coil, condenser, etc.

3. The functioning of the circuit as a whole. That is: is it regenerative? If so, by what system? Capacity feed-back? . . . Inductive feed-back? Through what agency? Tuned plate? . . . Ultra audion? . . . Etc. An understanding of these details furnishes a comprehensive idea as to the possibilities of the receiver, with regard to:

A. DX (long-distance) reception
B. Wavelength range
C. Selectivity
D. Loop or open antenna
E. Re-radiation

All diagrams to which the writer will have occasion to refer will be briefly analyzed in this fashion, in order that the reader may become accustomed to summing up the total significance of a circuit, making the most out of the diagrams he will encounter in the future. *A radio diagram in the majority of cases is a concise but complete article describing a particular transmitting or receiving arrangement, covering constructional details (the theoretical best spacing and relation of parts, with necessary limitations on mounting, etc.) a description of the required parts, how to operate the finished article, what the set will and will not do!*

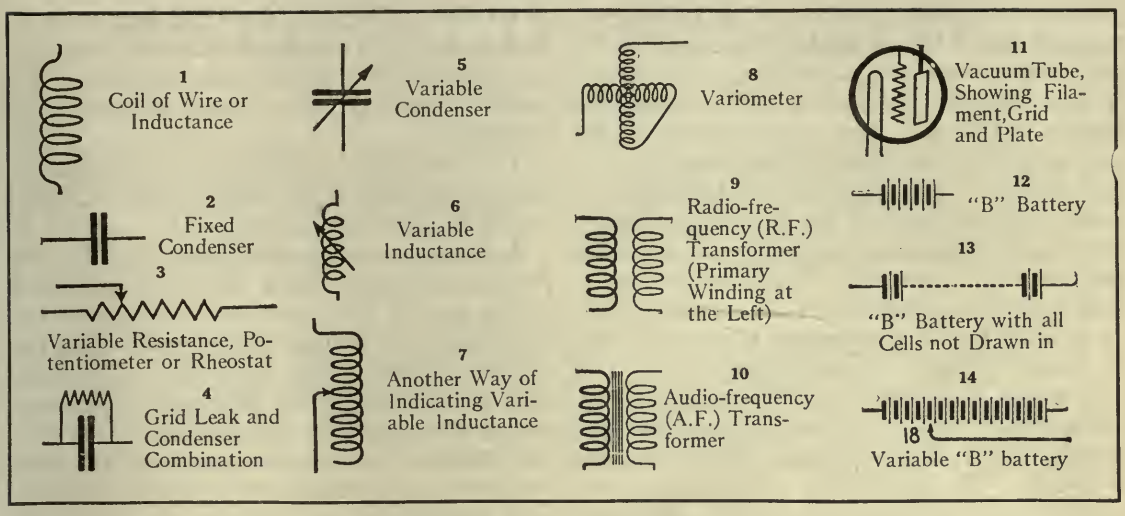
Have You Ever been Stumped by a Diagram?

Many new and interesting circuit diagrams find their way into print. They are the engineer's way of telling you what is necessary for the building of certain apparatus which he has found satisfactory. He is constantly using the symbols shown on the opposite page, and is familiar with what each signifies in any diagram he may come across. It does not take long for any one to learn what instruments each of the symbols represents, and such knowledge is necessary in making clear the function and construction of many radio circuits.

This article is the first of a series by an author who has been actively in the radio game for many years.—THE EDITOR.

LEARN THE VALUES AND FUNCTIONS OF SYMBOLS

THE knowledge that symbol no. 1 in the accompanying chart means a coil of wire or an inductance, and that symbol no. 2 indicates a variable condenser, is of little use to the broadcast listener when he possesses not the slightest idea of how many turns of wire the coil should consist nor of the capacity of the condenser. And in many cases these little points of information, vital to the uninformed reader, are omitted, sometimes through ignorance on the part of the writer, but more often because the value is conventional and the writer assumes it to be understood. The chart shows the symbols which the experimenter will most often encounter. First among those to which more or less arbitrary values may be assigned is the fixed condenser. The fixed condenser consists of metallic foil, with the "plates" separated by a non-conductor or dielectric of waxed paper or mica. It is "fixed" because the plates are permanently bound, and the capacity is therefore practically



constant. The most common use in radio for a condenser of this type is in series with the grid lead of a detector tube, in which position it is known as the grid condenser, and its capacity is .0005 mfd. *This value, as well as other values indicated in the course of the articles, may be taken as standard and may be used in all circuits excepting those calling for special values which will always be specified.*

In most cases the grid condenser is shunted (connected across) by a resistance (symbol 3 shows a variable resistance) of 2 megohms (2,000,000 ohms) and the combination is known as the grid-leak (symbol 4). (Cf. article, "Making Your Grid-leaks" in the October "R. B. Lab.") The combined function of the leak and condenser is to regulate the charge on the grid, so that the tube is operated at its highest efficiency as a detector.

Fixed condensers are also very often used as "by-pass" or bridging capacities, in which case their function is to pass a radio-frequency current which, without their assistance, would be impeded by various highly inductive coils, such as telephone receivers and the windings of amplifying transformers. These condensers, which average .002 mfd. capacity (the value need only be approximate—.001 to .0025 mfd.), are commonly known as telephone shunt condensers from the manner in which they are most frequently used. They will be found across the primary of the first stage in almost all audio-frequency amplifiers, and they are used extensively in the Grimes and other reflex circuits. While these condensers are easily made, they are very inexpensive and the labor is hardly justified by the saving.

All instruments with which a variation of their values is possible, may be indicated as variable on a diagram in either of two ways: by the addition of an arrow across the ordinary symbol (see symbols 4 and 5 on the chart); or, secondly, by indicating a slider or taps (see symbols 3 and 7). Variability as indicated by the arrow generally represents a continuously variable instrument (not in jumps, by taps or turns) such as a variable condenser or a variometer.

Variable condensers are made in three popular capacities, .00025 (11 plates), .0005 (23 plates) and .001 mfd: (43 plates). The smallest condenser is used wherever a slight additional capacity may be needed, but is principally designed to be used across the primary and secondary windings of radio-frequency amplifying transformers, where the slight tuning which it allows adds greatly to the efficiency of the amplifier. The two larger capacities are used as conventional tuning condensers, in series with the antenna, and in shunt with (i. e., across) the variocoupler primary and secondary. The largest condenser permits greater latitude in tuning, covering a greater wavelength range, but unless it is provided with a vernier adjustment, it is rather critical. Whenever there is doubt concerning the size of a required variable, the medium capacity, .0005 mfd., may be used in almost any designated place or circuit.

Tuning inductances for the transfer of energy from the antenna to the detecting circuit are either single-circuit (auto) or double-circuit transformers. The single-circuit transformer is the common tuning coil, generally with two taps or sliders, though often with one (symbol

7), and it may be any form of inductance—straight coil, lattice-wound, or spider-web. 100 turns of wire on a 3-inch tube will tune up to approximately 700 meters. The enthusiast should bear in mind that, as the lattice-wound and spider-web are more efficient inductances, the number of turns on such coils necessary to reach a wave specified for a straight single-layer coil, will be about four-fifths that required for the single-layer coil. If the experimenter acquires cardboard or hard rubber tubes to use as winding forms, these single inductance can be readily wound in his workshop.

Likewise, inductively coupled tuning may be accomplished through either straight windings (variocoupler), lattice-wound coils or spider-web coils. If the diagram calls for a variocoupler, and you possess a honeycomb mounting and have no coupler handy, use the former; forget the variocoupler and plug in an L35 and an L50 in primary and secondary respectively for broadcast reception. A good variocoupler is quite a proposition to construct and is best purchased.

The tickler coil is an inductance similar to a primary or secondary, and is indicated by the same symbol (symbol 1 in chart). It is placed in series with the phones and B battery, i.e., in the detecting plate circuit, and in inductive relation (close to) the secondary, or tuning coil. It feeds back energy from the plate to the grid circuit, causing regeneration. On broadcast wavelengths, the tickler coil should contain from one quarter to one third more turns of wire than the secondary—the coil to which it feeds back.

The variometer (8) is a variable inductance, and it has been well standardized by several reputable manufacturers. When used in the grid circuit (usually in series with the secondary of a variocoupler) it is merely for the purpose of tuning, a substitute for tapping a larger secondary, or using a shunt variable condenser. When employed to tune the plate circuit (connected in the same place as the tickler coil) it causes and governs regeneration. A set with a variometer thus placed is regenerative. The variometer for a permanent set should be purchased.

Amplifying transformers, both radio-frequency (9) and audio-frequency (10), like variometers, are quite standardized, and any one of the numerous reliable makes will give satisfaction. For audio-frequency amplification, the same type may be used throughout all stages, a change in ratio having, as a rule, little or no effect. Between three and four turns of wire to one is the usual ratio in audio-frequency transformers. For dependable and satisfactory results, this instrument should generally be purchased.

The vacuum tube is indicated by symbol 11. Sometimes there is no circle around it. The socket is, of course, understood.

A battery is indicated by symbol 12, the polarity generally being shown by plus and minus signs. The short thick lines are conventionally the positive poles (representing the carbon element in the dry cell), and the long, thin lines the negatives (the zinc). In designating a series of high voltages, very often only the terminals are drawn, a dotted line (13) indicating that many cells have been omitted. The voltages of the various, A, B and C batteries are determined by the tube and the purpose (detector, amplifier, or oscillator) for which it is to be used. Filament or A voltages on receiving tubes vary from $1\frac{1}{2}$ up to 8—from the dry-cell tube to certain power amplifiers. B batteries occasionally exceed one hundred volts, 60 volts being the average for amplifiers, with a tap somewhere between 18 and 22 volts for the detector plate, indicated by a small arrow (14). The positive terminal is connected to the lead from the amplifying plates. The C battery is a potential more frequently omitted than used, and is rarely more than $4\frac{1}{2}$ volts. It is placed in series with amplifying grids in order to reduce distortion or eliminate howling. The C battery is connected with the *negative* terminal to the *grid*.

The rheostat is simply a variable resistance (see 3). Like the battery, its size is determined by the tube, but excepting the UV-199 (which on a $4\frac{1}{2}$-volt battery requires a 30-ohm resistance), the standard 6-ohm rheostat, on the recommended battery, will permit the desired adjustment.

The reader is advised not to memorize the symbols and their accompanying values and functions as he would a name. Things learned without associations are of little practical value, and are difficult to apply. Instead of acquiring these details parrot-like, examine the various hook-ups appearing in this issue of Radio Broadcast, analyzing them to the best of your ability according to the manner suggested in our opening paragraphs. Look over your own set, noting how it checks up in practice with its theoretical operation as implied in its circuit diagram.

R. B.'s Coming Transatlantic Tests

By THE EDITOR

BY COÖPERATING with the best radio stations in England it is hoped that the campaign inaugurated by RADIO BROADCAST to establish radio-telephone communication with England during National Radio Week (Nov. 25th to Dec. 1st) will be successful. Amateur transmission across the Atlantic is a fact, and broadcasting stations here have been heard in England as have English stations been heard here, but two-way phone communication has not been achieved heretofore.

HOW THE PLAN ORIGINATED

MR. F. N. Doubleday, President of Doubleday, Page & Company, is an ardent radio fan and is deeply interested in anything that will stimulate friendship between America and England. He is of the belief that Americans are interested in what Englishmen have to say about international affairs and that the English will find interest in the remarks of representative Americans. With this thought in mind he asked the editor of RADIO BROADCAST if such a thing as international radio-telephony tests could be arranged.

WHAT IS TO GO ON IN ENGLAND

THROUGH the good offices of Mr. Hugh S. Pocock, Editor of *Wireless World and Radio Review* (England) it was possible to arrange with the British Broadcasting Company to have the tests made. A few important paragraphs from the letter from this company are very illuminating:

You may be aware that in England this company has, through the authority of the Postmaster General, sole control over broadcasting and it is fairly safe to assume that arrangements left in our hands will be carried out. By November 25th we shall have eight main stations and the following particulars may be pertinent:

Location	*Wavelength*	*Power to aerial*	*Call Sign*	*Location*	*Wavelength*	*Power to aerial*	*Call Sign*
London	370	1 KW	2 LO	Glasgow	415	1 KW	5 SC
Birmingham	425	½ KW	5 IT	Aberdeen		1 KW	
Manchester	385	1 KW	2 ZY	Bournemouth		1 KW	
Newcastle	400	1 KW	5 NO	Cardiff	353	1 KW	5 WA

We have means whereby all these can be energized from one microphone in London, and if we were to put in hand tests, I should suggest that in a preliminary test every station should transmit simultaneously for say an hour in order that you on your side should pick up the easiest station. In order that this station should be selected, it is suggested that after the hour is over, each station should transmit in turn giving call sign and location. We on our side, would attempt to receive your signals on alternate days and it might be possible to get two-way working.

From the above list it will be seen that the British stations are well within our receiving range from a standpoint of wavelength. In order to make it easy to pick them up, it will be well for us to listen-in on American stations of approximately the same wavelengths, make a list of dial settings for each station and have some definite plan of action to follow when the tests are made.

HOW THE TESTS ARE TO BE MADE

OUR good friends on the other side of the Atlantic are going to wait up until the small hours of the morning in order that we may hear them. The first transmission will be from England on the night of November 25th at 3 A.M. London time (10 P.M. U. S. Eastern Standard Time.)

On November 26th the transmitting will be done from this end by a group of stations selected by RADIO BROADCAST and the National Association of Broadcasters. Stations in the Eastern, Central, and Western part of the country are to be represented. Transmitting will begin at 10 P.M., Eastern Standard Time, and continue for one hour.

On alternate nights, thereafter, the sending will be done by English and American stations, until the last night—December 1st—when an attempt to establish two-way communication will be made. The details of the last night's program will be announced through the stations in England and America, in order to lend all assistance possible to listeners-in and to allow time enough for the broadcasters themselves to get everything ship-shape.

AMERICAN STATIONS WHICH WILL TAKE PART

THROUGH the National Association of Broadcasters, we are sure of having stations in Chicago, Davenport, Cincinnati, Boston and Minneapolis. Arrangements with additional stations will be completed in a few days, but too late to include in this announcement. Listen for the announcements over the air. England and America are joining forces in putting these tests across. The coöperation of every amateur and broadcast fan is wanted to help make a success of them. Will you listen-in?



What Our Readers Write Us



EDITOR,
RADIO BROADCAST,
DEAR SIR:

The stunt of making ear cushions out of $1\frac{3}{4}$" of old Ford inner tube folded back on itself as per illustration, has given me such genuine satisfaction and



comfort that I thought perhaps you would be interested in publishing the enclosed picture. You are welcome to it.

Very truly yours,
WM. L. DABNEY,
A satisfied subscriber.

DEAR EDITOR:

You are aware of the controversy which is rife in the radio world in general, and among our readers in particular, concerning the *polarity* implied by the two composite parts of the symbol designating a battery in radio circuit diagrams. The argument briefly summed up, is as follows:

We are all familiar with the symbol, which consists of long thin lines separated about an eighth of an inch, between which are placed shorter and thicker lines. One short and one long line indicates one cell of a battery, i. e., originally, the two plates or electrodes of one cell. Probably the majority (though it will be difficult to prove this, I think) of printed diagrams in publications, etc., indicate the short lines as negative and the long lines as positive. In many diagrams, however, the reverse is true, the short, thick line being positive and the longer line negative. The question is, which custom is correct? My attention was first called to this matter through my writing an article for RADIO BROADCAST, treating on the symbols, in which I stated that the short line was positive, being unaware of the fact that RADIO BROADCAST has been using the symbols the other way around!

Apparently we are thrown back on our own logic and other resources to determine the arbitrary sign, for the recent report of the committee on the standardization of symbols of the I. R. E., while accepting the usual battery symbol, neither implies nor states definitely which line is plus (positive) and which is minus (negative).

I suggest that RADIO BROADCAST adopt the method advocated by me and as submitted in the original MS of the article mentioned above, i.e., *the short line for positive and the long line for negative.*

In the first place, through association, it is the more easily remembered, the short dark line representing the thick black carbon rod (positive) of a dry cell, and the thin line, the long thin sheet of zinc (negative)! I am convinced that this consideration is what prompted the symbol. Used in this manner, the battery symbol is also more consistent with what a symbol really is, viz; a simplified drawing of a part or instrument, *representing the instrument in question as well as possible!* Thus in the symbol for a vacuum tube, that part of it which most resembles the plate, stands for the plate; that part looking the most like the grid, stands for the grid; and that part most resembling the filament, indicates the filament! A person altogether unfamiliar with radio, having once inspected a tube, and who is then shown the symbol for a vacuum tube, would in most cases be able to identify the parts suggested in the drawing. Then why not follow out the corresponding similitude for the battery or cell?

The immediate suggestion of the dark line for carbon (positive) and the thin line for the sheet of zinc is the reason that most of us receive a first and quite lasting impression that the symbol should be thus interpreted.

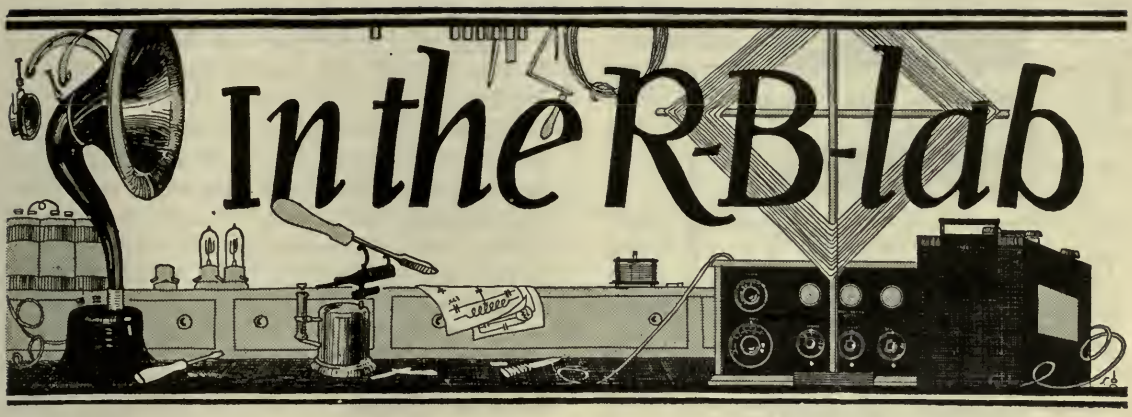
The only argument, if such it is, for the other side, is that the long line positive is possibly used by more magazines than the short line positive—a pretty poor argument as far as RADIO BROADCAST is concerned. Would it not be better for RADIO BROADCAST to set the precedent for other publications, rather than to follow theirs merely because their ideas are in the majority?

However, we already have the precedent. Doctor Goldsmith in his "Radio Telephony," uses the short line positive, as does Ballantine in his recent and excellent book, "Radio Telephony for Amateurs."

I know it isn't radio to be consistent and logical but the exception proves the rule—so why not try it?

73,

ZEH BOUCK.



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 endeavors to publish only "fact articles" backed by their personal observations.

RADIO BROADCAST will be pleased to buy from its readers, at prices from three to five dollars, any kinks, devices, original ideas, etc., with photographs if possible, which the Editor may consider eligible for this department.

Address all communications to the R. B. Lab Editor.

WINDING THE TRANSFORMER FOR YOUR BATTERY CHARGER

IN THIS department last month the construction of a panel arrangement was described for the remounting of the commercial type of bulb rectifier used for battery charging. The advantages gained by such rebuilding of the manufactured article were higher efficiency (greater charging rate at the same cost), and a neater, more businesslike instrument. For the benefit of those readers who have not commercial chargers, such as the Tungar, which can be rebuilt, the Lab has this month considered the home winding of a suitable transformer for mounting, with tube, socket, and other accessories, on the switchboard described in detail in the preceding issue.

The core is the first consideration in building the transformer, for on the quality of the steel or iron, and the area of its cross section, depends the number of turns of wire. The directions which will follow are for a core constructed of the average grade sheet iron obtainable from a dealer in such metals, cut to such a size, and built up to a thickness that will make a core with a cross section of three square inches. Of course, the best and most convenient plan is to use a core demounted from a discarded transformer. If the reader desiring to construct this rectifier does not possess one, or cannot, for any reason, comply with the directions as we give them, we shall be pleased to design special windings for his case, if he will communicate with this department, describing the core available (its dimensions and where procured).

Fig. 1 shows how the core selected by the R. B. Lab is built up of an equal number of strips $7\frac{1}{4}$ by $1\frac{3}{4}$ inches and $5\frac{1}{2}$ by $1\frac{3}{4}$ inches. The core is built up "log cabin fashion," each additional strip being lapped over the joint of the preceding ones, until the core is $1\frac{3}{4}$ inches high. This will give the specified cross section area, viz.: $1\frac{3}{4}'' \times 1\frac{3}{4}'' = 3.0625$ square inches.

When the transformer core is built up, the four legs should be taped and the core knocked apart into four bundles of iron. Two opposite legs are given an extra wrapping of tape and selected, one for the primary winding, and one for the two secondaries. Large fiber or pasteboard washers are placed on the sections thus chosen as guides for the wire, making large spindles of the bundles of iron. (If desired, and if the experimenter possesses the facilities, he may wind the primaries and secondaries on forms, slipping the finished windings over the core. This is really the preferred, though more difficult procedure.) Fig. 1 also indicates the placing of the windings.

The primary consists of 495 turns of No. 16 double cotton covered wire, all of which is wound on one leg of the core. The low voltage

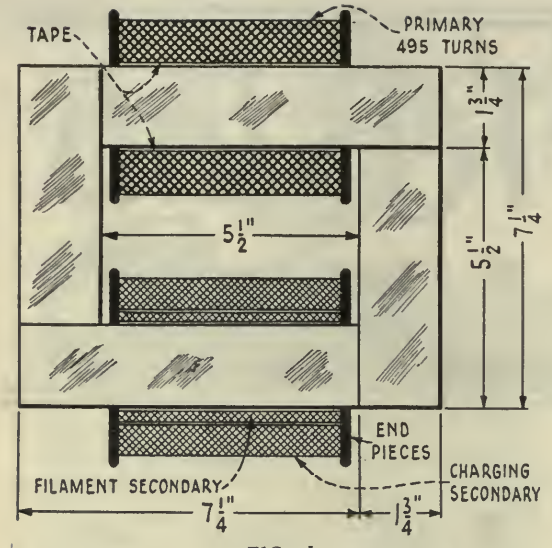


FIG. 1

Showing how the core is built up of iron strips and how the two windings are placed. The primary and secondary windings are shown cut away on the side nearest the observer, so as to show the iron core over which the turns of wire are actually made

or filament lighting secondary is wound on the opposite leg, and consists of 9 turns of number 8 or 9 double cotton covered wire. The high voltage secondary is wound over this (with several layers of taped insulation between) with 180 turns of number 12 double cotton covered wire, tapping at the 146th and the 112th turn. A layer of tape should be placed after every other layer of wire on the primary and high voltage secondary windings, in order to provide a smooth winding surface for the two following layers. Wind the transformer slowly and neatly.

When the windings are completed, the transformer is fitted together, a rather tedious task but accomplished with perseverance. The intersecting ends are started, and then tapped gently into place with hammer or mallet.

The requirements for this transformer are as follows:

Core.....5 lbs. of best core iron obtainable
Primary: 495 turns No. 16 D. C. C. (3lbs of wire)
Secondary (filament):9 turns No. 9 D. C. C. ($\frac{1}{2}$ lb. wire)
Secondary (high-voltage): 180 turns No. 12 D. C. C. (3 lbs. of wire)
tap 146th turn
tap 112th turn

This transformer is to be mounted as suggested in the rectifier described last month, and the connections for that particular panel are shown in the circuit diagram on this page, Fig. 2. The Tungar bulb with the other instruments indicated in the diagram may be purchased from any well stocked radio supply house.

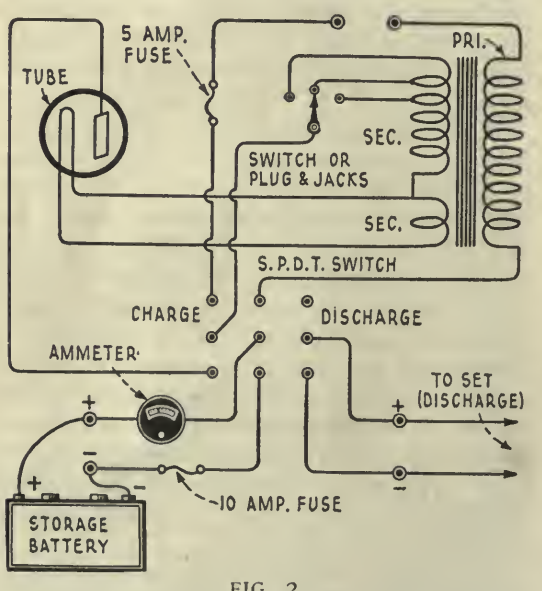


FIG. 2

Diagram showing how to connect the transformer to the bulb and panel apparatus shown in last month's *Lab*

BUILDING YOUR OWN LAB

TOOLS are an essential and probably the most important part of the laboratory. Good electrical instruments cannot be constructed or modified without the intelligent use of good tools and implements. A great many (perhaps the majority) of amateur layouts depend altogether too much on the utility of the overburdened jack-knife. Radio Broadcast's suggestion for this month's additions to the budding laboratory considers this prevailing deficiency. A set of taps and dies, with wrench and holder (Fig. 3) for working with $\frac{6}{32}$ and $\frac{8}{32}$ threads is recommended. The tap-wrench and die-holder (the first is the more important of the two if finances necessitate a choice), along with two taps and two dies, a $\frac{6}{32}$ (six thirty-two) and $\frac{8}{32}$ (eight thirty-two) in each, cost about $2.75, a price that is repaid with interest on almost the first occasion (and it will be an early one!) that the experimenter has to employ them.

The sizes as determined by the numerals 6–32 or 8–32 refer to two things, the first number indicating the diameter of the rod according to the Brown and Sharpe *screw gauge* (not

wire gauge), and the second numeral the number of threads to the inch. Thus a 6–32 is a number six screw with 32 threads to the inch, and an 8–32 is a number eight screw with 32 threads per inch. The smaller the first number (occasionally indicated as the numerator of a fraction, thus $\frac{6}{32}$) the smaller is the diameter of the screw. The $\frac{6}{32}$ is used mostly for comparatively small work, such as on vacuum tubes sockets, small binding posts, on rheostats, lamp socket connections, etc. The 8–32 is used on larger work, and such screws are found on battery binding-posts, large (and some small) panel binding-posts, and wherever more massive construction is employed.

The taps and tap wrench which holds them are used for threading holes so that they will take a machine screw of the correct size. This eliminates nuts in the thousand and one places where they are either undesirable, unsightly, or next to impossible to place. Holes in panels may be threaded, making it unnecessary to drill all the way through (thus not marring the front), and in any other hard substance into which it is desired to tighten a machine screw. In tapping, the tap should be inserted in the hole gently but firmly, and given a slow but forcible twist until the threads bite, after which it may be turned with less care, but with the same gentle pressure.

Fig. 3 shows the die-holder (resting on the knife) with a die clamped in place. Dies are used for threading rods or bolts to a smaller diameter thread. A long brass rod, completely threaded, makes very convenient shafting for variometers, variocouplers, etc., the rotors of which may be bolted with four nuts to any position on the shaft. A rod (number 20) with an $\frac{8}{32}$ thread is suggested for this. In threading a rod of a particularly hard material, it is often a good idea to start the rod by filing it to a slight taper at the end offered to the die.

In combination with taps and dies, the following drill sizes should be used in the hand drill described in the October Lab:

No. 18 drill passes an $\frac{8}{32}$ tap (permits it to go through the hole easily but not loosely). No. 27 passes a $\frac{6}{32}$. No. 28 is used for tapping with an $\frac{8}{32}$ tap. No. 32 is used for tapping with a $\frac{6}{32}$ tap. A No. 20 rod should be used for threading to an $\frac{8}{32}$, and a No. 29 rod for threading to a $\frac{6}{32}$. A $\frac{6}{32}$ nut is easily tapped to an $\frac{8}{32}$, and an $\frac{8}{32}$ rod is easily run through a $\frac{6}{32}$ die.

The intelligent use of these sizes of taps and dies greatly facilitates the assembling of apparatus and gives a professional finish to the work back of the panel.

FIG. 3
Tap and die tools. A tap is being placed in the tap wrench, with a die-holder and die lying alongside



The Grid

QUESTIONS AND ANSWERS

The Crystal Detector and the Grimes Circuit

Can the Grimes circuit be used with a crystal detector after the manner of a well known commercial reflex set? If so, I should like to see the circuit for the same.

A. J. N., New York City.

Any radio-frequency energy (a definition which includes the current oscillating in a radio receiver before detection) may be detected by means of a crystal, audion or another of the numerous forms of detection. It is only necessary to become familiar with the fundamental circuits, or the principles involved, and crystal or audion detection, about the only forms encountered in our present day radio, may be applied to any tuning system with which you may be experimenting.

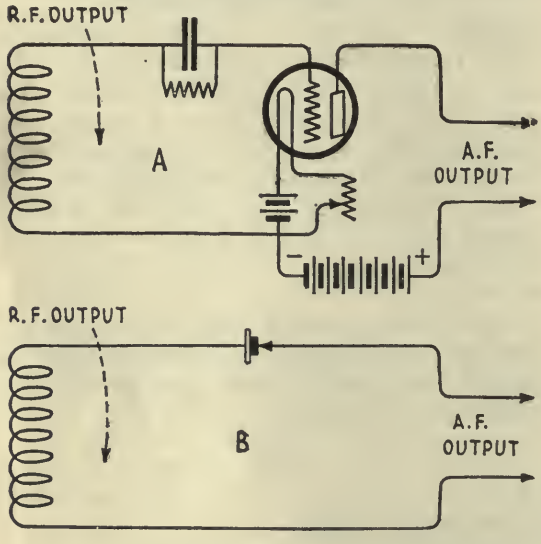


FIG. 1

The fundamental circuits for bulb and crystal detection

Fig. 1 indicates, in A and B respectively, the fundamental circuits for bulb and crystal detection. The coil of wire is the immediate source of radio frequency energy which is supplied to the detectors through the leads which are designated as the radio frequency output. This coil may be a simple tuning coil, the secondary of a vario-coupler or the secondary of a radio frequency amplifying transformer. The audio frequency output, is the output of the detecting circuit—the result of detection.

Detection is accomplished in the bulb circuit by connecting one side of the R. F. output to the grid of the tube through a grid condenser and leak, and the other side to the filament. The audio frequency output may be taken from any place in the plate circuit, generally between the B battery and the plate.

In the case of the crystal detector, detection is achieved by connecting the crystal in series with the coil, the audio output being taken anywhere along the connection.

It is generally a good idea to place a .001 mfd. fixed condenser across the output of the detector circuit.

These two circuits, A and B, accomplish the same thing (the bulb perhaps in a more satisfactory manner, according to circumstances), and they are, therefore, quite interchangeable. Fig. 2 shows the Grimes circuit with a crystal substituted for the third or detecting tube.

The crystal is capable of distance reception in the reflex circuit due to the radio-frequency amplification which compensates for the lack of sensitivity in the crystal. It is also free from the complications which attend bulb detection in this circuit, and which result in lack of stability and in howling.

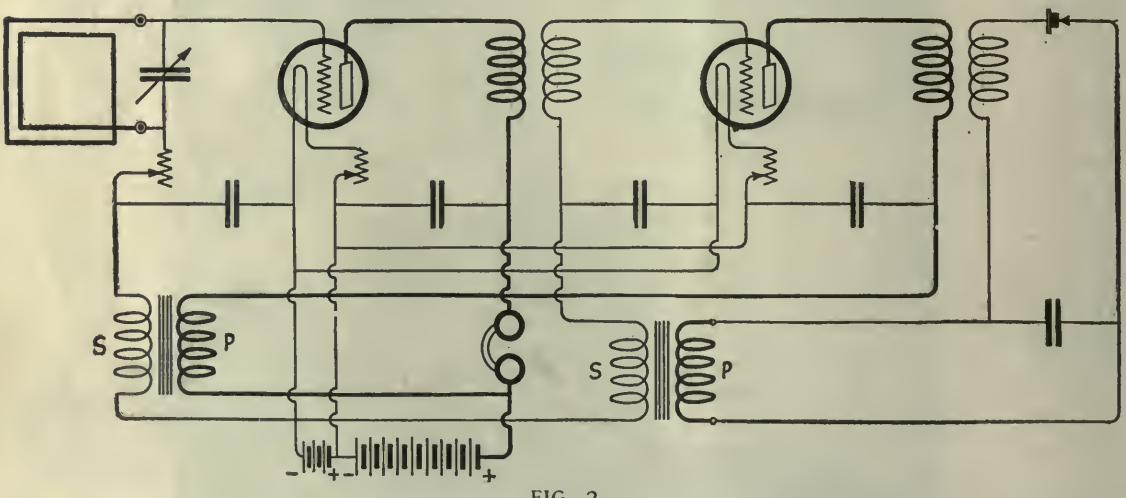
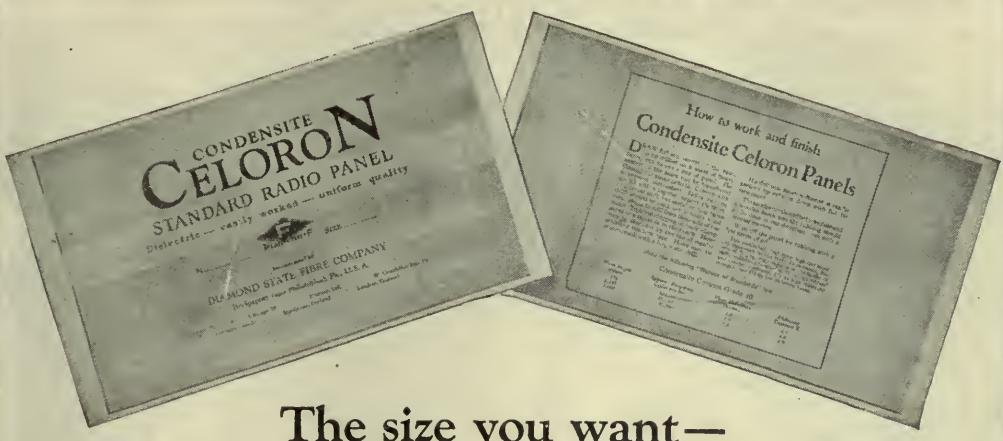


FIG. 2

The Grimes circuit with crystal detector. (For original Grimes circuit see Radio Broadcast for April, 1923; pp. 476)



The size you want— the insulation you need

YOU don't need to wait while your panel is cut to order when you get ready to build your radio set. Just go to your dealer and ask for a Celoron Radio Panel. He will give you, without a moment's delay, the exact size you want. And — what is more important — you get the proper insulation for successful results in radio receiving.

Celoron is recognized by radio experts as the best material for insulation purposes. Its high dielectric strength makes it the ideal panel material.

Used by leading manufacturers

Many of the leading manufacturers of radio equipment use Celoron in making their standard parts. It is approved by the U. S. Navy Department Bureau of Engineering and the U. S. Signal Corps.

Celoron Radio Panels come ready-cut in eight standard sizes, selected to meet the needs of the set-builder. Each panel is neatly wrapped in glassine paper to protect the handsome surface.

Celoron panels are readily worked with ordinary tools at home. They are easy to machine, saw, drill, and tap.

Ask a radio dealer for one of the following standard sizes:

1—6 x 7 x 1/8	5— 7 x 18 x 3/16
2—7 x 9 x 1/8	6— 7 x 21 x 3/16
3—7 x 12 x 1/8	7— 7 x 24 x 3/16
4—7 x 14 x 3/16	8—12 x 18 x 3/16

We also furnish Celoron in full sized sheets and in tubes, and can cut panels in special sizes when desired. If your dealer hasn't yet stocked Celoron panels, ask him to order for you, or write direct to us, indicating by number the size you want.

Send for free booklet

"Tuning in on a New World" is the title of a booklet we have prepared especially for the radio fan. It contains a list of the leading broadcasting stations in the United States and Canada, an explanation of symbols used in radio diagrams, and several popular radio hook-ups. This booklet will be sent without charge, on request.

To radio dealers: Write for special dealer price list showing standard assortments

Diamond State Fibre Company

BRIDGEPORT (near Philadelphia) PENNSYLVANIA

BRANCH FACTORIES AND WAREHOUSES
BOSTON CHICAGO SAN FRANCISCO

Offices in Principal Cities

In Canada: Diamond State Fibre Company of Canada, Limited, 245 Carlaw Ave., Toronto

CONDENSITE
CELORON ★
STANDARD RADIO PANEL

★ Tested and approved by RADIO BROADCAST ★

New Equipment

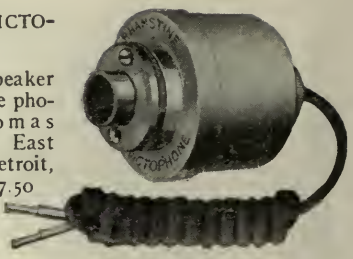


ACCO BATTERY CARRIER

A useful accessory of sturdy design. American Chain Co., Bridgeport, Conn. Price 50 cents

RHAMSTINE VICTOPHONE

An efficient loud speaker attachment for the phonograph. J. Thomas Rhamstine, 2152 East Larned St., Detroit, Mich. Price, $7.50





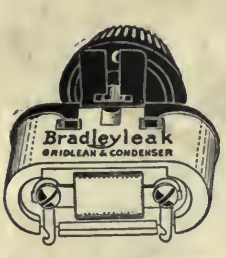
EXIDE STORAGE BATTERY

A small storage A battery for use with all tubes using from 3 to 3.6 volts. The Electric Storage Battery Co., Philadelphia, Pa.

NA-ALD FINGER-TOUCH VERNIER DIAL

The vernier is of the gear contact type providing very delicate adjustment. Alden-Napier Co., 52 Willow Street, Springfield, Mass. Price $1.45





BRADLEYLEAK

A compact unit embodying a grid condenser and variable grid leak made by the makers of the well-known Bradleystats. Allen - Bradley Co., Brockton, Mass.

HORNE VERNI-TUNER

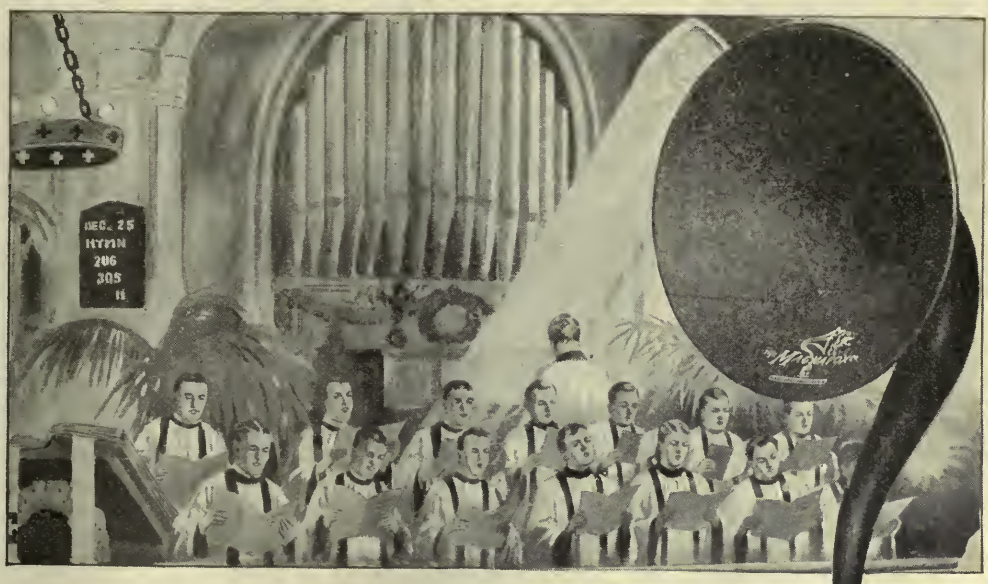
A three in one unit comprising primary, secondary and variable condenser. Horne Electric & Mfg. Co., Jersey City. N. J. Price $4





GLOBE MULTI-PHONE BLOCK

A convenient means of connecting from one to six headsets with any radio outfit. A sliding contact cuts out all phones not in use. Globe Phone Mfg. Co., Reading, Mass. $3



Magnavox brings you the Voice of all Christmastide

THE Art of Radio Reproduction is enjoyed by every Magnavox owner. Despite the ever-increasing quality and variety of Broadcast Programs, many a receiving set gathers dust unlamented because of insufficient sensitivity or an unsatisfactory "loudspeaker."

Every Magnavox owner is a master of the art of radio reproduction—the results obtained by the use of Magnavox Reproducers and Power Amplifiers cannot be equalled with apparatus constructed in the ordinary way.

The special attention of dry battery receiving set owners is called to the new Magnavox Reproducer M1, illustrated above.

Magnavox Reproducers

R2 with 18-inch horn . . .	$60.00
R3 with 14-inch horn . . .	35.00
M1 for dry battery sets . .	35.00

Combination Sets

A1-R Reproducer and 1-stage Amplifier	$59.00
A2-R same with 2-stage . .	85.00

Power Amplifiers

A1-One-stage	$27.50
AC-2-C-Two-stage	55.00
AC-3-C-Three-stage	75.00

Magnavox Products can be had of good dealers everywhere

THE MAGNAVOX CO.
Oakland, Cal.
New York Office: 370 Seventh Avenue

Perkins Electric Limited; Toronto, Montreal, Winnipeg, *Canadian Distributors*

★ MAGNAVOX PRODUCTS ★

There is a Magnavox for every receiving set

IZR

★ Tested and approved by RADIO BROADCAST ★

AMONG OUR AUTHORS

LIEUTENANT HAYDN PURCELL ROBERTS tells us that he signed "HA" on a spark coil back in 1911. In 1913, he completed the Marconi Radio School course and operated commercially on the Great Lakes in the summertime, taking courses in electrical engineering at the Case School of Applied Science during the winter. When America declared war, he enlisted in the Navy as Chief Radio Electrician, operated the Portsmouth, N. H., station, taught at the Naval Radio School at Harvard University, and then went to sea as a member of the "Armed Guard" aboard cargo transports. In 1921, he was commissioned in the Field Artillery, U.S.A., and transferred to the Signal Corps in 1923. At present, he is busy installing "Station AT9" at Fort Bragg, N. C.



LIEUT. ROBERTS
"Ex-U. S. N."

KIMBALL HOUTON STARK spent eighteen years "back in the 'sticks' and close to nature and the starlit skies . . . . Maintained his country post office on a paying basis by keeping the radio, mechanical, and electrical companies ever since 1912 sending him catalogs—to serve as textbooks. . . . Slung up his first antenna in 1913." As for hobbies, we are heartily in sympathy with his liking for "pulling speckled trout out of ice-cold mountain streams and hustling back to camp for a hot crisp piece of bacon drowned in steaming coffee."



SIR NEUTRODYNE STARK

PETER TAYLOR is still vagabonding. By this time, he and his sister and Blanding Sloan must have completed their voyage across the Pacific and started on their tour of the Orient. We hope to publish more of their adventures later on.

HARRY IRVING SHUMWAY, of Dorchester, Mass., writes us as fcllows: "At some point chronologically between the Tut Dynasty and Roosevelt's second term I was a humble member of the Doubleday, Page & Co. Family when said Family was located in Union Square, New York. In fact, I used to broadcast photos to the engravers, the type of machine being a pair of 6D's."

GEORGE J. ELTZ, JR., whose picture appeared in this section last month, is Radio Sales Manager of the Manhattan Electrical Supply Company, in New York. He is a past President of the Radio Club of America.

ALEXANDER NYMAN'S first work connected with radio was in 1918, when he designed a high-frequency generator for airplane spark sets. Later, with the Westinghouse Co., he developed pick-up and amplifying apparatus for broadcasting stations. He is now with the Dubilier Co.

WE EXTEND our hearty congratulations to Walter Van B. Roberts, whose marriage to Miss Margaret De Forest, of New York, recently took place. Mr. Roberts has been instructing at Princeton and doing special research work there. He is known to R. B. readers through articles appearing in our May, June and August (1923) issues.

CLEAR-*for the Crowd!*

MUSIC for the crowd as clear as one man gets it on the headphones! Sit back and listen. Tune in—shut your eyes—it's *real!* Every word clear—every musical note true—every instrument with its full rich tone. With a RADIOLA LOUDSPEAKER.

With the ordinary loudspeaker, there is something lost—and something added. The lost tones are the overtones and partials that give music or voice its richness, color, and personality. The added sounds are the independent vibrations of the horn itself—metallic—hard—and grating.

To erase these faults was the problem. Not to make another loudspeaker with the limitations of the old one—but to create a new one *without* those limitations. And we have it, in the RADIOLA LOUDSPEAKER.

First—we have greater tone range

To get the deep tones of the organ—the full range of the piano—the highest notes of the violin—all with full color and richness.

Then—adjustable volume

Volume enough for a large room, yet with means to soften the tone when a near station comes in too loud. On the RADIOLA LOUDSPEAKER you control the volume with a turn of the thumb.

And the horn

This was a problem for acoustical experts. The mere shape of a horn can *make* it or ruin it. Each curve of the RADIOLA LOUDSPEAKER horn has been developed for pure tone reproduction. And it is made of a composition with no audible vibration of its own—amplifying without adding.

Radiola Loudspeaker
Model U. Z.—1320
Price
$36.50



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This symbol of quality is your protection

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LOUD SPEAKER

This symbol of quality is your protection.

★ Tested and approved by RADIO BROADCAST ★

Revised List of U. S. and Canadian Broadcasting Stations

This list includes all commercial broadcasting stations in the United States licensed up to August 24, 1923. Additional lists, with deletions, are printed every month in RADIO BROADCAST.

CALL LETTERS	LOCATION	(KILO-CYCLES)	WAVE LENGTH	POWER (WATTS)
KDKA	East Pittsburgh, Pa.	920	326	1000
KDPM	Cleveland, Ohio	1110	270	250
KDPT	San Diego, Calif.	833	360	50
KDYL	Salt Lake City, Utah,	833	360	50
KDYM	San Diego, Calif.	1190	252	50
KDYQ	Portland, Oreg.	833	360	5
KDYS	Great Falls, Mont.	833	360	50
KDYW	Phoenix, Ariz.	833	360	20
KDYX	Honolulu, Hawaii	833	360	100
KDZB	Bakersfield, Calif.	833	360	100
KDZE	Seattle, Wash.	833	360	100
KDZF	Los Angeles, Calif.	1080	278	500
KDZI	Wenatchee, Wash.	833	360	50
KDZK	Reno, Nev.	833	360	25
KDZQ	Denver, Colo.	833	360	10
KDZR	Bellingham, Wash.	1150	261	50
KDZT	Seattle, Wash.	833	360	5
KFAD	Phoenix, Ariz.	833	360	100
KFAE	Pullman, Wash.	833	360	500
KFAF	Denver, Colo.	833	360	500
KFAJ	Boulder, Colo.	833	360	100
KFAN	Moscow, Idaho	833	360	50
KFAP	Butte, Mont.	833	360	100
KFAQ	San Jose, Calif.	833	360	250
KFAR	Hollywood, Calif.	1070	280	200
KFAU	Boise, Idaho	1110	270	150
KFAV	Venice, Calif.	1160	258	5
KFAW	Santa Ana, Calif.	833	360	10
KFAY	Medford, Oreg.	833	360	100
KFBB	Havre, Mont.	833	360	50
KFBC	San Diego, Calif.	833	360	20
KFBE	San Luis Obispo, Calif.	833	360	10
KFBG	Tacoma, Wash.	833	360	50
KFBK	Sacramento, Calif.	833	360	150
KFBL	Everett, Wash.	1340	224	10
KFBS	Trinidad, Colo.	833	360	10
KFBU	Laramie, Wyo.	833	360	50
KFCD	Salem, Oreg.	833	360	10
KFCF	Walla Walla, Wash.	833	360	50
KFCH	Billings, Mont.	833	360	10
KFCK	Colorado Springs, Colo.	833	360	10
KFCL	San Antonio, Calif.	833	360	500
KFCM	Richmond, Calif.	833	360	100
KFCP	Ogden, Utah	833	360	25
KFCV	Houston, Tex.	833	360	50
KFCY	Le Mars, Iowa.	833	360	100
KFCZ	Omaha, Nebr.	833	360	150
KFDA	Baker, Oreg.	833	360	5
KFDB	San Francisco, Calif.	670	509	750
KFDC	Spokane, Wash.	1060	283	10
KFDD	Boise, Idaho	1190	252	10
KFDH	Tucson, Ariz.	833	360	150
KFDJ	Corvallis, Oreg.	833	360	50
KFDL	Denver, Colo.	833	360	5
KFDO	Bozeman, Mont.	1210	248	50
KFDP	Des Moines, Iowa	1080	278	250
KFDR	York, Nebr.	833	360	10
KEDU	Lincoln, Nebr.	1250	240	20
KFDV	Fayetteville, Ark.	833	360	200
KFDX	Shreveport, La.	833	360	100
KFDY	Brookings, S. Dak.	833	360	100
KFDZ	Minneapolis, Minn.	833	360	5
KFEC	Portland, Oreg.	833	360	50
KFEJ	Tacoma, Wash.	833	360	10
KFEL	Denver, Colo.	833	360	50
KFEP	Denver, Colo.	1250	240	10
KFEQ	Oak, Nebr.	833	360	150
KFER	Fort Dodge, Iowa	1300	231	20
KFEV	Douglas, Wyo.	1140	263	100
KFEX	Minneapolis, Minn.	1150	261	100
KFEY	Kellogg, Idaho.	833	360	10
KFEZ	St. Louis, Mo.	833	360	500
KFFA	San Diego, Calif.	1240	242	50
KFFB	Boise, Idaho	1250	240	10
KFFE	Pendleton, Oreg.	833	360	10
KFFO	Hillsboro, Oreg.	1310	229	5
KFFP	Moberly, Mo.	1090	275	100
KFFQ	Colorado Springs, Colo.	833	360	100
KFFR	Sparks, Nev.	833	360	10
KFFV	Lamoni, Iowa	833	360	100
KFFX	Omaha, Nebr.	1080	278	250
KFFY	Alexandria, La.	1090	275	100
KFFZ	Dallas, Tex. (portable)	1330	226	20
KFGC	Baton Rouge, La.	1180	254	100
KFGD	Chickasha, Okla.	1210	248	20
KFGH	Stanford University, Calif.	833	360	500
KFGJ	St. Louis, Mo.	1130	266	100
KFGL	Arlington, Oreg.	1280	234	5
KFGP	Cheney, Kans.	1310	229	10
KFGQ	Boone, Iowa	1330	226	20
KFGV	Utica, Nebr.	1340	224	10
KFGX	Orange, Tex.	1200	250	500
KFGY	Baudette, Minn.	1340	224	20
KFGZ	Berrien Springs, Mich.	1120	268	10
KFHA	Gunnison, Colo.	833	360	50
KFHB	Hood River, Oreg.	1070	280	10
KFHD	St. Joseph, Mo.	1330	226	10
KFHF	Shreveport, La.	1130	266	150
KFHH	Neah Bay, Wash.	1060	283	50
KFHI	Wichita, Kans.	1340	224	20
KFHJ	Santa Barbara, Calif.	833	360	100
KFHL	Oskaloosa, Iowa	1320	227	10
KFHP	Kearney, Nebr.	1220	246	10
KFHQ	Los Gatos, Calif.	1240	242	5
KFHR	Seattle, Wash.	1110	270	100
KFHS	Lihue, Hawaii	1090	275	30
KFHU	Mayville, N. Dak.	1150	261	50
KFHX	Hutchinson, Kans.,	1310	229	50
KFHY	Trinidad, Colo.	1240	242	50
KFI	Los Angeles, Calif.	640	469	500
KFIB	St. Louis, Mo.	1230	244	10
KFID	Iola, Kans.	1220	246	20
KFIF	Portland, Oreg.	833	360	100
KFIJ	Platte, S. Dak.	1270	236	5
KFIK	Gladbrook, Iowa	1280	234	20
KFIL	Louisburg, Kans.	1280	234	100
KFIO	Spokane, Wash.	1190	252	50
KFIQ	Yakima, Wash.	1340	224	50
KFIU	Juneau, Alaska	1330	226	10
KFIV	Pittsburg, Kans.	1250	240	20
KFIX	Independence, Mo.	1250	240	500
KFIY	Seattle, Wash.	1270	236	15
KFIZ	Fond du Lac, Wis.	1100	273	100
KFJA	Grand Island, Nebr.	1230	244	100
KFJC	Seattle, Wash.	1290	233	100
KFJD	Greeley, Colo.	1270	236	100
KFJF	Oklahoma City, Okla.	1190	252	20
KFJH	Selma, Calif.	1190	252	10
KFJI	Astoria, Oreg.	1190	252	10
KFJK	Bristow, Okla.	1290	233	100
KFJL	Ottumwa, Iowa	1240	242	10
KFJM	Grand Forks, N. D.	1310	229	100
KFJQ	Grand Forks, N. D.	1190	252	5
KFJR	Stevensville, Mont.	1160	258	50
KFKA	Greeley. Colo.	1210	248	50
KFKH	Lakeside, Colo.	1330	226	10
KFLE	Denver, Colo.	1120	268	10
KFZ	Spokane, Wash.	1060	283	10
KGG	Portland, Oreg.	833	360	50
KGN	Portland, Oreg.	833	360	100
KGU	Honolulu, Hawaii	833	360	250
KGW	Portland, Oreg.	610	492	500
KGY	Lacy, Wash.	1160	258	5
KHJ	Los Angeles, Calif.	760	395	500
KHQ	Seattle, Wash.	833	360	100
KJQ	Stockton, Calif.	833	360	5
KJR	Seattle, Wash.	1110	270	50
KJS	Los Angeles, Calif.	833	360	750
KLN	Monterey, Calif.	1150	261	10
KLS	Oakland, Calif.	833	360	250
KLX	Oakland, Calif.	833	360	250
KLZ	Denver, Colo.	833	360	200
KMC	Reedley, Calif.	833	360	100
KMJ	Fresno, Calif.	833	360	250
KMO	Tacoma, Wash.	833	360	10
KNJ	Roswell, N. Mex.	833	360	500
KNT	Aberdeen, Wash.	1140	263	250
KNV	Los Angeles, Calif.	833	360	100
KNX	Los Angeles, Calif.	833	360	100
KOB	State College, N. Mex.	833	360	500
KOP	Detroit, Mich.	1050	286	500
KPO	San Francisco, Calif.	710	423	500

Will your battery stay for the concert?



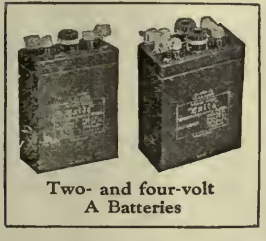
THERE is nothing more exasperating than a battery that "signs off" just when you are enjoying a splendid radio concert.

A good A battery should supply uniform filament current during a long period of discharge. Frequent recharging and replacements take all the fun out of radio receiving.

When you hook up your set to an Exide A Battery you'll appreciate what ungrudging battery service means. You'll be impressed time and again with the value of its ample capacity-rating and the smooth, unvarying flow of current that it delivers to your tubes.

Features you will appreciate

From its heavy, well-made plates to its convenient terminal binding posts, every detail of the Exide's construction is designed to help you get better reception. Vent plugs that may be inserted or removed by a single twist of the wrist make it an easy matter to add water or test the battery. A deep sediment space in the bottom of each cell eliminates danger of internal short circuits or reduced life. Wood separators of the same fine quality that are found in the Exide automobile batteries insulate the plates from one another and also contribute to the battery's long life. A stout detachable handle across the top of the battery makes it extremely easy to carry.



Two- and four-volt A Batteries

Two low-voltage A batteries

The Exide line has been extended to include two low-voltage A batteries, consisting of one and two cells. They are designed specifically for WD-11 and UV-199 vacuum tubes, and are right in line with recent developments in radio receiving.

The two-volt Exide A Battery will heat the filament of a quarter-ampere tube for approximately 96 hours. The four-volt Exide A Battery will heat the filament of a 60 milli-ampere tube for 200 hours.

Exide B Battery

Current from the new Exide B Battery is full-powered and noiseless. It is free from fluctuations that cause hissing and crackling sounds in your phones. When you tune in distant stations you know that your satisfaction will not be marred by imitation static that sounds as though a heavy electrical storm were in progress.



Exide B Batteries

You don't have to put up with a battery that discharges quickly. Go to any radio dealer or Exide Service Station and ask for Exide A and B Batteries.

If your dealer cannot supply you with free booklets describing the complete Exide line of radio batteries, write to us.

Exide
RADIO BATTERIES

THE ELECTRIC STORAGE BATTERY COMPANY, PHILADELPHIA

Oldest and largest manufacturers in the world of storage batteries for every purpose

Service Stations Everywhere — Branches in Seventeen Cities

★ Tested and approved by RADIO BROADCAST ★

CALL LETTERS	LOCATION	(KILOCYCLES)	WAVE LENGTH	POWER (WATTS)
KQI	Berkeley, Calif.	833	360	500
KQP	Hood River, Oreg.	833	360	10
KQV	Pittsburgh, Pa.	833	360	500
KQW	San Jose, Calif.	833	360	50
KRE	Berkeley, Calif.	1080	278	50
KSD	St. Louis, Mo.	550	546	500
KSS	Long Beach, Calif.	833	360	20
KTW	Seattle, Wash.	833	360	250
KUO	San Francisco, Calif.	833	360	150
KUS	Los Angeles, Calif.	833	360	100
KUY	El Monte, Calif.	833	360	50
KWG	Stockton, Calif.	833	360	100
KWH	Los Angeles, Calif.	833	360	500
KXD	Modesto, Calif.	833	360	5
KYQ	Honolulu, Hawaii	833	360	40
KYW	Chicago, Ill.	870	345	500
KZM	Oakland, Calif.	833	360	50
KZN	Salt Lake City, Utah	833	360	500
KZV	Wenatchee, Wash.	833	360	50
WAAB	New Orleans, La.	1120	268	100
WAAC	New Orleans, La.	833	360	400
WAAD	Cincinnati, Ohio	833	360	25
WAAF	Chicago, Ill.	833	360	200
WAAH	St. Paul, Minn.	833	360	100
WAAK	Milwaukee, Wis.	1070	280	100
WAAM	Newark, N. J.	1140	263	250
WAAN	Columbia, Mo.	1180	254	50
WAAP	Wichita, Kans.	833	360	150
WAAW	Omaha, Nebr.	833	360	200
WAAZ	Emporia, Kans.	833	360	100
WABB	Harrisburg, Pa.	1130	266	10
WABC	Anderson, Ind.	1310	229	10
WABD	Dayton, Ohio	1060	283	10
WABE	Washington, D. C.	1060	283	50
WABF	Mount Vernon, Ill.	1280	234	250
WABG	Jacksonville, Fla.	1210	248	10
WABH	Sandusky, Ohio	1250	240	100
WABI	Bangor, Me.	1250	240	50
WABJ	South Bend, Ind.	1250	240	10
WABK	Worcester, Mass.	1190	252	10
WABL	Storrs, Conn.	1060	283	100
WABM	Saginaw, Mich.	1180	254	100
WABN	La Crosse, Wis.	1280	234	100
WABO	Rochester, N. Y.	1190	252	20
WBAA	West Lafayette, Ind.	833	360	250
WBAD	Minneapolis, Minn.	833	360	100
WBAF	Moorestown, N. J.	833	360	100
WBAH	Minneapolis, Minn.	833	360	500
WBAN	Paterson, N. J.	1230	244	100
WBAO	Decatur, Ill.	833	360	50
WBAP	Fort Worth, Tex.	630	476	500
WBAU	Hamilton, Ohio	1160	258	50
WBAV	Columbus, Ohio	770	390	500
WBAW	Marietta, Ohio	1220	246	100
WBAX	Wilkes-Barre, Pa.	833	360	20
WBAY	New York, N. Y.	610	492	500
WBBA	Newark, Ohio	1250	240	20
WBBC	Sterling, Ill.	1310	229	50
WBBD	Reading, Pa.	1280	234	50
WBL	Anthony, Kans.	1150	261	100
WBS	Newark, N. J.	833	360	20
WBT	Charlotte, N. C.	833	360	500
WBU	Chicago, Ill.	1050	286	500
WBZ	Springfield, Mass.	890	337	750
WCAD	Canton, N. Y.	1070	280	50
WCAE	Pittsburgh, Pa.	650	462	500
WCAG	New Orleans, La.,	1120	268	50
WCAH	Columbus, Ohio	1050	286	250
WCAJ	University Place, Nebr.	833	360	500
WCAK	Houston, Tex.,	833	360	50
WCAL	Northfield, Minn.	833	360	250
WCAM	Villanova, Pa.	833	360	150
WCAO	Baltimore, Md.	833	360	50
WCAP	Washington, D. C.	640	469	500
WCAR	San Antonio, Tex.	833	360	100
WCAS	Minneapolis, Minn.	833	360	100
WCAT	Rapid City, S. Dak.	1250	240	100
WCAU	Philadelphia, Pa.	1050	286	100
WCAV	Little Rock, Ark.	833	360	20
WCAX	Burlington, Vt.	833	360	50
WCAY	Milwaukee, Wis.	1150	261	500
WCBA	Allentown, Pa.,	1070	280	5
WCBB	Greenville, Ohio	1250	240	100
WCBD	Zion, Ill.	870	345	500
WCE	Minneapolis, Minn.	833	360	250
WCK	St. Louis, Mo.	833	360	100
WCM	Austin, Tex.	833	360	500
WCN	Worcester, Mass.	833	360	600
WCX	Detroit, Mich.	580	517	500
WDAD	Lindsborg, Kans.	833	360	10
WDAE	Tampa, Fla.	833	360	250
WDAF	Kansas City, Mo.	730	411	500
WDAG	Amarillo, Tex.	833	360	100
WDAH	El Paso, Tex.	833	360	200
WDAI	Syracuse, N. Y.	1220	246	100
WDAJ	College Park, Ga	833	360	500
WDAK	Hartford, Conn.	1150	261	100
WDAL	Jacksonville, Fla.	833	360	100
WDAO	Dalias, Tex.	833	360	50
WDAP	Chicago, Ill.	833	360	500
WDAR	Philadelphia, Pa.	760	395	500
WDAS	Worcester, Mass.	833	360	5
WDAU	New Bedford, Mass.	833	360	100
WDAX	Centerville, Iowa	833	360	100
WDAY	Fargo, N. Dak.	1230	244	50
WDBC	Lancaster, Pa.	1160	258	50
WDBF	Youngstown, Ohio	1150	261	50
WDM	Washington, D. C.	833	360	50
WDT	Stapleton, N. Y.	740	405	500
WDZ	Tuscola, Ill.	1080	278	350
WEAA	Flint, Mich.	1070	280	150
WEAB	Fort Dodge, Iowa	833	360	100
WEAF	New York, N. Y.	610	492	500
WEAG	Edgewood, R. I.	1300	231	10
WEAH	Wichita, Kans.	833	360	100
WEAI	Ithaca, N. Y.	1050	286	500
WEAJ	Vermilion, S. Dak.	833	360	200
WEAK	St. Joseph, Mo.	833	360	15
WEAM	North Plainfield, N. J.	1190	250	100
WEAN	Providence, R. I.	1100	273	15
WEAO	Columbus, Ohio	833	360	500
WEAP	Mobile, Ala.	833	360	100
WEAR	Baltimore, Md.	833	360	50
WEAS	Washington, D. C.	833	360	100
WEAU	Sioux City, Iowa	833	360	100
WEAY	Houston, Tex.	833	360	1000
WEB	St. Louis, Mo.	833	360	500
WEV	Houston, Tex.	833	360	250
WEW	St. Louis, Mo.	1150	261	100
WFAA	Dallas, Tex.	630	476	500
WFAB	Syracuse, N. Y.	1280	234	200
WFAF	Poughkeepsie, N. Y.	833	360	20
WFAH	Port Arthur, Tex.	833	360	150
WFAJ	Asheville, N. C.	833	360	100
WFAM	St. Cloud, Minn.	833	360	20
WFAN	Hutchinson, Minn.	833	360	100
WFAQ	Cameron, Mo.	833	360	10
WFAT	Sioux Falls, S. Dak.	833	360	100
WFAV	Lincoln, Nebr.	833	360	100
WFI	Philadelphia, Pa.	760	395	500
WGAL	Lancaster, Pa.	1210	248	10
WGAN	Pensacola, Fla.	833	360	50
WGAQ	Shreveport, La.	833	360	150
WGAR	Fort Smith, Ark.	833	360	20
WGAU	Wooster, Ohio	1330	226	20
WGAW	Altoona, Pa.	1150	261	100
WGAY	Madison, Wis.	833	360	100
WGAZ	South Bend, Ind.	833	360	100
WGF	Des Moines, Iowa	833	360	250
WGI	Medford Hillside, Mass.	833	360	500
WGL	Philadelphia, Pa.	833	360	250
WGR	Buffalo, N. Y.	833	360	250
WGV	New Orleans, La.	833	360	100
WGY	Schenectady, N. Y.	790	380	1000
WHA	Madison, Wis.	833	360	800
WHAA	Iowa City, Iowa	1060	283	100
WHAB	Galveston, Tex.	833	360	200
WHAC	Waterloo, Iowa	833	360	20
WHAD	Milwaukee, Wis.	1070	280	100
WHAG	Cincinnati, Ohio	1350	222	100
WHAH	Joplin, Mo.	833	360	550
WHAI	Davenport, Iowa	833	360	50
WHAK	Clarksburg, W. Va.	833	360	15
WHAL	Lansing, Mich.	1210	248	20
WHAM	Rochester, N. Y.	833	360	100
WHAO	Savannah, Ga.	833	360	100
WHAP	Decatur, Ill.	833	360	10
WHAQ	Washington, D. C.	833	360	10
WHAR	Atlantic City, N. J.	1300	231	15
WHAS	Louisville, Ky.	750	400	500
WHAV	Wilmington, Del.	833	360	50
WHAY	Huntington, Ind.	833	360	10
WHAZ	Troy, N. Y.	790	380	500
WHB	Kansas City, Mo.	730	411	500
WHD	Morgantown, W. Va.	833	360	250
WHK	Cleveland, Ohio	833	360	100
WHN	Ridgewood, N. Y.	833	360	100
WIAB	Rockford, Ill.	190	252	50
WIAC	Galveston, Tex.	833	360	100
WIAD	Ocean City, N. J.	1180	254	10
WIAF	New Orleans, La.	1280	234	10
WIAH	Newton, Iowa	833	360	5
WIAI	Springfield, Mo.	833	360	20
WIAJ	Neenah, Wis.	1340	224	20
WIAK	Omaha, Nebr.	1080	278	200
WIAO	Milwaukee, Wis.	833	360	100
WIAQ	Marion, Ind.	833	360	10
WIAR	Paducah, Ky.	833	360	100
WIAS	Burlington, Iowa	833	360	100
WIAT	Tarkio, Mo.	833	360	15
WIAU	Le Mars, Iowa.	833	360	20
WIAY	Washington, D. C.	833	360	100
WIK	McKeesport, Pa.	833	360	250
WIL	Washington, D. C.	833	360	10
WIP	Philadelphia, Pa.	590	509	500
WJAB	Lincoln, Nebr.	833	360	500
WJAD	Waco, Tex.	833	360	150
WJAF	Muncie, Ind.	833	360	10



SIGNALING

CONSIDER the vast difference between the methods of the savage and the marvellous broadcasting of to-day. This difference can be stated in one word —instruments.

Modern broadcasting employs delicate instruments to transform messages into electricity. Satisfactory reception requires equally fine apparatus to translate this current into the original music or spoken word.

Upon your loud speaker or head phones falls the task of transforming the electric current that flows through your set into sound. Poorly designed or carelessly constructed instruments cannot do this with satisfaction to you.

Holtzer-Cabot Phones and Loud Speakers are the perfect results of 25 years' specialization in the manufacture of sensitive electric apparatus.

Holtzer-Cabot Loud Speaker,	**$25.00**
No. 2 Universal Head Phones,	**9.50**
No. 4 National Head Phones,	**6.00**

Write for booklets "What you should know about Radio Reception" and "A better Loud Speaker."

THE HOLTZER-CABOT ELECTRIC CO.
125 Amory Street, **Boston, Mass.**
6161-65 South State Street, **Chicago, Ill.**
Department A

Holtzer-Cabot
BUSINESS ESTABLISHED 1875

HEAD SETS

★ Tested and approved by RADIO BROADCAST ★

CALL LETTERS	LOCATION	(KILOCYCLES)	WAVE LENGTH	POWER (WATTS)
WJAG	Norfolk, Nebr.	833	360	100
WJAM	Cedar Rapids, Iowa	833	360	20
WJAN	Peoria, Ill.	1070	280	100
WJAQ	Topeka, Kans.	833	360	50
WJAR	Providence, R. I.	833	360	50
WJAS	Pittsburgh, Pa.	833	360	500
WJAT	Marshall, Mo.	833	360	20
WJAX	Cleveland, Ohio	770	390	500
WJAZ	Chicago, Ill.	670	448	20
WJD	Granville, Ohio	1310	229	50
WJH	Washington, D. C.	1140	263	50
WJX	New York, N. Y.	833	360	500
WJY	New York, N. Y.	740	405	500
WJZ	New York, N. Y.	660	455	500
WKAA	Cedar Rapids, Iowa	833	360	100
WKAC	Lincoln, Nebr.	1090	275	100
WKAD	East Providence, R. I.	833	360	10
WKAF	Wichita Falls, Tex	833	360	100
WKAN	Montgomery, Ala.	1330	226	20
WKAP	Cranston, R. I.	833	360	200
WKAQ	San Juan, P. R.	833	360	100
WKAR	East Lansing, Mich.	1070	280	100
WKAS	Springfield, Mo.	833	360	10
WKAV	Laconia, N. H.	833	360	50
WKAW	Beloit, Wis.	1240	242	10
WKAX	Bridgeport, Conn.	1300	231	15
WKAY	Gainesville, Ga.	833	360	20
WKC	Baltimore, Md.	833	360	20
WKY	Oklahoma, Okla.	833	360	100
WLAC	Raleigh, N. C.	833	360	750
WLAG	Minneapolis, Minn.	720	417	500
WLAH	Syracuse, N. Y.	1280	234	250
WLAJ	Waco, Tex.	833	360	50
WLAK	Bellows Falls, Vt.	833	360	500
WLAL	Tulsa, Okla.	833	360	100
WLAN	Houlton, Me.	833	360	100
WLAP	Louisville, Ky.	833	360	15
WLAQ	Kalamazoo, Mich.	833	360	20
WLAT	Burlington, Iowa	833	360	10
WLAV	Pensacola, Fla.	833	360	20
WLAW	New York, N. Y.	833	360	500
WLAX	Greencastle, Ind.	1300	231	5
WLAZ	Warren, Ohio	1210	248	20
WLB	Minneapolis, Minn.	833	360	100
WLW	Cincinnati, Ohio	970	309	500
WMAB	Oklahoma, Okla.	833	360	100
WMAC	Cazenovia, N. Y.	1150	261	100
WMAF	Dartmouth, Mass.	833	360	500
WMAH	Lincoln, Nebr.	1180	254	15
WMAJ	Kansas City, Mo.	1090	275	250
WMAK	Lockport, N. Y.	833	360	500
WMAL	Trenton, N. J.	1170	256	15
WMAM	Beaumont, Tex.	833	360	100
WMAN	Columbus, Ohio,	1050	286	20
WMAP	Easton, Pa.	1220	246	250
WMAQ	Chicago, Ill.	670	448	500
WMAT	Duluth, Minn.	1130	266	250
WMAV	Auburn, Ala.	1200	250	250
WMAY	St. Louis, Mo.	833	360	100
WMAZ	Macon, Ga.	1120	268	50
WMC	Memphis, Tenn.	600	500	500
WMH	Cincinnati, Ohio	1210	248	10
WMU	Washington, D. C.	1150	261	100
WNAC	Boston, Mass.	833	360	100
WNAD	Norman, Okla,	833	360	100
WNAL	Omaha, Nebr.	833	360	50
WNAM	Evansville, Ind.	833	360	500
WNAN	Syracuse, N. Y.	1050	286	100
WNAP	Springfield, Ohio	833	360	100
WNAQ	Charleston, S. C.	833	360	20
WNAR	Butler, Mo.	833	360	10
WNAS	Austin, Tex.	833	360	100
WNAT	Philadelphia, Pa.	833	360	250
WNAV	Knoxville, Tenn.	833	360	500
WNAW	Fort Monroe, Va.	833	360	5
WNAX	Yankton, S. Dak.	1230	244	50
WNAY	Baltimore, Md.	833	360	10
WNJ	Albany, N. Y.	833	360	55
WOAA	Ardmore, Okla.	833	360	20
WOAB	Grand Forks, N. Dak.	833	360	5
WOAC	Lima, Ohio	1130	266	100
WOAD	Sigourney, Iowa	833	360	10
WOAE	Fremont, Nebr.	833	360	20
WOAF	Tyler, Tex.	833	360	100
WOAG	Belvidere, Ill.	1340	224	20
WOAH	Charleston, S. C.	833	360	100
WOAI	San Antonio, Tex.	780	385	500
WOAJ	Parsons, Kans.	1160	258	15
WOAK	Frankfort, Ky.	1250	240	20
WOAL	Webster Groves, Mo.	833	360	500
WOAN	Lawrenceburg, Tenn.	833	360	150
WOAO	Mishawaka, Ind.	833	360	50
WOAP	Kalamazoo, Mich.	833	360	50
WOAQ	Portsmouth, Va.	833	360	15
WOAR	Kenosha, Wis.	833	360	50
WOAS	Middletown, Conn.	833	360	50
WOAT	Wilmington, Del.	833	360	50
WOAV	Erie, Pa.	1240	242	200
WOAW	Omaha, Nebr.	570	526	500
WOAX	Trenton, N. J.	1250	240	200
WOAZ	Stamford, Tex.	833	360	100
WOC	Davenport, Iowa	620	484	500
WOE	Akron, Ohio	833	360	40
WOI	Ames, Iowa	833	360	100
WOK	Pine Bluff, Ark.	833	360	500
WOO	Philadelphia, Pa.	590	509	500
WOQ	Kansas City, Mo.	833	360	500
WOR	Newark, N. J.	740	405	500
WOS	Jefferson, City, Mo.	833	360	500
WPAB	State College, Pa.	833	360	500
WPAC	Okmulgee, Okla.	833	360	200
WPAD	Chicago, Ill.	833	360	500
WPAF	Council Bluffs, Iowa	833	360	10
WPAH	Waupaca, Wis.	833	360	250
WPAJ	New Haven, Conn.	1120	268	30
WPAK	Agricultural College, N. Dak.	833	360	250
WPAL	Columbus, Ohio	1050	286	100
WPAM	Topeka, Kans.	833	360	100
WPAP	Winchester, Ky.	833	360	35
WPAQ	Frostburg, Md.	833	360	10
WPAR	Beloit, Kans.	833	360	10
WPAT	El Paso, Tex.	833	360	20
WPAU	Moorhead, Minn.	833	360	20
WPAW	Wilmington, Del.	833	360	10
WPAY	Bangor, Me.	833	360	20
WPAZ	Charleston, W. Va.	1100	273	20
WPG	New Labanon, Ohio	833	360	30
WQAA	Parkersburg, Pa.	833	360	500
WQAB	Springfield, Mo.	1270	236	10
WQAC	Amarillo, Tex.	833	360	100
WQAD	Waterbury, Conn.	1240	242	50
WQAE	Springfield, Vt.	1090	275	150
WQAF	Sandusky, Ohio	1250	240	5
WQAH	Lexington, Ky.	1180	254	10
WQAL	Mattoon, Ill.	1160	258	20
WQAM	Miami, Fla.	833	360	100
WQAN	Scranton, Pa.	1070	280	250
WQAO	New York, N. Y.	833	360	100
WQAQ	Abilene, Tex.	833	360	100
WQAS	Lowell, Mass.	1130	266	10
WQAV	Greenville, S. C.	1160	258	15
WQAW	Washington, D. C.	1270	236	5
WQAX	Peoria, Ill.	833	360	20
WQAY	Hastings, Nebr.	833	360	20
WQAZ	Greensboro, N. C.	833	360	30
WRAA	Houston, Tex.	833	360	200
WRAB	Savannah, Ga.	833	360	100
WRAD	Marion, Kans.	833	360	10
WRAF	Laporte, Ind.	1340	224	10
WRAH	Providence, R. I.	833	360	10
WRAL	St. Croix Falls, Wis.	1210	248	100
WRAO	St. Louis, Mo.	833	360	20
WRAP	Winter Park, Fla.	833	360	20
WRAR	David City, Nebr.	1330	226	20
WRAS	McLeansboro, Ill.	833	360	10
WRAU	Amarillo, Tex.	833	360	10
WRAV	Yellow Springs, Ohio	833	360	100
WRAW	Reading, Pa.	1260	238	10
WRAX	Gloucester, City, N. J.	1120	268	50
WRAY	Scranton, Pa.	833	360	50
WRAZ	Newark, N. J.	1290	233	50
WRC	Washington, D. C.	640	469	....
WRK	Hamilton, Ohio	833	360	50
WRL	Schenectady, N. Y.	833	360	500
WRM	Urbana, Ill.	833	360	500
WRR	Dallas, Tex.	833	360	20
WRW	Tarrytown, N. Y.	1100	273	150
WSAB	Cape Giardeau, Mo.	833	360	100
WSAC	Clemson College, S. C.	833	360	500
WSAD	Providence, R. I.	1150	261	50
WSAG	St. Petersburg, Fla.	1230	244	10
WSAH	Chicago, Ill.	1210	248	500
WSAI	Cincinnati, Ohio	970	309	500
WSAJ	Grove City, Pa.	833	360	100
WSAK	Middleport, Ohio	1160	258	70
WSAL	Brookville, Ind.	1220	246	20
WSAN	Allentown, Pa.	1310	229	10
WSAP	New York, N. Y.	833	360	250
WSAR	Fall River, Mass.	1180	254	10
WSAT	Plainview, Tex.	1120	268	20
WSAU	Chesham, N. H.	1310	229	10
WSAW	Canandaigua, N. Y.	1090	275	100
WSB	Atlanta, Ga.	700	429	500
WSL	Utica, N. Y.	1100	273	100
WSY	Birmingham, Ala.	833	360	500
WTAB	Fall River, Mass.	1210	248	10
WTAC	Johnstown, Pa.	833	360	150
WTAF	New Orleans, La	1240	242	20
WTAG	Providence, R. I.	1160	258	10
WTAH	Belvidere, Ill.	1270	236	10
WTAJ	Portland, Me.	1270	236	50
WTAK	Steubenville, Ohio	1130	266	20
WTAS	Elgin, Ill.	1090	275	500
WTAU	Tecumseh, Nebr.	833	360	10
WTAW	College Station, Tex.	1180	254	50
WTG	Manhattan, Kans.	618	485	1000

Pacent Plug and Jack Devices for ★ Every Radio Requirement



PACENT MULTIADAPTER

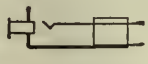
Provides one to five plug connections. Catalogue No. 54.

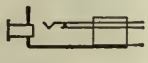
Price $1.50

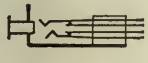


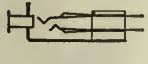
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61  Single Open Circuit Jack. Price 60c

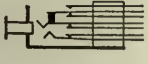
62  Single Closed Circuit Jack. Price 70c

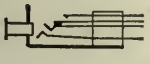
63  Double Circuit Jack. Price 80c

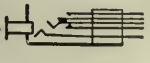
64  Heavy duty (Loop) Jack Price $1.00

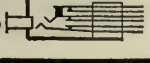
65  Three Spring Automatic Jack. Price 85c

66  Five Spring Automatic Jack. Price $1.00

67  Seven Spring Automatic Jack Price $1.00

68  Four Spring Automatic Triple Circuit Jack. Price $1.00

69  Five Spring Special Automatic Jack Price $1.00

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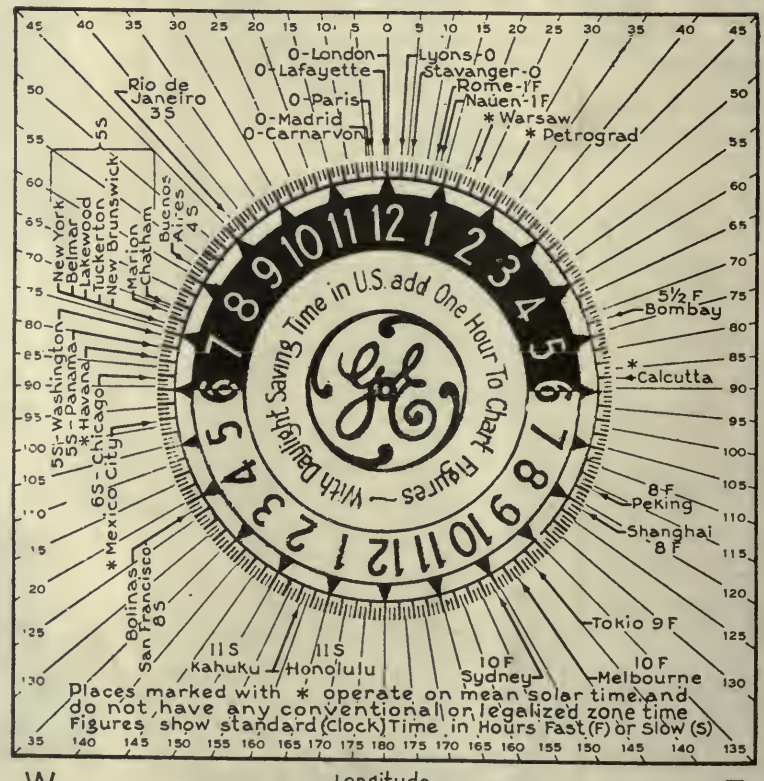
★ Tested and approved by RADIO BROADCAST ★

CALL LETTERS	LOCATION	(KILO-CYCLES)	WAVE LENGTH	POWER (WATTS)	CALL LETTERS	LOCATION	(KILO-CYCLES)	WAVE LENGTH	POWER (WATTS)
WWAC	Waco, Tex.	833	360	50	WWI	Dearborn, Mich.	1100	273	50
WWAD	Philadelphia, Pa.	833	360	50	WWJ	Detroit, Mich.	580	517	500
WWAX	Laredo, Tex.	833	360	50	WWL	New Orleans, La.	833	360	100
WWB	Canton, Ohio	1120	268	100	WWZ	New York, N. Y.	833	360	100

CANADIAN BROADCASTING STATIONS

CALL LETTERS	LOCATION	(KILO-CYCLES)	WAVE LENGTH	CALL LETTERS	LOCATION	(KILO-CYCLES)	WAVE LENGTH
CFAC	Calgary, Alberta	698	430	CHCL	Vancouver, British Columbia	682	440
CFCA	Toronto, Ontario	750	400	CHYC	Montreal, Quebec	732	410
CFCF	Montreal, Quebec	682	440	CJCA	Edmonton, Alberta	667	450
CFCH	Iroquois Falls, Ontario	750	400	CJCD	Toronto, Ontario	732	410
CFCI	Vancouver, British Columbia	667	450	CJCE	Vancouver, British Columbia	714	420
CFCJ	Quebec, Quebec	732	410	CJCI	St. John, New Brunswick	750	400
CFCK	Edmonton, Alberta	732	410	CJCN	Toronto, Ontario	732	410
CFCL	Victoria, British Columbia	750	400	CJCX	Olds, Alberta	750	400
CFCN	Calgary, Alberta	682	440	CJGC	London, Ontario	698	430
CFCO	Bellevue, Quebec	667	450	CJSC	Toronto, Ontario	698	430
CFCW	London, Ontario	714	420	CKAC	Montreal, Quebec	698	430
CFQC	Saskatoon, Saskatchewan	750	400	CKCD	Vancouver, British Columbia	732	410
CFUC	Montreal, Quebec	750	400	CKCE	Toronto, Ontario	667	450
CHBC	Calgary, Alberta	732	410	CKCK	Regina, Saskatchewan	714	420
CHCD	Quebec, Quebec	732	410	CKOC	Hamilton, Ontario	732	410
CHCE	Victoria, British Columbia	750	400	CKY	Winnipeg, Manitoba	667	450

WORLD TIME CHART



Courtesy of General Electric Co.

If you mount this chart on a piece of cardboard and cut around the outside circle with a sharp knife and run a pin through the center to form an axle, you can tell the hour in any of the places indicated for a given hour in any other place. (For instance, when we in America transmit to England at 10 P. M. Eastern Standard Time, the time in England will be found by placing "10" opposite "New York" and reading the figure opposite "London," i. e., 3 A. M.)

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