# RADIO BROADCAST

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# *The Story of Broadcasting in England*

*The Growth of the Radio Giant in Great Britain Compared With that in America—How John Bull Regulates Broadcasting—The New Radio Import and Licensing Regulations*


*By F. J. BROWN*

***Late Assistant Secretary of the British Post Office***


BROADCASTING in Great Britain began in a very small way by a half-hour's transmission of a musical program once a week from a station belonging to the Marconi Company at Writtle, in Essex. This was authorized as a concession to the two or three thousand amateurs who at that time had received experimental licenses from the Post Office, and who wished to test the efficiency of their apparatus by picking up Writtle's signals. They were mainly gramophone records, but occasionally more ambitious programs were introduced.

This was the limit of development in the winter of 1921-2, when I visited Washington as Expert Adviser on Communications to the British Delegation at the Arms Conference. At that time, the broadcasting boom in America had just begun. Fortunately, I was in a position to receive full information as to its progress from my friends General Squier, Doctor Austin and Doctor Cohen; and through their courtesy I was present at some of the meetings of Mr. Hoover's first Radio Conference, where I met other world-famous American radio authorities. An extract from a letter which I wrote to one of my colleagues in London on the subject in February, 1922, may be of some historical interest:

> The thing which has made the most remarkable progress here recently is broadcasting. The number of receiving sets which are being used is marvelous. The Westinghouse people gave it a great impetus. They have put up several broadcasting stations, and are stated to be selling receiving sets (varying in price from $30 to $150) at the rate of 25,000 a month, and are then quite unable to meet the demand. Other people are following suit, and it is likely that there are now between 200,000 and 300,000 receiving sets in use, though the number can't be stated exactly, as licenses are not issued for reception. The sending stations broadcast on 360 meters. They probably interfere to some extent with ship-and-shore work, and they certainly tend to interfere with one another. I heard a program from one of them last Sunday afternoon at Dr. Frank B. Jewett's home, by means of his boy's receiving set. Both speech and music were quite clear. The opinion is growing here that broadcasting is the main sphere of wireless in the future.

On my return to London in March, 1922, I found that applications were being made to the Post Office by certain wireless manufacturing firms for permission to broadcast programs of music, etc., for the purpose of promoting the sale of their apparatus.

ENGLAND REFUSED TO GRANT A BROADCASTING MONOPOLY

IT SOON became evident that, within the circumscribed area of Great Britain, it would be impossible to permit the establishment of broadcasting stations with anything like the freedom which was being granted in America. It was equally contrary to the policy of the British Government to grant a monopoly of broadcasting to one, or even to two or three, manufacturing firms, as this would place them in a superior position to their competitors for pushing the sale of their goods.

In these circumstances, the whole question was referred to the Imperial Communications Committee. This committee is composed of representatives of the Army, Navy, Air Force, Post Office, and other British government departments which are interested in wireless. It is presided over by a member of the Cabinet, and considers all important questions of imperial policy with regard to wireless and cables. To this committee I explained the position which had arisen in America, and the difficulties which were presenting themselves in England.

The Committee recommended that an endeavor should be made to induce the various manufacturing firms to coöperate in the establishment of a single Broadcasting Company, which, it was thought, might be allowed to establish stations of moderate power (say from $1\frac{1}{2}$ to 3 kilowatts) in eight areas, centering on London, Birmingham, Cardiff, Plymouth, Manchester, Newcastle, Edinburgh (or Glasgow) and Aberdeen. These stations would roughly cover the whole of the country.

The Committee further recommended that a band of wavelengths from 350 to 425 meters should be assigned to the stations. They considered that the Broadcasting Company should not be allowed to broadcast advertising matter, or to receive payment for matter broadcast. They also considered that, as the new organization would be placed in a privileged position (in that no competitor would be allowed) it was only fair to the press and the news agencies that its operations as a distributor of news should be rather severely restricted. They proposed that its revenue should be provided mainly by a share of one-half of the license-fee of ten shillings (about $2.50) collected by the Post Office on the issue of each receiving license.

In this connection, it should be mentioned that, in Great Britain (unlike the United States), a license from a governmental authority has always been held to be necessary for each receiving set, as well as for transmitting apparatus.

## Facts From Headquarters

COMPARISONS, if not exactly odious, are frequently too easily and carelessly made. One hears it said that in England the radio people do it this way, or that, which is better or worse than our method, as the case may be. This story of affairs radio in England is authoritative and extremely interesting to any one who has wondered how England has handled her radio problems. Mr. Brown, the author, was, until last January, the Assistant Secretary of the British Post Office and in administrative control of broadcasting and other wireless activities for the Government. He tells in interesting fashion just what happened in England to the licensing system which was inaugurated when broadcasting got its real start there in November, 1922—exactly one year after regular broadcasting service began in this country. It was the home constructor who spoiled the scheme and the revised schedule under which receiving licenses are now granted takes him into consideration. This article by Mr. Brown and "How the Government Is Regulating Radio Broadcasting" by R. S. McBride in RADIO BROADCAST for May, are of especial interest because they show how the two governments are trying to solve their administrative problems.—THE EDITOR

ENGLISH BROADCASTING BEGAN IN NOVEMBER, 1922

MR. KELLAWAY, who was Postmaster General at the time (he has since become Managing Director of the Marconi Company), threw himself into the scheme with much avidity; and on May 4th, 1922, he announced in the House of Commons that he had decided to allow the establishment of a limited number of broadcasting stations, and was calling a conference of the firms who had applied for licenses to open them. This conference was held a fortnight later and was attended by representatives of twenty-four firms. A committee of manufacturers was subsequently appointed by these firms, in conjunction with all other firms who were known to be engaged in the manufacture of wireless apparatus. Prolonged negotiations took place.

At one stage, the negotiations almost broke down. It seemed to be impossible for the manufacturers to agree on the formation of a single broadcasting organization: there was a marked tendency toward a division into two groups, which would have involved the creation of two broadcasting companies, each representing one of the groups. But finally all difficulties were surmounted and a single broadcasting organization was formed—although it was not until January 18th, 1923, that a license was actually issued to that organization. In the meantime (on November 15th), a daily broadcasting service had been started at the London station, and later at Birmingham and Manchester. The issue of broadcast receiving licenses by the Post Office began November 1, 1922.

## HOW ENGLAND PLANNED BROADCASTING

THE scheme as embodied in the license to the broadcasting organization was recognized from the start as being necessarily of a provisional nature; and the term of the license was accordingly limited to two years. The principal features of the scheme have been officially summarized as follows:—

(a) A Company (called the British Broadcasting Company) to be formed among British manufacturers of wireless apparatus. Any such manufacturer to be entitled to join the Company upon his subscribing for one or more £1 shares, and entering into an agreement in the form approved by the Postmaster General.

(b The Company to establish eight broadcasting stations and to provide a regular service to the reasonable satisfaction of the Postmaster General. The Company to pay a royalty of £50 per annum in respect of each station.

(c) The Post Office to issue broadcast receiving licenses at a fee of 10*s*. a year, containing a condition that the sets used, and certain parts (viz., valves, valve amplifiers, head telephones, and loud speakers), must bear a standard mark—"B. B. C.—Type approved by Postmaster General."

(d) The Post Office to pay the Company a sum equal to one half of the license fees received in respect of broadcast and experimental receiving licenses.

RADIO LISTENERS IN GERMANY

Broadcasting in the German Republic has not attained as great popularity as in either England or the United States. England is very completely served by a system of master stations and small local relay stations. The master stations in the larger centers originate programs of their own and relay programs from the London studio of the Broadcasting Company. This system, perfectly suited to England, could hardly be applied to American conditions. American stations have been "tied" together for programs from WEAF, New York, but the "tie-up" has been usually with stations only as far west as the Mississippi because of the difference in time between New York and the Central and Far West. The German enthusiasts here are using a receiver which is incorporated in a table lamp. The loop is covered

(e) The sets sold by members of the Company, as a condition of bearing the "B. B. C." mark, to be British made, to carry a payment to the Company in accordance with a tariff approved by the Postmaster General, and to require the Postmaster General's approval of the type of set, such approval being confined to securing that the apparatus would not be likely to cause radiation from the receiving antenna.

(f) No advertising or paid matter to be broadcast, and only such news as is obtained from news agencies approved by the Postmaster General.

(g) The Company not to pay dividends at a higher rate than $7\frac{1}{2}$ per cent. per annum.

(h) An understanding to be given that the requisite capital would be subscribed, that the service would be continued throughout the period of the license, and that any deficit should be met. Six firms undertook these responsibilities and were given the right each to nominate a director, two additional directors being nominated by the remaining firms who might take up shares, and an independent chairman being appointed by the six firms.

### THE RADIO CHILD GROWS

THE scheme excited much public interest and was, on the whole, well received. In the winter months following the first issue of broadcast receiving licenses by the Post Office (on November 1, 1922), a considerable number of these licenses were sold. By the end of March, 1923, the total was about 150,000 and the income of the Company from all licenses was about £60,000 (about $1,270,000). However, at that time difficulties began to be encountered. As already explained, the broadcast receiving license was applicable only to sets bearing the "B. B. C." mark. But in explaining the scheme to the House of Commons in July, 1922, Mr. Kellaway had given an assurance that "provision would be made under which amateurs who constructed their own receiving sets would be allowed to use them." The view then taken by the Post Office was that, if a person were sufficiently skilled to make his own apparatus, he would have sufficient knowledge of the subject to be described as an experimenter, and to be entitled to hold the experimental license which the Post Office, in its arrangements with the Company, had reserved the right to issue independently of the broadcast receiving license. I will say that the Post Office at that time had no adequate conception of the extent to which members of the public would make their own apparatus. Moreover, on the strength of Mr. Kellaway's assurance, firms began to place on the market ready-made parts which any intelligent person could build up into an effective receiving set by the aid of a diagram and a screw-driver. Such persons could obviously not properly be regarded as experimenters, and it would not have been fair to the Broadcasting Company, and especially to the manufacturing firms who constituted that Company, to issue experimental licenses to such persons, seeing that their apparatus carried no royalty payment to the Broadcasting Company and provided no revenue to the manufacturer.

### THEN CAME THE HOME CONSTRUCTOR

THE Post Office had, indeed, no license to fit the case of these persons. The experimental license was not applicable, and they were not entitled to the broadcast receiving license, inasmuch as it covered apparatus bearing the B. B. C. mark only. A deadlock had, in fact, arisen. Many thousands of "home constructors" were applying for licenses and their demand could not be met. What was to be done? Suggestions were made from various sources that a new type of "constructor's license" should be issued; but, although the Broadcasting Company agreed in principle to the issue of such a license, notwithstanding the fact that they need not have done so under the terms of their operating license, it proved impossible for the Post Office and the Company to arrive at an agreement as to the precise conditions upon which such licenses should be issued. A situation intolerable alike to the Post Office, to the Company and to the general community having thus arisen, Sir William Joynson-Hicks, who was then Postmaster General, referred the question to a committee known as the Broadcasting Committee. The Committee comprised representatives of the Post Office, of the Broadcasting Company, of the House of Commons, of the radio amateurs and of the general public. It held several meetings, and gave the most careful attention to the whole subject. Finally it recommended several important modifications of the original scheme—although it recognized that, as the original proposal had been embodied in a legal agreement between the Post Office and the Broadcasting Company, these modifications could not be carried out without the consent of the Company until that agreement had expired at the end of 1924. The substance of these modifications was as follows:

(1) A uniform and simple type of receiving license at 10s. ($2.50) to be issued and placed on sale at Post Offices without any formalities—the restriction against the use of apparatus not bearing the "B. B. C." mark being abolished.

(2) The Broadcasting Company to receive a maximum of 7*s*.6*d*. instead of 5*s*.—out of the license fee, subject to the operation of a sliding scale under which the payment per license would decrease as the number of licenses increased.
(3) The method of deriving revenue on royalties on the sale of "B. B. C." apparatus to be discontinued.
(4) Effective measures to be taken to prevent evasion of the license, and certain additional statutory powers to be obtained to strengthen the Postmaster General's hands.
(5) The gradual extension of the broadcasting of news to be allowed under proper safeguards.
(6) The broadcast band of wavelengths (hitherto from 350 to 425 meters) to be increased so as to include wavelengths between 300 and 500 meters (except those from 440 to 460 meters which are used for maritime purposes.
(7) The Broadcasting Company's license to be extended from the end of 1924 to the end of 1926, but the Government to keep its hands free to grant additional licenses if considered desirable.

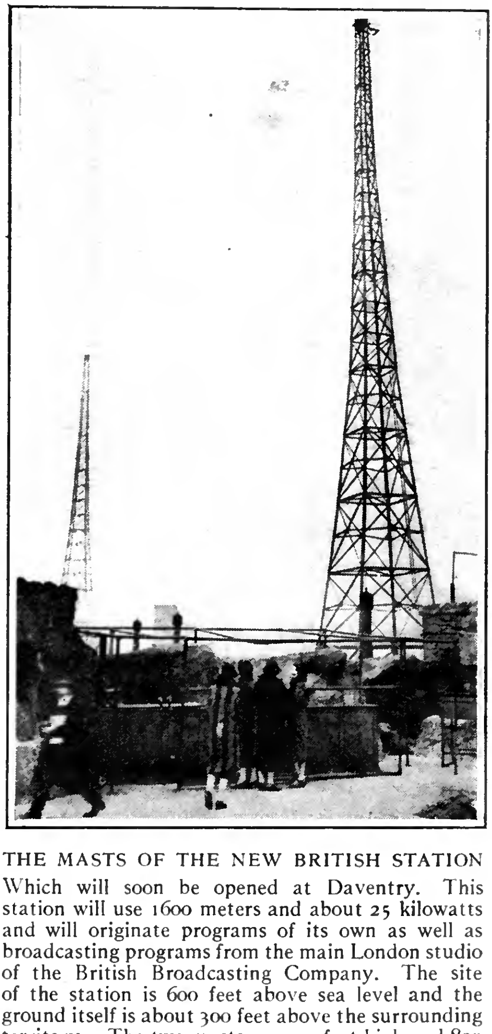
The Committee paid a well deserved tribute to the excellent service provided by the Broadcasting Company—a tribute which, when the Report was published, was generally echoed by the press.

SOLVING A DIFFICULT PROBLEM

WHEN the then Postmaster General, Sir Laming Worthington-Evans, received the Report in August, 1923, he immediately initiated further negotiations with the Broadcasting Company. He found the Company, as might have been expected, unwilling to accept the Report as it stood, in view of their strong legal position. They met him, however, in a very reasonable spirit and a compromise was arranged without serious difficulty. This compromise had been tentatively suggested while the Committee was sitting, and both parties, as well as the public, were well satisfied with it. Under this compromise, which was announced about the beginning of October, 1923, it was agreed that up to the end of that month a special form of license, known as the "interim license," should be issued in order to "whitewash" the many unlicensed receiving sets which, it was believed, had come into existence during the period of the deadlock. The fee for this "interim license" was to be 15*s*. a year, out of which the Broadcasting Company was to receive 12*s*.6*d*. In addition to this form of license, the broadcast receiving license at 10*s*., applicable only to apparatus bearing the B. B. C. mark, was continue to be issued; and a constructor's license at 15*s*. was to be introduced, applicable to apparatus made or put together by or on behalf of the licensee himself. The only special condition of this license was to be an undertaking by the licensee not intentionally to use, in the construction of his set, material or parts made elsewhere than in Great Britain.

ONE MILLION TWO HUNDRED THOUSAND RECEIVER LICENSES IN ENGLAND

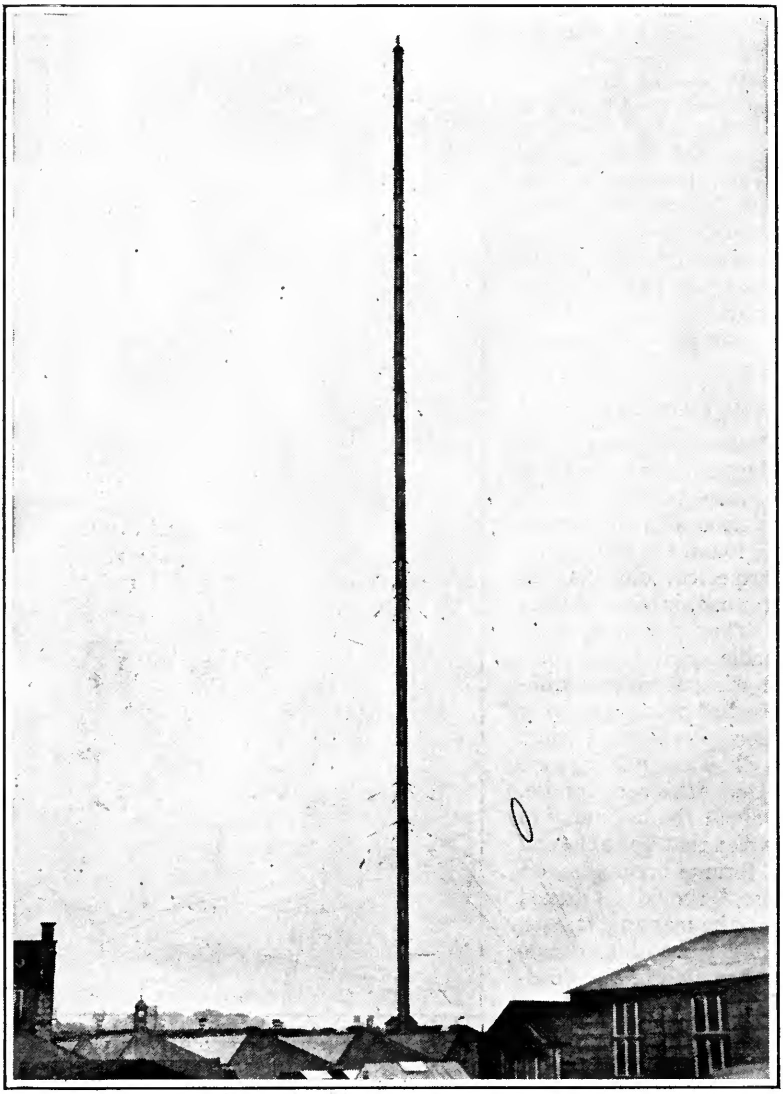
THERE was immediately a very large demand for the "interim license," and some 200,000 of these were issued up to the end of October. The constructor's license also proved popular, being issued in the proportion of about two to one B. B. C. license. The total number of licenses continued to grow at a rapid rate, and by the end of the year it had reached about 500,000. Each month of the new year also saw a rapid growth,



THE MASTS OF THE NEW BRITISH STATION
Which will soon be opened at Daventry. This station will use 1600 meters and about 25 kilowatts and will originate programs of its own as well as broadcasting programs from the main London studio of the British Broadcasting Company. The site of the station is 600 feet above sea level and the ground itself is about 300 feet above the surrounding territory. The two masts are 500 feet high and 800 feet apart

although there was some falling off during the summer months. By October, 1924, the total had practically reached 1,000,000 and at the time of writing (February, 1925,) it is 1,200,000.

In the new arrangements with the Broadcasting Company, the Postmaster General had reserved the right to issue on January 1st, 1925, the simple and uniform license (at 10*s.*) which had been recommended by the Broadcasting Committee. In view of the fact that this further reform was drawing near, and that there would be difficulty in inducing the public to pay 15*s.* for the constructor's license in the autumn of 1924 instead of waiting until the beginning of 1925 to secure a license for 10*s.*, the Broadcasting Company agreed to introduce this further reform at an earlier date. The growth in the number of licenses, and consequently in their revenue, had put them in a good financial position; and they accordingly agreed that the 10*s.* license should be issued as from July 1st, 1924. The condition about British manufacture was to be retained until the end of the year. This reduction in the license fee no doubt assisted in the growth in the number of licenses above referred to. On and from January 1st, 1925, a simple form of license (at 10*s.*), without any restriction as to the country of origin of the licensed apparatus, has been in existence.



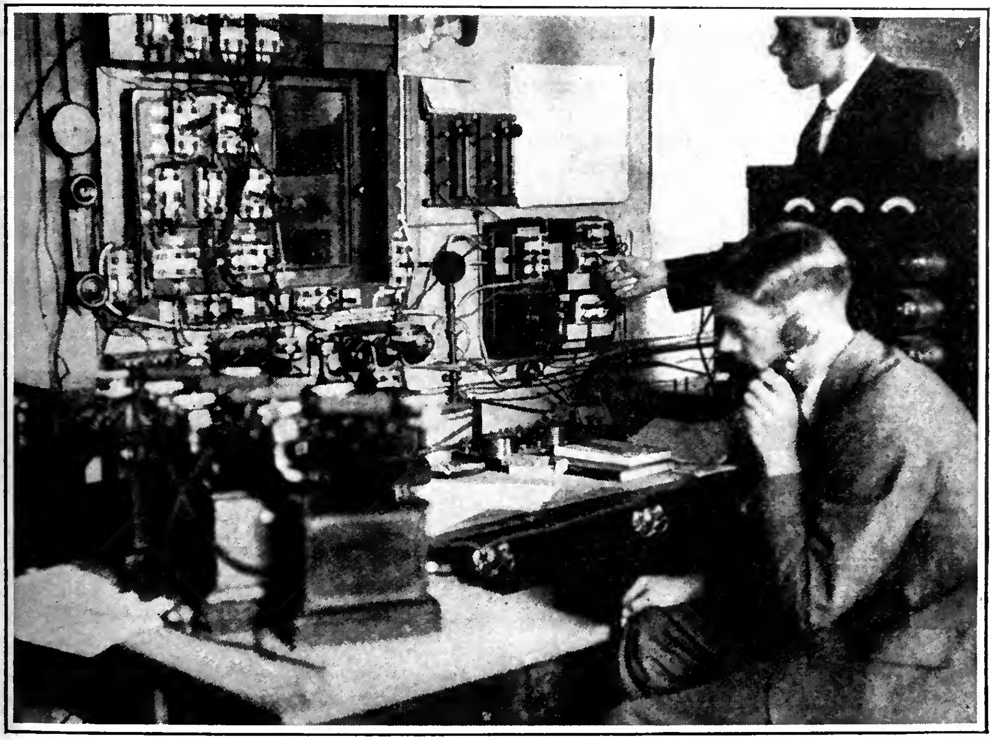
THE CHELMSFORD MAST

Of the experimental station 5XX of the British Broadcasting Company. The usual broadcast wavelengths of the various English stations are much the same as in this country, but 5XX uses a 1600 meter wavelength and a power of about 25 kilowatts. The Broadcasting Company engineers were testing with this station the possibilities of using a high powered station, located at a central point, broadcasting programs to be picked up anywhere in England with a crystal receiver

Meanwhile, with the increase in revenue, the Broadcasting Company had been able to maintain a very efficient service at their original stations, and they also had been able to erect a number of additional stations. These, for the most part, have been so-called relay stations, with a power of from 100 to 200 watts. A more interesting development, however, has been the use, experimentally, of a much higher-powered station. For this experimental work a 20-kilowatt station of the Marconi Company at Chelmsford has been used, and the effect of its use upon other services has been closely watched by the government experts, in order to see whether undue interference was likely to be caused. On the whole the results were satisfactory; and the Company was accordingly given permission to erect a permanent station at Daventry (near the center of England). This station is now nearing completion. It will use a wavelength of 1600 meters and will broadcast an independent program, which will be transmitted from London by means of the ordinary telephone circuits and then relayed. This station will, it is expected, enable programs to be received by a simple crystal set within a radius of about 100 miles, as compared with the crystal radius of about ten or fifteen miles which is covered by the existing main stations of the Company, and the crystal radius of four or five miles which is covered by the relay stations. It is possible that the Company may wish to erect similar high-powered stations in other parts of the country, with the object of bringing practically the whole population within crystal radius.

### THE BRITISH LICENSING SCHEME IS WORKING

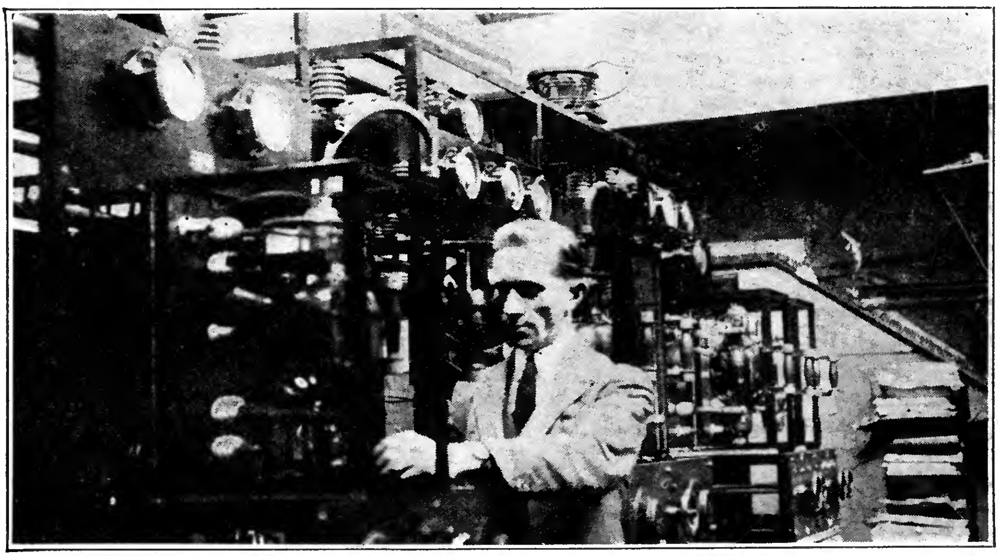
SINCE the revised scheme of licensing was brought into operation in October, 1923, the arrangements have worked with remarkable smoothness and success. Those who have been concerned with them flatter themselves that the arrangements have resulted in what is probably, on the whole, the most satisfactory and efficient broadcasting service in the world. It is, of course, extremely doubtful whether the same arrangements could have been adopted in the United States, where no attempt has ever been made to introduce a licensing system for receiving sets. Where the public have once got into the habit of installing receiving sets without let or hindrance it would be a very difficult matter to induce them to accept licenses and to pay a licensing fee. Hence, I do not for a moment suggest that the system which has been applied in Great Britain would be suitable for the United States. But here, where



APPARATUS AT THE GLASGOW STATION

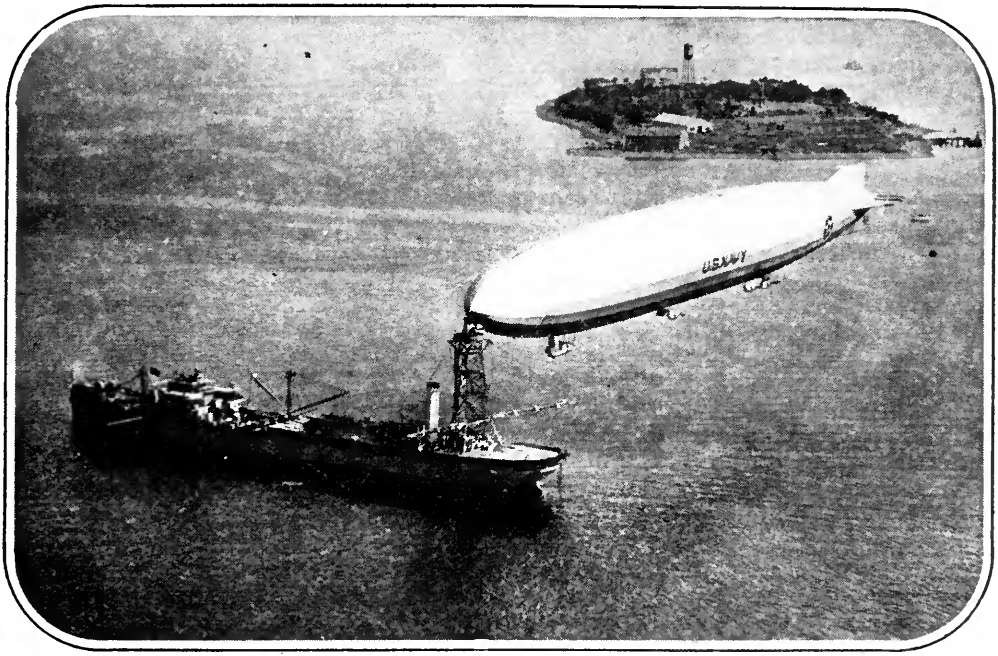
Of the British Broadcasting Company. Many of the switches in the foreground are for controlling the wire lines between the various stations the licensing habit is already in existence, it has proved a very simple and efficient method of collecting funds for the purpose of the broadcasting service—a matter which, I understand, is likely eventually to result in a rather difficult problem in America. No doubt there is some amount of evasion in Great Britain; how much evasion, there is no means of saying: but that the evasion runs to the lengths which some suggest is quite improbable. The figures, in fact, speak for themselves. There are 1,200,000 licenses in existence at the present moment. The same ratio of licenses to population would give a total of nearly 4,000,000 licenses if the population of Great Britain were as large as that of the United States. Of course, no one knows how many households have receiving sets in the United States; but I think the most authoritative estimates place the number at between 5,000,000 and 6,000,000. Bearing in mind the greater prevalence of the telephone habit in the United States than in Great Britain, one may reasonably assume that the habit of broadcast reception is also more widely spread in the States than here. And taking these factors into account, one may safely conclude that the great majority of listeners in Great Britain and Ireland have taken out licenses.

But of late a source of difficulty has arisen. Hypercritical persons have been examining the Wireless Telegraphy Act of 1904, upon which the whole system of licensing is based, and have raised the question whether it really applies to receiving sets at all, as distinct from sending sets. I am not a lawyer, but I know the opinion of lawyers who are well qualified to judge; and, personally, I have no doubt in the matter at all. The question, however, has never been referred to a Court of Law, so that there is no authoritative decision on the subject; and the Postmaster General, rather than risk an adverse decision, has decided that no proceedings shall be taken against any person who fails to take out a license for a receiving set, until the point has been placed beyond the shadow of doubt by means of new legislation which he has recently introduced in the House of Commons. This decision has no doubt resulted in some decrease in the number of licenses taken out; but one is inclined to believe that the great majority of the public are disposed to play fair in this matter and, irrespective of the Postmaster General's decision, to contribute their quota to the expenses of the broadcast programs to which they listen. The new Bill, besides setting this point at rest, imposes a number of new provisions in regard to licensing which do not in particular apply to broadcasting: and, as I write, it is arousing a good deal of criticism in Parliament and the press. What will be its fate does not yet appear; but the system of licensing in connection with the broadcasting arrangements has proved so convenient and popular that one cannot imagine that Parliament will scrap it.



ENGLISH BROADCASTING APPARATUS

Is not very different from that used by most American stations. One of the British stations, indeed, uses apparatus manufactured by an American company



THE U. S. S. "SHENANDOAH"

During the recent transcontinental trip of the *Shenandoah*, the Naval radio operators aboard the ship were in constant communication through their short wave transmission with radio amateurs in all parts of the country, as well as with the Naval Laboratory at Belleview, near Washington. A wavelength of 80 meters was used. The coöperation extended by the amateurs in this instance was one of many examples of a similar sort

# New Paths for the Short Waves

## Details of the Great Contributions Made by the American Radio Amateur to Radio Transmitting Knowledge—How the Amateurs Are Coöperating With the Navy—A New Theory for Radio Transmission

By KENNETH BOLLES

THE first congress of the International Amateur Radio Union which was held in Paris, April 14 to 19, with many delegates present speaking a great variety of languages, is really the first practical indication that amateur radio is destined to become an efficient and orderly world force. It has taken hardly two years for amateur radio to grow from a localized activity, chiefly confined to the United States, to an international relay system with far reaching influence. It must have its regulations and understandings in order that equal freedom and fair play may be given to those who desire to participate in its activities. The congress is the first official step in making such provisions.

Amateur radio, under the guidance of the American Radio Relay League, has trained some 20,000 young men in the principles of radio science and in a knowledge of the code. Those who refer to it as purely a sport reckon without a true appreciation of its influence in the development of commercial radio and broadcasting. Hiram Percy Maxim, and Kenneth B. Warner, president, and secretary of the A. R. R. L., respectively, and delegates to the I. A. R. U., said upon leaving, that they believed international friendships by radio would be a factor in bringing world peace.

They said that in all countries, where amateurs are found, hope may be held for swift progress in all lines of radio science.

The progress of amateur radio is already being realized by governments of various countries where amateurs are active. The I. A. R. U. may crystalize the opinion of amateurs all over the world for the benefit of those countries which desire technical guidance in drawing up regulations governing private international communication. The desire of amateurs to gain the utmost freedom is no stronger than their wish to turn over to the radio public the results of their deductions and experiments.

What have the amateurs done to warrant any sort of world-wide recognition? What practical thing have they accomplished that would justify giving them greater freedom? Almost everyone is familiar with their message handling during emergencies, their coöperation with the American Railway Association, their assistance to the Navy Department during the transcontinental trip of the *Shenandoah*, but these are outside of their established routine and are not as convincing as those things which are a lasting and permanent benefit to radio development.

## A Record of Accomplishment

THE American Radio Relay League is one of the unique organizations in America—a land of many organizations. It was founded a little over ten years ago to band together amateur radio telegraph experimenters whose activities were largely concerned with exchanging private messages with one another over comparatively short distances. Now, more than 15,000 experimenters are members and the exchange of messages is but a small part of their activities. Perhaps the field in which they have aroused most interest is in their experiments with very short radio waves. Every reader of newspapers knows that the only link that Donald MacMillan had with the outside world when he made the recent trip of exploration in the Arctic was that forged by amateur radio communication. The Department of Commerce recently recognized the excellent development work the radio amateurs were doing with short waves by granting them a band of waves between .7496 and .7477 meter. The present article describes some of the activities of the American Radio Relay League and tells particularly of the work of two of their most prominent members, John L. Reinartz, and F. H. Schnell. The work of these earnest amateurs is reflected in their excellent and authoritative publication, *Q S T*, and the Navy Department has shown its confidence in their earnestness by arranging to have Mr. Schnell, Traffic Manager of the League, accompany the Pacific fleet on its manoeuvres this summer.—THE EDITOR

### WHAT HAVE THE AMATEURS DONE?

THE one great outstanding contribution of amateurs to the radio art is their development of the short waves. They have gone farther in this field than any other group. They have proved short waves are of unsuspected importance. The various radio groups have become interested in these bands because of the pioneer work that has been done by amateurs.

With these short bands given over to their exclusive use, amateurs in this country have demonstrated they can send their signals to any part of the world where there are radio fans and radio receivers to pick them up. It has become practically impossible to name any country in the world where local amateurs are at all active that has not heard American amateurs calling.

The signals of operators on the west coast of this country are being heard regularly in South America and over similar distances, almost with as much ease as European and American amateurs could communicate with one another a year ago. English and New Zealand "brasspounders" demonstrate their superior skill by communicating with the Antipodes. Bartholomew Molinari of San Francisco, winner of the Hoover amateur efficiency cup for 1924, reports that his signals have been heard in the following lands and islands: France, England, Italy, Chile, Argentina, Cuba, Panama, Tahiti, Tonga, Samoa, Pribiloff Islands, Tasmania, Korea, China, British India, South Africa, Philippine Islands, Malay Straits Settlements, on ships off Cape Horn and off the coasts of Borneo, Guatemala, Honduras, Nicaragua and Costa Rica, and the Republic of Salvador.

The assumption upon reading this and many other similar records, is that short waves and low power are as capable of covering as great distances as long waves and high power at a cost that is astonishingly less.

That the development of short waves has

by no means been exhausted was demonstrated recently by two important events, one of these being the decision of the Navy Department to seek the coöperation of American Radio Relay League amateurs in an investigation of short waves during manœuvers of the Pacific Fleet this summer; the other, the announcement of John L. Reinartz's theory of daylight transmission.

### WHAT THE AMATEURS ARE DOING

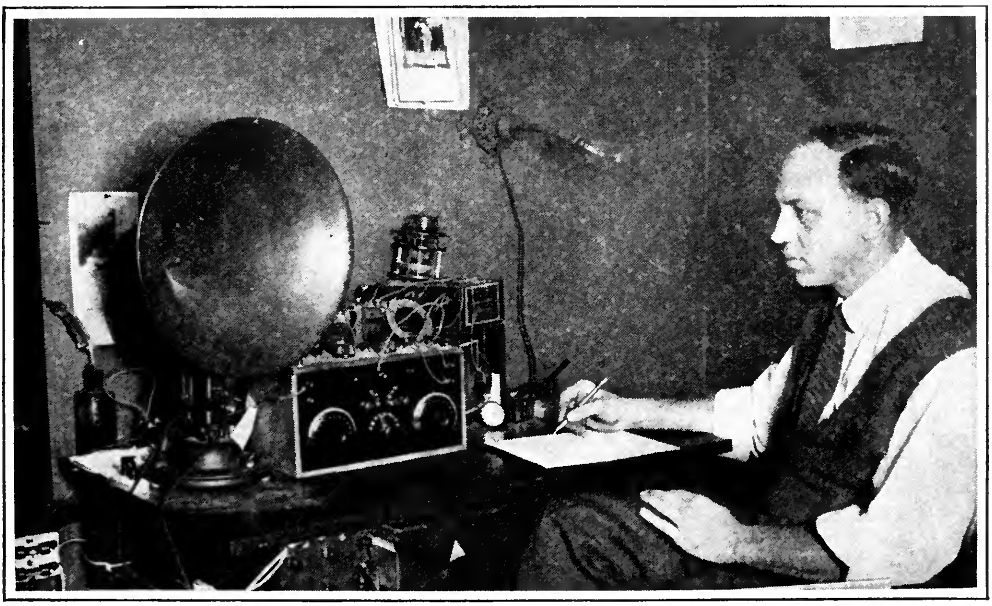
IN ORDER to carry out the navy experiments successfully, F. H. Schnell, traffic manager of the American Radio Relay League who has been given a seven months' leave of absence by the League, will conduct tests with amateurs in many countries. His work will serve as one more important link between American amateurs and transmitting operators in other parts of the world, and he will, at the same time, demonstrate under official supervision what short waves can do. His experience as traffic manager of the A. R. R. L. has given him a wide acquaintance among amateurs which the Navy believed would be of great service in the short wave tests and so it called him in active service in the Department with the rank of lieutenant.

It is significant that following closely upon the first international amateur congress, the U. S. S. *Seattle* is now steaming in Pacific waters equipped, among other apparatus, with a typical amateur radio transmitter and receiver. This first amateur type station to be installed on a Navy ship will have the call NRRL. One may imagine the interest and enthusiasm in which amateurs in Australasia, the Philippine Islands, China, Japan, South America, and probably Europe and Africa will listen for this special Navy station, pleased with the thought that the communication they have helped to build has been recognized by the United States Navy.

### THE U. S. S. "SEATTLE" EXPERIMENTS

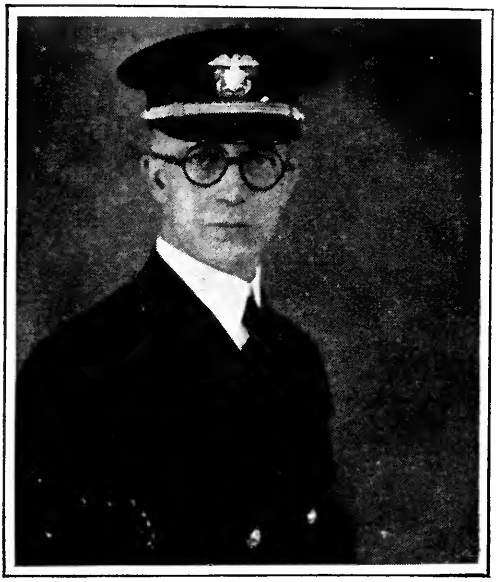
THE amateurs who intend to listen for NRRL, no matter whether they are located in this or foreign countries, must be prepared to tune-in on a number of different wavelengths, for the tests are to cover several bands of short waves. At night, the main set at NRRL will transmit on 54.4 meters while in daylight it will shift to 27.2 meters. There will also be transmitters functioning on 20, 40, and 80 meters.

If it is found that the low power amateur stations employing less than one kilowatt are just as efficient as regards the distance covered and dependability of operation, it may be seen very readily that their use would mean



JOHN L. REINARTZ

Of South Manchester, Connecticut. Mr. Reinartz, using a wavelength of 21 meters and low power recently established communication with an amateur on the Pacific coast at noon. This remarkable feat showed strikingly the possibilities of short wave radio work



LIEUTENANT F. H. SCHNELL

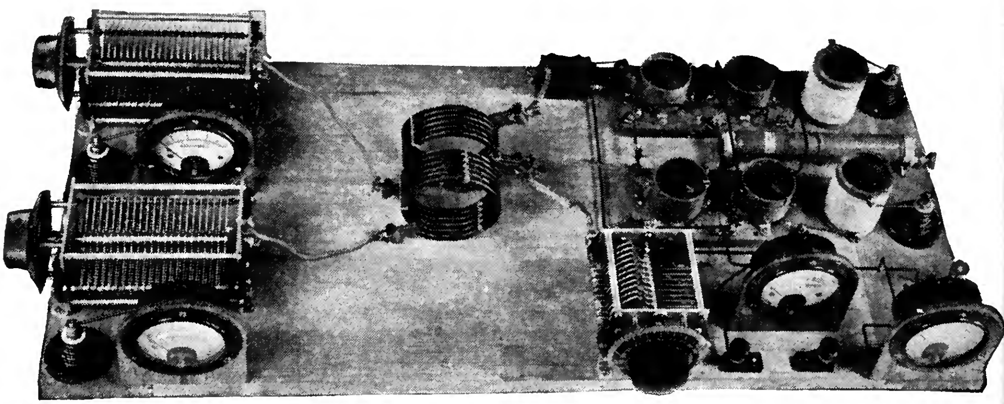
Traffic manager of the American Radio Relay League. Mr. Schnell has been commissioned a Lieutenant in the Navy, assigned to the fleet on its Pacific cruise this summer. He will experiment with short radio waves and communicate with transmitting amateurs all over the world. The American Radio Relay League has about 20,000 members, excellently organized for intercommunication by radio. Members of the organization have communicated great distances using short wavelengths and very low power

a tremendous saving in the cost of the initial radio installation. The average amateur transmitter can be put together for about $250. while the high power navy set may average somewhere around $6000. It is even possible that if the tests made by NRRL are quite successful, we may see the Navy changing to low wave sets in preference to the longer wave, high power transmitters they are now using.

The reader should not interpret from this that the Navy is just now beginning to show an interest in the short waves, for it has been working hand in hand with amateurs for some time. Some of the most important experiments ever made in connection with low power transmission have been undertaken through correct coöperation between the Navy and amateur operators. The Navy has been using short wave transmitters on certain ships for many months and as long as two years ago, the short wave station of the U. S. S. *Ohio* was heard on the west coast.

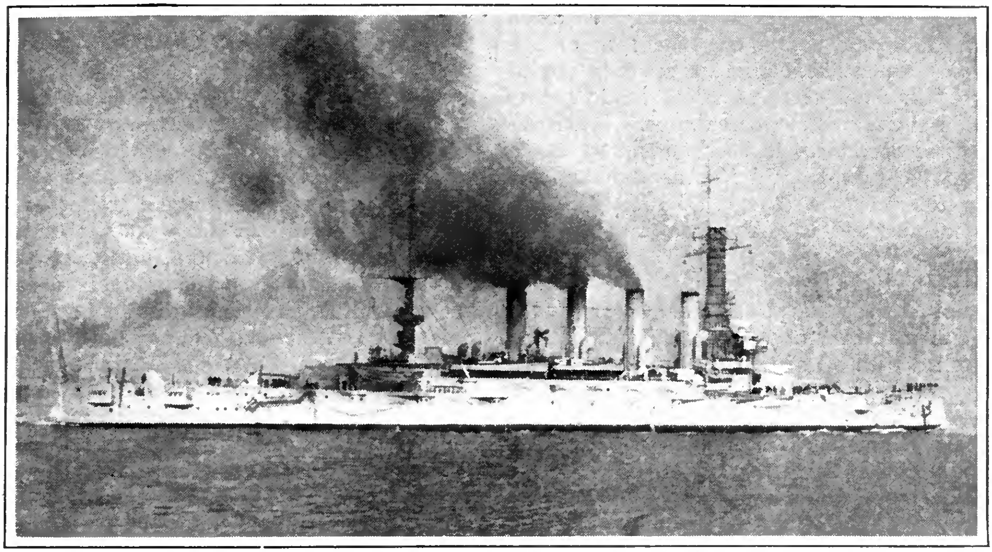
The theory of daylight transmission previously mentioned in this article was a direct result of tests conducted by John L. Reinartz at South Manchester, Connecticut, and Dr. A. H. Taylor of the Naval Research Laboratory at Bellevue, Washington, D. C. The experiments which they started a year ago are still in progress. As a result Reinartz has demonstrated repeatedly that with a low powered transmitter using 21 meters, great distances can be covered in daylight. While transmitting from his station at South Manchester, Connecticut, about noon, Eastern Standard Time, his signals have been heard by amateurs on the west coast, in Florida, and in England, and he has several times conducted two-way communication direct with the Pacific coast at noon.

This gave definite proof that the very short waves travel farther in the daytime than they do at night, which is the reverse of what has already been known, that the long



THE 200 WATT TUBE TRANSMITTER

For use on very short waves which Mr. Schnell will use for experimental communication while he accompanies the Navy fleet on its Pacific cruise this summer



THE U. S. S. "SEATTLE"

Where Mr. Schnell will make his headquarters during his short wave tests. The Navy has shown great interest in the possibilities of short wave communication and is coöperating with the American radio amateurs who have contributed a great deal to the development of this transmission. At present, Naval communication is carried on chiefly by long wave high power radio transmitters, which are not only expensive, but subject to the familiar effects of daylight fading

waves could cover great distances at night, but were unable to travel very far under daylight conditions. Until then, it was thought the ionization of the atmosphere caused by the sun's rays had practically the same unfortunate effect on all waves and that daylight might be always a big hindrance to radio transmission.

### THE EFFICIENCY OF SHORT WAVES

IN ADDITION to making the bare discovery, Mr. Reinartz developed a theory which appears to explain the phenomenon satisfactorily. It is based on the well known fact that radio waves are reflected by the atmosphere in the same manner that light rays are reflected with the aid of a polished surface. The distance that radio waves will travel in daylight is determined by the length of the wave, for it appears it is this factor which controls the height at which the reflection takes place.

There is a definite relationship which connects the position and effect of the sun with the length of the radio wave and the distance that it will be reflected. The depth of the reflecting layer varies with the time of day and season. The shorter waves seemingly have the peculiar faculty of penetrating farther into the ionization layer and they are therefore capable of being reflected to a much greater distance.

"The fact that the shorter wave penetrates the ionization layer to a greater height," declares Mr. Reinartz, "causes the reflection to take place at a higher altitude than would be the case for the longer; therefore, the diameter of the circle at which the short wave again appears on the earth's surface is larger. Inside of this circle there is no evidence of the radio wave until one gets very close to the transmitting station. The reason for this is that the waves which travel along the earth's surface have been subjected to all the absorbing influence which that surface carries, while those which went up to the ionized layer and were reflected back have traveled through a considerable space and very little energy has been lost. This makes it possible to cover tremendous distances with but a fraction of the energy needed for some of the longer waves.

"It is possible to use this information in such a way as to obtain reliable daylight ranges considerably in excess of reliable night ranges obtainable with the same power."

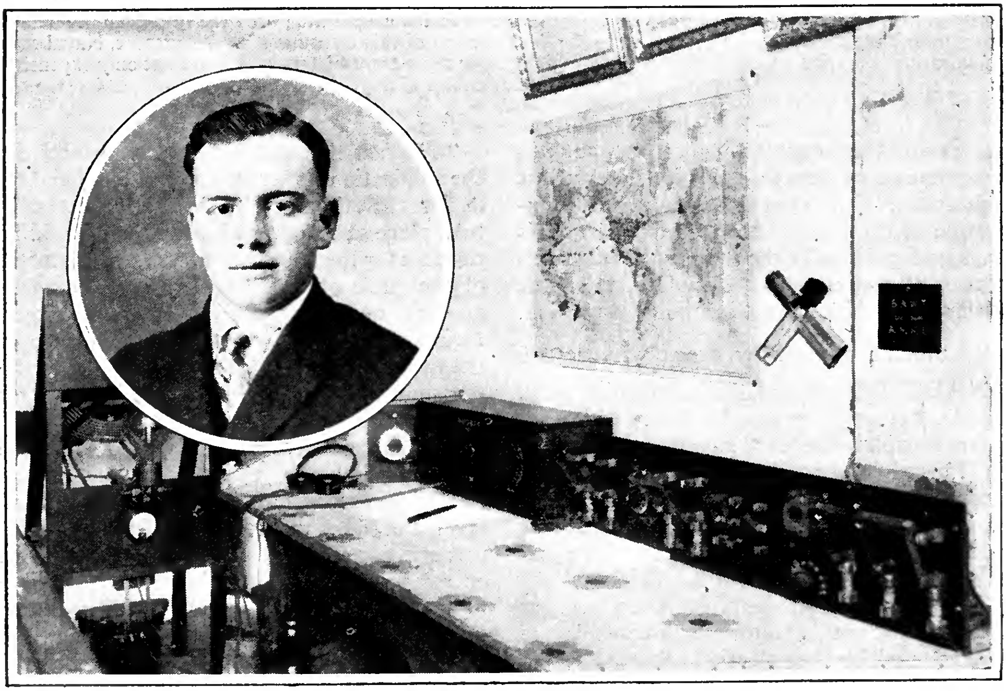
Mr. Reinartz makes the prediction that this year will see communication established between amateurs of the United States and Australasia on a wavelength of about 20 meters in broad daylight. Mr. Reinartz will have an intensely interesting opportunity to test his theory when he leaves as operator on Donald MacMillan's *Bowdoin* on June 15th of this year. Extensive experiments are to be carried on with daylight transmission on 20 meters while the ship is in polar waters. Mr. Reinartz as operator, has been appointed to the place held by Donald Mix aboard this ship on the previous voyage. Mr. Mix is also a member of the American Radio Relay League.

Both those appointments show beyond question the value placed on amateur talents.

For a number of years American amateurs worked with all of their might to send their signals across the Atlantic ocean. Their final success marked the real beginning of international amateur communication for it was not until that time that the future possibilities of low power and short waves were fully realized. Their next task was so to perfect their instruments and method of operation that they could exchange messages at will with private individuals in various foreign countries.

Immediately that two-way communication was established between amateurs on opposite sides of the ocean, interest of operators in this country reached a high state of enthusiasm and amateurs began to spring up here and there in countries where they had never been heard of before, until now they may be found dotting almost every part of the world. Three or four years ago American amateurs kept before them constantly a wall map of the United States, while now in these same radio shacks may be found world maps and globes.

With one kilowatt of power and a barrel of enthusiasm, amateurs threaten to conquer the three obstacles to radio communication, time, space, and daylight, using short waves that once nobody thought were of value.



THE WINNER OF THE HOOVER CUP FOR 1924

Bartholomew Molinari, owner of amateur radio station 6 AWT, San Francisco. The transmitter is one 250-watt tube, shown on the panel in the lower left. Note the wall map of the world, dotted with colored pins, showing the various parts of the world in which 6 AWT has been heard. Ten years ago, distance records such as these would have been considered an absolute impossibility

# Making Radio Receivers More Selective

## Practical Instructions on How to Improve the Selectivity of Various Popular Circuits in Use—A Clear Explanation of the Theory Involved in the Changes

By KEITH HENNEY

THE problem that has been bothering many radio listeners recently, is one of the selectivity of their receivers. Mr. Henney, in this article, has discussed the whole question of selectivity. There is such a variety of circuits and sets to be considered when one tries to solve the problem of increasing the sharpness of tuning that a general consideration such as this, we think is the best way to help the individual. This is distinctly not a how-to-make-it article, but the reader will find all the necessary constructional information given. The individual can apply this information to suit his own problem. The suggestions here given are more in the nature of a remedy than a cure. The real cure for the situation lies in a re-adjustment of the broadcast transmitting situation. We believe that Mr. Henney's discussion of the theory involved here will prove very helpful to the radio constructor.—THE EDITOR

ACCORDING to the average radio listener, the flaws in the present scheme of broadcasting are two: the multiplicity of stations and the approach of "super-power." And in his peculiar dilemma of wanting to be in touch with all that goes on in the ether and yet to be exclusive, the listener must turn in but one direction, to increased selectivity.

Whether the problem is to doctor a receiver now in operation or to build a set that will be sufficiently selective, the questions that face the radio listener are the same:

What is selectivity?
How may it be obtained?
How much is necessary, or desirable?

### WHAT IS SELECTIVITY?

SELECTIVITY is a relative term, and signifies the ability of a receiver to distinguish between several transmitting stations operating on frequencies that do not differ much from one another. To take an analogy from the phonograph field, let us suppose that the mechanism for recording music would respond only to those tones that lie between middle C and one octave above. Then no matter how many notes a pianist might play, the mechanism would record only those between the proper limits. In other words, the recording apparatus would be selective, and other tones would not bother it.

Broadcasting stations in Class B are now stationed 10,000 cycles apart. A receiver sufficiently selective will respond to only one station at a time. Frequencies 10,000 cycles different from that to which the receiver is tuned will not be heard to any marked degree.

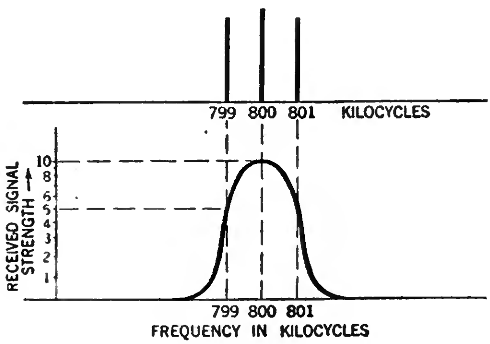



FIG. 1

The current in a receiving circuit increases as the resonance point is reached, as shown in this Figure. This receiver would be too sharp since it will respond to a band of frequencies only two kilocycles wide and would lose the higher musical notes entirely. A good receiver should have a resonance curve 10 kilocycles wide in order to get all of the notes broadcast from the transmitter

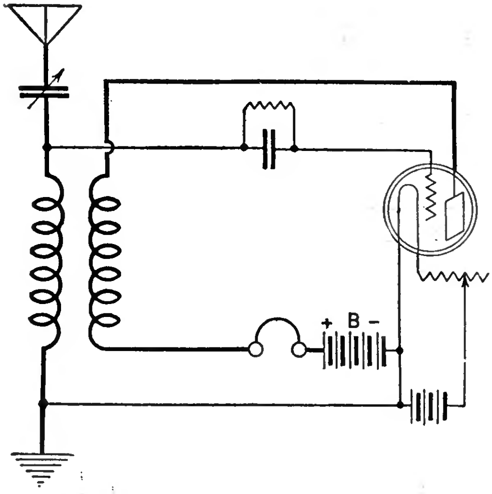



FIG. 2

This is the typical "blooper" circuit in which the antenna is closely coupled. This close coupling brings in the signals, but when the tube oscillates, it sends out signals as well—much to the discomfort of all near-by listeners

Fig. 1 is a resonance curve of a receiving set that will respond to a band 10,000 cycles wide.

Such is the ideally selective receiver.

How may it be obtained?

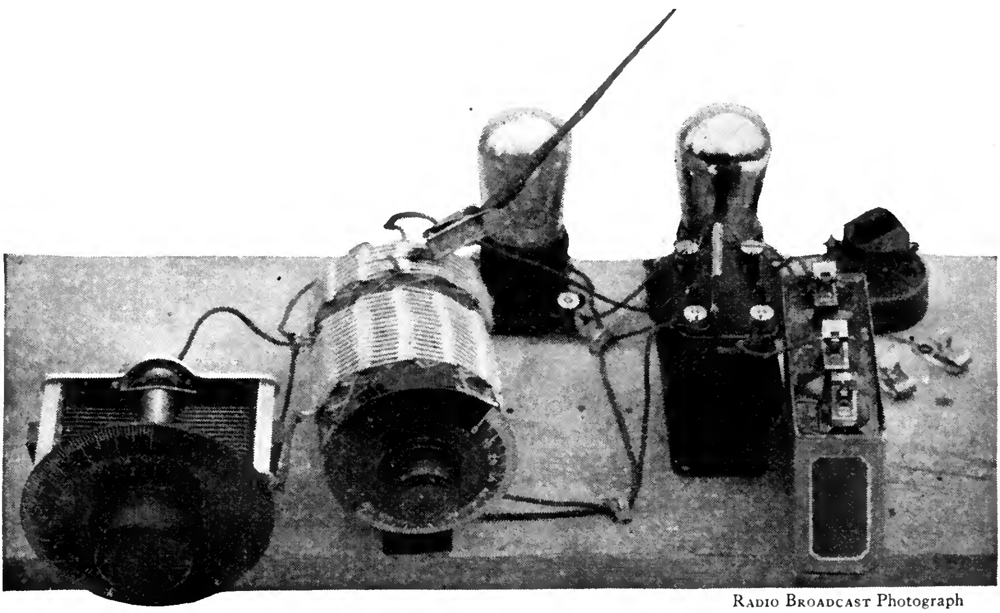
There is but one cause of poor selectivity—resistance, and the remedy is obvious: eliminate that resistance. This task, however, of separating the various resistances from a receiver reminds one of the adage of cutting off one's nose to spite one's face, for to remove all of the resistance would be to remove the receiver itself.

For the listener who builds his own receiving set, resistance is added through the use of long connections, poor coils and condensers, by placing coils too near large masses of metal, poor contacts, or by closely coupling a low resistance circuit to one in which considerable resistance exists.

The listener who owns a manufactured set must place his faith in the engineer who designed it and the factory that made it. There is little that can be done to the inner "works" that will better its tuning qualities. That little will be described in this article as well as the tricks that can be performed external to the receiver itself.

### TO IMPROVE SELECTIVITY

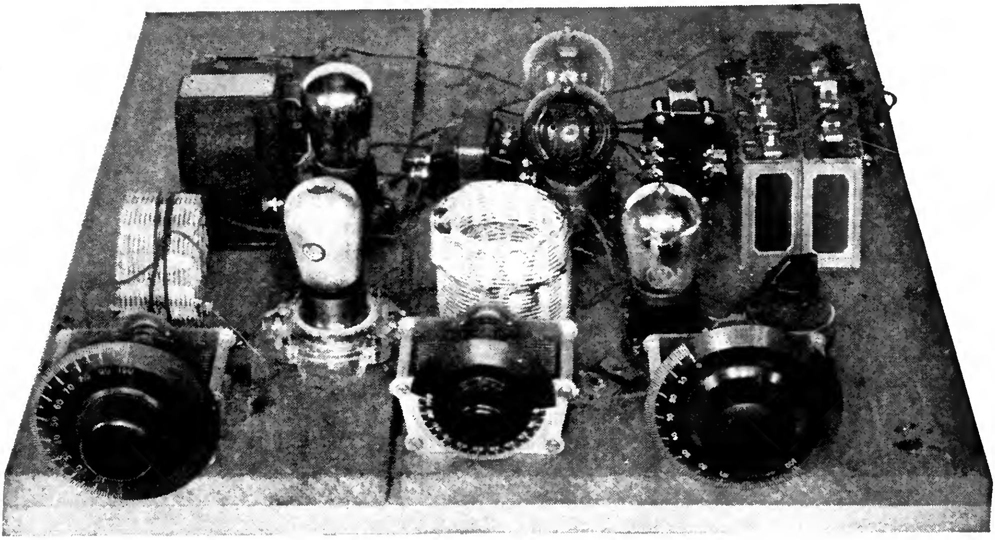
THERE are two general methods of improving selectivity. The first strikes at the cause, resistance. The second relies upon tricks such as placing obstacles in the path of unwanted signals, or of filtering out those that are desired and letting the others go where they will. In the latter method lie



Radio Broadcast Photograph

FIG. 3

A photograph of a single-circuit receiver in which the antenna is not actually connected to the detector but through another coil closely coupled to it. One stage of audio frequency amplification has been added. This is the nucleus of a good receiver such as shown in the photograph in Fig. 4



RADIO BROADCAST Photograph

FIG. 4

Here is a complete receiver built around the single-circuit blooper. The coil and condenser to the left compose the essentials of a radio-frequency amplifier, the second coil is the detector secondary and the amplifier plate coil coupled to it. The third condenser is for introducing regeneration in the detector. There are five tubes, three producing audio frequency amplification. The Pyrex socket is a good one for radio amplifiers due to its low losses

the wave traps and radio-frequency amplifier circuits.

In other words, we may eliminate the cause of poor selectivity—and there is a certain limit beyond which we cannot go in this direction—or we may force signals to go through a kind of maze through which those that are desired will emerge and in which the others will be lost.

### IMPROVING THE SINGLE CIRCUIT RECEIVER

IT IS in the realm of the simple receivers, the bloopers and any set that employs no radio frequency amplification that the most can be done to sharpen the tuning. In Fig. 2 is the typical blooper circuit with its antenna closely coupled to the remainder of the circuit—a condition that broadens the tuning, and sends out into the ether the parasitic signals that condemn this type of receiver. Fig. 3 shows how simply such a receiver may be made and provided with one stage of audio frequency amplification.

The use of regeneration is a method of reducing an already existent resistance, and the ability of this simple receiver to go out and get distance lies in this resistance reduction —the same phenomenon that makes it a nuisance to all near-by listeners. An oscillating receiver is without doubt the most sensitive and selective, but its very sensitivity makes it unhandy. Small changes in the antenna system cause the oscillating frequency to vary with accompanying distortion.

The best possible addition to make to a blooper is a single stage of radio frequency amplification, an addition that increases its range, its volume, and its selectivity as well as eliminating its liability toward radiation. Fig. 4 represents such a circuit, together with appropriate audio amplifiers. The coils should be far apart and at right angles to each other, so that proper neutralization may take place. The photograph shows how simply such an amplifier can be made and clearly illustrates the proper placing of coils.

The amplifier plate coil may be made by winding ten or fifteen turns around the middle of the blooper secondary that is now used, forming the connection between the amplifier and the detector. The coupling between the antenna and secondary of the radio-frequency amplifier should be as loose as is consistent with good signal strength, and the same may be said of the coupling existing between the plate coil and the detector secondary. In Fig. 5 is shown the effect of close coupling, which is one of the best methods of adding resistance to a circuit and ruining its selectivity.

The effect of retaining regeneration in the detector is shown in Fig. 6 where the resonance curve becomes sharper and sharper

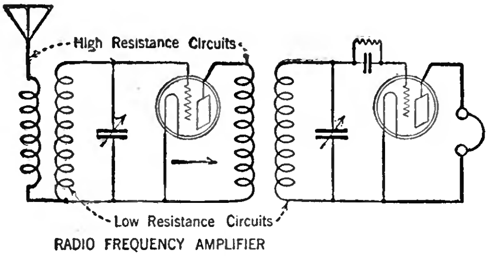



FIG. 5

Whenever a circuit of low resistance is closely coupled to a circuit of high resistance, it tunes broadly. In other words some of the high resistance has been "reflected" into the low resistance. The solution to this trouble lies in separating the two coils as far as is consistent with signal strength

with the result that near the oscillation point, the quality goes bad.

With the addition of such an amplifier to a blooper, the listener now has the advantage of decreased resistance due to regeneration but the added feature of a wave trap in the antenna circuit. All signals must pass the tuned circuit consisting of a coil and a condenser before they can get to the detector, and before that happens they must also pass through the vacuum tube which boosts their voltage by at least six times. The wave trap sharpens the tuning and additional tuned circuits may increase still further the narrowness of the received frequency band, but the trap itself does not add voltage; this is the function of the tube. These facts are shown in Figs. 7 and 8.

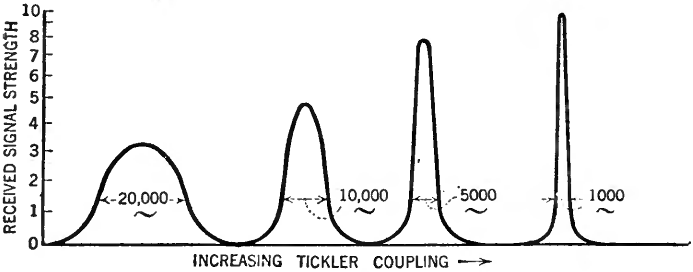



FIG. 6

According to most authorities, regeneration is a means of reducing the resistance in a circuit. It is accompanied by sharp tuning, and the more regeneration that is used, the narrower is the frequency band taken in by the circuit. Near the oscillation point, the circuit may become so sharp that "side bands" are chopped off and poor quality results

### WAVE TRAPS

IF THE listener does not care to add another tube, or if he already possesses a stage or two of radio frequency amplification, he may use the coil and condenser of Fig. 3 as a "wave trap," and provided that they be of low resistance, he will be able to cut his path through interference with greater ease.

Wave traps, in general, are of two kinds: those that are shunted across the antenna and ground and called "acceptors," and those that are in series with the antenna and ground which are called "rejectors." A rejector prevents one frequency from getting into the receiver, but lets all others pass; in other words, it cuts a slice out of the stations that are on the air. An acceptor provides a convenient by-pass for all frequencies but the one that the listener desires to hear.

The wave trap is simply a good coil and a good condenser connected and placed in some part of the antenna-ground system. The trap used in Radio Broadcast Laboratory

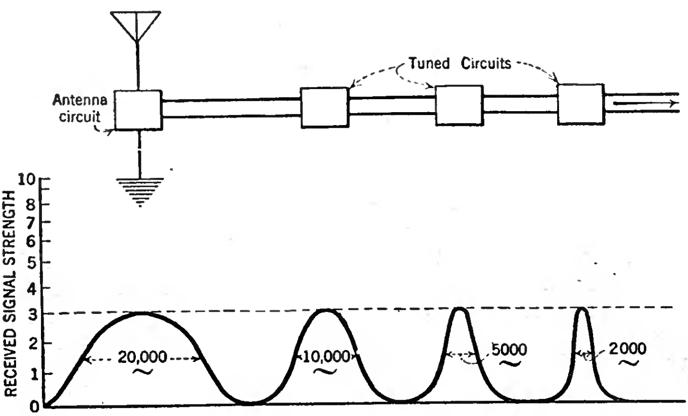



FIG. 7

A coil and a condenser are the requisites of an obstacle to put in the path of a radio frequency current. Such a device, if properly used, may sharpen the tuning because it must be accurately tuned before any energy can get through. Two or more increase the selectivity because nothing gets through until each obstacle is tuned correctly

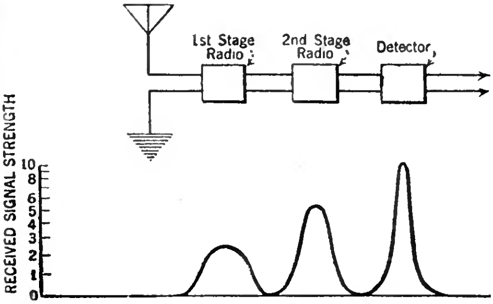



FIG. 8

A radio-frequency amplifier not only acts as a trap for unwanted signals but boosts the voltage of the one signal desired. In this Figure, the effects of adding several stages of tuned amplification are illustrated. Each additional stage cuts down the width of the frequency band that is passed and increases the voltage

and shown in Fig. 9 consists of a General Radio .0005 mfd. condenser, across the terminals of which is shunted a low-loss inductance coil. Around the coil were wound several turns of wire, and it is these turns that are inserted in the antenna-ground system. Any good coil and condenser that will cover the frequency range may be used. The receiver shown in Fig. 9, then, consists of a single circuit blooper with a wave trap to sharpen the tuning and cut down interference and a Samson 3-1 transformer to provide additional volume. Fig. 10 shows in a schematic manner the connections of a wave trap.

Various methods of connecting the trap to a receiver now in use are shown in Fig. 11. When in series with the antenna, as in A or C, they may be set at the wavelength of some interfering station. That station will not interrupt until the tuning of the trap has been changed. When across the input to the receiver, as in B or D, a trap will let into the set only the signal that is desired, and make tuning somewhat more complicated. On the other hand, once the listener becomes accustomed to the tuning, he will find this type of considerable value.

Two traps may be used, one tuned to some particular station and thereby eliminating its signals, and the other adjusted along with the tuning of the receiver itself, as is illustrated in E, Fig. 11.

A wave trap will not increase signal strength; it will work well only with a receiver in which the antenna circuit is completely or partially tuned; it will perform its duties only if low

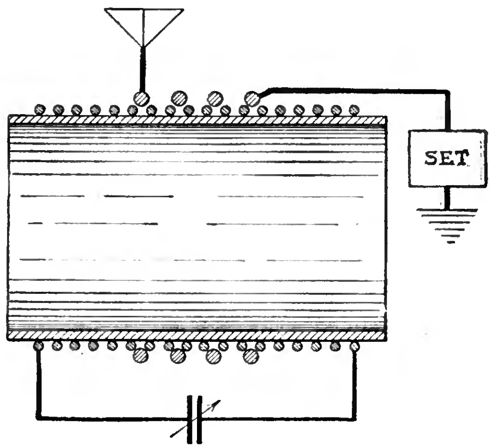
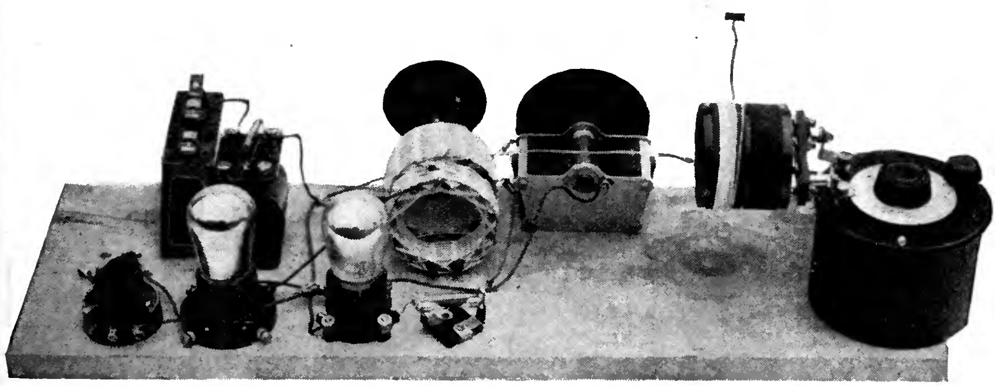



FIG. 10

The connections of the wave trap shown in Fig. 9 The coils and condensers in such a device should be of low resistance to make the tuning sharp



Radio Broadcast Photograph

FIG. 9

A simple wave trap consisting of a coil shunted by a condenser is inserted in the antenna circuit by means of several turns of wire wound around the coil. This is then a "rejector" since it rejects one frequency that is unwanted resistance parts are used; and will not be of value to the more complicated receivers of the radio-frequency amplifier type.

On the other hand, a wave trap will be a boon to the blooper, to the two-, the three-, and the four-circuit receivers; for it will cut a slice out of the ether where there is some interfering station, and it will stiffen up the tuning of the antenna circuit considerably.

The coil and condenser shown in Fig. 9 may be calibrated in wavelengths or frequencies and used as a measure of incoming waves, and it need only be placed near one of the coils of a receiver, be it a blooper or a five-tube affair, to indicate the frequency of incoming signals. When the condenser is tuned, a marked decrease in signals will be noted, and if it is used with an oscillating receiver, a sharp click will be noted in the phones when passing the frequency of the signal.

For this purpose, the additional winding is not necessary and the unit then consists of simply a coil and a condenser, which may be calibrated either in wavelengths or frequencies by noting where several well known broadcasting stations are tuned. A curve may then be plotted showing the relation between condenser setting and wavelengths or frequencies.

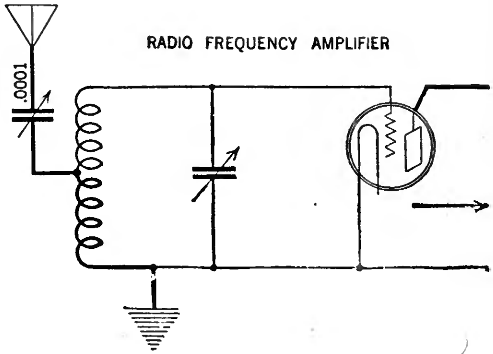



FIG. 12

A simple method of increasing selectivity is illustrated in this Figure. The condenser may be variable, but after the correct place to tap the coil is found there is no need for further adjustment

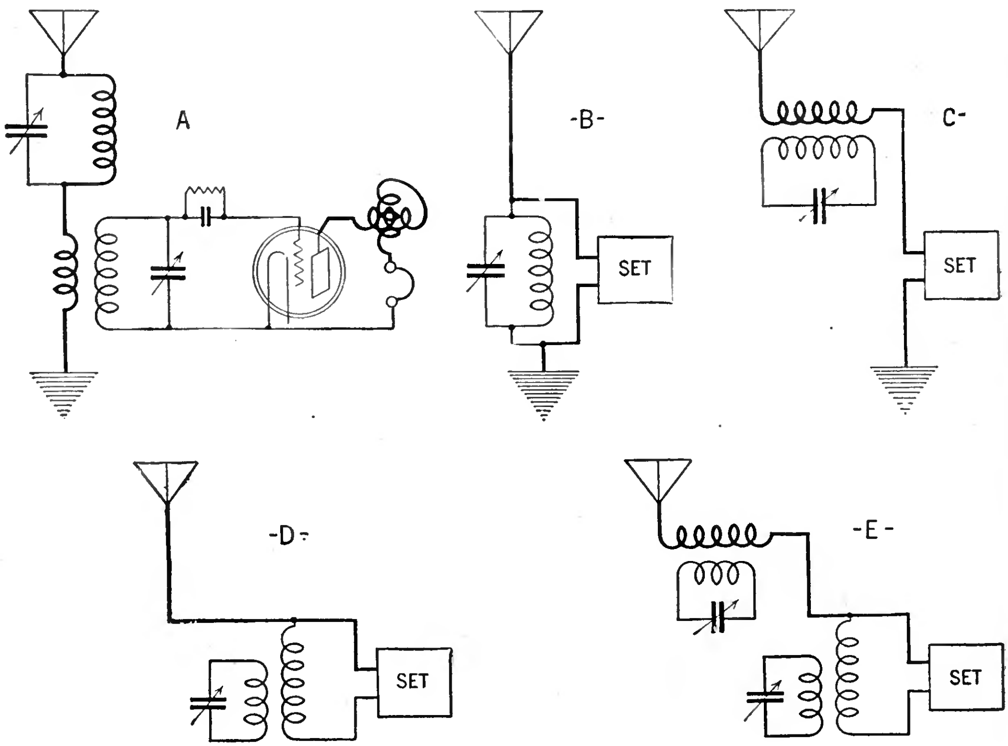



FIG. 11

Wave traps are really simple devices, consisting of a coil shunted by a condenser. But to be effective, both of these component parts must be of low resistance. In this Figure are shown several methods of connecting such a trap to the antenna circuit of a receiver. They are useful only if the antenna is partially or completely tuned, and will not do much good when used with a complicated receiver. With the simple circuits, however, they will enable the listener to cut out unwanted stations, and to sharpen the tuning of his receiver

### RADIO FREQUENCY AMPLIFIER-REGENERATIVE DETECTOR RECEIVERS

IN RECEIVERS such as the Roberts Knockout, the Browning-Drake, the Teledyne, and others of similar nature using a regenerative detector with one or more stages of radio frequency amplification, there are several things that may be done to improve the overall selectivity.

The series condenser in Fig. 12 is a potent device for sharpening tuning, especially since

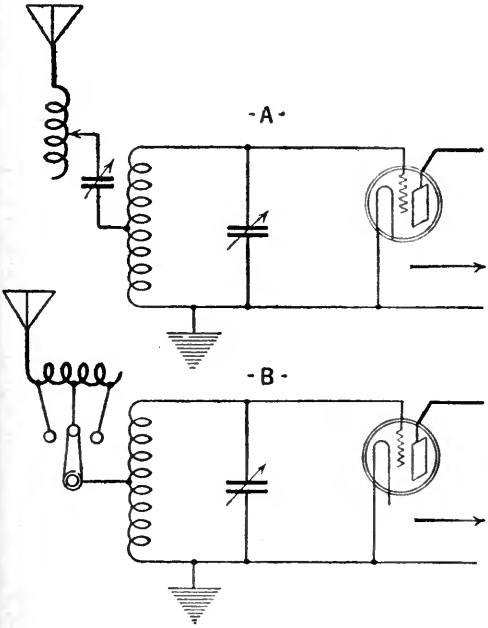



FIG. 13
Adding an inductance coil to the antenna circuit and partially tuning it by taps or completely tuning the circuit by a variable condenser will add to the ability of the receiver to select the signals a listener wants. The coupling to the receiver may be decidedly loose if the antenna is carefully tuned by means of the variable condenser

regeneration in the detector makes up for any loss in signal strength resulting from the insertion of this condenser.

Another method was described in Radio Broadcast for April in the article on experiment with the Roberts circuit. This is the addition of inductance in series with the antenna and partial tuning by means of taps, or complete tuning by means of a variable condenser. Fig. 13 illustrates both methods.

Loose coupling between the antenna coil and the secondary of the amplifier and the two coils connecting the amplifier and detector is necessary for the sharpest tuning, as shown

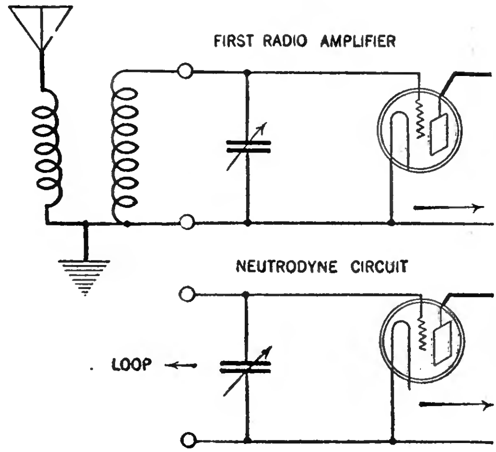
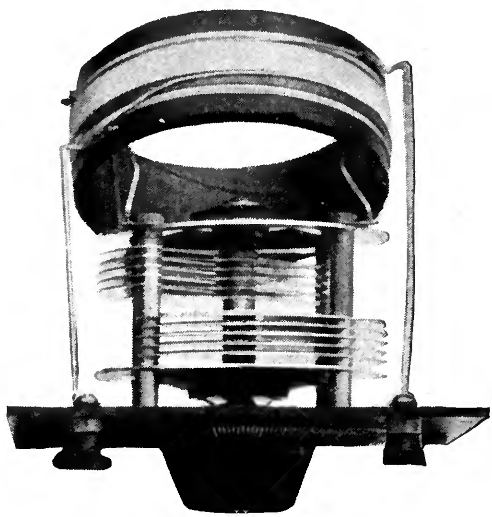



FIG. 14
The use of a loop in place of the first coil of a neutrodyne presents few difficulties, especially when it is to be used on local stations. The loop should have the correct dimensions so that it will take the place of the neutrodyne coil that is removed. The loop will provide a decided increase in selectivity due to its directional effect, but of course will cut down signal strength

in Fig. 5. This feature is embodied in several coils now made for the Roberts receivers.

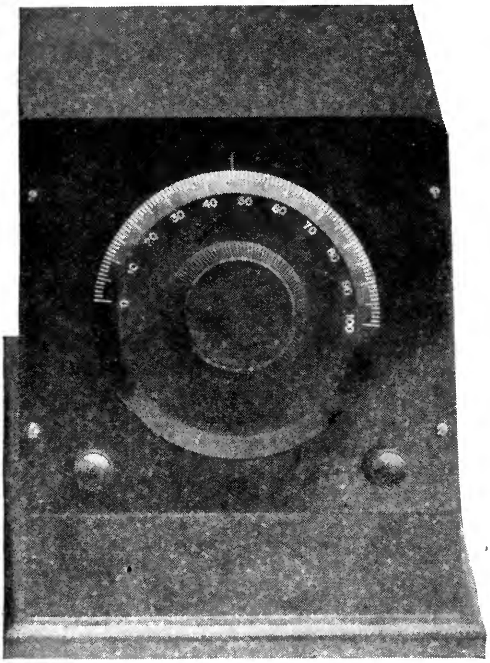
### THE NEUTRODYNE

THE two stages of radio frequency amplification of the neutrodyne are simply so many wave traps, each making the band of



Radio Broadcast Photograph

FIG. 15
The "inner works" of a wave trap used in Radio Broadcast's Laboratory. The conventional coil and condenser are well illustrated as well as a method of mounting them



Radio Broadcast Photograph

FIG. 16

The outward appearance of the wave trap illustrated in Fig. 15. This makes a neat-appearing addition to any broadcast listener's equipment

frequencies that is finally passed into the detector, sharper. For this reason a neutrodyne should be very selective. There is the additional advantage in the tuned radio frequency circuits that each vacuum tube adds a certain amount of amplification, so that there is a gain in volume as well as in select ivity, as shown in Fig. 8.

The use of a small antenna is advisable if interference is to be cut to a minimum. If space is available, two antennas may be erected at right angles to each other and their directional properties used in cutting out unwanted stations.

Proper neutralization is highly important in those receivers using the Hazeltine scheme of stabilization, and in the potentiometer-stabilized sets, this instrument should be used as far as possible toward the negative end of its scale.

Often the addition of slight regeneration in the detector circuit is helpful, but a receiver with two stages of high-frequency amplification is a bad place to add a tickler. The whole system is liable to howl.

Much will be gained by the use of a loop instead of an antenna, or even in place of the first coil of a neutrodyne. This is especially true when there are powerful near-by broadcasting stations. Fig. 14 shows how the antenna loop may be substituted for the antenna coil and secondary of the first amplifier.

The scheme illustrated in Fig. 11, in which a small condenser, say about .0001 mfd., is placed in series with the antenna, may be applied to the neutrodyne. This tends to loosen the coupling with the antenna and to prevent its high resistance from getting into the amplifier. It has the disadvantage that it may cause somewhat weaker signals and change the readings on the first condenser.

### IMPROVING THE SUPER-HETERODYNE

THERE is no receiver available to-day that has the potential sharpness of tuning of the super-heterodyne. Here is an oscillating circuit, in itself a maximum of selectivity; here are two or more intermediate circuits through which the signals must pass before being heard; here is a low-resistance energy collector, a loop.

There is little that can be done with a "super" that is already in operation. Methods of adding regeneration to a loop have been described in Radio Broadcast. If an external loop is used, the listener should make sure that it is of low resistance, not placed near any metallic objects, such as a radiator, or wall of a steel-lathed room or a steel building. If there are taps, they should make good contact.

A good loop is directional, that is, it receives better when pointed in the direction of the transmitting station. Full advantage should be taken of this tuning aid by the proper use of a compass fixed to the base of the loop.

### HOW MUCH SELECTIVITY?

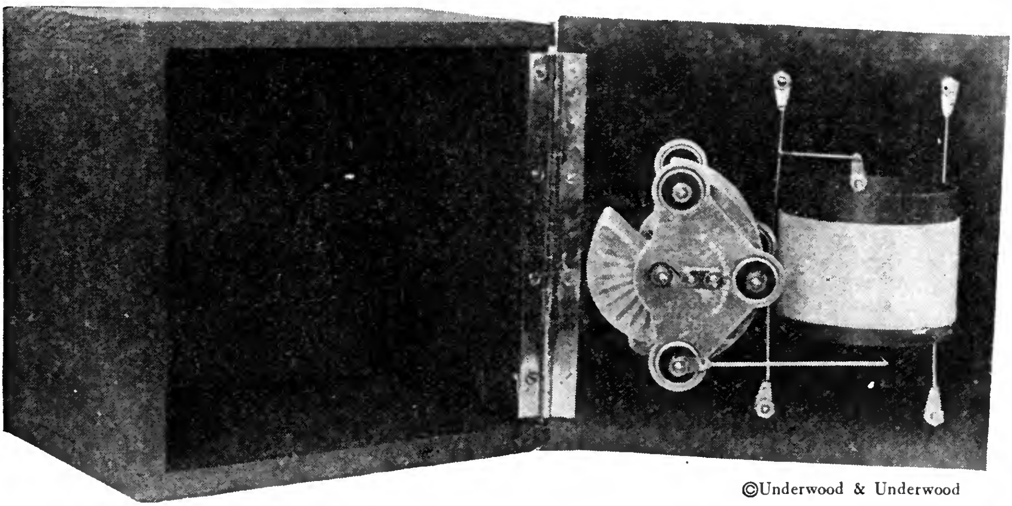
THE question finally faces the listener of how much selectivity is necessary or desirable. Broadcasting stations transmit into the ether a band of frequencies about ten thousand cycles wide, these frequencies being distributed on either side of a single sharp "carrier wave." Theoretically, all that is required for clear reception, is the carrier wave and one of the two "side bands," which would require a receiver with a resonance curve only five thousand cycles wide. Practically, it is difficult to make coils with low enough resistance that the resonance peak will be less than ten thousand cycles wide, and if this sharpness is secured the listener will have no difficulty in separating Class B stations—provided that they stay on their allotted frequencies.

Regeneration decreases the width of the resonance curve, and when it is pushed too far the higher audio notes begin to drop out, producing considerable distortion.

There is a scheme that might be tried on super-heterodynes that will bring in any station that happens to be transmitting with quality sufficient so that the announcer may be understood—but music will be pretty badly distorted. This scheme consists in placing a band filter in the receiver passing only frequencies between 1,000 and 2,000 cycles. This will make tuning so sharp that little interference will be experienced and many of the low-frequency spurts of static and noises will be eliminated.

Since the voice frequencies that carry intelligibility lie above 1000 cycles, such a filter would let through speech that could be understood, although entirely unnatural.

The band filter is really two wave traps in series, one cutting off all low frequencies and the other cutting off the high ones. If their cut-off frequencies are close enough together they will let pass a narrow band of frequencies, and this band of frequencies can be made as wide or as narrow as is necessary to get the required selectivity. Since the frequencies dealt with in this double wave trap are audio frequencies, large coils and condensers are required, and the proper design of these coils depends on measurements which cannot be made by the average radio constructor.



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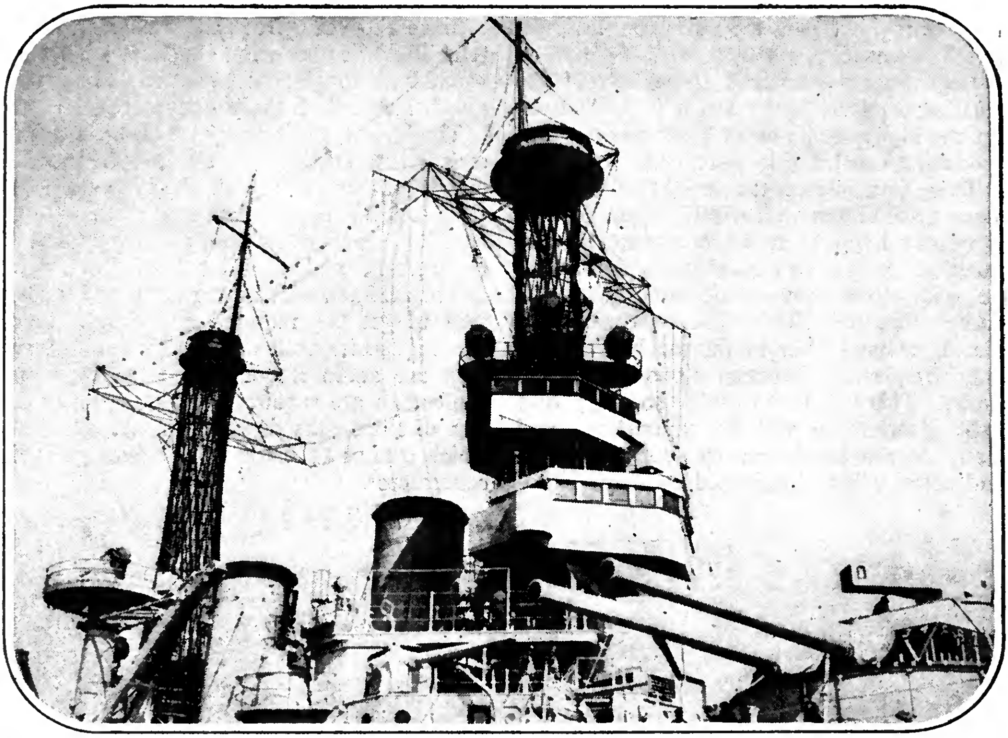
A WAVE TRAP IN A CABINET

Interior view of a wave trap using a Heath radiant condenser and a coil, which can be wound by the constructor. The simplicity of construction is obvious. The overall size of this cabinet is 8 x 7 x 5 inches

*HOW TO MAKE A DETECTOR AND TWO-STAGE AMPLIFIER UNIT*

*A REMARKABLY efficient radio-frequency amplifier unit was described by John B. Brennan in the May* RADIO BROADCAST *which has made a great appeal to many constructors who wanted to build such a unit using the most advanced ideas of construction. In an early number of* RADIO BROADCAST, *Mr. Brennan will describe the construction of a detector and two-stage audio amplifier. The unit is quite as compact as the radio-frequency one. The general experimenter will find the detector-amplifier unit of excellent service in testing out intermediate amplifier, tuned radio frequency, and other circuits. This unit is easy to build, it is well made and substantial and incorporates some excellent constructional features.*



THE U. S. S "ARKANSAS"

With her battery of big guns and radio antennas. At least seven separate antennas can be seen in the picture. All the Naval radio communication is carried on in the longer wavelengths with cipher codes. The larger ships have complete radio telephone equipment, which is chiefly used for communication between ships over short distances

# THE MARCH OF RADIO

By J. H. Morecroft

Past President, Institute of Radio Engineers

## Why Does Congress Refuse to Broadcast Its Proceedings?

WE ARE wont to give ourselves credit for being the most modern and progressive of people, and in the same breath affirm that the English are the most conservative, and that their excessive caution not to upset the accepted customs and methods of procedure effectually prevents progress. And of all the conservative bodies of statesmen in the world we have readily granted that Parliament was the most striking example.

Imagine then, introducing a new and novel instrumentality such as radio into the Houses of Parliament. Yet Prime Minister Stanley Baldwin announced recently that he contemplated creating a committee of members of both Houses to consider the question of broadcasting the proceedings of that ancient and honorable body.

Are we going to let our conservative friends show us the way?—or shall we introduce radio broadcasting as a part of Congressional procedure at once, before Parliament gets the "air"? It would appear from past news stories that many congressmen seriously object to having their oral activities spread out over the countryside where their constituents might be listening to their speeches. Can we suppose that the filibustering tactics, which have successfully blocked constructive legislation in the past as a result of petty partisan politics, could be carried out if several million healthy Americans were listening-in? Probably not. It would take more nerve than the average senator has, to get on his feet and read for hours senseless nothings for the *Congressional Record* with the idea of blocking some measure which millions of his listeners might want. He would get much worse than "Helen Marias" in his morning's mail, we imagine, and it would probably be unnecessary for Vice President Dawes to advocate changes in senatorial procedure.

We broadcast political conventions because, we now know, the people are intensely interested in the methods of governmental procedure, as well as in the men chosen to run for office. But we might well ask: What is more important, to know who is chosen to run for office or to know what he does after he gets in? Assuredly the activities of Congress are of more importance to the average citizen than are the proceedings of the national conventions. Let us then broadcast the proceedings of our congressmen, whether they will or no. The nation has certainly the right to demand the privilege of hearing its elected representatives perform in office. Fewer words would be used and much more government business would be transacted, we venture to prophesy. As the most probable man to act, we appeal to General Dawes to father the movement. Were this sponsoring to occur we are sure he would be no longer concerned with senatorial procedure and that incomprehensible political cross-word puzzle would soon solve itself.

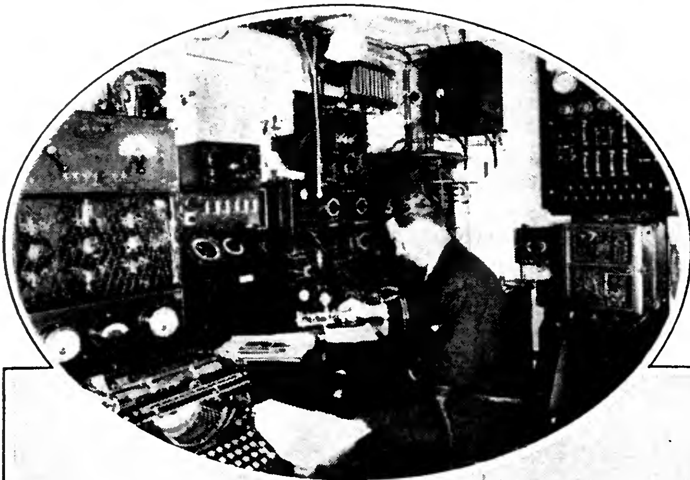
RADIO EQUIPMENT FOR THE HOTEL

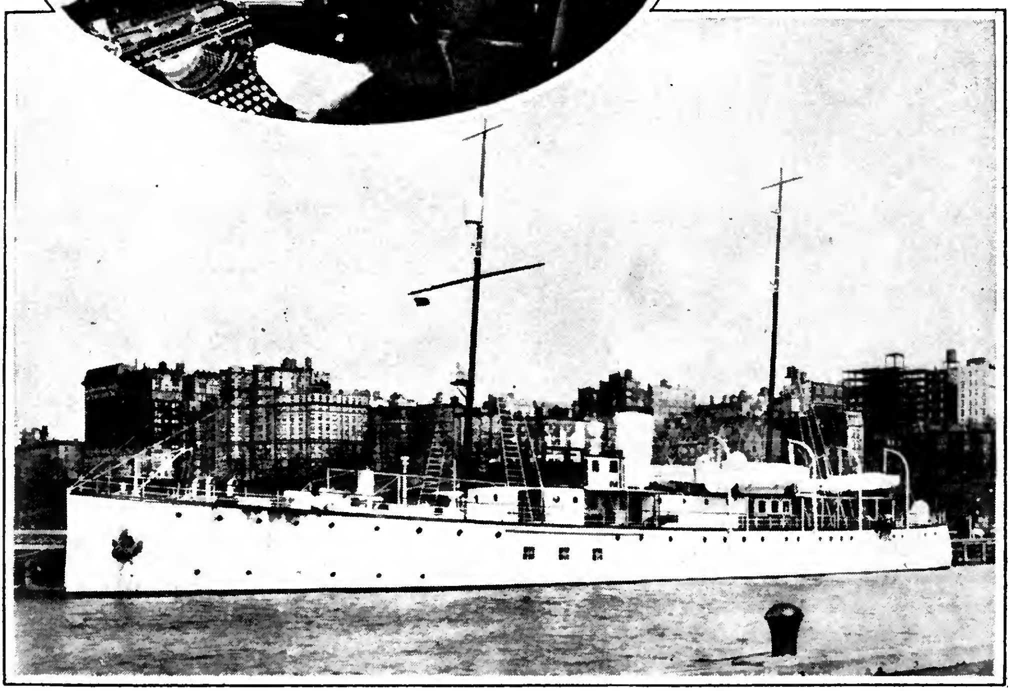
Among the many hotels in the country to install radio service for guests is the Biltmore, in New York. Individual receivers are used with A and B supply and loud speaker all contained in one cabinet. An attendant is tuning the receiver for Marion Benda (left) and Mary Mulhern, musical comedy actresses

## When Radio Aided Politics

THE service of radio to the public has been frequently analyzed and generally much over-estimated. The number of radio listeners is generally given as several million more than it is, with the idea of lending color to the news. Without exaggeration, however, it may now be stated that radio has really helped millions in at least one state. This help was not only in culture and entertainment, but it can be measured in real dollars and cents.

Governor Smith of New York State was actively working for the passage of an income tax reduction of 25 per cent., but the majority of his legislators, being of different political faith, were doing their best to thwart his plans. Probably had they thought at all (which is questionable) they would have been in favor of tax reduction themselves, if the reduction could have been pointed out as a Republican measure. But never must a Democrat be allowed to get credit for such a universally desired piece of legislation. So the tax measure seemed well on the way to be defeated by petty politics. From the Republican point of view this probably seemed a happy idea, for since they were in the majority, they could control the distribution of





THE S. Y. "ARA"

Owned by William K. Vanderbilt. The ship is lying in the Hudson River, off Riverside Drive with some apartment buildings of upper New York in the background. The radio equipment of the *Ara* is very complete and equals that of the largest of express liners. The interior of the radio cabin is shown in the insert. On the left is the $1\frac{1}{2}$ kilowatt c. w. transmitter, next is the radio compass equipment and then the receivers for long and short waves. A $1\frac{1}{2}$ kilowatt quenched spark damped wave transmitter and a $\frac{1}{2}$ kilowatt emergency set complete the elaborate equipment of station KFBO. The operator is using a double speed key, known among operators as a "side-wheeler"


EXHIBIT "A" FROM THE RADIO AMATEUR

A display that speaks for itself which was one of the exhibits at the recent radio show held by the amateurs of the Second United States District

the vast sums which the unneeded taxes would bring in.

The upstate press which is largely Republican, carried very little, if any, material which might make their readers think well of the Democratic governor, and probably most of the voters who read those papers thought him an impractical visionary, but he wasn't one, and the petty Republican politicians soon discovered that even with their influenced press the truth could not be kept from their constituents. Governor Smith decided to talk over the radio directly to the taxpayer, be he Democrat or Republican. "Al" Smith did talk and, so effectively did he place his arguments before the people of New York State that the Republican majority were forced to accede to him and pass this legislation which the people wanted. That is a real service which helps to weed out the petty, self-seeking politician and expose his actions to the sight of millions of those he is supposed to represent. Then indeed has radio the right to be counted as one of the important factors of our economic life.

## The Tangled Broadcast Situation

THE press recently featured interviews with such well-known radio men as Professor M. I. Pupin of Columbia University and Arthur Batcheller, the Supervisor of Radio for the Second District. The subject of the interviews was the ever increasing number of stations coming on the air. "We are at the end of the rope," says Mr. Batcheller. "The ether has reached the saturation point for broadcasters." Now if any one really knows about the situation it probably is Mr. Batcheller. He is the Government's representative in the most congested radio district in the world, and from morning to night he has to listen to radio troubles. In the opinion of Professor Pupin, "licenses were granted in the beginning without any discrimination,"—and we would add that such a policy still seems to control the issuance of licenses.

A strange instance of the attitude of the Department of Commerce on this jamming of the ether was recently reported from Cincinnati. Two stations in that city had been granted licenses to operate on the same wavelength, and after much squabbling as to a division of time they finally did operate on the same wavelength and at the same time! It was reported from Washington that the Department of Commerce had been repeatedly asked to step in and settle this impossible situation, but had declined on the ground that "to set such a precedent would get the Department hopelessly enmeshed in a maze of disagreements between stations." One might well ask the Department how it did expect such disputes to be settled? It is a strange idea of privilege and duty which consents to the issuance of broadcasting licenses to any who want them and then when trouble comes to the listening public as a result of the excessive number of stations, to turn one's back and let someone else settle the trouble when that trouble was directly due to the Department's freedom with licenses. Who, we also again ask, does Mr. Hoover think will step in to straighten out trouble between various stations if his department thinks the task too onerous?

Let us venture again the proposition that licenses be refused to a new station unless the request is accompanied by a petition signed by a reasonable number of prospective listeners. The more we consider this idea the more it appeals to us as a sensible method of controlling the number of broadcasting stations in the interest of the listening public.

## The Navy Establishes an Amateur Radio Reserve

CAPTAIN RIDLEY McLEAN, Director of Naval Communications, has conceived the idea of increasing the effectiveness of the Naval Reserve Force by enlisting in its personnel the radio amateurs of the country. During the World War, much time and effort were spent in training a staff of radio operators and technicians; several schools had to specialize in such work because, at that time, there was a great demand for radio communication, both on sea and ashore.

Hiram Percy Maxim, President of the American Radio Relay League, has sent out a call to all members of his organization to file certificates of willingness to join the Naval Reserve. Such enrolled amateurs will receive instruction in the use of Naval radio equipment, so that in any emergency the active radio personnel of the military organizations can be at once increased to its proper complement. It is expected that possibly 6000 amateurs will respond to this call. We regard this move as an exceptionally desirable one on the part of the Navy. There is much talent among American amateurs which can be used to good advantage by the Navy.

## The Month in Radio

EVERY month brings with it some patent decision in the radio field. There are so many suits being waged to-day that it would be strange if the month did not record some decision or other. As to who was the real inventor of the regenerative circuit, generally credited to Armstrong, seems yet to be a mooted question. The fortunes of legal war pass back and forth, and it appears that a recent decision of Judge Learned Hand, having to do with the possibility of a suit against the De Forest Radio Company, shows the tide of battle turning in favor of the De Forest Company. However, we cannot pretend to understand all the legal complexities and ramifications in these patent suits, but we note, in passing, that neither litigant seems to have received a knock-out blow up to this writing. They are both still in the commercial running.

IN SOME preliminary tests having to do with equipping army planes for summer maneuvers, it was found feasible for pilots in different machines to converse with each other when they were in full flight, and as far as five miles apart. This seems like a very short distance to us who nightly hear concerts a thousand miles away, but it is to be remembered that the power output of the airplane transmitter is necessarily low and the difficulty of receiving is enormous because of the excessive noise caused by the powerful motors exhausting almost in one's ear and the hurricane rush of the wind as the plane speeds through the air faster than two miles a minute.

IS THE radio market saturated? Every time a temporary falling off of sales occurs, this question is brought up. It seems that conservative estimates place the number of receiving sets in the United States at about 3,000,000 and on this basis we surely can guarantee the radio manufacturer a fruitful market for some time to come. Certainly as many people should own radio sets as at present own automobiles and phonographs and each of these numbers close to 15,000,000. Because of the lower cost of radio sets it would not be unreasonable to estimate the saturation point for radio receivers considerably higher than that for automobiles and phonographs. Our belief is that the market will keep on absorbing radio sets until there are about 20,000,000 in use.

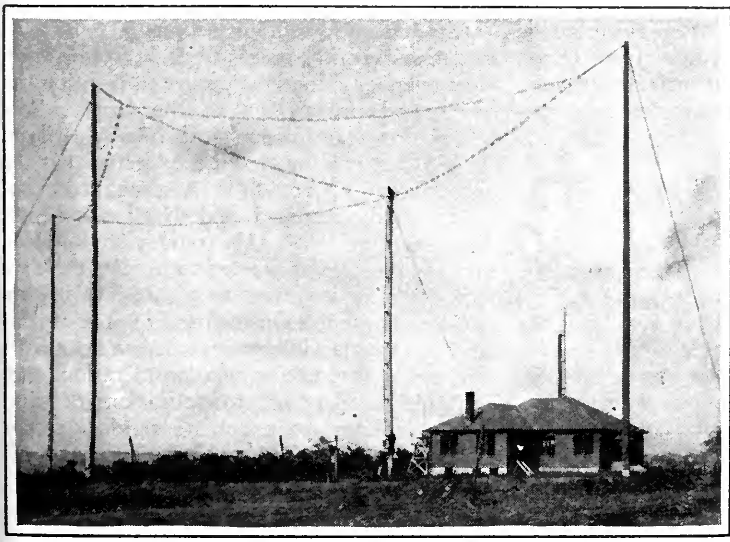
WHEN Donald B. MacMillan departs again for the polar regions the latter part of this year his radio outfit will be primarily designed to use short waves. His experiences with radio during his last expedition, as well as his recent conferences with radio experts here, have convinced him that the short wave channels will prove more reliable than the longer wavelengths used by broadcasting and commercial stations. So, if you want to hear news from the North Pole next winter, have one of your amateur friends build you a receiver for tuning to waves as low as 20 meters and then listen for MacMillan.

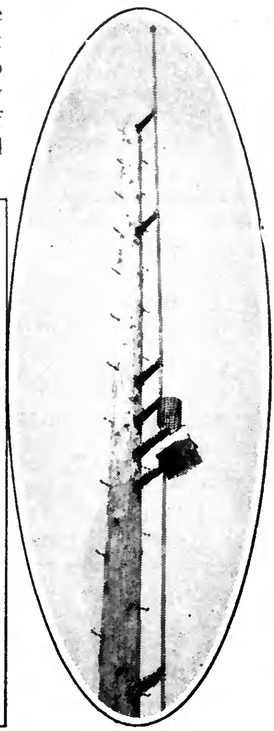
THE Turk has decided to modernize himself as far as radio is concerned, and the Radio Corporation of America seems likely to get a contract to build a huge station at Angora. The former station there was of German construction and, according to the press dispatches, it is not suitable for transoceanic traffic. It will probably be repaired and modernized sufficiently to carry on whatever European traffic may originate at this point.

THE Navy has put the airplane and radio to a new service in which they prove to be valuable aids in naval maneuvers. The modern gun has such a range that the target may be out of sight, or at least so far away as to make visual observation extremely unreliable. By having an observer equipped with a radio telephone in an airplane hovering over the target, the fire control officer on board the warship is at once notified of the accuracy of his fire. This method of control, using two-way communication, is so rapid and accurate that proper corrections can easily be applied to successive broadsides without interfering at all with the rapidity of fire.

FROM the radio research laboratory of the Soviet Government at Nijni Novgorod comes news that the workers there are perfecting a water-cooled triode tube. Apparently the scientific workers, or their press representatives, are going along the same independent lines of endeavor as are their experimenters in the fields of economics and sociology. Could they but profit by the experience of others they would find that the triode being "developed" there had already been developed successfully here quite some time ago.

THE Senate has just authorized the continuance for two more years of the private use of Pacific Naval Radio stations. The Department of Commerce recommends this use of the Government's stations, for it is their opinion that the private stations on the west coast are not now in a position to undertake efficiently the transmittal of all the commercial





THE EXPERIMENTAL SHORT WAVE ANTENNA OF KDKA

At East Pittsburgh. The high wooden poles to which the fan antenna is attached forms the experimental 309 meter antenna from which regular programs are radiated. The shorter vertical pole above the roof of the building is the short wave antenna. The oval at the right shows a close-up of the short wave transmitting antenna. Note how short the actual antenna is and that the conductor itself is rigid. Rigidity of the antenna conductor is absolutely essential where very short waves are being transmitted. Signals from this short wave station have been recently heard in Australia, a distance of about 11,000 miles from Pittsburgh

JOSEPH C. SMYTHE AND ANTHONY GERHARD

Both of New York City who won the awards of the Executive Radio Council of the Second Radio District for commercial radio code speed proficiency. Mr. Gerhard copied 56½ words a minute without an error. It is almost impossible to send the Continental code by hand at such a speed and the achievement of such a record is remarkable

and private messages which are being sent to-day. "Continuation of the service by the Navy is necessary," says Senator Jones (Rep., Washington), "because the private agencies have been unable so far to complete construction of facilities and handle all the messages.

## The Progress of International Broadcasting

FREQUENTLY the press tells us that the programs of KDKA and other American stations have served for operating the English stations, thus giving our English friends the same programs as we were listening to. Never has this been accomplished, however, in the reverse direction. It seems more difficult for us to receive a European station than for them to hear ours. A short time ago, however, a start was made which at least shows us the difficulties encountered.

The Radio Corporation station, WJZ, has on several occasions lately been actuated by signals received from 5XX Chelmsford, England. The transatlantic signals were sent across the water on a 1600 meter wave to Belfast, Maine, and from there rebroadcast on a 112 meter wave and picked up by the Radio Corporation's experimental laboratory on the outskirts of New York. From that point the signals went by wire to control station WJZ.

So the movement for transatlantic broadcasting, started by RADIO BROADCAST in November, 1923, has gone on. First by KDKA sending its signals to control 2LO in London and now we have our stations controlled by signals emanating from London. To be sure the reception of the London program here was so poor that the encounter must be recorded as a victory for Static, but it is a beginning and we can expect to hear the chimes of Big Ben with ever increasing distinctness and faithfulness of reproduction.

## Transatlantic Telephony Is Not Yet

IN HIS recent annual report, H. B. Thayer, Chairman of the Board of Directors of the American Telephone and Telegraph Company, reviewed his company's attitude toward radio development.

"In view of the great public interest in wireless telephony, it seems proper to mention the continued preparation of the British Post Office for transmission from Great Britain. When that is completed it is expected that the experiments referred to in the annual report of 1922, will be resumed, and that experimental conversations with this country will follow. It is impossible at present to predict the date of telephone conversation with Great Britain or even to predict, on the basis of present conditions, that it will be a practical and commercial possibility, taking into consideration other difficulties. Any other applications of wireless telephony to telephone service, except in minor instances where wire connection is impossible, appear even more remote."

## When Trains Are Run by Radio

WHEN an engineer is giving a technical talk to laymen not well acquainted with the field being analyzed, he is very likely to make statements that will appeal to the imagination of his listeners. With the idea of gaining their attention and interest, he is likely to venture much farther than he would if talking to a number of fellow engineers. We therefore take with a grain of salt a prediction of Mr. G. Y. Allen, of the Radio Department of the Westinghouse Company, given in a talk before the New York Railroad Club. After telling of the possibility of guided radio waves, that is, high-frequency current over wires, Mr. Allen went on to tell of the uses to which such currents could be put in railroad operation. "It is entirely feasible," said he, "through a combination of electric controls, and radio supervisory control, to start a train without a crew from a station, run it at full speed over clear tracks, and to slow down and stop it automatically in accordance with automatic block signals, giving to a central despatcher at the same time complete supervisory control of all of the movements of trains on a system."

Certainly all these things are possible, for it was only a short time ago that a warship was completely controlled in its course by suitable relays actuated by means of radio signals. But just as our warships still require crews of more than a thousand men to handle them, so our trains will, for quite some time to come, require the crews to which we are accustomed. For the time being, we prefer to have a train controlled by an experienced engineer rather than by a fraction of a watt of high-frequency power which, as we all know, may have all of its good intentions seriously interfered with, and possibly thwarted altogether, by static and other disturbances.

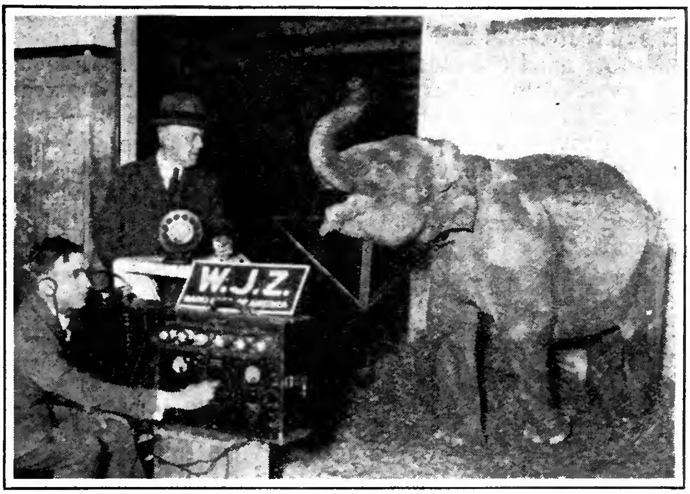
## More Facts About Radio Transmission

EVER since Marconi's first transatlantic experiment, attempts have been made to explain the difference between night and daylight transmission, the effect of wavelength on the distance a signal could travel, the reason for the difference in receiving between summer and winter, and many other observed facts. With the ever increasing use of short waves, we are more than ever convinced that much of our supposed knowledge of how radio waves are propagated is not based on fact. Waves 100 meters long should theoretically travel but a short distance before being dissipated, but in spite of this, they, at times, reach half way around the world.

Two of the engineers of the Bell Telephone Laboratories, W. H. Nichols, and J. C. Shelling, recently published a preliminary note on some theoretical work they are carrying out. This note states that, due to the combined effects of the ionized (electrified) upper atmosphere and the earth's magnetic field, peculiar effects on radio wave propagation may be expected. The theory, logically based on the known behavior of electric charges moving in magnetic fields, seems capable of explaining the remarkable fading and bending to which we well know the average radio wave is subjected. Possibly even the peculiar effects noted during the January, 1925, eclipse would prove explicable in the light of this new analysis. Dr. G. W. Pickard has just presented an interesting paper before the Institute of Radio Engineers, giving his findings on radio transmission during the recent sun's eclipse.

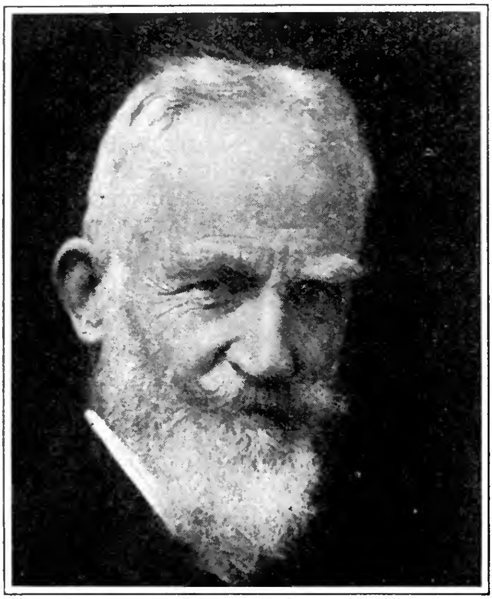
## Wireless Vision Achieved

SUCH an announcement recently appeared in the London press! Strange and unbelievable as this concept of television might have seemed ten years ago, it now seems almost sure to materialize at some time not far distant. The idea of seeing what




PACHYDERM AND MICROPHONE

Station WJZ, New York, recently broadcast the sounds and scenes of the circus. "Dolly," a two-year-old elephant, is doing the right thing by the radio audience



GEORGE BERNARD SHAW

London; Author and Playwright

*"If I could see and hear a play from my fireside, I would never enter a theatre again. I shall not prophesy, but I remind our managers that theatre-going is very dear, very inconvenient, and horribly stuffy and promiscuous. Unless they can overcome those disadvantages by the overpowering fascination of good plays, good acting, and theatres that are like enchanted palaces instead of hotel smoking rooms, broadcasting will knock them out."*

is taking place a thousand miles away would have been classed as the working of an unbalanced mind a decade or so ago, but now, after millions of us have heard, with perfect intonation, voices of speakers thousands of miles away, why should we be surprised at seeing things from the same distance? It is, as a matter of fact, as difficult a concept to picture radio carrying on voice communication as it would be to have it carry picture messages to our eyes. In voice communication, sound has to be changed to electromagnetic waves to transmit the suitable energy impulses and then these have to be changed back to sound for the benefit of the listener. The eye requires electromagnetic waves for its activation, and this is exactly the form of energy used in radio communication.

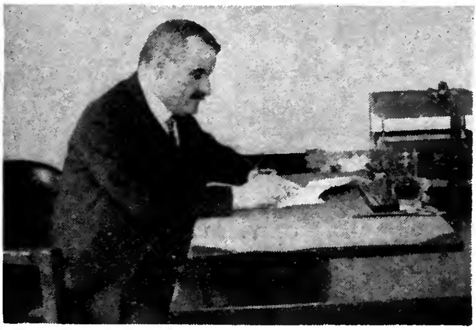
The transmission of pictures by radio has already been accomplished and many examples of these pictures have been printed in the daily papers. By most of the present methods it takes about twenty minutes to transmit a five-by-seven-inch picture. This process is really television. If the distant scene remains fixed for some minutes, it can evidently be sent by radio to the distant onlooker. Instead of gazing into the fabled crystal sphere, however, he would look at some kind of a chart, ink marked or photographic, upon which the distant scene would be slowly reproduced.

Now, if we imagine that such pictures could be reproduced in one tenth of a second instead of twenty minutes, wireless vision would be achieved. Thus the speed must be increased some thousands of times over its present value, but this is not at all unlikely. Many of us have seen the oscillograms by which the telephone engineer analyzes his sounds and the power engineer discovers what peculiarities exist in his transmission lines. Such pictures of electric current are reasonably accurate if the wave to be photographed does not reverse more rapidly than about one thousand times a second. To get pictures of frequencies higher than this has not seemed feasible in the past, yet recently it has been found possible to photograph electric currents which are reversing as rapidly as twenty million times a second. Here is an increase of speed of about ten thousand times, accomplished by an ingenious change in the method of photography employed. Instead of using light waves to affect the photographic plate, the electrons themselves, by the activities of which ordinary light waves are set up, are used to bombard the sensitized gelatine. This revolutionary step has increased the speed of oscillography thousands of times. By a similar application of the electron's activities to the problem of radio vision, the solution does not seem improbable.

## We Need More Delicacy in Radio Advertising

THE American Telephone and Telegraph Company, as has been frequently stated, is experimenting with the commercial possibilities of broadcasting. Their station, WEAF, is admittedly an advertising venture. To be sure, much excellent material is sent out over this channel which brings the owners of the station no financial return, but in the course of a week many hundreds of dollars find their way into its coffers through the appearance of the Gold Dust Twins and other organizations of a like character. The price of the station for broadcast purposes is high, but not so high, we imagine, that the annual balance does not have to be written in red figures. Certainly its income from advertising is much greater than that of any other station. The entire radio field looks to it as a trail blazer in the realm of radio broadcasting.

In the interest, then, of radio advertising, we suggest that altogether too much time and too many words are spent in telling us who is paying for the next hour's operation of the station. A mere statement that the Happiness Candy Stores are going to give the next hour's entertainment does not harm the listeners or the candy business, but to listen to a stiff, stereotyped eulogy of this special brand of candy is irritating, to say the least. Probably the candy firm, in common with others "using the



PROFESSOR MARIUS C. A. LATOUR

The French radio inventor, whose patent claims on many important radio devices and circuits have been recognized by the American Telephone & Telegraph Company, the Radio Corporation of America, and others. The Hazeltine group of manufacturers purchased the American license for the Latour patents and the A. T. &. T. Company, and the Radio Corporation have non-exclusive li-licenses from Prof. Latour whose patents are such as to involve, so he claims, every radio receiver made

facilities" of this station, specifies how much propaganda must be poured into their radio channel. If this be so, we suggest that a bit more music and a correspondingly decreased period of self-approbation would be more conductive to candy buying. It takes but little propaganda to give to radio advertising a distinctly negative value and that negative value has been reached several times by the clients of WEAF.

## Electrical Exports Are Increasing

THE Department of Commerce reports that during 1924, the total of our electrical exports approximates $85,000,000, a $12,000,000 increase over 1923. Most of this money is spent for machinery and transmission line equipment, but radio and its accessories are showing an ever-increasing share of the export business. The total for radio is estimated by the department to be $5,000,000. Dry batteries alone show an export value of nearly $800,000 during the past year.

South America, which last year was one of our principal foreign customers, has dropped from third to fourth place, probably due to the activity of German merchants, especially in such countries as Argentina where German sympathizers are very active.

Although the total of our electrical exports shows a very considerable figure, this pales into insignificance when our own expenditure for engineering projects is considered. Electrical power plants, dams, water and sewage systems, for 1924 mounted to the enormous total of $2,002,533,000. It's no wonder our engineering schools find great demand for their graduates when such technical activity prevails throughout the country.

## Interesting Things Interestingly Said

DAVID SARNOFF (New York; vice president and general manager of the Radio Corporation of America): "In whatever direction radio may develop, it will be, I believe, toward supplementation, not substitution. The truth is, printer's ink achieves something that radio cannot achieve; conversely, the security of radio lies in the fact that it provides a different service than the printed word ever rendered or ever could render."

HUGH S. POCOCK (London; Editor of the *Wireless World*): "To-day a number of broadcasting stations in different parts of the world are making use of Esperanto as a means of linking up with other countries.

". . . The employment of short waves for long-distance transmission using low power, the importance of which was first demonstrated by the amateur worker, has provided those who conduct experimental work with a means of linking up with their fellow workers all over the world, however distant. Demonstration has, in fact, already been given that there is no point on the globe so remote that it cannot be reached on short waves by amateurs, even when using very limited power. As the range over which amateurs communicate has been gradually extended, so the necessity for some common language has arisen.

". . . To-day it is not by any means an unusual occurrence when overhearing short-wave intercommunication to come upon the exchange of comment in Esperanto between amateurs of two different countries whilst experimental work is being carried out, each understanding the other without difficulty, although their native languages may be entirely unintelligible to either."

FRANK T. STANTON (New York; president Frank T. Stanton and Company): "I am not at all in sympathy with statements I have heard that the radio industry has been overfinanced. In fact, I still maintain that the radio industry is underfinanced. There is hardly a question that if the tremendous sums that have been paid for radio securities during the past six months had all found their way into the treasuries of the companies rather than into the pockets of the original organizers, a vastly different story could now be written regarding the market for securities representing manufacturing enterprises."

FRANK J. McENIRY (Denver, Colorado; General Electric Company, station KOA): "Never did Marconi, Armstrong, Hazeltine, Alexanderson and other famous experimenters dream that some day, the results of their efforts—radio—would be employed to capture murderers and bandits, put across community chest drives, detect human ills, recover lost dogs, and bring together parents and wandering or kidnapped children. What radio will accomplish and what is predicted for it are two entirely different things, according to experts in this field. On the face of it, however, radio is confronted with the peculiar problem of living up to everything that is expected of it."

G. C. FOSTER (New York; President of the American Piano Company): "The question as to the effect of radio on the piano business is frequently asked. We believe that radio is decidedly helpful. It is increasing the knowledge and appreciation of music, and it is awakening an interest in many to whom it has hitherto been a matter of indifference. It is increasing the desire to hear better music, especially in the home. The enjoyment that the radio brings has unquestionably pointed a way to even greater enjoyment through the actual possession of a means of making music, which leads directly to the thought of a piano."

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G. Y. ALLEN

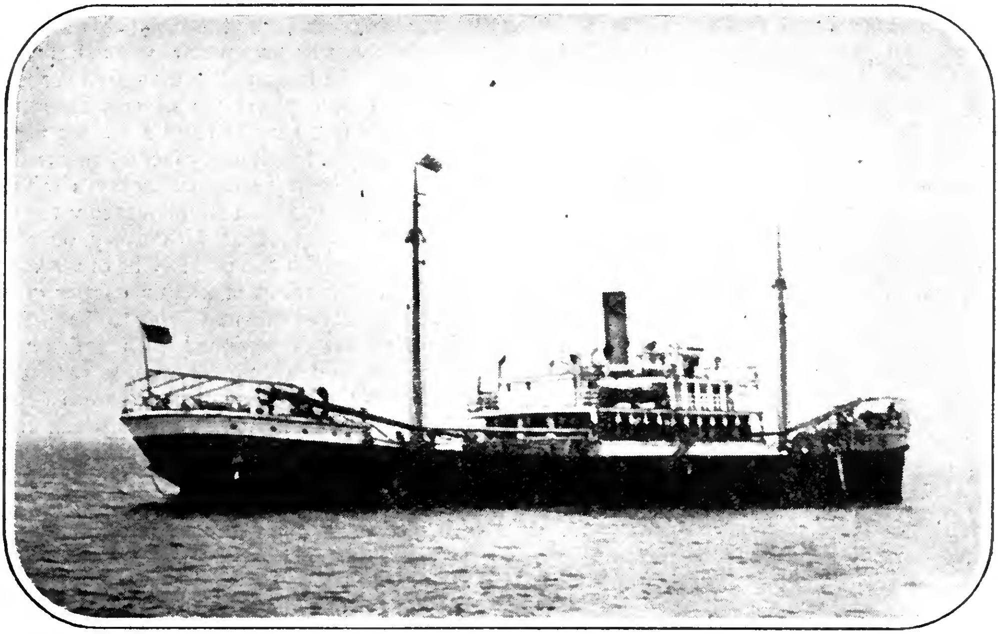
New York; Radio Department, Westinghouse Electric & Manufacturing Company

*"Through the use of modern developments in radio, it is entirely possible to operate electric trains from a central control office. I do not wish to be understood as advocating the elimination of the motorman, conductor, and crew. No mechanical device, however perfect, can take the place of human intelligence, but it is interesting to note some of the possibilities of radio control.*

*"It is now entirely feasible, through a combination of automatic control and radio supervisory control, to start a train without a crew from a station, run it at full speed over clear tracks, slow it down or stop it, in accordance with the signals of an automatic block signaling system, start it up again when the signals clear, stop it at its next station stop, and open its doors."*

DR. E. F. W. ALEXANDERSON (New York; Chief Consulting Engineer, Radio Corporation of America): "The shortest element of the telegraphic signal is the dot. The higher the signaling speed the shorter is the dot. Thus, while the wave amplitude is kept constant the total energy contained in the dot sign is inversely proportional to the speed of signaling. When the strongest single atmospheric impulse prevalent at any time contains as much energy as the dot in the telegraphic code it may be mistaken for a dot, or it may break up a dash into two dots, thus causing false telegraphic signals. It is therefore necessary to maintain a speed of signaling in which the total energy of the dot is somewhat greater than the maximum energy of a single atmospheric impulse. Thus, if a wave amplitude is doubled, the length of the dot may be shortened to one-half. This explains why in practice the telegraphic amplitude is double the length of the wave amplitude and also why it is inversely proportional to the atmospheric disturbance."

ALBERT E. HAASE: (New York; in an article in *Printers' Ink*): "There is no doubt in the minds of many who are getting their livelihood from radio that if this mad rush to get the advertisers' dollar for the support of radio continues, radio itself will suffer. And that would mean public resentment against advertising—all forms of advertising, for the public does not distinguish between advertising mediums. It is this point that makes it imperative for all thoughtful manufacturers to watch and study the attempts that are being made to turn radio broadcasting into an advertising medium."



THE S. S. "ARCTURUS"

The marine headquarters of William Beebe, the scientist and explorer. The *Arcturus* is the most perfectly equipped ship for scientific exploration in existence. A 3½ kilowatt continuous wave radio transmitter aboard keeps the expedition in constant touch with the mainland. Exclusive news dispatches from Doctor Beebe appear in the New York *Times*, telling of the findings of the party

# Radio's Part in the Sargasso Sea Exploration

## Dr. William Beebe's Scientific Expedition to the Unfamiliar Reaches of the Atlantic Ocean is Constantly in Touch with the World by Radio

By ALFRED M. CADDELL

WHAT did you write on that paper that you put in a bottle and cast from the ship on your last sea voyage? Have you heard from some romantic young lady, or from some ne'er-do-well beachcomber who has found your bottled message buried in the sands of some distant resort? If not, then the possibilities are that your bottle has followed in the wake of a derelict on its way to the Sargasso Sea. Situated between two legendary points on the compass, somewhere between Africa and the Continent on the west, lies the Sargasso Sea—that mysterious part of the Atlantic Ocean which, it is thought, marks the grave of the fabled continent Atlantis, and which has now become the graveyard of derelicts floating wreckage of all sorts.

Curiously enough, human nature likes to build fables and yarns upon which to feed the imagination, and there are many weird stories told of this great waste of seaweed and driftwood. And out of these stories there has grown the belief that, perhaps, after all, there may be a Sargasso Sea. Once that is admitted it is logical to conclude that there is a sunken continent under that grayish expanse of sluggish water and that on the continent, if exploration were possible, there might be found treasures in gold and ornaments and in historical value, equal to those uncovered when Tut-ankh-Amen's tomb was first opened.

And so, not so much in the hope of discovering lost treasure, but rather in the hope of obtaining valuable research data, an expedition has started for the Sargasso Sea. The expedition under the direction of Dr. William Beebe, has been fortunate in obtaining a party of noted scientists, among whom is Dr. William K. Gregory of Columbia University and the American Museum of Natural History.

The *Arcturus*, for so the vessel that has been chosen for this important work has been named, is the largest ship that has ever been employed in explorations of this character. She is 280 feet long and has a 46-foot beam. She is equipped with every facility required to probe into the mysterious Sargasso's secrets. Her laboratory, which is undoubtedly the finest afloat, is provided with every scientific instrument which can possibly be of service in making observations of whatever forms of life the dredge of the ship may bring to the surface. The *Arcturus* is equipped with a drum on which is wound seven miles of cable, so that the ocean may be dredged at any known depth. The cable is lowered with trawls which automatically close at prescribed depths, so that if any deep sea monsters become enmeshed in the trawls, the depth at which they live will be known. This will assist the scientists in tracing, step by step, the evolution from surface fish forms to the extraordinary

PLUMBING THE MARINE DEPTHS

From the bow of the *Arcturus*. A specially arranged bridge from the bow of the ship has been rigged so that the members of the party can work directly over the sea instead of having to drop a line over the side. The insert shows Doctor Beebe marine life which inhabits the lower regions of the sea.

THE SEARCH FOR UNDERWATER TREASURES

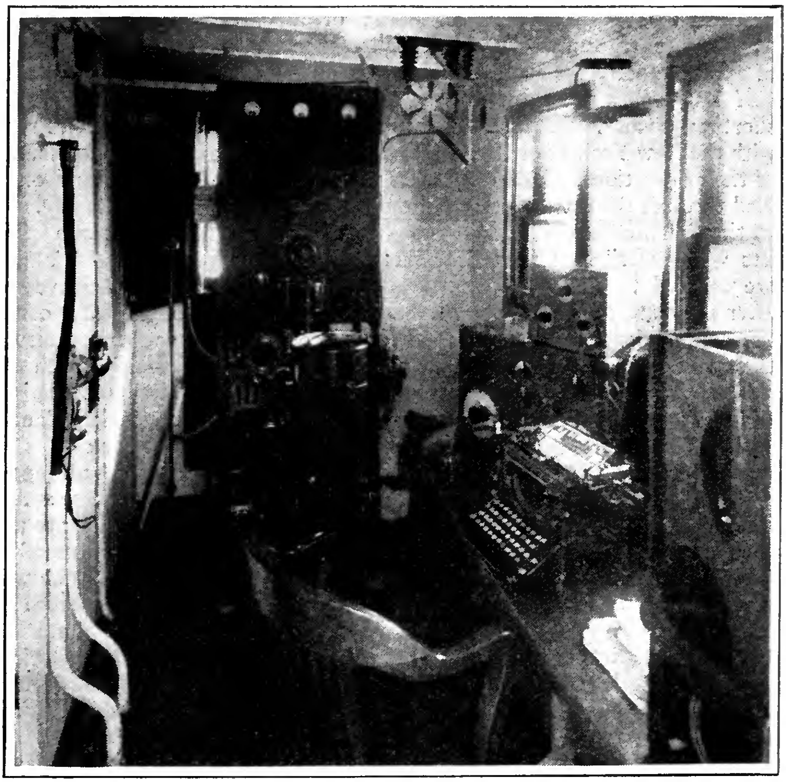
DEEP sea monsters provide treasure for almost inexhaustible thought. Many fish with remarkable lighting systems have been caught. Some of them are said to be aflame with light, so that they look more like a Hudson river night boat than fish, while others carry green, red, yellow, and pink lights. Some have peculiar shaped lanterns at the ends of long feelers, while the bodies of others of this peculiar species of fish are studded with blazing search lights. Some have eyes from which radiance streams, and others are continuously lighted. It is believed that only a small portion of the various species of lighted fish have been caught, so that they will be subjected to very careful study on this expedition.

Another interesting phase of deep-sea life will also engage the attention of the scientists. Deep sea fish, it is known, fill their tissues with compressed gases to resist the pressure of the water at great depths, so that when they are hoisted to the surface, the diminishing pressure no longer neutralizes the pressure of gas from within, causing them, sometimes, to expand or burst like popcorn. Other fish are able to live at various levels by means of muscular valves which release the compressed gases from their tissues as they rise, and replenish their chambers again when they descend. Needless to say, special study will be given to the compressor and decompressor systems possessed by these monsters.

Then on the *Arcturus* there are many tanks and one great aquarium in which many things of interest will be brought back to New York when the explorers return from that region of the South Atlantic where the Sargasso is supposed to be.

But best of all, one of mankind's recently developed wonders is playing an important part in this expedition. We will let Charles J. Pannill, General Manager of the Independent Wireless Telegraph Company, tell us about the radio installation on board the *Arcturus*.

"If you are able to tune-in on a 2400 meter wavelength," said Mr. Pannill, "you will be able to listen-in on some mighty interesting press despatches, if you can read code. Heretofore, expeditions have seldom been heard from until they returned to their point of departure, so that when to-day we are able to follow explorers, step by step, through their



THE RADIO CABIN OF THE "ARCTURUS"

The radio equipment is controlled by the Independent Wireless Telegraph Company. The *Arcturus* is a wooden ship built by the Shipping Board during the war for the Alaskan trade. It was owned by the Union Sulphur Company and was donated by Henry D. Whiton to the New York Zoölogical Society for this voyage of exploration tribulations and hardships, it only goes to show to what extent radio has become a daily adjunct in our lives. And, too, it is interesting to note that the progressive newspaper realizes the value of radio from the point of view of press despatches. The following excerpt from an article in the New York *Times*, takes the reader right to the spot and almost enables him to participate in the exploration:

"We are now at the site of the fabled Atlantis on Atlantic Ridge, midway between America and Africa, with 2300 fathoms of sea below us, and this morning our radio receiving set brought to us the lively music of a Pittsburgh orchestra playing 'Hands Across the Sea'—Souza's march.

"Even with continued heavy seas we have brought our heavy dredging apparatus into play, and yesterday our first bottom dredge brought up glass sponges and volcanic rock from a sea abyss three and one-half miles below us.

"The *Arcturus* has on board a radio installation furnished by the Independent Wireless Telegraph Company, and consisting of a $3\frac{1}{2}$ kw. arc transmitter with daylight range of approximately 1500 miles, and also a one-half kw. spark transmitter for emergency short range work. Doctor Beebe has arranged with the New York *Times* to report an account of their operations, which dispatches are handled through the East Moriches, Long Island, station. Thus the public and the philanthropists who contributed toward this expedition are enabled to read the despatches the day after they are sent. What an advance over the communication systems of other expeditions and other days!"

The *Arcturus* left the Sargasso Sea sometime during the last week in March, and on the 29th of March, Captain J. S. Howes reported by wireless that all was well with the *Arcturus* and her crew, and gave her position as 200 miles south of Balboa, Panama, in the Pacific Ocean. The *Arcturus* had left Balboa, Canal Zone, on the 28th of March and had headed directly for the Galapagos Islands, where Doctor Beebe and his party of scientists intended to continue their researches, and also, it is believed, to study the Humboldt Current, of which little is known. But there was a period of two weeks after the *Arcturus* sailed for the Galapagos, where nothing was heard from her—nothing further at least, than the Captain's report on the 29th of March. It was then that grave fears for her safety began to be expressed, and there was much excited comment as to her fate.

The waters of the Pacific Ocean in the vicinity of the Galapagos, and following the waters of the Humboldt Current along the Peruvian coast, are far from truculent. In fact, so calm is it in this immediate vicinity that it has become noted for this alone.

Recently, Dr. Robert Cushman Murphy, Assistant Director of the American Museum of Natural History, returning from a study of the vicinity, with new data on unfamiliar currents, told of the unprecedented weather in the vicinity of the Humboldt Current, and he expressed the opinion that some trouble might have been experienced with the wireless outfit on board the *Arcturus*. But there was little ground for this belief, for as previously stated in this article, the *Arcturus* is fully equipped and ready for any possible emergency to her radio or to any other part of her scientific equipment.

Members of the New York Zoölogical Society were unable to explain the *Arcturus's* silence, for the vessel had previously communicated directly with East Moriches, Long Island, sending her position to the radio station there every day. President Henry Fairfield Osborn of the Museum of Natural History, sailed from Miami on the steamship *George Washington* recently. The *George Washington* has the same equipment as that installed on the *Arcturus*, but though the operator on this vessel attempted persistently to get into communication with the expedition, he was unsuccessful. Then it was that all vessels south of the canal zone were asked to call the *Arcturus*, and the Naval radio station at Darien, Canal Zone, was instructed to send out her call.

What then, had happened to the *Arcturus*? Had her officers and men found another Sargasso Sea, never to return and tell us about it? Or, was it merely that old complaint "static" about which we hear so much now-a-days? Perhaps, even then, they were approaching the land of the tortoise, the Galapagos, the mysterious and romantic Galapagos of the 16th century Spanish buccaneers. And, indeed, this proved to be so, for on April 11th, it was learned through the Navy Department, that once again the *Arcturus* had been heard from and that all was well with those on board.

# The Listeners' Point of View
*Conducted by* Jennie Irene Mix

# Has Radio Any Relation to the Supernatural?

IT WAS in 1906 that Dr. Thomas Troward put forth the statement in his *Edinburgh Lectures on Mental Science* that there is no such thing as time or space: that, as the smallest portion of the ether contains all the elements of the whole, then every portion of the whole is within this smallest portion. Therefore, the entire universe is in one place and every place at one and the same time. Thus, neither time nor space exists.

This was, of course, long before the days of broadcasting, and the lectures aroused, except among those who had themselves gone deeply into the subject, the ridicule with which all new ideas are received. People thinking only on the surface interpreted Doctor Troward as saying that you did not have to cover any ground whatever to get from New York to China because there wasn't any ground. And so they went on.

VLADIMIR RASSOUCHINE
Pianist, who was heard recently at KGO and gained favor with a large number of listeners

The simple fact was that Doctor Troward was anticipating radio. Had you asked him, "What is the difference in time between London and New York?" he would have replied, "There is no difference, nor between any other two points in the world, no matter how far they are separated according to the estimate of the geographers."

We know now that this is true, and has been true since ever the earth was formed. The fact that while it may be daylight in this country it is night in China has nothing to do with the matter as set forth by Doctor Troward. He deals with those elements outside of the material that control our lives, and over which we have practically no control, and, therefore, foolishly grope our way blindly among all the other blind.

Years ago—for it must have been quite a time before these Troward lectures were brought before the public, F. Marion Crawford wrote a novel called *Mr. Isaacs,* in which the scenes are largely laid in India, and the psychic powers of the Hindoos, figure in the story. One of the characters remarks quite casually to another that he saw a mutual friend of theirs in a town some one hundred miles distant from his home although he knew perfectly well that the friend was in his home.

Marion Crawford states that long after this book was published, a woman asked him: "Why did you put such an absurd incident into a novel that, in the main, is plausible?"

Mr. Crawford replied that while he was in India he heard many such statements, and others that seemed even more impossible of belief. He asked the man who had seen his

THE EVEREADY TRIO

Whose artistic playing is frequently heard during the programs of the Eveready Hour, broadcast each Tuesday from nine to ten. From left to right they are, Alex Hackel, violinist, Edward Berge, pianist, Jacque de Pool, 'cellist

friend one hundred miles distant from where he was in the body, just what he meant. The Hindoo said, "But that is not unusual. By controlling vibrations one can project his personality through the ether to distant points."

Radio is projecting personalities in the form of photographs to distant points, by a man-made machine. Perhaps the Hindoo was right and one's personality can be projected by a God-made machine, the mind.

Impossible? Who can say that anything is impossible?

According to Edward Jewett of Detroit, who talked in an interview on what the boys have done for radio, they do not know the word "Impossible." He said:

"The boy mind grasps the theory of radio better than can the man mind because to the boy mind there are no inhibitions and impossibilities. Men, as they become men, learn that so many things, 'cannot be done.' The boy doesn't know that. So he goes ahead and does it. . . . I asked one youngster what he did when he discovered that a thing could not be done. 'Find out how to do it,' was his prompt reply."

(Perhaps by using this boy's method we may learn how to control vibrations with the mind so that we may be benefited by such control!)

To revert to Mr. Jewett:

"The youth grasps at the intangible far better than the grown person. He can see a thing that isn't there, and the minute that he sees it, then it is there. His imagination is neither tired nor spoiled. Boys think and say uncanny things. One remarked to me once, 'It's curious to know that every voice in all the world is here, now, in this very room, isn't it?'

"You mean," I countered with the old man wisdom we are so likely to effect, "that it's here if we bring it here."

"'No,' said he, 'it's here now if we will give it a fair chance to reproduce itself. If we don't hear it, that's our fault.'"

And yet you may be sure that youth had not read Troward although he was stating the basic principle of his Edinburgh lectures.

## How Archæology "Came Over" on the Radio

IF YOU missed hearing Joseph Emerson Smith give a talk last month through station KOA, Denver, then you are unfortunate.

Mr. Smith was a member of the expedition sent by the Colorado State Museum to the recently discovered prehistoric city of pit-houses extending along the tops of a straggling series of mesas in southwestern Colorado, and that swing from a point near the Colorado-Utah border in the Paradox Valley to Pagosa Springs, Colorado, and then south, well into New Mexico.

This is the largest lost city yet discovered on the American continent. Its civilization goes back to a period previous to that hitherto believed to be the oldest that ever existed on this continent, antedating the cliff dwellers by at least one thousand years. It is composed of scores of separate and distinct units, which, for the sake of defense advantages, were confined to the tops of mesas or table-lands, high above the valleys. Five hundred pithouses in one group alone have just been mapped in what is known as Chimney Rock.

There are tens of thousands of these pit-

AN ANCIENT WATCH TOWER

And skeleton of a prehistoric woman which were uncovered in the nearby pithouse, inhabited twenty-two centuries ago in what is now Colorado. A lecture on these archæological discoveries was given at station KOA, Denver, and is commented upon elsewhere in this department houses, large and small, dotting the tops of the mesas. Archælogical surveys indicate that they were excavated by the original builders to a depth of from three to five feet, and were surrounded by sleeping chambers and granaries. Entrance to these homes was through a steep decline or tunnel, accommodating only one body at a time. Fires were apparently built in the exact center of the large or main room, and an opening at the roof was skillfully fashioned to let out the smoke.

So far as investigation has at present gone it has been discovered that these people had a crude knowledge of astronomy, and carried on truck gardening and irrigation. Their principal crops were gourds, tubers, corn, melons, yucca and greens. Figurines have been discovered, of rare design and finish, and pottery that might well be used for decorative purposes to-day.

The photograph reproduced on page 215 shows the remains of an old watch tower, and also the perfectly preserved skeleton of a woman about 35 or 40 years of age, who was about five feet ten inches in height. It will be seen that the right cheek was resting on the right hand, and the left arm was placed across the breast. The knees were flexed. Beside the skeleton was an unusual elaborate gray bowl decorated with a conventionalized design of butterflies. Near by was a complete pottery face, that of a doll which originally was supported by a corncob.

Mr. Smith has been quoted indirectly, because to attempt quoting him verbatim would be an injustice to the exceptional interest with which every moment of this talk was filled. Station KOA has put on many fine features during its short existence, but probably nothing of greater interest to a certain class of listeners-in than this one.

LUKE HILL

No, the small boy, who is all of seven, isn't impersonating Oliver Twist and asking for "more." As a singer he was the "hit" of the radio show given recently for the benefit of "The City of Childhood," maintained by the Loyal Order of Moose for the dependent children of their deceased brothers. It was presented through WJJD

## American Music Is Inferior to None

IN THE course of a very interesting article comparing British and American radio receivers, the author says, in the *Wireless World and Radio Review* (London): "It may be said definitely that, taken as a whole, British wireless sets and components are superior to those manufactured in the United States, both in quality of workmanship, and in quality of reproduction. This is not so much due to the fact that American manufacturers are lacking in skill in the design of good transformers, etc., as it is due to the mentality of the American people. Anybody who is intimately acquainted with modern American music, or has had the opportunity of comparing the performances of the average quality orchestras in theatres and restaurants in the two countries, will readily understand why the quality of reproduction in the British sets is so greatly superior to that in those which emanate from the U. S. A. Indeed, the performance of an orchestra which would be considered mediocre in England, is usually termed, 'Highbrow' on the other side of the water."

Taking restaurant music by and large in England, this is no doubt true. Also, all who have taken the trouble to inform themselves regarding radio programs in that country as compared with American programs, know that England gives, on the average, music far superior to ours.

THE CAMERON SISTERS
Fair charmers with the flute and harp who broadcast an attractive program from KGO

But the writer of this article, M. P. Vincer-Minter seems unconsciously, to carry the impression that *all* music produced in England, whether by radio or through the usual public channels, is superior to American music. In truth, the opposite is exactly the case. Except for her great choruses which give yearly festivals, English music as heard in concert halls and opera houses cannot for a moment stand comparison with the great attractions in these same lines available in this country every season. England has been called, "The Ballad Country," for the reason that her people have never risen, as have the American people, to a point of appreciation of the lovely and masterly songs of such composers as Schubert, Schumann, and Brahms.

Also, where this country has well nigh a dozen orchestras of the highest rank, England has one and that is the London Philharmonic. Covent Garden Opera has been discontinued since the war, while here the Metropolitan and Chicago forces are still carrying on. All these points are cited, not to correct the writer in the *Wireless World*, but because to some he may unconsciously give the impression that he is talking about American music in general.

## When an Announcer Confides

MR. H. W. ARLIN, of station KDKA, who made his début as one of the world's pioneer radio announcers in 1921, assures the public that, "Although I have been continually on the job ever since then, it has never grown stale. This, for the reason that there are always certain individuals who furnish diversion. Such as, for instance, the woman who telephones: 'I have just left a package of pajamas on the street car, and would like to have the service of your station in recovering them.'"

"Or, 'I have just arrived at the Pennsylvania station and have some relatives living in the city, but do not know where they live. Will you please announce over the radio that I am here and waiting for them to get in touch with me?'"

Or, when Christine Miller Clemson, for many years one of the leading concert contraltos of the country, was requested to sing, "Red Hot Mama!"

## What the Flonzaley Quartet Think of Radio

ADOLPH BETTI, first violin and director of the Flonzaley Quartet, in speaking to the present writer of the first broadcasting experience of this organization when they were heard on a Victor program through WEAF, said:

"It is incredible, radio. It is the greatest influence in the world to-day! It will transform, perhaps, musical conditions and the transition stages may make confusion. But it will lead to glorious results. It is still impossible for me to realize that we were really heard by outside listeners as we played in that studio. We sat there, and played with the same ease and comfort as if in the parlor of friends. When the telephone calls began to come in telling how clearly we were heard even at a great distance, I could only exclaim: 'But did they really hear us?' I still cannot comprehend. I only know it is marvellous and that I am deeply interested.'"

This from one of the very greatest of living musicians.

## The Battleground of Jazz Opinion

DR. R. S. MINERD raised quite a breeze among the proponents of jazz through his letter published against cheap jazz last month, judging from the letters received by the conductor of this department calling him down. He raised quite a breeze among the anti-jazzites, too. All the letters that have ever been received

"DO A GOOD TURN DAILY"

Picked members from a number of crack Scout Troops assembled around a radio set to receive instructions in hooking up and operating the one-dial Mohawk set which is to be distributed through the Chicago *Tribune* to the blind of that city. The boys are installing the sets and instructing the sightless owners how to use them by the editor of this department upholding jazz, condemn what they call "the classics" being devoid of melody. Yet at least ninety per cent. of jazz is written from melodies drawn from the great composers, distorted for jazz purposes.

Probably, "Yes, We Have no Bananas," is not jazz, but the song is taken literally from the "Hallelujah" chorus of Handel's "Messiah."

IT IS little short of wonderful the way station KGO, operated by the General Electric Company, keeps up the high standard of its programs. Congratulations are well in order, not only for this station but KOA at Denver, operated by the same company. Both of them have fortunately managed to avoid many of the pitfalls into which new stations stumble through ignorance.

## The Stage and Radio Are Not Opposed

COSMO HAMILTON, the playwright, is among those who are pessimistic regarding the effect of radio on the theatre. People simply will not go to plays. They will stay at home and listen to them by radio.

Can any one imagine an intelligent person preferring to listen-in this way to Bernard Shaw's "Saint Joan" rather than to attend the performance in person? We may be sure that the theatre will not be seriously affected by radio until sight and sound are absolutely synchronized and equally successful in production. And we doubt if even then the public will accept this sort of production as a substitute for the real thing.

WE ARE, indeed, making progress in radio music but only because a few (very few) stations have progressive program directors. In featuring a series of concerts and lectures given during February and March at the Detroit Athletic Club, station WWJ of that city made it possible for their listeners to hear, in the musical line, William Backaus, pianist of international fame, Reinald Werrenrath, and Margaret Matzenauer. One could not ask for more than this.

ANY day or evening you can tune-in and hear from one station or another some of the latest books discussed. It may interest the broadcast directors to know that many people enjoy this feature who are not among those inclined to write letters expressing their commendation.

FLORENCE STERN

The youthful violinist who has been heard through station WEAF

THE young woman who, each evening at 7.05, from station WBZ, Springfield, talks to the kiddies is one of the star radio entertainers along this line. She gives the children such worthwhile stories that they are also enjoyed by grown-ups, which is the test that all stories for children must meet before they can be called literature.

MISTAKES in program printing are not infrequent. A short time ago a program contained the announcement, "Valet Music from Rosamund Suite by Schubert."

THERE must be good piano teachers in Iowa and Nebraska judging from some of the pupils heard through the radio stations in those states.

ALL communications addressed to this department should be signed with the full name and the address of the writer. Letters are sometimes received that contain valuable comments or suggestions, but signed with a fictitious name. It is contrary to the policy of this department either to quote from or otherwise to acknowledge any anonymous communication.

# How to Make a Chemical Plate Supply Unit

## A Double-Wave Rectifier Without Any of the Faults of the Usual Type—It Is Very Simple and Inexpensive to Make and the Parts Can Easily Be Secured

By JAMES MILLEN

THIS article of Mr. Millen's is a careful presentation of a new suggestion for a chemical rectifier to furnish plate potential. The average person is inclined to think that a chemical rectifier is necessarily sloppy and unreliable. This is not precisely true. A well-made chemical rectifier is, all things taken into consideration, highly satisfactory for use as a plate supply. This unit will furnish plate potential up to 120 volts and current enough for any receiver. On tests made on one of these units connected to a receiver in our laboratory it was noted that no hum at all was present in the loud speaker or telephones. It will be seen that the whole unit can be put together for less than $20, and for those who are anxious to build a plate supply unit, we can recommend this highly. Service tests of several hundred hours' duration made simultaneously with three complete units failed to show any noticeable sign of deterioration in any of the units. The Bureau of Standards Technologic paper No. 265, "Theory and Performance of Rectifiers" by H. D. Holler and J. P. Schrodt may be found very interesting to those readers who wish to go deeper into the theoretical side of this subject than Mr. Millen has.—THE EDITOR

THERE have been many articles published on B eliminators employing thermionic tubes, mean free path gas tubes, and even miniature dynamotors and motor generators. Very little has as yet appeared about a system which is in many ways superior to any of the others. No doubt this evasion of the chemical rectifier is due to a considerable extent to the existing opinion in the minds of many that this type of rectifier is sloppy, inefficient, and requires considerable attention. This, unfortunately, is true of the majority of borax rectifiers used in many amateur transmitting stations. Several years ago when chemical rectifiers were first used for that purpose someone suggested a solution of borax as an electrolyte and as a result borax has been almost exclusively used for this purpose ever since. Of all the different solutions available, borax is in my opinion by far the poorest. In fact one is almost justified in condemning the chemical rectifier if his experience has been restricted to the use of borax as an electrolyte.

Fortunately, however, there are several exceedingly fine solutions for use in lead-aluminum rectifiers, and a properly made cell, such as is described in this paper, is compact, clean, inexpensive, and efficient. Furthermore, it will seldom require any attention. The reliability of the chemical rectifier when properly made is most strongly emphasized by its use by one of the largest public utility corporations in the world.

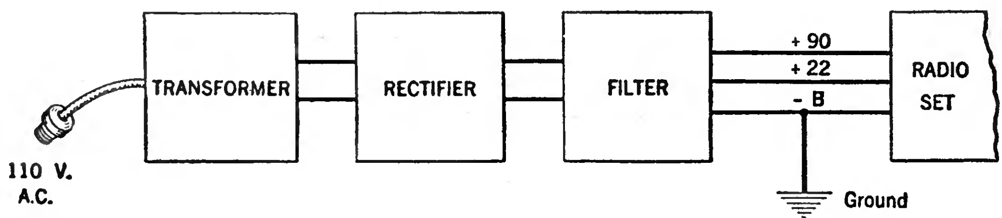



FIG. 1

From lamp socket to radio receiver. The illustration shows the entire system as used to change the 110 volt alternating current to a variable d. c. voltage for supplying plate potential to any radio set

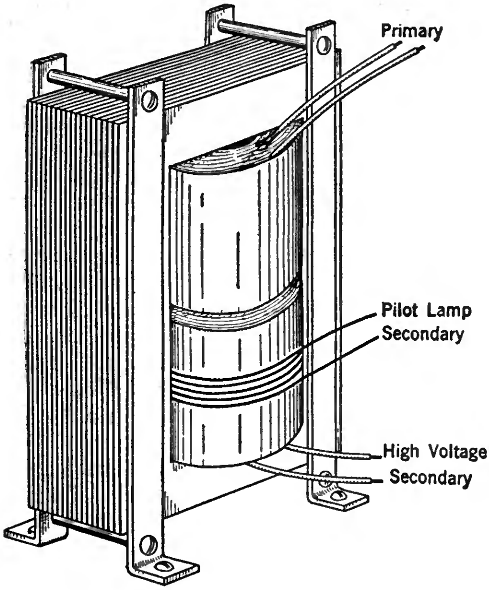



FIG. 3
A sketch of the transformer which steps up the voltage to compensate for the drop in voltage through the rectifier. This transformer is easily reconstructed from a toy transformer. An additional winding of a few turns provides for the pilot light current supply

As the chemical rectifier unit is very much cheaper than a tube rectifier, it is possible, without greatly increasing the cost of the complete B supply unit, to rectify both halves of the alternating current cycle. This complete rectification makes possible the use of a much smaller filter system. Still another reason for the much greater ease with which the output of a chemical rectifier may be filtered is the high inherent electrostatic capacity of the unit. The capacity of the single unit described in this paper is approximately 1 mfd. as compared with the negligible capacity of thermionic tubes.

Each cell (when used with the solution mentioned below) will stand well over 100 volts, which makes it possible to obtain between 80 and 120 volts at the set, depending upon the transformer voltage. This is ample when used with the average broadcast receiver. Where it is necessary to rectify higher voltages, then several cells must be used in series.

### CONNECTIONS OF CHEMICAL RECTIFIERS

THERE are two methods of connecting chemical rectifiers. In the first or bridge method, Fig. 4, four small cells are required. In the second method, Fig. 8, only one cell (slightly larger) is required, but a double transformer secondary is needed to feed it. Thus the saving in rectifier cells in the one case is more than offset by the additional transformer secondary required in the other.

The jar is a three ounce "salt mouth" bottle fitted with a rubber stopper having three holes, as shown in Fig. 2. The electrodes are $\frac{5}{16}$-inch rods. The aluminum rods must be chemically pure. Commercial aluminum will positively prove unsatisfactory. Lead rods, chemically pure aluminum rods, and "salt mouth" bottles are carried by the large chemical supply houses. Eimer and Amend, 18th St. and 2nd Ave., New York City can furnish these supplies. In drilling, tapping, and cutting the aluminum, extreme care should be exercised not to lay the rod in any metal filings which may be on the work bench, or to fasten it in the metal jaws of a vise unless protected by wood, cloth, or paper. If any small metallic filings become imbedded in the surface of the aluminum, then the film of aluminum oxide which forms and breaks down again with every reversal of the current when the rectifier is in operation, will not be complete at that point. In operation, this failure

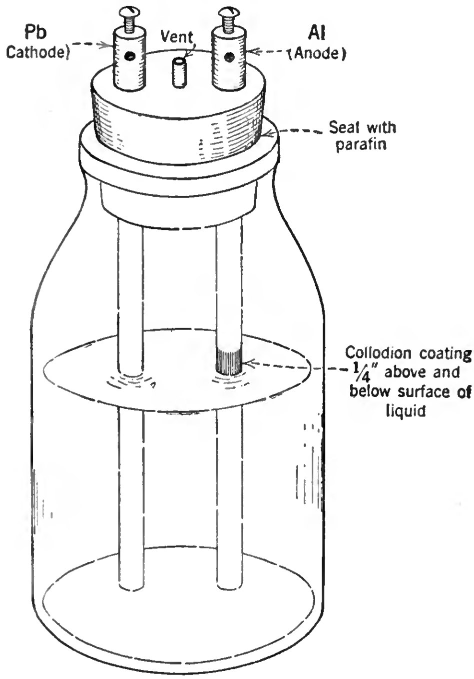



FIG. 2
The rectifying jar. Several of these cells go to make up the complete rectifying unit. The anode, cathode, and vent are supported in a cork top

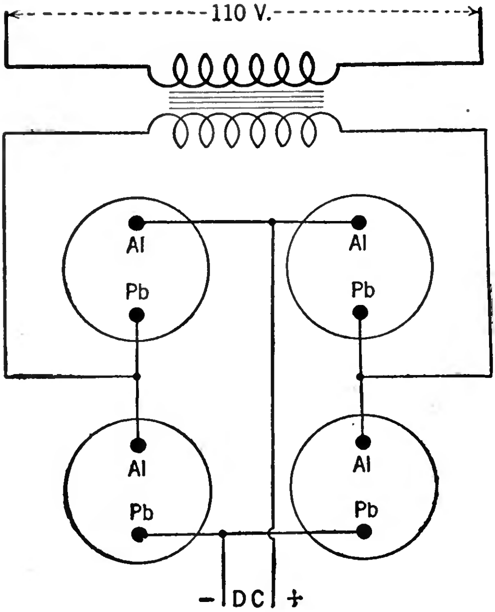



FIG. 4
The circuit of the chemical rectifier. Four jars are arranged in series-parallel to obtain the double-wave rectification which is properly smoothed out in the filter resulting in a direct current

of the oxide film completely to insulate the aluminum electrode from the electrolyte will be indicated by tiny sparks appearing at the impurity. This type of sparking should not be confused with the general scintillating sparking caused by using too high a voltage across the rectifiers. Such sparking is due to the electrical breakdown of the insulating film of aluminum oxide and will begin to take place when the impressed a. c. voltage is over 160 volts. The aluminum electrode in a properly operating cell will glow with a pale yellowish-green light and there will be no sparking. A slight sparking does not, of course, make a cell inoperative. In order to prevent sparking and consequent consumption of aluminum at the surface of the electrolyte where a protective film is not formed, the upper part of the electrode is coated with collodion, as shown in the illustrations. A short length of glass tubing is inserted in the vent hole in order to prevent its closing when the stopper is squeezed into the bottle.

Although there are several good solutions, I have found the two given below to be considerably superior to any others that I have tried.

Though not very generally known, they were among the original electrolytes used by Professor Nodon in developing his "Nodon" Valve. (See list of references at the end of this article.)

### WHAT SOLUTION TO USE

THOUGH not the better of the two, the solution most easily obtainable is a saturated solution of ammonium borate. It is most easily prepared by the layman by adding several tablespoonfuls of ordinary boracic (or boric) acid, such as is to be found in the medicine chest of every home, to a half quart of distilled water in a glass or china container. Add four tablespoonfuls of ordinary household

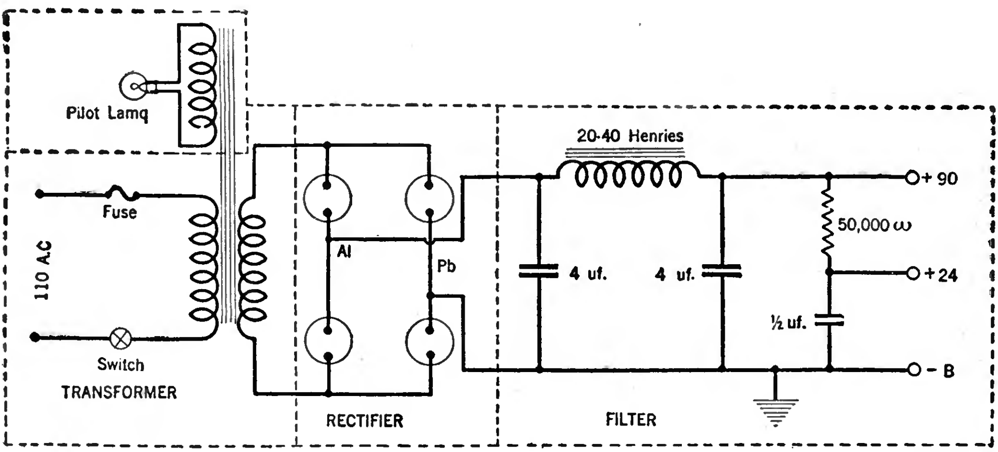



FIG. 5
The complete circuit diagram of the chemical plate supply from input to output. The dotted lines indicate the various subdivisions of the device, as follows: pilot filament, step-up transformer, chemical rectifier, filter. Usual engineering practise is used in this diagram referring to condenser capacities

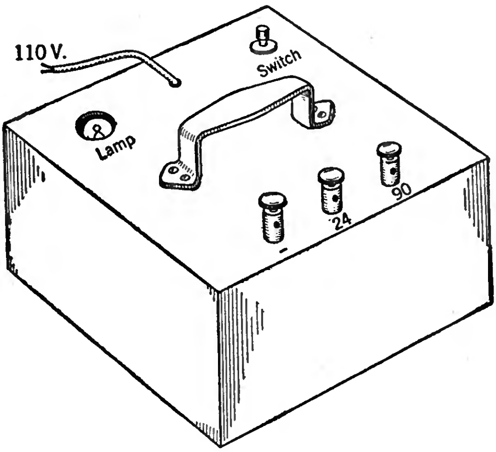



FIG. 7
The three posts on the right are the output. An external resistance (variable) is connected between the +90 and +45 posts to obtain the detector voltage

ammonia (the clear kind—not the kind containing soap or borax). Shake well and let stand for several hours. The excess salt will precipitate on the bottom and the clear solution is to be used in the rectifiers.

The other, and better, electrolyte is a saturated solution of primary ammonium phosphate. ($NH_4 H_2 PO_4$). It is prepared by adding enough crystals of primary ammonium phosphate to one-half quart of distilled water so that no more will dissolve and then using the clear solution after the excess crystals have settled to the bottom.

The practice of adding sodium or potassium salts to the electrolyte in order to reduce its resistivity is not to be recommended, for it will pit and corrode the anode (Al). The presence of sodium salts in any quantity will also cause the rectifier to give off an unpleasant odor after it has been in use for some time.

Never add anything but distilled water to take care of the loss of electrolyte due to electrolysis and evaporation. Addition of distilled water for every 400 hours of use will generally be sufficient unless an unusually large vent is incorporated in the cell.

In order to prevent a short circuit when the negative B terminal of the set is grounded, which is generally essential in order to entirely eliminate all a. c. hum, and also to raise the a. c. voltage, it is necessary to provide a transformer in the 110 volt a. c. line. The standard 75 watt amateur c. w. type transformer may be used for this purpose by running it with a resistance in the primary circuit or by feeding the 110 volt winding with a lower voltage obtained from a toy step-down transformer, in order to reduce the out-put voltage to a usable value. Such an arrangement is, however, both needlessly expensive and inefficient. A bell-ringing transformer may be worked backwards from a toy step-down transformer. Another bell transformer can not, however, be substituted for the toy transformer. Very satisfactory results were obtained by using an Acme 1½-henry double choke as a transformer. One winding serves as a primary and the other as a secondary. The air-gap must be tightly closed. (Some choke coils have no air-gap.) This will, of course, be merely a "one-to-one" transformer, and due to the design, the voltage regulation is poor.

### HOW TO MAKE THE TRANSFORMER

FOR best results, a transformer should be made which will meet the exact requirements. As the cutting and rolling of silicon steel for transformer cores is a task which the average person will not care to tackle, the use of the core from a toy step-down transformer is recommended. These cores are well made, of the shell type, and of the right size. The only thing to be discarded is the low voltage secondary. Moreover, they may be purchased at very reasonable prices, the list for the one best suited for this purpose being but $3.75. A transformer should be selected which has a no-load power consumption of not more than ten watts. The transformer referred to above and used in the current tap shown in the photographs meets all these requirements. It is the new model 40 watt

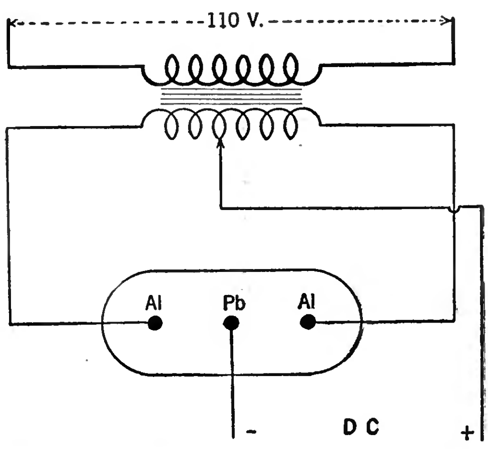



FIG. 8
The single cell method of rectifying. A double transformer secondary is necessary as the circuit shows

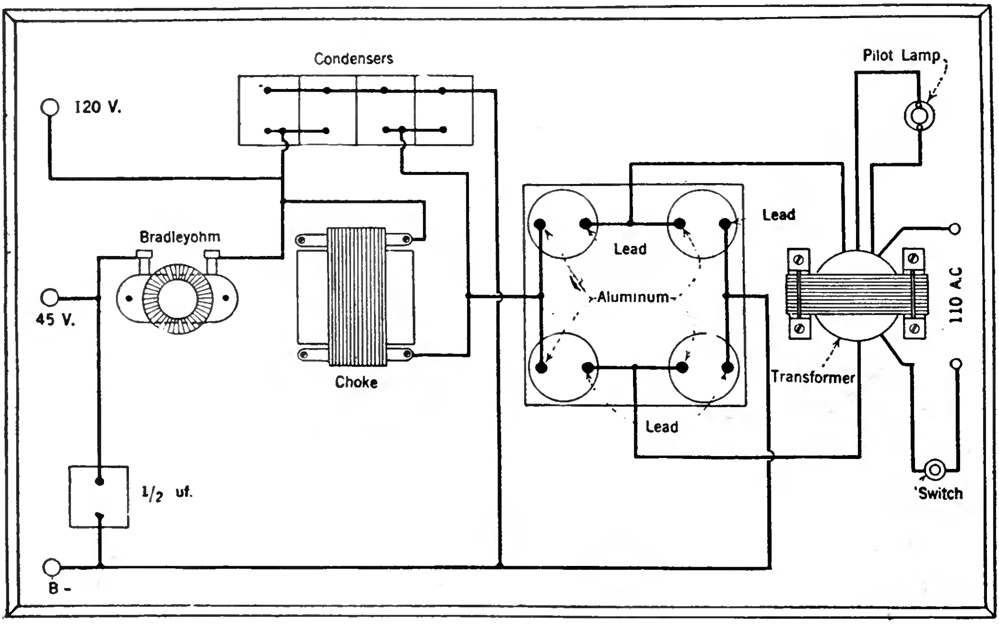



FIG. 6

The wiring layout. This drawing should be compared with the circuit diagram in Fig. 5 to identify the several parts and also the internal circuits of the choke coil and the transformer. The voltage regulation will be from 120 to 90 and 45 to 24, depending upon the internal characteristics of the transformer

Lionel toy transformer. The task of removing the core will be greatly simplified if some alcohol is first applied in order to dissolve the shellac which binds the core together. Remove the low voltage winding and in its place substitute a secondary wound with No. 28 or No. 30 enameled copper wire. Insulate each layer with thin tough paper. Protect the new winding from the core and case with Empire cloth or other suitable insulation. The proper number of turns will be 1125 for use with ammonium borate electrolyte and 1030 for use with the primary ammonium phosphate electrolyte. In either case, the final filtered d. c. voltage will be approximately 110 volts. For lower voltages use fewer turns.

The fact that turning off the A battery switch on the set does not shut off the input to the power unit, makes it desirable to employ a pilot lamp in order to remind one of the second switch. This lamp should be so connected as to burn whenever the power unit is turned on. A small-flash light bulb, or even an automobile type bulb may be used for this purpose. In order that its life may be long, it should be burned at less than rated voltage. It is to be fed from a separate transformer winding of a few turns of No. 20, No. 22, or

PARTS REQUIRED

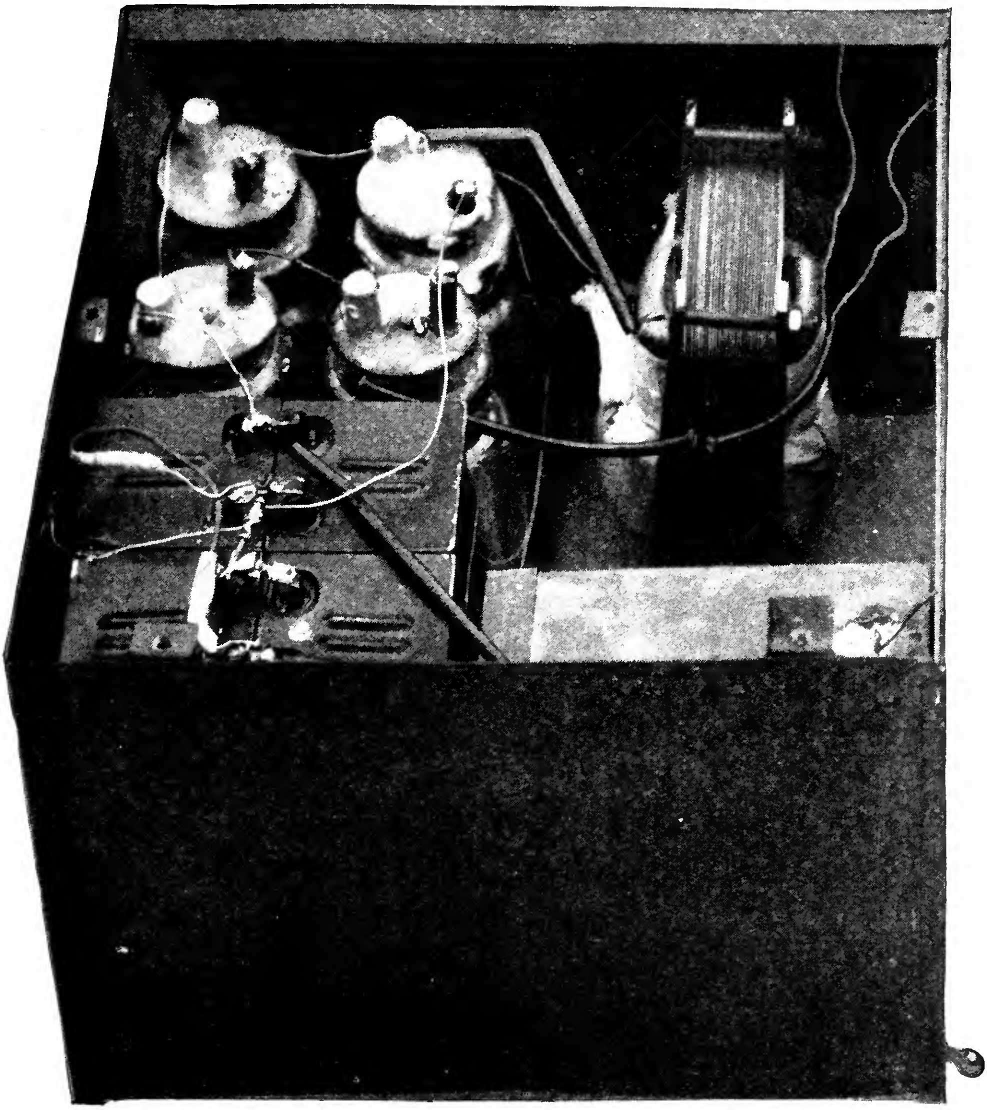
| | | |
|---|---|---|
| 2 | Lionel transformers, 40 watts | $7.50 |
| 4 | W. E. 2 mfd. condensers | 3.60 |
| 1 | pound No. 30 enameled copper wire | .88 |
| 1 | Bradleyohm No. 10 | 2.00 |
| 1 | Flashlight bulb and socket | .20 |
| | Steel box, panel, binding posts, etc. | |
| 4 | 3-oz. "salt-mouth" bottles | .20 |
| 4 | No. 6 rubber stoppers | .20 |
| 1 | 2-ft. length chemically pure aluminum rod $\frac{5}{16}$ inch diam. | .20 |
| 1 | 2-ft. length lead rod $\frac{5}{16}$-inch diam. | .20 |
| 1 | 6-inch length $\frac{3}{32}''$ outside diameter glass tubing | .05 |
| 1 | oz. NH4 H2 PO4 at 60c 8 oz. | .15 |

Total between $15.00 and $16.00

The lead and aluminum rods come in 2-foot lengths. This is more than required, but fractional parts of a bar are not sold.

No. 24 wire. The winding must be well insulated from the other windings. Ten turns will be right for a 3-volt flashlight bulb.

If the output of the rectifier were to be fed directly into the radio set, a disagreeable hum would be heard in the loud speaker. The first step to be taken in the elimination of this hum is to pass the current through a filter before it reaches the set. The purpose of the filter is to "smooth out" the pulsations in the rectified current in much the same manner as the air dome on a reciprocating water pump "smooths out" the flow of the water. Where very large capacity condensers are employed in the filter circuit (such as described by Mr. C. J. Lebel in the September, 1924, RADIO BROADCAST) then a more nearly correct hydraulic analog would be a pump feeding a reservoir from which a steady stream of water might be drawn. Filters of the reservoir type, while exceedingly effective, are needlessly expensive and cumbersome, so that the use of a filter of



RADIO BROADCAST Photograph

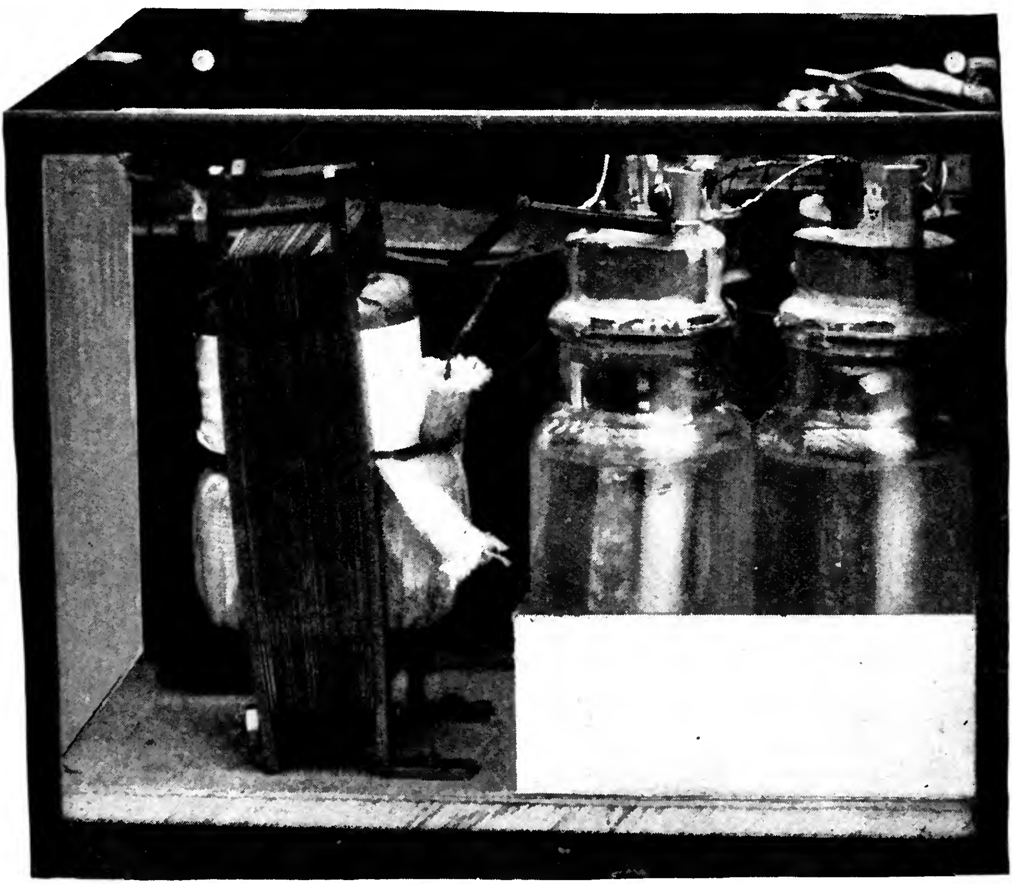
FIG. 9

The top is removed from the unit to show the construction. Either the transformer or choke coil should be shielded. In this model, the choke coil is shielded. This shield is grounded to the metal box which in turn is connected to the negative side of the output supply the "smoothing" type, such as was described in RADIO BROADCAST for December, 1924, by Mr. R. F. Beers, is to be recommended for use with this B supply unit. (When an S tube is employed as the rectifying device, then it becomes imperative to use the larger filter). The filter details are given in Fig. 5. The choke coil should have an inductance of about twenty henries and must be of fairly low resistance. The choke referred to in the December, 1924, RADIO BROADCAST meets these requirements.

### MAKING THE CHOKE COIL

AN EXCEEDINGLY fine choke for use with this outfit consists of one pound of No. 30 enameled copper wire wound on the same type of core as recommended for the transformer. If No. 30 wire is used for the transformer secondary, then one pound of wire will be sufficient for both purposes, as the transformer will require only about an ounce of wire. The d. c. resistance of such a choke is but 320 ohms. Thus the voltage drop across the choke will be negligible. The use of audio frequency transformer secondaries as chokes is not to be recommended, because of their extremely high d. c. resistance. (About 2500 ohms for the average transformer secondary.)

There have been many complaints about B substitutes whose output voltage varies considerably with different loads. Thus such devices might supply 90 volts to the plates of the amplifiers in a small two- or three-tube set equipped with proper C batteries, whereas they would not deliver more than forty or fifty volts when connected to a big "super," especially if no C batteries are employed. Such difficulties will never be encountered with the current-tap described in this paper, owing to the extremely low relative resistance of the



RADIO BROADCAST Photograph

FIG. 10

A metal pan for the jars keeps them in place and prevents spilling of the electrolyte and the breaking of jars. A wooden sub-base allows the unit to be assembled first and then placed in the metal cabinet choke and valves as well as the excellent voltage regulation of the shell-core transformer employed.

DETAILS OF CONSTRUCTION

THE next and almost equally important step to be taken in the hum elimination is the grounding of the negative B lead from the B eliminator. This is very important! *Before doing it, however, examine the regular ground connection to your set and see whether or not it is on the opposite side of the A battery from the negative B.* If it is, then a large fixed condenser must be connected in series with the regular ground lead or else it must be removed altogether. (We mean the ground to the set, not the ground to the power supply.) If both sides of the A battery were to be directly grounded, the A battery would be short circuited.

The third step is to insert C batteries in your set so as to reduce the tube space current to a minimum consistent with good quality.

The fourth step is to shield the choke coil from the power transformer. If they are both in the same metal box, then merely placing their cores at right angles to each other may be all that will be required, although quite frequently it is necessary to place a grounded iron or steel partition between them, or even to place one of them in a separate metal box. The entire unit should be located at least three feet from the set. This is not always essential, especially where the unit is thoroughly shielded, but nevertheless it is a good rule to follow.

The fifth and last of the precautions to be taken is to remove as far as practicable from the set any lamp cords carrying house current. Occasionally when one fails completely to eliminate all the a. c. hum in a receiver using this B supply it may be due to ungrounded BX cables and conduits which are used in the house wiring.

It might also be well to add that in regenerative sets a large fixed condenser (½ to 1 mfd.) must be connected directly from the plus detector B binding post on the set to the negative B binding post. This condenser must be located at the set and not several feet away at the unit itself. The small condenser connected across the primary of the first audio transformer in many such sets will not act as a substitute for the larger condenser connected as explained above. All regular neutrodynes have a small condenser connected directly from the detector plate to the negative B which is sufficient in such cases. Don't, however, try such an arrangement on a regenerative set or it will cease regenerating.

The small pocket voltmeters sold for testing B batteries are worthless for determining the

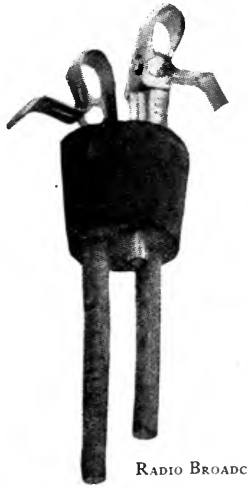
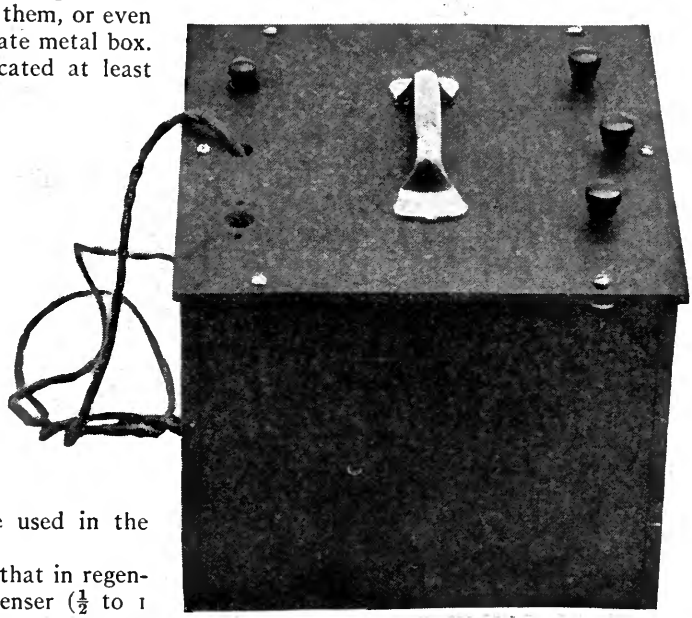


FIG. 12

A dummy jar element unit showing how Fahnestock clip binding posts of a special type can be used to connect to the elements. The support stopper is of rubber. The clips are so designed that they will slip easily over the anode and cathode tops

Radio Broadcast Photograph



Radio Broadcast Photograph

FIG. 11

The finished product. It is neat in appearance and very convenient. The unit may be placed on a lower compartment of the same table as the radio receiver, unlike many unsightly home made plate current supply devices voltage supplied to the set by a B substitute. If a milliammeter and some B batteries are available, then a fair method is to read the plate current when the power supply is being used, and then switch over to the B batteries and by varying the number in use, obtain the same plate current as with the power supply. The voltage of the B substitute is then roughly that of the B batteries, producing the same plate current.

The cost of operating a power unit drawing approximately ten watts from the house current is $0.0009 per hour. Thus it costs but about ninety cents for one thousand hours of B supply and there is no shelf life deterioration when the set is not in use.

GENERAL REFERENCES

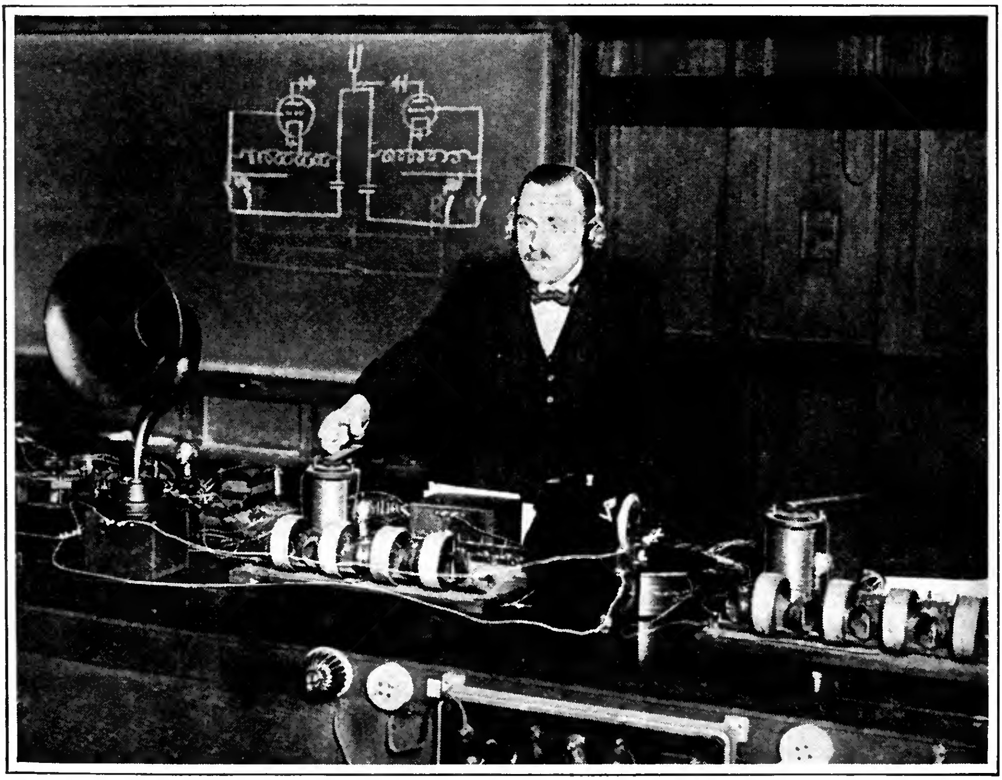
For the benefit of those who may desire to obtain further information on the interesting subject of electrolytic rectifiers, the following references are given:

Vol. 1: *Transactions of the International Electric Congress of 1904* "The Nodon Valve," by Prof. Nodon.

Vol. 1: *Transactions of The American Electro-chemical Society, 1902:* "Electrolytic Rectifiers," by Prof. Burgess.

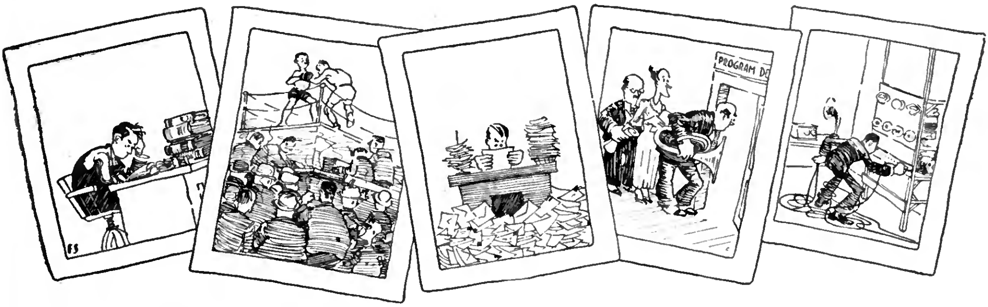
*QST:* June, 1922, "Electrolytic Rectifiers for Amateur Transmitting Work," by S. Kruse.

These references are mainly of a scientific nature and contain little constructional information which would help the builder of a plate supply unit such as described in this paper.



WILLIAM H. ECCLES

Demonstrating at a lecture at the Imperial College of Science in London a circuit on which he has spent much time, which is to bring about a new method of wireless communication. The sending apparatus produces easily recognizable musical chords at the receiving station. The most common chords would be assigned to the vowel sounds. Dr. Eccles is Professor of Applied Physics and Electrical Engineering at the London Technical College and a well-known authority on radio



# as the broadcaster sees it

## *by* Carl Dreher

*Drawings by Franklyn F. Stratford*

## Computing How Far a Radio Station Can Be Heard

MR. HARRY L. BEACH of Bristol, Connecticut, referring to our article on the SOS in RADIO BROADCAST for March, raises a pertinent issue. He writes as follows:

> While listening to the various stations each night, if I get KGO I am highly elated, having accomplished an extraordinary feat. On the other hand, if I get some little station in New Jersey, I never know whether to be elated or scornful. You have proposed an empirical formula for the interference caused by any station to a 600-meter signal. Can you produce an equally simple formula expressing some convenient unit of power or relative power available to me from a broadcast station, given its distance watts and frequency? Local conditions and the efficiency of my receiver make it impossible for me to compare directly with any other receiver, but if I knew I was doing as well to receive XYZ at 200 miles as KGO across the continent I would have that "Grand and Glorious Feeling" more often and would worry less.

A formula along these lines already exists, fourteen years old. It is the Austin-Cohen transmission formula, first reported in "Some Quantitative Experiments in Long Distance Radio Telegraphy," by L. W. Austin, in the *Bulletin of the Bureau of Standards*, Vol. 7, No. 3, Page 315, and reprinted in numerous places since. This formula gives the received current in terms of the current in the transmitting antenna, the effective or electrical height (which is only a fraction of the physical height) of both antennas, the wavelength, the distance, and some exponential factors. The exponential factors may be neglected—not because they are small, for as a matter of fact they are exceedingly great, but for the reason that distance reception is accomplished at those times when the absorption is slight, and the loss in signal is only that imposed by the simple inverse-with-distance law. In other words, the only time that a listener has a chance to make a distance record is when atmospheric conditions are such that the exponential factor approaches unity and does not figure in the problem.

It follows that the ability of a station to reach out is expressed by its meter-amperes product, obtained by multiplying the effective height of its antenna by the amperes flowing in the ground lead thereof. Suppose we have a typical 500-watt station with an antenna whose physical height above ground is 150 feet (roughly 50 meters). The effective or electrical height might be half of that, or 25 meters. The antenna current will be around 8 amperes. Hence the meter-amperes product is around 200. Some "mosquito" broadcaster might have an ampere in the antenna and a height of ten meters electrically: he would rate only 10 in this scale. High power trans- and inter-continental radio telegraph stations range from 20,000 to 300,000 meter-amperes.

The sporting factor sought by Mr. Beach might be very simply expressed as

$$\text{DX Index} = \frac{\text{Distance in Kilometers}}{\text{Meter-Amperes}}$$

The only trouble is that the Department of Commerce does not publish the meter-amperes product of broadcasting stations, although it asks for them in the license application. Worse, this product is seldom accurately known, because a rather intricate procedure is required to determine the electrical height. So, for practical purposes, we are more or less out of luck. A rough approximation would be simply to divide the distance in miles by the power in watts. The Department does print the ostensible power of the stations in occasional issues of the *Radio Service Bulletin*, a monthly publication obtainable from the Superintendent of Documents at twenty-five cents a year. On this basis, KGO with, say, 2,000 watts in the antenna, heard over a distance of 3,000 miles, would have a constant of 1.5. KMO, with 10 watts, would have the same constant only 15 miles away. This looks as if there should be some weighting in favor of the higher powers, cutting them down a little. However, with the meter-amperes product unavailable the problem really passes out of the realm of engineering speculation. It reminds me of a remark of Professor N. S. Shaler regarding the scientific value of spiritualistic manifestations, that it is like trying to make a topographic survey of the land of dreams. Besides, we have steered entirely clear of such factors as frequency.

Nevertheless, the fact remains that our correspondent's idea is a logical one. The fault is in the rating of stations by power alone, neglecting consideration of the actual radiating element, the antenna. If DX fishing is anything at all, it should follow that the smaller the fish, other things being equal, the greater the glory. It is therefore a unique sort of fishing, for all the followers of Izaak Walton boast of the great size of their catches; they love to stretch wide their arms and mouths when recounting their piscatorial exploits. The advent of real super-power stations will put a crimp in DX motives. But as long as little stations exist, they will have the function, not only of affording expression to local talent and taste, but also of keeping the DX spirit alive, by giving its devotees an almost inaudible signal, smothered in noise nine tenths of the time, to shoot at.

## Signor De Luca Tips the "Mike"

OUR illustration shows what happens when you let the artists run a station, or rather what would happen if they were allowed to run one. Here is Signor Giuseppe de Luca, one of the most talented of baritones, publicly tipping a carbon microphone. Naughty, naughty! For, when a carbon transmitter is tipped at such an angle, it ceases to be a microphone. The carbon falls away from the diaphragm, and can no longer transform into electrical impulses the agitations produced in the latter by sound waves. Microphones of this type must be kept in the vertical plane if one intends to allow it to be acted upon by voice or music. But in a photograph any microphone one can find, is just as good lying down as standing up.

THE TIPPED MICROPHONE

Giuseppe de Luca, baritone of the Metroplitan Opera Company, toying with a broadcasting microphone. When the microphone is placed in this position, it becomes practically inoperative

Looking at the picture again, we derive an obscure but definite, anarchistic pleasure from it. We are so tired of upright microphones! They stand for good transmission or the devil to pay, for correct placing, proper vocal-orchestral balance, criticism, watchfulness—all the tribulations and strains of the job of broadcasting. But a slanting microphone—there is freedom, a simian carelessness for consequences, a flinging of heels to the sky! It affects us like the spectacle of an orthodox, stout, and reputable citizen, reeling, in evening dress and hopelessly drunk, down Fifth Avenue on Sunday morning while the church-bells ring for all those who can hear them. Bravo for Signor de Luca and the publicity representatives!

## The "Layer of Lines" Confesses

IN THE New York *Herald-Tribune* for February 27th, "Pioneer," one of the bright constellations of radio criticism, writes:

> The lines from Schenectady to New York were blown down by high winds last night. That is why the comedy by the WGY players did not come as scheduled to the listeners at WJY. We wonder if this was not due in some measure to careless laying of the lines.

"Pioneer" is a charming, conscientious, but non-technical lady; she has never straddled a cross-arm forty feet above ground in a howling gale; the pole covered with ice, perhaps, and maybe a 30,000 volt transmission line in close proximity. In other words, she has never had the job of keeping an open wire circuit during bad weather.

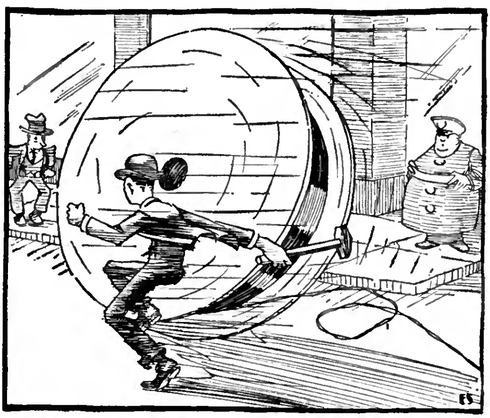
It happens that I am very intimately connected with WJY, in fact, I "lay" the lines. Whenever WGY and WJY are hooked up, I start out from Aeolian Hall in the afternoon, a reel of twisted pair twelve feet in diameter under my left arm, my mouth filled with carpet tacks, and a sledge hammer in my right fin. Loping along at the pace of Mr. Nurmi, I pay out the line with inconceivable rapidity, dodging trains, automobiles, and dangerous animals, and here and there fastening the pair to a handy telegraph pole with a carpet tack and a blow of the hammer. I cross creeks, rivers, ridges, valleys, and mountains, keeping as straight a course as possible up the Hudson Valley. At about the same time a representative of WGY starts south with the same paraphernalia and good intentions. We meet at Poughkeepsie, splice the wires, drink each other's health in a bucket of Hudson River water, and return to our respective stations.

On the afternoon of February 26th, observing the nasty weather, I fortified myself with three or four dozen drinks, prescribed by my physician, before starting out on my course. Something was wrong with those drinks, or else I did not have enough, for no sooner had I started than I perceived that I was not in my best form. I veered from one side to the other of Manhattan Island, missed the telegraph pole at Columbus Circle, striking a traffic officer instead, and mashed my thumb instead of the carpet tacks in several instances. Nevertheless, after the fashion of heroic radio men, I persisted and made fair progress until the Harlem River was reached. I generally cross this by way of the Spuyten Duyvil bridge, because a pretty girl lives near the Bronx end of the viaduct and waves to me as I pass. Besides the girl, I always pay the tribute of a thought to the intrepid Dutch courier who perished here when he plunged into the flood, crying that he would cross "in spite of the Devil!" to warn the burghers of New Amsterdam of an Indian rising to the north—from which episode the strait derived its name. All I can say is that I headed directly for the bridge. I missed it by fifteen yards, equivalent to about a foot for each drink. *Maladetto diavalo*, but the water was cold! And I had never drunk the Harlem water before. The mammoth reel of wire and the sledge hammer weighted me down. I thought I would meet the fate of the Dutch rider, and the channel would have to be renamed WJZ-WJY. How I struggled and yelled, churning up the waters of the Harlem like a steamboat, and bouncing my voice against the side of Inwood Hill. Suddenly something snapped. I thought it was my suspenders, but now I know it must have been the twisted pair. After epic exertion, I emerged on the north side of the river, and raced on to make up lost time. I flew past Yonkers, Tarrytown, Ossining, where I glimpsed the warm and well-fed convicts at their evening movie show, and Peekskill. Wet, frozen, and bedraggled, I staggered into Poughkeepsie at 7 o'clock. My WGY colleague sat at the amplifier.

"You're drunk and late," he said.

"Yes," I wept hysterically, "but here are the pair!"

We spliced the wires in silence, and began calling New York. More silence. New York did not answer. Then I realized that the



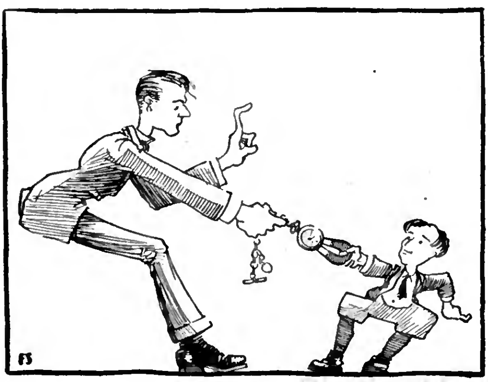
**I start out with a reel of twisted pair**

line was broken, grounded and crossed at Spuyten Duyvil. All was lost, including honor! And the next day "Pioneer" razzed us in her column. (A new critic has just been appointed and now rules in Pioneer's place.)

## The Memoirs of a Radio Engineer

RADIO is different from all the engineering arts, and has moved faster than any of the others in the last two decades. That is my first excuse for printing these memories now, instead of waiting until I am seventy years old. In the second place, to wait until one is old, before writing anything of an autobiographical nature, is a disparagement of youth. If the experiences of youth are worth anything—and they appear singularly precious to all but the most desiccated of men—surely they are worth setting down at a time when they are still comparatively fresh in one's memory, when some vestige of feeling still clings to them. It is logical, therefore, to write one's memoirs in two sections, one at the age of about thirty, the other after one has passed sixty. The writing of this first section is what I now undertake, in somewhat the same spirit as that which impelled Max Beerbohm to issue his "complete works" at the age of twenty-four.

Two objections remain to be disposed of. The writing of memoirs is, for presumably sound reasons, a prerogative of famous persons, and, indisputably, I am not famous. The answer to this is that such personages will appear in the narrative: I can be Boswell, if not Johnson. Furthermore, only the radio aspects of my career will be illuminated. The last suspicion of impropriety, that involved in the writing of such a history by a man still in the full tide of events, may be met by terminating the story at a point sufficiently far back to allay the apprehensions of the individuals and groups with whom I have fought so recently that they still remember it.



I made an attempt on father's watch

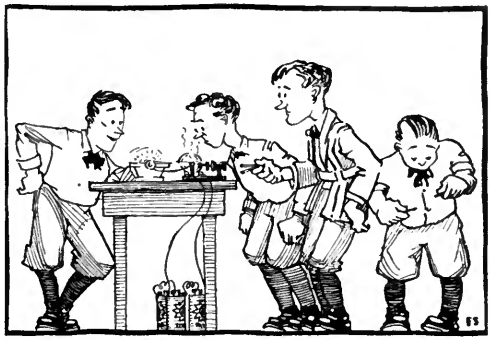
These apologies and reassurances completed, the epic begins.

In 1907, when I was about eleven years old, one of the elementary school teachers under whom I was incarcerated delivered to his class a lecture on magnetism, using for illustration one of those small, flat, red-enameled horseshoe magnets which at that time sold for a penny in the stationery stores. At the same time he told the boys a cock-and-bull story about Mohammed's coffin, which, he alleged, was suspended between heaven and earth, without visible support, through the agency of magnetism. This instruction was not a part of the work of that class, I might mention; the teacher was endeavoring to amuse us, during an interlude, in reward for good behavior. At any rate, the next day I bought one of these little steel magnets instead of gum drops, and amused myself magnetizing my mother's knitting needles. I also made an attempt on my father's watch, and, while I did not succeed in imparting to it any appreciable polarization, my efforts were not entirely in vain, for the watch stopped the same day. In my endeavors to suspend a miniature Mohammed's coffin between the magnet and the table I failed utterly. The armature either jumped to the magnet or fell to the table. After a time I gave it up and shot one of my playmates with an air-rifle.

Shortly afterward I became interested in electricity. As yet I did not suspect that magnetism and electricity had any connection. The first attracted iron; the second rang bells. I crawled around in a dark and dusty compartment under the stairs of my home, where the electric battery which rang the bells was located. This battery consisted of sal-ammoniac cells, each with a ponderous carbon cylinder and a zinc rod in a solution of ammonium chloride. Three such cells rang the bells of the house. Dry cells were very well known by this time, but their quality was not then good enough to push wet cells entirely out of the market. For the same reason, partly, the popular use of electric flashlights was practically unknown. The electrical industry has changed remarkably, even in these eighteen years. There were as yet no tungsten or other metallic filament bulbs, and most store windows in New York City were still lighted by Welsbach gas mantles. However, I was not yet interested in the state of the electric industry. The Leclanché cells in the cellar represented, to me, a kind of magic. I did not know them by their correct name, of course, and in some way I got the idea that they were storage batteries. In due time I went to my parents and asked for a battery for Christmas. I had no clear idea of what I wanted to do with it, but I believed that with a battery one might sustain and impart electric shocks and perform miscellaneous wonders.

My father, then as now, was a business man; he knew nothing about batteries and cared less. However, apparently he realized that a battery alone would not serve my purpose. He bought me a small electromagnetic engine, a little wire, and three dry cells. This engine could be belted, with a rubber band or a piece of string, to a toy buzz saw which, on days when it was feeling good, could cut a matchstick in two. I operated this machine for hours every day, and soon ran down the dry cells. At this time I became acquainted with the odor of ozone, for the remarkable engine functioned with a make-and-break contact at which a fascinating blue spark flashed. All the boys in the neighborhood came to see the spark, to smell the ozone, and to have matchsticks cut in two. I received many flattering trading propositions in connection with this possession—a cannon eight inches long, a dog which the owner swore was capable of speaking several intelligible words, and a wagon with a soap-box body and iron baby-carriage wheels, being among the offers. All were declined.

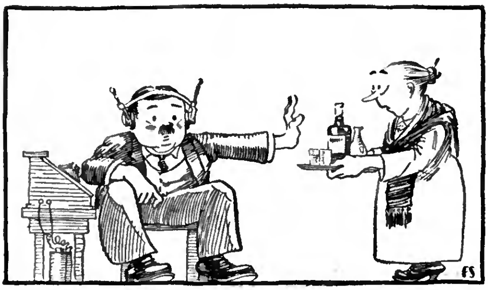
But, among children, as with their elders, the tendency is to grow tired of even the most precious possessions. After a few weeks, the excitement over the electric engine had died down, and it became necessary to seek new diversions. The engine had brought with it the catalogue of an electrical supply firm, and we began to study this. Such books are not only informing in themselves, but, to a boy, they bring up questions the answers to which he must seek elsewhere. What was a make-and-break spark coil, or a polar relay, and how did a burglar alarm work? Four or five of us began to inquire about these matters, more or less urgently. We were lucky because an electrician lived in the neighborhood who had a much greater theoretical interest in his craft than is common; he did not consider us merely as nuisances, which we undoubtedly were, but good-naturedly tried to answer our questions. But he was not our only source of information. In the public



small boys came to smell the ozone

library we found perhaps a half-dozen books of the "boy-electrician" type, written expressly for aspiring juvenile experimenters like ourselves. They contained directions for building voltaic batteries out of tin cans, telegraph sounders constructed of wood and the vital parts of discarded electric bells, and even induction coils which could throw one-quarter-inch sparks. We devoured these volumes and pooled our money to buy wire and 10-cent-store tools. At the same time we were perfectly normal and primitive, we had fist fights, pursued the neighborhood cats with bean-shooters, and played baseball on the vacant lots. If any one had urged us to study electricity we should probably have resisted instruction violently. But, as no one cared one way or the other, we made fairly rapid progress. The main obstacle in our experiments was a well-known ailment of the human race: lack of money.

Most of our energy, on this account, was taken up in finding substitutes for expensive materials. For instance, when I was twelve years old I built an electrophorus. This is an induction device for collecting positive charges on a metal plate, usually of polished brass, held by an insulating handle. In its classical form it consists of an ebonite disc about a foot in diameter. This is electrified negatively by beating or rubbing with a piece of cat's fur. A metal plate of about the same size is set on top of the charged ebonite. The experimenter touches the top of the metal piece. This draws off the negative charge of the same, while the positive charge induced by the ebonite remains bound. The metal electrode is then lifted by the insulating handle. Now let the knuckle be presented to the edge of the metal disc, and a spark about an eighth of an inch long will leap to it with a slight stinging sensation. To me, this



the workman prefers radio to whiskey

was an indescribably dramatic occurrence. Furthermore, by repeating the touch-and-lift procedure, one could draw sparks for hours, on a dry day, without the necessity of rubbing the non-conductor again. This puzzled me. It was not until years later that I understood that I had to work for each spark by overcoming the electrostatic attraction between the charged non-conductor and the metal plate.

My electrophorus was not as aristocratically constructed as the one described above. Instead of ebonite, I used beeswax and rosin in various proportions. I spent at least two months melting and remelting these ingredients over the gas stove in my mother's kitchen, in one of her pie plates donated to the cause of science, in the hope of getting a spark a sixteenth of an inch longer than in some previous attempt. When the composition had cooled, I would flagellate it with a piece of flannel, and set on top of it a wooden disc coated with tin-foil, which had originally sheltered a piece of Liederkranz cheese. The handle was a stick of sealing wax. Nature, however, is impartial. With blind equity, she bestowed her electrostatic sparks alike on me and on the learned professors at Princeton and Johns Hopkins.

(*To be Continued*)

## Blame It on Radio. II

THE custodians of the art and industry of the theater, which, according to the eloquent Mr. Brady, is in process of ruin through the intrusion of radio broadcasting, may find comfort in the similar sad plight of other altruists. Other hearts are breaking. The British rum shops are emptied of customers, the libraries are full of books which no one reads, the once lovely maids and matrons of Germany become the despair of beauty specialists. We reprint the evidence so that our readers may join in the universal lamentation:

### PREFER RADIO TO WHISKY

**British Workers are more Sober, Salvation Army Finds**

LONDON, Feb. 26.—The British workman of today prefers wireless to whisky and Bunyan to Barleycorn, Captain Charles Nicholson of the Salvation Army told the Finsbury justices at their meeting to consider liquor license renewals.

"Drunkenness has been reduced by one half during the last few years," said the Captain, "and many public drinking houses are often empty on Sunday evenings."

—New York *Times*, Feb. 27, 1925

### RADIO REDUCES DEMAND FOR LIBRARY BOOKS

It has been said that the new and increasing interest in radio work has caused a falling off of interest in the libraries of England. The Middlesex Library Committee reports that for November of last year there were over five thousand fewer books taken from the library than during the corresponding month of the year before. Even the work of the conference library was lessened by 20 per cent. during the same time.

—New York *Sun*, Jan. 16, 1925

### "RADIO WRINKLES" MAR FAIR LISTENERS' FACES

*By the Associated Press*

BERLIN

Radio wrinkles are the latest bugaboo of German women, who see their faces marred by folds and creases brought on by the strain of listening to wireless programs. Beauty specialists affect to find that the faces of female radio fans acquire a strained expression from listening night after night to the radio.

Their brows become knitted, their lips firmly pressed together and their whole expression hardened and less womanlike, say the beauty experts. The consequence is what is called the "radio face," of which the chief characteristics are radio wrinkles.
—New York *Herald-Tribune*, January 4, 1925.

As a professional broadcaster, practicing his art and mystery in the United States, I derive a certain comfort from the last item, which may be set against my grief at seeing the sum total of female pulchritude in the world diminished. May one not infer from this despatch that the German broadcast programs are even worse than the worst American efforts?

## Oliver Heaviside

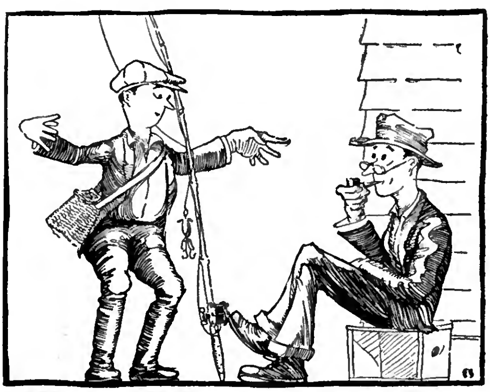
HOW many people who own radio sets heard of, much less heeded, the recent death of Oliver Heaviside, referred to in the current issue of the *Journal of the A. I. E. E.* as "an illustrious successor to Wheatstone, Maxwell, and Kelvin." Probably not as many as would regret the passing of some self-styled radio expert who never did anything better than write meaningless letters after his name, revamp in disguised form the inventions of better men, turn out a few trashy magazine articles, and plug himself in the Saturday radio supplements. That is the way of the world.

For Heaviside never tried, in the phrase of the day, to "sell" himself, to be popular and recognized. He was of the stature of the greatest figures of mathematical physics, and what he wrote was not adapted to the needs of the kindergarten or of the consumers of predigested mental foods. No editor of a tabloid newspaper ever printed his photograph beside that of some distinguished movie actress who had just shot her latest lover, not only because no tabloid newspaper editor ever heard of him, but also because few photographs of Heaviside existed. In his reluctance to be photographed he resembled a great American, Henry Adams, a man of somewhat less originality but not dissimilar temperament.

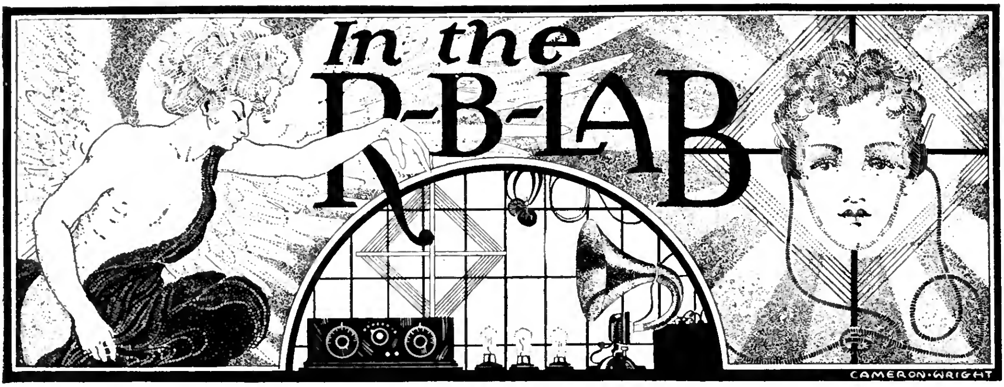
Heaviside was an Englishman. He wrote occasional articles for the *Philosophical Magazine*, the *London Electrician*, and other learned journals. He applied his mathematics, in which he was not much less adept than Newton or Leibnitz, to such problems as the propagation of electrical waves along wires, the distributed constants of telephone lines, and the development of the electromagnetic theory generally. His papers are inordinately hard to read.. This being called to his attention on one occasion, he answered sardonically that they were even harder to write.

His work had very practical consequences. The fact is that the Armstrongs, the Poulsens, the Heisings, the De Forests, stand on the shoulders of the Maxwells, the Hertzs, the Rayleighs, the Websters, and all the other dreamy investigators who live in a shadowy mathematical universe and write incomprehensible articles instead of selling real estate and trying to make enough money to buy a Packard. The engineers and inventors deserve all the credit they get, but it should not be forgotten that they owe their eminence and high visibility to the pure physicists who bear them up. In the case of Heaviside, it is a matter of common knowledge that Dr. Pupin's work in the loading of telephone lines was largely the conversion into physical facts of the British investigator's abstruse generalizations. The result was a clarification of speech and extension of range on telephone circuits, reputed, at the time, to be worth a few million dollars to the telephone companies, and probably second only to the development of modern equalizers and electronic repeaters in the expansion of the telephone art—which includes radio broadcasting and the tying up of broadcasting stations by wire lines—this last for the benefit of those radio listeners who don't see what Heaviside has to do with them. Pupin himself is a rare combination; he is equally at home as a mathematical physicist and as an engineer and inventor. He did not complain that Heaviside's articles required hard work on the part of those who read them; he did the work and collected his royalties. Personally, I am frank to say that I never had the brains to read Heaviside, but I have the sense to raise my hat.

Heaviside was deaf all his life, and because of that and no doubt other causes he was as shy and seclusive as Darwin, who could not take an ordinary railroad journey without the most profound agitation. He lived alone in a small cottage in Torquay, which is in Devonshire on the English Channel. He was extremely poor, and in his last years subsisted on a pension of £200 a year. Nevertheless, he was seventy-seven when he died. There is nothing to show that he cared one way or the other about either circumstance. What could such ephemeralities mean to a Heaviside?



they stretch their arms and boast




# SIMULTANEOUS OR TANDEM TUNING

AGAIN something new that is not new has come up in radio. In September, 1910, John V. L. Hogan filed a patent application for the "tuning of circuits." The application stated that the primary object of the methods described was to render the manipulation of the tuning elements more easy and accurate. Mr. Hogan goes on to state the specific case of two or more tuned circuits having the same values of inductance (electrically identical coils and wiring), shunted by the same capacities in variable condensers, which can be maintained in resonance (tuned to a common wave), throughout the entire range of the circuits by varying the capacities "similarly and simultaneously." Mr. Hogan suggests, "The component parts of capacities $C_2$ and $C_3$ (the two condensers) can be mounted on the same movable support." This patent was granted twenty-eight months later. Twelve years afterward, several companies appreciating the possibilities of simultaneous tuning, built condensers with two or more sets of stator plates, and with the rotating plates mounted on a single shaft—"the same movable support." These manufacturers were somewhat surprised to find themselves antedated by a decade and more.

The experimenter who is seriously interested in this excellent arrangement will find invaluable the theoretical considerations treated in Mr. Hogan's patent No. 1,014,002, and is strongly advised to study it. The enthusiast who does so will be less prone to fall for the incorrect arguments that prevail to-day among the advocates of simultaneous tuning. One of the principal misconceptions among these is the idea that any lack of matching in the coils can be compensated for by the use of verniers across the condensers. This is not the case, for if this is done, a balance is achieved only for one setting of the main condensers, and it is lost with the next variation of the tuning control. Sets employing such verniers take advantage of the simultaneous tuning effect only approximately, and the verniers in many cases are really separate controls.

> ### *The Lab Offers You This Month*
>
> *ARTICLES ON*
>
> *—Simultaneous tuning of two or more circuits with tandem condensers—Pointers that may save you months of experiment.*
>
> *—The second step in the Lab system of remedying radio troubles.*
>
> *—How to build an efficient and simple loop.*
>
> *—A modification of the Knockout Amplifier.*
>
> *—A safer and better way of connecting most loud speakers.*

To achieve simultaneous tuning of two or more circuits the inductance values must be the same. Also, the capacity values must be the same and varied similarly. This last provision is not so difficult. Any condenser carefully constructed will have identical capacities (or sufficiently near to them) at the same degree of turn. The circuit-inductance discrepancies are more difficult to balance, and experiments in the R. B. LAB show them to be the real problem associated with simultaneous tuning. These inductive differences are caused by the difficulty of winding r. f.

transformers to exactly similar inductance values, and the unequal effects of wiring which even the most scrupulous care will not always eliminate.

Fig. 1 shows the conventional two-stage tuned r. f. circuit, with potentiometer control, adapted to simultaneous tuning. It will be observed that the tandem condenser is used on the last two tubes, one stator to the second r. f. stage, the other to the detector secondary, and the common rotor shaft to the negative A battery terminal. A single condenser tunes the first stage, r. f. Due to the presence of the antenna primary coil, which is generally closely coupled to the secondary of the first stage, the inductive discrepancies which we are endeavoring to avoid are generally introduced in this coil. For this reason a single control (one shaft and three rotors) is not advised in a first attempt at tandem tuning. Also, in the author's mind, a two control set is the more logical and desirable arrangement.

The grid leak is returned to positive side of the filament to provide the desirable detecting bias.

The circuit should, it is needless to emphasize, be wired with care to maintain r. f. leads at similar inductive values, i. e., the same lengths and spacing from metallic parts. If the experimenter is successful in this, and the condenser and coils are matched, no further adjustments will be necessary, and Fig. 1 represents the most simple and ideal arrangement.

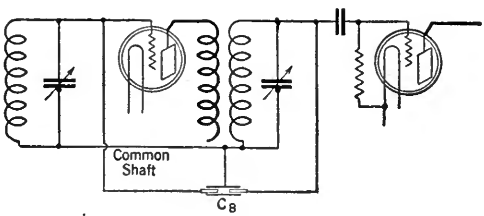



FIG. 2

A neutrodyne stabilizing condenser, C2 is convenient for correctly balancing the capacities of the two circuits

Should the inductances, however, not be balanced as will probably be the case, they must be matched by additional adjustments. The simplest method is to apply copper shielding to the coil with the highest wave, a fact that can be located experimentally. This will lower the wavelength of that coil. Shielding is easily applied by rotating a disk (cut from $\frac{1}{32}$-inch copper sheet) slightly smaller than the diameter of the coil, in the field of the coil as you would a tickler. Or, strips of the metal cut into semi-circles, can be clamped on the outside of the secondary, the width of which will determine the amount of inductive variation.

If these experiments fail to result in satisfactory resonance throughout the entire tuning range, it is probable that the capacities are slightly off balance due to wiring, etc. This can generally be remedied by connecting a condenser designed for neutralizing circuits

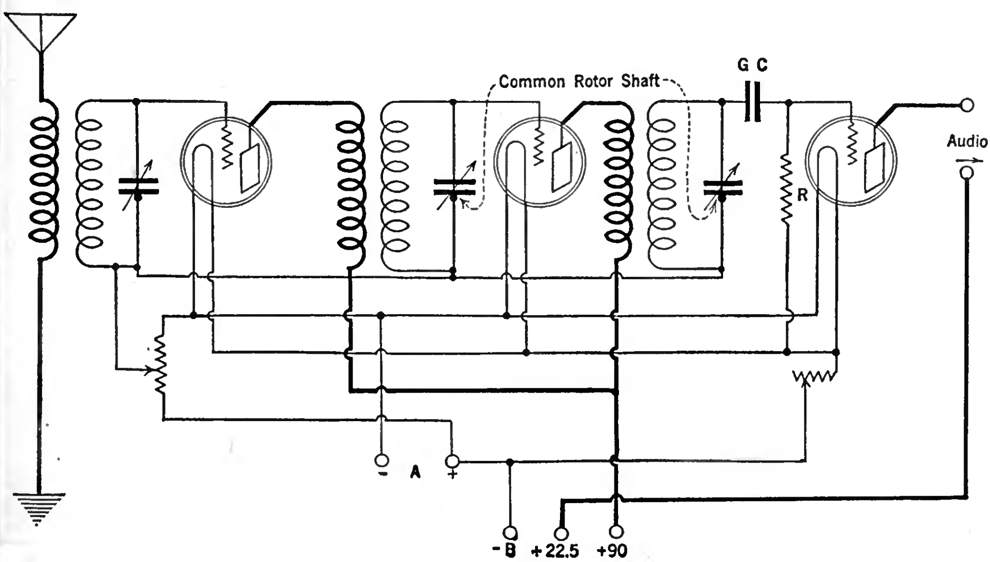
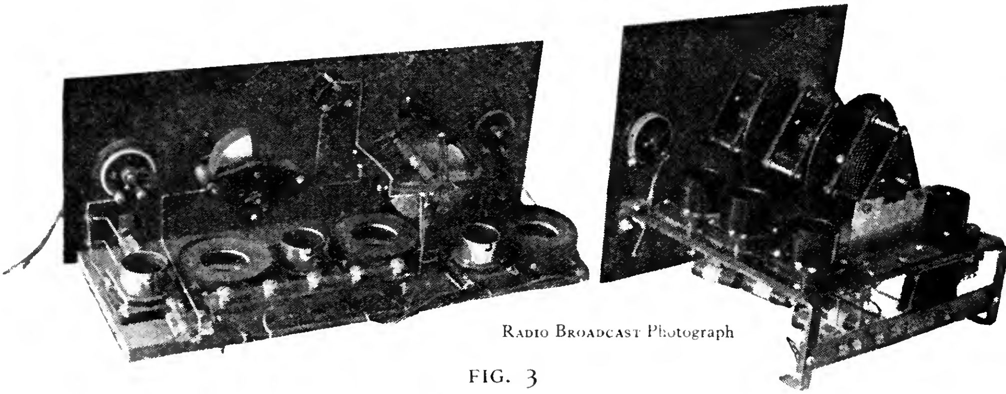



FIG. 1

Simultaneous tuning of the conventional r. f. circuit. Note the grid condenser-grid leak connections



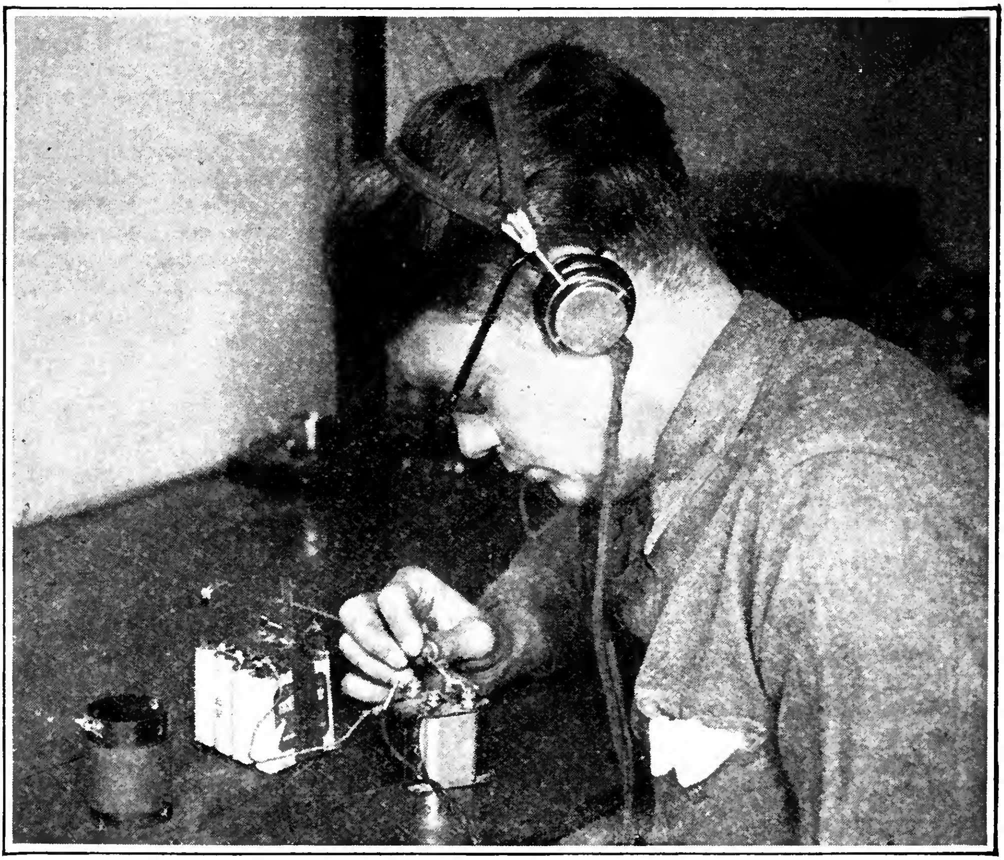
Radio Broadcast Photograph

FIG. 3

Type of "tandem circuit" sets experimented with in the R. B. Lab. Three circuits and one dial is considerably more difficult than the two control arrangement

as suggested in Fig. 2. A condenser of this type consists of two separated metal rods, covered by a glass tube, over which is clamped a movable metal clamp. Moving the clamp or slide will throw the extra capacity to the correct circuit.

Simultaneous tuning may be adapted to any form of circuit. Even three or four cir-



Radio Broadcast Photograph

FIG. 4

Coils, transformers, and condensers are easily tested in respect to "opens" or break down with a small battery and ear phones cuits can be controlled with one dial, if the arrangement is effected with expert nicety. With more than two stators, shielding is generally necessary between and around the stators to reduce undesirable capacity effects. Elementary shielding is illustrated in the single control set in Fig. 3.

## SHOOTING TROUBLE
## PART II

WE DISCUSSED last month a logical and efficient system for locating the "trouble area," in the various cases of a receiver becoming inoperative. When the difficulty has been located, the remedy is generally obvious and simple. Running in the same order as the tests, the following are the logical curative processes:

### A BATTERY

IF THE battery is found to be low, recharge it. Replace broken leads with new wire. Corroded terminals should be scraped, sandpapered, and coated with vaseline. Should hydrometer readings show a repeatedly low drop and short life in one cell, the battery should be taken to a dealer for examination. Rheostats can usually be repaired.

### B BATTERY

Replace or short out low cells or batteries.

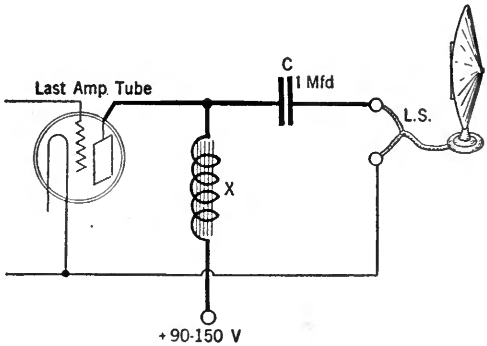



FIG. 6

A better way of connecting your loud speaker, without decreasing volume. This diagram offers several advantages

### AUDIO FREQUENCY AMPLIFIER

JACK prongs and sockets bear the first inspection. Pressing up or down with a pencil or a strip of wood will locate a faulty spring, which may be permanently bent into place.

The cure for broken connections in any part of the set is obvious. Knocking about the bus-bar with a pencil will often locate a break (generally at a soldered joint) which has before eluded a painstaking search.

Opens or breaks occasionally occur in the flexible leads to audio frequency transformers. Transformers and coils are easily tested for opens, with a small battery and a pair of re-

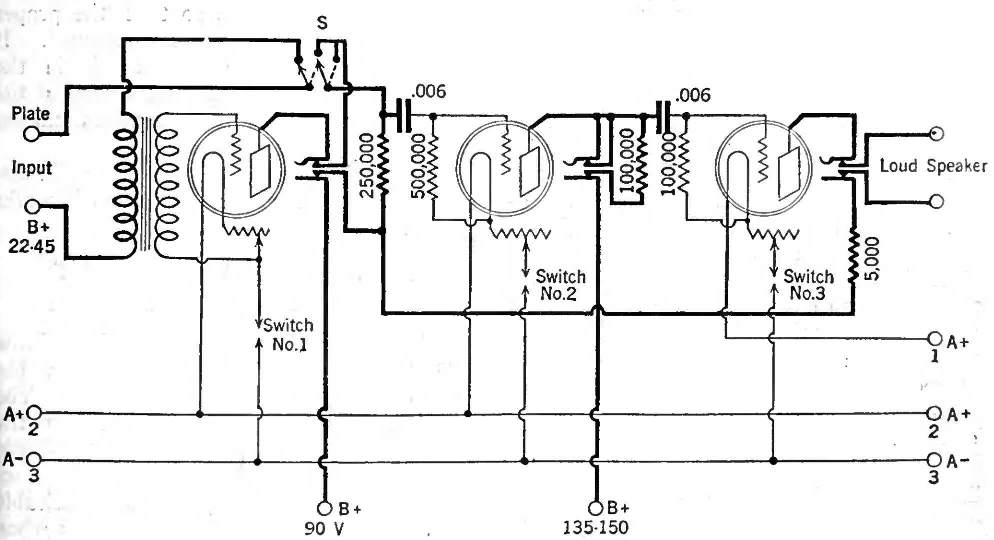
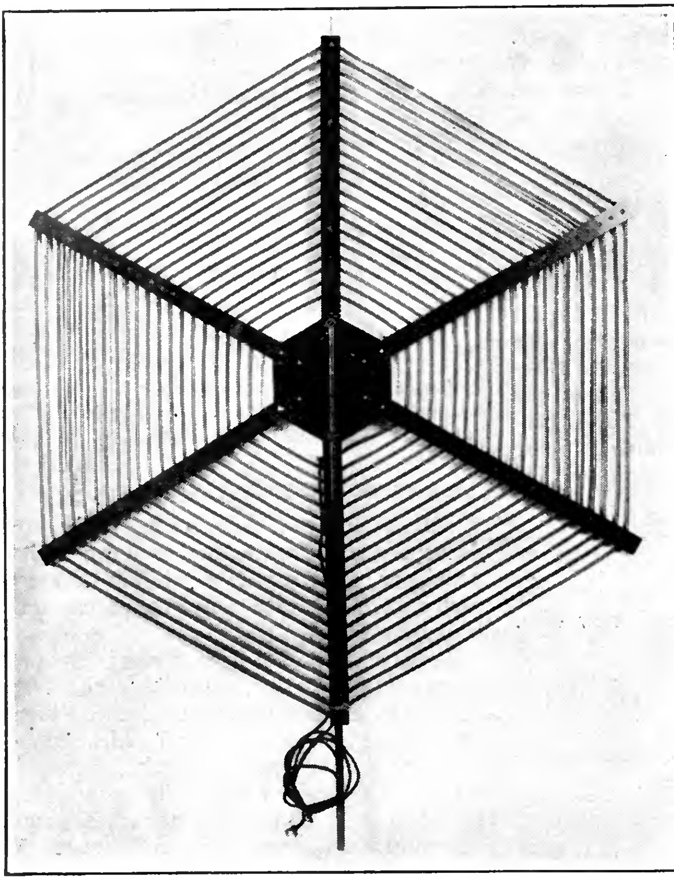



FIG. 5

The improved Knockout amplifier circuit. Volume control by the elimination of the transformer is effected by the rotary switch, and the extra A battery post facilitates the use of an 8-volt power tube in the last stage



RADIO BROADCAST Photograph

FIG. 7
The completed loop from the rear

Broken down bypass condensers should be replaced with new ones.

TUBES

A BAD tube is generally incurable. Once in a blue moon a hard knock with a pencil will help matters, but a replacement is generally the only recourse.

PHONES AND LOUD SPEAKER

LEADS are simply replaced and terminal breaks can be resoldered with resin core solder. Breaks in the windings are best referred to the manufacturer for repair.

ANTENNA AND GROUND

IF THE trouble is traced to the antenna or the ground, most of the remedies are obvious. If the antenna is down, there is but one thing to do. If the lead-in is short-circuiting against part of the building, the leads should be readjusted so that the proper tension is preserved. If there is a break in the ground lead soldering the broken connection or replacing the damaged wire will solve this problem.

In the July RADIO BROADCAST, we will discuss remedies for the receiver when it works poorly.

ceivers. (Fig. 4). One phone-cord runs to the battery, and the other to the winding under test. The remaining connection is from the winding to the battery. A loud click on breaking the circuit indicates a perfect coil. Transformers can be tested while in the set.

Terminal breaks can be soldered, but interior breaks in the transformer winding cannot be easily repaired. In a case like this it is much better to buy a new transformer.

Impedances and resistances can be tested in the same manner, and should be replaced if defective.

RADIO FREQUENCY AMPLIFIER AND DETECTOR

OPEN circuit in wiring or windings in radio frequency transformers, can almost always be soldered with comparative ease. Potentiometers may be repaired or replaced according to the ability of the experimenter.

## AN IMPROVED KNOCK-OUT AMPLIFIER

FIGURE 5 shows a modification of the Knockout amplifier described in the December RADIO BROADCAST. The essential variation of this diagram from the original circuit is switch "S," of the two-blade rotary type permitting the elimination of the transformer. This provides a desirable volume control in the many instances when the intensity delivered by the full complement of tubes is excessive. With the transformer out, the amplifier functions as two stages of straight resistance coupling. Because of this, best results will probably be secured by using a 100,000-ohm resistor as a coupling resistance in the first resistance-coupled stage rather than the 250,000-ohm unit recommended in the original article. The suggested values hold for the remainder of the circuit.

In Fig. 5 a further modification will be noted in the provision of a separate binding post for the positive filament terminal of the output tube. This provides for the use of a UV-202 or similar power tube in the last stage. This tube requires a lighting potential of eight volts for most efficient operation. When so used the six-volt leads run to posts 2 and 3, while the eight-volt lead or tap is connected to post No. 1. When six-volt tubes are employed throughout, posts 1 and 2 are birdged over.

This amplifier may be added to any receiving set, immediately following the detector or reflex tube. For additional details, the interested reader is referred to December, 1924, RADIO BROADCAST.

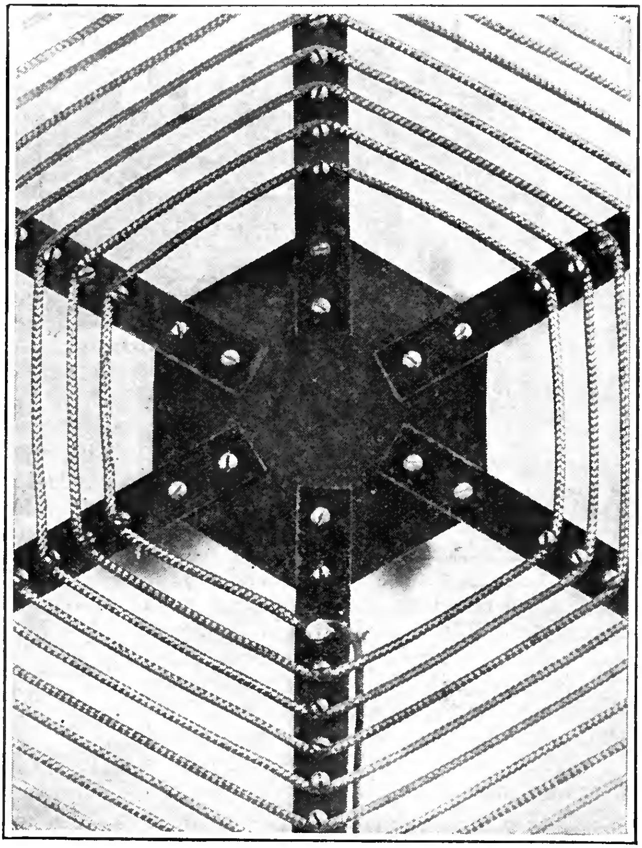
## A BETTER LOUD SPEAKER CONNECTION

IN MANY cases, from the standpoint of general results, it is incorrect practice to connect the loud speaker directly in the plate circuit of the last or output tube of the amplifier. Such a connection is usually recommended by the manufacturer because of its simplicity. The improvement suggested in Fig. 6 is offered to the fan who has been graduated from his first book of instruction.

The diagram represents the last stage of any amplifying system: resistance, impedance, or transformer coupling, and its output, the loud speaker. The additional parts required are the choke, "X", and the one-microfarad condenser C. Reactance "X" can conveniently be the secondary of an ordinary amplifying transformer. It will be observed, and herein lies the variation from the conventional, that the loud speaker is not in the plate circuit proper, but its place is taken by the choke coil. The audio results are of the same intensity as those outputted by the more usual arrangement, with the following advantages:

Only alternating current, the sound-producing variations, passes through the speaker windings. This removes the stress of a strong magnetic attraction on the diaphragm, a strain that often results in a rattle when strong signals are coursing through the windings. The loud speaker windings are also safeguarded from induced surges when the plate circuit is suddenly opened, or the stress resulting from short-circuited tube.

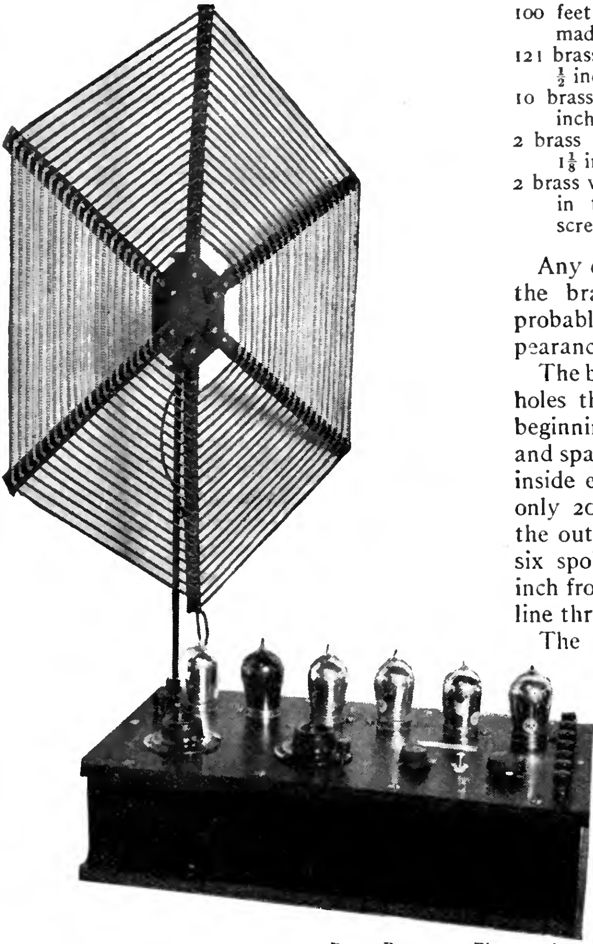
There are, however, a few loud speakers, especially designed for inclusion in the direct plate circuit, and which work better in that position. These instruments generally place importance on the polarity of connections. In Fig. 6, no consideration is given to polarity.



RADIO BROADCAST Photograph

FIG. 8

The center construction of the loop. Any convenient wire below No. 20 can be substituted for the braid



Radio Broadcast Photograph

FIG. 9

An attractive and efficient coil antenna

## A UNIQUE LOOP

MANY descriptions of receiving sets take the loop a little too much for granted, merely specifying it as the correct antenna, and leaving the details to the imagination of an often inexperienced radio constructor. The loop pictured in Figs. 7, 8, and 9, will function very satisfactorily on all loop receivers and will cover the broadcast band when shunted by a .00035 mfd. variable condenser. Its form is somewhat unique and its qualities excellent. The following parts were used in making this loop:

6 pieces of Formica, or hardwood, 12 inches long, $\frac{3}{4}$ inch wide and $\frac{3}{16}$ inch thick.
1 piece of Formica cut in the shape of a hexagon, $4\frac{3}{8}$ inch from face to face and $\frac{3}{16}$ inch thick.
1 piece of brass tubing or rod 20 inches long and $\frac{1}{4}$ inch in diameter.
100 feet of Springfield 16-strand braided copper, made at Springfield, Mass.
121 brass round head machine screws, $\frac{8}{32}$ or $\frac{8}{24}$, and $\frac{1}{2}$ inch long.
10 brass round head machine screws $\frac{6}{24}$ and $\frac{3}{8}$ inch long.
2 brass round head machine screws $\frac{8}{24}$ inch and $1\frac{1}{8}$ inch long.
2 brass washers about $\frac{1}{4}$ inch thick and with a hole in them large enough for the $\frac{8}{24}$ machine screws to go through.

Any convenient wire can be substituted for the braid. No. 18 annunciator wire will probably give quite as good results, though appearances may suffer slightly.

The bottom spoke of the loop should have 21 holes threaded in it with an $\frac{8}{32}$ or $\frac{8}{24}$ tap, beginning one half inch from the outside end and spacing the holes one half inch toward the inside end. The remaining five spokes have only 20 holes beginning one half inch from the outside end. From the inside end of all six spokes tap two holes, the first $\frac{3}{8}$ of an inch from the end and the second $1\frac{1}{8}$ inch on a line through the center.

The rest of the story is told in the photographs. Fig. 7 details the control construction and the manner of winding. Fig. 8 is a rear view of the complete loop, which Fig. 9 shows in operation.

SOLDERING has been a problem of the radio fan for some time. The acid fluxes and pastes that facilitate a creditable joint in the more strenuous trades are taboo in radio construction. Acid corrodes the delicate wires, and, like the conventional pastes, works its way into places where it introduces leaks with accompanying noises. The R. B. Lab has had great success with an excellent non-acid soldering fluid manufactured and sold by John Firth and Company, New York City.

THERE are four or five different sizes of B batteries available to the radio experimenter, and it is often a puzzling question as to which size is the most economical in the long run. The ultimate economy is determined by the number of tubes, and where the batteries are to be used (r. f., a. f., etc.), B battery voltage, C battery, and the amount of usage and the individual characteristics of the tubes themselves.

If you replace your B batteries more often than every three months, it will be profitable for you to change to a larger size.

# Some Facts About Sound Waves

## How They Are Produced and How They Are Analyzed —The Laws That Govern the Action of Sound

BY B. F. MIESSNER

SOUND, as radio experimenters who have had a hand in developing communication by radio telephony have discovered, is a subject deserving of much study and experiment. Broadcasting, after all, is merely the transference of sound from a broadcasting studio to the listener. We are using radio means to accomplish this, and many devious electrical paths does the sound follow before it emerges from the loud speaker of the radio listener. A good broadcast engineer has to devote almost as much of his attention to sound as he does to the actual radio mechanics of its transmission. Mr. Miessner in these articles is attempting to tell the important physical facts about sound. In his first article (RADIO BROADCAST, for January, 1925), he told of the importance of sound in the cosmic system and its particular relation to radio. His second article in the April RADIO BROADCAST was a discussion of the basic physical facts about sound. This article continues the discussion and includes some excellent photographs and diagrams of sound waves. This discussion of Mr. Miessner's, while somewhat technical, has a direct and important bearing on radio broadcasting.—THE EDITOR

THE sound waves we hear are produced by minute variations in the normal pressure of the atmosphere. The crests of these waves are called condensations, because in them the air is condensed or compressed. In a graphical analysis they are shown as the positive halves of the wave graph. The hollows of the waves are called rarefactions, because in them the air pressure is lessened or rarefied; these in graphical analysis are shown as the negative halves of the wave graph.

The actual variation in pressure constituting sound waves is very small indeed compared with normal pressure. While measurements of these variations are very difficult to make because of their extreme minuteness and fleeting nature, the most reliable results thus far indicate that the ear can hear a sound having an amplitude or pressure variation of only one one thousandth of a dyne per square centimeter. The actual pressure variation of the weakest audible sound is about one part in ten billion—in terms of the normal atmospheric pressure of nearly fifteen pounds per square inch. A pressure variation of one thousand dynes per square centimeter, which is one million times the minimum audible variation, is painfully loud and represents the high intensity extreme ordinarily encountered. Extremely loud sounds then,

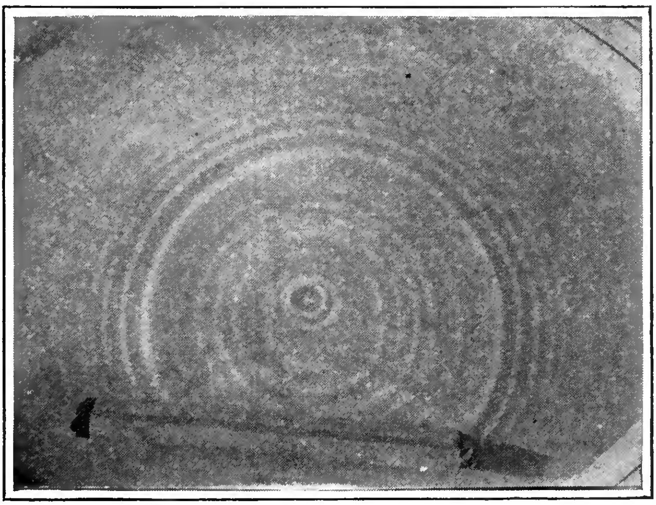


FIG. 1

A photograph showing the reflection of a circular water wave by a plane surface, such as a straight sea wall

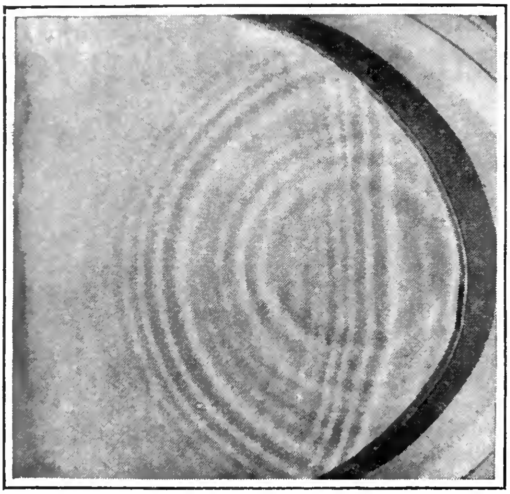


FIG. 2
The photograph shows the reflection of a circular water wave by a curved surface as a curved sea wall

are produced by pressure variations of only one ten thousandth part of the normal atmospheric pressure, or, in actual pressure, about .0015 pounds per square inch. There is no pressure gauge which will measure such small variations of pressure. Some indication of the delicacy and sensitivity of the human ear may be gained by these facts.

### SOUND WAVE PICTURES

PHYSICISTS have long used a kind of topographic map to indicate the sound waves in a given locality. As the civil engineer shows high lands by closely spaced lines and low lands by widely spaced lines, and connects all points of equal elevation by these lines, so the physicist has used such lines to indicate the regions of high and low pressure forming the condensations and rarefactions of sound waves. The actual photographs of spark waves published in a previous article of this series (RADIO BROADCAST for April), show these same effects very clearly and beautifully. Refraction shadows of water waves also show them very clearly.

As the result of much experiment, the writer has succeeded in developing an exceedingly simple method of producing and photographing water waves, which illustrate perfectly the effects of sound waves and the laws determining their behavior. Several of these photographs are reproduced herewith, and numerous others will be used in succeeding articles.

While these representations of sound waves are valuable in aiding the understanding of acoustic phenomena, and particularly in tracing qualitatively the effects of reflection, refraction, absorption, diffraction, and other important characteristics, a more accurate method is necessary for quantitative representation and analysis. If we take an instantaneous cross section of a simple water wave, we may get a picture like that shown in our illustration. Such views of waves may be obtained in aquariums, where a plate glass window constitutes one side of the tank, and permits observation of the fishes inside. The wave is seen here as variations of height from point to point above and below the normal water level.

If we place a pressure measuring device at P and measure the pressure of the water at that point at equal time intervals as the wave passes overhead, we may construct a curve or graph with rectangular coördinates, which will show the variations of pressure with time, as the illustration shows. If the point P moves downwards, thus increasing the normal or steady pressure of the water, the axis of the curve will move upwards, and vice versa, but the wave itself will remain unchanged, being shifted up or down accordingly. The vertical

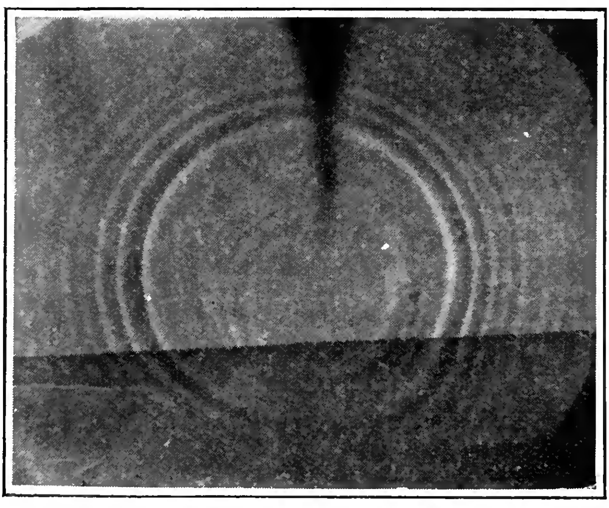


FIG. 3
How a circular water wave is absorbed without reflection by an inclined surface such as a sandy beach

lines or *ordinates* represent pressure, the horizontal lines or *abscissae,* represent time. Such representations of waves, or in fact any kind of variation, are quite common and serve a very useful purpose in study and analysis.

THE PHYSICAL CHARACTERISTICS OF SOUND

SOUND waves, like alternating currents, are classified and described physically according to amplitude, frequency, length, and form.

*Amplitude.* The amplitude of a sound wave refers physically to the actual increase above or decrease below the normal atmospheric pressure at the crest or hollow respectively. It is usually expressed in terms of dynes per square centimeter although for convenience, any other units of force and area may be used. The amplitude is related to the volume or loudness of a sound. But while the loudness increases with the amplitude, the relation between them is not simple or linear. The loudness is more closely related to what the physicist calls the *energy* of the vibration. The physical energy of a simple vibration is proportional to the square of the amplitude. This expresses a general law true for all kinds of vibratory energy. To illustrate: If several similar waves have amplitudes of one, two, and three, their respective energies will be in the ratio of one, four, and nine.

While the physicist must use such interpretation in his study of the physics of sound, the psychologist knows that the ear does not respond with a loudness sensation strictly proportional to the physical energy of the impressed sound. There is a general law familiar

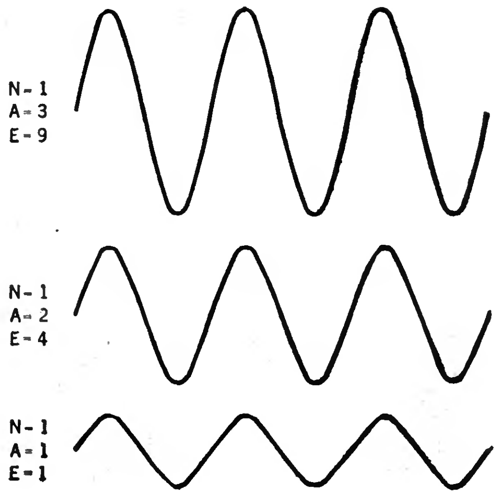



FIG. 5

Waves of similar frequency, but of differing amplitudes. This drawing shows that the energy of a simple wave is proportional to the square of the amplitude, the frequency remaining constant

to the psychologist as Weber's law, which has been verified approximately for most of the senses, and which states that the sensation produced by a sense stimulus is proportional to the logarithm of the physical energy of that stimulus. That is to say, if the loudness of a given sound be increased from 1, to 5, to 10, the actual energy would be increased accordingly from 1, to 150, to 22,500. The corresponding physical amplitudes would be the square roots of these latter values, or, 1, 12, and 150.

This law, while not accurately true, and varying considerably for different ears, is nevertheless important and must constantly be borne in mind in radio. For example, if a loud speaker must be made to give five times as much sound intensity or volume, it must be provided with about 150 times as much energy in its actuating current!

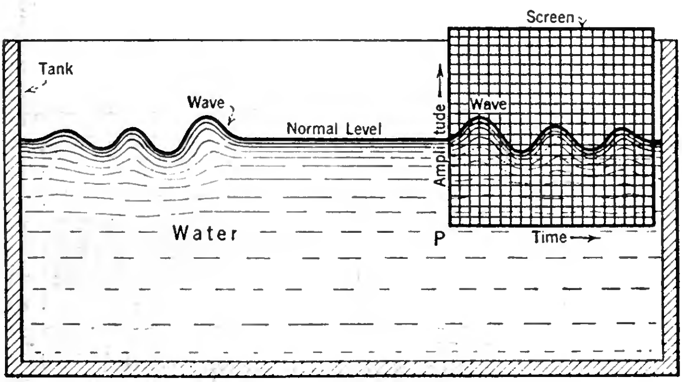



FIG. 4

A sketch of a water wave as seen through the glass side of a tank, showing the wave in cross section. If one view the wave on one side through a cross section screen as indicated, with its lower left hand corner on P, the wave appears as a graph on the rectangular coördinates. Moving P and the screen up and down merely moves the curve oppositely on the chart without changing the wave form

SOUND WAVE FREQUENCY

THE frequency of a sound wave, like the frequency of any other wave, may be stated as the number of similar waves passing a given point in a second. The term *wave* de-notes a compression and a rarefaction. Frequency in general terms refers to the pitch of a sound. Grave or low-pitched sounds are low in frequency; shrill or high-pitched sounds are high in frequency.

The lowest sound on a piano tuned to international pitch is 27 vibrations per second; middle C is 259, and the frequency of the highest sound is 4138 cycles, or double vibrations, per second. Fig. 6 shows a piano keyboard tuned to international pitch and the corresponding sound pitch and wavelength of each key. The piano is thus an extremely valuable frequency standard for use in determining by comparison the frequency of any musical sound. While not so accurate and unchanging as a set of tuning forks, it is nevertheless a very convenient and fairly accurate standard which is available in almost every home. The piano strings, of course, sound many overtones, so that each key actually produces a number of sounds besides the lowest or fundamental vibration. These are exact multiples of the fundamental. Inasmuch as the fundamental tone characterizes the pitch as we hear it, we need not concern ourselves with the overtones in such pitch comparisons for determining the vibration frequency of some other sound source.

The normal human ear will detect sounds of frequencies as low as 16 and as high as 20,000 cycles per second. The actual limiting frequencies depend largely on the intensity of the sounds themselves, the limits extending with the loudness of the test sounds; for example, with very weak sounds the limits might be 20 to 15,000 cycles—for very strong sounds 12 to 25,000 cycles.

### SOUND WAVELENGTH

THE length of a sound wave is the distance between successive waves measured from corresponding points. If the frequency be known, the wavelength may be computed by dividing the frequency into the velocity of propagation. Thus, a sound having a frequency of 100 double vibrations (cycles) per second has a length of 1090 divided by 100, or 10.9 feet.

In general, these relations are represented by the equation $V = NL$, where V is the velocity, and L the length of the wave. By using $V = 300,000,000$, the velocity of radio waves in meters per second, N in cycles per second, and L in meters, the wavelength or frequency of any radio broadcast wave may be computed similarly, providing one of these factors be known.

The loudness sensation of sounds having the same physical amplitude but differing in frequency (i.e., wavelength), is not the same. It requires a much greater amplitude in low than in high tones to produce a given loudness sensation. This curious fact may easily be observed in a piano. The large, low-toned strings move visibly and strangely with a circular kind of motion, the higher strings vibrate less visibly, and the very highest cannot be seen to vibrate at all. And yet all of the strings emit sounds of about the same loudness.

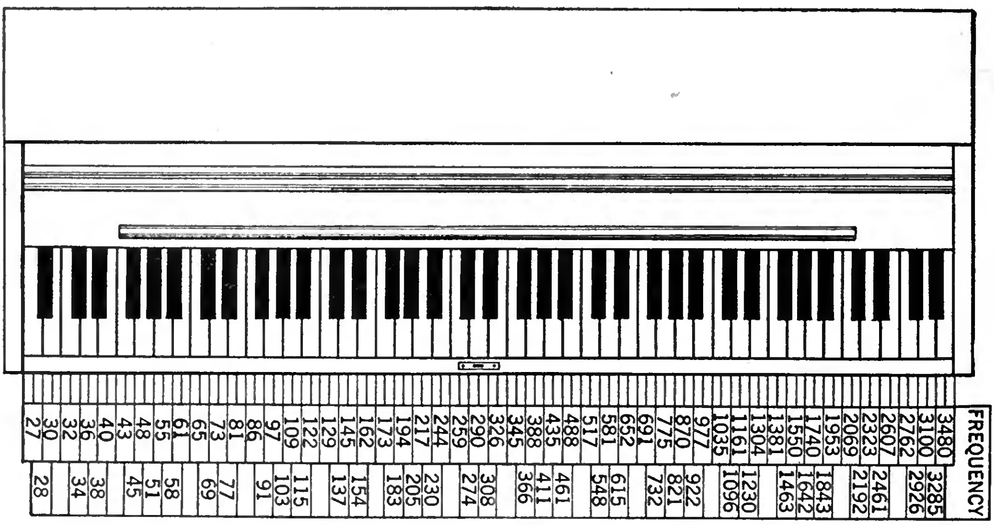



FIG. 6

The frequencies and corresponding wavelengths of the sounds produced by the keys on a piano

The physical law, true for all vibratory energy, states that the energy of the vibration is proportional to the square of the frequency, the amplitude remaining constant. To illustrate: Three sounds having equal amplitudes but unequal frequencies such as 100, 200, and 300, would have physical energies in the relation of 1, 4, and 9. The actual perceived loudness, however does not follow this physical law closely. While a detailed analysis of the perception of sound is not properly a part of a physical discussion, and will be reserved for a later article, it may be stated in passing, that, for equal energies the ear hears very high pitched sounds louder than very low ones, and mid-range sounds louder than either high or low. We can hear sounds of wavelengths between about 68 feet (i.e., 16 cycles) and 0.65 inch (i.e., 20,000 cycles). When both the amplitude and frequency vary, the energy is proportioned to the product of amplitude squared and frequency squared.

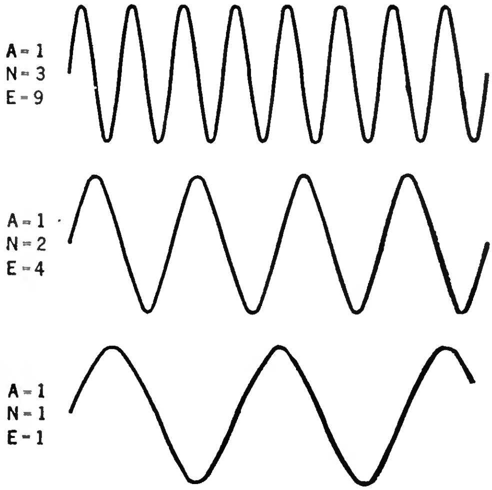



FIG. 7

Waves of the same amplitude, but of differing frequency. The energy is shown here as proportional to the square of the frequency when the amplitude is the same

### THE WAVE FORM OF SOUND

THE only form of wave thus far discussed is that of the simplest possible type which is known as the curve of sines, or more generally as a sine wave. Its mathematical derivation need not be introduced here. This type of wave in sound, while valuable as a basis for analysis, is really an extremely rare phenomena.

The sine-wave sound is called a pure sound or tone, meaning that it consists of but one vibration frequency; it has no overtones. The purity of a tone refers to its freedom from overtones, and not to any æsthetic quality which this expression is sometimes meant to convey. A pure tone is extremely uninteresting musically.

The sounds of nature, of music and of speech, are always relatively complex in this sense. Your voice in speaking or in singing what you think is a single tone may consist of twenty-five or more component simple tones, extending upwards in frequency from the fundamental or lowest frequency vibration to the highest overtone detectable by the human ear. A few musical instruments, such as the flute, the French horn, and certain types of organ pipes, can be made to produce nearly pure sounds, in which most of the emitted energy is concentrated in one frequency, but a few weak overtones are always present.

Complex sounds consisting of many component partial tones, do not have the simple wave form of the pure sound. Instead, the wave form, like the sound itself, is very complex. Fig. 9 shows such a wave form representing the complex sound of a single organ pipe. The frequencies, amplitudes, and energies of all the partial simple tones in this sound, as tabulated, completely describe the sound itself, except for what is known as the phase relations of the components, which is a matter of secondary and even doubtful importance. The energy column is calculated from the other two. The sum of the energies of the separate component partial tones is the total energy of the whole sound.

### FINDING THE WAVE FORM OF SOUNDS

THE wave forms of various sounds can be photographically recorded by an instrument known as the oscillograph. The electrical oscillograph when used in conjunction with special microphones and amplifiers such as are now used in high-quality broadcasting, will produce a visual moving picture or a photographic record of the wave form of any sound impressed on the microphone.

Professor Dayton C. Miller, of the Case School of Applied Science, about ten years ago devised a remarkable type of sound oscillograph which he calls the "Phonodeik." This ingenious instrument permitted him to record the wave forms of many different types of sound and to analyze their records at leisure. By his skillful mathematical calculations, the slight distortion of the instruments could be corrected and the true wave form of the recorded sound developed.

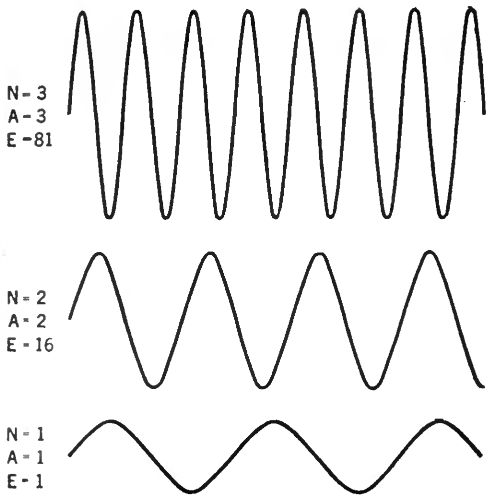
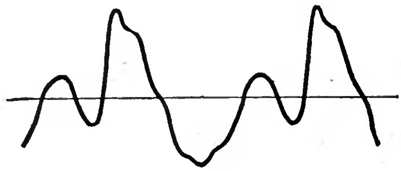



FIG. 8
Waves whose frequency and amplitude are both different. The energy is here shown as proportional to the product of the amplitude squared and the frequency squared

Once the wave form is obtained, it is possible for sounds with only harmonic components (that is exact multiples of the fundamental frequency) to analyze the wave and to determine exactly what simple waves it contains; it is further possible to determine the relative frequencies and amplitudes of all the component partials. This may be done by a rather laborious mathematical calculation using the Fourrier equations, or an instrument



| | FREQ. | AMP. | ENERGY=$N^2A^2$ |
|---|---|---|---|
| Fundamental = 1st Partial | 100 | 32.0 | 104.0 |
| 2nd " | 200 | 22.0 | 194.0 |
| 3rd " | 300 | 13.0 | 152.0 |
| 4th " | 400 | 7.0 | 78.5 |
| 5th " | 500 | 3.5 | 30.6 |
| 6th " | 600 | 3.0 | 32.4 |
| 7th " | 700 | 2.0 | 19.5 |
| 8th " | 800 | 4.0 | 102.0 |
| 9th " | 900 | 2.0 | 32.0 |
| 10th " | 1000 | 1.5 | 22.5 |
| 11th " | 1100 | 1.0 | 12.1 |
| 12th " | 1200 | 1.0 | 14.4 |

FIG. 9
The complex sound wave produced by a single organ pipe. Its harmonic analysis gave the table of simple tones which provides an accurate physical description of the sound itself. The wave was obtained by Professor Dayton C. Miller of Case School of Applied Science, Cleveland, with his "Phonodeik"

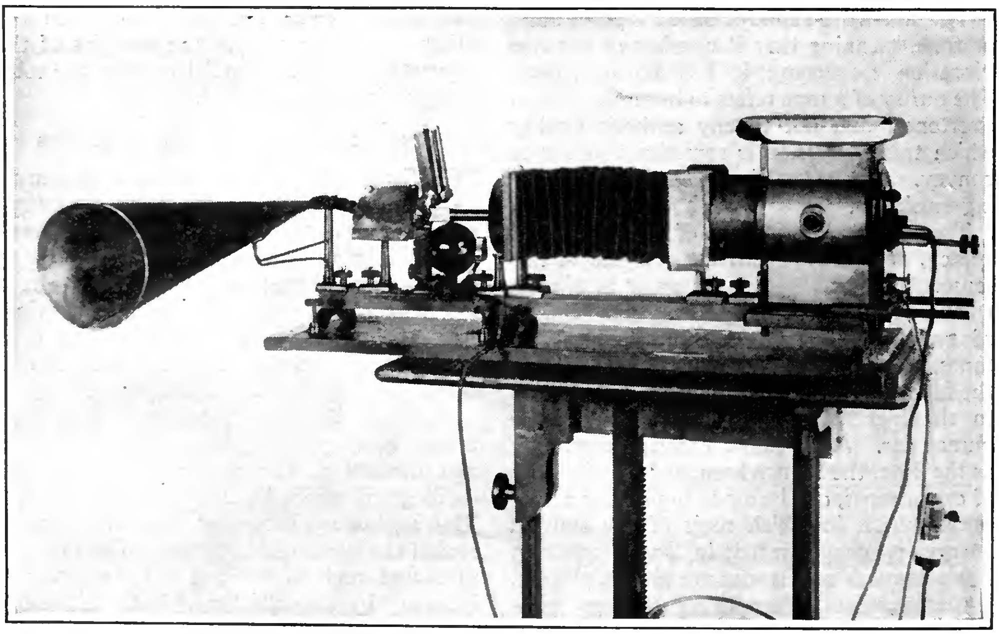


FIG. 10
Professor Miller's "Phonodeik" which records the wave form of sounds

known as the Harmonic Analyzer may be used (based on the same mathematical laws) which traces the curves of all the partial tones directly.

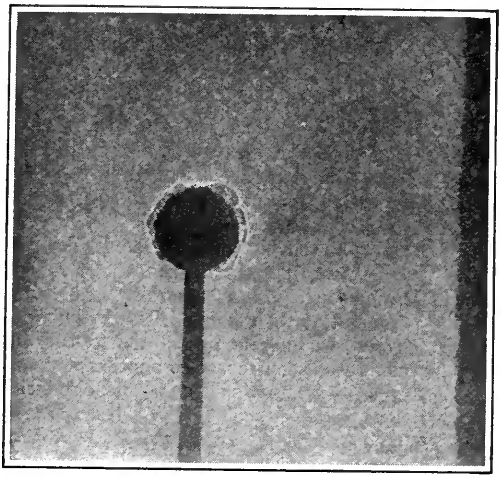


FIG. A

Through an error, the spark wave photographs published on page 1061 in Mr. Miessner's article, "The Physics of Sound" in RADIO BROADCAST for April were printed so as not to show the actual waves themselves. Figs. A, B and C, are reproductions showing the circular shadows of the spherical waves of condensation (dark), and rarefaction (light) produced by an electric spark behind the central black disc. This, Fig. A, shows a curved wave striking a soft felt pad without reflection. Here the wave in the felt is being absorbed and converted into heat

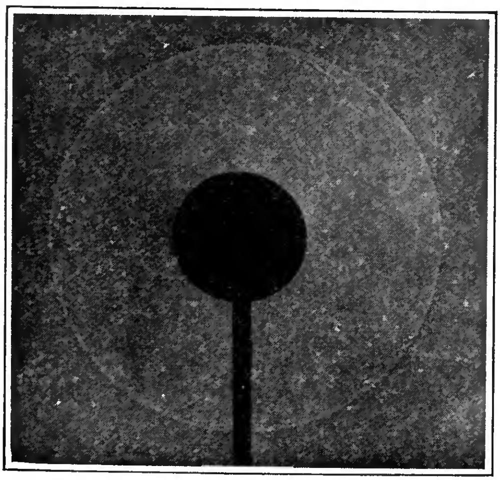


FIG. B

Here the large circle is the shadow of an expanding spherical wave. These photographs are presented through the courtesy of the Riverbank Laboratories, Geneva, Illinois

By means of such a process of recording and analysis, the mixture of simple tones in musical sounds can be determined just as the optician can determine with the spectroscope the various light frequencies present in any particular light emitted by a given light source.

Not only this, but even more remarkable things can be accomplished. With such an analysis of any given sound as is shown in Fig. 9, the physicist, like the artist who mixes numerous colors to produce the particular shade he desires, can synthetically produce the same kind of sound. To do this he produces simultaneously the component pure tones of correct frequency and amplitude, as determined by the analysis, using electrically vibrated tuning forks or stopped organ pipes. Almost any kind of musical sound can thus be imitated with practically perfect completeness.

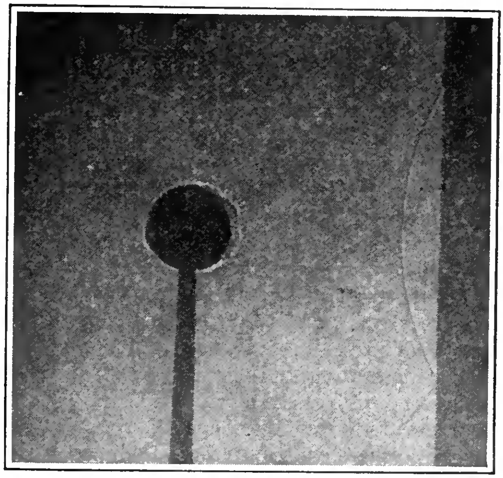


FIG. C

The wave here shown is being reflected with reversed curvature from a hard, flat surface. It shows the reflection or "echoing" of a spark sound at the surface of a hard body. These photographs are very unusual ones, even though from a photographic point of view they may appear to be slightly hazy. The poor appearance of the negatives is due in no part to poor photographic technique, but it is wholly the result of the extreme difficulty of the subject

The modern pipe organ is one of the finest examples in which these principles are used. Dozens of different musical qualities or tone colors can be produced by control of the tone mixing stops on the manual. The "Telharmonium" and the "Choralcello," in which similar effects are produced by electrically vibrated sounding bodies, have wonderful possibilities in this direction, but have never attained commercial development.

# The Better Receiver Contest

## Additional Information About Our Search for an Improved Receiver for Home Construction—A Prize of $200 for the Design of a Better Set

AS EXPLAINED in the April magazine, RADIO BROADCAST, since its inception, has been endeavoring to present to its readers an abundance of up-to-the-minute radio information with special attention to exceptional receivers for home construction. Not content, however, with news alone, it has always been a policy that nothing be printed that was not an improvement over that which had gone before.

So it was that eventually the Roberts Knockout receiver was first presented to the radio field, and we have failed since that time to find a better circuit combining the various and singular attributes of this unusual set, although much effort and considerable money have been spent in this direction by the RADIO BROADCAST Laboratory. Members of our technical staff, combining a wealth of technical knowledge and experience, have been experimenting for the past eight months, but they confess that they are unable to improve the basic features of this receiver.

Now what we should like to know is, Where can a better receiver be found? We confess we are beaten, and we are ready to pass the buck. The responsibility naturally devolves upon those to whom the radio field, in the final analysis, owes most, to those experimenters and amateurs, engineers and what not, who have contributed development upon development, discovery upon discovery to the art of radio telegraphy and telephony.

#### WHERE CAN A BETTER RECEIVER BE FOUND?

DO YOU know of a better receiver? If you do write to us and tell us about it, or, better still, send us a set all hooked-up and we will test it in our Laboratory. If it is better than the Roberts we are willing to pay generously for an article completely describing it and if it meets with the approval of those selected to serve as judges in this contest, we will mail you a check, not for $100 as indicated in our April announcement, but for $200 which amount we consider more in keeping with the magnitude of the task which we have set before you.

We remain unconvinced. We don't believe that you can do it. Do you think you can? Then write to us and prove it!

The following specifications must be incorporated in the desired receiver:

1. The receiver must not radiate.
2. It may employ four tubes (or less if you think four are unnecessary).
3. It must be extremely selective.
4. It must be constructed to occupy a reasonably small amount of space.
5. It must be capable of operation with dry cell and storage battery tubes.
6. It must be capable of operation with tubes operated at their normal filament voltage.
7. It must be built to permit the transfer of tubes from one socket to another without materially changing the results obtained.
8. It must produce good quality, without blasting or rattling on a cone-type loud speaker.
9. It must be capable of satisfactory performance with several makes of parts designed for similar use.
10. It must not require critical grid condenser or grid-leak adjustment.
11. It must be simple to control.
12. It must permit the use of voltage up to 120 on the audio amplifier tubes (though less may be used if desired).
13. The plate current consumption of the four tubes (measured at normal filament voltage) must not exceed 10 milliamperes when storage battery tubes are used.
14. It must be capable of exceptional long-distance reception, with volume sufficient to fill a good-sized living room.
15. It must be simple to operate.
16. It must be free from hand capacity.
17. Shielding must not be used.
18. It must be capable of loud speaker operation on two tubes.

It will be noticed by comparing the above specifications with those contained in the April announcement that a few changes have been made. These changes have been considered necessary in view of the extreme difficulty of the task we have set before you, and they make the goal, on the whole, perhaps easier of attainment.

Three judges have been appointed to decide impartially which is the better receiver—yours or the Roberts. You will get a square deal at their hands.

The conditions of the tests which we will give your apparatus remain as indicated in the original announcement.

This offer is made, we repeat, only to those who are interested in designing receivers for home construction. Later, if manufacturers of complete sets wish to employ a similar method of proving the excellence of their apparatus, we will have no objection, but in this particular contest only home built sets are concerned.

Most of the letters received thus far presenting us with descriptions of apparatus to be entered in this contest, have failed to comply with the conditions set forth above. We caution future participants that unless the rules governing this contest are adhered to, their communications will not receive our consideration. Many of our correspondents about this contest have failed to adhere to some one or more of the rules. The receiver to be entered must fit the specifications printed above. When you write us about your receiver, please condense your information as much as possible and take great care with the circuit diagrams.

Now we ask again, Have you a better receiver than we have discovered? We doubt it, but if you are sure you have, submit it to us and we will test it out.

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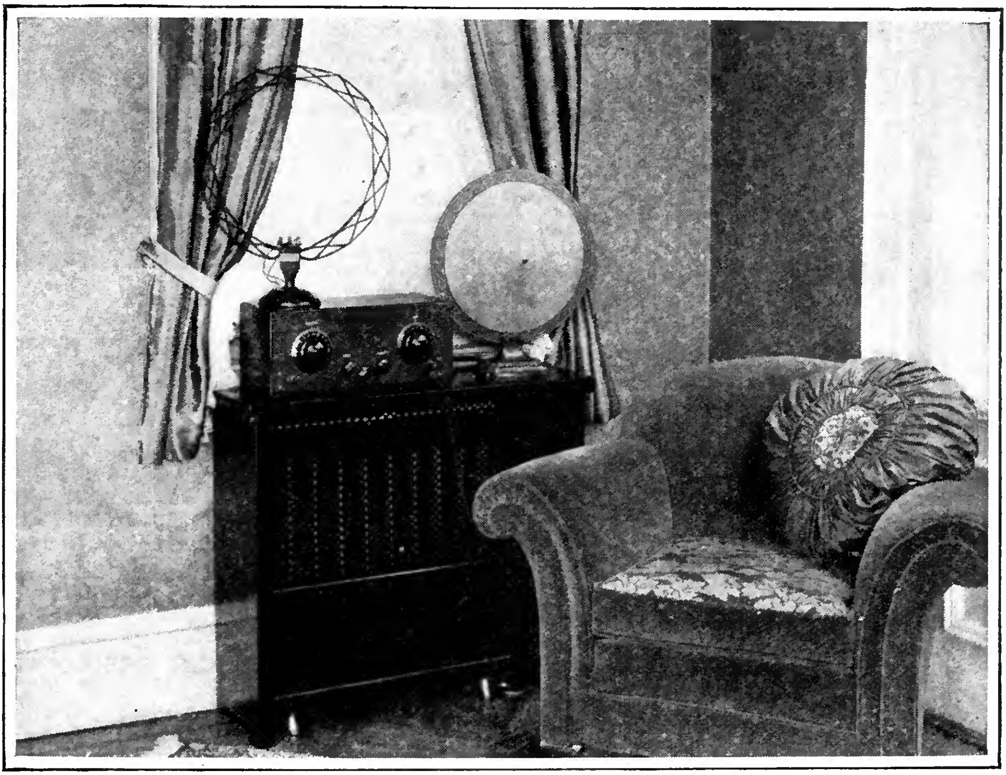
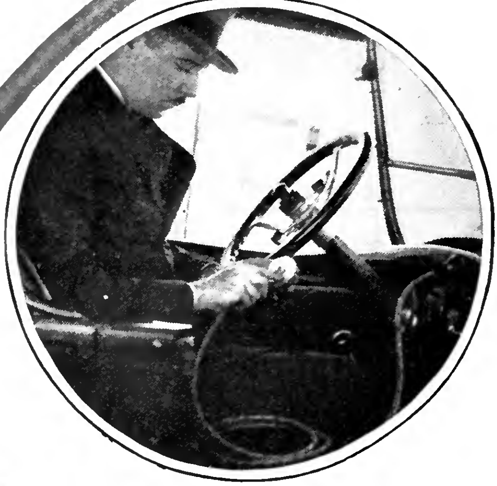
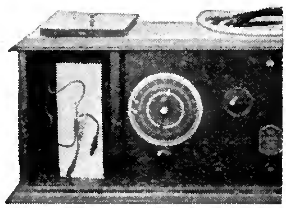


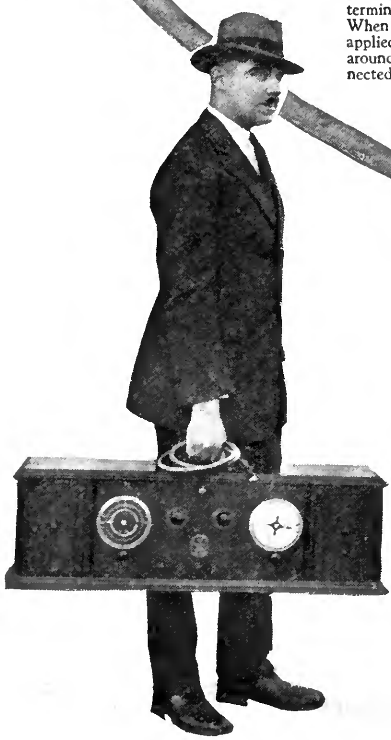
FITTING THE RADIO TO THE RADIATOR

This photograph shows a receiver placed on a metal cabinet which fits over the radiator. Ordinarily, the radiator, especially in small homes and apartments is somewhat uneconomical, because the space it occupies cannot be used for anything else. The cabinet contains a humidor which moistens the air and the shelf is insulated which keeps it from absorbing heat. With this cabinet, made by the Dixie Metal Products Company at Birmingham, Alabama, the radiator is made to do double duty. The new Farrand-Godley loud speaker and Carter self-supporting loop are also shown



THE photograph in the lower left shows the receiver with the Lynch Lead ready to put in the automobile. The circle in the upper left shows how a potato can be used to determine the polarity of the battery leads. When the current is on and the bare wires applied to the potato, a green deposit forms around the negative wire which is then connected to the negative terminal of your receiver



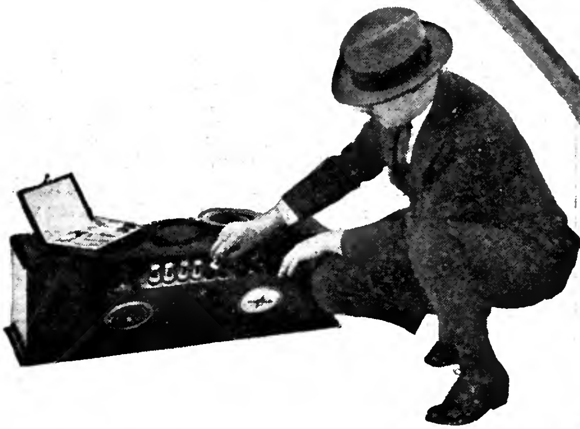


# Take Your Radio Set to the

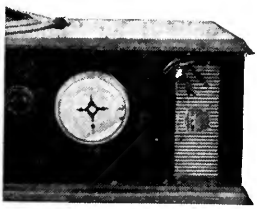
WHEN your radio receiver goes on summer motor and camping
ent to take along storage batteries to supply the filament vol
of the automobile furnishes six volts which is the proper potential
of the tubes. The photographs on these pages show how the Lynch
H. Lynch, editor of this magazine, can be used for connecting the
to the radio receiver. The Radiola super-heterodyne is supplied
the illustrations show how Brightson True Blue Power Plus tubes
tery filament and a small base can be substituted in the "super."

In the Radiola super-heterodyne, the dry cells which furnish
considerably to the weight of the receiver. If the Lynch Lead is
tomobile storage battery for the dry cells the decreased weight of
more portable—an important consideration for summer radio.

Any radio receiver, including all those described in this magazine,
can be operated in this way from the automobile battery. The
shows Mr. Lynch operating super-heterodyne in his automobile.
loud speaker in use.



THE upper cut shows John B. Brennan, Technical Editor of RADIO BROADCAST, substituting Brightson True Blue Tubes in the Radiola super-heterodyne so that it may be operated from the automobile storage battery. The center photograph shows the space left in the battery compartment of the "super" when the dry cell A batteries are removed



# Country !

trips, it is often inconveni-
tage. The storage battery
for supplying the filaments
Lead, developed by Arthur
automobile storage battery
with three-volt tubes and
which have a storage bat-

the filament potential add
used, substituting the au-
the receiver makes it far

with the use of this cord,
photograph at the right
Note the small Amplion

# Making Your Receiver a Super-Heterodyne

## A Simple and Inexpensive Unit Which the Home Constructor Can Easily Build—It Can Be Applied to Any Type of Receiver

BY A. O'CONNOR

ANY number of radio users have tried for a long time to find a simple method of converting their present receivers to super-heterodynes. Nothing short of complete rebuilding has been the solution in the past. Up to now, there has really been no satisfactory method. The frequency-changer circuit described by Mr. O'Connor in this article is really a "canned" super-heterodyne which can be applied to any kind of a receiver except a super-heterodyne itself.

Obviously there are two main avenues of endeavor which lead to the discoveries of real improvements in radio: those undertaken by commercial interests, and those in which the home experimenter plays the leading rôle. RADIO BROADCAST believes that it should present the best and most helpful material which may be developed by both types of radio investigators. We judge the material which is considered for the editorial pages of the magazine by one measure: Will it help the reader? The fact that Mr. O'Connor falls into the commercial rather than the private investigator class has not influenced our policy in publishing this interesting and helpful article.—THE EDITOR

A SUPER-HETERODYNE of two tubes is not only possible but practical; any receiver now in operation may be made into a sensitive, selective super-heterodyne. With these two thoughts in mind, the writer began experiments over a year ago that brought the results outlined in this article describing a simple one-tube unit that will make a "super" out of any good receiver, be it simple or complicated.

Briefly, this unit changes incoming signals to a given frequency, just like the best of super-heterodynes, and the receiver that the listener now possesses acts as the "intermediate frequency amplifier" that is such an important part of present super-heterodynes. This unit is not difficult to construct, requires but little room, and uses standard parts that may be obtained generally.

Such a unit will allow hundreds of thousands of listeners to have the benefits of the "super" at small cost and without discarding their present receivers.

### WHAT THE "SUPER" REALLY IS

TO UNDERSTAND just how such a simple super-heterodyne may be constructed it is necessary to delve a bit into the theory underlying this selective circuit. The "super" is really a frequency-changer, and this unit, described in RADIO BROADCAST for the first time is, simply, a frequency changer.

In super-heterodyne receivers incoming frequencies are changed to some lower frequency, after which they are amplified by "intermediate-frequency" amplifiers and then detected in the usual fashion. The lower frequency varies with different super-heterodynes, but usually is about 30,000 cycles (10,000 meters). There are reasons why this frequency

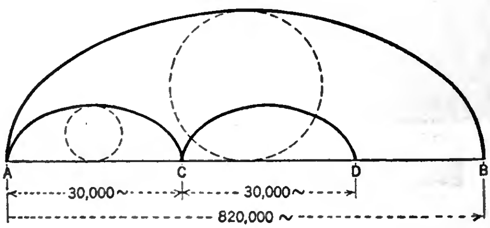



FIG. I

The broadcasting band of frequencies is 820,000 cycles wide and is represented here by taking a point on the circumference of a wheel and marking out its path as it rolls along the frequency line. At the end of one complete revolution the point has traversed 820,000 cycles. The smaller wheel representing the oscillator dial traces a similar path but in one revolution it traverses only 30,000 cycles. There are two points 60,000 cycles apart that a given station may be heard may not be much lower, but few why it cannot be higher. and that is what is done in this unit where an intermediate frequency of about 500,000 cycles (600 meters) is used.

These lower frequencies are generated by a phenomenon called "beats" and are the result of compounding two waves of different frequency. As a concrete example, let us suppose the intermediate amplifiers are tuned to 30,000 cycles and an incoming signal has a frequency of 750,000 cycles (400 meters.) Within the receiver is a frequency generator which we may vary until the difference between its frequency and that of the incoming wave is 30,000 cycles. At this point the intermediate amplifiers work

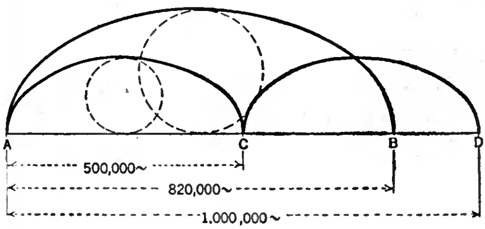



FIG. 2

By making the smaller wheel much larger, the path a given point on its circumference would trace out is longer. Before it completes two revolutions however, it is outside the broadcasting band, and for this reason there will be only one point on the oscillator dial where a given station will be heard

best and the signal will be passed along to the detector.

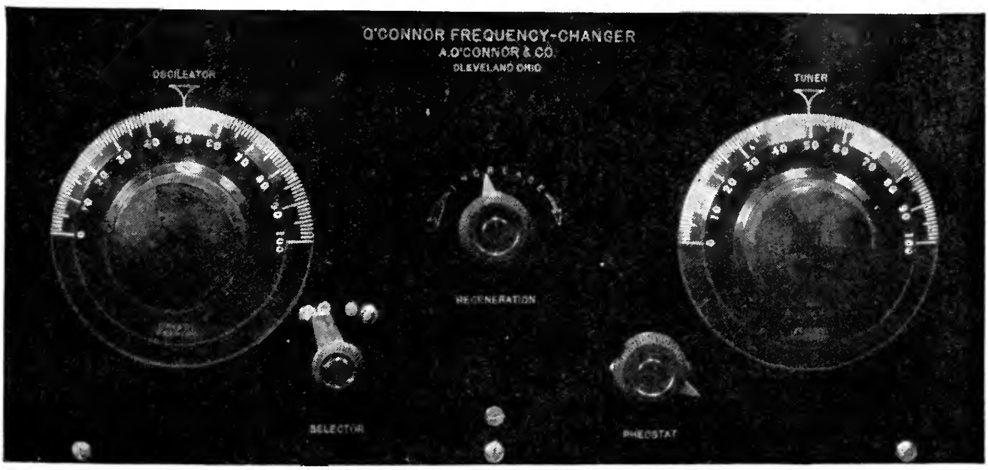
This lower frequency may be obtained, in general, at two adjustments of the oscillator dial, namely, at the 750,000 plus 30,000 or 780,000 cycles and 750,000 minus 30,000 or 720,000 cycles. These two points correspond to 417 and 385 meters.

Thirty thousand cycles is such a small percentage of the broadcasting frequencies that the two points on the oscillator dial are always close to the value of the incoming frequency, although on the longer waves the two points are farther apart on the dial than at the low wavelength end of the dial.

These two points are 60,000 cycles apart, and the action of tuning a given station at two points within the broadcasting band is something like a small wheel revolving within a large one as shown in Fig. 1. The small wheel may begin to rotate at any point, but at the end of two complete revolutions the same broadcasting station may be heard again. And since the present broadcasting band covers 820,000 cycles, it is apparent that there will always be two points on the oscillator dial for each incoming frequency—if the intermediate amplifiers are tuned to 30,000 cycles.

Suppose, however, that the intermediate amplifiers are tuned to 500,000 cycles. In this case, the same station will be found at two points 1,000,000 cycles apart, and since the broadcasting band is only 820,000 cycles wide, we may plan our coils and condensers so that the incoming frequency will be heterodyned at only one point on the oscillator dial.

All we have to do now is to design an oscillator that will beat at frequencies 500,000 cycles different from incoming frequencies. At the lower end of the broadcast wavelength band, 220 meters equals 1,363,636 cycles and at the




RADIO BROADCAST Photograph

FIG. 3

The panel view of the frequency changer. Simplicity and symmetry are the keynotes of construction and layout. Due to the engraved indicators, the functions of the various control dials are self explanatory other end of the broadcasting band, 550 meters corresponds to 545,454 cycles. To find the frequency of the oscillator to give us the required 500,000-cycle beat note, we must add to or subtract 500,000 cycles from these two extreme frequencies. Thus,

220 meters = 1,363,636 cycles plus 500,000 cycles = 1,863,636
220 meters = 1,363,636 cycles minus 500,000 cycles = 863,363
550 meters = 545,454 cycles plus 500,000 cycles = 1,045,454
550 meters = 545,454 cycles minus 500,000 cycles = 45,454

Therefore an oscillator of the range 1,863,636 to 1,045,454 or an oscillator of the range of 863,363 to 45,454 cycles would give the required beat frequency. These two oscillators would cover wavelengths from 161 to 287 meters or 348 to 6600 meters. Obviously the first one is the proper one to use.

In this case there will be only one point in the oscillator dial where a given station may be found as shown in Fig. 2.

There is still another advantage in heterodyning to 500,000 cycles. When heterodyning to 30,000 cycles, it is quite often the case that the lower one of the two points for station No. 1 is in exactly the same spot as the upper point of station No. 2 which is on a shorter wavelength. This causes heterodyning with the attendant howls and moans. Sometimes the upper point of station No. 1 interferes with the lower point of station No. 3 which is on a longer wavelength; again we have heterodyning with the resultant discordance, and we find that we are unable to get station No. 1 clearly on either of its two points. Such a condition is impossible with 500,000 cycle beat frequencies, as it is impossible to get a station at more than one point on the oscillator dial.

With most "supers," the oscillator is continually making an audible heterodyne with the incoming station as the dial is turned between the two points for the incoming station. This is because of the fact that half way between the two points it is actually on the exact frequency of the incoming station. With a 500,000-cycle beat frequency this is impossible as the oscillator always beats 500,000 cycles away from the incoming station.

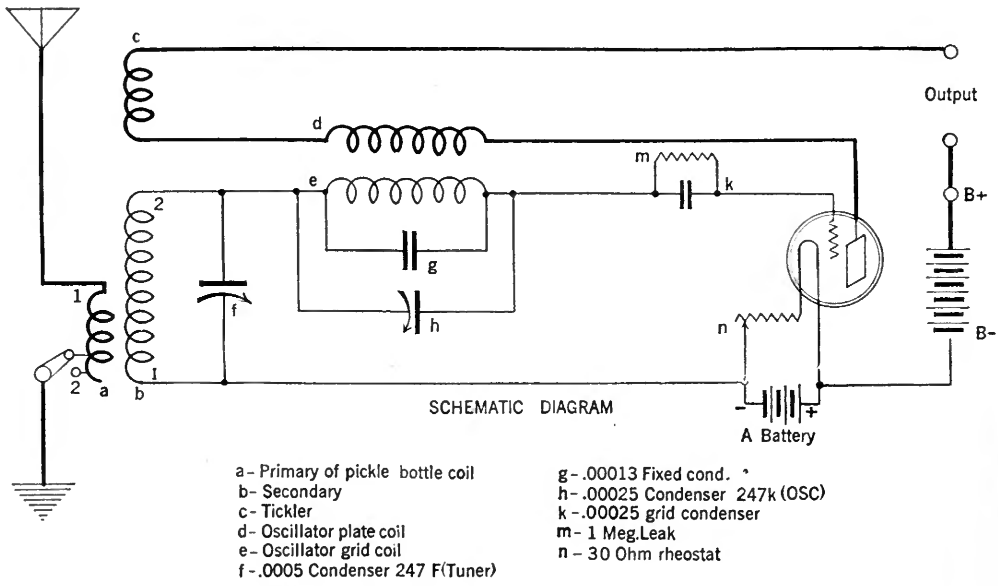
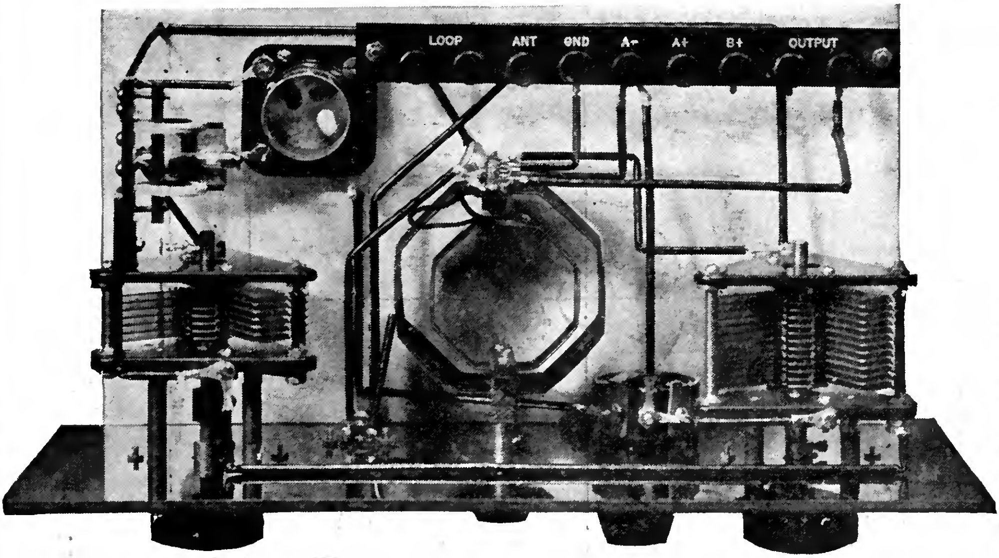



FIG. 4
The schematic diagram of the frequency changer showing the Armstrong system of securing local oscillations in the first detector tube

HOW YOUR PRESENT RECEIVER IS USED

NOW that we have the 500,000-cycle beat note generated in our frequency-changer, it remains to provide an intermediate amplifier tuned to this frequency, and here is where our receiver now in operation comes in. All that is necessary is to tune it to 600 meters (500,000 cycles) and to place




RADIO BROADCAST Photograph

FIG. 5

Looking down on the layout one clearly sees the general disposition of parts and the wiring scheme. The frequency-changer is really a very simple unit as this photograph shows

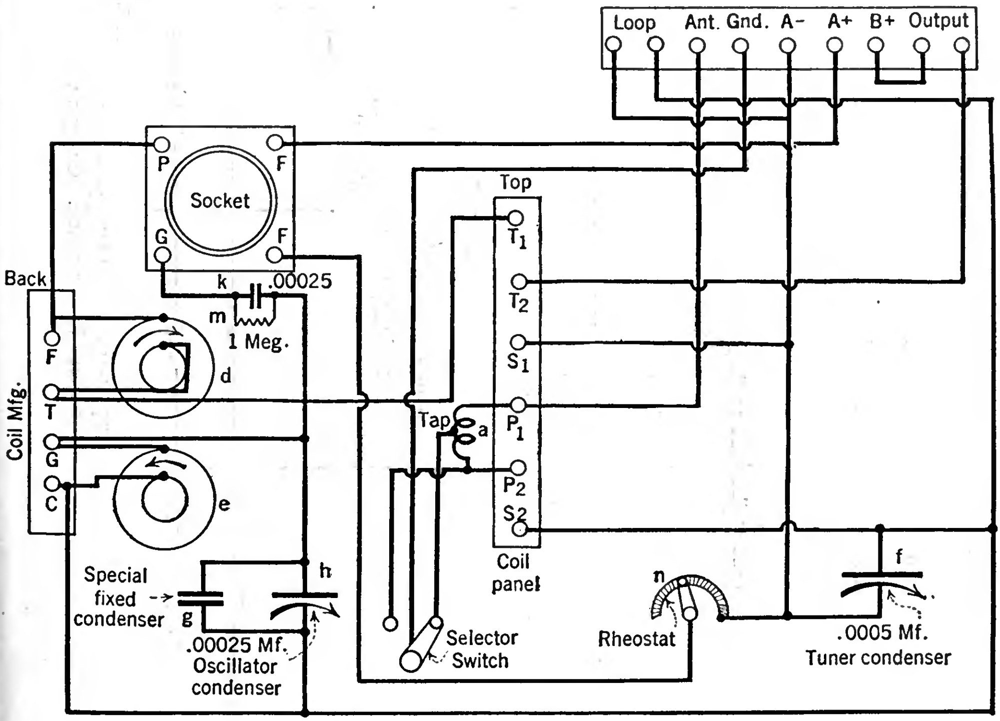



FIG. 6

The wiring diagram of the one tube super-heterodyne showing the connections of the various units

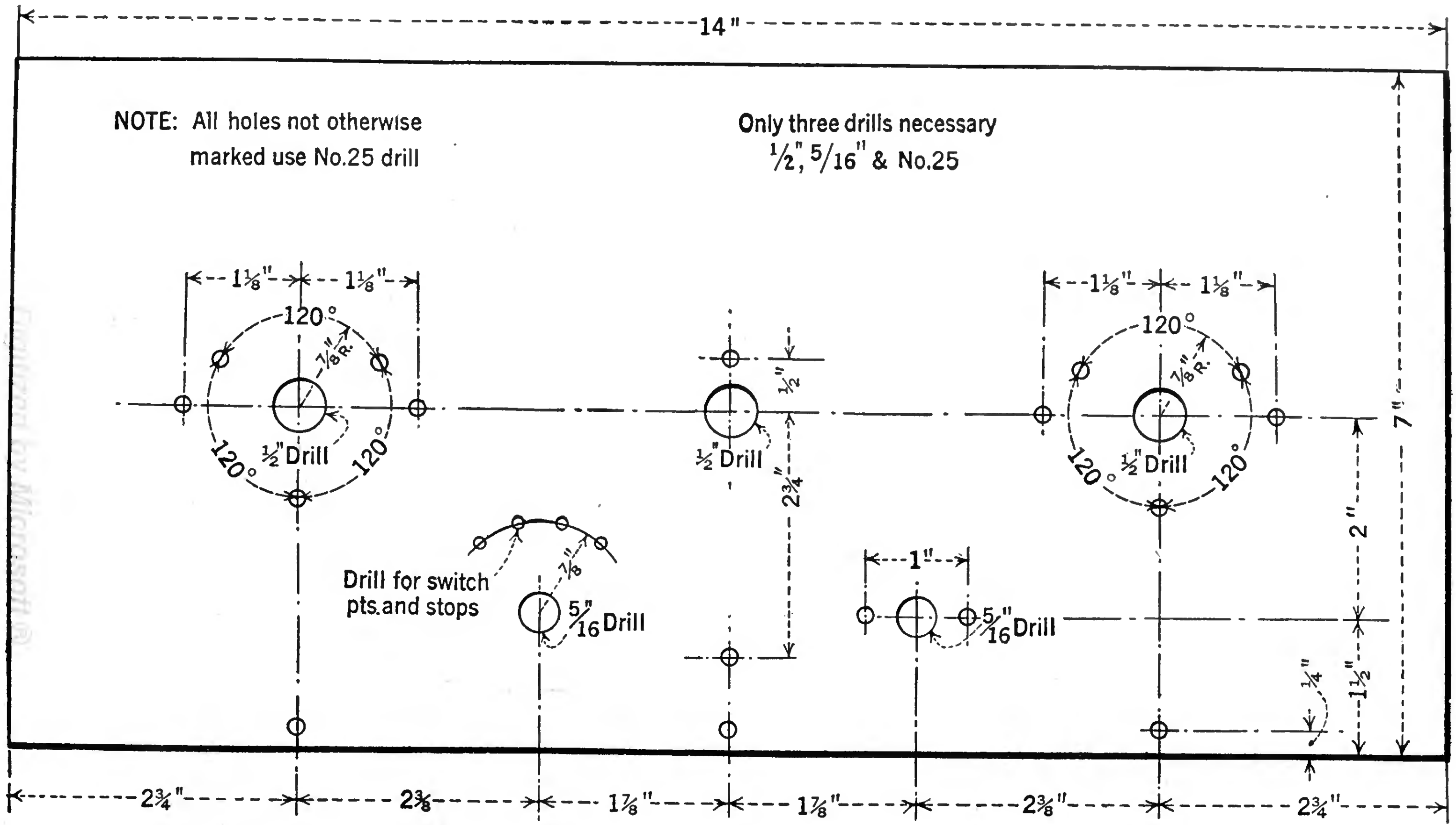



FIG. 7

This is the actual drilling template for the panel, and the dimensions given apply to the parts described in this article. Changes will have to be made if other parts are substituted its antenna and ground connection to the output of the frequency-changer, and we have a super-heterodyne.

Fig. 4 shows the schematic diagram of the circuit and Fig. 6 shows the connection hookup. In Fig. 6, coils A, B, and C are the

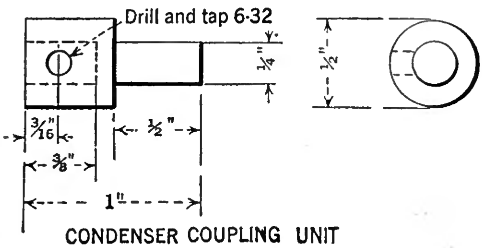
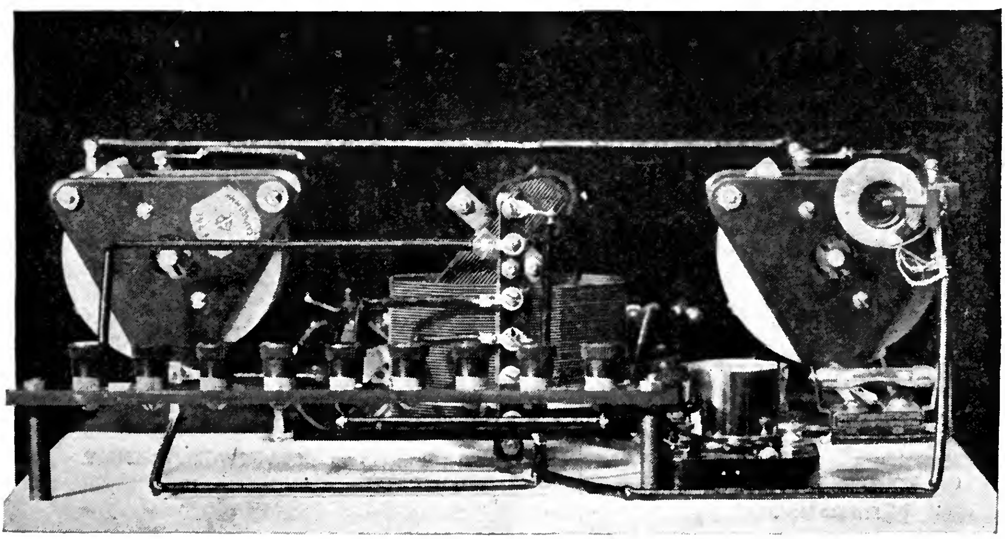



FIG. 8

To shield the condenser from body capacity effects it should be placed some distance from the panel and this coupling member enables the proper spacing to be carried out

three windings of a three-circuit tuner, the primary (A) being untuned. Incoming stations are tuned by the condenser F across the primary coil B. Their frequencies are heterodyned to 500,000 cycles by oscillator coils D and E, the latter coil being tuned by condenser G and H. Condenser G is placed in the circuit to increase the spread of the stations on the oscillator dial. The plate circuit, before it is introduced into the next tuning circuit, is brought into inductive relation with the secondary tuning coil B, thus causing regeneration and increasing both volume and selectivity. The plate circuit now contains, among other frequencies, the desired frequency of 500,000 cycles, and is introduced into the receiving system, where it is tuned and rectified in the same way that a 600-meter station can be tuned in.

You will note that in this arrangement, one tube receives and heterodynes at the same time. Up until a year ago this was not considered feasible, because tuning the oscillator circuit would detune the antenna circuit, due to the two frequencies being so close together. Major Armstrong showed that it is possible, if the frequencies are quite a distance apart, and exhibited an ingenious scheme for using one tube while maintaining a low frequency intermediate wave. In the frequency-changer which we are describing, the two circuits are always 500,000 cycles apart and tuning one circuit has no effect on the other. In constructing the frequency-changer, the idea of low loss has been kept constantly in mind, and, by direct comparison, low loss parts gave the best results. Distributed capacity in coils was hunted down, and condensers of the highest type were used, the oscillator condenser being insulated from the hand by means of a good dielectric. The parts used are listed below, but of course equivalent parts can be used, always providing that the constants are correct.



RADIO BROADCAST Photograph

FIG. 9

This rear view shows clearly the disposition of the coils and other apparatus. Note how the oscillator coils are clamped between the two bakelite strips which are fastened to the oscillator condenser

ITEM

*1* 1 Formica panel 7 x 14 x $\frac{3}{16}$ inches
*2* 1 Baseboard 12 $\frac{3}{4}$ x 7 x $\frac{1}{2}$ inches Poplar
*3* 2 National Velvet Vernier 4-inch Dials
*4* 1 General Radio Switch Lever $\frac{7}{8}$-inch with two Contact Points and two stops
*5* 1 General Radio No. 301 Knob and Pointer; for use on the tickler coil.
*6* 1 General Radio No. 301 Rheostat 30-ohm.
*7* 1 General Radio No. 247 F Condenser .00025 mfd. logarithmic plates.
*8* 3 $\frac{1}{2}$-inch Lengths Formica Tubing $\frac{5}{16}$ inch o. d. $\frac{3}{16}$ inch i. d. to space Item 7 from panel
*9* 1 Formica Coupling Member for Item 7 (Fig. 6)
*10* 1 General Radio 247F Condenser .0005 mfd. logarithmic plates
*11* 3 $\frac{1}{2}$ inch Lengths Formica Tube $\frac{5}{16}$ inch o. d. $\frac{3}{16}$ inch i. d.
*12* 1 Eastern Coil Corporation Coupler, Broadcast Wavelength, (15 turns on tickler, with middle tap on primary)
*13* 1 King Socket R730 for UV-201-A Tube
*14* 1 Dubilier Grid Condenser .00025 mfd. Type 601-G.
*15* 1 Daven Grid Leak .1 megohm
*16* 1 Binding Post Panel complete with 9 binding posts
*17* 1 Oscillator Coupler as per Fig. 7; coupler includes two coils as per description later in this article.
*18* Screws, wire, spaghetti, terminal lugs, etc.

Total cost of the above parts should be between $35.00 and $40.00.

Fig. 7 shows the actual drilling template for the panel, but of course changes must be made if other material is used.

Fig. 8 shows a coupling member for the .00025-mfd. variable condenser. This insulates the condenser from body capacity. Item No. 3 in the list above covers three Formica tubes which are used to set the oscillator condenser back from the panel, and to line it up with the other condenser. Item 11 covers spacers for the .0005 mfd. condenser. These are necessary because the design of the Velvet Vernier dial requires that the condenser be set back from the panel.

The Eastern Coil Corporation coupler is known as a pickle-bottle coil, and has fewer turns than normal due to the fact that it is in circuit with the plate coil of the oscillator coupler.

### THE UNUSUAL OSCILLATOR COUPLER

FIG. 10 shows the details of the oscillator coupler. This coupler is not the conventional type at all. In the usual coupler, the coupling between the plate and grid coils is fixed, and the coils are so large that their external fields exert an influence on all parts within a range of several inches. An attempt was made in this frequency-changer to design an oscillator which would have no effect on other parts, and this result was finally achieved. The coils shown have an exceptionally small external field, and the grid coil is placed $1\frac{1}{4}$ inches back of the oscillator variable condenser, a position in which it has no effect on the condenser. The coils are known as "cross-wound," and have about as little distributed capacity as any coil known. The coils are wound on a $\frac{5}{8}$-inch core, are $\frac{1}{8}$ inch thick, and each has 49 turns

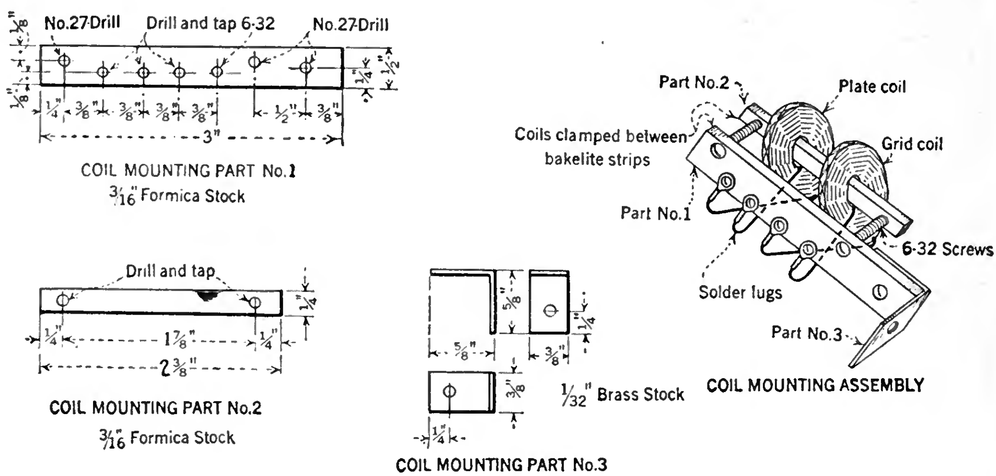
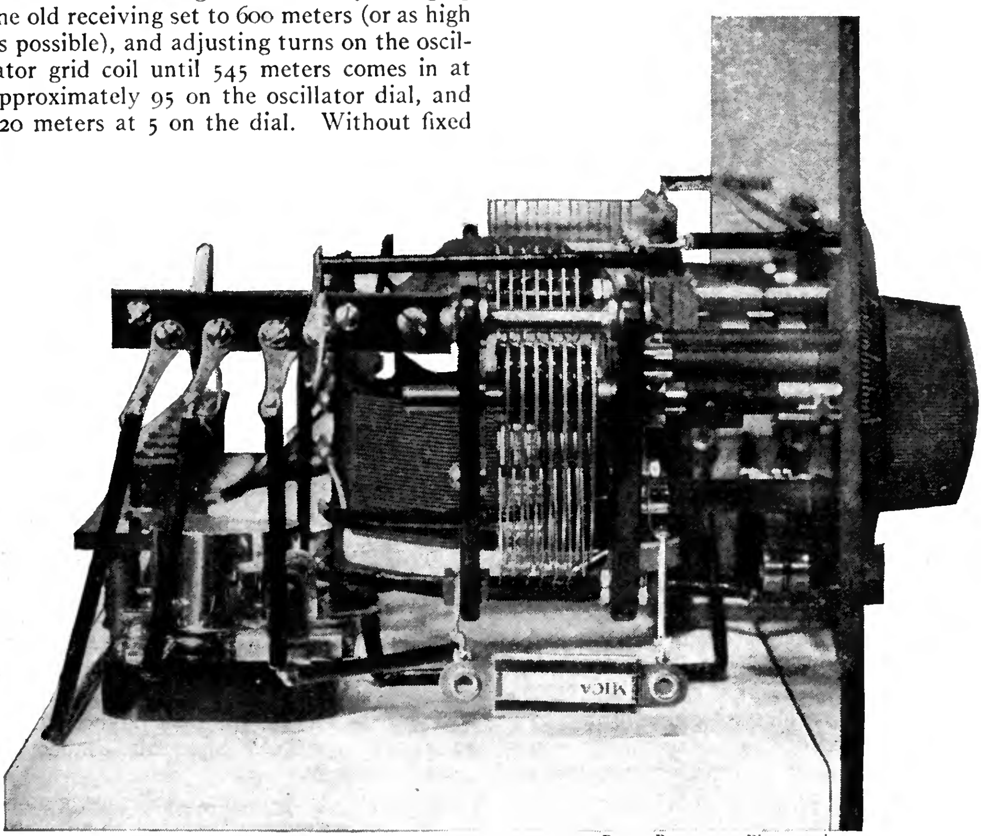



FIG. 10

The details of the oscillator coupler are shown in this Figure. Small coils placed at some distance from their tuning condensers decrease the external field and the resultant coupling effects to other parts of the circuit of No. 24 double cotton covered wire. Experimenters who desire to wind their oscillator coils, and are unable to make cross-wound coils, can use Lorenz (basket-weave) such as made by the Perfection Coil Co. or Sickles (diamond-weave) coils, and attain the same results, although the coils should be set back some distance from the oscillator variable condenser. By a cut-and-try method, the right number of turns can be ascertained, the calibration being determined by changing the old receiving set to 600 meters (or as high as possible), and adjusting turns on the oscillator grid coil until 545 meters comes in at approximately 95 on the oscillator dial, and 220 meters at 5 on the dial. Without fixed condenser G of Fig. 4 it would be impossible to obtain this spread on the dial and the capacity of this condenser will have to be determined by trial. The value used in the frequency-changer shown in the photograph was .00013 mfd.

As mentioned above, in the usual oscillator coupler the coupling between plate and grid coils is fixed. Yet the best value of coupling varies with the frequency, and experiments have shown that most couplers have a value of coupling that is good for some frequencies and poor for others.

The best value of coupling for a given frequency is minimum coupling; in other words, the coupling should be decreased until the point is reached where the tube is just ready to stop oscillating. By finding this coupling distance for all frequencies, a point can be determined that will give the best average coupling for all frequencies. In the coupler shown in Fig. 10 this point is determined by test, and the coil locked in place.



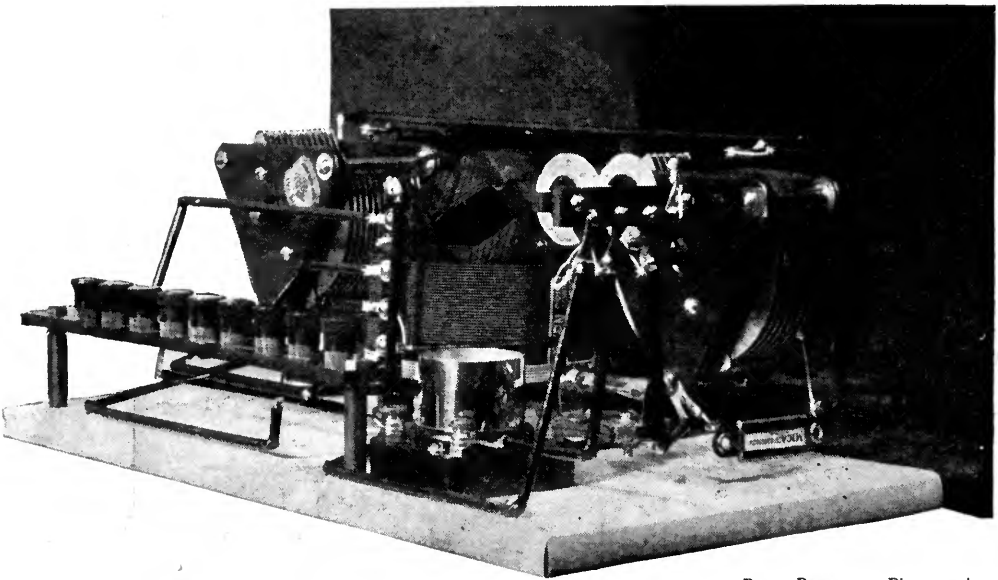
Radio Broadcast Photograph

FIG. 11

End view showing the method of placing the condenser some distance behind the panel to lessen body capacity effects. The separation of the coupling coils is clearly shown here

### HOW TO PUT THE "SUPER" TOGETHER

MOUNT all apparatus on panel and baseboard, assemble the oscillator coupler on rear of .00025 mfd. condenser, or some distance back of the condenser if other than cross-wound coils are used. Connect the parts as per connection diagram Fig. 10, soldering wires to the terminal lugs instead of



Radio Broadcast Photograph

FIG. 12

A perspective of the completed frequency changer. The grid leak and condenser are supported by the tube socket and the wiring to it

wrapping them around screws. Connections to S1 and S2 on the pickle-bottle coil should preferably be of flexible wire, as these two wires must be disconnected if a loop is to be used. A loop can be used when this unit is to be attached to a multi-tube set such as a neutrodyne, or tuned radio frequency set. If the unit is to be used with a single-circuit or three-circuit regenerative set, a loop can be used if maximum selectivity and a range of 100 to 200 miles is all that is desired.

After all internal connections are made, connect the battery terminals to the same battery terminals on your present set, making sure that positive B on the frequency-changer has a value of at least 45 volts. You will notice that there is no minus B on the frequency-changer. This is because this connection is taken care of in your present set. Connect the antenna and ground to the frequency-changer instead of to your present set. If you have a five- or six-tube radio frequency set, you may use a loop instead of the antenna and ground by disconnecting S1 and S2 of Fig. 2 from the secondary winding of the pickle-bottle coupler. Now tune your receiving set to 600 meters, get maximum regeneration, and leave your dials set. All tuning is now taken care of by the two dials on the frequency-changer panel and regeneration can be obtained by rotating the pickle bottle tickler.

### CARE MUST BE USED IN CONNECTIONS

BE VERY careful to examine *the circuit in your set* to which the output circuit of the frequency-changer is connected. This circuit *must not* be connected to the A battery circuit, or else there will be a short-circuit across 45 volts of the B battery. In some regenerative sets, and in neutrodynes, the A battery is grounded and this connection must be broken.

In an article to follow we will show a number of single-tube regenerative circuits and discuss the connections to, and operation of, the frequency-changer. We will also show how it is possible to "tune-in by the squeal" without annoying your neighbors. We will show the frequency-changer connected to a neutrodyne circuit and illustrate how to operate it on an antenna or on a loop. Best of all will be a method of connecting a frequency-changer to a crystal set, giving the long distance range of a single tube set with the selectivity equal to the finest super-heterodyne circuit. This makes a one tube circuit with the finest selectivity known.

# Radio Broadcast's Phonograph Receiver

*An Entirely New Method of Building the Four-Tube Knock-out Receiver to Fit in Any Phonograph—A Design Which Sets A New Mark for Home-Built Receivers*

By ARTHUR H. LYNCH

THE most popular phonograph to-day is the phonograph in which radio is an integral part. It is possible to double the use and value of the many thousands of phonographs in this country to make them better instruments for the home by using some sort of radio receiver in connection with them. For some months, it has been possible to buy factory-made radio receivers which could be fitted into a compartment of the phonograph. But the home constructor has had to worry along as best he could.

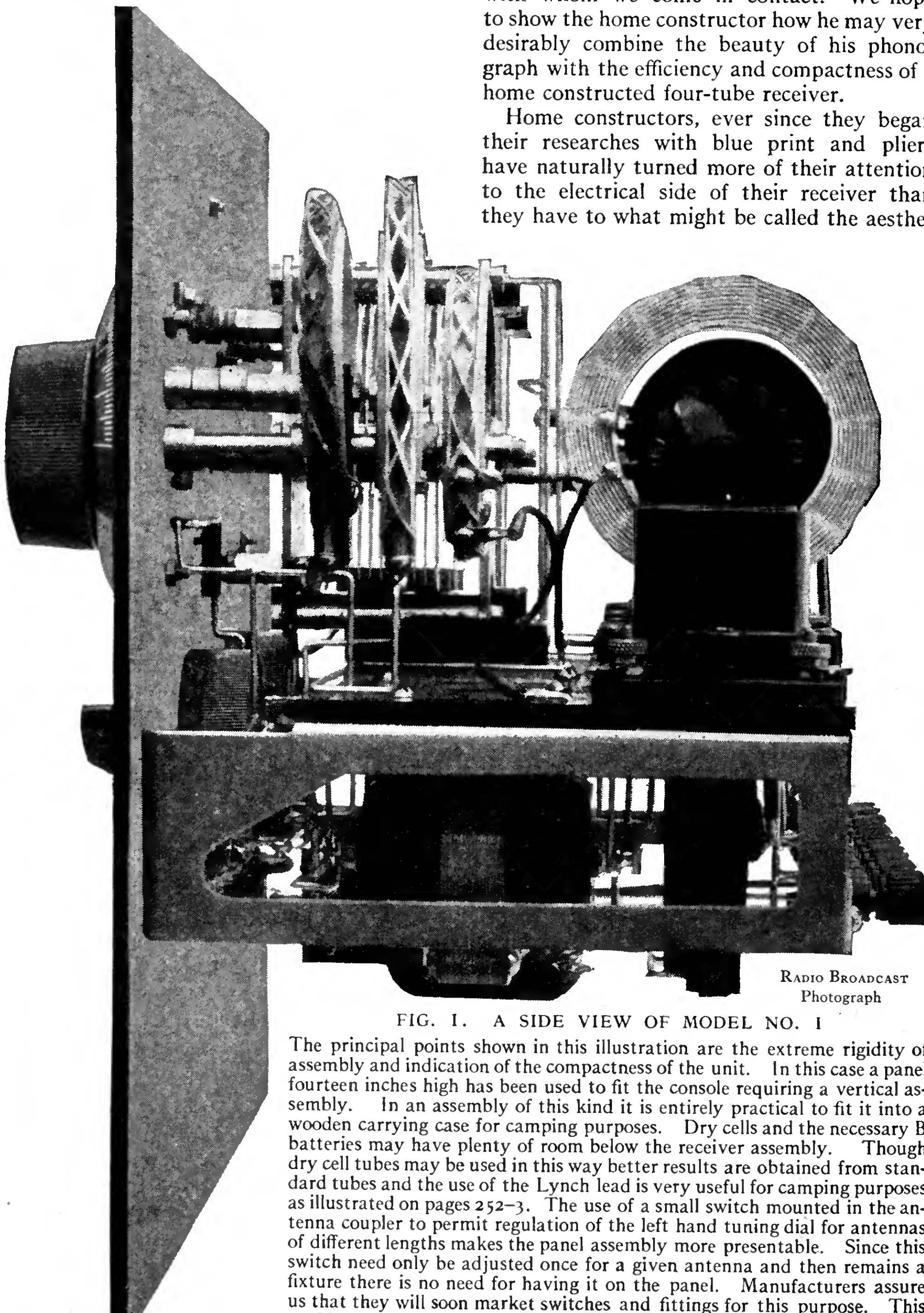
RADIO BROADCAST has determined to experiment with the idea of furnishing the best design possible for home constructed receivers in the phonograph. We are gambling on our conviction that the home constructor, that everyone, in fact, is interested in making the phonograph a more valuable bit of domestic equipment. To that end, we have spent a great deal of time and money in canvassing the entire situation and we shall bring to you every month, for some time to come, the results of our findings. Those findings, we think, involve some distinctly new ideas in radio construction. We shall offer you an opportunity to build various models of one of the most compact and efficient radio receivers for home construction that we have ever seen.

The phonograph is a very satisfactory means of entertainment, and we feel sure that by the proper design of a receiver for incorporation in practically any model of phonograph we are going to present something of great use to a large number of people. Many a perfectly good phonograph has been done out of a home by the radio set. Many more have been pushed aside, and their sole present use is to hold a beautiful lamp or a flower pot.

### HOW TO GET THE MOST RADIO IN THE LEAST SPACE

RADIO has brought a new problem into the home. Space in many modern homes is often scarce. When the piano, the books, the library table, and the phonograph are properly placed, where to put the radio receiver has caused many brows to wrinkle. If a phonograph is part of the household equipment, it is often necessary to relegate it to an inconspicuous corner. And, if our observation counts for anything, there are entirely too many phonographs that are now gathering whatever dust the housewife will permit it to collect. Too many phonographs are not used from one end of the year to the other. This has been the case in the homes of a number of our staff and in the homes of many people with whom we come in contact. We hope to show the home constructor how he may very desirably combine the beauty of his phonograph with the efficiency and compactness of a home constructed four-tube receiver.

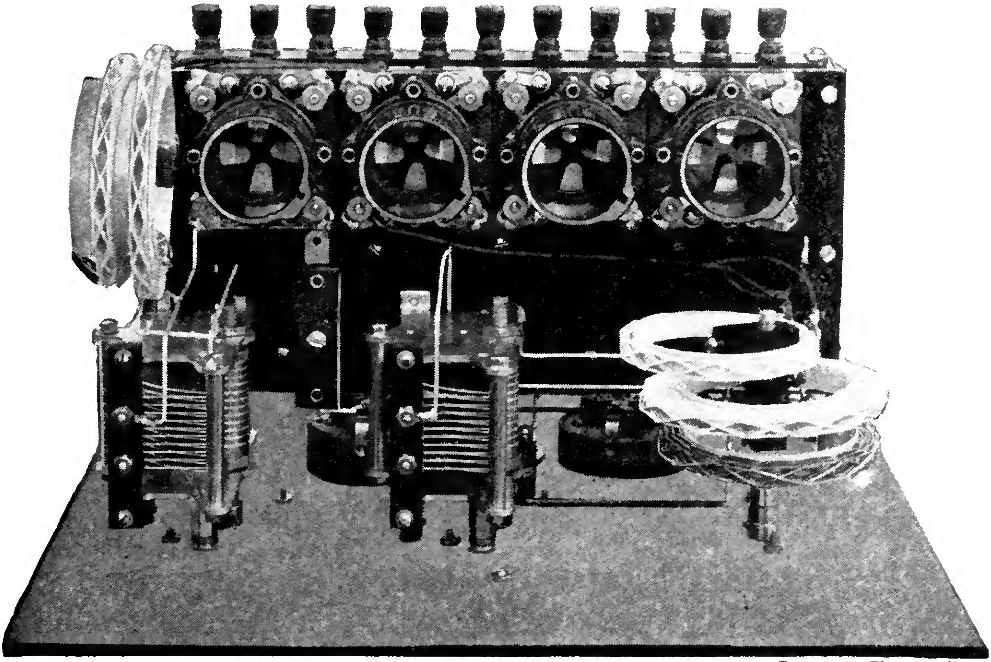
Home constructors, ever since they began their researches with blue print and pliers have naturally turned more of their attention to the electrical side of their receiver than they have to what might be called the aesthe-



Radio Broadcast Photograph

FIG. I. A SIDE VIEW OF MODEL NO. I

The principal points shown in this illustration are the extreme rigidity of assembly and indication of the compactness of the unit. In this case a panel fourteen inches high has been used to fit the console requiring a vertical assembly. In an assembly of this kind it is entirely practical to fit it into a wooden carrying case for camping purposes. Dry cells and the necessary B batteries may have plenty of room below the receiver assembly. Though dry cell tubes may be used in this way better results are obtained from standard tubes and the use of the Lynch lead is very useful for camping purposes as illustrated on pages 252–3. The use of a small switch mounted in the antenna coupler to permit regulation of the left hand tuning dial for antennas of different lengths makes the panel assembly more presentable. Since this switch need only be adjusted once for a given antenna and then remains a fixture there is no need for having it on the panel. Manufacturers assure us that they will soon market switches and fittings for this purpose. This idea was suggested to us by P. R. Morrison of Freeport, Long Island



Radio Broadcast Photograph

FIG. 2. TOP VIEW OF THE PHONOGRAPH UNIT

Particular attention is called to the assembly of the sub-panel as well as the position of the tube sockets. In order to permit the complete unit to be used in either a vertical or horizontal position without requiring a single change in construction and to offset the possibility of the tube filaments sagging and touching the grids, the correct placing of the sockets is important. Manufacturers who are to market a four-tube sub-base of this type at our suggestion have agreed to see that their products incorporate this attractive and important feature. Even though this receiver is very compact it will be observed that there is no crowding

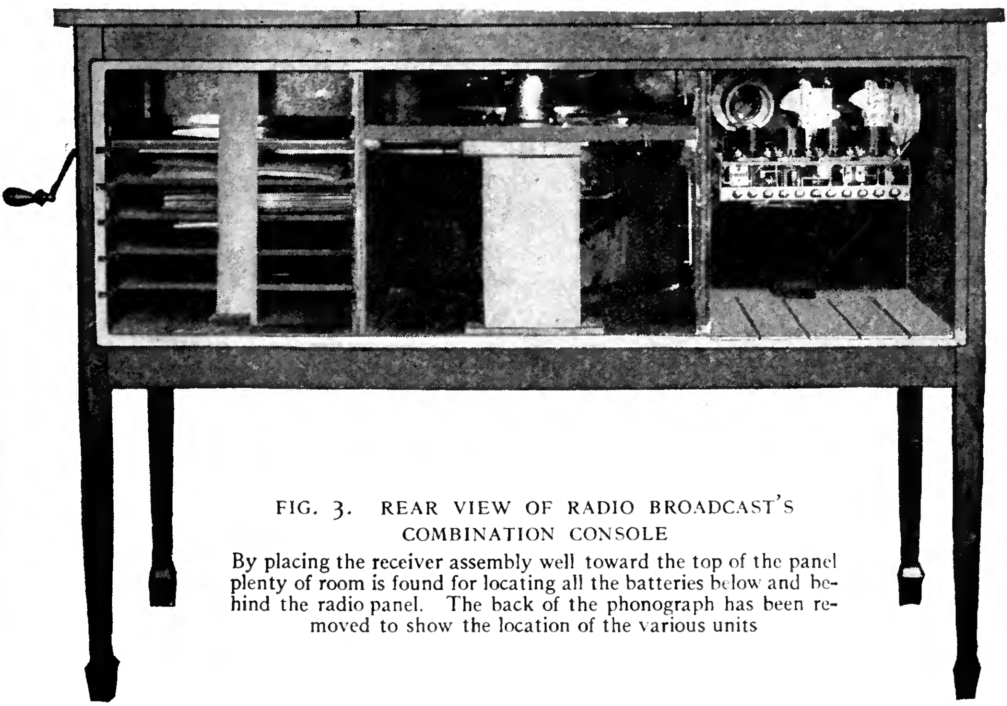


FIG. 3. REAR VIEW OF RADIO BROADCAST'S COMBINATION CONSOLE

By placing the receiver assembly well toward the top of the panel plenty of room is found for locating all the batteries below and behind the radio panel. The back of the phonograph has been removed to show the location of the various units

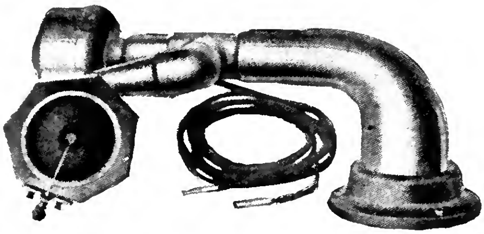
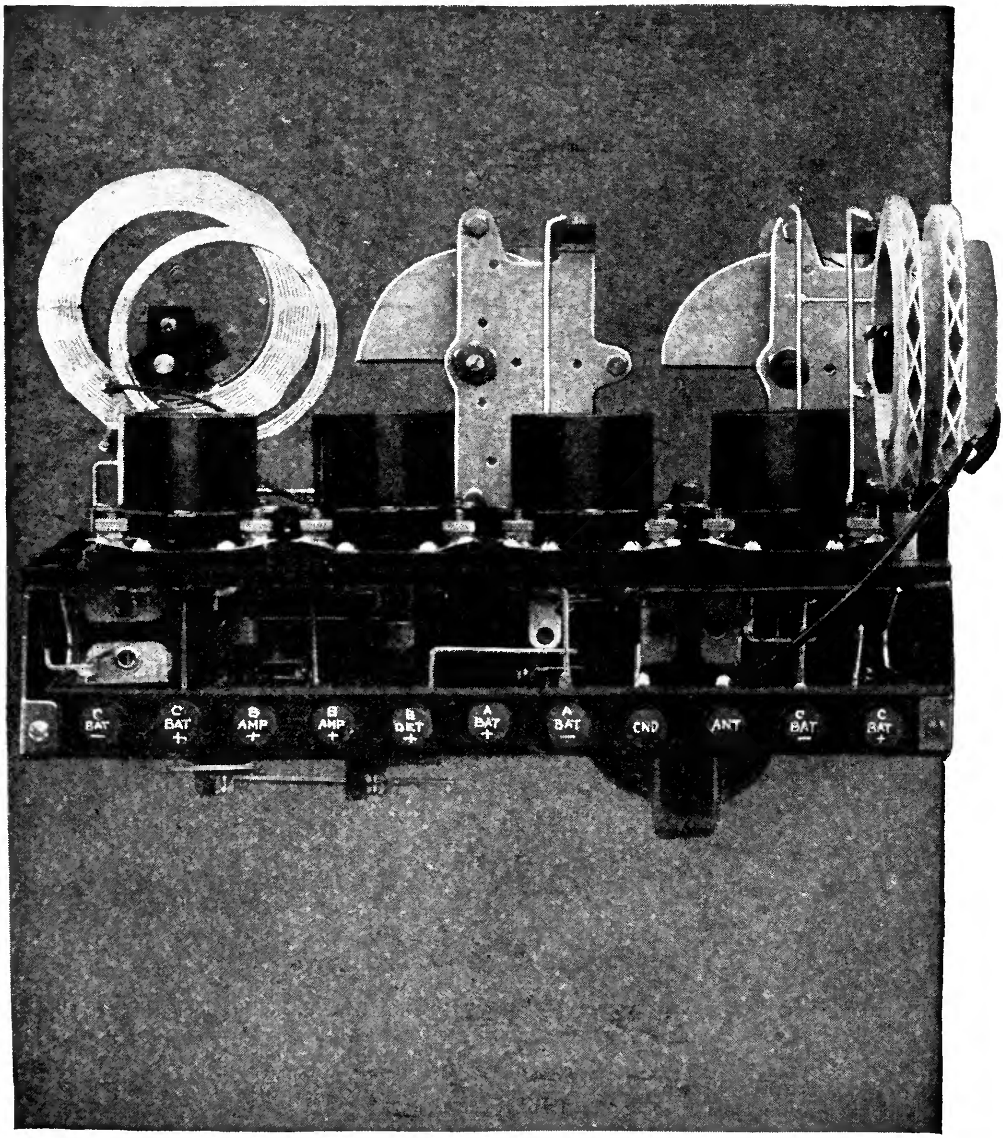


FIG. 4
A loud speaker and phonograph tone-arm now available commercially

tic side. If the set was put together and it worked, the cabinet in which the set was contained was often a secondary consideration.

Radio Broadcast's Phonograph Receivers will allow the constructor to utilize the handsome qualities of his phonograph cabinet, and the excellent sound chamber of that instrument. For these two reasons alone, we believe that many, many phonographs are going to come out of the shadow, not only to be seen but to be used again.




Radio Broadcast Photograph

FIG. 6. FROM THE REAR
This is how the unit appears

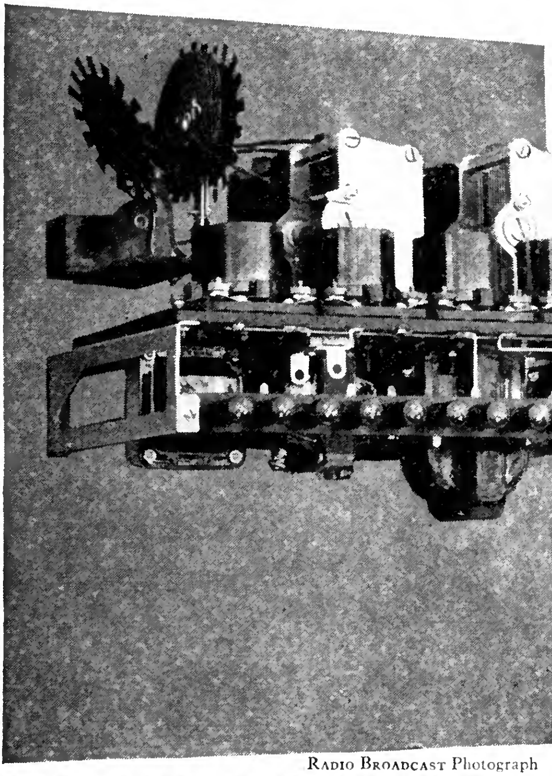
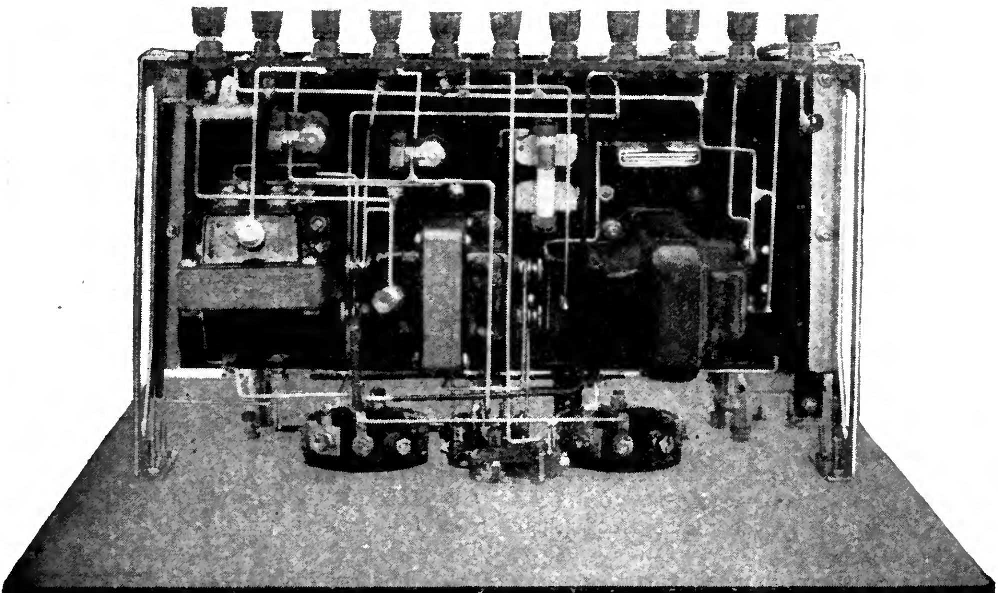


FIG. 6A. ANOTHER REAR VIEW

Showing how other coils and condensers may be employed without any change in layout

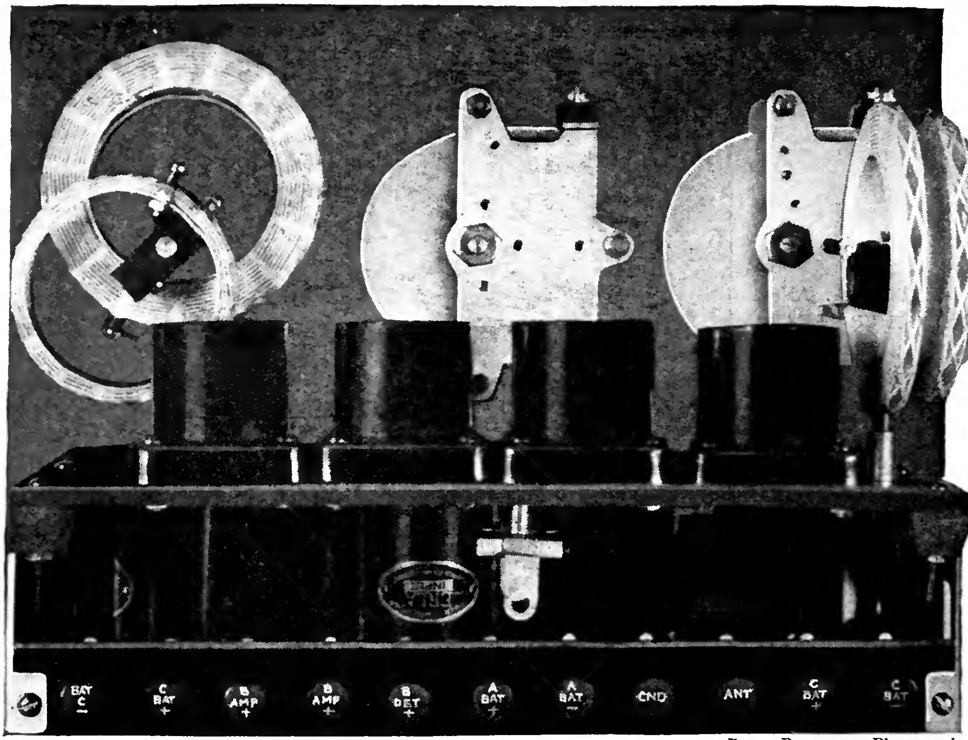
Radio Broadcast Photograph



Radio Broadcast Photograph

FIG. 7. FROM THE BOTTOM

We get some idea of the wiring. In this unit we have used audio transformers of rather large physical dimensions in order to be sure that practically any transformers may be used without undue crowding. Amperites are used in the filament circuits of the push-pull tubes to reduce the number of manual controls as in Fig. 12. In receivers designed for use with UV–199 or similar tubes for operation from flashlight or dry batteries it is sometimes advisable to use a single rheostat for the two tubes as shown diagrammatically in Fig. 11




RADIO BROADCAST Photograph

FIG. 8. ANOTHER SAMPLE

In this arrangement another group of audio transformers are used and the spring sockets have been replaced by the rigid type. In order to cushion the tubes two strips of sponge rubber are placed between the sub-panel and its supporting brackets. In this receiver, flexible wiring is used and a series of wires with special colored covering as described in the article on standardization in the April RADIO BROADCAST is suggested. It is not a difficult matter to arrange color combinations within the receiver just as standards have been suggested for the wiring outside the receiver. It is not unlikely that design of this nature will soon find its way into receivers other than those for home construction. Wire manufacturers assure us they will soon be ready to supply such wire. It is well to compare this unit with Fig. 6. There was no noticeable difference in performance. Convenience for your particular assembly problem is the factor to decide upon between the two

If you use this combined radio-phonograph unit, there is no reason why you should ever be deprived of the very best in the world's entertainment. When the radio programs do not suit your mood, there is certain to be a record among your collection which will suit the occasion. The radio receiver and the phonograph have taken a tremendously important place in the home, and RADIO BROADCAST believes that both should be used to their fullest capabilities.

A radio receiver for a phonograph has to be designed so that it will fit the various cabinets in which it might be installed. The RADIO BROADCAST Phonograph Receiver consists of an extremely compact unit employing the excellent circuit developed for us by Walter Van Braam Roberts of Princeton University. The unit itself is so designed that it can be adapted to a panel of any size. The dimensions of the panel conform to the size of the phonograph cabinet into which the receiver is to be put.

## THE MAIN FEATURES OF THE PHONOGRAPH RECEIVER

FOLLOWING articles will show just how to build this receiver, down to the very last binding post and drop of solder. The photographs which are reproduced with this story show just what we have been able to do with the Phonograph Receiver and several representative types of phonograph cabinets. For the experienced radio constructor, the photographs are self explanatory, but for the builder who sets great store by complete constructional details and diagrams, the later articles will show exactly how it is done.

The main feature of the Phonograph Receiver is its wonderful compactness. The panel layout, as you will observe, is extremely symmetrical. The assembly of the parts is not particularly difficult and the results which we have obtained with several models with which we have been experimenting have been highly satisfactory. This Phonograph Receiver combines all the good features of the Four-Tube Knockout, plus some very significant mechanical and electrical improvements. By referring to the announcement of the Better Receiver Contest, which appears on another page of this magazine, you will find listed the qualifications which the Roberts Knockout receiver possesses. We believe that tube for tube, dollar for dollar, and result for result, this is by far the best receiver ever designed for home construction.

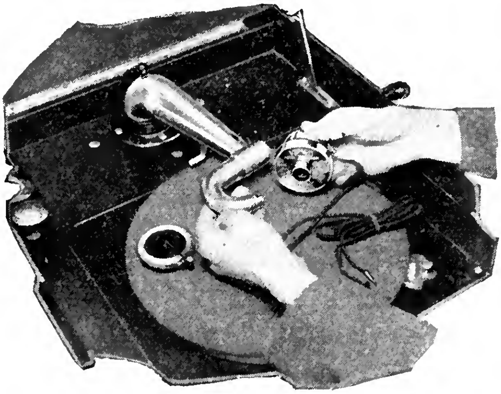
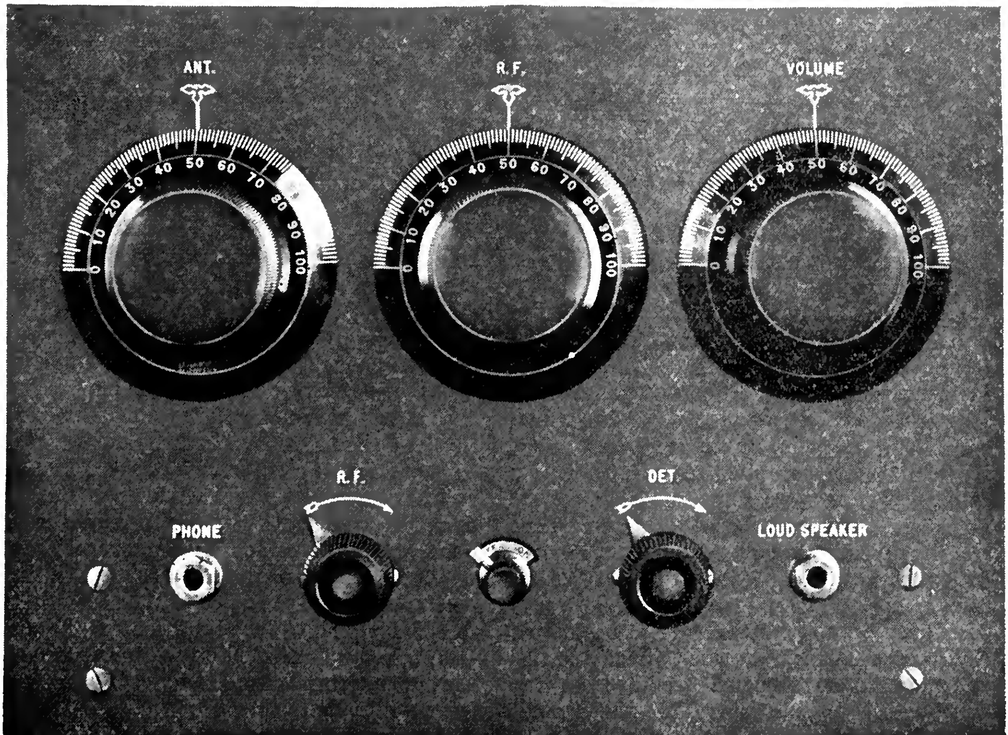


FIG. 9. A SIMPLE METHOD OF CONVERTING THE TONE CHAMBER OF A PHONOGRAPH INTO A LOUD SPEAKER

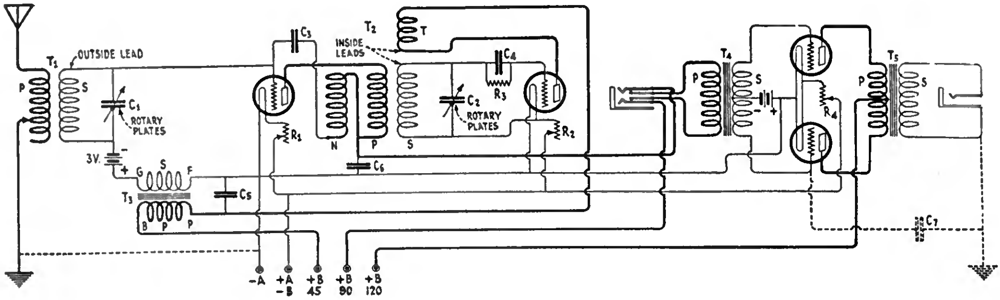
After we had satisfied ourselves that we had the best possible receiver for the purpose, the next most important point was the actual mechanical layout of the parts. In this, we feel, we have been highly successful.




Radio Broadcast Photograph

FIG. 10. THE UNIT ON A SMALLER PANEL

This model was made to illustrate the points outlined in Fig. 8 and shows a very symmetrical panel design. The application of a unit like this to any phonograph is a very simple matter. It is merely necessary to procure a piece of five ply veneer large enough to fill the desired space, cut a hole in wherever the unit will fit most satisfactorily and set it in place. If, to conserve space, it is necessary to install the receiver in a sidewise position, the precaution concerning the position of the tube sockets to prevent sagging filaments touching the grids must be taken into consideration and the mounting of the sockets changed accordingly. The engraving may then be put on the proper part of the panel to make reading the dials from the side unnecessary




FIGS. 11–12. THE SIMPLEST WIRING ARRANGEMENT

Is shown in Fig. 11. It differs from Fig. 12, (below), in several minor details. Simple jacks are used instead of those incorporating the filament control feature. A rheostat controls the filaments in the push-pull tubes instead of the Amperites. This circuit is a much simpler wiring job but where the receiver is to be used by the entire family the additional wiring necessitated by Fig. 12 will be found very much worth while. The dotted lines in both these diagrams illustrate simple and effective methods for overcoming any difficulties which may arise in the audio amplifiers such as a continual whistle which was observed when certain transformer combinations were used

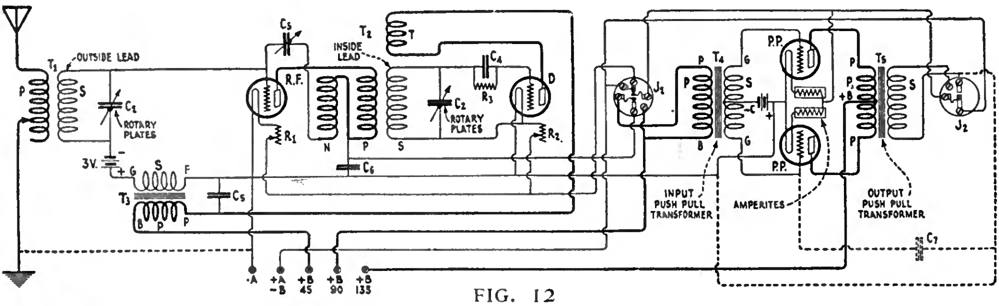



FIG. 12

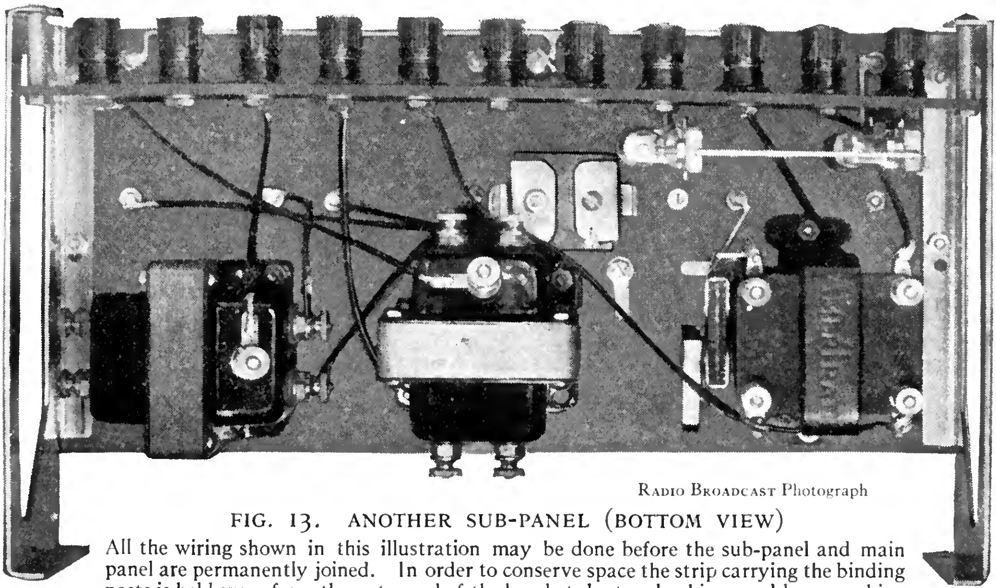
The possibilities of this Phonograph Receiver are best shown by an examination of the accompanying illustrations.

A great many Victor phonographs of the upright type are in use to-day. In these, the record cabinet is of two kinds. Some have two sets of shelves; the upper holding books for ten-inch records and the lower holding books for twelve-inch records. In order to fit the Phonograph Receiver in such a cabinet, it is merely necessary to remove the upper shelf and find some other convenient place for them. An unused corner of a bookcase does very well. A panel of wood or some composition is then made to fit the space previously occupied by the record-books and the receiver-unit is then fitted directly to this panel, or to a sub-panel mounted on the panel which is substituted for the record-book shelf.

The illustrations show that this radio-phonograph combination will save a great deal of space, and since the storage battery and the B batteries may be included in the phonograph itself they are permanently placed out of sight. This is, of course, impossible when the radio set is used on some sort of table

In another upright Victor model, there are a series of four to six shelves used to hold the phonograph records, with books to contain them. In placing the Phonograph Receiver in such a cabinet, it is only necessary to measure about twelve inches down from the upper end of the record space, remove the shelves and have a panel of wood or composition made to fit this space.

There are a great many receiver devices now on the market which enable one to use a so-called loud speaker attachment with the phonograph. These devices are connected to the audio output of the receiver and the unit itself mechanically coupled to the tone-arm of the phonograph. The sound compartment of the phonograph is used as the loud speaker. This operation is very simple, as can be seen from one of the illustrations. The character of the signal resulting from the use of a good loud speaker attachment and the phonograph itself as the "loud speaker" is extremely good. There are also some new types of tone-arms which combine both the tone arm for the phonograph and an attachment for employing the loud speaker unit. In such a combination, the phonograph or loud speaker attachment



Radio Broadcast Photograph

FIG. 13. ANOTHER SUB-PANEL (BOTTOM VIEW)

All the wiring shown in this illustration may be done before the sub-panel and main panel are permanently joined. In order to conserve space the strip carrying the binding posts is held away from the outer end of the brackets by two bushings and long machine screws. The space saved in this way is nearly $\frac{3}{4}$ of an inch. Units like this completely wired are soon to be placed on the market. The Radio Research Laboratories, New York City, are the originators of this unit idea. It would be well to compare this illustration with Fig. 7 to note the changes

may be used at will without taking the sound box from the tone arm. A tone-arm of the sort described has been used in our laboratory and has produced very satisfactory results.

In our experiments with this new design, we have used a great number of different radio parts designed for the same purpose. In practically every case, the overall efficiency of the resulting models has been substantially the same. For example, we have used a number of different types of transformers. We have used various kinds of coils, various makes of rheostats, and vacuum tube sockets. We have not as yet been able to use standard jacks in this receiver, although we are working on that problem now. It may, perhaps, be difficult for some of our readers to secure circular jacks as used in these Phonograph Receivers in their locality, but these may be obtained by mail order in a few days from almost any part of the country.

What we are trying to do is to present a design, which in the final analysis will give satisfaction, even in the hands of an inexperienced person. We are trying to make it possible for the home constructor to obtain the necessary parts without putting himself to a great deal of trouble. By incorporating as we have, well known, standard parts, we have made it possible for the radio dealer to supply all the necessary units for this receiver with a minimum of trouble.

All those who have seen the first models of the Radio Broadcast Phonograph Receiver are unanimous in agreeing with us that it fills a distinct need of the home constructor. The next article will describe the building of this receiver.

## ¶ MARCONI HIMSELF

HAS written about his most recent experiments. During late years, Senator Marconi has centered his energies on perfecting a method for transmitting guided radio waves and he believes that one of the great developments is in radio "beam" transmitting. Senator Marconi's article will appear exclusively in Radio Broadcast for July. It contains many interesting photographs never before published in this country.


*See Important Special Announcement on Page 278*

# QUERIES ANSWERED

WHAT IS THE FUNCTION OF A DETECTOR TUBE?
A. G. N.—Atlanta, Ga.

WILL YOU PUBLISH A CIRCUIT ON IMPEDANCE—COUPLED AUDIO-FREQUENCY AMPLIFICATION?
L. P.—San Antonio, Tex.

WHAT IS THE CIRCUIT DIAGRAM FOR INCLUDING A 110-VOLT LAMP IN A B BATTERY CIRCUIT FOR PROTECTING THE TUBE FILAMENT?
P. V. O.—Grand Rapids, Michigan.

WHAT IS THE PROPER WAY TO STAIN AND POLISH A HOME-MADE CABINET?
N. D.—Nashville, Tennessee.

EXPLAIN IN DETAIL THE USE OF THE COIL WINDING CHART FOR DETERMINING CONDENSER CAPACITY,
J. H. W.—St. Louis, Mo.

WERE THE DIMENSIONS USED FOR THE PANEL IN THE CONSTRUCTION OF THE TWO-STAGE RADIO-FREQUENCY AMPLIFIER IN THE MAY, 1925, ISSUE OF RADIO BROADCAST CORRECT?
L. G.—Chicago, Ill.

## HOW A DETECTOR TUBE "DETECTS"

THE term detect is somewhat erroneous when used in describing the function of a vacuum tube detector. If our ear mechanisms were able to respond to radio signals as they are transmitted, there would be no need for detector tubes.

However, the frequency, or in other words, the rapidity with which the radio vibrations are produced, is too great for us to hear, so that some means of reducing the number of vibrations must be employed. The action is one of rectification rather than one of detection. For instance, the maximum number of vibrations that can be heard by the human ear is about 20,000 cycles, while the minimum number that can be heard is but 16 cycles.

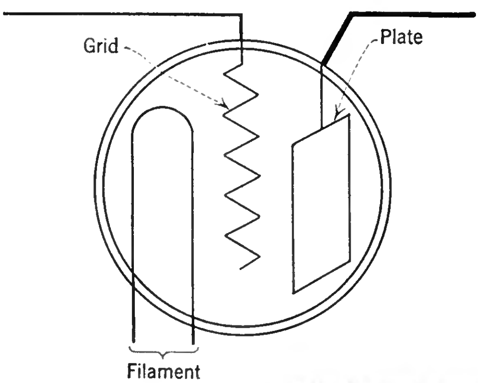



FIG. 1

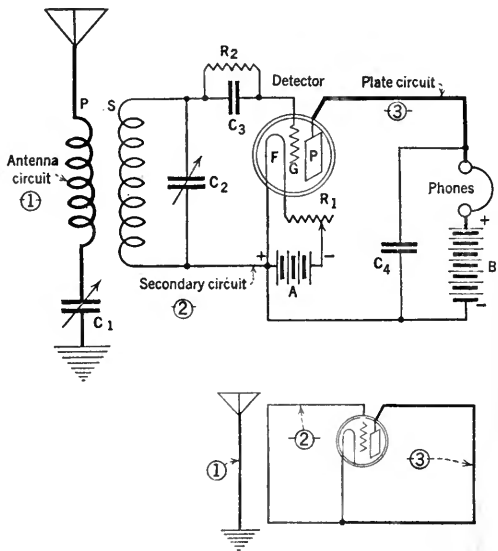
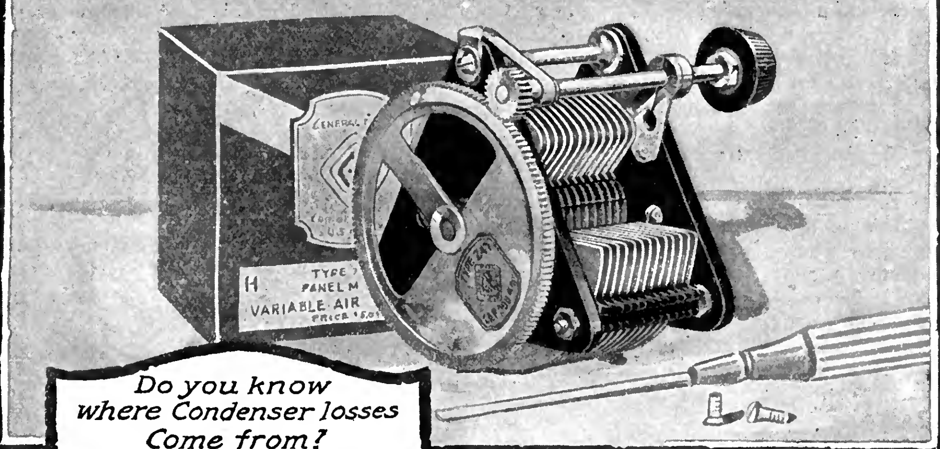



FIG. 2

# Facts! not Fancies!



### Do you know where Condenser losses Come from?

RESISTANCE LOSSES are the losses which most seriously affect the efficiency of a condenser when at working radio frequencies. They arise from poor contacts between plates and from poor bearing contacts. Soldered plates and positive contact spring bearings reduce these losses to a minimum.

Eddy current losses occur in metal end plates and the condenser plates themselves. While not so serious as resistance losses, they increase with the frequency, and therefore should be kept as low as possible.

Dielectric losses are due to absorption of energy by the insulating material. Inasmuch as they vary inversely as the frequency, they have less effect upon the efficiency of a condenser at radio frequencies than any other set of losses. The use of metal end plates in short-wave reception to eliminate dielectric losses is never justified, because they introduce greater losses than well-designed end plates of good dielectric.

The design of General Radio Condensers is based on scientific facts and principles, not on style and fancies.

Specially shaped plates always in perfect alignment give the uniform wave-length variation which permits extremely sharp tuning.

Rotor plates are counterbalanced to make possible accurate dial settings.

In 1915 the General Radio Company introduced to this country the first Low Loss Condenser, and ever since has been the leader in condenser design.

Lower Losses and Lower Prices make General Radio Condensers the outstanding values of condenser design.

*Licensed for multiple tuning under Hogan Patent No. 1,014,002*

| | |
|---|---|
| **Type 247-H, with geared Vernier** Capacity, 500 MMF. *Price* | $5.00 |
| **Type 247-F, without Vernier** Capacity, 500 MMF. *Price* | $3.25 |

GENERAL RADIO CO.
CAMBRIDGE, MASS.

★

# GENERAL RADIO

**Quality Parts**

Now waves of greater or lesser frequencies than this must be either increased or reduced before they can be heard. To accomplish this purpose, a detector, or rectifier, is used, which breaks up the frequency of the oscillations into groups and makes it possible to hear the vibrations as they are recorded on the telephone diaphragm.

The elements of which the tube consists are (A) a filament which is energized by a source of direct current (storage A battery.) Around this filament is (B) a wire mesh or grid. Then outside and around the grid is (C) a metallic member termed the plate. These elements are supported by wire rods imbedded in a glass tube from which the air has been evacuated. Convenient contacts are provided by prongs protruding through the base.

Diagrammatically, the vacuum tube is represented as in Fig. 1 while Fig. 2 shows a vacuum tube connected in an ordinary receiving circuit.

The action of the circuit and the function of the tube are as follows:

The antenna circuit consisting of the antenna, primary, the variable condenser and the ground, have been adjusted to the wavelength of a transmitting station.

The secondary circuit, S-C[2], to which is connected the vacuum tube, its batteries and phones, is tuned in resonance with the primary.

This makes it possible to receive energy in the antenna circuit so as to set up an electro-magnetic field, which induces a voltage in the secondary circuit.

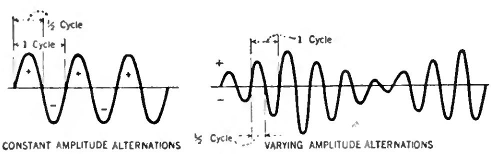



FIG. 3

Now, by referring to Fig. 2, it will be seen that there are, primarily, three parts to the circuit.

When the filament is lighted to incandescence it emits electrons which flow to the plate, so that when a signal is received, it sets up in the antenna circuit an electro-magnetic field, due to the variations in amplitude of the received signal. See Fig. 3A and B. This field induces in the secondary, or grid circuit, a voltage which charges the grid condenser.

Doctor Van der Bijl explains the succeeding rectifying action as follows:

> "When the grid potential becomes positive, electrons are attracted to the grid and during the next half cycle when the grid potential becomes negative, the electrons cannot escape from the grid, because they are trapped on the insulated part of the circuit comprising the grid and the one plate of the condenser C3. During the next positive loop of the incoming wave the grid attracts more electrons, which are also trapped so that they cannot escape from the grid during the succeeding negative loop. In this way, the grid builds up a negative potential, and the high frequency potential variations on the grid, vary around a mean value of the grid potential, which becomes more and more negative as the strength of the incoming oscillations increase. This reduces the plate current, and if the condenser C3, and the insulation of the part of the circuit comprising C3 and the grid were perfect the plate current would be permanently reduced and this would make the tube inoperative. To prevent this, a high resistance leak, R2, is shunted across the condenser, its value being so proportioned that the electrons cannot leak off this resistance to any appreciable extent in a time comparable with the period of the high frequency oscillations. But the electrons do leak off in the time of the order of magnitude of the low frequency variations of the amplitude of the high frequency oscillations. The result is, that the potential of the grid takes such values as are represented by the curve in Fig. 4A. The high frequency variations in the plate circuit pass through the condenser C4 inserted in the output circuit, and the current in the telephone receiver takes the shape shown by the curve in Fig. 4B."

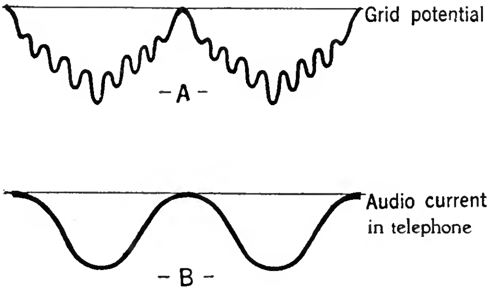



FIG. 4

The current passing through the phones energizes the electromagnets and conforms with its

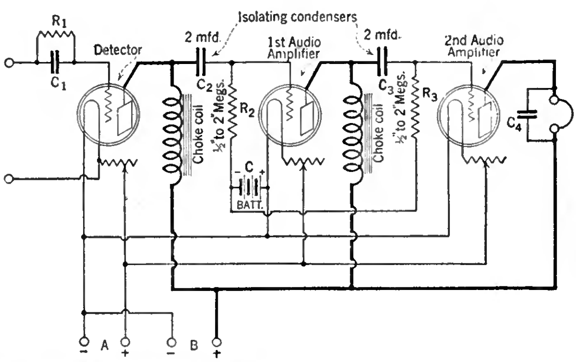
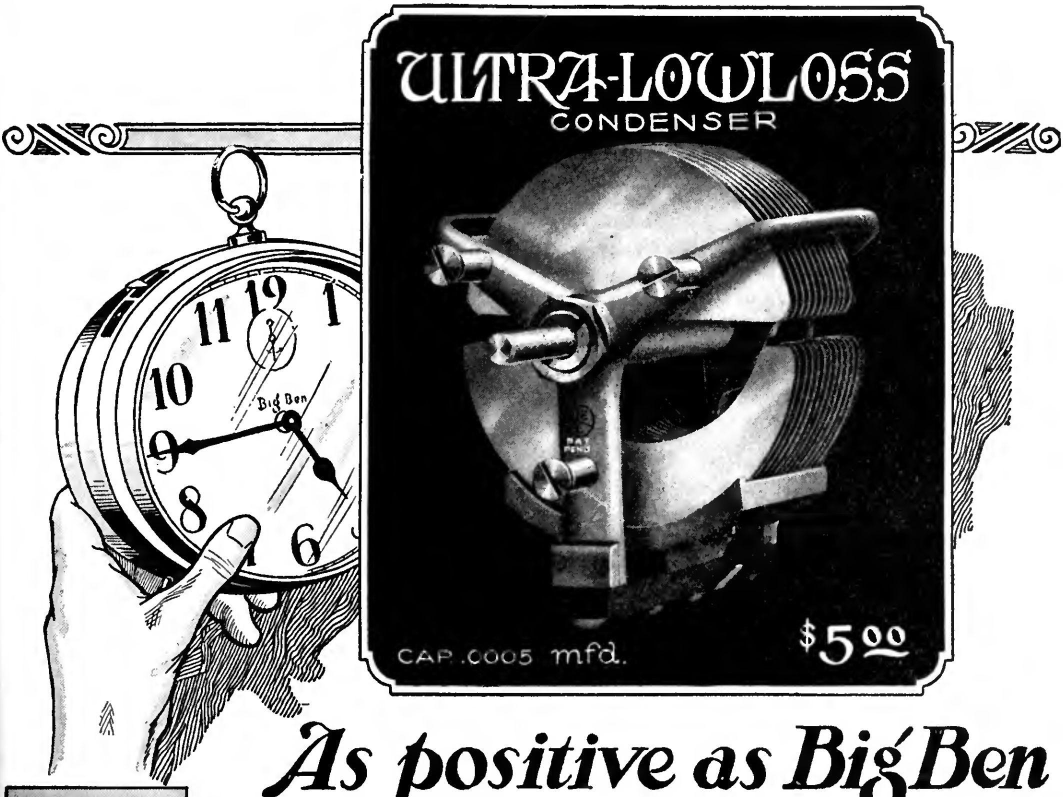
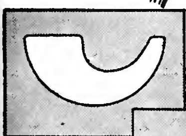



FIG. 5




# As positive as Big Ben



Cutlass Stator Plate exclusively an Ultra-Lowloss feature

A guarantee of satisfaction and Lacault design

SET Big Ben at seven and at seven o'clock you're bound to get the alarm.

Just so, the Ultra-Lowloss condenser can be set at any wavelength—the corresponding station will come in clear and sharp. You know instantly where to turn, once a station of known wavelength is located. Makes tuning easy—direct—positive. Special Cutlass Stator Plates spread wavelengths evenly over a 100 degree scale dial so that each degree represents approximately 3½ meters.

Ultra-Lowloss condensers are designed by R. E. Lacault, originator of the famous Ultradyne Receivers, and built upon scientific principles which overcome losses usually experienced in other condensers.

At your dealers, otherwise send purchase price and you will be supplied postpaid.

*Design of lowloss coils furnished free with each condenser for amateur and broadcast wavelengths showing which will function most efficiently with the condenser.*

**To Manufacturers Who Wish To Improve Their Sets**

Mr. Lacault will gladly consult with any manufacturer regarding the application of this condenser to his circuit for obtaining best possible efficiency.

★

## ULTRA-VERNIER
TUNING CONTROL

Simplifies radio tuning. Pencil-record a station on the dial—thereafter, simply turn the finder to your pencil mark to get that station instantly. Easy—quick to mount. Eliminates fumbling, guessing. Furnished clockwise or anti-clockwise in gold or silver finish. Gear ratio 20 to 1.

**Silver, $2.50 Gold, $3.50**

# ULTRA-LOWLOSS
## CONDENSER

**PHENIX RADIO CORPORATION - 116-C East 25th Street - New York**

strength, actuating the diaphragm which produces sound vibrations which are audible to the ear.

### IMPEDANCE-COUPLED AUDIO AMPLIFICATION

FOR those who wish to experiment with choke coil audio amplification, the circuit in Fig. 5 is especially interesting.

A detector and two-stage amplifier is shown.

In the plate circuit of the detector and first stage amplifier, the variations in voltage drop take place in the choke coils. These variations are impressed on the grid of the succeeding tube through the large isolating condenser. In the amplifiers the grid leaks connected from the grids to the negative side of the filament (through a small C battery) furnish a path for excessive negative voltages, which are accumulated on the grid, to leak off.

The choke coil may be the secondary of an audio transformer. Usually transformers having burned out primaries may be found in the junk box of the radio laboratory which will fit in nicely here.

The small C battery applies a negative bias on the grids which permits the amplifier tubes to operate on the proper point on their characteristic curve.

The value of an isolating condenser is such that a minimum of voltage loss is effected by its use.

Besides being a coupling agent between the plate and grid of adjacent tubes, this condenser isolates the high B voltage from the grid of the tube.

The values of the parts are C1 .00025 mfd., C2 2 mfd.; C3 2 mfd.; C4 .001 mfd: R1 3 megohms; R2 and R3 $\frac{1}{2}$ to 2 megohms.

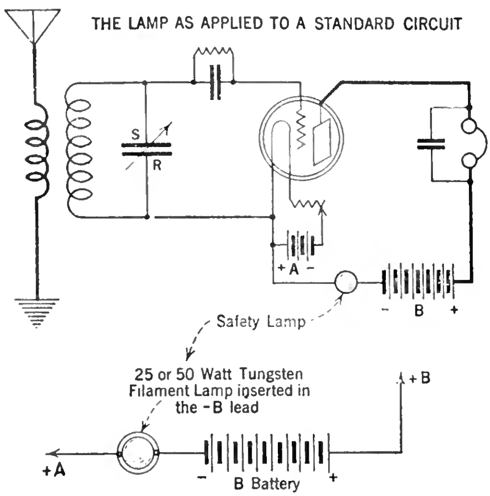



FIG. 6

### A TUBE PROTECTOR

VERY often radio tubes are consigned to the junk heap because some too enthusiastic experimenter was not careful enough to keep his high voltage B battery leads away from the filament circuit of his receiver.

By the simple addition of a 25 or 50 watt lamp inserted in the negative B battery lead (Fig. 6), tubes may forever be protected from blow-outs. Ordinarily the negative side of the B battery connects to either the plus or minus of the A battery.

Assuming that the connection is made to the plus A, if the plus B should happen to come in contact with the minus A, then 45 or 90 volts (as the case may be) would be applied to 6 volt filaments. Result: blown out tubes.

Now, by placing the lamp in the negative side of the B battery, the full voltage of the battery is applied to its filament thereby choking off the B current and so protecting the tube filaments due to the relatively high resistance of the lamp being inserted in series in the circuit. The tungsten type of lamp seems to give better results than the carbon filament type. Ordinarily if the plus B lead should touch the plus A lead then the B battery would become short-circuited, but if the lamp is in the circuit it will indicate the connection by lighting brilliantly.

### STAINING AND POLISHING CABINETS

THE true constructor must know a bit about the carpentry that enters into the make-up of a receiver. The art of carpentry is closely allied with the radio art as is manifest in the elaborate cabinet designs now so plentiful in the radio market.

For the home-constructor, a few pointers on staining and polishing will not be amiss. There are several kinds of stains, namely, the alcohol stain, the penetrating stain, and the oil stain. The first two named seem to act better for quality work, although no doubt good work may be accomplished with oil stain. This discussion will apply only to the penetrating and alcohol stains.

The equipment needed is as follows:

1. A small supply of alcohol—one pint.
2. Stain.
3. Cheesecloth pad made with cotton waste.
4. Steel wool.
5. Rotten stone.
6. Wax (in powdered or grease form).
7. Shellac—one-half pint jar.

The cabinet is first coated evenly with the stain until the desired shade is obtained. Shellac is applied with the cloth pad so that the entire surface is covered. Then with the alcohol, the surface is lightly washed, which removes much of the surplus shellac. After this coat is allowed to dry for about twenty minutes, another coating of shellac is applied which is again washed down with the alcohol. This is repeated until the desired surface effect is obtained. Then, with rotten stone the surface is fully cleaned, after which it is rubbed down by the steel wool. Finishing touches consist of polishing with a waxed cloth.

### THE COIL WINDING CHART FOR CALCULATING CAPACITY

IN LAST months' RADIO BROADCAST, a chart for the computation of coil sizes was described on page 46, which would aid the experimenter in determining the proper size coil required where

a certain sized condenser was designated to tune a circuit to a predetermined wavelength range.

In the article it was mentioned that the chart might be used in the reverse manner, where the coil size and wavelength range desired were known, to determine the value of variable condenser needed to accomplish this end.

In detail this reverse operation is described as follows:

Count the number of turns per inch on the coil and measure its length. On the chart connect these two points by a pencil line. Then determine the diameter of the coil and at that value on the chart and draw a line to intersect with the one previously drawn, at the index line and at the inductance scale.

Then by knowing the inductance value, since it is indicated by where this last line touches the inductance scale, and by knowing the maximum wavelength range desired, we draw a line between these two points and continue the line on to the capacity scale. This intersection at the capacity scale gives us the maximum capacity of the variable condenser necessary for tuning the coil in question to the maximum wavelength indicated.

### CORRECTED DIMENSIONS

THE dimensions for the panel used in the construction of the two-stage radio-frequency amplifier described in the May, 1925, issue of Radio Broadcast Magazine should read as follows: Panel 7 inches wide, 18 inches long, and $\frac{3}{16}$ inch thick.

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# *Before You Write to the Grid*

THOUSANDS of you are writing the Grid for technical advice every month. The expense of framing a complete and exhaustive reply to each letter is very high. The editors have decided that the benefit of the questions and answers service will continue to be extended to regular subscribers, but that non-subscribers, from April 15, on, will be charged a fee of $1 for each letter of inquiry which they send to our technical department. Very frequently, our technical information service proves of definite money value to you who write us, for we are often able by a sentence or two of explanation, to put you on the right path before you have made a perhaps expensive mistake.

The occasional reader of Radio Broadcast will be charged a fee of $1 for complete reply to his questions, and the regular subscriber can continue to take advantage of the service as before. In that way the non-subscriber will help share the cost of the technical staff whose service he gets. Every letter receives the benefit of the experience of the editor and the technical staff and every correspondent may be sure that his questions will receive careful consideration and reply.

When writing to the Grid, please use the blank printed below.

## GRID INQUIRY BLANK

*Editor*, The Grid,
Radio Broadcast,
*Garden City, New York.*

*Dear Sir:*

*Attached please find a sheet containing questions upon which kindly give me fullest possible information. I enclose a stamped return envelope.*

*(Check the proper square)*

☐ *I am a subscriber to* Radio Broadcast. *Information is to be supplied to me free of charge.*

☐ *I am not a subscriber. I enclose $1 to cover costs of a letter answering my questions.*

*My name is* ____________________

*My address is* ____________________


# By-Pass Condensers

## *remove disturbing noises and reduce losses*

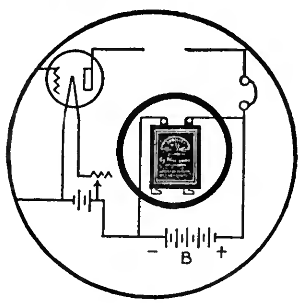
BY-PASS Condensers do a double job. They filter the fluctuating "B" battery current. They provide a free path for the radio frequency currents around the high internal resistance "B" battery.

The first function tends to remove disturbing noises—the second increases efficiency by reducing losses and properly routing the available energy.

The tone quality of every set will be greater in strength—purer—smoother—with a By-Pass Condenser.

★

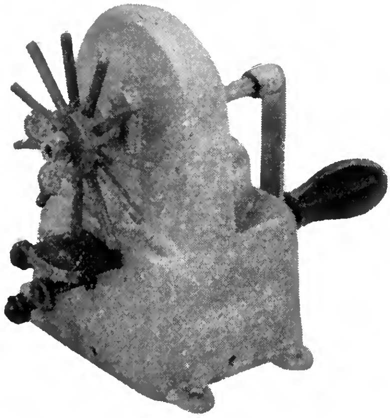
External connections for the By-Pass Condenser may be made by connecting it from the minus "B" terminal to the plus "B".




# Dubilier

CONDENSER AND RADIO CORPORATION

# *New Equipment*



SEE—ESS WINDER

The winding of numerous inductances for experimental work is made easy with the above apparatus. The result is a self-supporting diamond weave coil of any desired inductance. A desirable addition to the constructor's laboratory. Distributed by the Wireless Electric Co., 204-206 Stanwix St., Pittsburgh, Pennsylvania. Price, $10.00

BELDEN LOOP WIRE

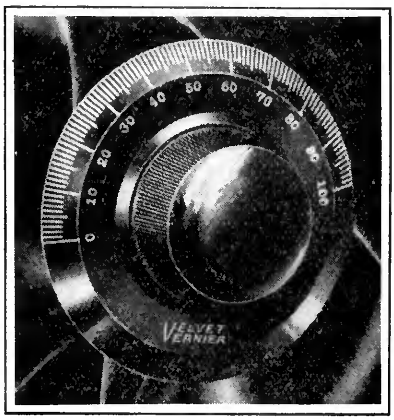
A wire composed of 60 strands of bare copper twisted with 5 strands of half hard phosphor bronze wire. This twist is then covered with cotton and finally with a good looking brown covering to match the better grades of loop frames. Made by the well known makers of wire, the Belden Manufacturing Company, Chicago, Illinois

KELLOGG REPRODUCER

The unit of this speaker is of special construction, having a magnetically modulated diaphragm. Coupled with this is the horn which was developed to be as nearly correct acoustically, both as to shape and material, as possible. This reproducer covers practically the entire auditory range of sound waves very successfully. Made by the Kellogg Switchboard & Supply Co., Adams & Aberdeen Sts., Chicago, Illinois. Price, $20.00

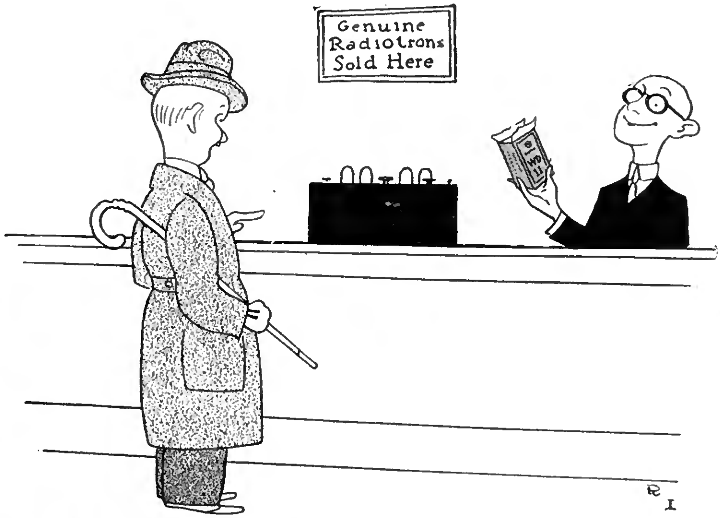
"BALLGRIP" BINDING POST

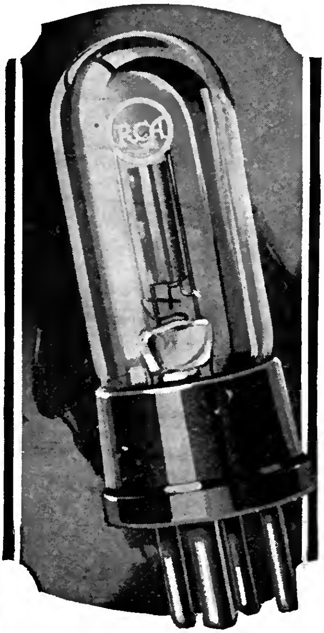
These interesting binding posts represent a new idea in this field. Connections may be made instantly and the opening in the post is large enough for receiver cord tips. Springs force the ball to make good electrical contact when a wire is placed in position. The fact that there is no head to loosen and be lost is a decided point in its favor. Made by the Quality Moulded Products Inc., Jersey City, New Jersey




VELVET VERNIER DIAL

An all-vernier dial with a ratio of approximately four to one and is entirely free from back-lash. With this dial you not only enhance the appearance of your receiver but also make tuning very easy. Made by the National Company, Inc., 110 Brookline St., Cambridge, Massachusetts



# *Do you believe in* Names?

Do you buy things by name because the name tells the quality? Do you ask for a RADIOTRON, instead of just a "vacuum tube"—demand the standard by the name that marks it as genuine?

The most important part of a radio set is the tube, and you can't get the best out of any set without putting the best tubes into it. There's a Radiotron for every use, in every kind of set. Look for the name—and the RCA mark—and be sure it is *genuine*.

**WD-11**
**WD-12**
**UV-199**
**UV-200**
**UV-201-a**

Radiotrons with these model numbers are only genuine when they bear the name Radiotron and the RCA mark.

Radio Corporation of America

*Sales Offices: Suite 37*

**233 Broadway, New York** **10 So. La Salle St., Chicago, Ill.**
**28 Geary Street, San Francisco, Cal.**

★

# Radiotron

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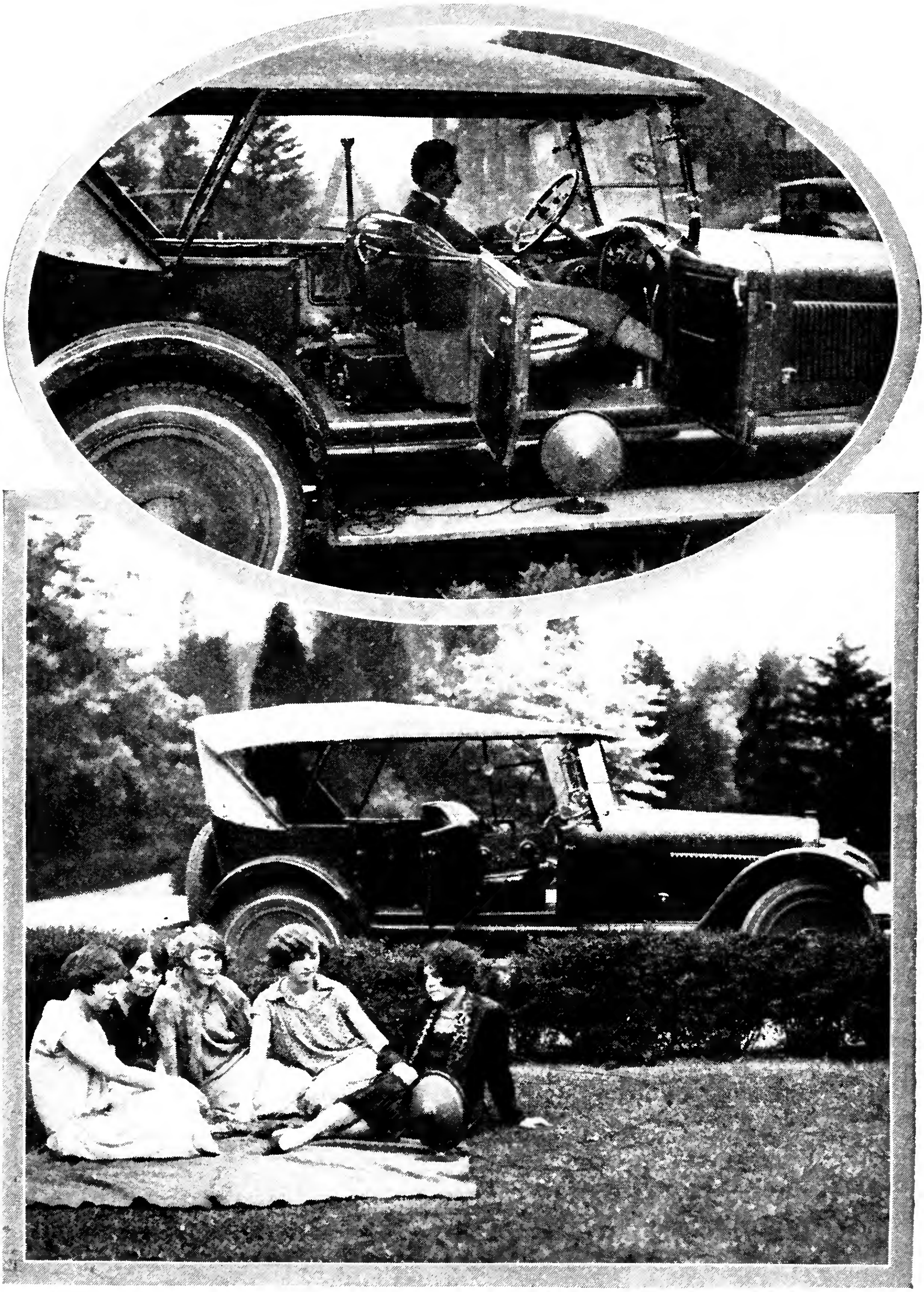
**PRODUCED ONLY BY RCA**

RCA



★ Tested and approved by RADIO BROADCAST ★



SUMMER-TIME RADIO

The super-autodyne described in this issue is made portable by use of the Lynch Lead which connects the filaments to the automobile battery. The Crosley " Musicone " is connected by a long cord so that the receiver may be left in the car and the speaker taken to any convenient spot nearby. It is growing more and more fashionable to make a portable set a part of motoring and camping equipment