Popular Radio

SEPTEMBER, 1922

15¢

How to Build the New Armstrong-Circuit Receiving Set

lacquer,
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phone, silk-co
—all ready t
no "extras"

Be

When Marconi heard *the* AERIOLA GRAND

© UNDERWOOD & UNDERWOOD

"IT comes closest to the dream I had when I first caught the vision of radio's vast possibilities. It brings the world of music, news and education into the home, fresh from the human voice. It solves the problem of loneliness and isolation.

"The Aeriola Grand is at present the supreme achievement in designing and constructing receiving sets for the home—a product of the research systematically conducted by scientists in the laboratories that constitute part of the R C A organization."

G. Marconi

The Importance of the Symbol R C A

CRUDE radio apparatus of a kind can be made even by embryonic organizations. But the vitally important inventions that have made radio the possession of every man, woman and child are those protected by patents owned by the Radio Corporation of America and developed as the result of costly research conducted in the engineering laboratories of the Radio Corporation of America.

The name plate of a Radio Set is all-important in the purchase of radio apparatus. If it bears the letters "R C A" the public and the dealer are assured that at the time of its introduction it is the highest expression of the advancing art of radio.

In tone quality, in simplicity of manipulation the Aeriola Grand is unrivalled. A child can snap the switch and move the single lever that tunes the Aeriola Grand and floods a room with song and speech from the broadcasting station.

Any R C A dealer will be pleased to show you the Aeriola Grand and to let you judge its wonderful tone quality for yourself. There is an R C A set for every purse—Prices range from $18 to $350.

Aeriola Grand with stand $350

Radio Corporation of America

WORLD WIDE WIRELESS

Sales Dept., Suite 2067
233 Broadway
New York City

District Office
10 South La Salle St.
Chicago, Ill.

Announcing—

Bel-Canto

The Superlative Loud Speaker

Photo by Paul Thompson

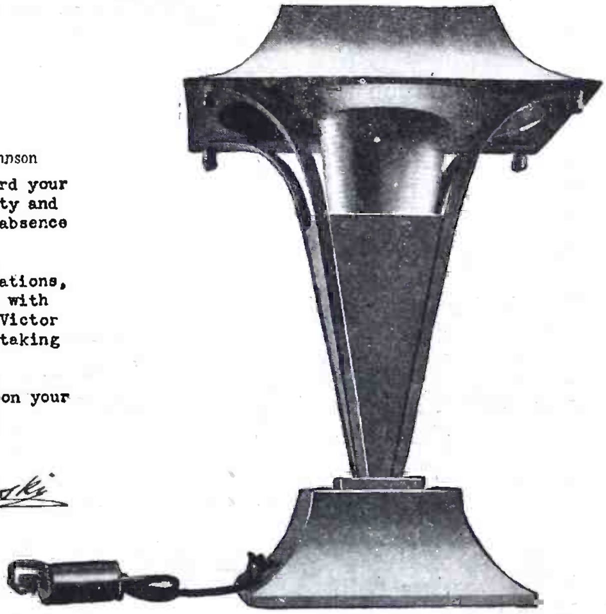
It was with great pleasure that I heard your Bel Canto loud speaker, the other day. The clarity and volume of tone transmitted, and particularly the absence of sound distortion make it a remarkable device.

While listening to different radio stations, some of them far away, I heard music and lectures with surprising distinctness, and the reproduction of Victor records sounded to me as if the performance were taking place in the same room.

You are indeed to be congratulated upon your ingenious invention.

Truly yours,

I. J. Paderewski



HERE, at last, is the perfect loud speaker — the Bel-Canto. Not simply "another" loud speaker, but an entirely new instrument, endorsed for its remarkable volume and beauty of tone by one of the world's greatest musicians—Paderewski.

The Bel-Canto reproduces perfectly and without distortion, and, unlike other loud speakers, it disperses the sound in *all directions,* filling the entire room.

The Bel-Canto is a thing of beauty, sturdily constructed and handsomely finished in dull lacquer. It comes fully equipped with a special, extra-sensitive, imported, loud-speaking phone, silk-covered cord, and hard rubber plug —all ready to attach to your set. There are no "extras" to buy.

The Bel-Canto is constructed of reeds and brass in strict conformity to every known principle of acoustics. The sound is purified in a specially constructed chamber before being conducted through the reed amplifying tube to a brass resounding chamber. The result is a tone of such clarity and mellowness as to surpass any other amplifying device on the market—even those selling at $100 or more. Yet the price of the complete Bel-Canto is only $30.

Ask to hear the Bel-Canto at your dealer's. If your dealer has not yet stocked the Bel-Canto, we will forward you the complete instrument prepaid on receipt of check or money order for $30.

Bel-Canto Corporation, 417 East 34th Street, New York

Jobbers and Dealers—write for our proposition

POPULAR RADIO

CONTENTS *for* SEPTEMBER, 1922

(Cover design by Adolph Treidler)

VOLUME II

NUMBER 1

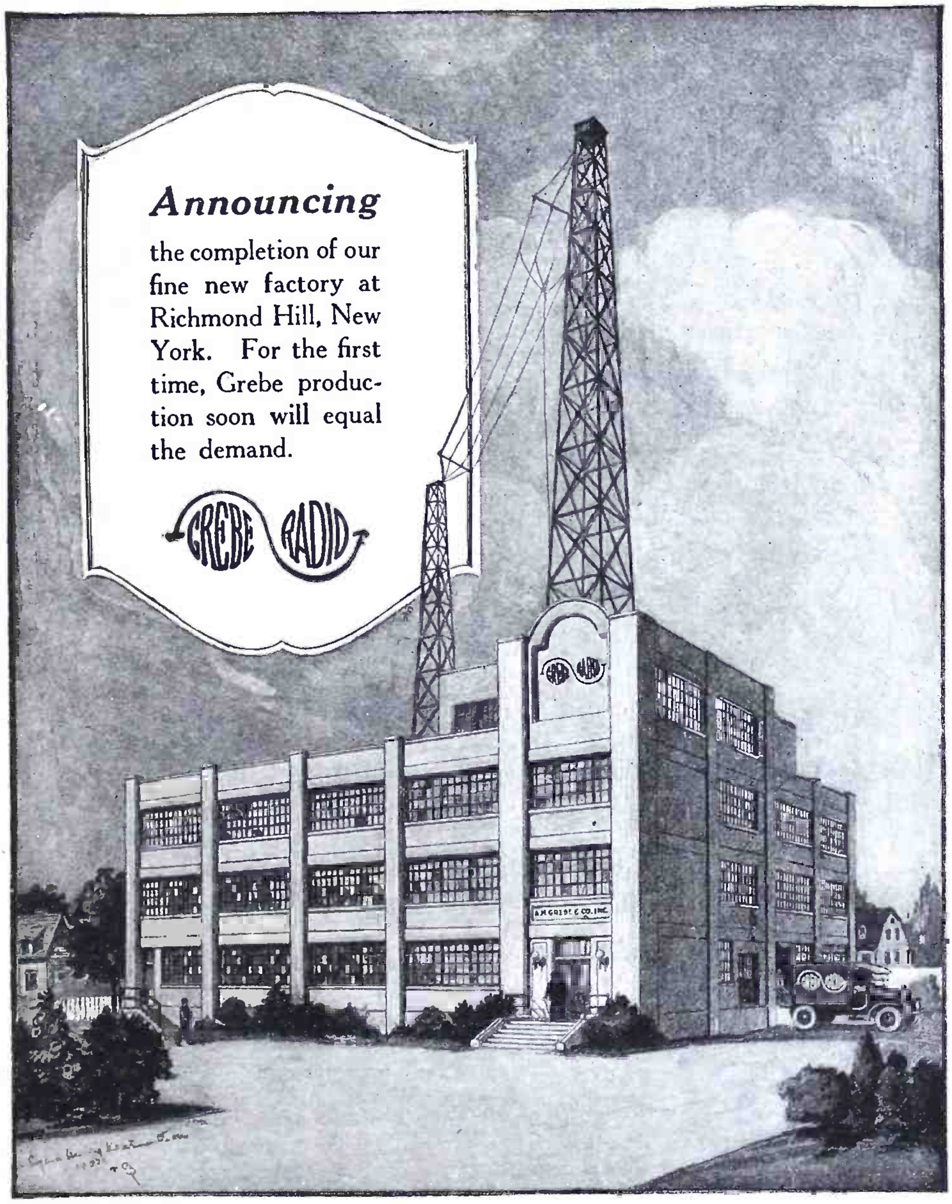
DEPARTMENTS

VOLUME II SEPTEMBER, 1922 NUMBER 1

Published monthly by Popular Radio, Inc., 9 East 40th Street, New York, N. Y., telephone number Vanderbilt 9985; H. B. Emerson, President; E. R. Crowe, Vice-President; P. O. Batch, Treasurer. Price, 15 cents a copy; subscription $1.50 a year in the U. S., $1.75 in Canada; elsewhere $2.00 a year, payable in advance. The International News Company, Ltd., No. 5 Bream's Bldg., London, E. C. 4, sole distributors in England. Entered as second-class matter April 7, 1922, at the Post Office at New York, N. Y., under the act of March 3, 1879.

KENDALL BANNING, *Editor*

E. E. FREE, PH.D., *Contributing Editor* LAURENCE M. COCKADAY, R.E., *Technical Editor*


Announcing
the completion of our fine new factory at Richmond Hill, New York. For the first time, Grebe production soon will equal the demand.
GREBE RADIO

A Page with the Editor

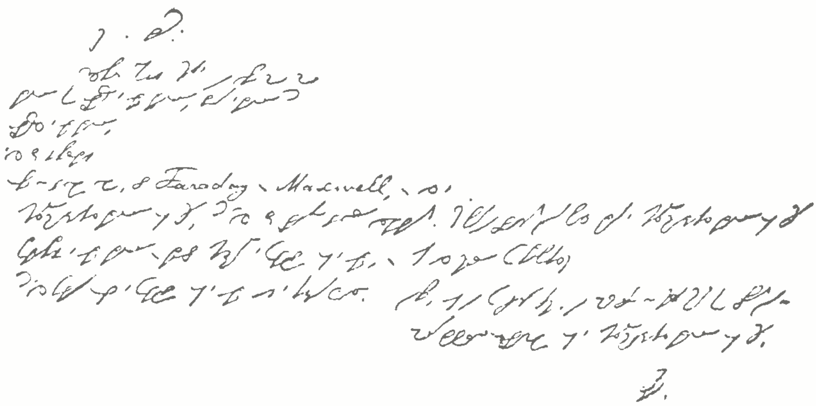
WITH this number POPULAR RADIO celebrates the completion of Volume I by adding 4 pages more—an increase of 20 pages over our first number. *Yet the price remains at only 15 cents.*

* * *

"Certain of my friends say that the article *There Are No Ether Waves* was not written in Dr. Steinmetz's style and do not believe it is authentic," writes Dr. Leo B. Arnold of Los Angeles. The Editor is glad to assure Dr. Arnold that not only is this article absolutely authentic—(the original manuscript reached us exactly as Dr. Steinmetz dictated it)—but also the same assurance can be given about every article that appears in this magazine. If anyone doubts Dr. Steinmetz's personal interest in the article, the Editor is reproducing on this page for his benefit a *facsimile* reproduction of Dr. Steinmetz's promise to write another article for us on the same theme—written in pencil in the good doctor's own original hieroglyphics. Read it yourself!

* * *

THOSE of our readers who have derived both pleasure and profit in the excellent articles by Dr. E. E. Free will be glad to learn that the author is now a member of our editorial staff—a fact that will insure not only a continuance of his writings, but also his collaboration in the preparation of other features as well. Dr. Free holds a degree in chemistry from Cornell University and a Ph.D. in biology from Johns Hopkins. Most of his life has been devoted to scientific research work; incidentally he has served as a university professor, as a scientist in the U. S. Department of Agriculture, as a consulting chemical engineer, and during the War as a Major in the Chemical Warfare Service. Dr. Free is a Fellow of the American Association for the Advancement of Science, a member of the American Chemical Society, the American Institute of Mining and Metallurgical Engineers, the Association of American Geographers, the American Ecological Society, the American Society of Agronomy and numerous other learned institutions.



* * *

THE flood of requests for back numbers of POPULAR RADIO emphasizes the wisdom of subscribing by the year instead of depending upon the newsstand for your copy. In most cases the local newsdealer had completely sold out his copies—a condition that is gratifying to the Editor, of course, but disappointing to the prospective buyer. Ask your newsdealer to reserve your copy for you.

* * *

WHO are the world's greatest living radio experts? Who are contributing most to the development of the radio art? *From which great scientists and inventors do the readers of* POPULAR RADIO *most want to hear?* The Editor asks the question not through idle curiosity; he wants to publish articles by these scientists in this magazine. Among the distinguished radio experts who either have contributed to our pages already or who have contracted to are General Squier, Dr. De Forest, Tesla, Maxim, Senator Marconi, Prof. Pupin, Dr. Steinmetz, Hogan, Prof. Morecroft, Hammond, and many others.

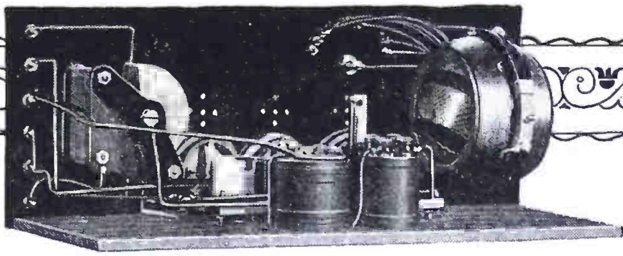
Whom would *you* like to see added to this great list?

* * *

As this issue of POPULAR RADIO is being made up, the railroad strike is assuming menacing proportions and threatens to interfere with the distribution of the magazine. In order to avoid disappointing our readers, we are going to press a week earlier than schedule —merely on the chance that this foresight may insure the deliveries of the magazine on time.

Kendall Banning

Editor, POPULAR RADIO



The S-P-2 RECEIVER

A Remarkable Refinement in Radio

The S-P-2 Receiver is offered, at a list price of $85, as the most remarkable VALUE and QUALITY achievement in the history of radio.

This Receiver has been developed by our own experts with a view to furnishing a complete Receiver of radio-telephone and radio-telegraph signals over a wavelength range of from 180 to 650 meters, using three tubes, viz.: detector, one stage of radio frequency amplification and one stage of audio frequency amplification.

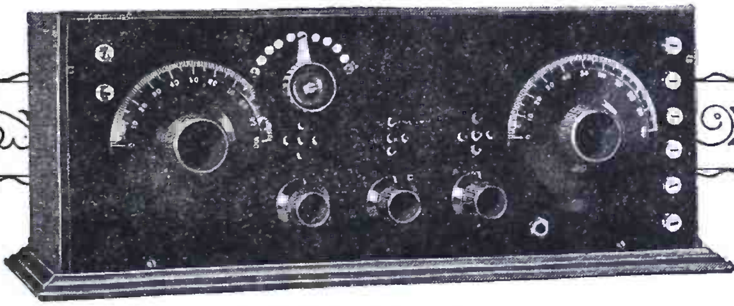
WITH THIS ASTONISHING RESULT, that the volume of signal received is EQUIVALENT TO THAT OF ANY REGENERATIVE CIRCUIT RECEIVER, DETECTOR AND TWO-STAGE AUDIO FREQUENCY AMPLIFIER ON THE MARKET TODAY, the S-P-2 in price comparison offering *one* to *two* times GREATER VALUE.

In emphasizing REMARKABLE REFINEMENT, we claim for the S-P-2 a TONE QUALITY of distinct class. The great "evil" of radio (harsh and distressing foreign noises) has been wonderfully overcome in the amazing manner in which the S-P-2 PRACTICALLY ELIMINATES all atmospheric disturbances, commonly known as static, and also such interferences as received from local power stations, arcing commutators, street cars, rumbling traffic, etc.

The S-P-2 accomplishes the exit of the day of blatant and aggravating "noise" in radio reception. It brings the QUALITY in music and in all instrumental and vocal signals that is now universally desired and demanded.

The S-P-2 Receiver is also especially designed for the reception of long distance and weak signals. In thorough tests, using a single wire antenna 40 feet long and approximately 20 feet above ground, the entire broadcasting programs of Newark, N. J.; Schenectady, N. Y.; Atlanta, Ga.; Detroit, Mich., and Kansas City, were received nightly in Pittsburgh, Pa.—and during the midsummer, supposedly poor receiving months. This reception was duplicated when using four wires strung along the ceiling of a one-story building. In the most severe tests, interference from static was not noticeable.

It is the unreserved opinion of every expert who has observed the S-P-2 that this Receiver is the marvelous advancement for which the radio world has been intently seeking.



DEALERS: Write for Catalog 101A

PITTSBURGH RADIO SUPPLY HOUSE

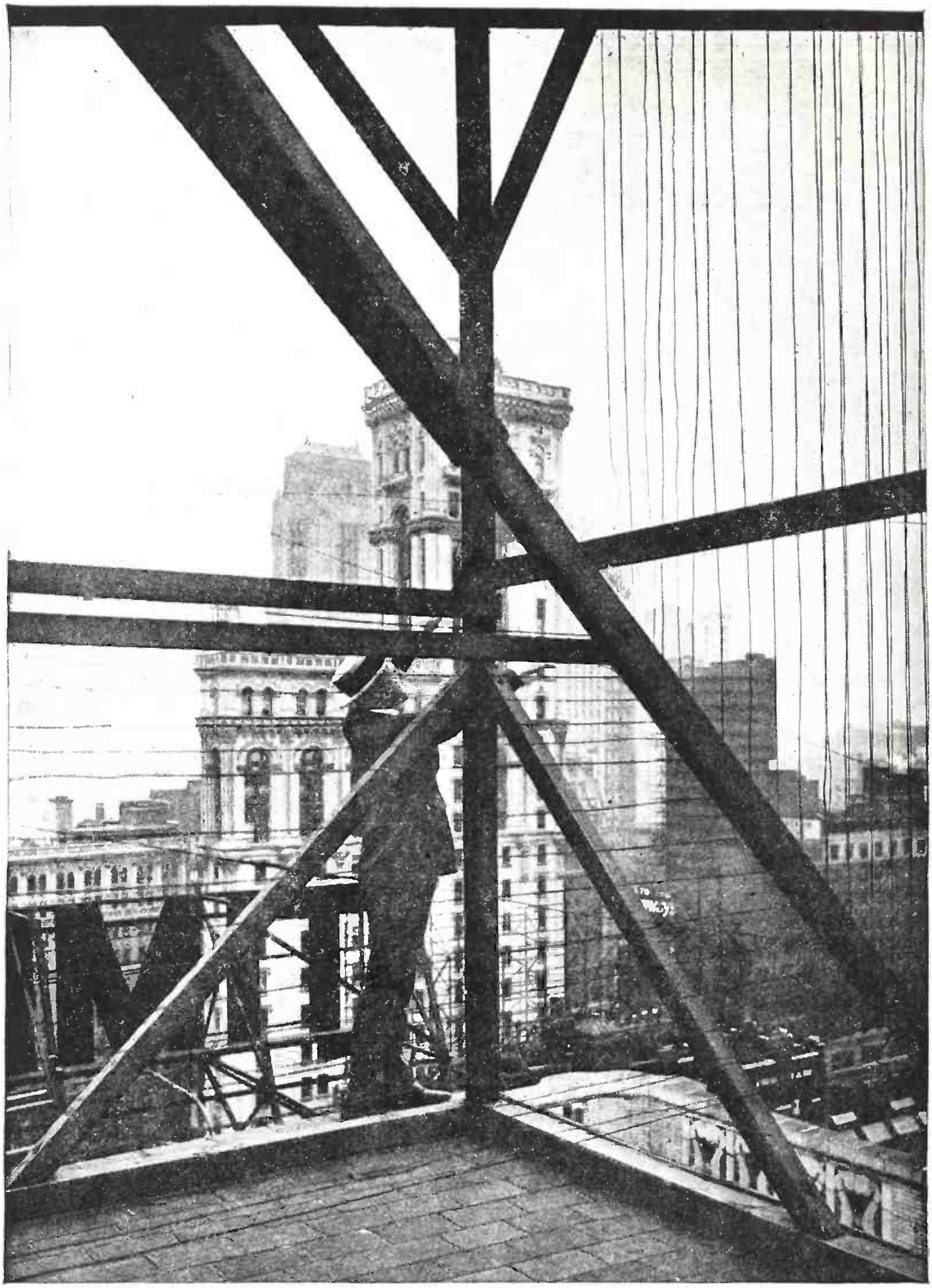
Bell Telephone, Grant 3632 **963 Liberty Avenue, Pittsburgh, Pa.**

The COMING USE OF SHORT WAVELENGTHS

"IT *has been shown for the first time that electric waves of the order of* 15 *to* 20 *meters in length are quite capable of providing a good and reliable point to point directional service over quite considerable ranges.*

"In these days of broadcasting it may still be very useful to have a practically new system which will be to a very large degree secret, when compared to the usual kind of radio."

G. Marconi



From a photograph made for POPULAR RADIO

A POST THAT LISTENS IN ON EUROPE

On this giant loop—a part of the aerial system atop the offices of the New York Times.—are received daily about 5,000 words of news items from the radio stations at Bordeaux, France (LY, 23,200 meters), Hanover, Germany (OUI, 14,500 meters), Nauen, Germany (POZ, 12,600 meters), and Leafields, England (GBL, 12,300 and 8,750 meters).

Popular Radio

VOLUME II SEPTEMBER, 1922 NUMBER 1

The Battle in *the* Air Lanes

A HERETOFORE UNWRITTEN CHAPTER OF AMERICAN HISTORY

This article gives an intimate glimpse behind the scenes of the greatest war in all history. One of the most dramatic and vital phases of that war was the fight for the Public Opinion of the allied, the neutral and the enemy nations—a fight which developed in a colossal struggle that reached to the farthermost ends of the earth, and much of which is here revealed for the first time. And in this struggle the commanding and the decisive rôle was played by the radio.—EDITOR

By GEORGE CREEL

NOTHING is more amusing than to watch science make fools of politicians. Even today, while certain Senators are jealously guarding America's "detached and distant situation," and thinking of the United States in terms of Chinese walls, the radio has made Europe and the Orient our next door neighbors—almost to the extent of gossiping over the back fence.

Fast steamships marked the end of national isolation; cables pushed the good work still further along. But it has remained for radio to smash the superstition until there is not enough of it left to take up with blotting paper. Right now our communication with every foreign government is easy and direct, and with the thousand and one advances that are constantly being made, it will eventually be as simple to communicate with a country half way around the globe as to telephone from one country farm to another.

It is impossible to overstate the changes that radio is going to work in the whole scheme of international relationship. World trade, of course, will be revolutionized by the instancy and cheapness of wireless. But even this obvious gain is infinitely less important than other gains too great to be measured in money. Before science has finished with radio it will have wiped out boundary lines as far as the thought and friendship and understanding of peoples are concerned.

Today, while their governments bicker at "conferences," the radio amateurs of Europe are talking one to the other, establishing contacts that will grow and grow until there is an end to these petty social hates that are bred and fostered in misinformation and misunderstanding. "How could I hate him if I knew him?" is as true now as when Sidney Smith uttered the words.

Already there are signs of the coming revolution. Study your newspaper these days and you will notice a vast increase in the amount of foreign news. If you were to see a European or Oriental daily, you would, in turn, observe an amazing improvement in the number and length of news items about the United States. Radio is almost entirely responsible for the change. The high cost of cable tolls is no longer a barrier against the exchange of news, and the lower rates of radio are commencing to infuse the great press associations with new energy and ambition.

Never doubt that this is not going to exert a powerful influence on international relations. When the citizens themselves know day by day what the citizens of another country are doing and thinking and saying, politicians will have a sad time attempting to play on ignorances and outworn hates. News—not propaganda, but real news—is about the best binder that the human family has ever developed. We proved it during the war and we proved it by radio.

Much of the war work of radio is well known. Its varied and important employment by the military and naval establishments has been completely disclosed, and the miracle of it all is now commonplace. An even larger use of wireless, however, is little understood. In the fight for "the verdict of mankind"—propaganda, to use the hackneyed word—America put her chief dependence on radio, finally reaching a peak of operation that used the air lanes of the whole world, reaching every country on the globe with the American message. Germany's collapse was moral as well as physical, and in this disintegration of enemy morale, radio was the principal and the determining factor.

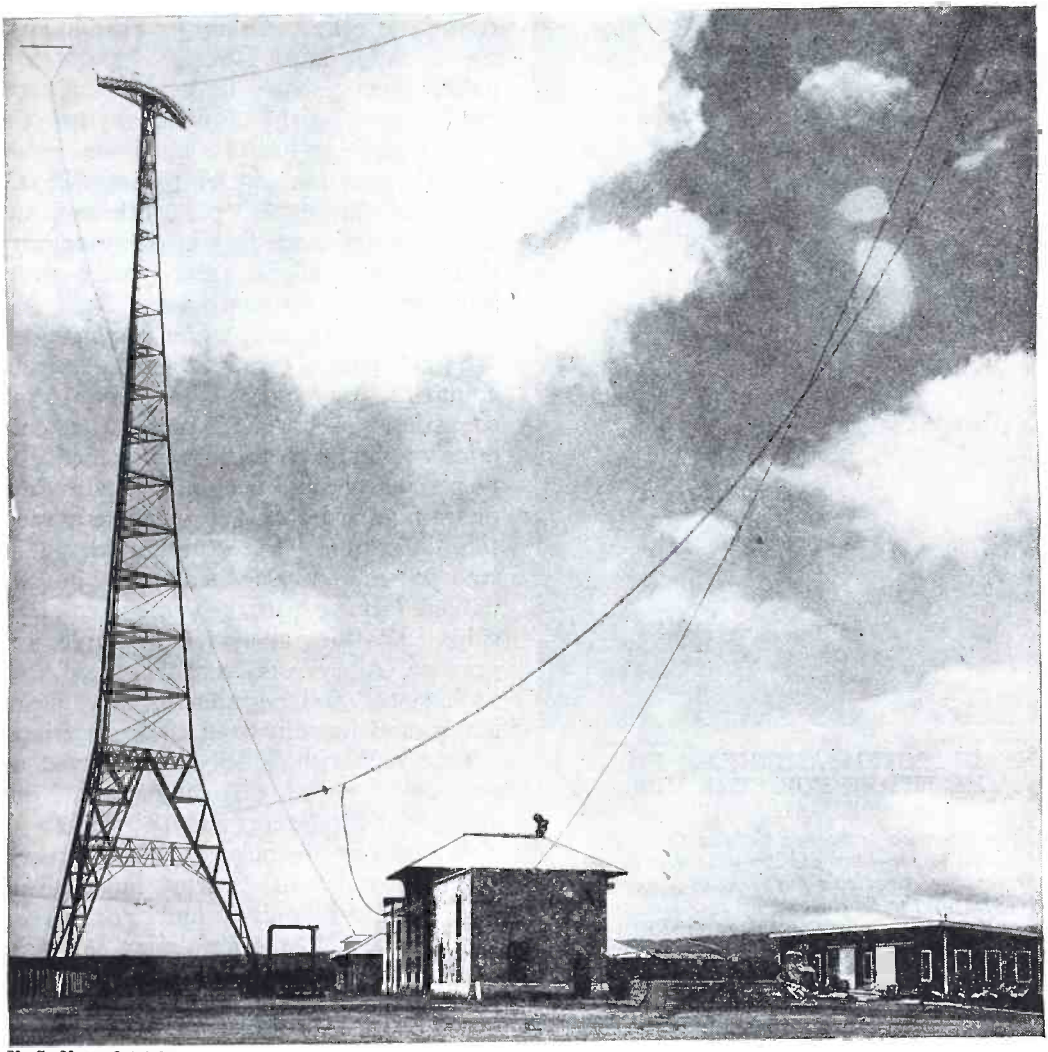
It was in recognition of Public Opinion as a major force that the Great War differed most essentially from all previous conflicts. The trial of strength was not only between massed bodies of armed men but between opposed ideals; moral verdicts took on all the value of military decisions. Other wars went no deeper than the physical aspects, but German Kultur raised issues that had to be fought out in the hearts and minds of people as well as on the actual firing-line. This was the fight that the Committee on Public Information was called upon to make.

The domestic task was simple compared with the undertaking that faced the Committee when it turned from the United States to wage the battle for world opinion. It was not only that the people of the Allied Powers had to be strengthened with a message of encouragement, but there was the moral verdict of the neutral nations to be won and the stubborn problem of reaching the deluded soldiers and civilians of the Central Powers with the truths of the war.

It was a task that looked almost hopeless. The United States alone of the great nations of the world had never engaged in propaganda. For years preceding the war Germany had been secretly building a vast publicity machine in every corner of the earth, designed to overwhelm all foreign peoples with pictures of Germany's vast power, her overwhelming pre-eminence in industry, commerce and the arts. German agents, carefully selected from among her journalists and authors, neglected no opportunities for presenting Germany's case to readers of every language, and her commercial firms linked a propaganda of liberal credits with this newspaper campaign throughout the world.

Great Britain, through Reuter's news agency, likewise conducted a governmental propaganda. France had official connection with the Havas Agency. Both England and France, through ownership or liberal subsidy of certain great cable arteries, had long been able to direct currents of public opinion in channels favorable to themselves. Other nations had publicity machines of varying types.

America controlled no cables, manipulated no press associations, operated no propaganda machinery of any kind. We were and always had been dependent upon foreign press agencies for inter-



U. S. Navy. Official

THE NAVAL RADIO STATION THAT LED AMERICA'S FORCES OF PUBLICITY INTO CHINA

From San Diego was sent America's war message to the Orient—by way of Pearl Harbor and the Philippines. The military value of radio in disseminating news of America's war activities was "worth more than a million soldiers."

course with the world. The volume of information that went from our shores was comparatively small; after it had been filtered in London or Paris it grew smaller and smaller until it amounted to mere "flashes" when it reached a far country. Strangely enough, we were at once the best-known and the least-known people in the world. There was no corner of the globe in which America was not a familiar word, but as to our aims, our ideals, our social and industrial progress, our struggles and our achievements, there were the most absolute and disheartening misunderstandings and misconceptions. For instance, when some "gun-men" were executed in New York, papers in South America actually printed accounts that told of an admission fee being charged, with Governor Whitman taking tickets at the door!

The Germans projected themselves into this situation with vigor and decision. From the first, Berlin had an exact ap-

Brown Bros.

HE DIRECTED AMERICA'S FIGHT IN THE ETHER FOR "THE VERDICT OF MANKIND"

To a remarkable degree George Creel was in a position to see—and did see—the urgent need of presenting America's purposes in the war to the peoples of the world and of counteracting Germany's intensive and ruthless propaganda. In this article he reveals for the first time to what an amazing extent we relied upon, as our chief weapon in combating these forces, the most far-reaching and powerful of agencies—the radio.

preciation of the military value of public opinion, and poured out millions in its endeavor to win or else to corrupt it. It is impossible even to estimate the amount of money spent on propaganda by the Germans. Russians competent to judge assured us that the agents of Berlin spent $500,000,000 in that country alone, and their expenditures in Spain were estimated at $60,000,000. Close to $5,000,000 went to Bolo Pasha for the corruption of the Paris press, and the sums spent in Mexico ran high into the millions. I knew that they owned or subsidized dailies in most of the important cities of Spain, South America, the Orient, Scandinavia, Switzerland and Holland; that their publications, issued in every language, ran from costly brochures to the most expensive books and albums; that they thought nothing of paying $25,000 for a hole-in-the-wall picture house, and that in every large city in every country their blackmailers and bribe-givers swarmed like carrion crows.

Their propaganda, while playing upon different points of prejudice in various countries, was much the same in all countries. As an initial proposition America's military strength was derided. By no possibility could the United States raise or train an army, and if, by some miracle this did happen, the army could not be transported. America was a fat, loblolly nation, lacking courage, equipment, and ships. Working away from this pleasing premise, Americans were described as a nation of dollar-grabbers, devoid of ideals, and inordinate in their ambitions.

Our war with Mexico was played up as a cold-blooded, evil conquest and our struggle with Spain was painted as an effort of our financial masters to enter upon dreams of world imperialism. Cuba, the Philippines and Porto Rico were pitied as "America's slave nations;" Pershing's expedition to Mexico was declared to be the start of a war of conquest that we were later forced to relinquish because our "cowardice" shrank before the "dauntless" courage of Carranza. The Colorado coal strike, the Lawrence strike and the Paterson strikes were all treated in the utmost detail to prove America's "system of wage-slavery;" pictures were drawn of tremendous wealth on the one hand and peonage on the other; lynchings were exaggerated until it was made to appear that almost every tree in America was used for purposes of execution, and we were charged in every conceivable form and fashion with being the secret partner of one or the other of the Allies in commercial plans to control the trade of the world.

Where there was French sentiment, America was set down as "the secret partner of England." Where English sentiment prevailed, we were the "secret partner of France;" and where Italian sentiment obtained, America, England and France were assumed to be in a plot to destroy Italy.

In Spain every effort was made to revive the prejudices and passions of 1898, and the pro-German press ran daily lies in proof of "Yankee contempt for the Spaniard." One falsehood was that a favorite American recruiting slogan was: "Enlist for the War! Remember the Maine and Spain."

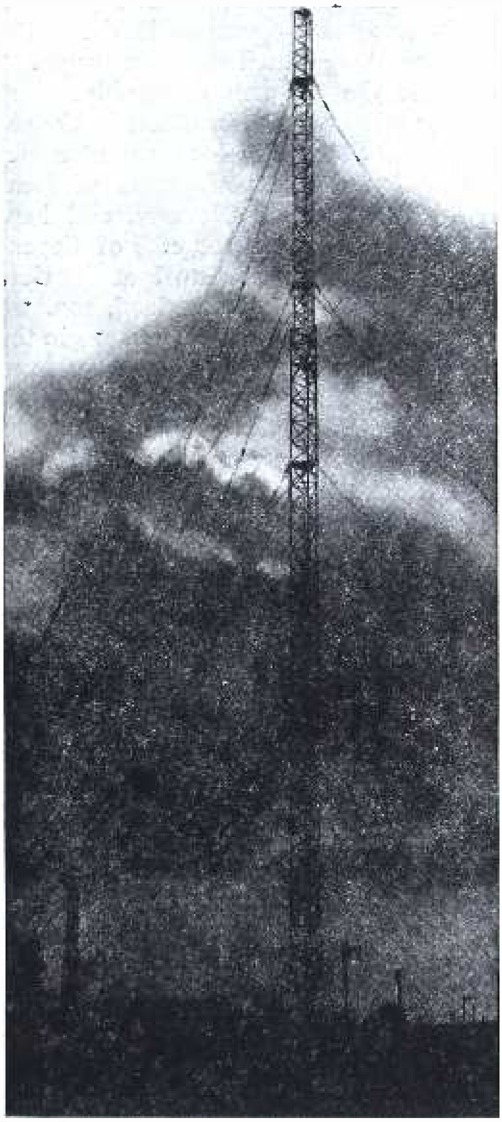
When we first set about the creation of a news machinery to carry American facts to the world a natural reliance was placed upon cables—the one established medium for international communication.

The cables, however, were virtually all foreign owned. The cable rates were prohibitive; what was even more conclusive, all of them were so overburdened as to endanger vital war business by their delays. Forced to look in some other direction, our eyes fell upon the wireless, taken over by the navy some time before and lying idle for a good part of the time. Without more ado, we put our problem before the Secretary of the Navy, Mr. Josephus Daniels, who straightway placed the wireless stations of the United States at our disposal, likewise the expert navy personnel under Captain David Todd.

Offices were taken in New York, a news force was gathered and in September, 1917, the "Compub" (as its code address soon advertised it to the world) commenced business.

The first radio service was from Tuckerton to the French wireless station at Lyons. From Lyons by arrangement with the French government it went to our office in Paris, and after translation and distribution to the press of France, it was relayed to our offices in Switzerland, Italy, Spain and Portugal.

The next step in the world dissemination of news came through arrangements heartily entered into by the British government. The same wireless report sent to Lyons was intercepted by navy operators at the American naval base and was relayed to London, where the representatives of the Committee received it and distributed it to the English press.



Brown Bros.

WHERE THE FIRST GUN WAS FIRED

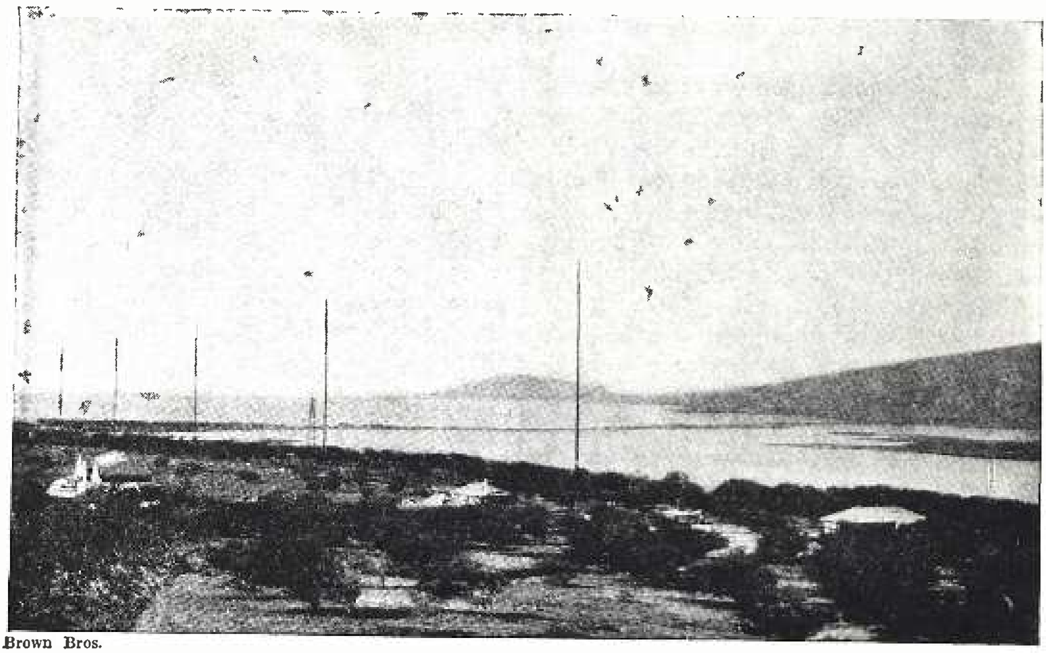
In America's fight for public opinion the first propaganda to be sent out by radio was broadcasted from the station at Tuckerton, New Jersey. It was relayed via Lyons to Paris.

The London office, in turn, relayed the service to the Committee's representative in The Hague for the Dutch press—a highly important operation in the machinery, as many Dutch papers managed to get past the German censorship. A further relay was to our offices in Copenhagen and Stockholm for translation and distribution to the newspapers of Denmark, Sweden, and Norway, and here again, particularly in the case of Copenhagen, we had a chance to beat the German censors. In Switzerland, too, we scored heavily against the Germans in the same fashion. The service also went from London to Saloniki and other Greek points, for not only was Greece to be considered, but it was good ground from which to shoot into the Balkans.

Our first effort to serve Russia was by wireless, and after much experimentation under the direction of Captain Todd we were actually able to reach the Russian station at Moscow. This service, put into Russia for the press, for the billboards and even on the movie screen, was relayed town by town all the way from Petrograd to Siberia. When the Bolsheviki overthrew Kerensky, however, one of their first actions was to grab the wireless stations. The one at Moscow, either intentionally or through ignorance, they put out of operation. The wireless station at Cracow, in Poland, was inefficient at first, but towards the last managed to receive, although sending continued to prove a failure.

Continued pressure upon the Italian government finally resulted in wireless improvements to such a degree that the station in Rome was able to receive directly from Tuckerton. This did away with the necessity of relay from Paris and enabled the New York office to pour a daily stream of news straight into Italy, an immediate contact to which the Italian press responded enthusiastically.

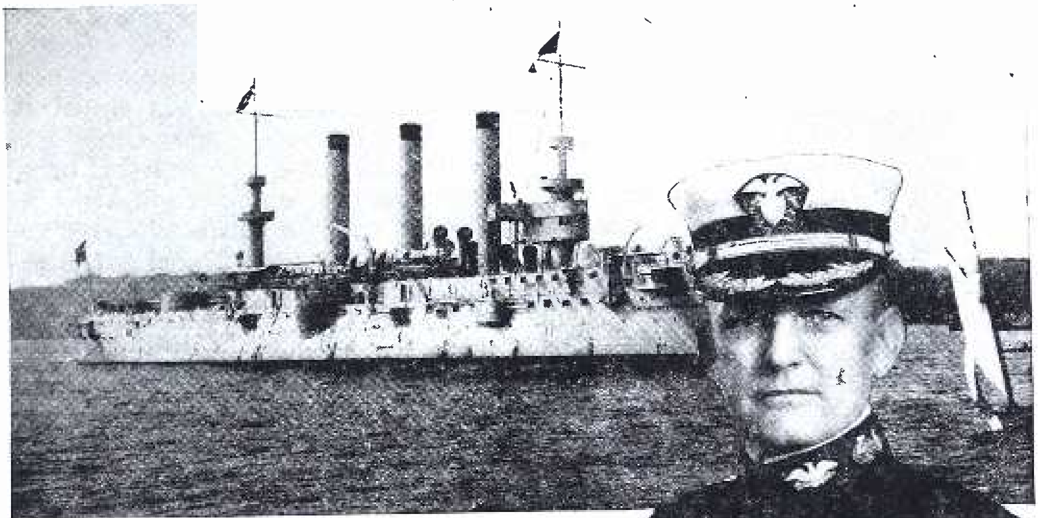
With Europe accounted for, attention was next given to South and Central America. Virtually every South and Central American country had a wireless



Brown Bros.

A REMOTE LINK IN UNCLE SAM'S RADIO CHAIN AROUND THE EARTH

Even in such far away outposts as this, at Koko Head in the Hawaiian Islands, the radio operators were able to serve their country by carrying on her valiant fight for "the verdict of mankind."



U. S. Navy, Official

ONE OF OUR "PORTABLE RADIO SETS"

The "Brooklyn" (shown above), was stationed at Vladivostok to relay radio messages to Russia. Captain David Todd (at right), was in direct charge of that part of the warfare that included the use of the naval radio equipment and personnel.

Harris & Ewing

station and each government agreed instantly to take our news service out of the air and hand it to the Committee's representatives for translation and distribution. It was not even the case that dependence had to be placed on the one wireless leap from Tuckerton, for there was our high-power station on the Isthmus of Panama to act as a relay. Mr. John Collins, "borrowed" from the Panama Canal Board, handled Central America from Darien, broadcasting it for interception by the wireless stations of the United Fruit Company.

The next link in the world chain was the Orient. "Compub" opened a branch office in San Francisco and commenced the preparation of a daily service of particular interest to China, Japan, the Philippines, and Hawaii. The navy wireless station at San Diego flashed this to Pearl Harbor for distribution to the Hawaiian press, and from Pearl Harbor it was flashed to the Philippines. Our original theory was that the Chinese and Japanese stations would receive from Manila, but owing to many mechanical difficulties it became necessary for our own station at Guam to take the service out of the air and put it on the cables to Shanghai and Tokio. In China the service was distributed through a specially organized chain of newspapers, and in Japan we worked through the Kokusai and Nippon Dempo, the two principal news associations. From Shanghai the service was relayed to Vladivostok, where our office gave it Siberian circulation. Distant Australia picked the service out of the air and used it.

The installation of "Compub" at Vladivostok, Harbin, Irkutsk, and Omsk in Siberia enabled us to send a direct Russian service from the wireless station at San Francisco.

Immediately upon the signing of the armistice, orders were given to close every division of the Committee on Public Information with the exception of the wireless. This exception was due to the dilemma in which the press of America found itself. The four transatlantic cables, already overburdened, became hopelessly jammed when an army of newspaper men commenced to file daily despatches in Paris for quick transmission.

To meet the situation, Mr. Walter S. Rogers, director of the Committee's Foreign Wireless and Cable Service, was placed unreservedly at the disposal of the correspondents, and directed to find a "way out." As a first measure to lighten the cable load, the committee agreed to radio to the United States all formal statements, speeches of the President, and other like matter requiring textual sending, and to make simultaneous delivery in New York to the press associations.

A second step was in the direction of aid to individual correspondents. The Navy, in charge of the wireless, was forbidden by law to charge tolls, nor could it even receive private messages; but in view of the importance of giving the American public all possible news of the peace deliberations, it was agreed that the Committee on Public Information might undertake the delivery of the matter to the American press.

After many negotiations the French government and the United States navy entered into an arrangement through which the Committee was able to offer thirty-five hundred words daily on the wireless, absolutely free of charge, to the American correspondents in Paris.

Such, then, was radio's war record in the fight for the "verdict of mankind," in which, as a well-known statesman expressed it, "it was worth more than a million soldiers." The Allies were given new courage and hope, Central and South America were brought into the war on America's side, the neutrality of other countries changed from suspicion to friendship, and the German morale was steadily sapped and eventually destroyed.

Keystone View Co.

RADIO LOOK-OUTS AGAINST ENEMY SUBMARINES

Day and night these vigilant sentinels listened in at Lands End, England, for communications between German and Austrian naval vessels. Only the records of the government will reveal the invaluable service they rendered.

From a photograph made for POPULAR RADIO

A LIVE NEWS STORY IN THE AIR

The newspaper of the near future will not depend solely upon wires for collecting its information. Today stories are being received by city editors from reporters miles away who use radio-equipped motor cars. This picture shows W. F. B. McNeary of the Newark Sunday Call, receiving a news item by radio.

The Newspaper that Comes Through Your Walls

The "Radio Newspaper" Is No Longer a Theory; It Has Arrived—Abroad. In This Country the Wireless Is Being Used Both for Collecting and Disseminating News. This Article Tells How.

By HOMER CROY

IN Budapest there is a newspaper that has no printing presses and no newsboys. It is a large and flourishing newspaper and, as far as I know, all its subscribers are satisfied. It has never been "scooped" and there is little likelihood that such a catastrophe will soon happen. It begins to give its news to the public at nine o'clock in the morning and it does not stop until ten o'clock in the evening. On opera nights it does even better; on such occasions it stretches its service a little and gives its subscribers the opera.

The newspaper is called *The Telephone-Hirmondo* and has been in existence for twenty-eight years.

As its name implies it is a telephone newspaper. It furnishes news direct to its subscribers by an elaborate system of party lines. All a subscriber has to do is to step to the telephone and put the receiver to his ear. To each subscriber is furnished a schedule showing the hours different news goes out: local, national, world news, sports, fashions. Fiction stories are read to the subscribers, speeches are delivered; puzzles are told and English is taught to all who wish to learn it. Even serials running in local motion picture shows are read to subscribers; that night a person may go to the theatre and see for himself the story his newspaper has told him. Budapest's telephone newspaper is not an experiment; not some vague, uncertain, half-baked theory. It has been a success for more than a quarter of a century.

Germany is a step ahead of this! Just outside Berlin the German government has a newspaper that instead of sending out news by telephone, sends into the air. At certain hours it sends out government news, political news, sports and so on. But Germany rules its radio with a heavy hand; in this regard it takes itself very seriously. Every radio set which goes out is licensed and watched. The person who installs the set is allowed to receive but one kind of news; the government authorities see to that and lock the box. This is done by sending out different kinds of news on varying wavelengths; the owner of the set can receive only the kind his license calls for.

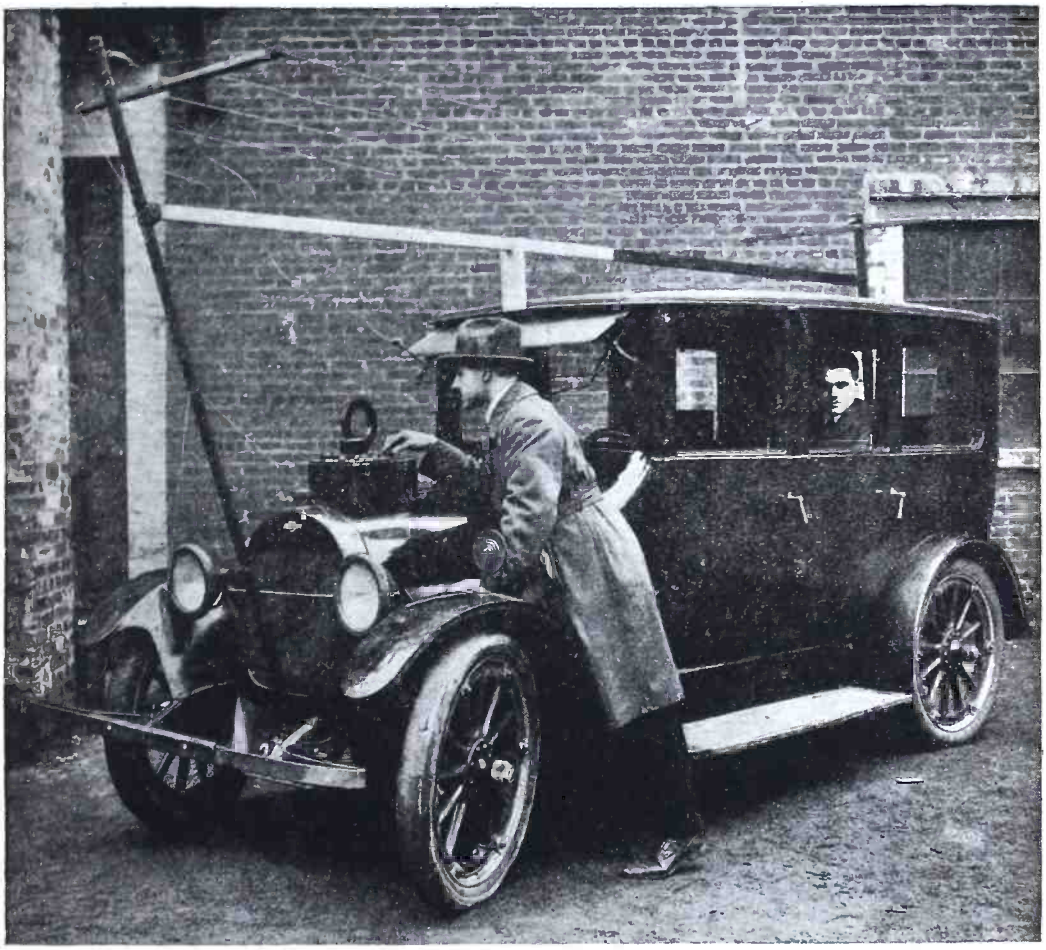
We would not stand for that in this country, but just the same there is an idea behind it—the radio newspaper is coming. It is assured. France and Italy both have been watching Germany's experiment with the radio newspaper and now are planning to install equipment for disseminating news—but on a much more liberal policy.

The United States has never gone into the radio newspaper as a governmental proposition, but in this country our newspapers are far and away ahead of European newspapers—when it comes to hitching up to radio of their own accord. Over there they are just beginning to scratch their heads and wonder if there isn't something in the idea, while in this country eight of ten individual newspapers are actually broadcasting.

It will be recalled that last summer the world was awaiting the outcome of a

THE PRESS GALLERY AT THE FIRST FOOTBALL GAME EVER BROADCASTED

The reporter using the telephone is "Sandy" Hunt, former Cornell guard, reporting the first intercollegiate contest that was ever described by radio, play by play, in October, 1921. The story was sent from the field to the operating room of station WJZ at Newark over a private wire, whence it was broadcasted. Several intercollegiate games were similarly reported later that season.



From a photograph made for POPULAR RADIO

THE FIRST AUTOMOBILE TRANSMITTING STATION TO BE LICENSED

Equipped with a radio transmitting set, this car was sent out on a news assignment by the Newark Sunday Call on May 6, 1922—the first recorded instance of its kind. The car bears the call letters 2CNJ. In the picture Emery H. Lee, the radio inspector is seen measuring the wavelength, which was exactly 200 meters.

battle in Jersey City, where two men were stripped to their waists to fight for life or death. In all parts of the country the hours were counted on that day when Messrs. Dempsey and Carpentier drew crowds of excited fight fans to Boyle's Bowl. Newspapers found that there was but one "story" for them that day—all other happenings were small "items."

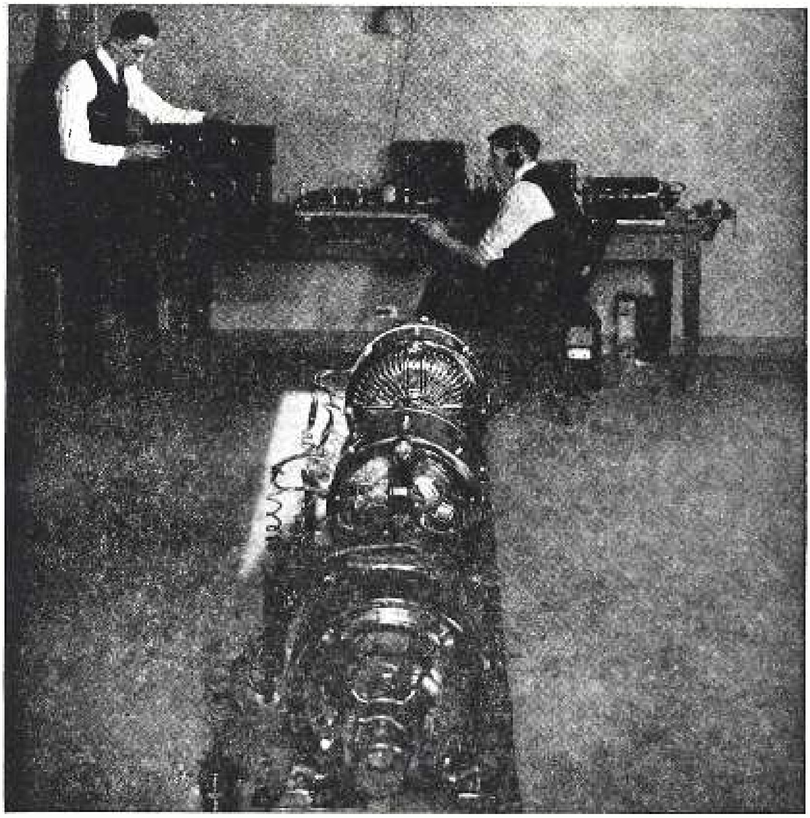
The Seattle Post-Intelligencer had an idea. Why not get the news to the people in and around Seattle fast—faster than presses could run? It was the first time such a thing had ever been tried. Steam was put behind it and arrangements were made with a local radio distributing company, and a sending outfit was engaged for the day. The paper spread it on the first page and Boyle's Bowl was practically taken up and dumped down in Seattle. The people in that city were almost as close to the two heated gentlemen as were the owners of the fifty-dollar seats. The fight was practically as much of a success in Seattle as it was in Jersey City. After the final and lamented fourth round, the paper thought the excitement was over; they told the radio company to come and take the equipment away.

But the next day the letters began to

pour in. Why couldn't the paper give the subscribers news by radio all the time?

That would be biting off a big chunk, especially in view of the fact that never before had such a news service been rendered. But the newspaper sank its teeth and pried off an experiment. Now on top of the building it has a radio room and tower antennae 105 feet tall. Six hours a day it sends out news—anything, everything. It furnishes music for charity dances, civic organizations, luncheon parties, entertainments for graded schools to raise funds for baseball suits, entertainment for disabled soldiers, music and speeches for patients in hospitals; for style shows, hardware meetings and even helps teach radio in the high schools of the state. Every Friday night it hires an orchestra, brings it to its own sending room and puts on a dance program. Friday night radio dances are now being held not only in Seattle, but in Spokane, San Francisco, Portland, Vancouver, B. C., and even in Craig, Alaska. As if this were not enough, word came from a ship on the Pacific that its passengers had shaken a wicked foot in response to the same tintinnabulations. On top of this the Chamber of Commerce in Butte, Montana, wanted to have a social where their wives and sweethearts could be brought together. The radio brought them——.

At first it was thought that only residents in and around Seattle would be able to hear the radio programs, but such was



THE POWER PLANT OF THE RADIO STATION OF A MIDDLE-WESTERN DAILY

One of the best-equipped transmitting stations in the country is WWJ, maintained by the Detroit News for broadcasting both entertainment and news features. The picture shows the 5½ H.P. motor, driving a 1600-volt, 1-kilowatt plate current-generator and a 16-volt, 615-watt filament current-generator, providing power for the transmitter tubes.

REPORTING A WORLD'S SERIES BY RADIO
The sporting editor, G. A. Falzer, is here seen using an ordinary telephone for reporting the baseball games at the Polo grounds, New York, in 1921. But his telephonic talk went to a transmitting station, where it was broadcasted.

not the case. The *S. S. Montgomery City* was 3,600 miles out in the Pacific when it picked up Seattle, and messages inland have gone as far as Minot, N. D. When the paper started its broadcast there were only 284 receiving sets within range; now, it is estimated, there are 20,000. That is how things have moved along in the world of radio.

In the meantime the wheel of progress was rolling on in other parts of the United States. Newark, for instance, where you would not expect to find much hustle. And the experiment in radio was not by a daily, either, but by a Sunday paper—*The Newark Sunday Call.*

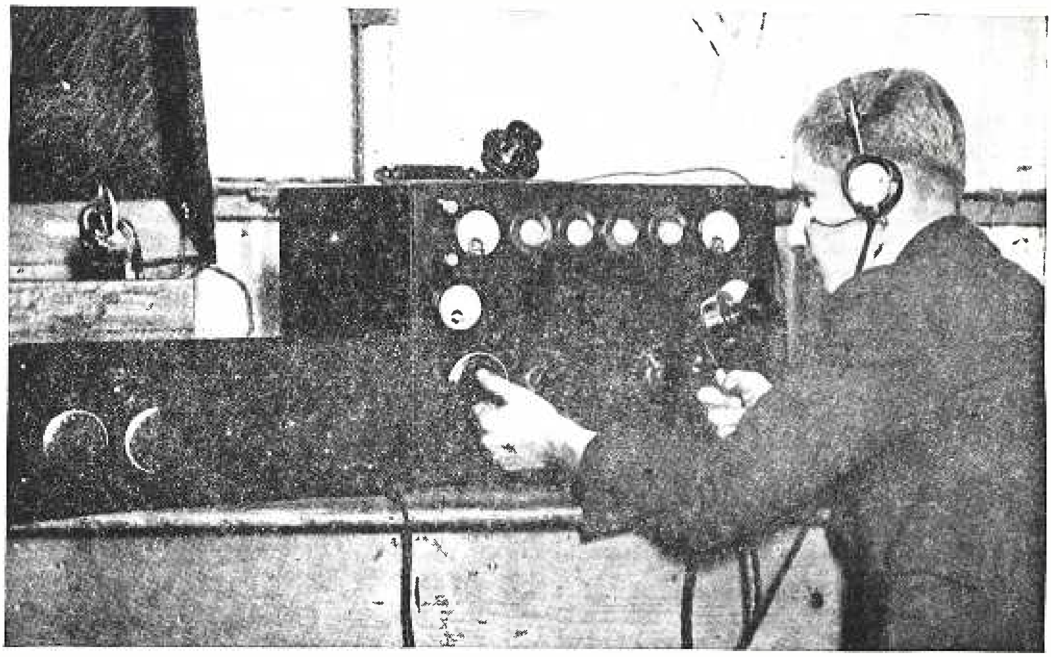
The World's Series came along, October 5th, 1921, and a man went to the Polo Grounds and there put the news on a telegraph line. In the office of the *Sunday Call* it was taken down and then hustled on a telephone line. This came to one of the editors in the newly established broadcasting station of the Westinghouse Company and there the man spoke into the transmitter and sent it up into the air.

The experiment was a success. Things began to move along for the paper and it originated bedtime stories for children, and started broadcasting news. This went out about half-past eight in the evening. It made such a success of it that the paper began broadcasting in the day time, beginning at ten o'clock in the morning and continuing throughout the day on the hour. Broadcasting breathed the breath of life into amateur radio, and on October 16th this paper started a radio department of two pages—the first radio section started by a newspaper. The people couldn't get enough of it. It was not long until a New York paper took a nibble—and then sank its teeth. Radio departments sprang up with the speed credited to toadstools, although personally I have never seen one do this amazing feat.

Newspaper after newspaper started departments until now two New York newspapers get out a whole magazine section each Saturday devoted to the wonders of wireless. But they were not content for long merely to run programs and conduct departments. *The Detroit News* began to broadcast; others began to itch, and now *The Hartford Courant,* started before the Revolutionary War began, has felt the urge of the latest departure in journalism. Other papers are taking it up; soon, no doubt, a metropolitan newspaper which does not broadcast will be considered quaint and a bit inclined to old-fashioned ways.

Two things may happen, and both of them, it must be known, are entirely in the realm of speculation. There is no definite fact to substantiate it—only a few straws blowing in the wind. In the future the newspapers will broadcast in their territories. St Louis will have newspapers sending out their silent appeals on different wavelengths; Omaha will be doing the same; Waco, Wheeling, Woonsocket. They will send out local news. For example: "George Washington Jones, the millionaire manufacturer of folding wash boards, was arrested this afternoon for speeding and was fined $4." The license numbers of stolen automobiles will be given out and the police departments will be assisted in recovering the missing property, as they have been already in several cities. Local, grain and crop markets will be sent out; whether wheat is up or down, what activity potatoes show and what chickens are doing — the domesticated variety, that is. Gossip, sports, local news items will go out.

On the other hand, a national newspaper may be established to send out on a different wavelength entirely different matter—news of national and international interest. Those who wish to hear about some peace parley in Europe can hook onto the big newspaper; those interested



International

A DAILY NEWSPAPER THAT SENDS OUT NEWS BY RADIO

The San Francisco Examiner broadcasts both local items and news of national moment from its station in the Examiner Building, as well as the usual weather reports and market quotations.

© Harris & Ewing

THE FIRST TIME THAT A HORSE RACE WAS BROADCASTED

The methods of the race-track crooks who swindle guileless bettors by "tips" over private wires will have to change when racing news is reported by radio. The officials at the Bowie (Maryland) track recently transmitted the results of the races by radio—although in this particular picture the results are apparently being transmitted by a receiving set.

in home affairs can give the knob a twist to "local." The national newspapers will have the biggest and most famous contributors—even the President may use it.

But, anyway, the radio newspaper era is coming. How soon? No one knows. Maybe next year. This time last year no newspaper knew that it could broadcast; now the air is full of them. It would be no greater surprise than what has happened in the past year.

The newspaper reporter of the future will not go on the subway, or pegging along in a trolley. He will have his own automobile. Is there a wreck? A shooting? A catastrophe? The reporter will merely plant his ground wire and with his small sending set send the news back to the office. Other reporters will be out gathering up different threads; securing interviews, running down the police end of it. The "city room" will coordinate and simplify these reports. A re-write man will put it all in a connected story and then hand it to a stentor. The stentor will carry it to the sending room and up it will go into the ether. While the people are still being taken out of the wreck, those in their homes for hundreds of miles around will know about it.

> "The building is still burning. Firemen with their oxygen helmets are feeling their way through the smoke . . . A child has been found . . . It is alive . . . It's mother is weeping"——

So the reports of the future will go out.

The idea seems fantastic? So did the application of radio to Boyle's Bowl a year ago.

There is only one safe bet about radio; and that is not to try to judge its future by its past.

¶ *Another amazing development of radio is in the hospital service, particularly in rendering medical care to men at sea. Many a marine owes his life to "Old Doctor KDKF"—whose original methods of looking after his patients will be told in another article.*

From a photograph made for POPULAR RADIO

THE NEW SUPER-REGENERATIVE SET IN USE

This receiver employs three hard vacuum tubes and receives signals of extraordinary strength on a small circular loop antenna—shown at the left of the above picture. The set is complete as shown above.

How *to* Build *the* New Armstrong-Circuit Receiving Set

No recent development in the field of radio has attracted anything like the attention or has so directly affected the radio amateur as the super-regenerative receiving set invented by E. H. Armstrong. The apparatus is in effect a regenerative circuit in which the ordinary limitations to amplification have been overcome—specifically by eliminating self-oscillation while at the same time increasing regeneration. Because of the extraordinary degree of amplification the outdoor antenna is replaced by a small loop aerial.

The set illustrated in the article was built for POPULAR RADIO, *and the circuit-diagrams here given have been tested and proved successful in actual operation.*

By LAURENCE M. COCKADAY, R.E.

ANOTHER great step has been taken in the radio art—a step that is destined vastly to extend the use of radio by improving the receiving apparatus in important particulars. Announcement of this important development has only recently been made by Edwin H. Armstrong, the inventor, who gave two impressive demonstrations in New York of what he calls the "super-regenerative circuit." The first demonstration was made before the Institute of Radio Engineers and the second was made a few days later at Columbia University; both meetings were open to the public and both were attended by great numbers of radio enthusiasts. So important is this discovery regarded in scientific circles and so far-reaching is it in its effect upon the development of radio, that detailed information concerning it is of value to radio amateurs and professionals alike.

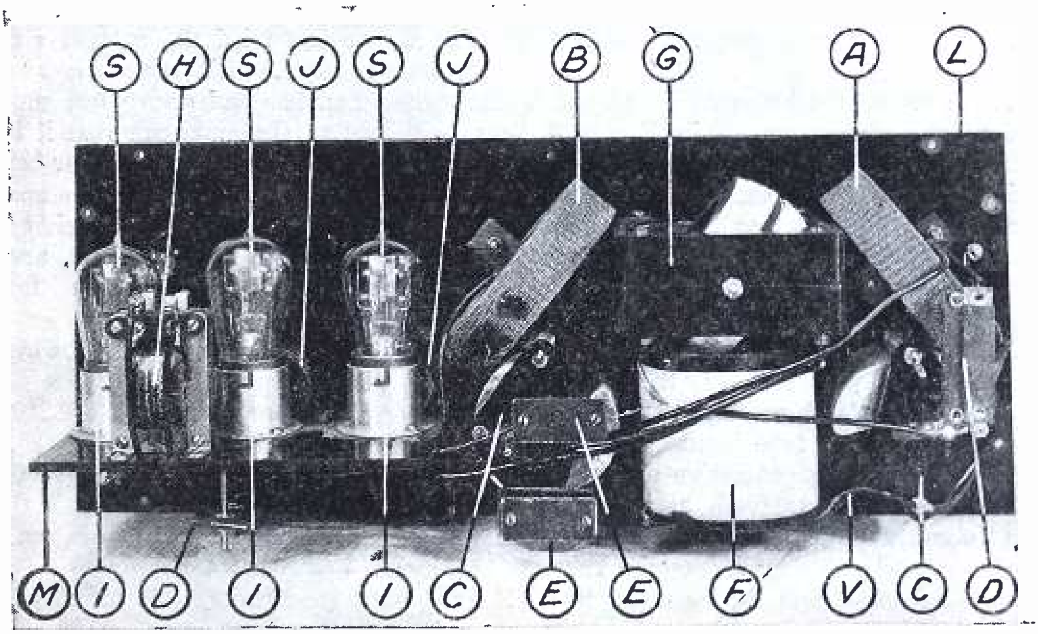
The remarkable feature of the new Armstrong circuit lies in the fact that it permits almost unlimited amplification —but at the same time requires only a small number of tubes. In Armstrong's demonstration he used one, two or three.

Users of Armstrong's ordinary regenerative circuit will remember how, by turning the knob of the dial marked "regeneration," the signal strength of incoming messages could be increased slowly at first and then with a rush as the dial approached the point on the scale where the circuit began to oscillate. If the dial were turned beyond this point the voice signals would become distorted.

Many investigators have wondered if it would be possible to prevent the circuit from self-oscillation by some means, even if the dial should be turned past this point, thus obtaining an unlimited amount of amplification without experiencing trouble from the distortion which would certainly take place were the circuit to produce oscillations. The general opinion among the experts was that this was not possible; Armstrong himself, up to a year ago, would have replied in the negative.

Nevertheless he continued his researches with the vacuum tube, studying the reactions that took place in the tube circuits and learning just what sudden changes in the positive and negative resistances of the circuits would accomplish. Finally he conceived the idea of his new invention.

It is a well-known fact that a tuned circuit will oscillate if the resistance of the circuit is not too great to dampen out the oscillations. Now suppose that we should introduce a certain critical amount of resistance in the vacuum tube input circuit of an ordinary regenerative receiv-



From a diagram made for POPULAR RADIO

HOW TO MOUNT THE INSTRUMENTS

FIGURE 1: *The various items that are required in the assembling of this Armstrong-circuit set are illustrated in this diagram. Note that the coil F and the variometer G are placed in inductive relation to each other. The regeneration in the first tube circuit is controlled by the variometer.*

ing set while it is in a state of oscillation. Under these new conditions the oscillations would suddenly be dampened out and cease.

If this adding of resistance to the circuit could be done periodically (say at a frequency just above the frequency that the human ear could detect), the vacuum tube circuit would become, alternatingly, extremely sensitive and then dead and sluggish.

In other words, the circuit would be "damped" at intervals that occurred at a high rate of speed. During these intervals the circuit would be of increased resistance and the self-oscillation would cease. But between these intervals the circuit would be at an extremely critical stage, as the resistance would be withdrawn and the circuit, while trying to start oscillating, would amplify incoming signals enormously. This would give a series of periods of almost unbelievable amplification which would follow each other so rapidly that they would seem to run into each other; so far as working the telephones and affecting our sense of hearing are concerned, they really do just that.

These results are brought about by the use of the circuit shown in Figure 4. The damping device consists of another vacuum tube which is attached to the regenerative circuit so that the oscillations generated by the second tube effectively vary the damping of the first tube circuit with respect to the regeneration.

Another method for accomplishing the same results would be to vary the amount of regeneration with respect to the damping of the vacuum tube input circuit. If the handle of the regenerative dial could be rotated back and forth at a terrific rate (above audibility), what would happen? The circuit would become enormously sensitive for an instant; then when the knob was brought back in the opposite swing, it would be effectively prevented from self-oscillation. This method would give the same series of periods of increased amplification as the first method, and is accomplished by the use of the circuit shown in Figure 5, in which the second tube is attached to the plate circuit of the first tube by means of the coupling transformer T and the condensers C2 and C3, so that the oscillations generated by the second tube are used to vary the amount of regeneration in the first tube circuit.

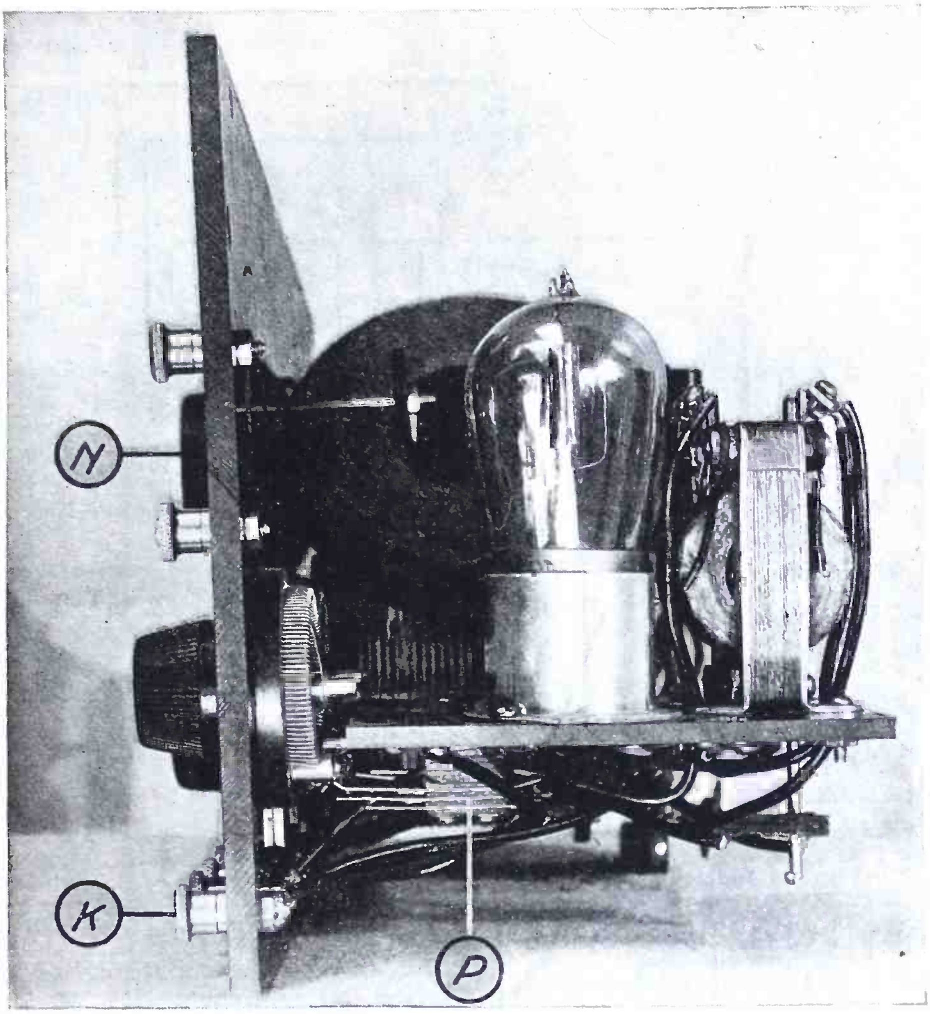
Still a third method may be used for super-regeneration. This is accomplished by varying both the damping of the first circuit, and the amount of regeneration, at the same time, with respect to each other, keeping the proper phase relations. Figure 6 shows such a circuit, where the same tube is used for both regeneration and for generating the oscillations by which the characteristics of both circuits are varied, the second tube being used merely as a detector.

Since Armstrong made his announcement many experimenters have tried to get a receiving set that embodies one of these different methods to work. Some have had great success with it, while others have had little or none.

The writer has tried the various circuits as described, with variations and adaptations and has had such great success with one particular circuit that it is recommended for use by the amateur because of its simplicity of operation and flexibility. It can be used for receiving continuous waves, telephone, music, and (by making slight adjustments) for spark reception.

For building this set, the following materials will be required:

1 duo-lateral or honeycomb coil, L-1250, A.
1 duo-lateral or honeycomb coil, L-1500, B.
2 variable condensers, .001 mfds. capacity, C.
2 fixed mica condensers, .002 mfds. capacity, D.
2 fixed mica condensers, .0005 mfds. capacity, E.
1 insulating tube, 4 inches long, 3 inches in diameter, wound with 60 turns of

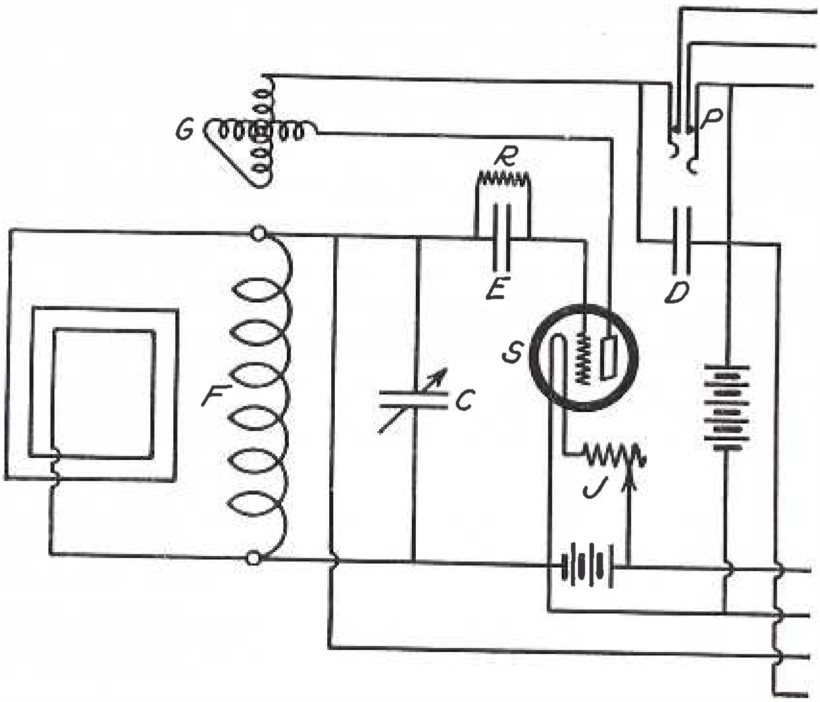


From a photograph made for POPULAR RADIO

A SIDE VIEW OF THE SET

This diagram shows how the shelf for supporting the tubes and the amplifying transformer is mounted on the jacks P. (These jacks are fastened to the panel L, shown in Figure 1.) The filament rheostats are fastened to the rear of the panel with the small controlling knobs protruding through the panel. Compare this view with that on page 19.

No. 18 SCC copper wire, F.
1 moulded variometer, G.
1 amplifying transformer, H.
3 tube sockets, I.
3 filament rheostats, J.
10 binding posts, K.
1 insulating panel, 8 inches by 20 inches by ¼ inch, L.
1 insulating panel of suitable size for mounting sockets and the amplifying transformer, M.
3 large knobs and dials, N.
1 cabinet, outside dimensions 8 inches by 20 inches by 6½ inches, with a door at right top, 4 inches by 8 inches, for inserting tubes, O.
2 automatic lighting jacks, one double circuit and one single circuit, P.
1 duo-lateral or honeycomb choke coil, L-200, Q.
1 1-megohm grid leak, R.
3 radiotron UV-201 vacuum tubes, S.
Miscellaneous screws and bolts (brass), T.



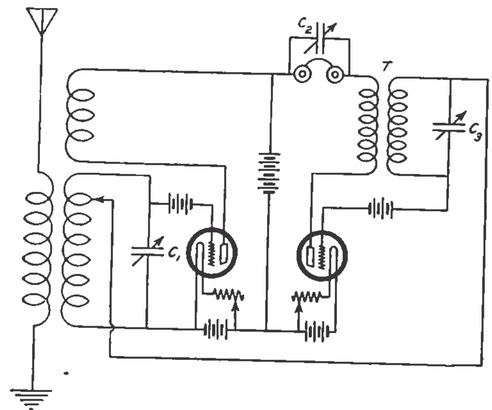


FIGURE 4

This diagram illustrates the method of obtaining super-regeneration by varying the damping of the first tube circuit with respect to regeneration. The set described in this article uses an adaptation of this method.

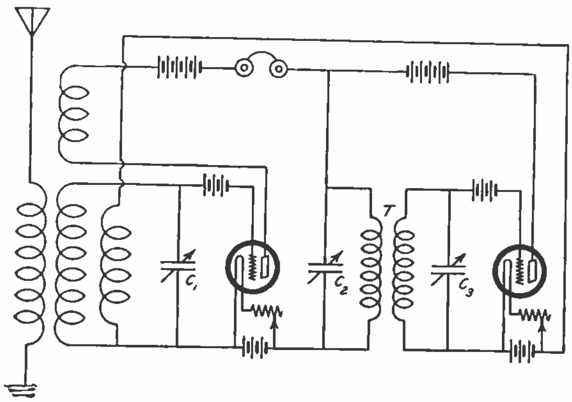


FIGURE 5

This circuit diagram shows how super-regeneration may be obtained in still another way—by varying the amount of regeneration with respect to the damping of the input circuit of the first tube.

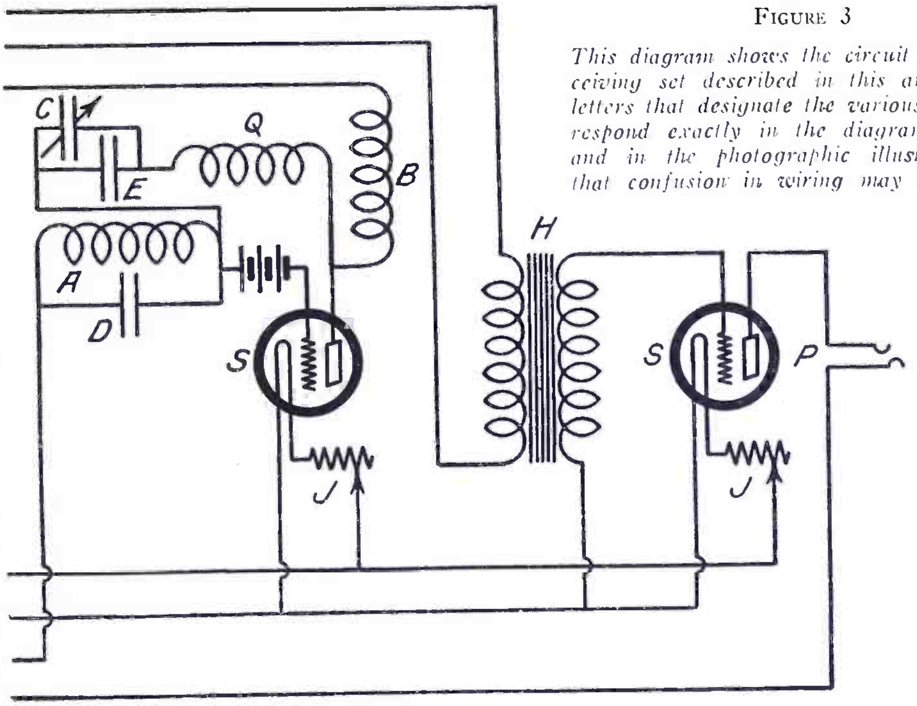


FIGURE 3

This diagram shows the circuit for the receiving set described in this article. The letters that designate the various parts correspond exactly in the diagram, the text and in the photographic illustrations, so that confusion in wiring may be avoided.

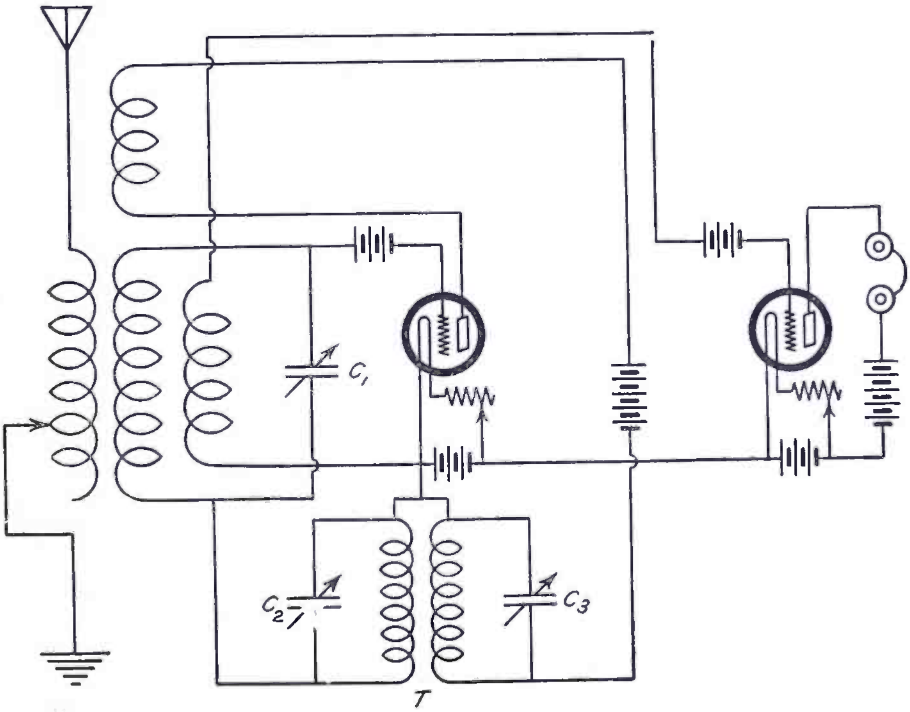


FIGURE 6

How super-regeneration may be obtained by varying both the damping and the regeneration with respect to each other, keeping the proper phase relations.

Some connecting wire (bare copper), U.
Varnished cambric tubing for insulating the connecting wire, V.

The panel is laid out as shown in the illustration on page 18, in which the three small knobs and pointers at the right are the filament rheostat controls, with the two telephone jacks mounted directly beneath. The two large knobs at the left bottom are connected to the two variable condensers and the large upper knob is fastened to the variometer.

The method of mounting the various instruments on the back of the panel is shown clearly in Figure 1.

The method used for mounting the tube shelf on the telephone jacks is indicated in Figure 2.

After the instruments have been mounted, they should be connected up according to the diagram shown in Figure 3. All joints should be soldered. Connecting wires should not run parallel for any great distances.

The parts on the diagrams and the photographs bear the same letters as the list of parts in the text so the amateur should have no trouble in assembling this set.

The duo-lateral choke coil cannot be seen in the illustration, but it is mounted flat against the panel in the rear of the coil, F.

The two binding posts at the left of the panel in the first illustration are for connection to the loop antenna. Starting at the left, the row of binding posts shown in the illustration should be connected as follows: first, negative "A" battery; second, positive "A" battery and negative "B" battery; third, "B" battery positive of the first two tubes; fourth, "B" battery, positive of the third tube; fifth, positive "C" battery for second tube grid; sixth, negative "C" battery for second tube grid. The two binding posts arranged vertically at the right can be used for connecting to a loud speaker.

When the set is completed and hooked up to a suitable loop antenna, which can easily be made by winding on 12 turns of No. 18 SCC copper wire on a three foot square wooden frame, extremely good results may be obtained.

The writer used an 8-volt "A" battery and a "B" battery potential of 100 volts on the plates of the first two tubes, and 150 volts on the third tube. The "C" battery on the second tube, used to keep the grid at the correct negative potential, was 3 volts. An ordinary grid condenser and grid leak was used here with fair results, although the "C" battery was better.

The condenser connected across the primary of the amplifying transformer was found sufficient to bipass the high frequency current generated by the second tube and prevent it from inducing a strong current in the grid circuit of the amplifier tube, thus "knocking" the amplifier tube. No other form of filter was found necessary, although a good filter probably would help here.

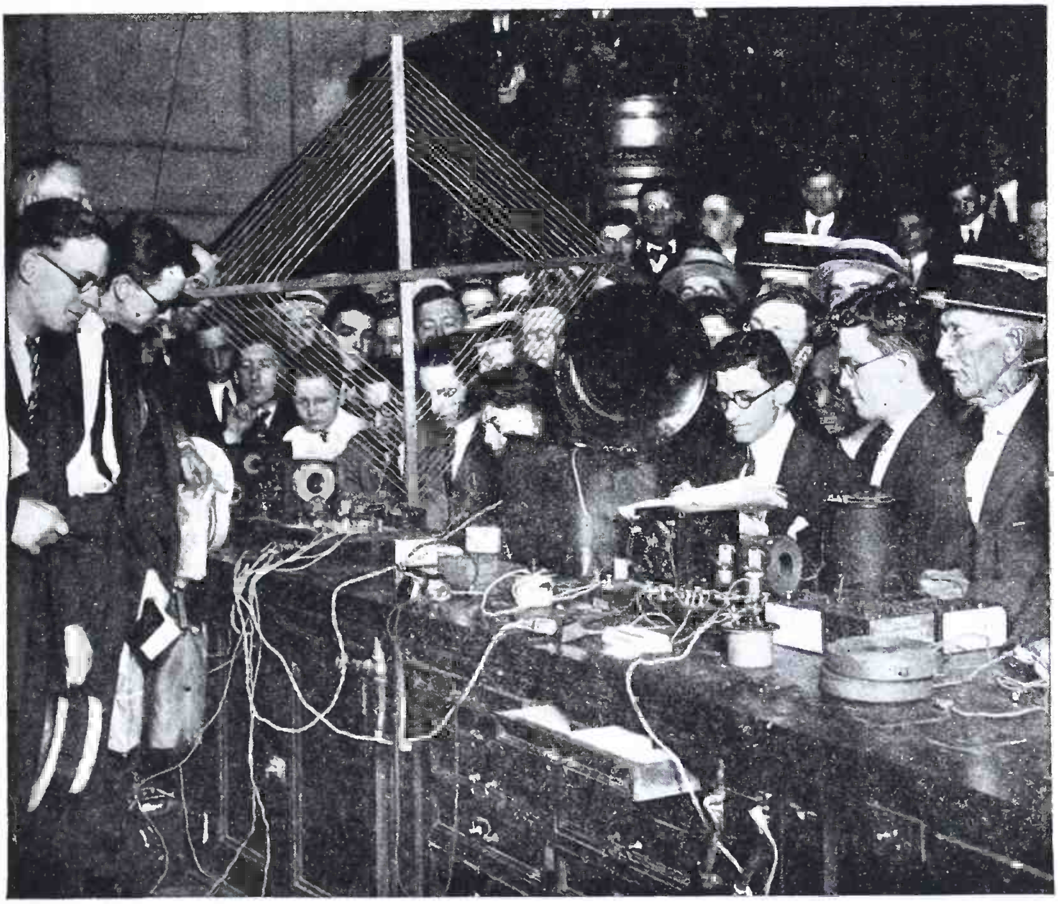
The object of this description of the set is not so much to show the amateur all the structural details of a set that employs this circuit, but to give a general idea of a simple way to build it so that it will work, if the main points are carried out to completion.

The easiest way to find out how to tune the set is to turn up the filaments of the tubes rather high, and then set the tuning condenser located at the lower left hand corner of the panel at zero. The next move is to turn the other lower condenser to a near-maximum setting. Then the upper dial which is affixed to the variometer should be turned in the same manner as the ordinary tickler adjustment until a loud squawk is heard. Then turn down the filament of the second tube slightly until the squawk increases in intensity. The squawk is then tuned out by adjusting with the variometer and for each given setting of the wavelength tuning condenser, there is a setting on the variometer at which static and signals will come in loudly. When a signal is finally tuned in it may be slightly distorted or mushy at first, but it can be cleared up by careful adjustment of the two lower knobs and by slightly varying the filament adjustments of the three tubes.

In a few hours of practice the amateur can master the method of tuning this new set by learning what each particular sound heard in the receivers means in regard to adjustment.

After operating such a set as described for three hours the writer was able to tune in with ease on a loop any of the Eastern broadcasting stations; some of these stations were clearly heard throughout the room even when there was not any loop connected to the receiving set at all.

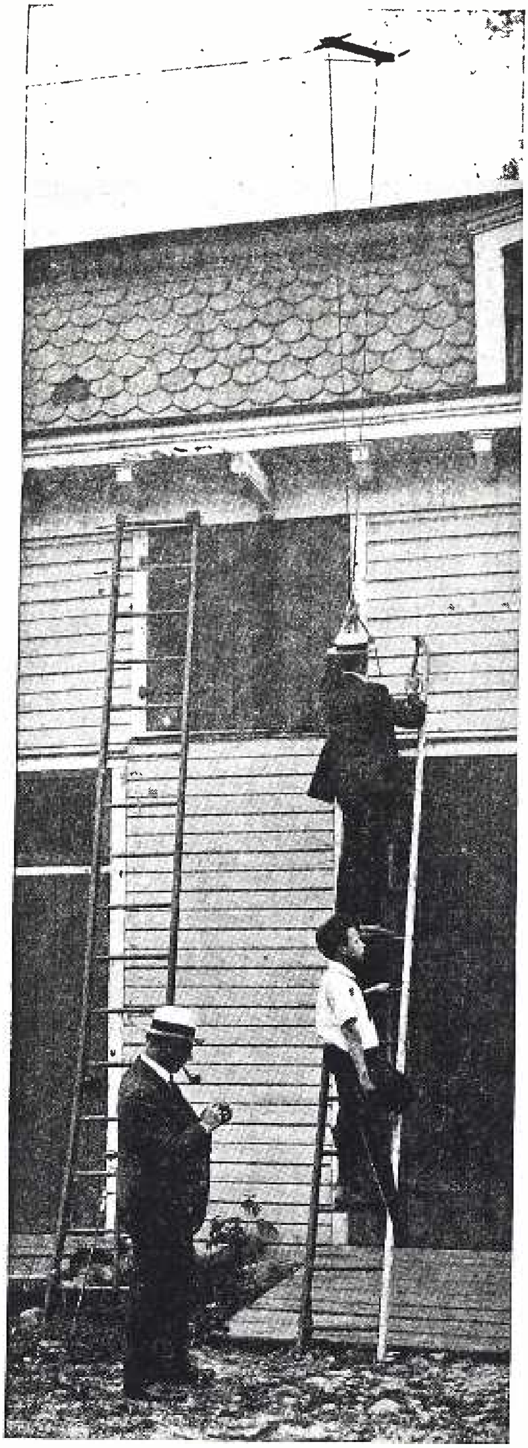
During the first night of operation of this set, in fifteen consecutive minutes, the following C. W. amateur stations were picked up on a round loop one foot in diameter; the set was installed in the writer's laboratory in New York, with a steel elevated structure almost directly overhead: 1CXB; 1BDU; 3OT; 3ZO; 4DC; 4GL; 4GV. By turning the loop east and west the experimenter picked up 8BDT; 8BPA; 8UE; 9DZY; 8AQW and Canadian 9AL, stations as far west as Kansas, as far south as Georgia and as far north as Canada.



Kadel & Herbert

THIS SET AMPLIFIES FROM 100,000 TO 1,000,000 TIMES

When E. H. Armstrong demonstrated to the public his remarkable super-regenerative receiver at Columbia University he remarked: "The super-heterodyne circuit is still the Rolls-Royce method of getting practically unlimited amplification. But there are some people who prefer to use Fords. This super-regenerative circuit is the Ford method of amplification." This picture shows some of the radio fans, young and old, who grouped about the set—following the demonstration of its capacities.



From a photograph made for POPULAR RADIO

I STRING UP MY ANTENNA

Some people use a screw-driver and some use a monkey-wrench, but I have found that a boden works better than either.

I Install My Receiving Set

This Article Is Written for the Purpose of Giving Sound and Practical Help to the Layman Who Puts Up His Own Radio Apparatus With No More Experience than that Possessed by the Author——

ELLIS PARKER BUTLER
Author of "Pigs Is Pigs"

FOR installing a radio outfit some people use a screw-driver and some use a monkey-wrench, but I have found that an ordinary boden works quicker and does a better job. To install my radio outfit I used one large boden and one small one, and the results were perfect. For installing radios I shall hereafter use nothing else.

It was like this: Someone called me up on the telephone and asked me if I had a radio outfit, and I said "No." Then he asked me if I didn't want to buy one, and I said "No!" Then he asked me why, and I said I had a player-piano and a phonograph and a pair of twins learning to play the piano and no time to bother with a radio anyway. I told him that I wouldn't have anything to do with radio. I said that three or four years from now, when my small son was big enough to make and install one, he might have one if he wished but that I did not want one and that was all there was about it.

When my radio outfit was delivered at my house three or four days later I found it consisted of one flat cardboard box full of things and one oblong box full of things and some other things. In each box was a paper sheet of "Directions," with a picture of a house and a barn with a wire stretched between them. The picture was evidently taken just after the Mohawk Indians had made an attack on the settlement, for everything was stuck full of red arrows. Some of the arrows were marked "Screw Eye," that probably being the name of the Indian that had shot the arrow. Personally I think Screw Eye is as good a name for an Indian as Rain-In-The-Face or Sitting Bull, but some of the names were peculiar. I can imagine some romantic Indian mother naming her child "Insulating-Entrance-Bushing" but, if I was an Indian mother and had forty children I don't believe I would think of naming one of them "No. 14 Copperweld Antenna Wire." And yet one of the arrows was marked that. It was also marked "75 to 150 feet long, 25 to 50 feet high." If this was the size of the Indian that shot that arrow he must have been a giant. He was probably the Chief.

At exactly 10:45 Sunday morning I spread out the direction sheets and counted the things in the boxes. This is always a safe way to begin. It looks efficient. Then I counted the things mentioned on the sheet of directions and found that they agreed in number and variety with the things in the boxes. There were thirty-three things, thirty-one of which I did not know what to do with. The other two were screw eyes. A man with a mechanical turn of mind such as mine is not often fooled by a screw eye. As soon as he sees it he knows it is meant to screw into something. The only question was what I had better screw the screw eyes into.

The man who brought my radio outfit to my house—when I was not at home—had taken a look around and he had told my father to tell me that he thought I had better string the antenna wire from the roof of the house to the tree out back there. This was all right except that the tree was beyond my fence and in Mr. Bourguignon's back lot. It was not my tree; it was Mr. Bourguignon's tree. Of course I might have bought the tree and had it moved into my yard, but no one would have moved it on Sunday, even if Mr. Bourguignon wanted to sell it, and I wanted to get through with the job that day. The other alternative was to leave the tree where it was—it was a big tree—and buy Mr. Bourguignon's property, but his property has a house and six garages (five cement ones and one frame) and a chicken coop and a tennis court and other things on it and it hardly seemed worth while to go to the expense of buying it.

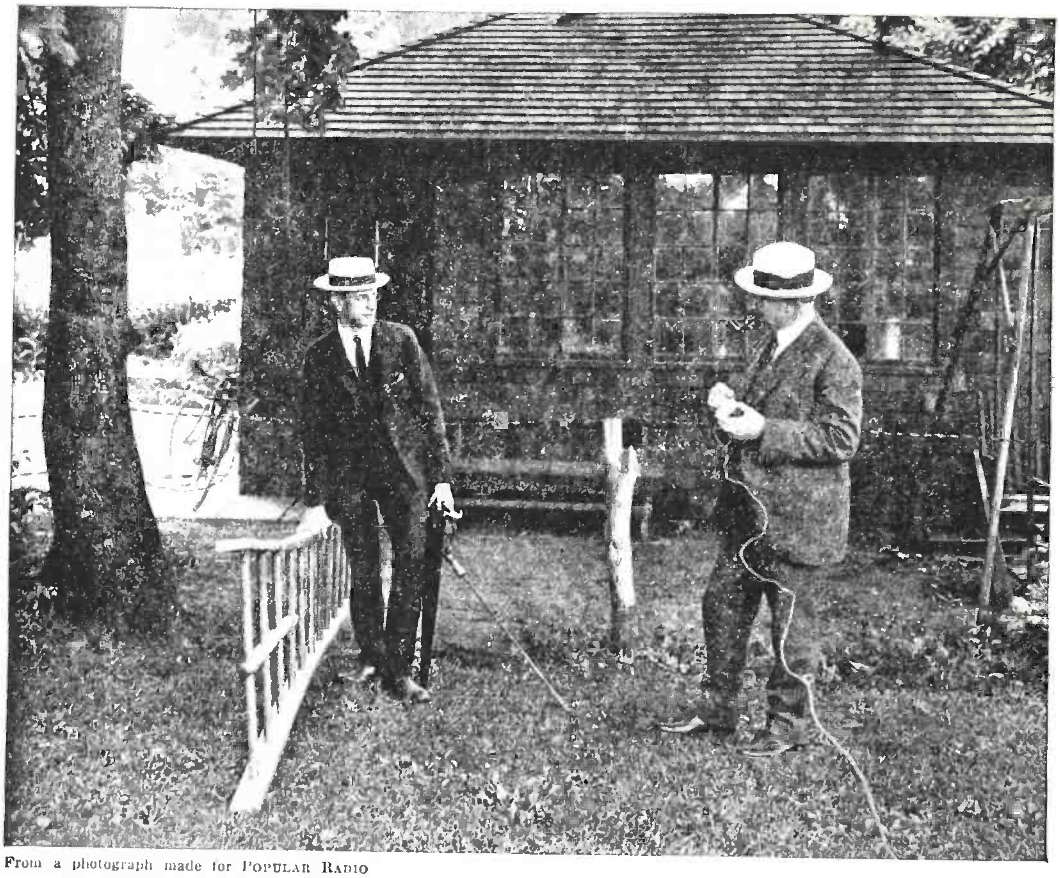
I might have gone to Mr. Bourguignon and have asked him to loan me one cubic inch of the tree to screw the screw eye into, but my wife has a garden and the Bourguignons have chickens. The Bourguignons keep their chickens cooped up and out of our garden in the nicest way possible, but one can never tell. A cyclone might blow down their chicken coop and let the chickens into my wife's garden and a chicken might eat a petunia. Then, if in hot anger I murdered the chicken, Mr. Bourguignon might climb the tree and chop down my antenna just when Galli Curci was going to sing an aria or something, and that would be a catastrophe.

You can see by this what tremendous difficulties we radio engineers have to contend with. So I put the large flat cardboard box on the grass at the corner of my house and hung the loop of antenna wire over my arm and lighted my pipe and read Article 1, Section 1, of the Constitution and By-Laws, which said, "Select location for antenna as free as possible from trees, buildings, towers, etc."

This was a stumper! The only two places I knew of that were as free as possible from trees were the Sahara Desert and the Arizona Desert, and that was not where I was. It was not where I wanted to string the antenna. I wanted to string it in my own back yard.

The directions then said that "except at ends, antenna wire should not come closer than ten feet to any of these objects." Then "Wire may be supported from buildings, poles, or trees." Direction 2 said "Uncoil Copperweld Antenna Wire and lay along ground between supports."

This was something like business! This



From a photograph made for POPULAR RADIO

I AM CONFRONTED WITH A TECHNICAL PROBLEM

It was evident to me that the 70 feet of bedspring was not going to lay itself down flat and neat and then boost itself into the air like a properly trained antenna.

was something to do. I began at once.

"Here!" I told my young son; "Take the end of this wire and walk down to the fence with it and hook it onto the fence."

I said this calmly and with seeming indifference, but, as a fact, I was deeply agitated. I had meant to come out of the house, rig up the antenna, put it through a window, hook it onto the doojah that you hear through, and then sit down and hear the morning sermon. That was allowing fifteen minutes for the job, and to a man of my capabilities it should have been sufficient. It is all right for a ten-year-old boy to take an hour to two to build and install a radio outfit, but a man—and a busy man—cannot afford to waste time.

Unfortunately I saw at once that if the "No. 14 Copperweld Antenna Wire" was to be "25 to 50 feet high" I would need a ladder. I can reach eight feet high, and if I stand on a chair I can reach eleven feet high, but I cannot reach fifty feet high. And I had no ladder. In stringing an antenna wire between a house and a barn properly a ladder is almost a necessity. There is only one thing that can take its place; this is a boden.

My son took the end of the wire down to the fence and as the wire unrolled off my arm it took the form of a spiral. It was like a seventy-foot bedspring, and I had a lot of wire left on my arm. It was evident to me right then that the wire was not going to lay itself down on the ground as flat and neat as a stretched string and then boost itself up into the air where I wanted it, and behave like a properly trained antenna, with soldered connections and everything.

At that moment a voice behind me said:

"Hello! Putting up your radio?"

I turned and saw the very boden I had been needing. Perhaps it is better to spell it with a big B, like this—Boden.

"Yes," I said to Boden, and he came up to the fence.

"I am spending this Sunday collecting money for the Flushing Hospital," he said, and added: "You can't unroll a coil of wire that way, as if it were a rope; it twists and kinks if you do. I'll show you how to unroll a coil of wire."

So the Boden—perhaps it is better to say it with a Mister, like this—Mr. Boden—came over into my yard and unrolled the coil of wire. It reached from where I was to the fence and back, and as Mr. Boden wanted to show me how to straighten a wire that had spiralled itself into kinks I let him show me. I held the end of the wire while he showed me.

I was now making good progress and was well pleased. Mr. Boden came and took the end of the wire out of my hand and placed it on the lawn. The difficult part of my work was now to be done: the brain work. That is my specialty. I felt at home. I spread out the sheet of directions and picked up a screw eye. Then I put the screw eye back in the box. I am never afraid of good hard work.

"The picture on these directions," I said, "shows a single antenna wire, and the directions say 75 to 150 feet. As it is only seventy feet from my house to my barn I guess seventy feet will do."

Having settled that once and for all I was well pleased. I like to get things settled definitely. I detest indecision. Once I had decided on a single wire seventy feet long the rest was easy. I lit my pipe while Mr. Boden decided that my aerial was not to be a single wire but a double wire hung with spreaders and insulators. I lit another match and remarked that I did not have any spreaders and that I had only two insulators. Mr. Boden went over to his house and got two hickory spreaders that happened to be nicely wired and to have holes in them where holes were needed, and also two more insulators. I then lit another match—I smoke damp tobacco—and Mr. Boden said my aerial was going to be fastened to my kitchen chimney with a rope and to the barn with another rope. I told him I had a rope, and he seemed pleased. One's labor is made much more pleasant when installing a radio outfit if the Boden used is the sort that seems pleasant now and then.

Having proceeded this far I looked at the barn and said I would probably need a ladder, so Mr. Boden went home and got a large ladder that was in two sections. He brought it into my yard and put the two sections together and stood them up against the barn.

I was now ready to get down to solid work. I took out a fair-to-middling looking safety match and struck it while Mr. Boden strung the antenna wire through the spreaders and made them fast there, wiring the insulators where they should be. As there was a slight breeze the match went out, and I lit another. This assistance greatly inspired Mr. Boden and he sent a junior Boden home for his soldering outfit while he uncoiled the 35 feet of No. 14 B & S gauge insulated copper lead-in wire and twisted it neatly to the antenna wire at the proper place.

Having allowed Mr. Boden to solder the joints neatly and permanently I was now ready to begin work in real earnest. I took out my watch—it was given to me by the citizens of Flushing because of the tireless manner in which I do any job I undertake—and while I wound it Mr. Boden got a large length of stout wood out of my barn and, climbing the ladder, nailed it upright against one of the dormer windows of the barn. I then permitted him to come down, because he wanted to go home to get his saw, and when he had brought the saw and several pieces of board into my yard, I showed him a good place to put the boards while he sawed them into braces. Then he went up the ladder and nailed the braces in exactly the place I should have selected myself.

Luckily for us all, Mr. Boden, when he went up the ladder, had taken one end of a rope with him as well as the two screw eyes. He now screwed the two screw eyes into the upright length of stout wood and ran the rope through the eyes of the screw eyes. With my usual indefatigability I tied the other end of the rope to the antenna business so that he could pull it up and fasten it snugly in place. You can imagine my pride when I saw that glistening copper wire high above my head ready to receive the mysterious electric waves that are the marvel of the twentieth century, and knew that I had done the whole job myself without assistance of any kind.

"Boden," I said, "I have done a good job."

"I have to go home for dinner now," he replied.

"In that case," I said, "it is time for me to rest and refresh myself with a little food. I believe a laboring man deserves his full hour at noon."

After dinner I looked around for the full sized Boden but he was not to be seen. I was a little hurt to be thus deserted just when I was ready to begin the really intellectual part of my job—hooking up the lightning arrester and connecting the batteries and the Type NF Style 319564 Receiver and attaching the telephone earpiece doodads. Fortunately I am a man of resourcefulness. To do all this delicate work I had nothing but a pocket knife

From a photograph made for POPULAR RADIO

I LET MY NEIGHBOR BORE THE HOLE

I had intended boring the hole myself, so that I could say that I had installed my radio outfit myself and without any help whatever. But Boden went for the brace and bit so cheerfully that I thought I would reward him.

and a small sized Boden. For a reason which I shall mention a little later I was unable to insert the "insulating entrance bushing" through the side of the house to poke the wire through, so—temporarily —I opened a window and put the wire through the opening thus created. As the window was large I had little difficulty in putting the wire through the opening. I then laid the second sheet of directions on an almost-mahogany table while the small sized Boden attached twelve or fourteen wire ends to different parts of the lightning arrester and receiver. When I had thus hooked on the various wires my real work began.

In installing a radio outfit it is necessary to have what we technical experts call a "ground wire." This is a wire that connects the aerial with the earth. The idea seems to be that when the radio wave leaves its distant home and roosts on your antenna it immediately becomes homesick and wants to get back home. If you give it a "ground wire" it slides down it and goes right home by subway, giving your receiver a kick as it goes. This is what puts life into your receiver, but if you do not give the wave a "ground wire" it roosts on the antenna and dies there and falls off and never squawks again. This explanation may be too technical for some of my readers but those who have made a life study of radio will understand it. It therefore became necessary for me to save the lives of countless radio waves. I did so. I took the coil of wire—one end of which the junior Boden had fastened to the lightning arrester—and threw it out of the window. I then went outdoors and wrapped one end of this wire around the spigot I use to fill the watering can when I want to fill the bird bath.

It was now 3:45 P. M. and I was quite exhausted. I went into the house and found that the junior Boden had attached the ear things and had pushed the glass bulb into the place that was meant for it and done something to several dials. At exactly 3.46 P. M. I put the ear piece to my ear and broke right into the middle of a Mother's Day sermon that was coming through the air from Newark, New Jersey.

This shows what a man can do when he is not afraid of work and makes up his mind to do a thing, no matter how difficult or laborious it may be. Nothing dismays such a man. Nothing can conquer him. He decides to do a thing and he does it.

And I am not a radio installer by profession either; I am an author. The fact that I am an author makes the work I did in installing my radio outfit all the more wonderful, but it led to the second and final triumphant day of work.

The room in which I had temporarily installed the radio receiver is the room in which I do my authoring and I soon found that having the receiver one foot and three inches from my desk cramped my style. It is almost impossible for an author to turn out work like Thackeray's and Shakespeare's while he is listening to WJZ give the weather forecast, the final baseball score, an orchestral concert, a lecture on Oral Hygiene and a talk on "The Hopeful Side of the Cancer Problem." It is almost annoying to write with ink when two twins, three minimum sized boys, a wife or two and a few neighbors are sitting on the desk, the inkstand and sheet 6 of the manuscript, listening to radio. So I decided to move radio to another room and install him permanently there according to a column and a half of new fire and lightning regulations.

No sooner said than done! Unhooking all wires I threw them out of the window. And now came the strenuous part of the work. A week had passed by and again it was Sunday morning. I went out in my yard and waved lengths of wire in the sun but no Boden came to the fence. I leaned against a fence post and studied the sheet of directions but no Boden appeared. I feared some other radio enthusiast was using my Boden, but I discovered this was not so; he had gone to church.

I had purchased thirty-five more feet of lightning proof wire and a lot of porcelain thingumbobs. The thingumbobs I

From a photograph made for POPULAR RADIO

I PUT THE FINAL TOUCHES ON THE INSTALLATION

I found that the Junior Boden had attached the ear things and had pushed the glass bulb into the place that was meant for it and done something to several dials.

screwed to the side of my house and on them I strung the wire. This brought me to the window casing in which I wished to insert the "insulating entrance bushing" without which no modern home is complete. As it looked as if it was going to be impossible to push a baked clay "insulating entrance bushing" through a hard pine window casing I went inside the house. To do this I had to go half around the house, up the back-porch stairs, through the back entry, through the kitchen, through the butler's pantry, through the dining room and into the "little room." Having done this I looked at the floor. It was a hard floor. I must bore a hole through the hard floor into the cellar and run the "ground wire" down to a water pipe there. I went out of the "little room," through the dining room, through the butler's pantry, through the kitchen, through the entry, down the back-porch steps, across the yard, into the barn and looked at the tools there. The only tool I saw that would bore a hole was a gimlet, so I took the gimlet and went out of the barn and across the yard and up the steps and through the entry and through the kitchen and through the butler's pantry and through the dining room and into the "little room."

I next decided to bore the hole and bored it. As the hole was not big enough to admit the wire I went out of the "little room," through the dining room—well, anyhow, I went to the barn and got a brass rod that I found there, and a hammer, and went back and hammered the brass rod down the gimlet hole. Immediately the far end of the brass rod hit something as solid as the rock of Gibraltar —solider, even. It was the foundation of the house. Then I tried to pull the brass rod out of the hole and it would not come. It was stuck there.

I went out to the barn and got a puller and went back to the house and pulled the brass rod out of the gimlet hole. I chose a spot three inches from the first hole and bored another gimlet hole in the floor. This time the brass rod, when driven into the gimlet hole, struck the foundation of the house. It was the same foundation of the same house.

When I had pulled the brass rod out of the gimlet hole I went down cellar and looked at the foundation and came upstairs and bored another hole. I drove the brass rod into this hole and hit something medium hard. I went down cellar and looked for the end of the rod, but I could not see it, and I went upstairs and looked at the rod and downstairs and looked for it again and upstairs and measured from the window edge to the rod and downstairs and discovered that the cellar window was not as wide as the room window. So I went upstairs and outdoors and measured from the edge of the cellar window, and went downstairs and measured from the edge of the cellar window there, and discovered that the gimlet hole was undoubtedly immediately above the washroom partition. So I went upstairs and bored another gimlet hole in the floor.

This time the brass rod, when hammered into the gimlet hole, went through and took a part of the cellar's plaster ceiling with it. I pulled the rod out of the hole and poked a quarter of a mile of insulated wire down the hole and went down cellar to sand-paper the water pipe and attach the patent "ground clamp, Style 319501." There was no wire! A quarter of a mile of wire had gone down the gimlet hole and mysteriously disappeared!

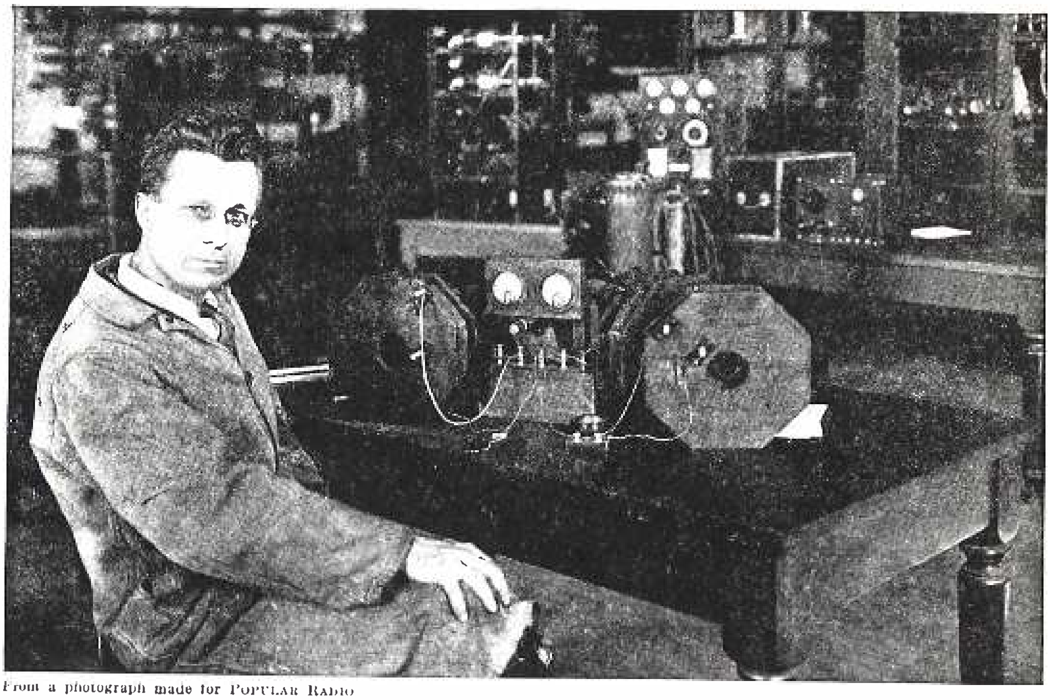
Later I found it between the cellar's plaster ceiling and the floor above, and eventually I coaxed it—by speaking to it gently—to go down into the cellar.

I was now all ready to perform the final operation of the installation of the radio outfit, and while I waited for the sermon in the Congregational Church to conclude I attached the lightning arrester to the wall. By this time I heard a noise like a Boden next door and I wandered over in that direction and casually remarked that the directions said a five-eighths bit was a good size to use in boring a hole for the "insulating entrance bushing." My priceless Boden immediately went down into his cellar and returned at once with a brace and a bit about a yard and a half long.

I had intended boring the hole myself, so that I could say that I had installed my radio outfit myself and without any help whatever, but the Boden went for the brace and bit so cheerfully and returned so promptly that I thought I would reward him. I let him bore the hole.

Should Uncle Sam Levy a Tax on Radio Receiving Sets?

Broadcasting is already a public utility. Some way must be found to make it a profitable enterprise in itself. Foreign governments, which subsidize operas and theatres, may levy a tax on radio apparatus and contribute the proceeds to government-controlled broadcasting stations. Will that happen in the United States? Read Waldemar Kaempffert's thoughtful article on this problem—one of the most vital problems that confront the radio fan—in a near issue of POPULAR RADIO



From a photograph made for POPULAR RADIO

A MASTER OF ELECTRICAL THEORY

Few scientists have done more useful experimental work with vacuum tubes than Prof. Morecroft of Columbia University, and none has written more clearly and authoritatively on the subject. This article is one of a series which he is writing especially for POPULAR RADIO.

How *the* Vacuum Tube Works

SIMPLE "HOW" ARTICLES FOR THE BEGINNER—NO. 5

What the "Triode" Is, How It Is Made and What Takes Place Inside of It—Told in Language that Every Radio Fan Can Understand

By PROF. J. H. MORECROFT

THE vacuum tube is a device which, by a peculiar action, can take continuous (or direct) current power from a battery or generator and transform part of it into alternating current power. The frequency of the power generated by the oscillating tube is determined entirely by the electrical constants of the circuit; the amount of power it is possible to generate is determined primarily by the size of the filament and plates of the tube, and secondarily by the adjustment of the circuits.

To any one at all familiar with the ordinary laws of the electrical circuit it will seem strange that a source of continuous power supply can, by means of such a device, be changed to an alternating current power supply. The ordinary laws of electrical circuits seem to prohibit just such an occurrence. If we have a generator that gives a continuous voltage and we connect a circuit of any kind to the terminals of this generator we expect to get a flow of continuous current, and practically always we do so. How then is it that the vacuum tube, or triode, as it is gradually being re-named, can transform such a continuous energy flow into an alternating energy flow?

It is first to be pointed out that there are many occurrences in our everyday life where just such phenomena are taking place, yet we scarcely notice them—occurrences in which a simple, straightforward push or pull makes something vibrate backwards and forwards. In fact, it seems likely that the present popular study of radio, including such things as the triode, will react to make us observe more closely many of the ordinary events that take place around us, which we do not understand and which have many points of similarity with radio. The oscillating triode certainly has a place in this category; an attempt to understand its action will surely make us pay closer attention to many events taking place around us which we have never questioned, although we have understood them no better than we understand the triode.

Everyone who has studied physics in high school knows that sound is a to-and-fro motion in the air, that it is a vibratory action in which energy flows past the ears at a non-uniform rate; the flow of energy goes from a maximum to zero with a frequency depending upon the musical pitch of the note. Thus the sound from a violin string, giving the middle C, is really caused by a compression and rarifaction wave in the air which sends energy past our ears in the form of "pulses" at a regular rate of 256 a second. The question should occur to anyone who hears such a sound: how can the man's arm, which is evidently exerting a uniform pull on the violin bow, send off energy at the rate of 256 pulses a second? Certainly the man's muscles are

Paul Thompson

A GIANT VACUUM TUBE, AS COMPARED IN SIZE TO A TELEPHONE INSTRUMENT

Tubes of this size (½ kilowatt) are used for transmitting only. Of the various names applied to such tubes, ranging from "radio bottle" and "Aladdin's lamp" to audion, the term "triode" is coming into general use among scientists.

not causing that phenomenon directly.

The answer to this question, although the phenomenon is a common one, is not simple; it can probably be accurately given by no one who reads this article. The question has probably not even occurred to any one of them, yet we frequently hear nowadays the question: "What makes a triode oscillate?" It is a case of the unusual; the violin string is so simple that every one thinks he knows how it works. But the vacuum tube seems much more complicated in its action. As a matter of fact it is easier to get an exact solution of the action of the triode than of the violin string.

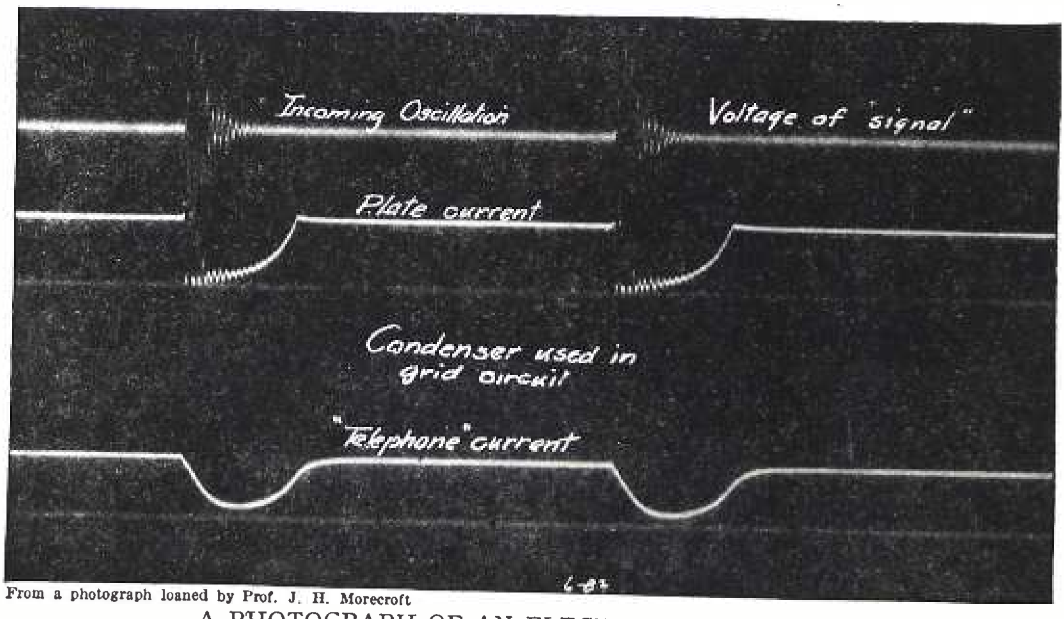
What makes the brakes of a train or automobile give off such a shrill squeal when they are suddenly applied? Does the driver actually vibrate the brake shoe thousands of times a second? Evidently not. What makes the balance wheel of a watch continually oscillate back and forth when the main spring is evidently trying always to push it in the same direction? What makes the steam rush out of a whistle in pulses, giving off high-pitched musical notes when it could apparently flow through the hole through which it is escaping more easily if it came out uniformly—in which case no sound would be given off at all?

Will a toy balloon, towed behind an automobile, proceed uniformly through the air or will it vibrate sideways, even though the towing string is exerting a uniform forward pull? Why does a flag flutter in the breeze?

These cases could be multiplied without number; it seems in many instances that Nature would rather do things in an oscillatory fashion than in a straightforward fashion.

We should not be surprised therefore, in view of the actions just outlined, if the electrons in the triode, on their way from the filament over to the plate, may be made by certain circuit connections to proceed at a variable periodic rate rather than flow uniformly as the continuous current generator or battery in the plate circuit tends to make them do.

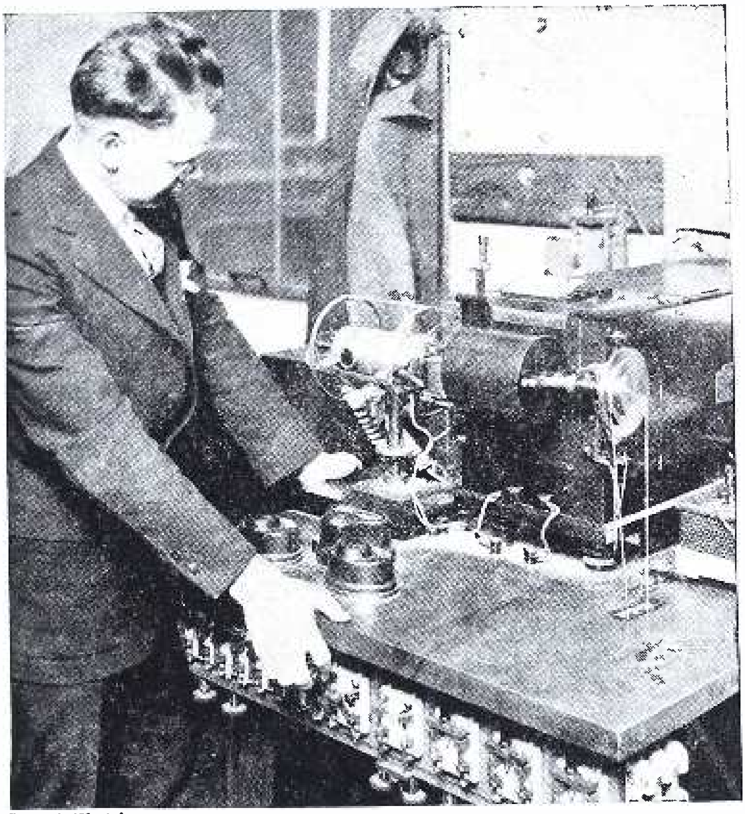
The elements of an oscillating tube circuit are as shown in Figure 1. The plate



From a photograph loaned by Prof. J. H. Morecroft

A PHOTOGRAPH OF AN ELECTRICAL VIBRATION

This picture is termed an "oscillogram." It shows in graphic form how a vacuum tube that is used with a condenser in series with the grid, detects a high frequency signal.



General Electric

THE OSCILLOGRAPH—A MACHINE THAT PHOTOGRAPHS ELECTRIC CURRENT

The film end of an oscillograph box, showing the arc lamp in the spring tube at the left and control switches, vibrators, electric shutters and field magnets. The kind of picture that such a device produces is shown on the opposite page.

circuit generator with its associated choke coil delivers a continuous flow of energy; this energy coming to the tube may be partly used up in the tube and partly flow on to the output circuit, which is the place where the high frequency power oscillations are started. The oscillating circuit may be made to act on the tube, so that the energy is supplied to the circuit in pulses, thus serving to keep it continually in oscillation. This action is much the same as in the escapement of a watch, which lets energy flow into the balance wheel in pulses—the pulses being so timed as to maintain the oscillatory motion of the wheel.

The period, or frequency of oscillation of the balance wheel, is fixed by the effective mass of the wheel and the size of spring used; shortening the spring will increase the frequency and lengthening the spring will lower the frequency. This is what is accomplished by the "faster" and "slower" adjustment of your watch.

As the electrical constants of the oscillating circuit determine the frequency of the alternating current that is generated, it might be presumed that any frequency could be generated at will. Such is nearly the case. With one of the ordinary tubes obtainable for small transmitters the writer has produced frequencies as low as one cycle a second by use of large inductances and condensers, whereas the same tube with the smallest inductances and condensers feasible has generated ten million cycles a second. These are not necessarily limits; it is possible for one who has large and efficient coils to go lower than one a second and

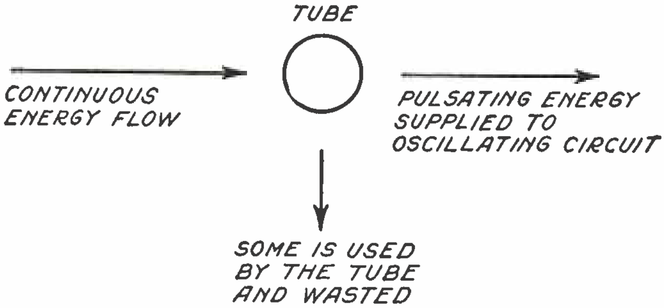


FIGURE 1: *The elements of an oscillating tube. This diagram illustrates in simple form the action that takes place within the oscillating vacuum tube.*

by using proper care in the selection and arrangement of the apparatus the upper frequency can be pushed as high as three hundred million cycles a second—a wide enough frequency range to suit almost everyone!

The amount of power output of an oscillating tube is limited entirely by the amount supplied by the continuous current machine that furnishes the power to the plate circuit; only a certain fraction of this can be transformed into alternating current power. The power supplied by the continuous current machine is equal to the product of its voltage and current, hence to have a large output from a tube its plate circuit must be arranged to stand high voltage and its filament must be sufficiently large to liberate a great many electrons without operating the filament at such a high temperature that its life would be short. In the smaller tubes used for transmitting about 500 volts pressure is used in the plate circuit and a current of about 30 milliamperes is permissible, thus requiring from the plate circuit generator 15 watts of power. As an efficiency of 30 per cent is common in these tubes as generally used, the amount of alternating current power available is about 5 watts, which is the rating of the small transmitting tubes.

For more power, larger filaments are required and the arrangement of connections in the tube must be such that high voltages may be applied between the plates and filament. Tubes are now being made for experimental purposes which permit an electron current from filament to plate of 60 amperes and which permit a voltage in the plate circuit of 15,000 volts. As the efficiency of these larger tubes can be made much higher than it is for the smaller tubes (just as is the case for any electrical machinery) we may figure on an efficiency of 80 per cent to 90 per cent, so that the output would be measured in the hundreds of kilowatts. Of course, these powerful tubes cannot follow the same constructional lines as the smaller tubes; they are made of metal instead of glass, and all the parts of the tube must be arranged for cooling by circulating water through jackets properly built into the tube.

For a given tube, well constructed and evacuated, there are two prime factors which serve to limit the safe output: the safe filament temperature and the safe plate temperature. Excess values of either will materially shorten the life of the tube.

An oscillating power tube may be either separately excited or self-excited, the same as any continuous current generator. In case but one tube is being used it must evidently be self-excited, but if three or more are used better results will be obtained by using one of them (self-excited) to excite the grid circuits of the others. The writer has always found it possible to get more power out of three tubes by using one of them as an exciter and the other two as power amplifiers than if all of them were used to deliver power to the antenna. It is easier to control the various required adjustments for separately excited tubes than for those self-excited.

It is especially advisable to use separately excited tubes for short wave telegraph transmission because of the greater constancy of the frequency generated; if self-excitation is used the frequency of oscillation is determined by the capacity of the antenna and any change in this capacity will affect the frequency sent out. If double frequency amplifiers (Armstrong's super-heterodyne) are used for receiving, the reception will be comparatively poor.

The safe output of an ordinary tube is fixed by the heating of the plate. The largest tubes used by amateurs have a safe plate rating of 250 watts. If the tube is adjusted for 50 percent efficiency it is evident that the maximum safe output of the tube is 250 watts. Suppose that by a suitable adjustment the efficiency could be raised to 90 percent, what would be the safe output of the tube? Again the safe output would be fixed by the fact that there must be no more than 250 watts used on the plate, but with 90 percent efficiency, when the loss on the plates is 250 watts, the output of the tube will be 2250 watts; that is, the possible output has been increased something like ten times!

It is easy to state the conditions which must be obtained in a tube to get its maximum efficiency for any given filament current and plate voltage, but it is not quite so easy to furnish these conditions on an actual set. A comprehensive study of the question of triode efficiency was made by the writer, with the assistance of Mr. Trap Friis, and the results were published in the Proceedings of the A. I. E. E. for October, 1919. This seems to be the only work on record in English that shows the necessary conditions for maximum efficiency and how to obtain them.

The grid potential and plate potential of a tube fluctuate as the tube generates alternating current power, generally following the form of a sine wave. For best conditions the plate voltage must fluctuate an amount nearly equal to the voltage of the machine in the plate circuit. For example, if a 500-volt generator is used in the plate circuit the plate voltage should fluctuate from about 50 volts to 950 volts, the exact amount depending somewhat on the structure of the triode. The proper value of the lower limit (50 volts) is very important in determining the efficiency, but it can only be given accurately when the exact characteristics of the tube are

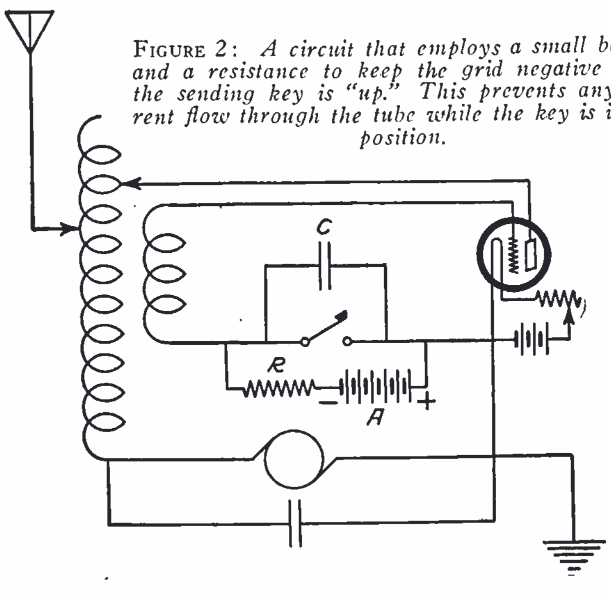


FIGURE 2: *A circuit that employs a small battery and a resistance to keep the grid negative while the sending key is "up." This prevents any current flow through the tube while the key is in this position.*

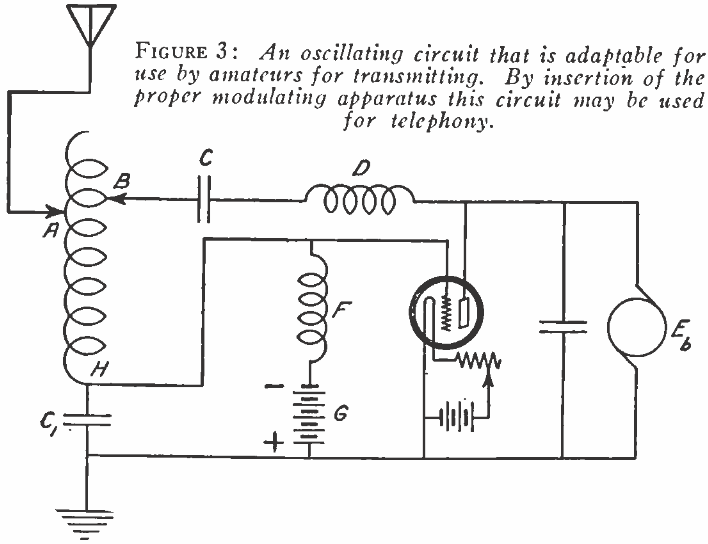


FIGURE 3: *An oscillating circuit that is adaptable for use by amateurs for transmitting. By insertion of the proper modulating apparatus this circuit may be used for telephony.*

known. The article cited above deals with this point in detail.

The grid potential must fluctuate by an amount about equal to the fluctuation of plate voltage multiplied by the factor $W_o/2$ where W_0 is the theoretical voltage amplification factor of the tube, generally about five for the small power tubes sold for amateur use. The amount of grid bias voltage (always negative) should be so chosen that when the grid voltage has its maximum positive value it is nearly equal to the minimum plate voltage. This condition may be obtained either by the use of a C battery of small dry cells or by the use of a suitable grid condenser and grid leak. In either case a high frequency choke coil should be placed between the grid and ground (filament connection) to prevent the use of excessive power in exciting the grid.

Not only must the proper magnitudes of grid and plate voltage fluctuations be obtained, as given above, but the relative phases of the two must be accurately adjusted. The phase of the two must be exactly 180 degrees apart, so that the maximum positive grid potential occurs simultaneously with the minimum value of plate voltage. This is an important point to observe if the maximum output of the tube is to be obtained, and is the most difficult condition to fulfil when the tube is using self-excitation.

The fourth condition has to do with the load circuit. In the case of separate excitation the natural frequency must be the same as the frequency of the exciter and for either separate or self-excitation, the effective resistance of the antenna circuit, between the two points where the tube supplies the alternating current power, must be equal to the alternating current resistance of the plate circuit of the tube. This is nearly equal to (but always somewhat less than) the voltage of the B machine divided by the continuous current furnished by this machine.

It is possible, of course, to put the transmitting key directly in series with the antenna circuit if but little power is being generated, if opening the circuit at the point selected does not also interrupt the current from the B machine. It is generally better, however, to put the key in the grid circuit, thus cutting off the excitation of the tube when no signals are being sent out.

Whenever possible the key should be so placed that when the key is "up" no plate current flows from the B machine; in this case when no signals are being sent (all the time the key is up) the plates are being cooled off and also not so much power is used from the B generator. If this connection is properly made the safe output of the tube is nearly twice as much as if this precaution is not observed.

Thus if a tube is rated at 12 watts safe power on the plate and the above condition is satisfied, the circuit may be adjusted so that when the key is down the power dissipated on the plates is 20 watts, and still the plates will not overheat.

In the case of highly evacuated tungsten filament tubes this may be accomplished by leaving the grid "free" or "floating" when the key is up; with oxide coated filament tubes this free grid is a dangerous condition and should never be tried. The free grid of a well evacuated tungsten tube will practically always be negative, thus cutting the plate current down to a very small value. The free grid of an oxide coated filament tube may suddenly go positive, in which case the plate current increases to a dangerous value and the tube is spoiled in a few seconds; in fact, they many times "blow up," breaking all the internal structure.

For these oxide filament tubes it is best to have the key so inserted that when it is up the grid is forced to a proper negative value by a battery of small dry cells, as indicated in Fig. 2. With the key up the voltage of cells A forces the grid to become so negative that the plate current is brought to practically zero and when the key is down the cells are "shorted" through the high resistance R, which is sufficiently high (say 50,000 ohms) so that the current which flows from the cells doesn't materially affect their life. A small condenser C across the switch points will eliminate whatever slight sparking might occur. Using this scheme it is possible for a small hand key to successfully control kilowatts of power in the antenna.

When the conditions for best efficiency are obtained it often happens that the tube is sluggish in "picking up" when the switch is closed, thus not permitting rapid sending; for this reason as well as for the others cited above, it is best to have the power tubes excited by a separate tube, which is continually left in the oscillating state.

Of course, every one finds his "best" circuit by using that in which he gets most power out of his tubes. But any circuit which permits the fulfillment of the conditions analyzed will be as efficient as any other.

A circuit certainly as convenient as any is shown in Fig. 3. This is the one used most frequently by the writer. A coil H, A, B, is wound with sufficient inductance so that combined with the capacity of the antenna it will give frequencies considerably lower than any which it is desired to generate. It has about twelve taps, say every second turn is brought out for making connection to it by a clip. Condenser C_1 is a mica condenser with four or five values, the minimum being about equal to the antenna capacity; a better but more expensive set-up uses a variable condenser in this place. F and D are high frequency chokes of about one millihenry each. C is an insulating (or blocking) condenser of say 0.1 microfarad. G is the biasing battery of a few small dry cells; for the ordinary 5-watt tube 20 cells will do.

The wavelength sent out is controlled by the position of contact A. The grid excitation is controlled by the size of condenser C_1; it should generally be about twice the capacity of the antenna. The position of contact B affects the wavelength slightly but its principal function is to make the effective resistance of the antenna, as measured between contact B and ground, equal to the plate circuit resistance of the tube. The amount of bias voltage in battery G affects the efficiency of the tube primarily; this, and the capacity of the condenser C_1, should be varied together in adjusting for maximum efficiency. For small power the sending key can be placed in the antenna circuit between condenser C_1 and ground. If the maximum safe output is desired the grid should be excited through a condenser and the key arranged as shown in Fig. 2.

For the single tube transmitter this circuit arrangement seems as good as any.

From a photograph made for POPULAR RADIO

A DEMONSTRATION OF THE "TALKING CRYSTAL"

Without the aid of a battery or other electric generator, Dr. A. M. Nicholson, who developed what is called "Piezo electricity," enables his audience to listen in on music broadcasted by radio.

The Voice in a Lump *of* Salt

How Crystals Are Made to Yield the Beautiful Supersensitive "Pressure Electricity." Today a Laboratory Stunt but Tomorrow—What?

By JAMES H. COLLINS

RATHER a dirty looking chunk of something or other—like paraffine melted up with fine sand. And a queer shape—flat on one side and a squatty pyramid on the other. It might be a setting lost out of the ring of a very untidy giant.

It is wrapped with a ribbon of tinfoil, clamped between two aluminum plates and squeezed a little by springs. Finally it is hooked up in an electrical circuit.

"Now listen!" the visitor is told, and he is handed a pair of telephone receivers. He hears the music from a phonograph in another room—it would travel just as well from another city. Sound cannot be transmitted over a telephone wire without electric current. But there is no battery on this circuit. The queer-shaped object clamped between the aluminum plates is furnishing the intermittent currents. Tested with a voltmeter it would register as much as 500 volts on twisting the object with the fingers.

Then it is hooked up to a powerful

vacuum tube amplifier and is laid on a sheet of paper. One edge of the paper lifted with the fingers produces a sound as though somebody were ripping clapboards off a house. The ticking of a watch laid on the paper sounds like a pile-driver at work. A grain of sugar is laid on the paper; presently a fly lights and begins investigating. The feet of a fly have suction pads—that is what enables him to walk on the ceiling. His promenade around the sugar sounds like a cow wading through a mudhole!

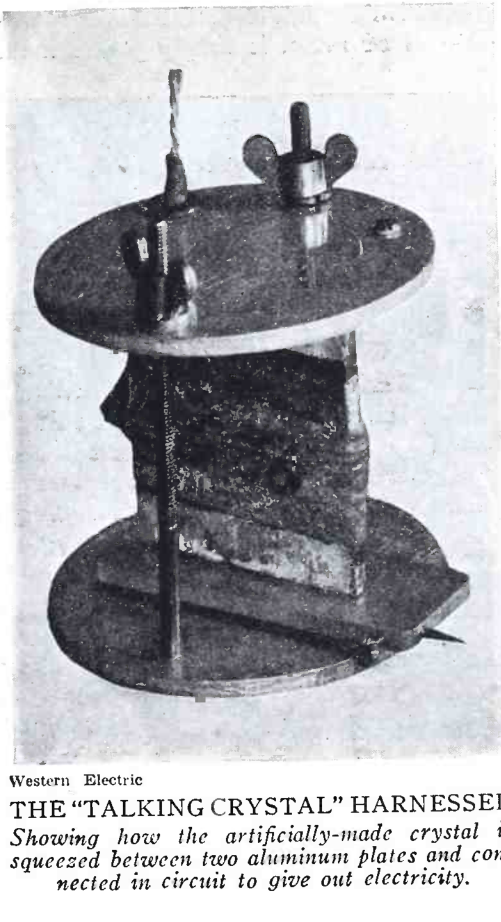
The strange object is a crystal. We are in a room devoted to crystal-electrical research in the big New York laboratory of the Western Electric Company, the guests of Mr. A. McLean Nicolson, who might be called a "crystal farmer," for besides studying the electrical phenomena of crystals he has to grow them from "seed crystals." He is showing us the "piezo-electric" property of "pressure electricity," of certain crystals which were discovered by the Curies. "Piezo" is from the Greek "piezein" which means "to press." Torsion applied to these crystals converts mechanical energy into electrical energy, following certain lines in its crystalline arrangement or pattern. Why certain inorganic crystals like quartz and gems should have taken different patterns in cooling from molten liquids or gases in the remote ages when the globe was young, or why organic substances like sugar and certain salts should cool from liquid into different patterns, is one of the unsolved riddles of matter. But a most fascinating riddle! For if matter as we perceive it through our senses is nothing more than electrical energy working in the impalpable ether (and no scientist has ever detected the ether by the most delicate apparatus) then in this electrical phenomenon found in crystals we are leaning over the very eaves of the material universe and looking into its ether abysses. That is to say, looking into the Everlasting Nothing—from the standpoint of mere humans.

You can push speculation along this line so far into mathematics and metaphysics that it is comfortable to find a material chair under you and see material ships out the laboratory window doing their chores up and down the North River, and hear the blunt question of a matter-of-fact visitor:

"Well, what practical use can you put it to? Will it make a better crystal detector for radio?"

Just what the skeptical man in the street wanted to know when Sir William Ramsay isolated argon and helium, "But what are they good for?" And science itself couldn't then predict that in less than thirty years we would be using one in electric light bulbs and the other to make safer dirigibles.

"During the war, we used these crystals as submarine detectors," explains



Western Electric

THE "TALKING CRYSTAL" HARNESSED

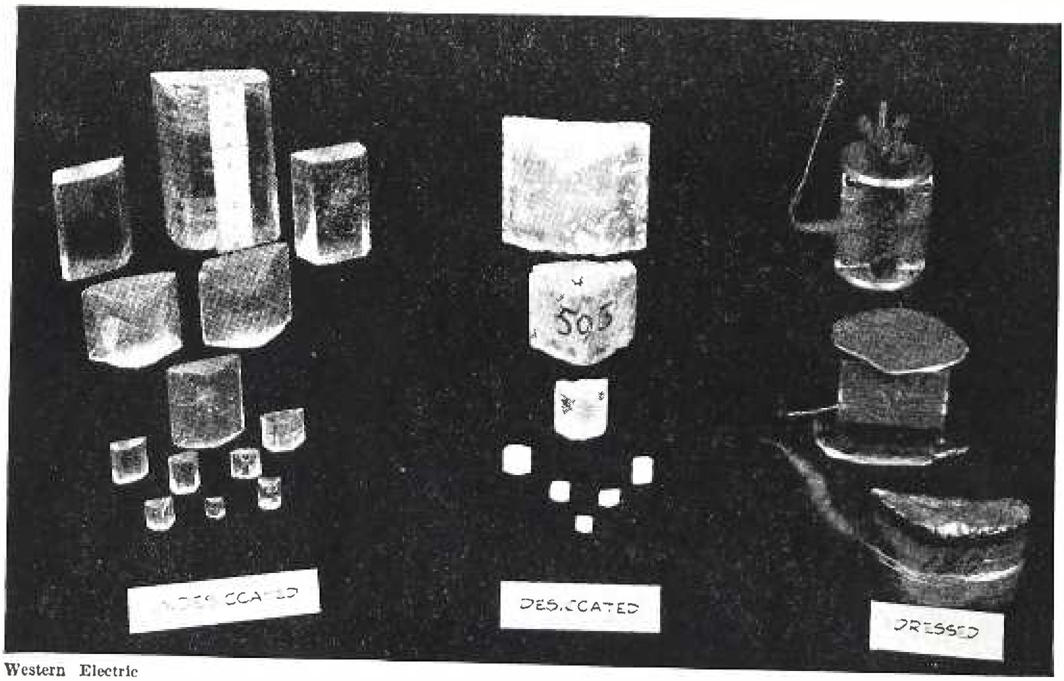
Showing how the artificially-made crystal is squeezed between two aluminum plates and connected in circuit to give out electricity.

Mr. Nicholson. "Placed in watertight cans, dropped over the side of a ship and connected with a telephone circuit, their supersensitiveness revealed the vibration from a submarine propeller several miles away. But we haven't found a real workaday job for them yet."

The time may come when crystals will replace the carbon microphones in the telephone transmitter and receiver, but there is no immediate practical application in sight, and the physicist refuses to make any predictions. They have no advantage in radio telephony because, while many amateurs use galena, carborundum and other crystals as detectors, this type of crystal is "different." The radio crystal detector is a rectifier. It changes the inaudible high frequencies that are transmitted through the ether into lower frequencies capable of acting upon a telephone receiver. But while this crystal is sensitive enough to detect the high frequencies of radio, it simply passes them along without changing potential, and for radio purposes it would have to be connected with something else. The crystal radio detector is only a makeshift, anyway. We have the ideal detector in the vacuum tube, the only reason why it is not universally used being that it is somewhat expensive compared with crystals.

The present problem is to find better kinds of crystals, and learn more about the organic crystals generally—which is where "crystal farming" comes in, a field of investigation in which amateurs might help and find an interesting hobby. This requires some chemical knowledge, but is not difficult and should appeal to those who take an interest in pure science and like to extend their knowledge by experiment.

None of the inorganic crystals so far investigated have any great degree of sensitiveness—the quartz and gem crystals that Nature grew millions of years



Western Electric

THE THREE STAGES IN THE CREATION OF THE PIEZO CRYSTALS

These bits of crystals, grown from seeds in the laboratory, are as clear and pretty as gems when they first come from the solution. After they are "desiccated" (or baked and shrunk), they are "dressed"—meaning that they are covered with varnish and tinfoil.

From a photograph made for POPULAR RADIO

HOW THE CRYSTALS ARE MADE

The best crystals are made of Rochelle salts, but good effects have been obtained from various kinds of sugars, especially from common rock sugar. Even ice is a crystal from which piezo effects may be obtained.

ago. Only the organic crystals grown in the laboratory become satisfactory generators or transmitters of electricity under torsion. The best of them all thus far found is the crystal of Rochelle salt, a product of the juice of the grape. For practical purposes it has shortcomings, it is easily damaged by humidity, for one thing.

Relatively few of the many salts, sugars, tartrates and so forth, have been investigated. As an illustration of the field to be explored the writer told Mr. Nicolson about the rare sugar work of another investigator, Mr. T. Swann Harding, who is producing a dozen or more little-known sugars for bacteriologists. Harding's sugars are a queer lot. One of them is a bitter sugar, several are unfermentable, and another is extracted from pants buttons, so to speak—the vegetable ivory trimmings from button factories.

"There you are!" he said enthusiastically. "The only sugar we have tested for the piezo-electrical effect is the common rock sugar of the candy store."

If Mr. Harding can grow better crystals for Mr. Nicolson, they will still have to make a horse trade on costs, for some of the rare sugars fetch several hundred dollars a pound!

Crystals are grown in several ways. Like plants, each particular substance thrives best under certain conditions. The purpose of growing the crystals is to get them in masses large enough to generate or transmit sufficient electricity. The growing process is really freezing. Incidentally, ice is a crystal, and snow, probably with the piezo-electrical effect, but they have obvious shortcomings.

The Rochelle salt crystals are obtained by heating a solution of the salt in water and cooling it to supersaturation rapidly, in about twelve hours. A small "seed" crystal is added as the liquid cools, and the salt grows around it, taking its characteristic crystal formation. Masses weighing two pounds have been grown, but they are usually defective. After growing, the "raw" crystal must be "desiccated" or baked. This dries and cures it, shrinking the size and increasing its electrical properties. It also improves with time, if it is not affected by atmospheric conditions. Mr. Nicolson has crystals which, after several years' use, are just as effective as ever, and in some ways more effective than newly grown crystals. Its production of electricity takes nothing from the crystal. Put under compression and torsion, it gives out electricity, and when released it takes up electricity. A handy comparison is with a sponge, from which water can be squeezed, and which will take up water when the pressure is relaxed, yet nothing is taken from the sponge in the process.

After the crystals have grown and are baked, they must be dressed—coated with a special varnish and fitted with tin-foil electrodes. The small seed crystals used in growing the larger ones are obtained from previous croppings or by disturbing the solution in which crystallization is taking place, this causing it to break up in many small crystals.

Kelvin reasoned that matter is nothing more than electric swirls or "vortex rings" in the ether, comparable to smoke rings. If they swirl without friction they will go on forever. But if there is the slightest modicum of friction, eventually the material universe must run down and disappear. That will happen so many aeons in the future that we needn't worry about it, but it is inevitable just the same.

The Hindus hold that the visible material universe is simply the "breathing out" of Brahma into the invisible spiritual universe.

"I will realize and express myself through material manifestations," says Brahma, and his out-breathing is the energy that makes spirit appear as matter—or the ether as Kelvin's vortex rings in terms of modern science. But there is an in-breathing, too, and when Brahma breathes in again, the material universe disappears and an unthinkably vast cycle of creation ends, and the universe rests in spirit until another out-breathing.

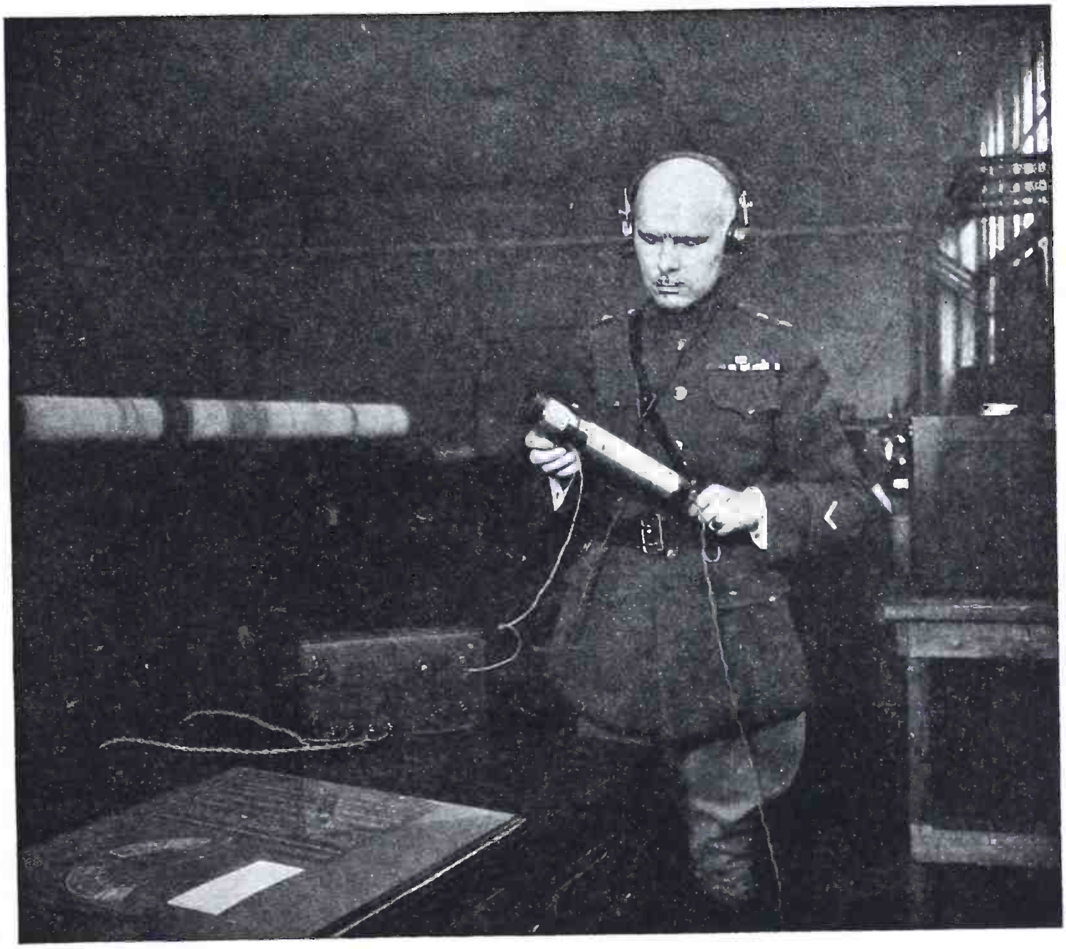
Kelvin didn't find Brahma, nor carry the microcosm of his vortex ring to the microcosm of Brahma's cycle. But his physical and mathematical results suggest that the Hindus may not be, after all, so far off in their metaphysical conception of the universe.

In the piezo-electrical phenomena of crystals, as in radio communication, we are perhaps dealing with the basic stuff of the universe—certainly the finest states of matter. And we are using some of them to enormously extend the range of human intelligence, so pitifully blanketed under its dense robes of flesh.

Yesterday radio communication was a beautiful laboratory plaything, useless to the practical man. What it has since become, the piezo-electrical effect of crystals may become tomorrow.

What Will Take the Place of Today's Broadcasting?

Publication of Major General George O. Squier's article on this live topic has been postponed from this issue—for which it was announced—to the next issue, October. This change will enable the General to include in his article some timely material that was not available earlier. Ask your newsdealer to reserve your copy.



U. S. Signal Corps

THE MOST EXCLUSIVE ANTENNA IN THE WORLD

By merely sliding the ring along this miniature resonance wave coil—thereby changing the wavelengths which are received—Major-General Squier, the inventor of this device, is enabled to keep out not only the wavelengths he does not want, but also most of the static that comes along with them.

A Resonance Wave Coil *for* Reducing Static

By S. R. WINTERS

BY the use of a so-called "resonance wave coil"—which is in effect a complete and compact wireless antenna—the Signal Corps of the United States Army reports that it has developed a method whereby "static," the persistent disturber of orderly radio communications, may be practically eliminated. This discordant element in the reception of radio signals is operative from June to October—about five of the twelve months in the year—and has always been one of the retarding factors in the development of the radio art.

The invention of the Signal Corps for eliminating static takes the form of a drain coil of wire. The incoming signals from broadcasting stations, for instance, traverse the so-termed "resonance wave coil" and then proceed to the conventional radio-telephone receiving outfit, irrespective of the design—vacuum tube or crystal set. But this coil of wire or compact antenna is of a discriminating caliber and only radio signals are admitted into the radio-telephone receiver, while the static electricity is sidetracked and conveyed to the ground. Such are the claims made for this new form of "static eliminator."

The length of the drain coil varies with the distance traversed by the communications that are to be received. The strength of the incoming wireless signals are not robbed of their strength by the draining process. Moreover, facilities are accessible for amplifying the messages as required.

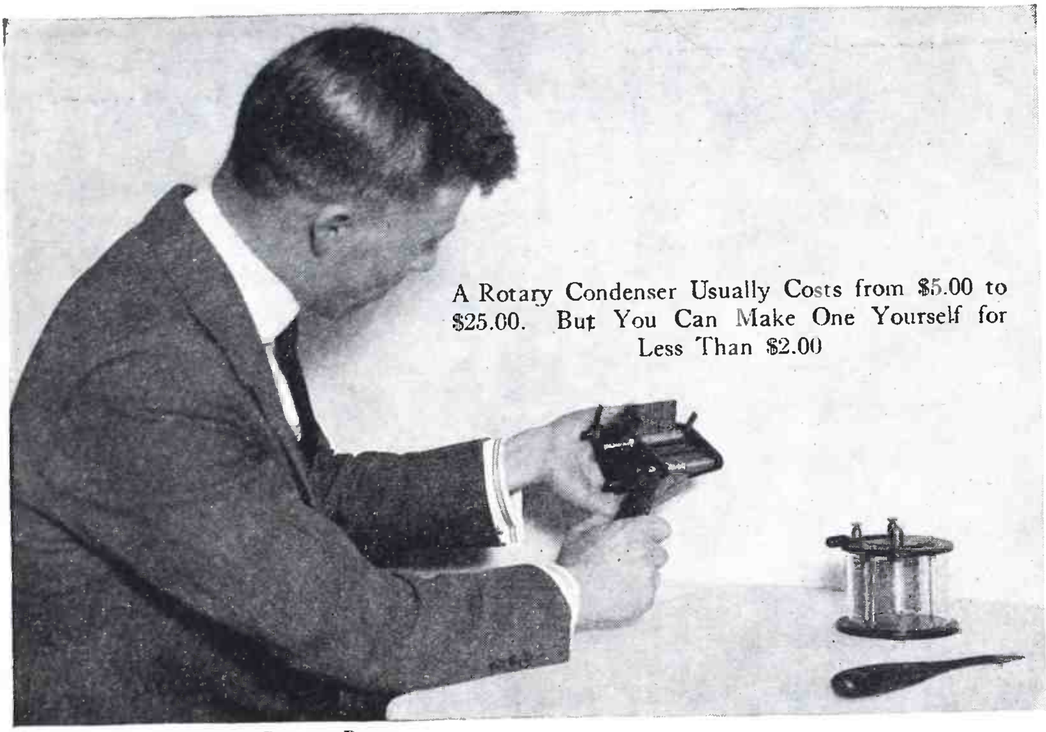
"Eliminating static noises has been one of the most serious problems in radio development," says Dr. Louis Cohen, consulting engineer of the Signal Corps of the United States Army. "Due to the electrical charges in the atmosphere, especially in summer, even the largest stations must shut down at times. This device represents a new and radical departure in receiving radio signals. The method consists in receiving the radio signal, passing it through a very long coil which drains off the interfering disturbances and leaves the full strength signal without noises."

This resonance coil obviates the need of a receiving apparatus other than a detector and a pair of telephones; indeed, it has been fittingly described as a "vest-pocket edition of wireless equipment," and is adaptable to service in the absence of ground connection, either actual or counterpoise. As a transmitter, the device tunes its own waves and is a single-unit direction finder.

The experimental unit of the resonance wave coil built by the Signal Corps is of a hollow cardboard design, 38 inches long and 2¾ inches in diameter, around which is threaded a single layer of No. 32-gauge insulated wire. This afforded 100 windings to the inch. Terminal binding posts are placed at each end of this tube or coil. A brass band or ring, a fixture of the compact antenna, is supplied with the binding post. This ring in its formation is interrupted by a split ¼ of an inch wide at a point opposite to the binding post. This break avoids interference from disturbing eddy currents. The ring is of ample size to slip snugly over the wired tube. The coil is pivoted to swing to any angle in the vertical plane. A dial on the base of the framework indicates the compass direction of the tube, and another dial, facing the operator, reflects the degree of elevation.

A resonance wave coil of the dimensions indicated is capable of receiving signals ranging upward to a wavelength of 1,200 meters. Contrary to the operating principle of former designs of tuning coils, the shortest wave point on this device is at the center of the coil. If the tube is in a position exactly at right angles to incoming electro-magnetic waves, the brass ring may be moved toward either end of the coil as a means of tuning to the incoming signals. In other words, there are two points along the coil, located at equal distances from its center toward either end, where 600-meter wavelengths will be audible. By the same token, at two points, a bit farther along on both ends of the coil, 750-meter wavelengths may be received.

When the tube was located in the Washington laboratories of the Signal Corps, wireless signals from the radio-telegraph station of the United States Navy Department in Cuba could be heard distinctly. The reduction of static electricity to a minimum by the use of the resonance wave coil inspired the Signal Corps to apply the principles of this device to the development of this static eliminator.



A Rotary Condenser Usually Costs from $5.00 to $25.00. But You Can Make One Yourself for Less Than $2.00

From a photograph made for POPULAR RADIO

How *to* Make Your Own ROTARY PLATE CONDENSER

Another of the Practical Little "How to Build" Articles for the Novice

By A. HYATT VERRILL

IN some ways the rotary type condenser is a little more desirable than the sliding type. It occupies less space, it looks neater, and a finer adjustment can be obtained with it. On the other hand, it is perhaps a trifle more difficult to construct, but if you use a little care, you will not have the slightest difficulty in building a rotary plate condenser that will serve as well as the most expensive ready-made instruments.

Although the condenser described here has 23 plates, the number of plates may be varied to suit the requirements and you may make one with 11, 23, 43 or any other number of plates in exactly the same manner, the only difference being in the length of screws. But in each case, the dimensions of plates, base and top given, as well as the sizes of screws, washers and other parts may remain the same.

Before commencing work on the condenser, or for that matter on any instrument, it is a wise plan to study the directions carefully, before beginning work. By studying the directions until you thoroughly understand each step in the construction you will avoid mistakes which are apt to occur if you go ahead with the work and trust to following directions as you proceed. Ordinary tools, such as a screwdriver, drills, hack saw and files are all that are required, but a

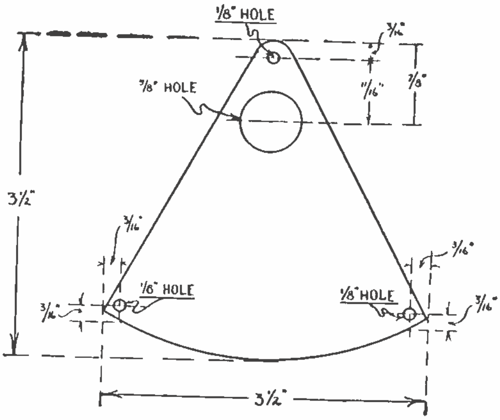


Fig. 1

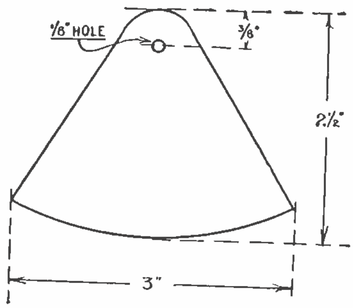


Fig. 2

set of taps and dies will prove a great help.

As the sheet aluminum in this condenser is fairly thick, you will save time and trouble if you secure a pair of tinners' snips or get the local tinsmith to cut the plates for you, although there is little difficulty in cutting the sheets with a hack saw and then trimming the rough edges with a file. Be very careful, however, not to bend or buckle the plates, for if you expect good results they must be absolutely flat and even.

The supplies required will be a sheet of 1/8-inch Bakelite or Formica large enough to give you two pieces each 3 1/2 by 3 3/4 inches in size. A supply of sheet aluminum 1/16 inch thick and large enough to give you the 23 plates. As each plate takes a piece 3 3/4 inches square, you can readily figure this out, or better still, mark the patterns on a sheet of paper or card and measure the size required.

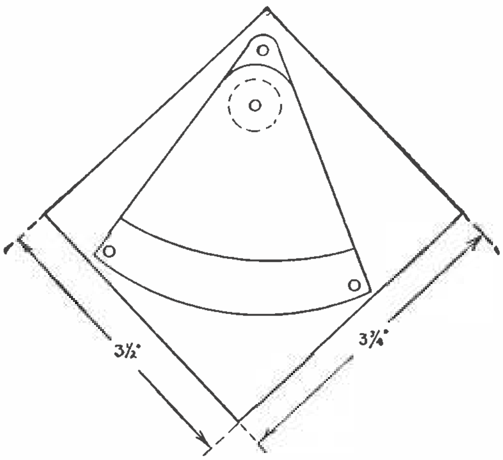


Fig. 3.

You will also need about four dozen brass or copper washers 3/8 inch in diameter and 3/16 inch thick with a hole 1/8 inch in the center. If you cannot get washers of this thickness, use several thinner washers. They may vary 1/32 of an inch in diameter without harm. You will also need a few similar washers 1/16 inch thick. You must also have four 1/8-inch brass screws four inches long, a number of nuts to fit these, two binding posts, a little wire and two bushings of either brass or fibre 3/16 inch thick and 1/4 inch in diameter with a hole 1/8 inch in diameter. If you cannot secure these you may make them by cutting off short sections of brass or fibre tubing of the right size, or you may use a number of 1/16-inch washers of the right thickness to make the desired size.

The first thing to do is to scale off the patterns for the plates, shown in Figures 1 and 2, to full size on a sheet of stiff paper or thin cardboard. Do this with a pair of compasses and a ruler and be sure to get all the measurements exact as upon this depends the whole success of the condenser. Cut these patterns from the card and using them as guides, mark around them on the aluminum and cut out the plates. There should be twelve of Figure 2 and eleven of Figure 1.

Next cut the two blocks of Bakelite or Formica 3½ by ¾ inches. Place one piece of the Bakelite on the other and pile the plates on them as in Figure 3, placing the larger plates first, then the smaller, and being sure that all the edges are even as shown. When all are arranged, clamp plates and panels firmly in a vise and bore the holes through all at the exact spots and distances shown. Then remove the plates and panel and clamp the larger plates alone in the vise with a piece of board behind them, after arranging them so all holes are in perfect alignment. If you run ⅛-inch rods through the three holes at the corners it will be easy to align them.

With a reamer or a large drill, cut the hole marked ⅝ inch to that size. Ream the corresponding holes in the panels to ¼ inch. The worst of the work is now done and all that is necessary is to assemble the condenser.

Insert the four brass bolts 4 inches long and ⅛ inch in diameter in the four holes in one of the panels and turn the panel over so the heads of the screw bolts are underneath. Slip one of the 3/16 by ⅜ inch washers over the bolt placed in the large hole in the panel.

Slip one of the bushings 3/16 by ¼ inch over this central bolt and push it into the ¼-inch hole in the panel.

Place one of the 1/16 by ⅜-inch washers over each of the three corner bolts but not on the one in the large hole.

Slide one of the large aluminum plates over the bolts, pushing it down until it rests firmly against the three 1/16-inch washers.

Place one of the ⅜ by 3/16-inch washers over each of the four screws and work that upon the bolt in the large hole down through the large hole in the plate until it rests against the panel and the bushing, as shown in Figure 4.

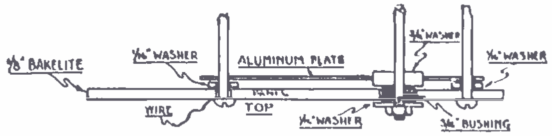


Fig. 4

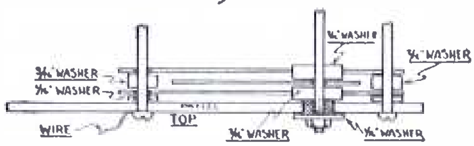


Fig. 5

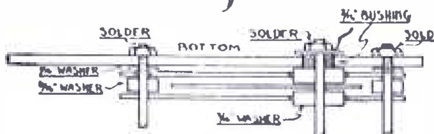


Fig. 6

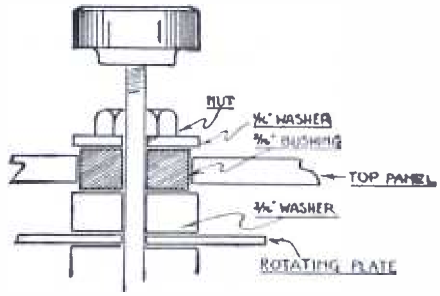


Fig. 7A

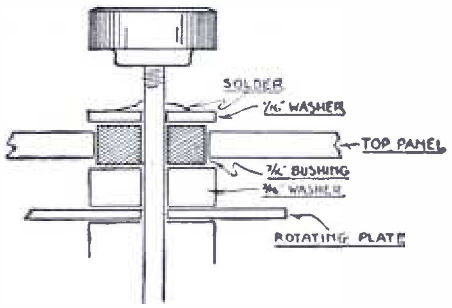


Fig. 7B

Slip one of the small aluminum plates over the bolts and slide it down until it rests upon the washer on the central bolt but do not bend it or buckle it. Let it lie loosely. Put another one of the ⅜ by 3/16-inch washers over each of the four bolts and slip on another large plate. It will now be as in Figure 5. Continue

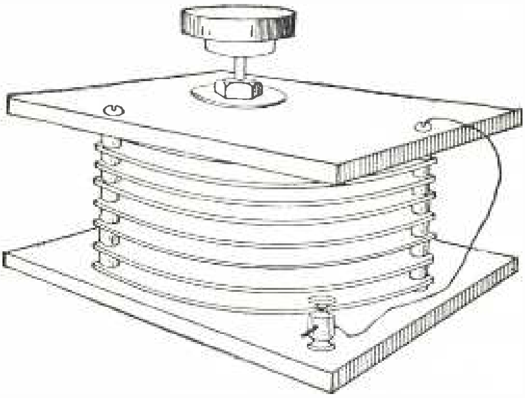


Fig. 8

putting on plates and washers in the same order until all are on.

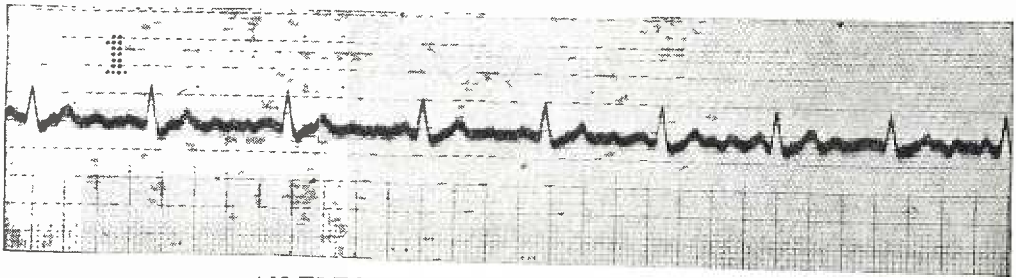
When the last large plate has been slipped over the bolts, place a 3/16 by ⅜ inch washer on the central bolt and a 1/16-inch washer on each of the other three as in Figure 6. Slip the second piece of Bakelite over the bolts. Place the second ¼ by 3/16 inch bushing over the central bolt, fit it in the hole in the panel and place one of the 1/16 by ⅜ inch washers over it.

Place nuts on the three corner bolts and twist a wire a few inches in length around the head of one of them and screw the nuts on firmly, tightening first one and then another. When these are all tight, slip a nut on the central bolt, turn it on for a few threads and turn the entire affair right side up.

If you have used a screw headed bolt for the central one you must solder the thin washer above the bushing to the bolt, but if you have used a threaded end rod you should screw a nut down against the washer as shown in Figure 7. In the first case, after soldering, tighten up gradually upon the nut at the opposite end of the bolt until the smaller plates bind slightly between the washers. Then swing them out from between the large plates until you can get at them and while holding the edges in perfect alignment, tighten up on the nut until the plates are securely bound together.

If a threaded end rod has been used, you may tighten up on the top nut instead of on the bottom. When all this is done, fit a knob or handle to the top of this central bolt as shown in Figure 7. Solder a short section of wire to the lower end of this bolt. Solder the nuts to the bolts all around. Lead the two wires to binding posts at the corners of the lower panel as shown and place small leather headed tacks or any other similar devices upon the under surface of the base so that it will rest evenly without bearing on the bolt ends.

The finished condenser should appear as in Figure 8, ready to connect to your set. By rotating the knob, you can vary the capacity of the condenser, thus accomplishing your tuning.



AN ELECTRIC PORTRAIT OF ANXIETY

Radio is entering into medical circles; some of the same radio apparatus that is used for receiving purposes is now being employed by doctors for recording the nervous reactions of patients. The above graph, for example, is an "electrocardiogram" that shows the cardiac current of a woman during a moment of worry over the safety of her jewels which she had left in the dressing room! How radio is being used by doctors will be told by Dr. Henry Smith Williams in a near issue of Popular Radio.

Radio Fans Who Are Paid *to* Learn

WHAT THE NATIONAL GUARDSMAN IS DOING WITH WIRELESS

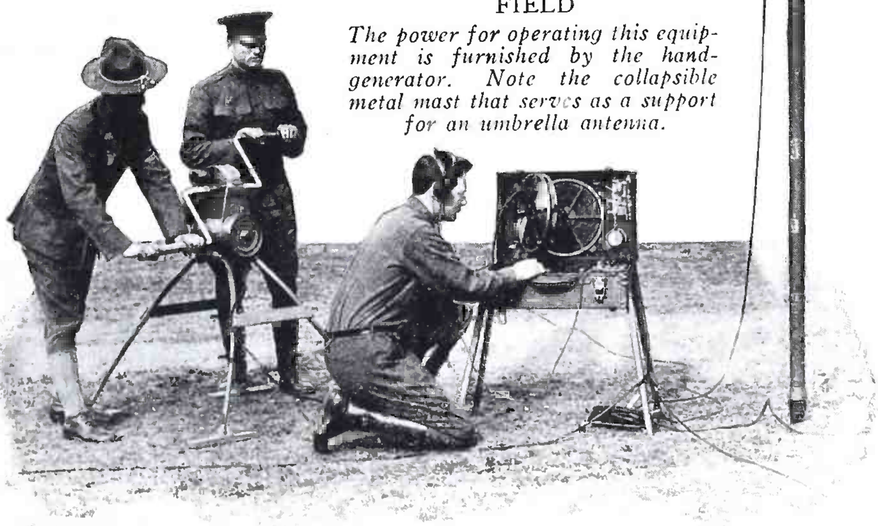
In no organization in the world is the amateur given money for the privilege of getting expert instruction in radio except in the State Militia. For weekly drills in radio of an hour and a half each, Uncle Sam pays from $1.00 *to a Private to over* $3.00 *to a Master Sergeant—and when the new bill goes into effect these rates will be increased* 80 *percent. And in camp the militiaman gets both his full-time salary and his expenses! But in return Uncle Sam is getting a capable force of young men trained in the military uses of radio; this article tells how he trains them.*

By ALFRED M. CADDELL

WHEN the war was over the soldiers of the United States army—about 96 percent of them—returned to civil life. But of this number not all of them gave up entirely their connection with the military. Some of them went into the Reserve Corps; some went into the National Guard; and of the latter group a goodly number of veterans joined the Signal Corps, in which they are enabled to continue their activities in radio—a phase of military work which had barely been started when the war began.

Indeed, the war did a good turn when it aroused in the mind of men the latent possibilities of radio. For years men of science had been peacefully developing wireless telephony—and then along came the war and the necessity, and the interest in the subject was stimulated with a bang.

Although the war-time personnel has largely vanished, we now have as a legacy the nucleus of two military organizations working for the furtherance of radio. One is the Signal Corps of the U. S. Army; the other is the Signal Corps of the National Guard.



TRANSMITTING IN THE FIELD

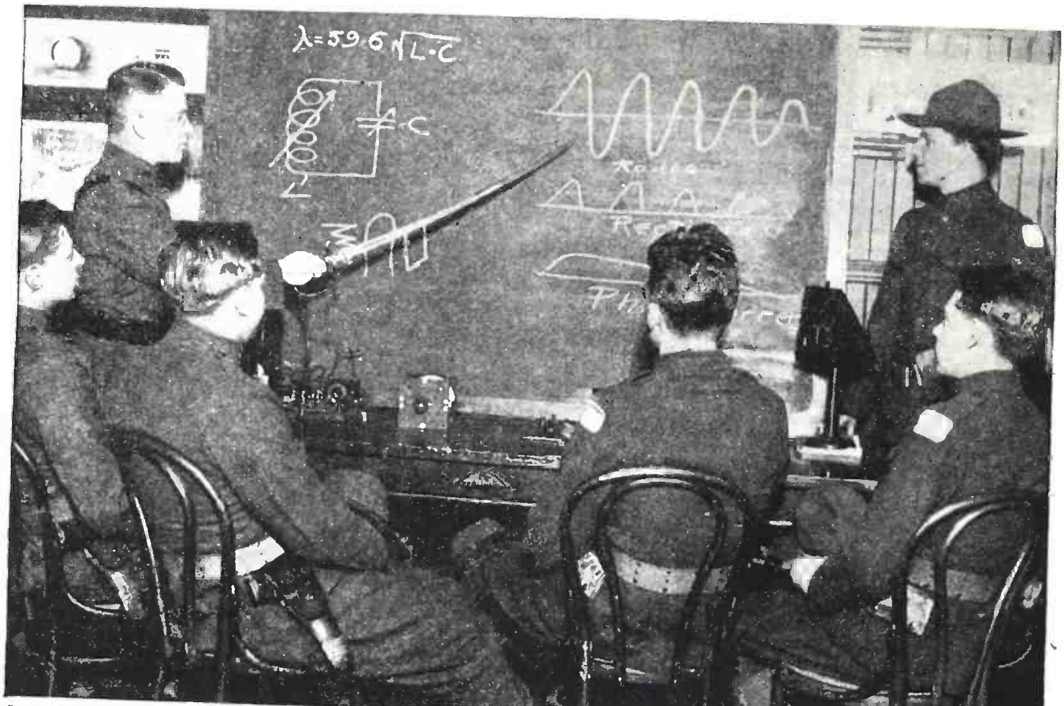
The power for operating this equipment is furnished by the hand-generator. Note the collapsible metal mast that serves as a support for an umbrella antenna.

Brown Bros.

One of the best of the National Guard organizations devoted to radio is the 101st Signal Battalion, Second Corps Headquarters, located in New York. It was formerly known as the 102d Field Signal Battalion of the 27th Division. For purposes of illustration of what the National Guard can do in radio work, it may be accepted as representative. It has an authorized war strength of 17 officers and 460 men, although at present it is composed of only 14 officers and 156 men. The battalion is in command of Major James C. Fox, and is composed of two companies, A and B. The latter is the radio company.

Company B is composed mainly of operators and maintenance men capable of handling the actual transmission of messages. Their work covers the operation of the radio net, consisting of tractor and truck sets, and of maintaining (trouble shooting) and operating the lines as constructed by A Company or taken over from the enemy. They speak as freely of polarities and eccentricities of electrical phenomena as a mother would relate the habits of her child. Yes, the boys have wireless down pat. At times their talk sounds a little bewildering to the layman—vacuum tubes, condensers, wavelengths, amplifiers, decrement. They have been drilled and schooled until radio has become part of their being. We'll get acquainted first at headquarters, and then accompany them on a camping trip where actual warfare is simulated, where they go through all the manoeuvres, establish message centers, send and receive all kinds of "copy" over the waves of the "chartered" ether.

We are the spectators at a Monday or a Thursday night drill. Expectancy fills the air. B Company assembles on the



International

IN ORDER THAT THE MEN MAY COMPREHEND THE PRACTICE, THEY ARE TAUGHT THE THEORY

This class-room scene does not constitute a "drill" as the average guardsman knows it. But such classes are included in the instruction course in radio—and an important part they are, too.

From a photograph made for POPULAR RADIO

ON ACTIVE DUTY WITH THE ARMY'S "RADIO NET"—WHICH IS BEING EXTENDED OVER THE WHOLE COUNTRY

The first duty of the stations in this net is to handle the traffic of the Amateur Radio Reserve, which transmits radio messages for the army. But they also relay messages for others—free of charge.

big floor of the armory, equipment in hand,—poles on which to string a V-type antenna, generators, sending and receiving sets, head gears. The command is given:

"Open station!"

Every man is at his post. In less than three minutes' time the antennae are up, messages are broadcasted or received and couriers are ready for quick dispatch to "headquarters."

"Station BG4 testing; calling 2BHA. Station BG4 testing; calling 2BHA. Station BG4 testing; calling 2BHA."

The operator is speaking into the radiophone. A slight pause, then possibly a brightening of the operator's face as an answer comes over the ether waves. Or possibly not, as the case might be, for BG4 may have to tune in on a different wavelength and call again before 2BHA can hear him. Station 2BHA may be at the further extremity of Long Island, or up at Niagara Falls. It is all a matter of his detector picking up or not picking up the wavelength sent out by BG4.

The instruction work of the radio company is essentially practical. It maintains telegraph classes and code classes, and it teaches the men to read by the sounder or buzzer, so that they become familiar with wire lines as well as radio. The men are taught how to operate and maintain the instruments. The company also has what is known as a field buzzer set, on which the continental code is used; it is similar to a telegraph line, but is intended for special use in the field; likewise it has a "buzzerphone," an ingenious instrument first adopted by the British during the World War and called a "Fullerphone." This was perfected by the Signal Corps and utilized by the A. E. F. The buzzerphone is used in the front lines and can be employed for telegraph code or phone. Telephony is not permitted except where there is no possibility of being heard by enemy listening-in posts. The buzzerphone, however, cannot be intercepted as it operates on low potential and both sending and receiving stations must be tuned to one another and all ground potentials balanced out.

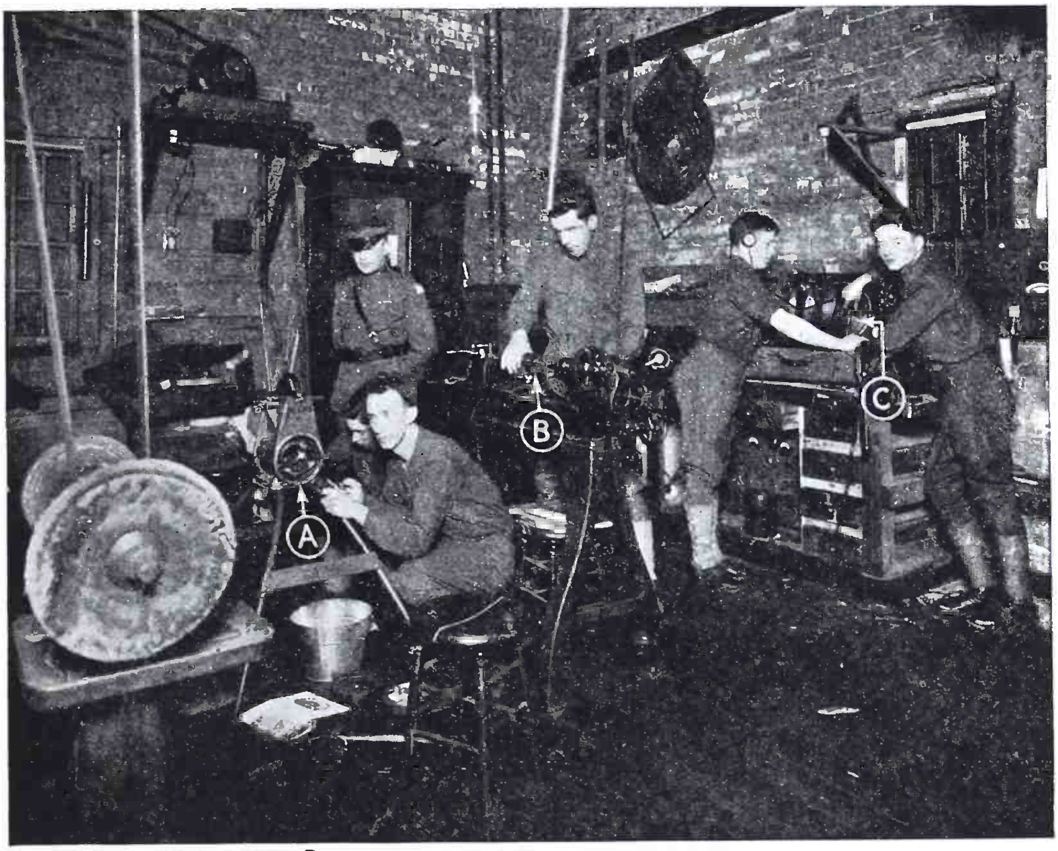
The radio company has regular schedules for drill nights, during which it operates radio with the army stations of the 2nd Corps, and maintains communication with amateurs in the handling of traffic. Many of the men, after learning radio technique in the classes, install sets in their own homes. The radio course extends over a period of twelve weeks, and is then repeated; it covers all practical applications of radio phenomena. This class is open to all members of the battalion.

There are the different sets to be used and kept in working condition. There are practice sets as well as sets for broadcasting and receiving. The men are enabled to keep up with new developments, as apparatus and equipment are constantly being changed and added. A recruit is allowed to sit in at the classes and be systematically coached. There is nothing more important than to encourage him in his quest for knowledge about radio; a cheery word and a slap on the back promotes his enthusiasm—and enthusiasm in the work pays the government mighty good dividends. Perhaps the recruit wants to specialize in the air service; perhaps he has visions of himself talking from an airplane or balloon. All well and good—there is an airplane set for him to practice on. Perhaps he wants to operate the radio "net;" indeed, he won't be allowed to forget that! But meanwhile, as a member of the National Guard, he is being paid for attending drill and learning.

Not all the activities center around teaching recruits, however, nor around the mere exchange of messages with this station or that. The battalion functions in what is known as a radio "net," which transmits government messages that ordinarily would have gone over telegraph wires from Washington to the army corps headquarters located in various sections of the country. This net has effected a large saving to the government in wire tolls. The long-distance stations linked together in an "army net" permit the distribution by radio of army orders and other official communications that emanate from Washington to the corps centers. Thus Washington is in direct touch with Fort Sheridan, Chicago, which in turn connects with Fort Crook, Omaha, and on out to Fort Douglas, Utah, and to the Presidio, San Francisco, and the 9th Corps headquarters. This forms the central trunk line of communication across the country, while a similar border trunk system runs by way of a relay at Fort Sam Houston, Texas, to San Francisco. A total of 1,627 messages aggregating 71,295 words was handled during the first two months the army radio "nets" were in operation. The Amateur Radio Reserve assists in the relay of such messages; operators of the radio company are on duty two hours every evening for this purpose. Altogether, therefore, the work is varied, profitable and intensely interesting.

During the summer the men of the 101st Signal Battalion convert armory training into field practice. Let us travel along with them and get an insight into their field work.

Around the middle of August the battalion entrains for its Peekskill camp. Heretofore the outfit has been mounted, and while mount practice is still included in the training, the unit is now completely motorized. In fact, quickness and ease of mobility is a prime necessity of its work. This year, for example, the



From a photograph made for POPULAR RADIO

THE MEN ARE TAUGHT HOW TO REPAIR RADIO APPARATUS

Soldiers in the field cannot drop into a mechanic's shop to have their equipment fixed up, nor can they ship it back to the factory. So they do the job themselves in a shop of their own. The men are shown (A) dismounting a hand generator; (B) resurfacing a commutator and (C) repairing inductances.

corps has at its disposal four motor trucks equipped with radio sets capable of an efficient range of 500 miles, together with trucks, motorcycles and other appliances needed for a unit of this size.

The men motor to Peekskill. They strike camp, say, late in the day. They come upon a town in a valley, perhaps a peaceful village with only a few telegraph and telephone facilities. A "war" is in progress. They "seize" whatever facilities there are and operate them. A detachment is ordered to an outlying point that is well guarded from shell fire, with instructions to establish a radio station. This forms part of the net, and is connected up by wire lines to headquarters, message centers and other units as required. This station, if working with division units, would likewise have a division radio set for relaying traffic received from army or corps headquarters. The men like these detached service jobs because they are placed on their own initiative, usually under the command of a non-commissioned officer. Small details are dispatched along the land lines—at test points to watch for lines going out of service. These men are supplied with motorcycles or light cars to do the "trouble shooting" and see that the lines are kept in service. Should the lines go out, radio fills the gap.

The use of radio, however, fulfills a mission scarcely conceived by a non-military man—that of invisible scout. For by use of goniometric apparatus, which was developed by the French in the late war, compass bearings can be obtained rapidly on any station that sends a message. By triangulating, or taking the bearings from each of a series of goniometric stations in a given enemy area, and charting the point of intersection of those bearings, the location of enemy stations operating radio with each other can be determined. The data thus gathered is then given the artillery, which then aims to destroy the enemy station. Thus war conditions can be largely simulated.

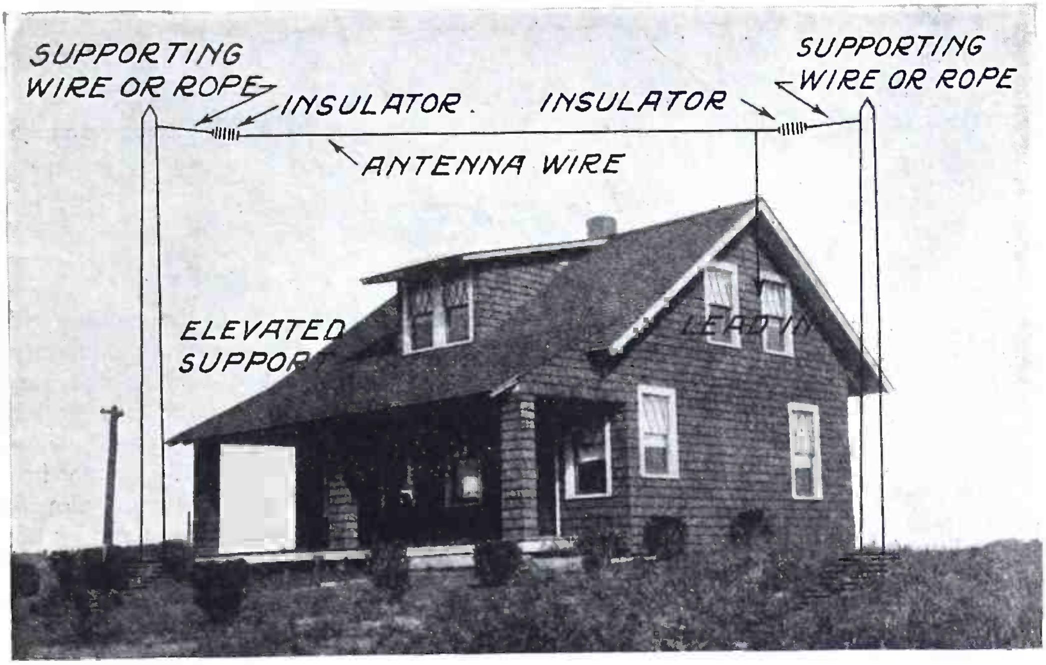
The apparatus used by the corps unit is known as the SCR-99, which has a working range up to 100 miles. It is compact and easy to transport; it consists of VT-1 tubes for receiving and VT-2 for transmitting on wave lengths between 900 and 1500 meters C. W.—320 volts on the plate of the transmitting tubes. The SCR-97 is used for communication with airplanes, as it has a telephone transmitter; in field practice, however, the actual required working distance is seldom more than fifty miles, different units overlapping one another. But should the unit find itself in a bad locality, camouflaged in the woods, handicapped by bad static conditions, the excess power will then come in to advantage in overcoming any possible trouble.

Big things are being planned for radio in many National Guard activities—more intercommunicating stations, more unfolding of radio possibilities, more trained men. Indeed, the development of radio in the National Guard has barely begun. The most interesting work lies ahead.

From a photograph made for POPULAR RADIO

LEARNING THE CODE BECOMES A GAME WHEN IT IS TAUGHT IN CLASSES

There is a big difference between studying the code alone and in company with other beginners. Fifteen minutes of concentrated study a day will enable the average student to receive code messages within a month.



THE BEST ANTENNA FOR RECEIVING BROADCASTS
A single-wire inverted L-type antenna. The two elevated supports—in this case poles—may be used only in cases where trees or buildings are not available.

The Simplest Receiving Antenna

THE INVERTED L-TYPE

The First of a Series of Short Articles on the Various Types of Antennae and Their Uses

By DAVID LAY

Since the advent of radiophone broadcasting, there has been such a great amount of interest created in radio, and so many receiving sets installed and antennae erected, that one can look out of almost any window in a large city, and see at least one or more antennae or "aerials" as they are popularly called, stretched along the skyline. Some of them are high ones, some of them are low ones, some are short, some are long, some look neat and some look mangled, some are insulated, and some are not, some work well, some fairly well, some poorly, and some do not work at all.

Very few of the beginners who erect their antennae know what they are doing. Some of them have not the slightest idea what it is all about; they just follow the directions and "String up a single wire, about 100 feet long, and as free from surrounding objects as possible."

The antenna and the ground connection form the means of converting the radio waves into electrical oscillations, and if the antenna is inefficient, how can we expect the results to be satisfactory? Even though we have good apparatus, if the antenna does not convert the waves into electrical impulses strong enough to operate the set, we cannot expect the set to work.

This series of short descriptions of the different conventional types of antenna is written to give the beginner an idea of the structural details of the antenna as well

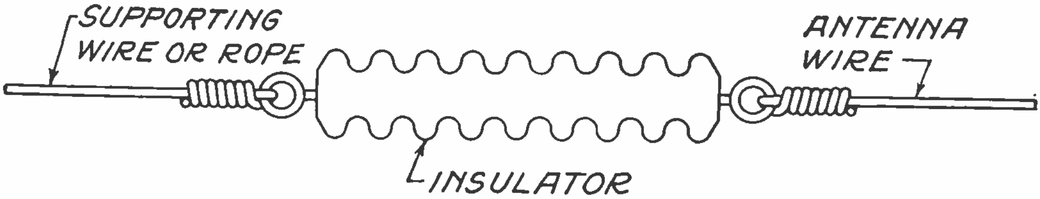


FIGURE I
How the insulator is fastened to the antenna wire and to the supporting wire.

as the uses of the different types so that he will know which type is best suited to his purpose and how to build it.

The type which has gained greatest popularity on account of its simplicity and general usefulness is the inverted "L" antenna. The "L" antenna gets its name from the likeness of its shape to an inverted letter "L."

For broadcast reception the L antenna is usually made of one single wire stretched between two high supports, with an insulator at each end of the wire. The lead in wire is attached (soldered) to the antenna wire at one end and brought down as straight as possible, to the receiving instruments, as in the diagrams on the accompanying photograph. The insulators are attached to ten foot lengths of supporting wires (or ropes) which are fastened to the elevated supports. The supports may be poles, high buildings, large trees, or other elevated structures.

The insulators are used to prevent the currents induced in the antenna by the passing radio waves, from leaking down the elevated supports to the ground without going to the receiving apparatus. These insulators are sold in the radio supply stores and are made of some kind of good insulating material that is waterproof. They are usually made in a tubular corrugated shape to make the surface leakage path across them as long as possible. Two metallic rings are fastened at the ends of the insulator for connecting to the antenna and supporting wires. An insulator of this type is shown in the diagram in Figure 1.

The length of the antenna wire stretched between the insulators should be approximately 100 feet.

The L type antenna will receive better from the two directions in which the antenna wire points than in other directions, and will receive best from the direction in which the lead-in end points.

For transmitting on 200 meters, the L antenna is made with more than one wire in the antenna proper. Four wires are usually used. With this construction, two insulators are used at the ends of

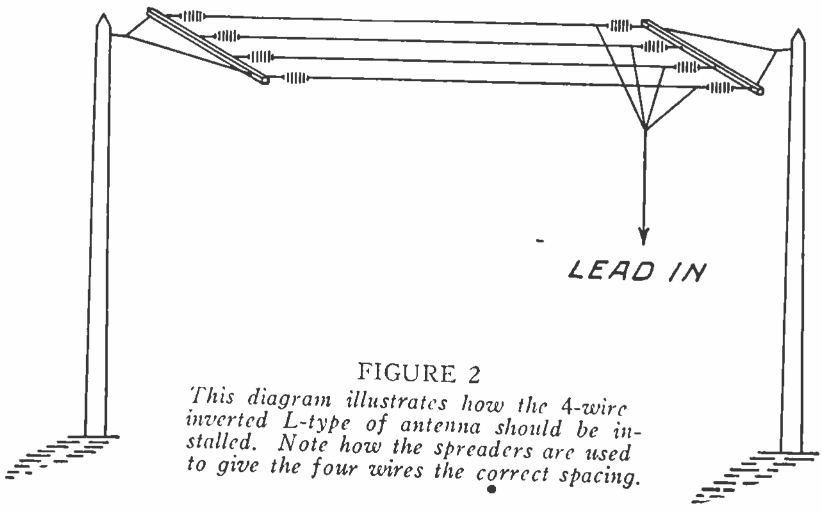


FIGURE 2
This diagram illustrates how the 4-wire inverted L-type of antenna should be installed. Note how the spreaders are used to give the four wires the correct spacing.

each wire as shown in Figure 2. The wires should be spaced at least two feet apart. This is accomplished by the use of two wooden "spreaders," each six feet long. These should be made of hard wood sticks, two inches square. The sticks are connected to the elevated supports by means of wires (or ropes) as shown in the diagram. Four lead-in wires are soldered to one end of the four antenna wires and these are brought to a common junction from which a single wire is run down to the instruments.

This latter type of antenna may be used for both sending and receiving and has a greater electrical capacity than the single wire antenna. It has about the same directional characteristics as the single wire antenna.

Its inductance is of about the same value as the single wire antenna, but its capacity is much greater and this is the main reason for its superiority for use in transmitting. Each of these adaptations of the inverted L antenna should be constructed as high in the air as possible, especially in cases when the antenna is to be used for transmission, as the effective height of the antenna greatly affects the sending range.

The "T" type antenna will be described in a near issue of POPULAR RADIO.

RADIOGRAMS

BY A. J. DE LONG

A MAN *fell off the roof yesterday and broke his antennae.*

* *

THE *station that is issued the call letters GOD will have a lot of publicity to start with.*

* *

ANYBODY *who can throw a stone into a pool of water ought to understand the fundamentals of broadcasting.*

* *

A YOUNG *man who has been saving his money doesn't know whether to buy a radio set or get married.*

* *

WHAT *a radio fan needs is a shop that will repair vacuum tubes while you wait.*

* *

THE *trouble with most folks is that when they get a station good, the program is spoiled because they wonder what another place is doing.*

* *

WHAT *makes the dog scratch so? Maybe he's got the radio bug.*

* *

WHY *the lights in the boxes? That's to show the sound waves the path to the receivers.*

* *

A BEGINNER *wants to know if it's the scarcity of radium that makes radio equipment so high.*

* *

NEXT *to the lady who is always knitting on a street-car few things are as annoying as the man who is always getting distance stations.*

WHAT READERS ASK

THIS *department is conducted for the benefit of our readers who want expert help in unravelling the innumerable kinks that puzzle the amateur who installs and operates his own radio apparatus. If the mechanism of your equipment bothers you—if you believe that you are not getting the best results from it—ask* THE TECHNICAL EDITOR.

IN order to make this department of greatest help to the beginner, it is possible to publish only those questions which are of the widest application and of most general interest. To insure prompt attention and to help the Technical Editor in handling the large amount of correspondence which the department has developed, our readers are asked to observe the following requests:

1. Confine each letter of inquiry to one specific subject.
2. Enclose a stamped and self-addressed envelope with your inquiry.
3. Do *not* ask how far your radio set should receive. To answer this inquiry properly involves a far more intimate knowledge of conditions than it is possible to incorporate in your letter.

The questions that are not of sufficient general interest to warrant publication in this department will be answered personally. Many of these questions are being answered by referring the correspondents to items that have already been printed in these pages. To get the full benefit of this service, therefore, *save your copies of* POPULAR RADIO.

QUESTION: Will you give me a hookup for a receiving set that employs a variometer and variocoupler and a detector tube, and batteries? What kind of batteries and what kind of receivers are best? Would a one thousand ohm receiver work?

WM. H. F. REHON

ANSWER: A circuit diagram for connecting the apparatus you wish to use is shown in Figure 1. You will need the following additional apparatus however:

1 Variable condenser, .001 mfd. capacity
1 2-megohm grid leak R_1
1 Grid condenser, 0003 mfd. capacity.
1 5-ohm filament rheostat R_2
1 22½ volt "B" battery
1 6-volt storage battery, 40 to 60 ampere-hour
1 pair 2000 or 3000-ohm telephones

You may obtain the batteries at any radio supply store; ask for them as indicated in the list. The 1000-ohm telephones are not as sensitive as the higher impedance telephones.

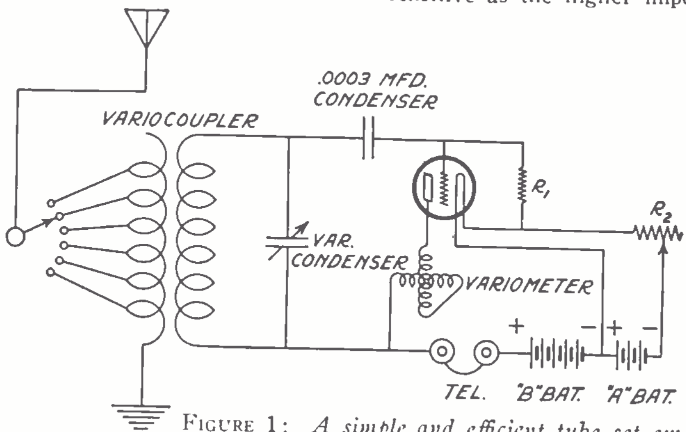


FIGURE 1: *A simple and efficient tube set employing a variometer and variable condenser. The variocoupler insures selectivity.*

QUESTION: I am building a receiving set that employs one stage of amplification, two variometers with a Paragon control panel, and also a 4-circuit telephone jack and a 2-circuit jack. I do not understand the connections of the control panel. Kindly publish a hook-up for it.

GEO. DUFFNER

ANSWER: The diagram in Figure 2 clearly shows the connections for the complete set.

* * *

QUESTION: What is the difference between a UV-200 tube and a UV-201 tube and what are their uses?

A. ALLEN

ANSWER: The two types of vacuum tubes mentioned are similar in details of construction, and their only difference is in the degree of evacuation of gases in the tube. All tubes containing an incandescent filament must be evacuated to a certain extent to prevent the filaments from burning up when heated to a white heat, that is, the oxygen in the air in the tube must be pumped out so that the filament will not oxidize and burn out. The UV-200 tube is not evacuated to such a high degree of vacuum as the UV-201. A small amount of gas is left in the UV-200 which permits the use of larger plate currents with reduced plate voltages. This is because the gas left in the tube tends to ionize and thus make the space between the filament and the plate more conductive. The UV-200 is used for a detector, and the UV-201 is used as an amplifier.

* * *

QUESTION: I have a Manhattan 7-plate condenser (variable) and would like to know where to hook it up. I have tried it in series with my aerial and also in series with my ground, but I find that the signals and the programs of broadcasting stations come in louder without it. Mine is a number 15 tapped coil, 2 switch set, using a crystal detector.

Can you tell me how to construct a variocoupler?

Is radiocite better than galena?

A. JACOBSON

ANSWER: The capacity of your condenser is too small to do any good in either your antenna or ground circuits. The only place it will be of any use with your present set is connected across the secondary circuit of the coil.

We will publish in a near future issue an article showing how to build your own variocoupler.

This article will explain to you in detail the construction of the instrument, which should work to good advantage in your set.

Radiocite and galena are both very sensitive crystal detectors, and there is not much choice between them.

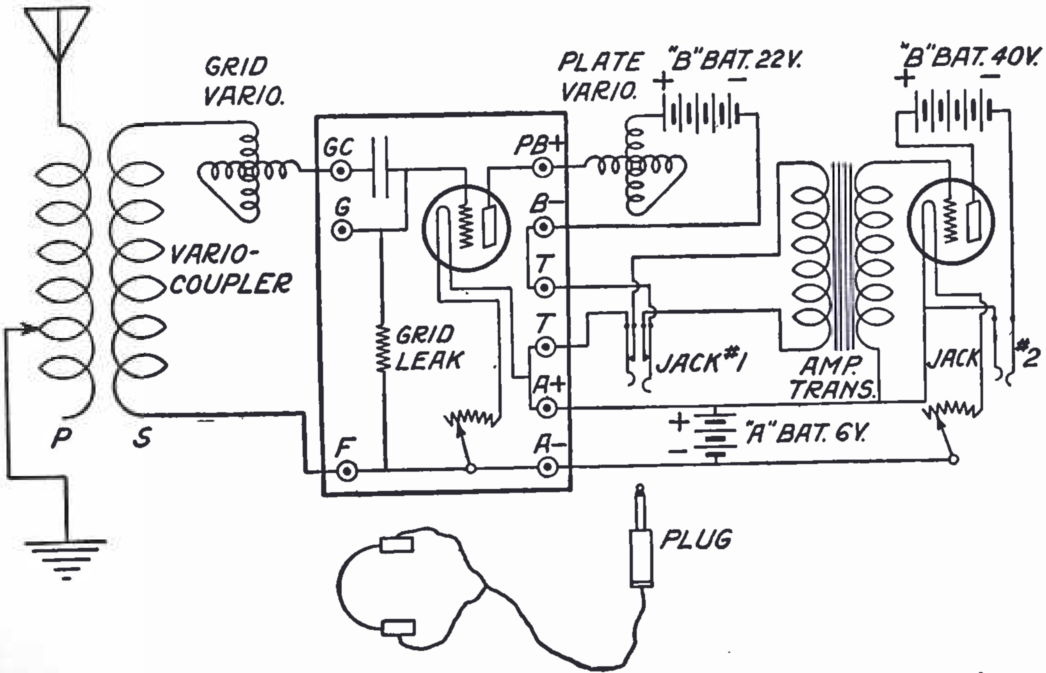


FIGURE 2: *Connections for adding one step of amplification to a Paragon control panel using a 4-circuit telephone jack and a 2-circuit jack.*

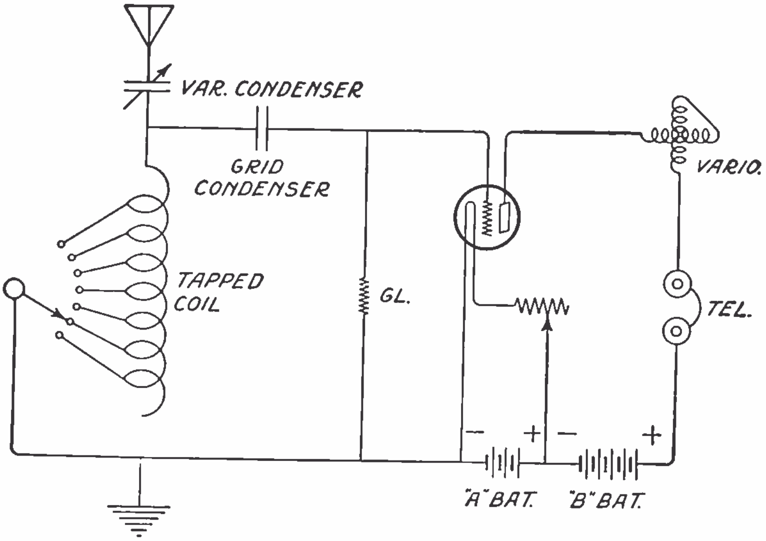


FIGURE 3: *A simple regenerative hook-up in which the antenna circuit is tuned with a condenser, the secondary is tuned with the tapped coil, and the plate circuit is tuned by a variometer.*

QUESTION: I cannot hear anything on my regenerative receiver, as shown in my diagram. What is the trouble?

GEO. H. STRUBLE

ANSWER: We have drawn the circuit correctly for you; if you use it as shown in Figure 3 your set will work.

* * *

QUESTION: What is the difference between a regenerative and a non-regenerative receiving set?

C. PEARSON

ANSWER: Regeneration in this sense means throwing the incoming signal back upon the oscillation transformer (or loose coupler, as it is often called), in such a way that the signal will reinforce itself. This is done through a coil inserted in the amplifying circuit and placed in inductive relation to the oscillation transformer. A common circuit of this type is one which employs a third honeycomb coil.

* * *

QUESTION: Why are honeycomb coils better than ordinary coils? Will you tell me how to make one?

HAYWARD HEWSON

ANSWER: In a honeycomb coil there is a minimum of distributed capacity, as the wires are some distance apart except where they cross. By using such a coil, the proper amount of inductance may be inserted in a circuit without adding as much capacity as is commonly found in other types of coils.

It is almost impossible for an amateur to wind a honeycomb coil satisfactorily. To wind such a coil by hand would require many hours of tedious labor. As the coils the amateur requires are not expensive, it is better for him to buy them until some young inventor can perfect a home-made winding machine.

* * *

QUESTION: I built a crystal set described in POPULAR RADIO, but I can hear nothing with it but code messages. I built the set just as you described it. Could the trouble be with my antenna? It is about 25 feet long, as that is as long as I can possibly make it where I now live.

S. A. LOUNSBURY

ANSWER: The trouble is undoubtedly in your antenna. If you cannot make it longer, the next best remedy is to build a loop aerial and use radio frequency amplification if necessary.

* * *

QUESTION: Is my small switch sufficient to protect my house against lightning? Where can I find out?

A. J. WILSON

ANSWER: Any fire insurance agent can furnish you with a list of regulations. There are many other stipulations which you should know if your house is insured against fire.

Question: Please publish a hook-up of a radio set with which I can receive a distance of 300 miles. This hook-up should use a loose coupler, one grid leak, one grid condenser, one rheostat, socket, and "A" and "B" batteries.

C. Fred Sylvester

Answer: In Figure 4 is a hook-up that uses the instruments you find obtainable. But they cannot be arranged to receive over the distance you require.

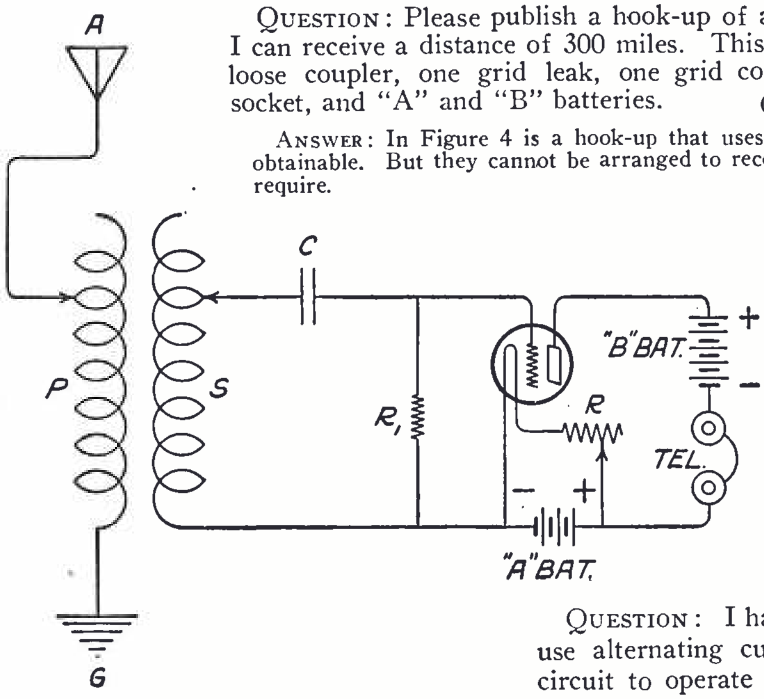


Figure 4
A straight audion circuit that employs a loose coupler for tuning.

Question: Is it always necessary to place a variable condenser in the antenna circuit?

C. T. Smith

Answer: This is not necessary unless your antenna is too long for you to get down to the proper wavelength. A condenser used in this way shortens the natural wavelength of the antenna circuit. The ordinary antenna circuit is easily tuned with inductance alone.

Question: I have been told that I can use alternating current from the house circuit to operate my set. Can you tell me how?

A. H. Franz

Answer: In a future number of this magazine such a hook-up will be explained in detail. It is somewhat complicated, and you should understand it thoroughly before you try it, so that you will not damage your set.

* * *

Question: I have a two-slide tuning coil, crystal detector, condenser, loading coil and buzzer test. I would like to know how to connect them. Can you show me how?

W. A. Randall

Answer: The circuit diagram that you require is shown in Figure 5.

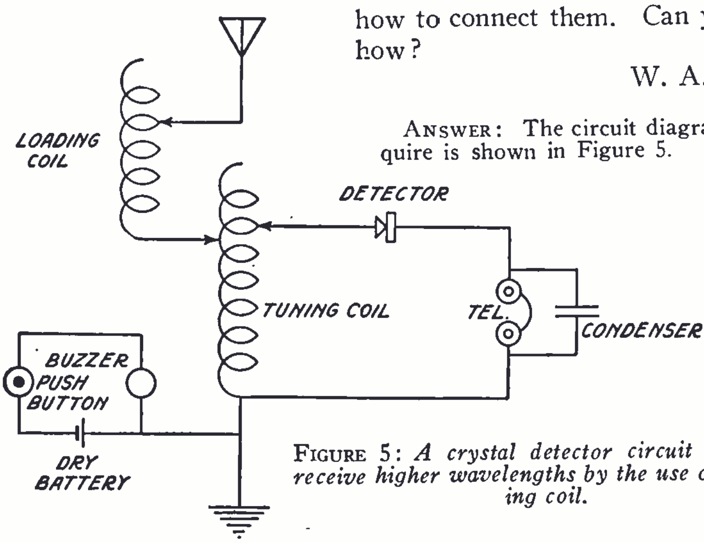


Figure 5: *A crystal detector circuit that will receive higher wavelengths by the use of a loading coil.*

This department—conducted by a patent attorney of wide experience in radio work—will keep you in touch with the latest inventions of interest on which patent rights have been granted, and which are significant contributions to radio art.

An Arc Converter

Patent No. 1,410,730; R. R. Beal, Palo Alto, California.

IT is estimated that the arc converter is responsible for around 80 per cent of the energy that is radiated into space by transmitters—other than amateur transmitters.

There are two types of transmitters: the damped wave transmitter and undamped wave transmitter.

In the first system the amplitude of the wave train that is radiated decreases or dies down just as the amplitude of a vibrating string or tuning fork dies down if force is not continuously applied to it. This is called damping. A spark transmitter is an example of a transmitter of the damped wave type.

Continuous or undamped waves may be radiated by the use of an alternator, electron tubes or an arc converter; such continuous waves are used in the transmission of speech and music. Although broadcasting or speech transmission is at present done by means of electron tube transmitters, yet the arc converter has possibilities for such transmission when fully developed, especially for transoceanic transmission. For that reason, and also because of its extensive use in radio telegraphy, it is of interest.

The apparatus illustrated in Figures 1 and 2 represents an arc converter. It reminds one of the old street arc lamp with its spaced carbon electrodes and electromagnets for "striking the arc" and to keep it going as the carbons wear away; it also reminds one of an electric furnace. In the arc converter as used in radio the magnet is for the purpose of assisting in steadying the arc, and for deionizing the gap by blowing the "ions" away—a magnetic breath, as it were.

The Beal converter illustrated is in two segments 2-3, which are hinged together at 4. These segments comprise casings 5 and 6 of magnetic material (steel), the opposite ends of which are closed by transverse plates 7 and 15 of similar magnetic material. To the plates 7 and 15 are secured the magnetic cores 8 and 16, surrounded by the magnetic windings 9 and 17-18-19 respectively. The cores 8 and 16 are arranged axially with the converter and their inner adjacent ends are slightly spaced from each other on line with the plans of contact of the two segments 2 and 3. The magnet coils are held in position by means of the plates 12 and 21 and bolts 13. Between the magnet coils is the narrow arc chamber formed by the plates 14 and 22; these plates are formed with passages 15 and 23, through which water may circulate for cooling purposes.

The electrodes 25 and 27 are arranged on the lower segment in the chamber formed by plates 14 and 22 and at right angles to each other; the gap between the electrodes is located between the spaced ends of the electromagnet. The cathode or negative carbon electrode 25 is supported in the holder 24, and the anode or positive electrode 27 is supported in the holder 26. Arranged on the top of the apparatus is a hydrocarbon liquid feed cup 28, from which the hydrocarbon drips through conduit 29 into the electrode chamber. An exhaust pipe 31 permits discharge of exhausted atmosphere from the electrode chamber.

The apparatus here described appears simple in construction and resembles the old arc lamp, yet when properly connected in circuits it has the power of "converting" direct current into high frequency alternating current which causes the radiation of continuous undamped electro-magnetic waves when properly connected to an antenna. The circuit for an arc converter comprises a generator or dynamo, generating a direct current, say of 500 volts, electrically connected to the electrodes 25 and 27. An inductance is inserted in the generator circuit to keep the current constant—an inductance being a coil which acts with reference to the current very much like a flywheel does for an engine, keeping the speed thereof constant. A resonant circuit is also connected to the electrodes in shunt with the generator circuit and comprises an inductance (electrical inertia) and a condenser or capacity (electrical tension); these elements are analogous to a tuned string that has mass and tension. A circuit that has inductance and capacity tends to oscillate, as it is a tuned or resonant circuit.

When direct current voltage is applied to the electrodes an arc will burn between them if the arc is struck in the proper way. The property of the arc which makes it available as a transmitter lies in the fact that as the voltage across the arc is increased the current through the arc decreases, and *vice versa*. In a metal conductor the current and voltage vary directly relatively to each other and not inversely as in the arc. An arc that has this property is said to have a "falling characteristic" or negative resistance.

The arc is started by striking the electrodes together and then separating them. This heats the electrodes and they get red hot or even white hot. The electric field between the electrodes "ionizes" the gas that surrounds them, making it conductive. These "ions" are charged molecules which carry the current. The presence of the ions between the electrodes accounts for the "falling characteristic" of the arc.

The action of a converter is about as follows: When the condenser circuit is connected in shunt with the electrodes the condenser charges in a positive direction, storing up a part of the current and diverting part of it from the arc. The decrease of arc current results in an increased potential difference at the arc electrodes, which forces more current into the condenser until it has about all it can hold. As the condenser nears its maximum charge, less and less current flows into it. This means that the arc current is increasing and the arc potential difference is decreasing. The condenser now discharges by reason of the release, so to speak, of the applying potential. The condenser as it becomes charged is put under a strain or stress just like a spring when it is compressed and it acts like a spring when it is released.

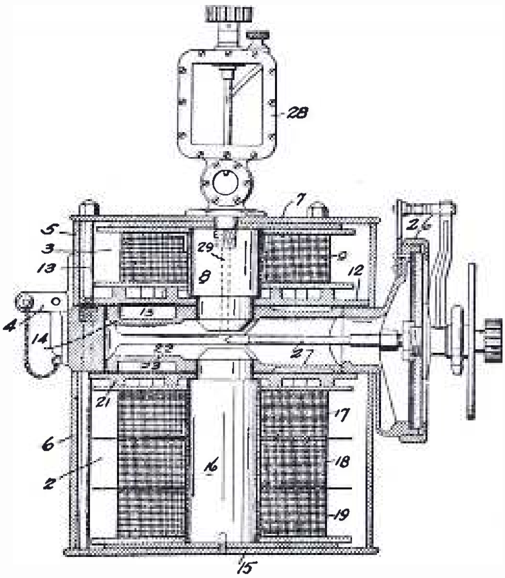


FIGURE 1

Showing the construction of the arc chamber and method of striking and steadying the arc.

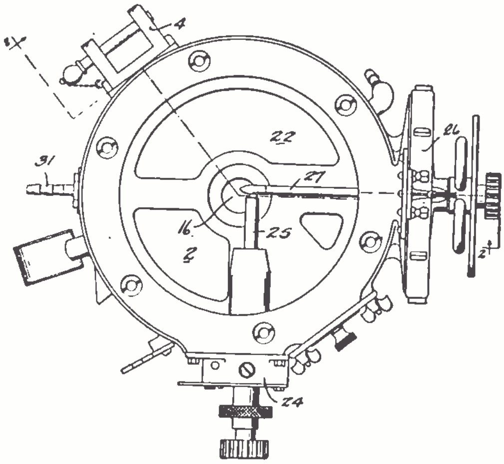


FIGURE 2
Another interior view of the arc chamber, showing the two arc electrodes at right angles to each other.

The inductance in the shunt circuit now acts to keep this discharging current going and the condenser recharges, but in a negative direction. As the recharging is completed the arc current decreases, causing a rise of arc voltage which tends to charge the condenser in the positive direction and the condenser again discharges from the negative direction. This released current further decreases the arc current and accentuates the charging of the condenser in the positive direction. Hence the current oscillates in the resonant shunt circuit first in one direction and then in the opposite direction—the arc acting like a valve which moves to direct the current first into one end of the shunt circuit and then into the other. These oscillations set up in the resonant circuit are transferred to the antenna circuit in any well-known manner where electromagnetic waves are radiated into space:

The maximum discharging current from the condenser which tends to neutralize the arc current may be large enough to extinguish the arc. In order to make the arc more sensitive to voltage changes, means are provided to deionize the arc gap when the arc is extinguished, thus making it non-conducting and requiring a longer period to build the current up to full strength. A strong magnetic field or "magnetic blow-out" will remove these ions, drawing them to one side away from the gap. Cooling means and the use in the arc chamber of hydrogen or a hydrocarbon gas also assist in deionizing the gap. It is seen that the Beal apparatus contains these features, which are due broadly to Poulsen.

The magnetic field set up between the ends of the magnet is transverse to the flow of ions across the arc, and this field draws the arc flame to one side of the electrodes, making its path longer. The principle involved here is the same as that which causes a motor armature that carries a current to rotate in a magnetic field. When the condenser discharges it is easier to extinguish the arc with the arc flame drawn to one side. After the arc is extinguished, ions of course are also removed by means of the magnet; these ions are drawn to one side away from the electrodes just as a pin is attracted by a magnet.

The magnets used in high-powered arc sets are large and powerful. For instance, the magnets of a 500-K.W. set may weigh as much as 65 tons.

Cooling of the electrodes also greatly aids in the rapid deionization of the chamber. For this reason the positive electrode is usually made of copper (which is a good heat conductor) and cold water is circulated around them.

Hydrogen and hydrocarbon gases also assist deionization because these gases, being very light, diffuse rapidly into the outside space and carry the ions with them. A hydrogen atmosphere also has high heat conductivity and also prevents the oxidation of the electrodes.

The object of the invention of Patent 1,410,730 is to provide a generator or converter that has an efficient magnetic circuit and a readily accessible arc chamber. The inventor claims that in his magnetic circuit the leakage flux is reduced to a minimum. This is of decided advantage on ship board where such magnetic leakage would produce a deleterious effect upon the ship's compass. The magnetic circuit, including shells 5 and 6, end plates 7 and 15 and cores 8 and 16 has a minimum "reluctance" or magnetic resistance. Leakage flux is also reduced by placing the magnet coils on opposite sides of the chamber, one in each segment. By reducing the length of the magnetic path the coils may be placed close together and the arc chamber made very shallow. By building the converter in segments, as shown, access may be had to the narrow arc chamber by lifting the upper segment.

Arc transmitters are especially adapted for high-powered long-distance work at long wavelengths, but the high cost has prevented extensive study by scientists and engineers except when installed for commercial use.

The most powerful radio station in the world (that at Bordeaux, France, constructed by the United States Navy) is equipped with a 1,000-K.W. arc set. The most powerful station in the United States (that at Annapolis, Maryland) is equipped with a 500-K.W. arc transmitter. Most of the capital battleships and other ships of our Navy have arc transmitters.

It should be a matter of only a few years when arc transmitters will be used in radio telephony as well as in radio telegraphy. Before they can be used extensively in broadcasting the generation of objectionable harmonics, secondary waves that have frequencies which are multiples of the fundamental frequency, and intermediate frequencies called "mush," must be eliminated. These secondary frequencies cause interference.

A Crystal Detector

Patent No. 1,410,793; A. Bonnefont, Paris, France.

ONE of the important elements of a receiving set is a "detector"—a name which is inappropriate because such an element does not detect but merely makes possible the detection of electro-magnetic waves or radio signals. Detectors convert high frequency currents or voltages into forms capable of operating an indicating device (such as the telephone head piece), so that the signal may be heard.

Such detectors are of various forms and kinds, such as the electrolytic, audion (the vacuum tube) and crystal detectors.

Crystal detectors and detector tubes are, of course, familiar to all who are interested in radio.

Certain crystals have the curious property of being unidirectionally conductive; that is, they conduct currents that flow in one direction through them and do not conduct those that flow in the opposite direction. Such a crystal acts like a "valve" which allows water to flow in one direction but not in the opposite direction. As examples of such crystals we may mention galena (lead sulphide), silicon (a chemical element) and certain other sulphides. Why these crystals have this curious property is not clear unless they were especially designed for radio reception. Possibly the future study of "electrons," those negatively charged ultimate particles of the atom of which we now hear so much, will result in the discovery

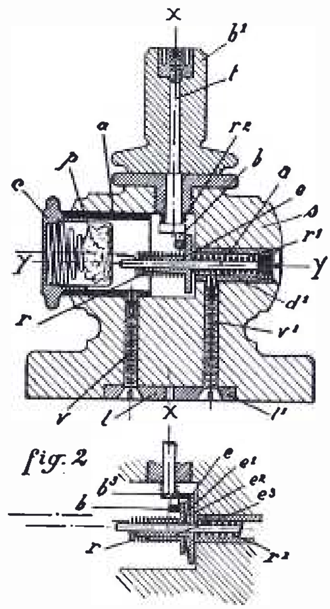


FIGURE 3

A crystal mounting which protects the crystal from dust and grease, though at the same time affording ease of adjustment.

of sufficient facts to formulate a plausible theory of the cause of this phenomenon. Most of these crystals are chemical compounds that comprise a combination of a metal atom (a conductor) and a sulphur atom (one of our best insulators). It is possible that the atoms of each of these crystals and, in turn, the electrons which comprise each atom are so arranged and related as to cause the crystal to be strongly metallic in one direction and therefore conductive and strongly sulphurish in the opposite direction and hence non-conducting—the electrons acting very much like those in the electron tube or detector which is now so important in radio communication.

Another property of such a crystal, which must be considered a defect, is that all points on the crystal are not sensitive. We must feel around on the crystal to find or select a spot that has such unidirectional conductivity. The case is much like that of our bodies, portions of which are insensitive to pin pricks.

On account of these properties of crystal detectors they have been used for years to rectify alternating currents or high frequency radio oscillations; that is, to change them into direct pulsating currents of a form capable of actuating a diaphragm of a telephone receiver at audio frequency so that the signal can be heard.

A. Bonnefont has devised an interesting improvement in crystal detectors for locating the sensitive spots while the crystal is enclosed so that dust and grease cannot touch it and which also allows variation of the pressure of the metal point on the crystal. (See Figure 3.)

The casing *s* encloses the crystal *p*, which is held in a rotatable thimble or support *c* by means of a spring. A guide rod *a* is secured in casing *s* opposite the crystal *p*, but on an axis *Y-Y*, which is eccentric with the axis of the crystal. A flanged sleeve *e* is slidably mounted on rod *a*. A coiled spring *r* is mounted on the sleeve *e* and has an eccentric free end adapted to contact selectively with the crystal. A spring *r'* upon rod *a* tends to force sleeve *a* with its spring *r* toward crystal *p*. The free end of spring *r* may be rotated around the axis *Y-Y*, to selectively engage different points on the crystal, by means of an actuating knob *b'* secured to a shaft *t* journaled in casing *s* and extending at its inner end into the casing. The inner end of the shaft *t* is provided with an eccentrically arranged stub *b*, engaging the flange of sleeve *e*. When shaft *t* is rotated, stud *b* will rotate sleeve *e* and spring *r* to position the contact end of the spring at different points on the crystal.

It should be noticed that this rotation will also move the sleeve axially against the pressure of spring *r'* to vary the pressure of the point *r* on the crystal. By rotating the thimble or plug *c* that carries the crystal, the latter is rotated to present a new circle of point *s* capable of being engaged by the contact end of spring *r*. The electrical connections are made at opposite sides of the crystal through the screws and plates *v* 1 and *v'* 1' and sleeves *d d'* which are mounted in the insulating casing *s*. The spring *r* 2 is to frictionally maintain shaft *t* in any desired position of adjustment.

Because the rod *a* is eccentric to the axis of crystal *p* and by reason of the eccentric arrangement of the exploring point *r* with reference to rod *a*, either crystal or point *r* may be rotated to present new and different sensitive points for contact, without exposing the exploring point *r* or crystal to the air, dust or hand. The crystal detector is easily adjusted by the eccentric stud *b* not only to rotate the exploring point *r* but also to move it axially.

When a detector of this character is used in a radio receiver it changes the alternating current or oscillations set up therein into a direct pulsatory current capable of actuating the telephone diaphragm if the pulsations are of audio frequency as is the case in the reception of modulated radio frequency continuous waves. The new device helps in this function by keeping the crystal clean.

ITEMS *of general interest that you ought to know; bits of information of practical usefulness to every radio amateur.*

Fewer and Better Broadcasting Stations Needed

THE demand for broadcasting licenses is growing apace; already more than 360 licenses have been granted. Every State in the Union is represented in this number except five. Sooner or later the confusion that must inevitably result from what is developing into an overcrowded condition must lead to some restriction that is not at present within the authority of the Department of Commerce to impose. At present any applicant can get a broadcasting license if he complies with the legal requirements. The result is that in certain centers there are as many as fifteen broadcasting stations, all operating on the same wavelength. Some of them are inadequately equipped for broadcasting entertainment, and most of them have but a limited range.

The bill now before Congress will give authority to the Secretary of Commerce to use wider powers of discrimination in the issuance of broadcasting licenses.

A Scheme for Paying Artists for Broadcasting

WHO will pay for the broadcasting programs? The question has been seriously agitating the radio world for many months; sooner or later it must be answered in some way by some one. Many solutions of the problem are being put forward; one of the latest schemes has been projected by an organization created in New Orleans that calls itself "The National Co-Operative Radio Society," the purpose of which is not financial gain, but "to effect a community of interest among parties who are now interested or may hereafter become interested in radio telephony" and to establish the whole broadcasting business upon a sound economic basis.

Briefly, the society aims to build or lease and to operate a chain of broadcasting stations, each of about 1000 miles radius, throughout the country. It proposes to divide the country into zones and to relay the program from zone to zone. It also proposes to pay for the talent it employs and to establish a daily program lasting from 10 o'clock in the morning to 10 o'clock at night. The costs of all this will be borne by the members of this society, who will be assessed sums not to exceed $12.00 a year. The plan is said to have the backing of a number of owners of receiving sets as well as of numerous manufacturers, jobbers and dealers. According to the announcement, the membership is open:

1. To any individual or firm who may be interested in the welfare of radio telephony.
2. To any individual, or firm, owning a receiving set, or who may contemplate owning a receiving set.
3. To any corporation, manufacturer, distributor, jobber, or dealer in radio apparatus or complete receiving sets, or kindred lines.

(These are urged to take as many memberships as may be warranted by the pecuniary benefits to accrue from increased sales, due to De Luxe Program properly broadcasted by the National Society.)

4. To any radio engineer, or other individual holding certificate, or permission to broadcast or receive.

5. Honorary memberships may be extended when considered advisable by the National Committee on Memberships.

Radio Opens the Mines

THE mining industry of the country in certain quarters is being affected by the widespread extension of the use of the radio telephone. The supplying of crystals of certain ores has become a small industry in itself.

These mineral crystals are used as detectors that transform the pulsating electrical vibrations received by the antenna into those that can be converted into sound waves by the telephone receiver. The bright cubical crystals of galena, a compound of sulphur and lead, is a favorite detector, and pyrite or chalcopyrite, the first combination in chemical form of sulphur and iron, and the other, sulphur, iron and copper, are also used. Not all crystals of these minerals will detect radio messages with clearness. A demand for suitable crystals has caused the mining operators to search over their ores and to submit perfect crystals for the radio manufacturers. Meanwhile there is a constant search for a dependable supply of the best material.

Kadel & Herbert

DR. LANGMUIR EXPLAINS TO MARCONI THE "MESSAGE FROM MARS"

During the Italian scientist's visit to the laboratories of the General Electric Company the assistant director, Dr. Irving Langmuir, shed some light on the unexplained "signals of 150,000 meter wavelength" which Marconi is said to have recorded. "During the time Marconi was reported to have received this long wavelength message, engineers of this company were experimenting with carrier current on the Schenectady-Saratoga trolley line," Dr. Langmuir said. "As these tests were made on a trolley wire forty miles long, thus making an antenna of that length, I had thought that possibly our high voltage tests on this wire had created such a wavelength. But I talked with Marconi, and he tells me that he never received any such signals as reported in the newspapers." Marconi is shown above talking to Dr. Langmuir.

Kadel & Herbert

GERMANY'S FIRST BROADCASTING STATION

This unpretentious scene reveals Berlin's first and only radio broadcasting headquarters; it furnishes impressive evidence of the progress that has been made in radio in the United States. American amateurs have been entertaining their friends for more than ten years with such concerts as pictured above. The picture contrasts strikingly with the views of modern American stations.

Few amateur radio enthusiasts, probably, are aware that there is one material in the many pieces of apparatus that cannot be replaced by any substitute that scientists have yet discovered. This material is mica—a mineral substance found in nature that has unique dielectric properties; that is, it resists the passage of electricity even at remarkably high voltages. It seems unbelievable that thin sheets of this transparent material, only a few thousandths of an inch thick, can successfully perform this necessary function.

The market for copper, which has been very poor, has also felt the effects of increased demand due to the extensive use of copper wire and brass in the manufacture of radio outfits. It is estimated that the average radio receiving set requires at least two pounds of copper in its manufacture.

Swimming Contests by Radio

DURING the coming winter radio amateurs expect to lengthen their radio relay traffic lines to all parts of the world. For several years messages each night have been flashed from amateur station to amateur station in all parts of this country and Canada. With the increased use and efficiency of continuous wave telegraphy and the interest and energy that radio amateurs in China, Japan, Hawaii and European countries are showing, officials of the American Radio Relay League believe that when the summer's static storms and interfer-

The Demon Illustrator, Don Herold, has again had his imagination stirred by the radio and its possibilities in the home—as seen from the Mere Man's point of view.

ing vacation trips are over, duplications of amateur short wavelength spanning of the Atlantic which was accomplished in February may be nearly a nightly occurrence. The development of the new Armstrong circuit (described on page 18 of this issue) has brought the realization of world-wide amateur radio closer.

The thrill of long distance transmission alone does not urge the amateurs on, however. They hope to put their carefully worked-out radio relays to practical use. The American Radio Relay League has just been approached by a Buffalo athletic organization with the hope that a long distance radio swimming meet with a Hawaiian swimming club could be arranged. All results—times and events both ways—would be reported by amateur radio. This scheme cannot be worked out in warm weather because of the poor sending conditions of summer and the fact that many of the relay operators are taking their vacations. But a water contest by radio is among the possibilities for the fall.

A Jules Verne Dream Come True

THE individual whose father was astonished when Dr. Bell announced that he could talk over a wire has experienced somewhat the same feeling as his parent during the past year's expansion of radio. But he has more surprises in store for him.

Armstrong, already famous for his regenerative circuit, calmly announces that he can make his radio signals 10,000 times stronger by making a simple addition to the appartus simply by rearranging the wires. The General Electric has made a new tube that will replace the large alternator machines that are used in large sending stations. A new wire antenna system is being perfected. Marconi predicts a future for extremely short waves. Radio frequency amplification is being refined and improved.

It is becoming increasingly hard to predict just where our receiving range will end and the distance which even a small amount of power will transmit. The amateur is having visions of a future of which the world has not dreamed.

Bureau of Standards

A WORKING MODEL OF THE RADIO COMPASS

To demonstrate just how the radio fog-signaling device works, the Bureau of Standards has devised this miniature scene. The coil of the radio compass rotates on its axis as the radio signal from the lighthouse decreases in intensity, until the minimum point is found—at which point the indicator points to the lighthouse. Each lighthouse is provided with a buzzer that operates by clockwork.

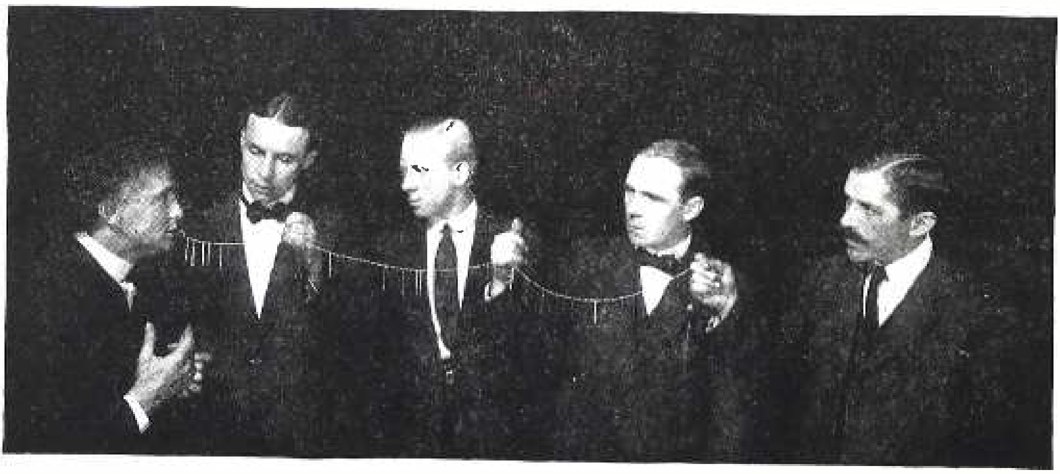
The Summer Slump as a Boon to the Radio Novice

THE summer slump in the radio business came according to schedule. By the time these lines are published the inevitable fall revival should be well started. The experience has not been unprofitable to the trade; indeed, one well-known manufacturer of radio apparatus has referred to the slump as a "boon," and explains his attitude thus:

"Dealers are beginning to realize the fact that they cannot afford to carry a large and heterogeneous lot of odds and ends in radio apparatus in the hopes that they will be able to dispose of it. They are learning that hysterical overstocking of apparatus in an effort to meet the spasmodic demand of radio faddists is not going to prove profitable in the long run, and that dependable apparatus, bought to meet the varying radio conditions, is more to be relied upon than unknown apparatus that looks good in the catalog and is merely an ornament upon the shelves.

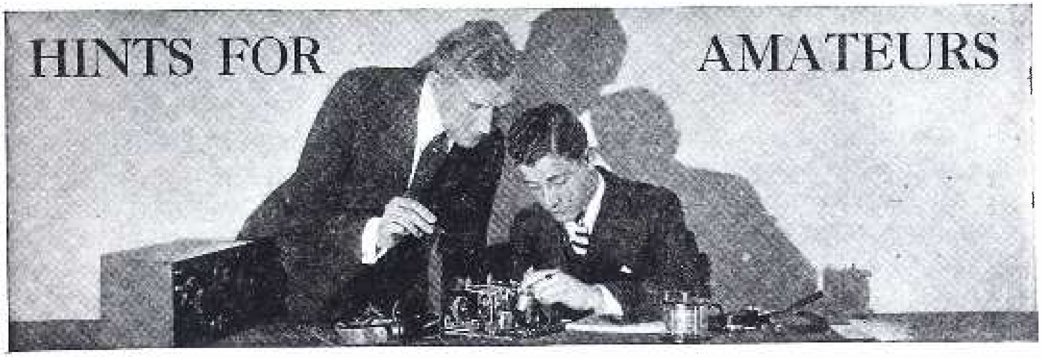
"Manufacturers, too, are learning their lesson from this slump. They are realizing that the time of order taking is past and that the time of order getting is here; that in order to sell radio apparatus, they must give good value, serviceable merchandise, attractive prices and real service and dealer co-operation. Competition is keen and hitherto there has been too little of this healthy form of competition. Now that dealers find they must discriminate between the good and the bad in radio apparatus, they are learning to serve themselves and their customers better, in that they are buying and selling apparatus they know to be good. As a result the entire industry must improve; that is why I believe the slump in radio, which brought the industry to its senses, is a good thing."

All of which reacts to the interest of the radio novice in that it tends to remove from his reach some of the junk that has been foisted upon the market by inexperienced or unscrupulous manufacturers and sold by equally if not still more inexperienced or unscrupulous dealers. But the time has not yet come when the uninformed layman can enter a shop and buy his radio supplies with the same assurance with which the salesman represents them.



HOUDINI "SAYS A MOUTHFUL"—OF THREADED NEEDLES

No man in the country knows more about the tricks of the professional magicians than Harry Houdini—or just "Houdini" as he prefers to be called. In this picture he is performing his famous Yogi trick of swallowing a package of needles and some thread and extracting the needles threaded—and doing it before a committee appointed to find out how he does it. For the next number of POPULAR RADIO *Houdini has written a startling article that exposes the tricks of the fraudulent "spirit mediums" who have used radio for years for getting money from their credulous public.*



BE sure to turn down the rheostats before relighting your tubes as the battery may "pick up" and produce too high a voltage for the tubes.

* * *

GAS pipes are usually insulated from the ground with special fibre joints and therefore do not make such a good ground as the water pipes.

* * *

IF you use a tungar rectifier to charge your batteries, remember never to turn on the filaments of the tubes while charging, as you will probably burn out the tubes with the higher voltage.

* * *

Do not try to mount your crystals in solder. The heat needed to melt the solder will destroy the crystal's sensitiveness. Use Woods metal, which has a very low melting point.

* * *

Do not clean any part of the radio apparatus with soap and water, as the moisture will ruin the electrical properties of the instruments. Use a light furniture oil and rub dry.

* * *

YOU can convert one of your receiver telephones into a loud speaker by placing it against the small end of an ordinary megaphone. This will cause the sounds to be acoustically amplified so that they can be heard all over the room.

* * *

THE use of stranded wire for the transmitting antenna is recommended as the high frequency currents that are used in radio communication travel on the surface of the wires, and the stranded wires naturally have the larger surface.

* * *

Do not try to use the electric light wires in your house for a ground; all you will hear if you do will be a continuous humming sound in the telephones. If you should choose the wrong side of the line you will get a shock or blow the fuses.

* * *

THE higher the voltage you put on the plate of the last step of amplification used in connection with your magnavox loudspeaker, the louder will be the signals. Amplifying tubes now on the market will stand about 150 volts without any trouble. This requires about 6 or 7 "B" batteries.

* * *

Do not use unglazed porcelain cleats for the insulators of your antenna. In rainy weather they will absorb a large quantity of moisture and the weak electrical currents induced in the antenna will leak through the insulators to the ground instead of passing through the receiver.

* * *

WHEN testing your "B" batteries, do not touch the ends of the two wires together (as many amateurs do) to see if there is any "juice" left in them. This short-circuits the battery, and if it should be in good condition, this form of test will reduce its life greatly. Use a voltmeter.

* * *

USE the same kind of wire for stringing up your insulators that you use for the antenna itself. Rope will stretch and shrink with the changes of weather and will cause the antenna to sag and tighten up. This strain may cause the wires or the rope to give way.

* * *

A SHORT circuit in a variable condenser can easily be detected by connecting a buzzer and a battery in series with the condenser. If upon turning the knob of the condenser the plates do touch, the buzzer will buzz. A little spark will be seen where the plates touch and repairs can then be made.

* * *

FOR insulating a receiving antenna, ordinary porcelain cleats that can be obtained in almost any electrical supply store will be satisfactory. The dimensions of these cleats are approximately 3½ inches in length, ¾ inch in width, and ½ inch thick. The cleats have a hole in each end through which the wires may be readily fastened.

* * *

WHEN running your lead-in down the side of the house, keep it as far away from the building walls as possible. The walls of the building will absorb energy from your antenna if it is run too close. When you fasten your antenna to a tree, place your insulator at least twelve feet from the branches so that the absorption by the tree will be reduced to a minimum.

* * *

A LOOP antenna can be used indoors without any connection outside the house or without any connection to the ground. It cannot be used without some form of amplifier, however, as the amount of current induced in a loop antenna is small and should have at least two steps of either radio or audio frequency amplification to increase the feeble currents to sufficient strength to make signals that are readily audible.

* * *

To get the best results from your audion detector, use a grid leak. A grid leak is a resistance of 1,000,000 to 2,000,000 ohms that is connected in shunt to the grid condenser or between the grid and the negative lead of the filament. Its purpose is to allow the negative charges that accumulate on the grid during operation, to leak off so that the tube will not become inoperative on account of the grid becoming too negative.

* * *

IF you operate a sending station, do not start to send or test it out without first listening in and making sure that you will not cause interference by doing so. Give the warning signal as prescribed by the regulations of the Department of Commerce; if anybody else is working and you cause them interference, they will ask you to "stand by" for a minute and then you may have your own turn on the ether. Courtesy is the best policy, after all, in the ether as well as elsewhere.

* * *

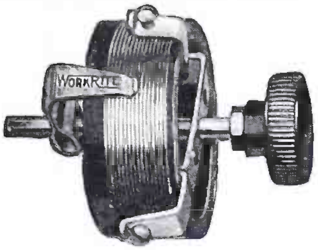
To find out which is the positive and which is the negative pole of any kind of a battery is a puzzling problem—until you know how. The simplest way to do this is to obtain a glass (not metal) dish filled with water; in it place two wires which have been connected to the terminals of the battery. When the two wires are placed under the surface of the water, small bubbles will soon be seen to collect around the end of one of the wires. This wire is the negative wire and the little bubbles are hydrogen gas bubbles.

* * *

THE difference between a "hard" and "soft" vacuum tube lies in the degree of vacuum that the tube has been pumped to, or the rarity of the gases which the tube contains. A hard tube has been exhausted to a high degree of vacuum; a soft tube, on the other hand, has a little gas left in it. The hard tubes are used as amplifiers because they will stand a higher "B" battery and are less critical; the soft tubes are used for detectors because they are more critical and have a higher plate current with a given plate voltage. Soft tubes are not good amplifiers because they are apt to ionize when large currents are passed through them.

"WORKRITE"

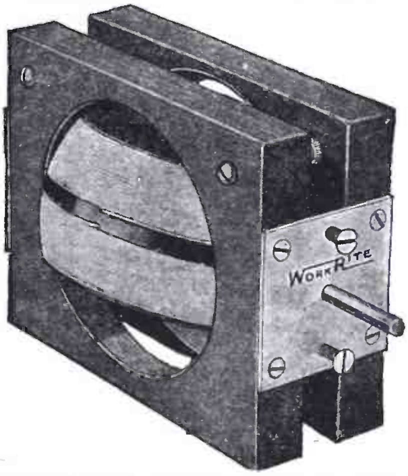
This name stands for the same high quality in Radio Parts that "Sterling" does in silverware. Insist that your dealer furnish genuine "WorkRite" Parts, or go to another dealer who will. They are standard in all parts of America and many foreign countries. Immediate deliveries in any quantity guaranteed.



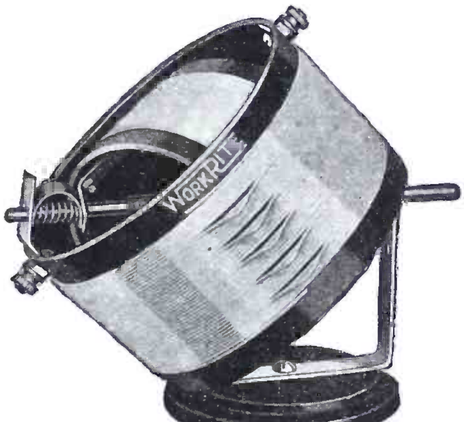
How you long for just that *exact* adjustment when listening to distant concerts, but it always seems to be just between two loops on the old-style rheostats. Put in a "WorkRite" Rheostat on your detector tube and HEAR THE DIFFERENCE. By pushing the knob in or out you can have 6½ ohms resistance, or direct current, or shut it off entirely, or by *turning* the knob you can get 50,000 different adjustments. With the "WorkRite" Super Rheostat you can tune in distant concerts clear and loud that you only can dimly hear with other rheostats. TRY ONE AND SEE FOR YOURSELF. PRICE, $1.50.

WATCH THE MAGAZINES FOR ANNOUNCEMENTS OF OUR "WORKRITE" CONCERT-OLA, JR. and SR. They will "speak for themselves." Something entirely new and BETTER in loud speakers

WorkRite Super Variometer



WorkRite 180° Super Variocoupler



The WORKRITE VARIOMETER is made from finest quality mahogany and absolutely guaranteed not to warp or shrink. Our new ones are now finished just like your piano—a beautiful piece of work. We hereby offer to give FREE a WorkRite Variometer to anyone who can show that there is a variometer on the market (no matter at what price sold) which is more efficient in its work. Our Variometer does everything such an instrument can do, and does it perfectly. Price, $5.25. With Dial, $6.00.

The WORKRITE SUPER VARIOCOUPLER represents perfection in its class. Made from formica tubes and wound with just the right number of wire turns to make it most efficient. All metal parts made from brass, nickel plated and highly polished. THIS 180-DEGREE COUPLER TUNES JUST TWICE AS SHARP AS THE ORDINARY 90-DEGREE COUPLER. Get one WorkRite Variocoupler and two WorkRite Variometers for a tuner set that will bring in the far-distant concerts. Write us for a simple diagram showing how to make a set. Sent free on request. WorkRite Variocoupler, price $5.00. With Dial, $5.75.

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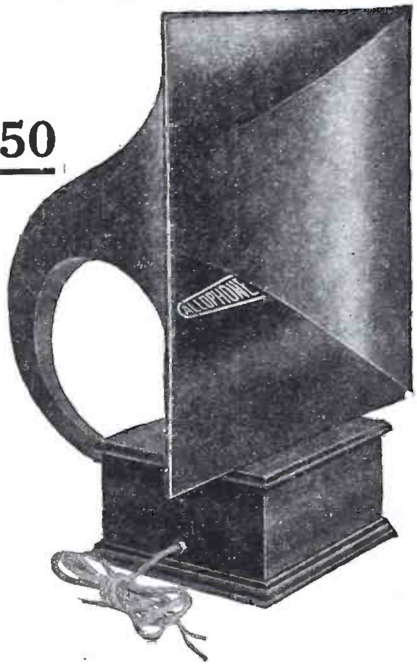
This Remarkable Loud Speaker—$37.50



Specially adapted to amateur radio work, giving perfect tone quality and surprising volume. Will easily fill a large room or hall. Operates on two or three stages of amplification. Solid mahogany piano-finish base, perfect modulating horn, complete with flexible cable ready to connect, requiring no separate battery or attachments. You will not realize the full possibilities of a loud speaker until you hear the CALLOPHONE.

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Highest quality 3200-3500-ohm receivers, detect the slightest radio signal with wonderful strength and clear tone. Self-adjusting universal joints, an exclusive feature, respond to any head movement or any shape of head or ears. Headbands of black enamel spring steel with special composition guards, highly flexible, resting lightly on the head and relieving the ears of all pressure. May be worn *comfortably* for any length of time. Handsomely finished, durable, and fully guaranteed.

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Send $1.05 for either of the following combinations:

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1 00 Feet No. 14 hard-drawn antenna wire.
4 Porcelain insulators.
1 Solid copper approved ground clamp.
1 Single-pole, double-throw approved lightning switch.
20 Feet No. 14 weatherproof insulated lead-in wire.

No. 2

1 Wound Enameled wire coil, 8 inches long, 3½ Diam.
2 Brass rods, 9 inches long, with evenly drilled holes.
2 Brass sliders to fit the above rods.
4 Nickel-plated brass binding posts.

No. 3

2 60-cent switches (1½-inch lever).
20 Nickel-plated brass contact points with nuts.
4 Nickel-plated brass stops with nuts.
4 Nickel-plated brass binding posts.
1 Detector stand unmounted includes: Adjustable cup, adjustable cat-whisker (any position), 2 extra binding posts, 2 connections from cup and detector to binding posts.
1 Drilled fiber base for mounting same.

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1 Nest of 4 radio tubes, 8 inches long by 3, 3½, 4, 4½ inches long.
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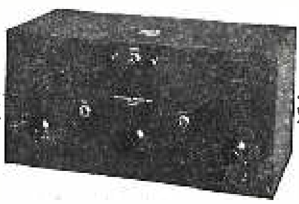

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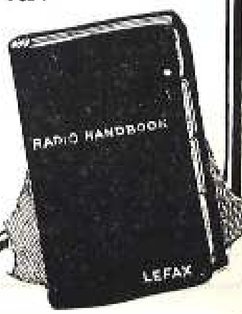

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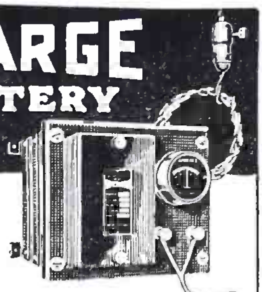

NO muss, trouble, dirt — no moving of batteries—loss of time — no effort on your part—no technical or professional knowledge needed.

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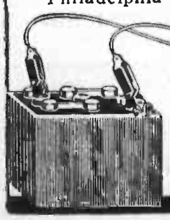

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To be "as good as Brandes" a headset must have behind it the cumulative experience of fourteen years—an experience which reflects itself not only in the high quality and super-sensitiveness and ruggedness of Brandes *Matched Tone* headsets but also in a remarkably low price. Fourteen years' experience is not acquired in a week or two.

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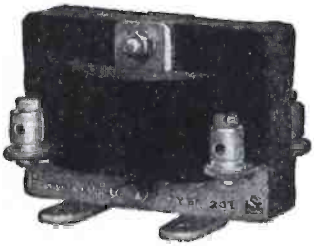

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THIS IS TO CERTIFY that the Tube Socket manufactured by the Union Radio Corp. has been tested in the Laboratory of THE EVENING MAIL RADIO INSTITUTE. It has been found that the instrument agrees with the standards set by the Institute. The materials used in its construction are of a quality commensurate with the price and the design is based upon sound engineering practice.

Signed

All Union Radio Apparatus and Accessories are guaranteed by us without any reservation whatsoever as to workmanship and material.

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Knowing that the real earnest amateur can get satisfactory results only from the very best equipment, we urge your consideration, inspection and comparison of Union Radio Apparatus and Accessories.

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"Spare" charges can be kept indefinitely. They will not "run down" prior to insertion in the battery. They need no more care than a hammer. By keeping "spares" on hand your concert will never be interrupted.

Each Magno Battery is a 2-volt unit. Two in series is sufficient for the new 4-volt tubes. Three in series for the 6 wet tubes. Each positive electrode is rated at 30 ampere hours, but because of their unusual recuperative power they last much longer than their rated capacity.

You can get a greater ampere hour capacity with Magno batteries and a few "spares" per dollar invested than from any other battery. And with Magnos maintenance costs are much lower.

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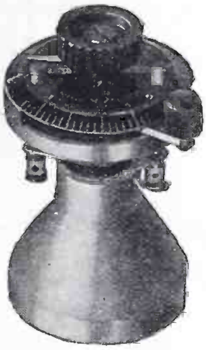

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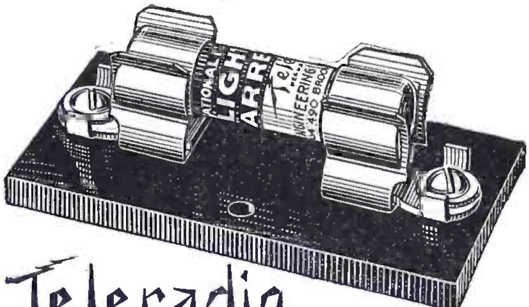

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Lightning Arrestor

THINK of it! Only $1 for the Teleradio Lightning Arrestor!

Here is a guaranteed Lightning Arrestor that has been approved and passed by the National Board of Fire Underwriters, and has been granted the Electrical Number 5837. This is the only Lightning Arrestor that we know of that has been approved by the *proper* authorities and that sells at so low a price as $1.

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The Teleradio Lightning Arrestor is the result of over 10 years' experience in the manufacture of electrical apparatus and each Lightning Arrestor is guaranteed to be mechanically and electrically perfect.

Teleradio Lightning Arrestors are the latest addition to the Teleradio line, so if your dealer has not yet stocked them, order direct from us. Enclose dollar bill, check, or money order, mentioning your dealer's name and address. The coupon is for your convenience.

Ask your dealer to show you the Teleradio Vacuum Tube Protector and Teleradio Supersensitive Phones.

Jobbers and dealers—write for prices and proposition on the nationally advertised Teleradio line. Immediate shipment. Orders for Teleradio Lightning Arrestors now being filled.

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Please find enclosed dollar bill, check or money-order. Kindly send me by return mail, prepaid, one Teleradio Lightning Arrestor.

Name . . . .
Address . . . .
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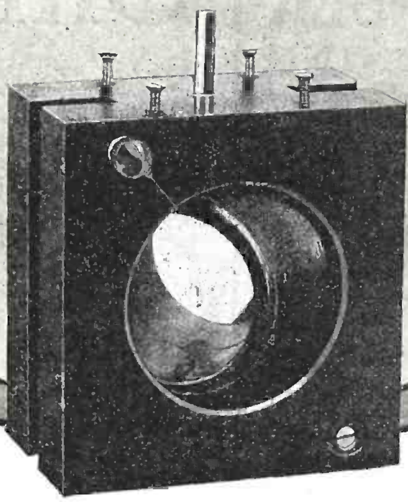
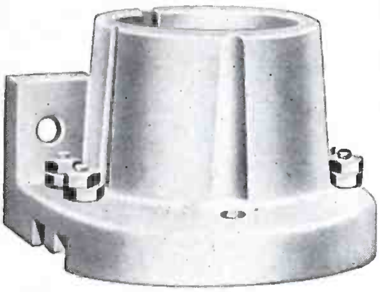
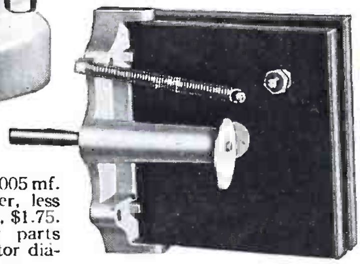


CROSLEY



The efficiency and success of the CROSLEY V. T. SOCKET has been duplicated in the entire family of CROSLEY radio parts



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Crosley V. T. Socket—porcelain, base or panel mounting—very efficient —price 50c.

Crosley Model "B" Condenser, (.0005 mf. Capacity) a radically better condenser, less internal resistance, gets louder signals, $1.75.

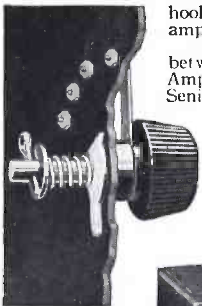
Crosley unassembled variometer parts complete. Assembled size 3 x 4¾", rotor diameter 4 inches, shellacked, $1.50.

Crosley Rheostat for vacuum and filament current control, sturdy construction, unusually efficient, price 60c.

New Crosley design knob and dial, tapered knob, clear white figures. Price 40c.

Crosley Tap Switch, special washer and lug permits soldering of buss wire, tapered knob. Price 30c.

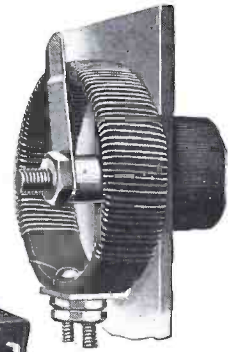
New CROSLEY T. R. F. Unit extends Summer range of CROSLEY RECEIVING APPARATUS

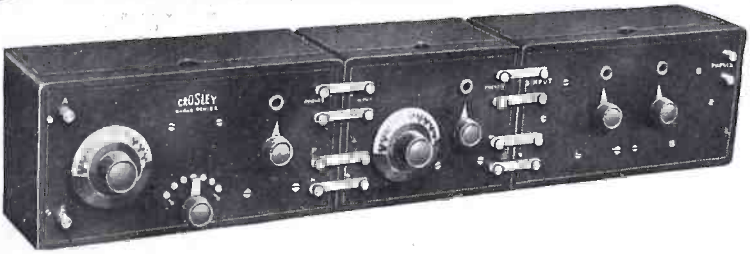


Illustrated below is Crosley Harko Senior Receiver hooked up with new Crosley T. R. F. Unit and two step amplifier.

By putting the Crosley Tuned Radio Frequency Unit between the Harko Senior and Two-stage Amplifier, an Amplifier is used in place of a detector tube in the Harko Senior for radio frequency amplification tuned by means of the dial on the radio frequency unit, and the detector tube is placed in the radio frequency unit, making one stage of tuned radio frequency and detector in the first two cabinets.

Superior results are achieved with this unit. Static is decreased and stations never heard before will come in loud and clear, summer or winter.





THE CROSLEY MANUFACTURING CO.

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