Popular Radio

OCTOBER 1922

15¢

"Radio broadcasting as now conducted may pass. I think that it will. But it will pass into something bigger, into something more useful to men."

Major General, United States Army

The A. C. AMPLIFIER *for the* AERIOLA SR.

AERIOLA AMPLIFIER
Model A. C.
Complete with two WD11-A vacuum tubes (without batteries) $68.00

VOCAROLA LOUD-SPEAKER
Model L. V.
$30.00

RCA

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THE Aeriola Sr., simplest and most efficient of all single-tube receiving sets, becomes still more efficient with the new model A. C. amplifier.

No storage battery is required. With only two dry cells, two tubes, and a 45-volt plate battery the model A. C. amplifier greatly increases the Aeriola Sr's. range of reception. Used with the Vocarola loud-speaker, the amplifier connected with an Aeriola Sr., fills a whole room with concerts received over distances of ten to thirty miles.

Anybody can make the simple connections required, including mother and the girls.

Because there are no storage batteries to charge, because both the Aeriola Sr. and this new model A. C. amplifier are so light and handy, the combination is ideal for Boy Scouts and for campers.

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WORLD WIDE WIRELESS

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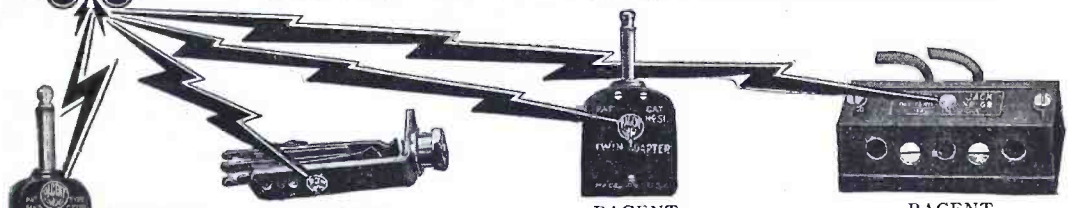
PACENT RADIO ESSENTIALS

PLAY SAFE! LOOK ~ FOR ~ THE PACENT TRADE MARK



PACENT Universal Plug

PACENT Radio Jack

PACENT Twin Adapter

PACENT Multi-Jack

PACENT Audioformer

PACENT Universal Detector Stand

PACENT Duo-lateral Coil

WHY TAKE CHANCES?

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In the ordinary purchases which you make every day, you invariably depend upon some mark of quality as an assurance of value and satisfaction. In buying radio materials the average purchaser is a great deal more dependent upon the reputation of the manufacturer than in buying everyday commodities. A radio instrument may look good and act bad. How much more important it is in this case, therefore, to look for the trademark of a competent, dependable manufacturer; The Pacent trademark on any radio product is an absolute assurance of satisfaction.

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It means that the device bearing this trademark was made to fill a definite, important radio need: that is the meaning of PACENT RADIO ESSENTIALS.

It means that the product was originated by a radio expert and has passed the acid test of experience. The Pacent Plug was the *first* radio plug; the Pacent Jacks were the first radio jacks, and so with the Twin Adapter, Multijack and other PACENT RADIO ESSENTIALS. Every Pacent product is also backed up with Mr. Pacent's fifteen years' personal experience in the radio industry.

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Therefore, when you buy PACENT RADIO ESSENTIALS bearing the Pacent trademark you are absolutely sure that you are getting the best for your money. You are playing *safe*. Don't accept substitutes, imitations or something "just as good." Insist on seeing the Pacent trademark.

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Member Radio Section, Associated Manufacturers of Electrical Supplies

POPULAR RADIO

EDITED *by* KENDALL BANNING

CONTENTS *for* OCTOBER, 1922

(Cover design by Joseph Cummings Chase)

VOLUME II NUMBER 2

DEPARTMENTS

VOLUME II OCTOBER, 1922 NUMBER 2

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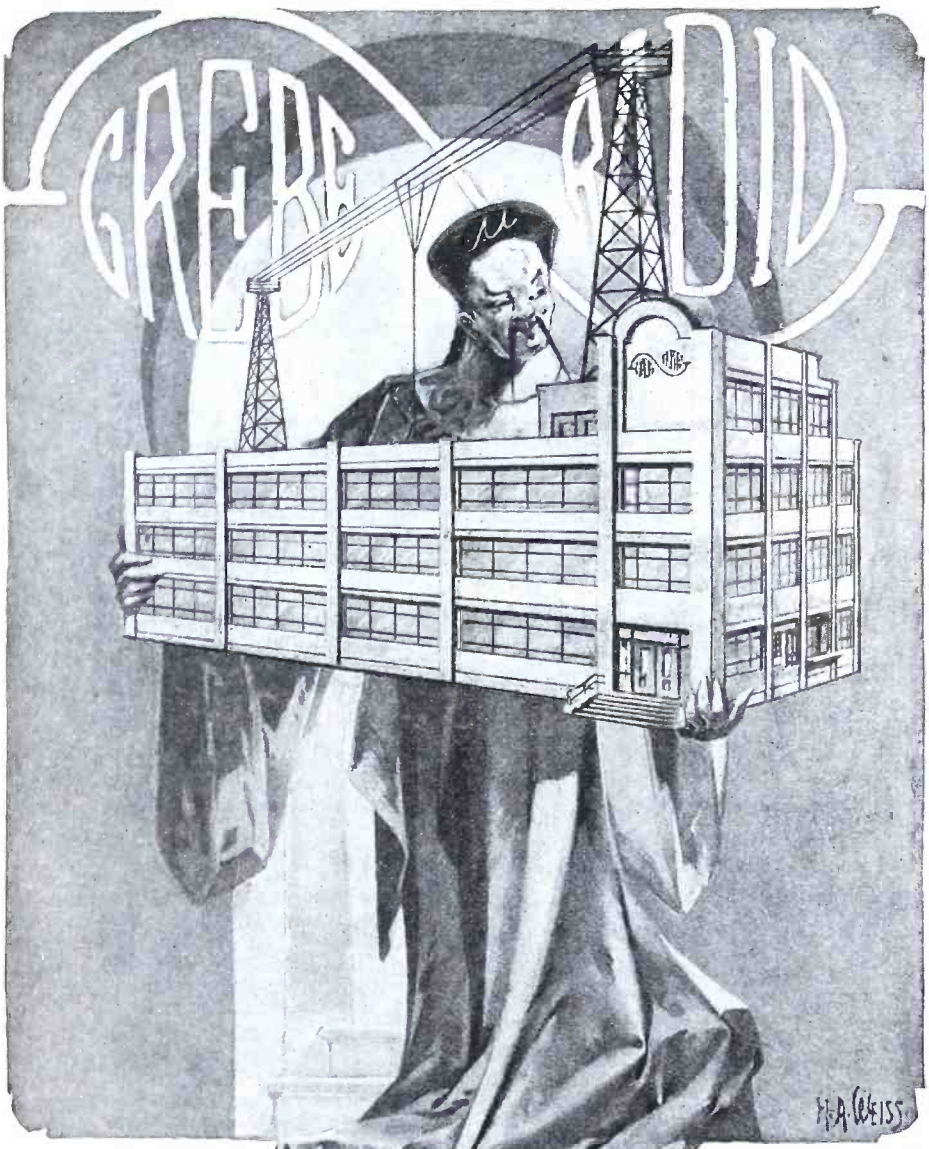
E. E. FREE, Ph.D., *Contributing Editor* LAURENCE M. COCKADAY, R.E., *Technical Editor*



"TREASURES OF GOLD AND JADE," SAID LAO TZU, "DESERVE A PROPER DWELLING!"

"GREBE RADIO IS NOW HOUSED IN A MANNER BEFITTING ITS EXCELLENCE.."

Doctor Why.

A PAGE WITH THE EDITOR

IF our readers could only peep over the Editor's shoulder at the store of timely and interesting articles that are scheduled for publication during the next few months they would become as impatient over the delay in getting them into our magazine as is the Editor himself. Our editorial files are rapidly becoming a veritable gold mine of material—articles of practical helpfulness to the radio fan everywhere. Among our contributors whose manuscripts are awaiting the chance to appear in our pages are such distinguished men as Dr. Lee De Forest, Commander S. C. Hooper, John V. L. Hogan, Thomas C. Martin, Guglielmo Marconi, Sir Oliver Lodge, Hiram Percy Maxim, Prof. William C. Ballard, Jr., Prof. J. H. Morecroft, Waldemar Kæmpffert, Dr. Clayton H. Sharp, Prof. Gordon D. Robinson, Dr. Henry Smith Williams—to mention only a few. Only the limitations of space at present available prevent the early publication of *all* this material. The question is whether or not the Editor is not in duty bound (entirely aside from the extra expense involved) to enlarge POPULAR RADIO and thus enable our readers to profit from this material while it can be of the greatest timely value to them. Some of our readers have been urging the Editor to do just this.

What do *you* think?

* * *

THE feat of broadcasting the concerts of the New York Philharmonic orchestra served as a two-edged sword; it hit both the radio fan and the music lover. No more flattering tribute to the part played by POPULAR RADIO in this undertaking has been paid than that written by the indefatigable Cromwell Childe, of the Philharmonic orchestra management:

"Music has had signal service done for it," he gracefully acknowledges, "and in a way that seems incredible. The night of August 11th, 1922, is memorable in the annals of music. . . . But the real historic moment came several weeks before that date; a record of it should be preserved. On the field of the Stadium one evening in July the Editor of POPULAR RADIO met the manager of the concerts, Arthur Judson, and the writer. 'Why not broadcast these concerts?' the editor asked. Mr. Judson and I looked at each other. 'Yes,' we agreed. And so it all began."

* * *

No more impressive demonstration can be required, even by the most exacting editor, of the eagerness with which his subscribers look forward to the arrival of the magazine each month than the disappointment they experience when something deprives them of their accustomed treat. When Fred C. Clough, of Ridgefield, New Jersey, found that he had received a spoiled copy he sent a messenger all the way to our office in New York to replace it with a perfect copy. And as for old Major Lawrence Mott, known to amateurs throughout the country as 6XAD (and an editor of an Esteemed Contemporary), his perfectly justified chagrin over a similar experience overcame him completely and stirred him to send a telegram from Avalon, California—clear across the continent—for a duplicate copy!

The Editor is grateful for this proof of esteem. If he were a subscriber he would do exactly what these two subscribers did!

* * *

"BUT won't the radio craze pass?" now asks the inevitable sceptic. He asked the same question years ago about the steam engine, the talking machine and the motion picture: his clinching argument against the automobile was that it could not possibly come into general use "because it would scare all the horses!"

No, radio will not pass—at least not until electricity becomes a quaint and useless toy. Indeed, it is not unlikely that radio will prove to be the most significant discovery yet made by man. Certainly no development of science has so stirred the imagination or promised such far-reaching effects upon civilization.

* * *

HERE'S a man after our own heart! George A. Martin is so properly fearful lest he miss a single issue of POPULAR RADIO that he sent in his subscription from Buffalo by special delivery!

* * *

"I MUST admit that POPULAR RADIO," writes Thomas Hedges from Oklahoma, "is about the only radio magazine that I can really understand."

"After a week of futile tinkering with my regenerative set," writes Francis Greene of Rensselaerville, N. Y., "I bought a copy of POPULAR RADIO. In it I found in a few moments the solution of my problem in hooking it up. I shifted the connections of my 'B' battery, and ever since I have gotten wonderful results."

These two comments are quoted not because they are exceptional, but because they are representative of the flood of letters that pour into the editorial sanctum. Such messages are particularly gratifying because they indicate that POPULAR RADIO is accomplishing two of its main objects:

First—to present its articles in language so clear that even the radio novice can understand it.

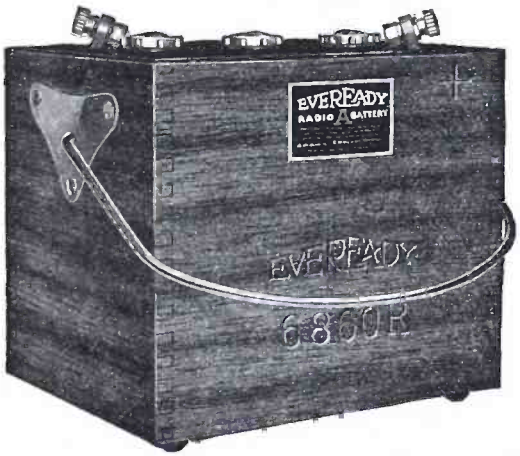
Second—to publish only sound and authoritative information about radio—information that is of practical value and that can be depended upon.

If you see it in POPULAR RADIO, *it's so!*

Kendall Banning

Editor, POPULAR RADIO

FOR BETTER RESULTS:
USE
EVEREADY
"A" and "B" BATTERIES



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—hardwood box, mahogany finish
—convenient handle, nickel plated
—rubber feet protect the table
—insulated top prevents short circuits
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No. 6860—
90 Amp. Hrs.—45 Lbs.....$18.00

No. 6880—
110 Amp. Hrs.—52 Lbs..... 20.00

EVEREADY "B" BATTERIES

No. 766 is the most popular size in use. Contains 15 cells and has a long service life. It is equipped with five positive Fahnestock Spring Clip Binding Posts ranging from 16½ to 22½ volts, making it the most desirable type for use with vacuum detector tubes, such as Radiotron, Model UV-200. Dimensions:—Length 6⅝"; width, 4"; height, 3". Weight, 3 lbs. 7 oz. **Price $3.00.**

EVEREADY "B" BATTERIES can also be obtained in the following Types:

No. 763

is especially suitable for use where light weight or small space is essential, such as in small portable sets. Contains 15 cells, enclosed in waterproof cardboard box, equipped with two coil wire leads. Initial voltage of 22½ volts. Dimensions:—Length, 3⅜"; width, 2"; height, 2½". Weight, 13 oz.

Price, $1.75

No. 767

contains 30 cells of the same size as in No. 766 and is therefore approximately twice the dimensions. It has the same voltage taps as the No. 766 and in addition has a 45-volt tap; all Fahnestock Spring Clip connections. The lower range of voltage taps is to be used in connection with the detector tube and the 45-volt tap for the amplifier tubes.

Price, $5.50

No. 746

consists of 72 cells equipped with two coil wire leads enclosed in a wooden box, made airtight. It gives 108 volts and is most widely used in conjunction with loud speaking devices, such as the Magnavox. It is especially suitable for theatre and auditorium use, or outdoors, where the message must be carried to the longest distance required. Dimensions:—Length, 17"; width, 9"; height, 3½". Weight, 20 lbs.

Price, $15.00

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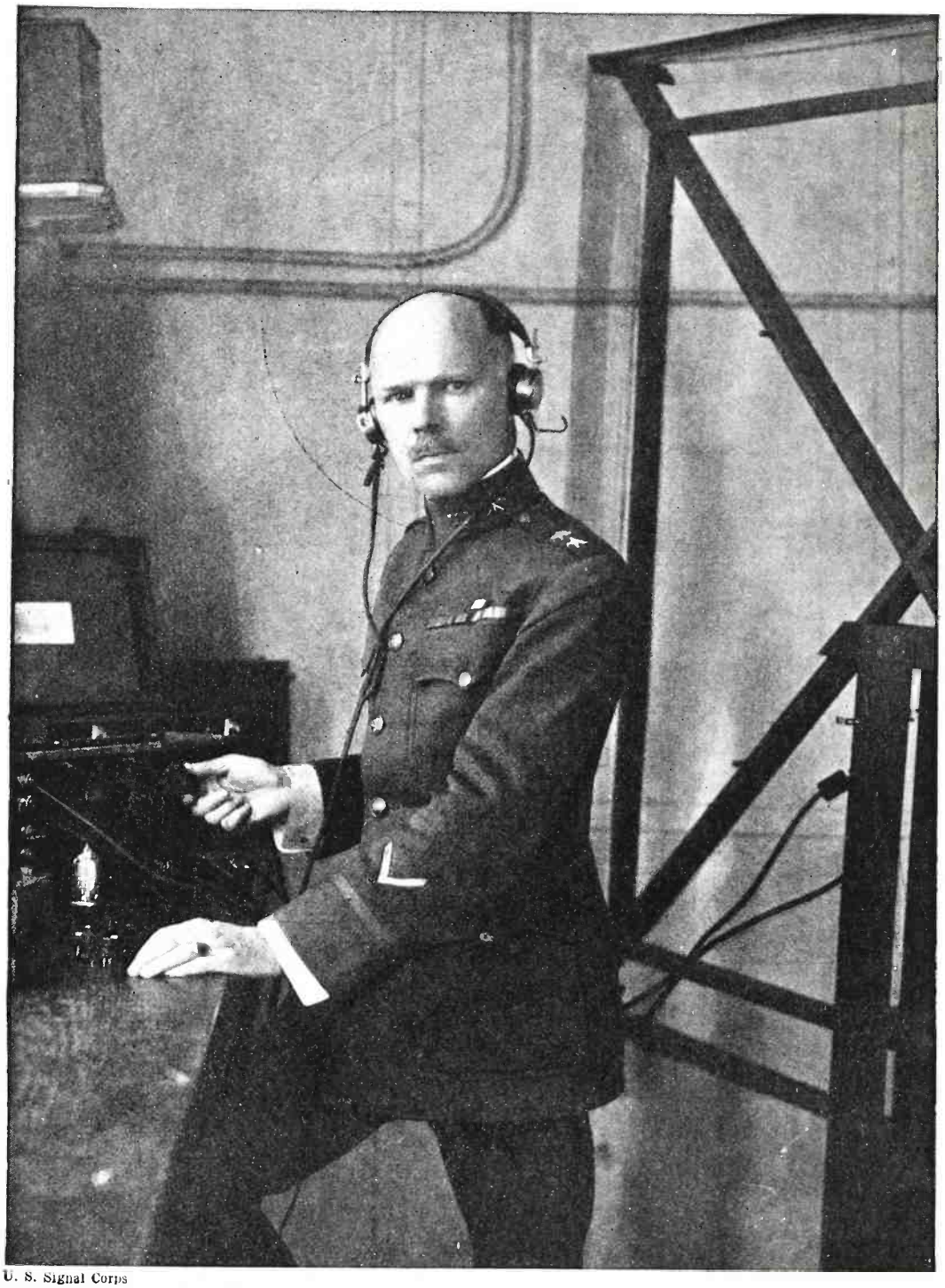
DR. LEE DE FOREST BROADCASTS HIS OPINION OF *POPULAR RADIO*

It comes my close to my ideal
of what a popular, semi-technical
radio magazine should be.

Lee de Forest



U. S. Signal Corps

¶ *"RADIO will bring to the people of this country the intellectual background which heretofore only the rich could afford. Yet the work of the radio engineer as an educator has only just begun. Soon we will be measuring culture by watts."*

—GEORGE O. SQUIER

Popular Radio

VOLUME II OCTOBER, 1922 NUMBER 2

What Will Take *the* Place *of* TODAY'S BROADCASTING?

One of the Possible Solutions of the Most Vital Problem Before the Radio Fan Today, as Proposed by——

MAJOR-GENERAL GEORGE O. SQUIER

BROADCASTING was impossible without an audience. As soon as an audience was provided, broadcasting was possible, and it began. The audience was provided by the boy amateurs—by the youthful tinkerers who for four or five years had been playing with coils and sparks and antennæ—who had been trying, night after night, to get through a few dots and dashes to the other boy enthusiast in the next block. This amateur audience was ready and waiting for the broadcaster; its existence is what made broadcasting such an instantaneous success.

The present conditions in radio are training a larger audience. Father and mother have joined the boys around the radio set. It has been estimated that about five million people listen in every evening on the broadcast programs.

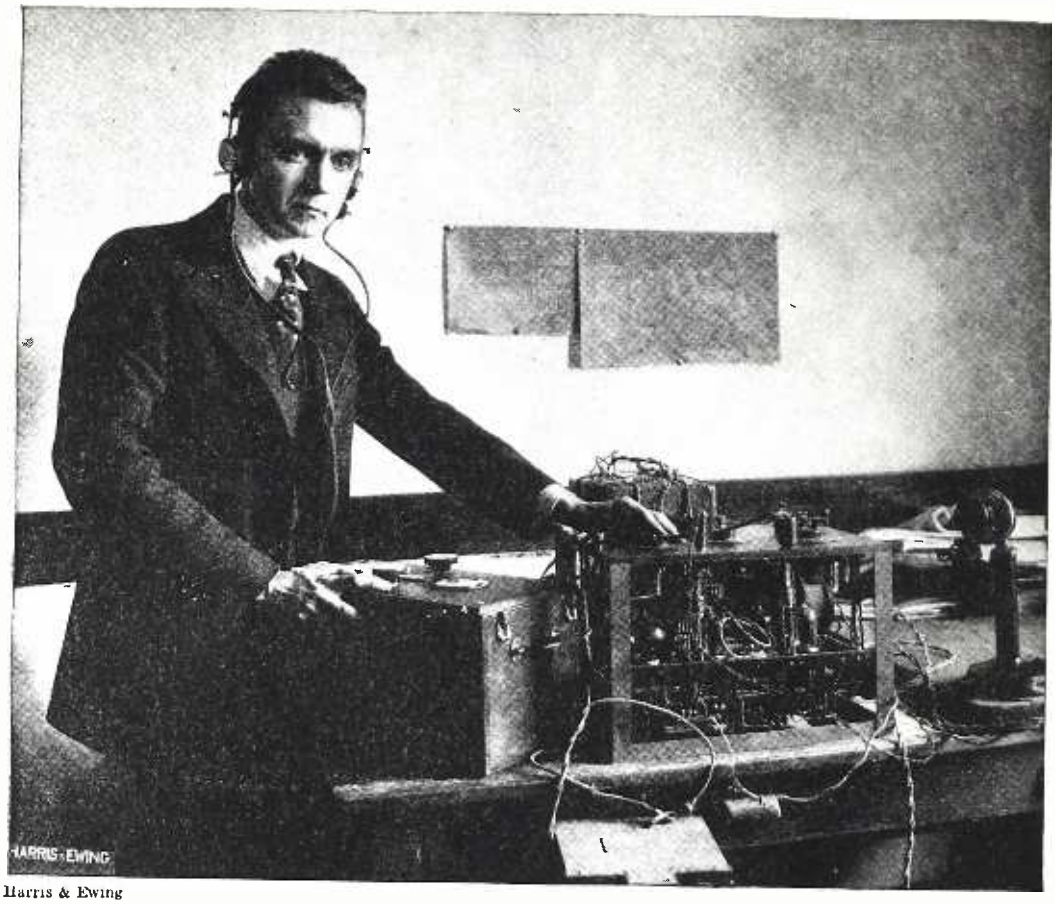
What are we going to do with this audience?

Amateur radio prepared the audience for broadcasting. Broadcasting is now preparing another audience, a larger one —for what?

Some people seem to think that broadcasting is a fad; they believe that people will return for entertainment to the phonograph, to the motion picture and to the spoken drama. They believe, so they say, that the radiophone is a temporary craze.

I do not think so. What happened to amateur radio? In one sense it passed, but it passed into a far bigger thing. It passed into radio broadcasting. Radio broadcasting as now conducted may pass in its turn. I imagine that it will. But it will pass into something else, into something bigger and better, something more useful to men and to society.

The basis of a democracy is education. Unless we can properly educate our children and our immigrants, the American idea of government will fail. And no one can be educated solely in school. Far more important is the atmosphere at home; the background, good, bad or in-



Harris & Ewing

A RADIO RECEIVER THAT USES A TELEPHONE WIRE AS AN AERIAL

The scheme for transmitting radio programs to subscribers only is brought within the realms of possibility by this super-phone, or "line radio duplex transmitter and receiver," developed by R. D. Duncan, Jr., head of the research laboratory of the Signal Corps. The device may be attached to the ordinary desk telephone.

different, against which the family life goes on. Is this a background of good books, good music, intelligent conversation? Or is it a background of crime news from the papers and of neighborhood gossip?

Think of what radio can do to help this situation. Radio can go a long way toward supplying whatever kind of home background the country needs its citizens to have. Inspiring music, the uplifting words of great teachers, the everlasting principles of our political fathers, can be poured every day and hour into the waiting ears of all our citizens—poured in to form the minds of children, to revive the courage of the common man, to instruct and set right the newcomer from foreign lands.

The country can *make* us listen, all of us. It will be so easy to listen that we cannot escape. We will not want to escape. Comfortably, each one of us beside his own library table, in his favorite chair, without cost or exertion or the annoyance of dressing up, there will come to our ears at the turn of a little knob the best thought and the finest artistry of all the world.

And to our children's ears no less. To our children radio will bring the intellectual background which only the very rich have been able to provide, a background of exquisite sound. The poorest

nursery can have its interior decoration of music, its aural furnishing, as now we put bright pictures on its walls. For nurseries and for all the house we can replace mere noise with controlled harmony. Already the music of the Marine Band, which all of us help to support, is not confined to Washington; it is broadcast regularly. Already any little town in Maryland or Virginia can have its radio set and its loud-speakers—can gather in the evening at the band stand for its own concert by this world-famous organization. Yet this is only a beginning of the work of the radio engineer as an educator. Soon we will be measuring culture by watts.

And as to the more permanent social influences of such daily aural backgrounds, what might be, for instance, the influence on business morality if fifty people heard each day the simple and persuasive eloquence of the Sermon on the Mount?

This is exactly what radio can do. The radio engineer will be, I firmly believe, the prophet and the architect of a new social era, the inventor of the first successful system for the education of all the people.

For this to come about we need only two things:

First: we must simplify the radio receiver, and

Second: we must avoid, somehow, the present confusion of broadcast messages, the overcrowding of the ether.

Both of these improvements can be made, and can be made easily.

The Bureau of Standards has produced a vacuum tube equipment which works on an ordinary electric lighting circuit. This may eliminate from the radio set the present type of battery. The principle of the resonance coil, developed in the laboratories of the U. S. Signal Corps, not only accomplishes the virtual elimination of static but reduces the laborious and uncertain tuning to a single operation, to the mere sliding of a contact arm along a coil. These two advances remove the main reasons why the present-day radio set is overcomplicated and is too hard to manage and adjust. The next step is get rid of the aerial. This can be done easily by using the electric light wire or the telephone wire.

Every house has two avenues through which the outside world comes into it, the electric light wire and the telephone wire. Already the massed network of these wiring systems is prodigious in extent. The United States is one vast grid of wire. If some jinn could dissolve away all the brick and iron and concrete of the buildings of lower New York, leaving only the electric light wires, the form of the buildings would be as visible as before. Each floor, each wall, each room would be represented by a cage of intercrossing wires. The telephone wires make another system equally complete and complex, in fact, since the telephone system is continually changing its configuration as its calls are plugged in and out.

Each of these vast networks of wire is really a cage aerial, a three-dimension antennæ system. The electric light wires and the telephone wires of New York pulsate every instant with all the potential changes due to every wireless message passing through the ether. Each Marconigram from Europe is recorded, pulse by pulse, on these two independent networks of wire.

Both of these networks come into your house. Why not use them to get your radio signals? What is the use of spoiling your roof with troublesome and unsightly aerials, or filling up your parlor with complicated loops? The light and telephone wires are there. They have been laboriously and skilfully insulated from the ground and protected against lightning. Why do this all over again for a little private wire system of your own? Why not forget about your own private aerial and use those already available to you?

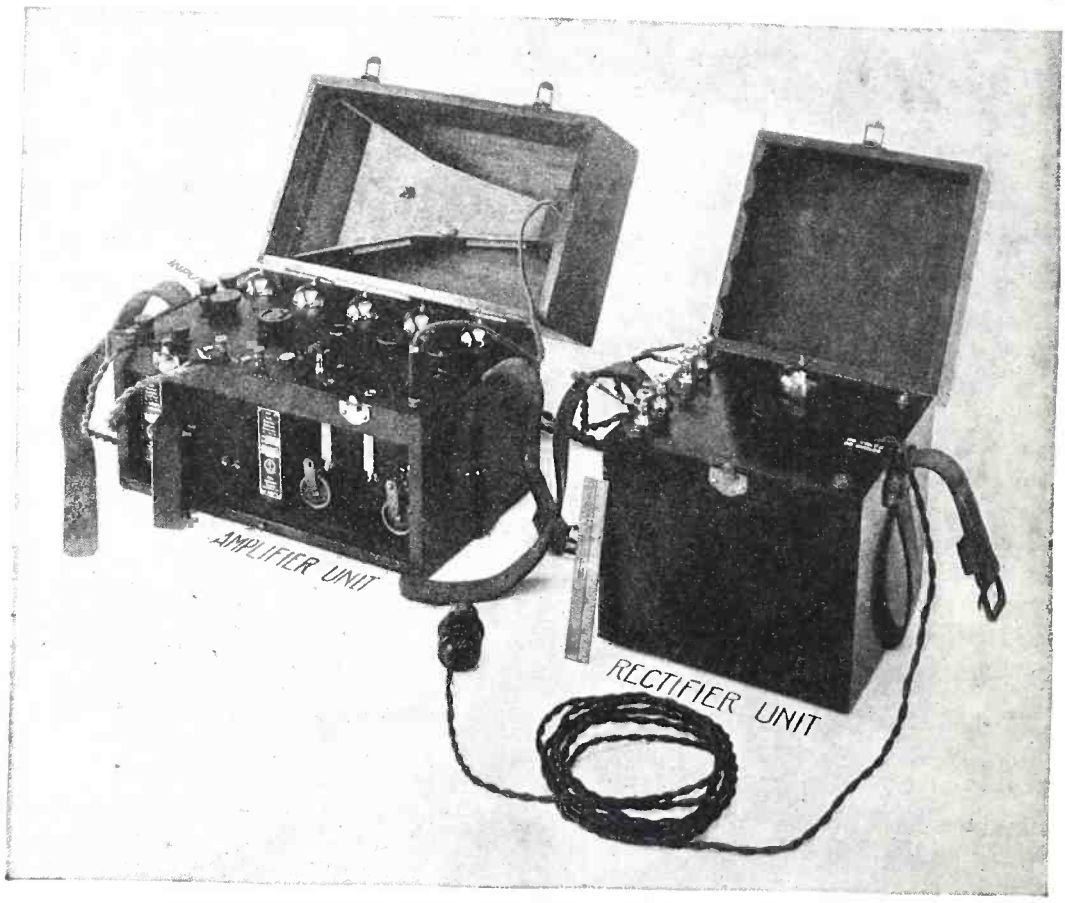
With proper apparatus there is no danger to or from the wires, no interference with their use for light or telephone

service. All the music and speech which is pulsating through the ether, all this wonderful potential background of education, comes into your house anyway through the two avenues, namely, the light wires and the telephone wires. The radio set of the future—I believe, of the very near future—will be some simple apparatus which you can plug into any light socket, or connect to any telephone. It will be something which you can buy in any drug store. It will be something dependable and standard, which you do not have to "set up" or "install."

When we get this we can begin to count on developing an intelligent, well-meaning and broadminded public opinion.

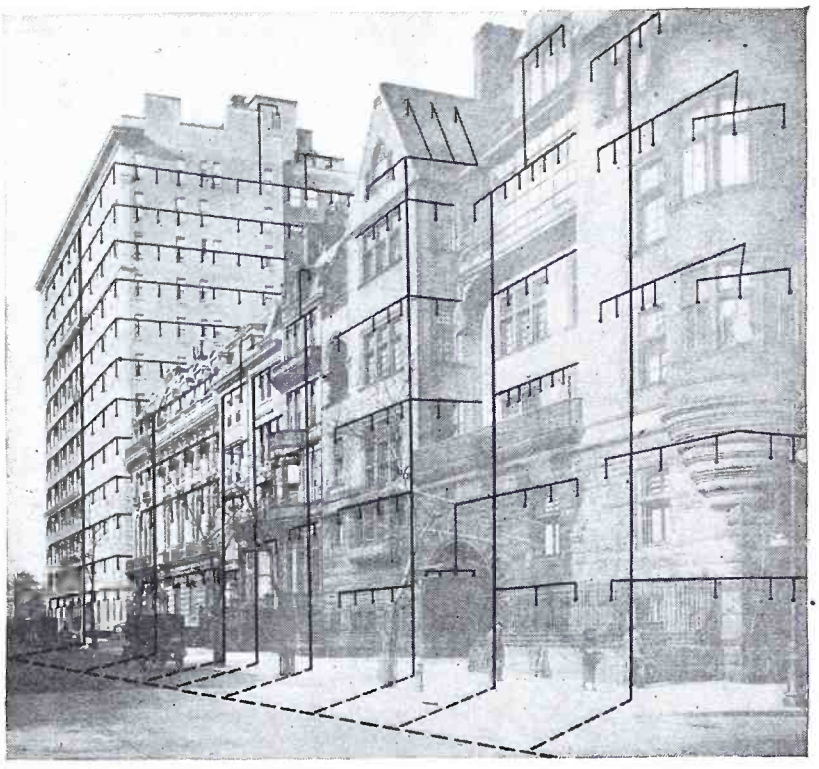
The difficulty of an overcrowded ether can be met with equal ease. The work of the Signal Corps on carrier current radio, or "wired wireless," is well known. By this system radio waves can be sent over ordinary wires. This is already in use for telephone service over power or telegraph wires and for superposing two or more telephone conversations on the same wire.

By the use of this system anything could be broadcast over the electric light wires of a city. Items of local interest only need not be loaded on the ether for everybody to hear; the local



YOU CAN "PLUG IN" THIS RECEIVING SET ON YOUR ELECTRIC LIGHT CIRCUIT

That the ordinary electric light wiring can serve as aerials for "wired wireless" reception has been demonstrated by this receiving set devised by the Bureau of Standards under General Squier's direction. It is possible that the electric light corporations of the future will furnish the broadcast service—to customers only.



From a drawing made for POPULAR RADIO

THE WIRE SKELETON OF A CITY BLOCK

The possibilities of bringing radio programs into buildings by way of the telephone and light circuits is illustrated by this diagram. If all the brick and iron of our city structures were dissolved away, the forms of the buildings would still be indicated by the wiring.

wire systems will carry the load instead.

For instance, department store advertising is of real interest to people who live near the store. It is not of interest to listeners a thousand miles away. It will be necessary to distinguish between local news and general news; between local civic matters and general governmental ones. The use of the local wire systems for broadcasting by radio permits one to make this distinction effective.

Like the use of the electric light wires as aerials, this broadcasting over them will interfere in no way with their proper purpose of carrying current. Several power companies are understood to be experimenting already with the idea of furnishing their customers with broadcast entertainment just as they now furnish them with electric light.

These, then, are the three developments in radio which I can see near at hand.

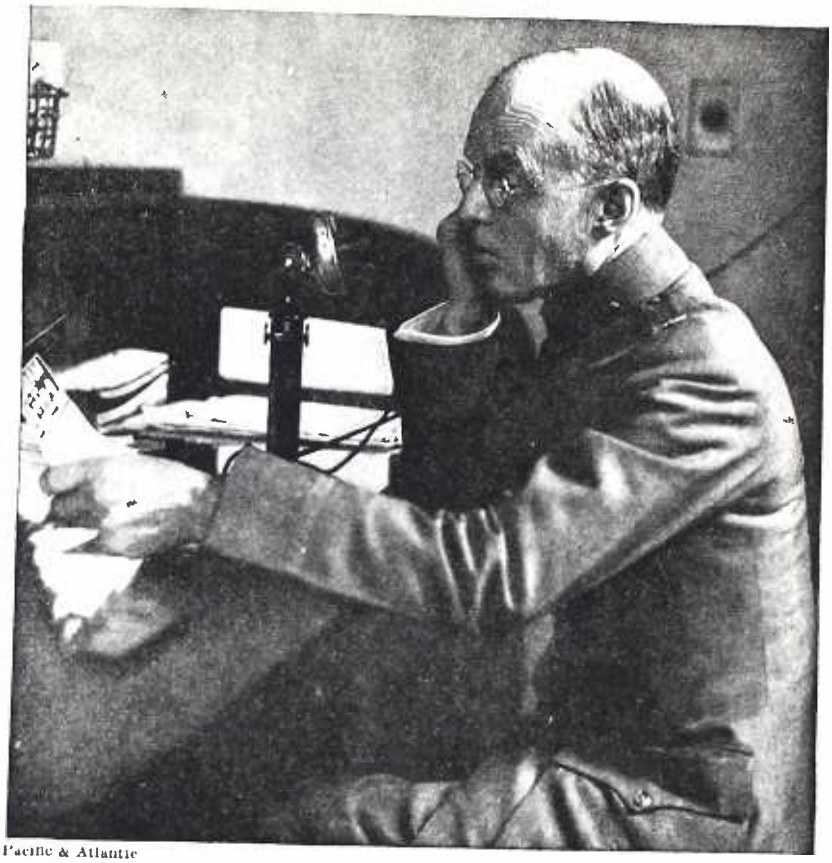
First: the simplification and standardization of the receiving set.

Second: the use of light wires and the telephone wires as aerials for everybody.

Third: the use of local power systems for local broadcasting.

Through these three developments there will come to every man's home a stream of the best things of the world—a stream to be tapped and enjoyed when he wishes, to be shut off by the simple turn of a switch when he does not; a stream out of which he may select what pleases his fancy or meets his changing needs.

Thus will the radio engineer provide a new cultural background for humanity, a new and powerful agency for the advancement of mankind.



Pacific & Atlantic

HE ADMINISTERS TO HIS PATIENTS AT SEA FROM A CITY SKY-SCRAPER

Emergency radio calls for medical help from vessels off our coasts are relayed by Uncle Sam's coastal stations to one of three hospitals maintained by the Bureau of Health—the U. S. Marine Hospital in New York, the U. S. Veterans' Hospital in Philadelphia and the U. S. Marine Hospital in San Francisco—from which expert advice is returned. Dr. E. K. Sprague (shown above) is in command of the New York headquarters of this unique service.

"Old Doctor KDKF"

A Remarkable Form of Long-Range Medical Service that Uncle Sam Is Developing to Cure the Sick and Injured on Ships Beyond the Reach of Surgeons

By HOMER CROY

BLOSSOM HEATH, an English cargo ship, stopped at New York, discharged part of its freight and steamed confidently for Panama. It passed through the Canal and started on the long stretch across the Pacific ocean for Hong Kong and the China Coast.

And then one night, abruptly, misfortune laid its heavy hand on the ship.

There was groaning in the quarters of one of the ship's crew. When help came the cook was writhing in pain. For anything to happen to the chief cook on such a long voyage is a catastrophe. The captain was called and in the glory hole, gently rocking to the movement of

the ship as it plowed steadily into the tropical night, the captain sought to find out what was the matter. But he was not a man of medicine and the cook could tell him little. All the cook knew was that he was in great misery; he had eaten nothing; taken no wrong medicine. He could not explain it. The captain took his pulse, and found a fever thermometer, but otherwise he was helpless. The pains grew worse. It would be days before port was made, before there could be hope of medical attendance.

And then as he bent over the groaning man in his bunk, with the silent seamen outside in the narrow passageway, an idea came to the captain.

"Send me Sparks," he said. Everyone knew what he meant, for over the seven seas the ship's wireless operator is thus known.

The captain wrote a brief description of the cook's symptoms on a pad and signed it as master of the *Blossom Heath.*

"Call Station KPH, San Francisco, and ask them to tell me what to do."

San Francisco answered the call and a physician of the United States Marine Hospital was brought to the telephone. The captain's message was read to him and the doctor gave his advice—and in just sixteen minutes after the captain's message was sent into the air the doctor's advice was back.

Two days later the cook was well!

Thus had the cook on an English cargo ship in the midst of the Pacific ocean been saved by American radio.

Another instance: the *Chester Valley,* one of the United States Shipping Board ships, was at sea when one of the petty officers began to complain of pains. Small sympathy is to be found among the hardened men of the sea until it becomes serious—and then before they realize it, it is too late. It is a stern school. The man's pains grew worse; the captain was sent for and in bewilderment stood over the moaning man. The captain called New York by wireless. Almost immediately advice was back. The man was saved and another feather was added to radio's cap.

On still another occasion, a sailor on a slow-moving cargo ship came down with pneumonia. To cure such a disease was quite beyond the ambitions of even the most adventurous members of the crew. It would be days before the freighter would make land—and the man must have immediate attention. At last a passenger ship was called and its doctor was asked to prescribe. This he did. The two ships were going in the same direction; the passenger ship arrived first and when the freighter came in the doctor, whose interest had been aroused, was there to receive his patient. The sailor was transferred safely to a hospital and in time recovered. Without radio a shorter—and sadder—story would have been written.

Thus do we see the workings of another of the wonders of radio—the giving of medical advice to ships at sea. Sailors now can have the best of medical advice, even though the doctor may be thousands of miles away. Many and many is the ship that has no doctor: freighters, cargo ships, tramp steamers, tankers, fruit boats, fishing vessels, schooners. In fact, only 25 percent of the ships that sail the seas carry doctors. There is a law which requires all ships with fifty or more in the crew to carry a radio outfit, but they may have a hundred in the crew and not have a doctor aboard—so long as they don't carry passengers. But a ship with even one paying passenger must have a doctor. It is one of the queer quirks of the law. To judge by the statutes a seaman is a hale and hearty individual who has felt well ever since he cut his teeth, while a passenger with nothing to do but sit around and enjoy himself is trembling on the brink of a breakdown. As a result, a freighter with a huge crew will start to sea with nothing more complicated in the way of medical nostrums than Nujol and be expected to put into port with every man jack aboard danc-

ing a hornpipe. But if one lone passenger gets aboard, a ship's doctor has to come trailing after him.

The English marine law is better than ours. By it the master of a vessel is required to know the principles of first aid. But we have no such law. The captain of an American freighter can put to sea without knowing a hypodermic needle from a belaying pin. The English captain, in time of emergency, can administer rough help, but our captain can only look sympathetic and offer to write to relatives. As a result, thousands of American seamen suffer. And the stories they can tell! Boxes fall on them, legs are crushed, fingers disappear in the machinery—and the captain is called on to perform the office of doctor. Sailors hold the screaming man while the captain amputates. There is no opiate; the victim is tied to the bunk and the ship goes on. Engine-room waste is used to bind wounds and oakum is poured on open sores. When there is a burn, lubricating oil is emptied on it and the crisis is considered past.

So it has been for many centuries.

From a photograph made for POPULAR RADIO

ACCIDENTS ON DOCTORLESS SHIPS HAVE BROUGHT HORRORS THAT RADIO IS AT LAST RELIEVING

For time immemorial, the only treatment received by injured seamen has been rendered by the ships' captains. Now the emergency ambulance call "KDKF" is bringing expert help even to the remote lanes of the Atlantic and Pacific.

From a photograph made for POPULAR RADIO

THE SHIP MEDICINE CHEST THAT HAS BEEN STANDARDIZED BY "DOCTOR KDKF"

Every vessel may some day be equipped with such a first-aid cabinet that will enable the ship's captain to administer the exact drugs prescribed by doctors via radio.

Then, one day, a man on the top floor of a sky-scraper at 25 South Street, New York, had an idea.

That man is Captain Robert W. Huntington, who has sailed the seas when sailing was sailing and scurvy was a dreaded disease. Once he went out to meet the whale and stood with his finger on the trigger of the harpoon-gun; now he is in the quieter waters of New York Harbor, but his heart is still with the sailors setting their course by the evening star.

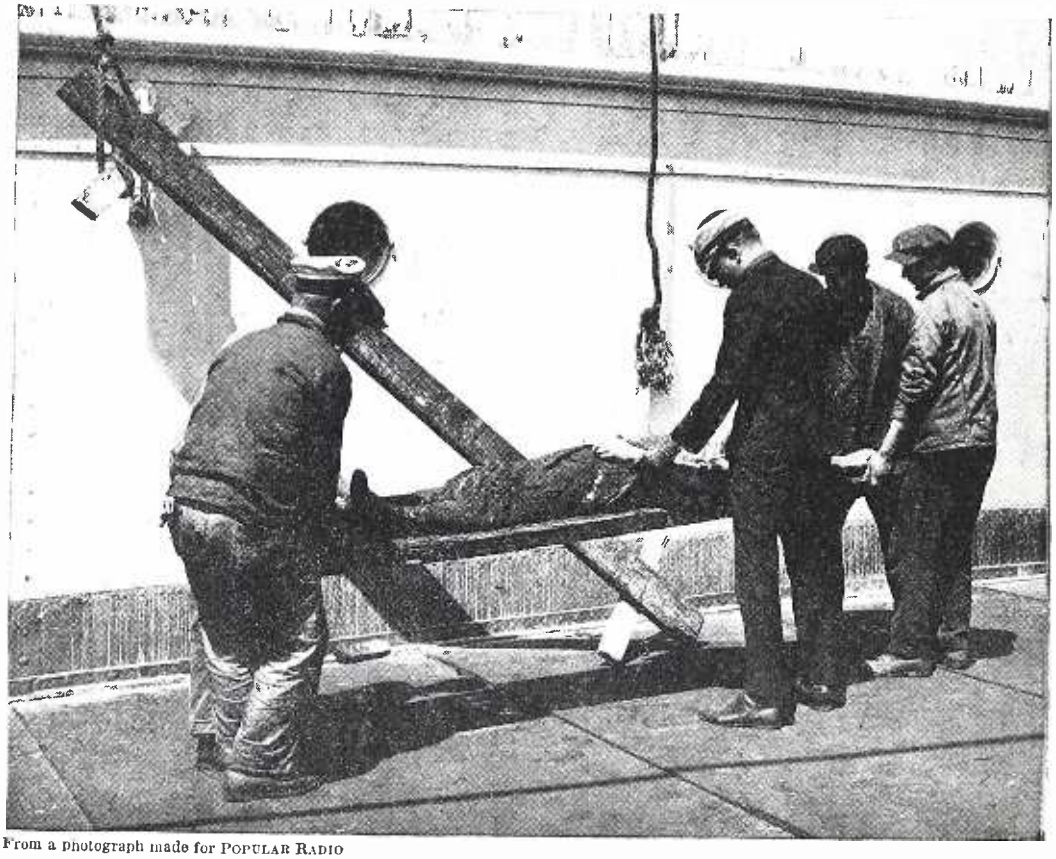
"Why can't we give them medical advice by radio?" he asked.

It was a new idea; it had never been tried. He was connected with the Seamen's Church Institute as chief of the navigation school. Immediately his idea was put up to the authorities. There was a medical staff with the Institute giving advice to sailors ashore; now its services could be enlarged. Washington was communicated with and soon the only doctor thousands of sailors knew was KDKF. When pains set upon them, or when their hands went into the machinery, instead of trusting themselves to the efforts of a bewildered skipper they called the mysterious Dr. KDKF and after a short interval advice came back. That was all they knew. The machine would sputter, sparks would fly and from some place out of the air advice would come.

But this was what was really happening. As soon as the distress message was received an Institute doctor was communicated with. The message was read to him. He in turn telephoned advice back, but the Captain wasn't going to run any risk; passing through so many hands the advice might be garbled. So to the telephone he hitched a dictating

machine, and the doctor's instructions went on wax. These in turn were read back to the doctor and later the record was put away for safe keeping. With the rubber tips in his ears the captain read out to the wireless operator the exact words of the doctor and into the air they were sent flying. The radio operator aboard some lonely ship copied them down and the message was given to the captain. Then, confident of his medical bearing, the ship captain went to the sailor and gave orders with as much assurance as if he had a medical degree. The message, to reach its destination, had gone through four machines—the telephone at the hospital, the wax record, the sending outfit and the receiving outfit on the ship.

So far so good; a great boon had come to the sailorman—or so it seemed. But not as much oil had been poured on the troubled waters as the quieted waves might seem to indicate. Underneath, there was still something wrong. For many times when calls came in for help, and medical advice was sent back, the ship had none of the remedies suggested; in fact, outside of castor oil, calomel and quinine the ship's medical chest was as bare as Mother Hubbard's cupboard. The doctor might prescribe relief, but he had no means of knowing that the ship had this on board. He was prescribing in the dark. Then it was that Captain Huntington hit upon another idea—the idea of the standardized medicine chest.



From a photograph made for POPULAR RADIO

FIRST AID IS NOW RENDERED *VIA* WIRELESS

Not only can the nature of accidents be reported to distant surgeons, but even the patient's heart-beats may be transmitted to him for determining the physical condition. Many a broken bone has been set by instructions received by radio.

Each ship going to sea was to be equipped with a medicine chest in which were to be all the standard drugs and remedies. These were to be plainly marked; the doctor was to know exactly what was aboard the ship and then he could dovetail complaint and treatment. The matter was taken up with the Department of Commerce and was favorably received. It is now awaiting action. If passed it will bring relief to thousands of seamen who in the past, in the words of the fo'c's'le, have had to grin and bear it. The supplies are to be bought by the United States Public Health Service, that cheap and inferior drugs are not foisted upon the seamen, and inspected from time to time to see that their strength has not deteriorated.

The work of the Seamen's Church Institute continued, and legs were saved and stomachs were calmed, but the job became too big. It meant that an operator must be on duty day and night. Money was low; a few donations came in, but it was more than the Institute could manage on its slender resources. At last arrangements were consummated with the Radio Corporation of America and this in turn with the United States Public Health Service. The doctors of the latter are at its call. It now has stations at Chatham, Mass,; Siasconset, Mass.; on the Bush Terminal Building, Brooklyn; one in Cape May, New Jersey, and another in San Francisco. The call letters, in order, are: WCC, WSC, WNY, WCY, with KPH for San Francisco.

Thousands and thousands of sailors—who once suffered and died needlessly—now, in whatever part of the world they are, can have medical aid within a few minutes. In fact, it is now possible for a sailor in the Sargasso Sea to get attention more quickly than if the doctor lived a few blocks up the street. With radio there is always a doctor at home. Radio has hung a shingle on every ship.

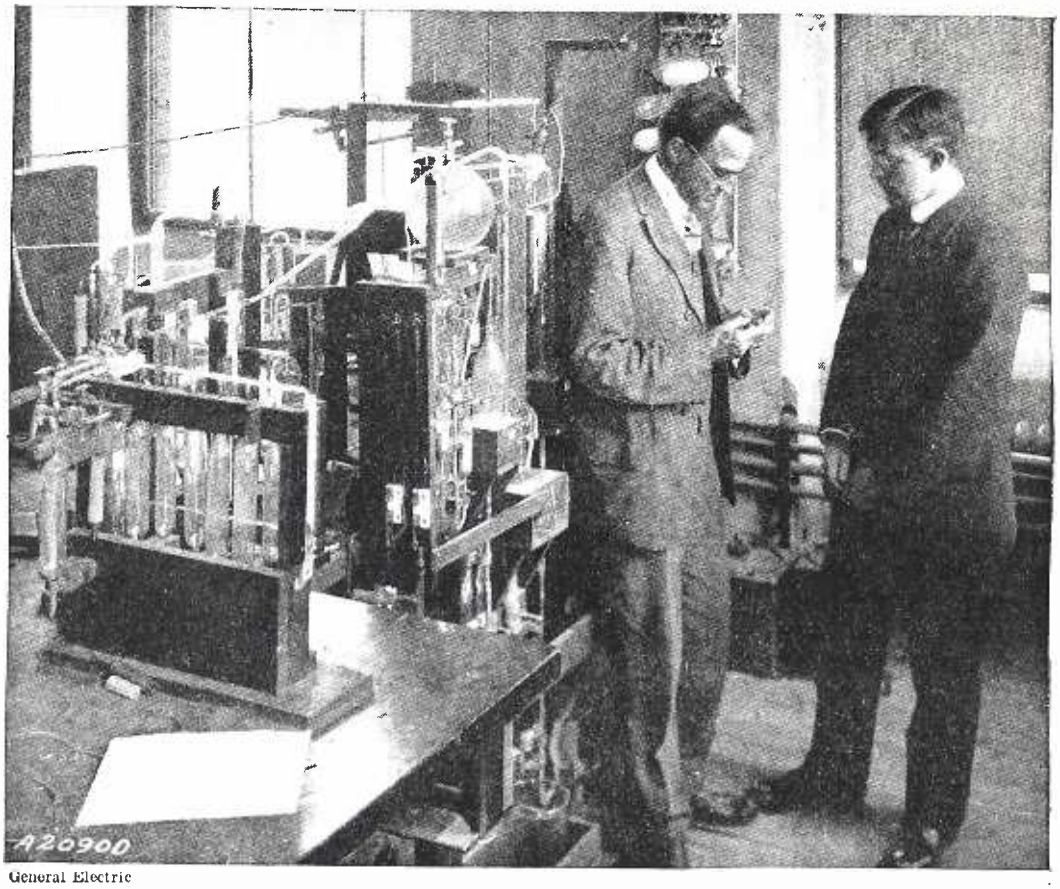
"SPARKS"

The law requires every ship that carries a crew of fifty or more to carry along a radio outfit also. The radio operator is known aboard as "Sparks."

The HOOK-UP NUMBER

Will Be Published Next Month—November

¶ *In response to the demand for diagrams and descriptions of radio circuits—practical, tested hook-ups that the radio novice and the radio amateur can adapt to his own needs*—POPULAR RADIO *will feature this subject in the next issue, November, out October 15th. Ask your newsdealer to reserve your copy for you. Ask him TODAY!*



General Electric

A SCIENTIST WHO CONTRIBUTES TO THE WORLD AN ALMOST-PERFECT NOTHING

Dr. Irving Langmuir (at right), inventor of the Langmuir pump that has removed about 99.999,999,990 percent of air from a tube, and who has thus made possible the high vacuum tubes used in radio. He is conferring with Dr. W. R. Whitney.

The Bottle Filled With .000,000

The Key to the Radio Art Is the Vacuum Tube; the Secret of the Vacuum Tube Is the Vacuum Created Inside of It. This Article Reveals How this Vacuum Is Made

By E. E. FREE, Ph.D.

MODERN radio depends upon our ability to fill a bottle with nothing. The bottle is the vacuum tube. The nothing is the vacuum.

To the layman this seems perfectly simple. You merely take a glass bulb and pump the air out of it. Inside you have a vacuum.

The physicist knows that this is easier to say than to do. For hundreds of years science has been trying to learn how to pump all of the air out of anything. So far science has failed. No one has ever gotten out every last molecule and atom of air and of every other gas. No one has produced an absolutely per-

fect vacuum. Probably no one ever will.

Nature not only abhors a vacuum, but she takes mighty good care that nobody ever gets one.

But science has come very close to a perfect vacuum. After many years of research, after the laborious study and improvement and final rejection of scores of different methods of producing a vacuum, science has come at last close enough to perfection for the practical problem of producing a workable electron tube for radio use. This was done, as it happens, not for radio purposes at all, but in connection with some fundamental scientific researches on the theory of the ordinary incandescent lamp and on the X-ray tube; one more example of the way in which scientific researches undertaken for one object or for no object at all except the pursuit of knowledge, turn out so often to be useful in directions originally quite unforeseen.

This is the story of the present state of this long search for the perfect vacuum, of why high vacua are necessary in radio tubes, of how they are produced, of why a perfect vacuum is so exceedingly hard to get, of how air molecules penetrate into solid glass and then boil out of it as they might out of water, of how this and other experimental difficulties have been fought and overcome. Were it not for the success of the scientists in these researches (partial success though it is) the radiophone as we know it could not exist. You can receive with a crystal but you cannot send with a crystal. Modern radio depends absolutely on the vacuum tube, on some or all of its many uses. And the vacuum tube is possible only by virtue of what science has discovered about vacua and how to get them.

The most perfect vacuum attained so far by any scientist is one in which the remaining gas—the tiny fraction by which the vacuum fails of being perfect—has a pressure of about .000,000,075 millimeters of mercury. The ordinary air pressure is about 760 millimeter of mercury. In this almost perfect vacuum, therefore, about 99.999,999,990 percent of the air has been removed. Less than one ten-billionth of the air originally present has been left.

Scientists and engineers have three common ways of denoting gas pressures. One is the equivalent mercury column, as in the ordinary barometer, and as used above. Another is in pounds per square inch. A third is in "atmospheres," one atmosphere being the normal pressure of the air at sea-level. An atmosphere equals approximately 760 millimeter of mercury, or 14.5 pounds per square inch.

The record vacuum noted, the vacuum of .000,000,075 mm. of mercury, equals approximately .000,000,001,4 pound per square inch, or a little less than one ten-billionth of one atmosphere.

Though this is the measured record it is possible that vacua slightly more perfect than this have been attained in some of the experiments. The measurement of these very low air-pressures is extremely difficult. Ordinary barometers and gauges are useless, and the very delicate instruments which have to be used are not perfectly dependable. It is suspected that they may not have recorded perfectly the lowest pressures—the highest vacua—attained.

But, at the least, a vacuum of about one ten-billionth atmosphere has certainly been reached; it has been reached, indeed, many times. Yet even this extreme attenuation of the air is still far from a perfect vacuum. The evacuated bulb is not really empty. An ordinary vacuum tube for radio use has a volume of at least two ounces, about 50 cubic centimeters. At the highest attained vacuum of one ten-billionth atmosphere a tube like this will still have inside it about one hundred and thirty billion molecules of air—more than eighty times as many molecules as there are people living in the world.

And this tube, with its one hundred and thirty billion gas molecules still inside it, is the emptiest space that anybody has

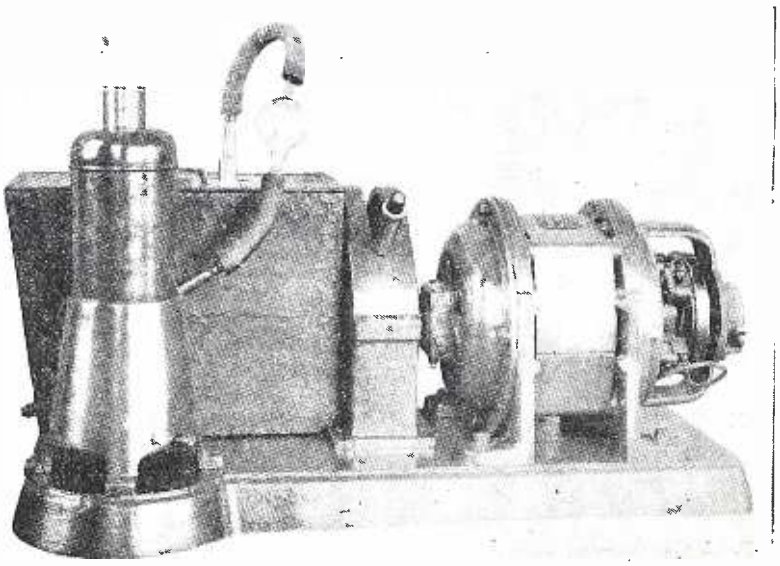
ever produced, the last word of science in perfect vacua. It is the highest vacuum known to man, a vacuum obtained only after years of research and after overcoming the most extraordinary experimental difficulties. And yet, with the best that science can do, there are still one hundred and thirty billion gas molecules inside a tiny two ounce tube. Each man, woman and child in the world could take away, out of this "empty" bulb, a flock of eighty little air molecules for personal pets. Nothing could give you a better idea of the almost inconceivable minuteness of those molecular sizes.

Even in the "empty" bulb the mathematical totals are astonishing. Only those who can remain undizzied on top of the tallest mathematical peaks will dare to calculate how many pet molecules could have been provided from the original air-filled bulb before 9,999,999,999 ten-millionths of these molecules were pumped out and thrown away.

A novel way of getting at the visualization of these staggering molecular totals is due to Mr. L. A. Hawkins, one of the engineers of the General Electric Company. Suppose, he says, each air molecule enlarged to the size of a fine grain of sea-sand, one hundredth of an inch in diameter, the molecules in a cubic inch of ordinary air would make a beach extending from New York to San Francisco, one thousand feet wide and over ten feet deep. This is for a cubic inch, about one-half of the air in an unexhausted radio tube. After exhaustion to the highest attained vacuum there are still enough air molecules per cubic inch to make, Mr. Hawkins calculates, a line of sand grains across the continent; but only a double line this time, only two grains side by

THE APPARATUS THAT ATTEMPTS TO MAKE THE PERFECT NOTHING

The condensation pump, connected with a rotary vacuum pump that runs in oil. This device produces only a moderate vacuum which the Langmuir pump then reduces further to create the very high vacuum.



General Electric

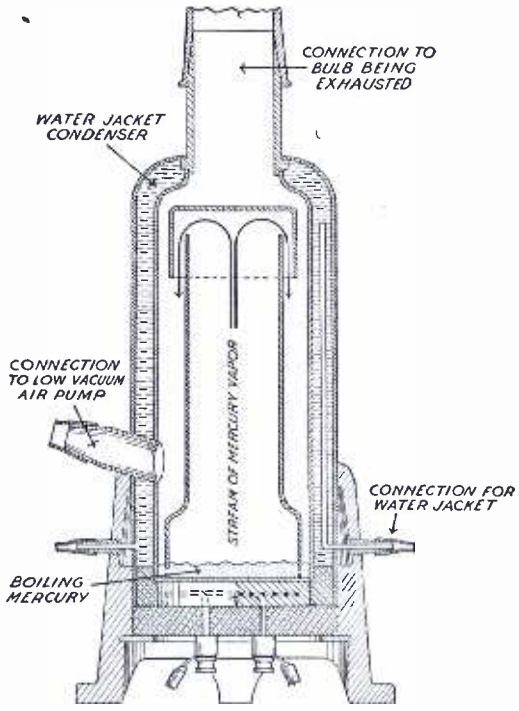
side, instead of the thousand foot beach.

Inside the ordinary commercial radio tube there are many more air molecules than this. The most perfect attainable vacua are not necessary for ordinary work and, because they are very expensive to produce, they are not used. All that is necessary is a good vacuum, a vacuum perfect according even to the scientific standards of twenty years ago, but considerably less perfect than the vacua now attained for important scientific researches. The ordinary commercial tube is exhausted to about .00001 millimeter of mercury, corresponding to about one hundred-millionth of an atmosphere. This means that there are left in the tube about one hundred times as many air molecules as are in the bulb which we talked about above, the bulb exhausted as highly as possible. In the ordinary tube the molecules total over thirteen trillions. But this is still too few to interfere with the operation of the tube.

First, however, let us see why a vacuum in the tube is necessary at all.

As every radio fan knows, the operation of the vacuum tube depends upon electrons, which are little particles of electricity. These electrons fly off from the hot filament of the tube, cross between the wires of the grid and hit the plate. The passage of the electrons causes an electric current to flow between the plate of the filament and the charge on the grid affects the strength of this current. The tube serves, therefore, to detect or to amplify changes in the potential of the electric charge on the grid. Everything depends on the electrons. If they do not fly off properly from the hot filament and pass across to the plate, the tube will not work.

Air molecules left in the tube, or any kind of gas molecules left in it, affect the behavior of the electrons in two ways. *First,* they interfere with the flying off of the electrons from the hot filament. *Second,* they cause what is called "ionization."



THE LANGMUIR PUMP

The device used for creating a vacuum in the tubes used in radio. This diagram illustrates the construction of the metal form of pump.

Proper electron emission from the filament, their continual flying off in sufficient quantity, requires a clean filament, a surface of metal freely exposed for the electrons to get out of. If there is much gas in the tube, some of the gas molecules attach themselves to the surface of the filament and keep the electrons from getting out, much as crawling moths or flies will stick to the surface of an outdoor lamp at night and keep the light from getting out. A little gas in the tube does small harm, just as a very few flies would interfere scarcely at all with the brilliancy of a lamp. And ten or fifteen trillions of molecules is really very few, considering their very small size. Millions of them could crowd together on the point of a needle. In comparison with a molecule, the surface of the hot filament is a broad and empty plain.

Ionization works differently to affect the electron current. When an electron

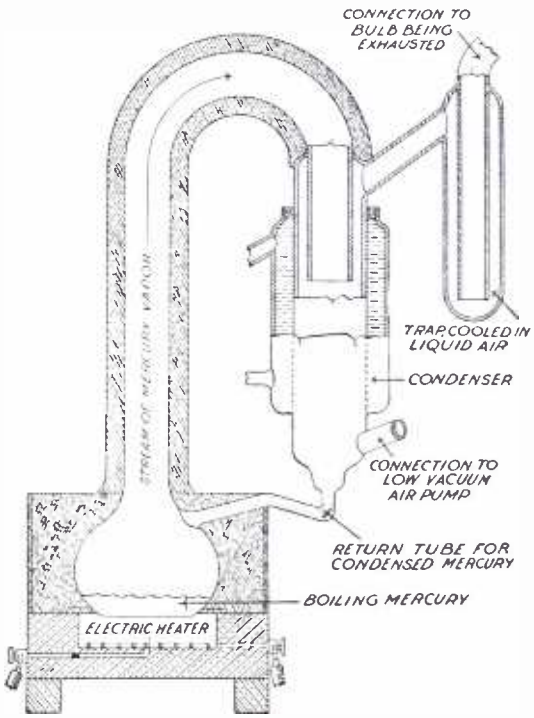
flies off from the hot filament it is moving very rapidly; speeds up to 60,000 miles a second have been observed. In an assemblage of gas molecules such a fast moving electron behaves exactly like a high-power cannon ball in a crowd of people. Presently the electron hits a gas molecule and when it does it knocks the molecule apart. Frequently it knocks another electron out of the molecule, for electrons, remember, are contained in all molecules, in the gaseous ones as well as in the metalic molecules of the filament.

A gas molecule which has been assaulted in this way and has lost one or more of its electrons is called an "ion." From the viewpoint of this article an ion has one especially important property. It carries a predominating positive electric charge, whereas the charge of the electron is negative. These positively charged ions set up, therefore, an electric traffic reverse to the traffic of the electron current. The electrons are negative. They move from the filament to the plate. The gaseous ions are positive. They tend to move from the plate toward the filament. This causes all kinds of confusion. The traffic gets into a snarl and the tube ceases to work properly—to work properly, that is, as a radio detector or amplifier. There are certain other kinds of tubes, such as a rectifier tube, used in changing alternating current into direct current, in which the presence of ions inside the tubes is desirable. Such tubes are filled with nitrogen or with the rare gases argon or neon. But in ordinary radio tubes ions are troublesome; consequently the less gas in such tubes the better they work.

It is not necessary, however, to have absolutely no gas. The few trillion molecules inside the ordinary tube do no harm. They are so scarce, relatively, that the electrons, which themselves are far smaller than a molecule, seldom hit them. The crowd is too thin. The cannon balls go through without doing any real damage. In the ordinary tube there is not enough ionization to do any harm. In the very best vacua there is practically no ionization at all.

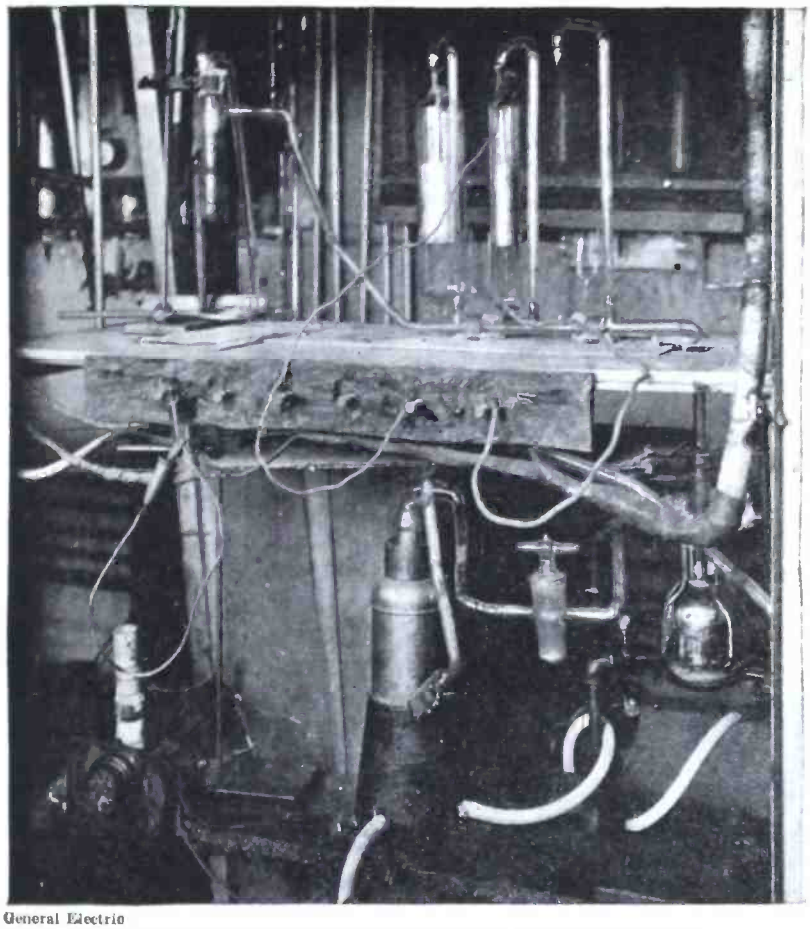
These very best vacua, including the record vacuum of one ten-billionth of an atmosphere, have been made possible by an apparatus developed by Dr. Irving Langmuir of the Research Laboratory of the General Electric Company. It is called the Langmuir condensation pump. The principle of this pump is very similar to that of the ordinary steam injector used to draw water into steam boilers. In these injectors a blast of steam is blown through a nozzle in a pipe filled with water and directed into the boiler. As the steam blows out of the nozzle it picks up some water and carries it along into the boiler.

An analogy which is more familiar, even if not quite so similar in scientific principle, is the way in which water running out of a bathtub will suck the air down with it through the tub outlet. The



HOW THE PUMP WORKS

A sectional view of the Langmuir apparatus for producing the vacuum in the triodes. This form is constructed of glass for laboratory use.



General Electric

MAKING THE HIGHEST KNOWN VACUUM

The Langmuir pump in actual use, creating an almost-perfect vacuum in the electron tubes seen on the work bench. At the right is a thermos flask containing liquid air, to cool the tube connecting the pump and the bulb that is being exhausted.

stream of running water entraps some air and takes it along down the pipe.

In the Langmuir pump, instead of a stream of steam or of water we have a blast of gaseous mercury, of the vapor from boiling quicksilver. This blast of mercury vapor blows out of a nozzle into a glass tube connected to the bulb from which we wish to draw out the air. As the blast of mercury vapor blows along through the tube it takes some air with it, entangles the air molecules in the great crowd of mercury molecules and drags them along. The farther part of the glass tube is kept cold. The hot mercury vapor condenses to liquid mercury and is returned, as a liquid, to the little heater which serves as a boiler. Here the liquid mercury boils away again and supplies new mercury vapor to keep up the blast.

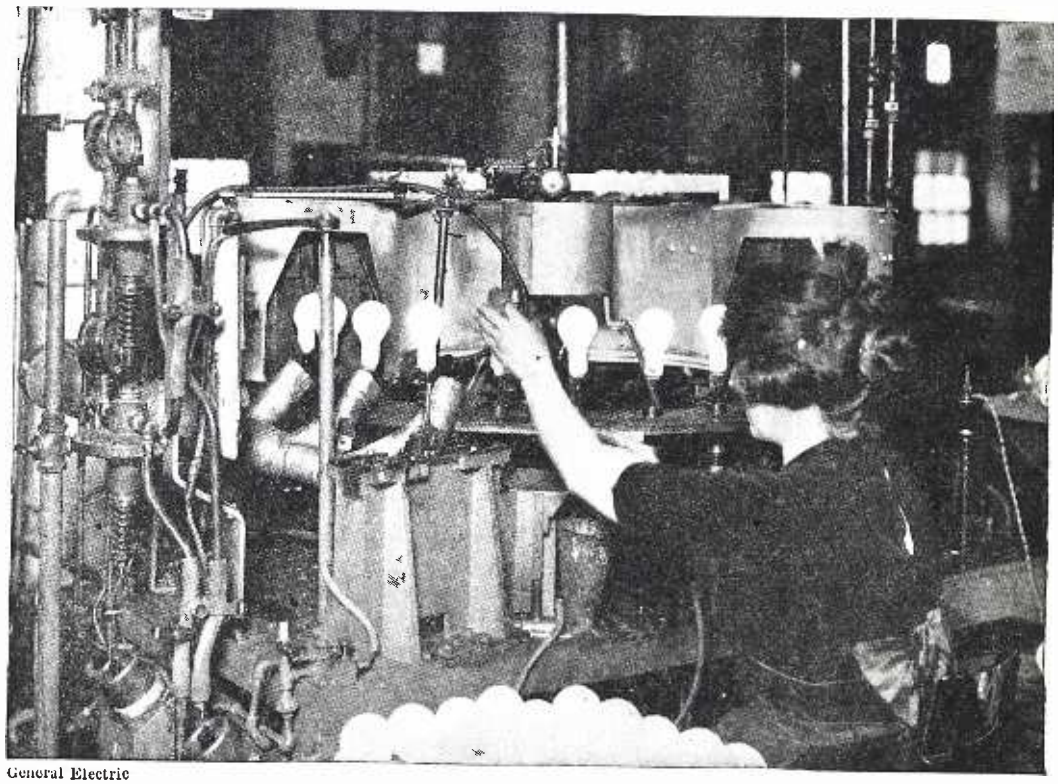
But the molecules of air which were with the mercury do not condense. They have been carried out of the tube and they stay out. They cannot get back in, against the blast of mercury molecules, any more than one man can make headway against a running crowd.

There are some practical precautions necessary in using the Langmuir pump. For instance, a part of the tube which connects the pump with the bulb to be evacuated is cooled in liquid air, cooled to a temperature of about 290 degrees Fahrenheit below zero, or even lower.

This freezes and keeps out any mercury vapor which might otherwise get back into the evacuated bulb and produce in it an atmosphere of mercury gas; for mercury does make a gas, though a very thin one, at ordinary temperatures.

Another great experimental difficulty which has to be overcome in high-vacuum work is due to the gas which is given off from the glass walls of the bulb, from the metal filament and from anything else which may be inside the bulb. The experiments of Dr. Langmuir and of Dr. Saul Dushman have proved that everything contains a great deal of gas. For instance, air will penetrate into solid glass, into solid metal, into nearly everything else. Physicists call this gas *adsorbed gas*. When a glass bulb is evacuated this adsorbed gas comes off slowly—boils slowly out of the glass or metal or whatever is inside the bulb. It may take days or weeks for all of this gas to come out. Indeed, it is probable that it never *all* comes out, that a little of it is always left —inside the solid matter of the glass or metal.

Of course this adsorbed gas, as it comes gradually out of the glass walls of the bulb, spoils the vacuum in the bulb. To get around this, the bulb, the filament and everything else is heated in a furnace as hot as it is possible to heat it without softening the glass. While hot, the bulb is exhausted by the pump. This is repeated many times until as much of the adsorbed gas as possible has been cooked out. Even then they never get quite all of it. A little will come out later for months, probably for years. This is one reason why an absolutely perfect vacuum has not yet been attained.



General Electric

CREATING VACUUMS IN THE LITTLE BROTHERS OF THE RADIO TUBES

On this rapidly moving machine ordinary lamp globes are exhausted on the turntable that carries them through the oven; as they come out (at left) they are cooled by three blasts of air.

These are some of the ways in which Nature fights against the perfect vacuum. So far Nature's efforts to prevent man from attaining the perfect vacuum have been successful. But there is one way in which Nature helps. This is the phenomenon called the "clean-up."

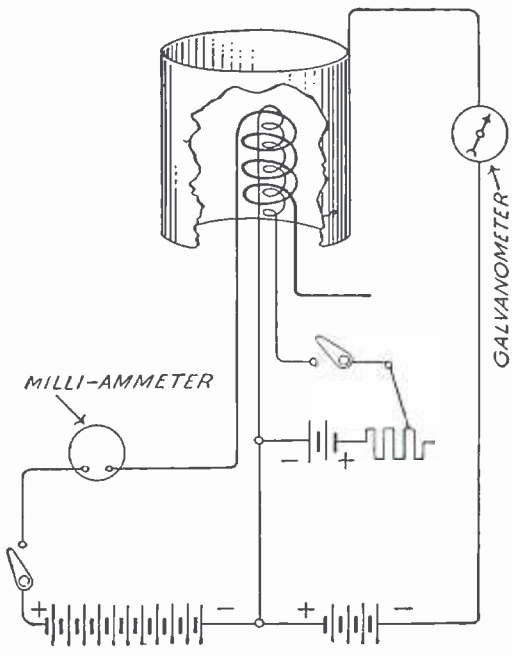
It was observed years ago that when a tungsten-filament electric lamp, like an ordinary mazda lamp, was burned for a while the degree of vacuum inside the lamp globe increased. Some of the air which had been left in the globe when it was made disappeared on use. The gases were "cleaned up"; hence the name of the phenomenon.

The scientific reasons for this clean-up have now been investigated. There are believed to be several ways in which it happens, in which the gas molecules are got rid of. Some of the molecules combine chemically with the metal of the filament, others with the materials of the glass wall or of something else inside. Many of them, Dr. Dushman thinks, are ionized by collision with electrons and are then shot off so violently, either by the mere collision or by electrostatic repulsion, that they penetrate deeply into the glass wall of the bulb and stay there, just as a bullet shot against a plank will go in and stick. Some of these ionized molecules may be shot at the glass wall of the globe so fast and so powerfully that they go clear through into the outside air and get away altogether.

The clean-up helps us toward a perfect vacuum; but it has not, as yet, enabled us actually to attain it.

Will science ever attain a perfect vacuum? What can we expect from continued research? Science is accustomed to hope and try for absolutes; the perfect conductor, the absolute zero of temperature, the ultimate particle of matter. Can we look forward to the attainment of an absolutely empty space?

Who knows? Recently there came prospect of help from an unsuspected quarter—from the Army's investigations

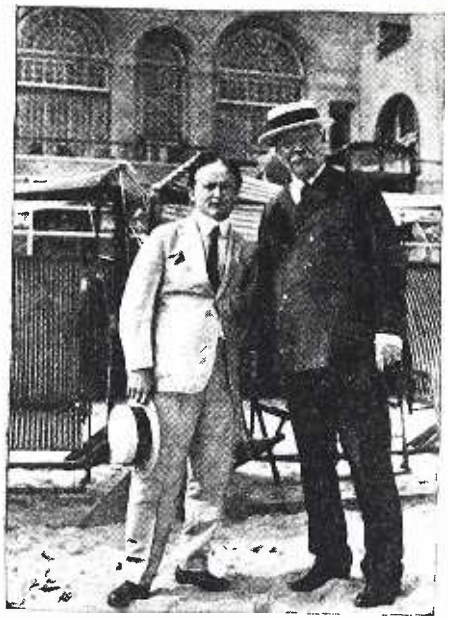


HOW GAS PRESSURES ARE MEASURED

Connections for the ionization gauge used in measuring small gas pressures. Electrons are produced by the inner hot-wire filament and pass across to the outer filament; these electrons ionize the gas in the tube and the positive ions are collected by the surrounding molybdenum cylinder. The number of positive ions is measured by the galvanometer and is proportional to the number of gas molecules in the tube.

on gas masks. An essential part of the gas mask was the powdered charcoal contained in the little tin box called the canister. The duty of this charcoal was to absorb certain of the poisonous gases. It was found, in studying this, that charcoal absorbed all gases, and the scientists of the Chemical Warfare Service were able to prepare, before the armistice, certain special kinds of charcoal which were hundreds of times better as gas absorbers than ordinary charcoal is. These special charcoals have been tried by Dr. Dushman as means of removing the last trace of gas from high vacua. They promise to work very well.

Perhaps something of this sort, used in connection with the Langmuir pump, will give us before long a still nearer approach to Nature's traditional abhorrence, a space containing nothing at all.



From a heretofore unpublished photograph

←Sir Arthur Conan Doyle, the famous spiritualist, and Harry Houdini (professionally known merely as "Houdini") are close friends—as this snapshot indicates. "I respect Sir Arthur for the sincerity of his beliefs in spiritualism," states Houdini. "But I do not share them."

Ghosts that Talk —by Radio

An Exposé of Some of the "Spiritualistic Phenomena" Perpetrated by Fraudulent Mediums for Getting Money from Their Credulous Followers

By
HOUDINI

The author of this article is the president of the Society of American Magicians. All the members of that exclusive organization are pledged to keep inviolate the tricks of their profession—except when those tricks are used for dishonest purposes. Houdini (who in order to study "spiritualistic phenomena" once entered the ranks of the professional mediums himself) properly considers those mediums dishonest who claim that voices transmitted by confederates by low frequency induction or "inductive radio" are the voices from the dead. He is, accordingly, as a public duty, disclosing in this article how these tricks are performed.

MAGICIANS have used the radio telephone in their performances for several years—long before radio was generally known to the public. I am not at all surprised that the radio is being used by fraudulent mediums to convince their patrons that they are in direct communication with the dead.

I regret profoundly to admit that in over thirty years of investigation, during which time I have attended hundreds of seances with a mind ready and eager to discover some sign from those who have gone to the Great Beyond, I have never witnessed anything that I could accept as evidence that there was life beyond the grave. All the "evidence" that I have seen is merely phenomena that are well known to the average magician. What are "wonders" to the average human being are merely everyday tests that are familiar in the profession. In performing some of these experiments I have myself seen men and women faint away, overcome with what they thought were supernatural occurrences. As a matter of fact I was merely performing more or less common tricks.

The passing away of my mother first started me on a serious investigation of the doctrines and claims of the spiritualists. Only those who have lost their loved ones can know the fervor with which such investigations can be pursued. There is no sacrifice I would not make to be able to get in communication with my mother. After years of research I still hope that there is a way of communicating with her from this life. But I have no faith in the existing forms of communication as known to mediums or practised by them at the present time.

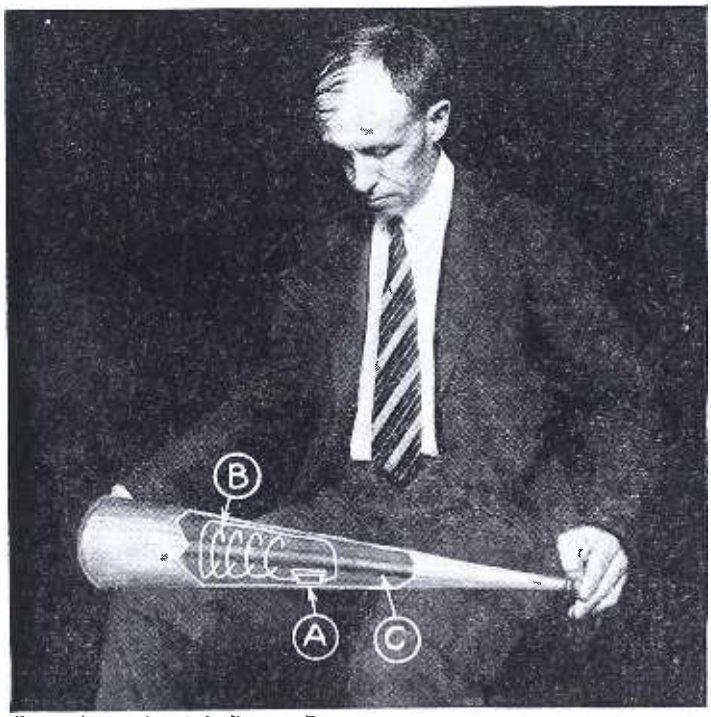
There is not the slightest doubt in my mind that such men as Sir Oliver Lodge and Sir Conan Doyle are sincere in their beliefs. They regard spiritualism as a religion; to them it is something sacred. They think that the evidence they have

obtained is sufficient evidence to justify their faith in their "communications" with those who have passed beyond. I respect them for their sincerity. But I do not share their beliefs.

I have made definite compacts with seven intimate friends and relatives to the effect that the one who died first would communicate with the others. All of my seven friends are dead. Up to the present time I have not received the slightest sign from any of them. In order to get into communication with them I have gone to seances conducted by famous mediums. Yet I never received any sign that was not obviously a trick on the part of the medium—a trick with which I was thoroughly familiar.

The human senses are easily deceived. People believe what they want to believe. The human being is always seeking something in which he can put his faith. A combination of deception and faith is capable of leading human beings to almost any extreme of self-delusion. It is the business of the mediums to capitalize this faith.

I exposed a medium in Bochum, Germany, twenty years ago by throwing ordinary carpet tacks under his bare feet when he came out to the audience in a dim light and posed as a spirit from another world. Today I would need a radio receiving set to uncover his latest deception. Before attending this seance I had been repairing one of my cabinets and had a number of tacks in my pocket. I casually threw them on the floor before the curtain in front of the opening whence the ghost of Cæsar was to appear and lecture. The medium who impersonated Cæsar stepped upon the tacks and burst forth into a profusion of German oaths.



From a photograph made for POPULAR RADIO

THE FAMILIAR TRUMPET OF THE SPIRITUALIST MEDIUM

Only in this case the instrument is fitted with (A) a telephone receiver that converts the received current into sound and (B) a receiving coil that collects energy from the transmitting coil, which may be hidden some yards away—all concealed in false sides. (C) is the orifice through which the voice issues. The medium's confederate may be located several yards away.

Radio has given the "spirit business" an enormous boost in the last few years. While the rest of us have just been getting acquainted with it, many of the so-called psychics have been reaping a harvest.

I love an honest-to-goodness trick that mystifies and entertains me. It is my business to know them all and to try to perform them better than other magicians. As President of the Society of American Magicians, numbering over 1,000 members, it is my duty to hold such tricks; indeed, we have all taken an oath not to reveal them. But concerning the deceptions of fraud mediums—that is another matter. I regard it as the duty of every thinking man, whether or not he believes in spirits, whether or not he believes in God, to expose imposters who profane the concepts of future life merely to extort money from believing souls who in their ignorance misplace their confidence.

A total of $300,000 was extorted by one clever medium from Luther B. Marsh (the law partner of Daniel Webster) in 1888 by the use of a primitive radiophone. Her name was Ann O'Delia Dis Debar, and she made a spectacular career for herself until she was exposed in court by Alexander Herrmann and Carl Hertz.

There have been countless other swindles through the invention which has been practically unknown up to the present time. The device was little more than ordinary telephone by induction in most cases, but in the more intricate deceptions the principles of modern wireless telephony were employed.

I have the largest library of magic in the world. It was while trying to buy books that I read of the auction of a well-known medium in New York, and the day before the sale I bought all of her books and bound volumes of the publication, "Medium and Daybreak." I was shown a kettle, and as I knew that the kettle was used by mystifiers, bought this also.

The device was a "talking kettle." When the proper "spiritual connections" had been established by the medium, through her facial and bodily contortions in the approved "psychic manner," the kettle became most intelligent. Anyone in the room could ask the kettle a question and receive an intelligent answer at once by placing the spout of the kettle to his ear. The answer would come in a whisper, a most ghostly whisper, such as is familiar to those who have attended spiritualistic seances.

That same kettle is now installed in my home and it talks to my friends in the same kind of whisper with absolutely no change except the replacement of the battery. Sane men of prominence in public life, men who should by all means suspect me of trickery, have actually been deluded by this simple device.

There is no doubt in my mind but that I could cause a great many people to believe that spirits speak through the medium of the kettle; in this way I could merchandise spirit messages for substantial sums of money.

The kettle can be handled and carried about the room while it is whispering, turned upside-down and otherwise explored.*

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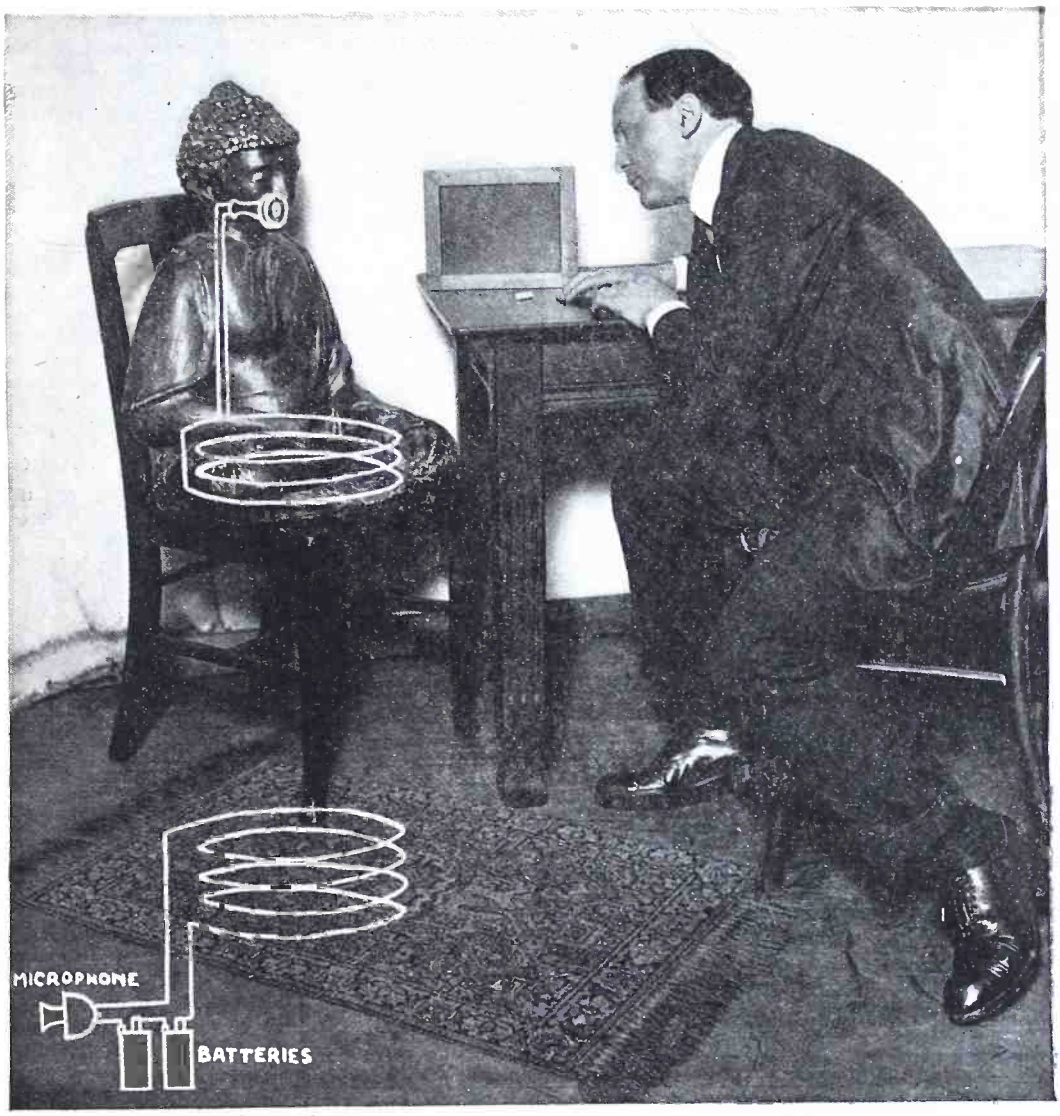
*While the author does not feel at liberty to describe the operation of this kettle, the explanation of it is obvious. The secret lies in the radio receiving apparatus that is concealed in its hollow walls. The kettle is made of *papier-mâché*, so that it will not absorb the radio waves which are intended for the aerial coiled inside. The medium who operates the kettle or similar radio device must have a confederate in an adjoining room, who hears everything through a sensitive microphone concealed in the room where the seance is held.

One of the best devices for concealing such a microphone is an oil painting, a painting made on gauze rather than canvas. By placing a deep shadow box over the picture the thin gauze is made to look like canvas. The shadow box acts as a resonator for the sounds in the room and the thin gauze enables the sounds to pass to the microphone with but little obstruction.

The confederate in an adjoining room may thus hear every question that is asked in the room and make his replies by radio. The transmitting wireless instruments are placed in the room with the confederate, but the transmitting antenna is concealed in a rug directly beneath the kettle. This arrangement makes it necessary for the radio waves to travel only a few feet to reach the receiver in the kettle, so that not much power is required for transmitting.

With modern improvements in radio, the kettle may be carried to any part of the room, and with the sensitive microphones they are making today, the slightest whisper can be heard by the confederate who may be elsewhere in the building, or even at some distant point.—EDITOR.



From a photograph made for POPULAR RADIO

ANOTHER COMMON "PHENOMENON"—THE TALKING IMAGE

The voice of the medium is transmitted to the confederate in another room by the ordinary microphone. The confederate's reply is transmitted into another microphone that is connected with a transmitting coil concealed in a rug (or other object). This energy is collected by the receiving coil in the statue and is converted into sound waves by the telephone receiver concealed in the image's head.

Sometimes my friends ask questions in such a low tone of voice that I cannot hear them; they are, accordingly, completely converted to the belief in spirits when the kettle answers. This "spirit-talking" kettle has been used by mediums for years; it is the invention of David Abbott, who devised it for purposes of entertainment only.

To the best of my knowledge the first application of the principles of radio to spiritualistic manifestations was in 1852, when Jonathan Koons, a farmer of Dover Village, Ohio, installed a "spirit machine"—described as a "crude structure of zinc and copper for localizing and collecting the magnetic aura."

This radio telephone trick is per-

From a photograph made for POPULAR RADIO

THE "SPIRIT" LISTENS AND SPEAKS

The ears and mouth of the "talking" objects are merely microphones in the hands of the medium's confederate—who may even be in another building.

formed in many ways. Statues of Buddha are among the popular bits of property employed by mediums; they are made to answer questions as glibly as hollow balls and trumpets.

In my collection of old clippings from magazines and newspapers, I find a description of the trick reported in the *Gazette de France* some years ago. The pages are yellow and the printing is old fashioned. The story concerns "The Invisible Girl" who mystified all Europe. To quote the article:

> In a small chamber in this house is seen a chest of white glass suspended from the ceiling by four little chains, which keep it perfectly separated from every other thing. This chest is transparent and penetrable to the eye in its whole extent. To one of its extremities is adapted an opaque tube or horn, by which a voice is heard; the voice appears to be that of a young girl, who replies distinctly to every question put to her.
>
> The impression of breathing and the heat of the air of respiration (impregnated with the odor of liquors which she has taken) are also perceived.
>
> I thought at first that this voice was that of a ventriloquist, and that it was the voice of him who showed the curiosity. But on the morrow my astonishment was extreme, when this pretended ventriloquist went out of the chamber with another, and, when I put new questions with a voice so low that I was not heard by any of the other spectators, to find that the replies were perfectly applicable and well articulated.
>
> If it be said that magnetical or electrical virtues are introduced for some purpose in the operation, we would ask how it happens by any of these virtues that the Young Invisible sees and names, without ever being deceived, the object which is held in the hollow of the hand, such as a piece of silver, the surface of which is held up to the orifice of the tube in such a manner that these objects cannot be perceived from any other point.
>
> We concluded that perhaps there was in the chest a really invisible girl, a dwarf much smaller than that of the King of Poland. This dwarf died in 1764. A wooden shoe served it a long time for a cradle. At six years old it was 15 inches high, at sixteen years it was 29 inches high. History speaks of a dwarf who at thirty years of age was only 18 inches high. It belonged to Queen Henrietta of France.
>
> If this is the fact, the dwarf must be only from twelve to fifteen inches in length and above five or six in thickness, this being all the space of the chest which cannot be seen, it being behind the communicating tube.
>
> The questions we put to the Invisible Girl and the replies which it made are as follows: *What age are yow?* "Fourteen." *Where were you born?* "At Marseilles" (she has an accent absolutely provincial). *What is your name?* "Francoise." *Are you pretty?* "No." *Are you good?* "Yes, though sometimes ill-natured." *What is your position in this chest?* "I am reclining." *Do all the questions which are put to you disgust you?* "Never, but I am sometimes very much wearied."
>
> Although I could not discover the solution of the mystery, I would rather believe it to be a dwarf than any other thing.

This ancient and sceptical reporter would not believe the invention to be magical, but if he were living now, a good medium could make him think it spiritualistic. In reality the "Invisible Girl" was a full-grown woman.

A description of this trick is illuminating as illustrative of the methods of the fraudulent mediums even in those days. John Wyman, one of our well-known old time magicians, copied it from an early publication and put it in his book which was published in 1851. The device consisted of four upright posts, united by bars or nails at top and bottom. From the corner posts four wires bent in ogee form converged and terminated in a crown ornament. From these wires a hollow copper ball about one foot in diameter was suspended by four short, slender ribbons. The ball thus suspended was fitted with four copper trumpets pointing at right angles, with their bells directed to the side top-bars. The ball was simply hung in space by the ribbons, and trumpets were fixed in suspension along with the ball. The voice was conveyed to the flaring bells of two of the horns by a speaking tube concealed by one of the corner posts; then at right angles along the top bars to points directly at the center of two trumpet bells.

Questions were asked by spectators, who spoke into the bell of a trumpet which conveyed the message by the speaking tube to the lady assistant concealed in an adjoining room. Her answer was conveyed back by the same speaking tube. The voice was weak in volume and discernible only to those listening attentively at the four trumpets. The effect was that which might conceivably come from a small "Invisible Girl." The woman confederate was in a side room with a peep-hole through which she was able to see her dupes and make pert remarks about them. A signal system was also operated between the "person who attended the machine" and the concealed operator. The whole "machine" was so simple in construction that it appeared perfectly portable and movable to any part of the room.

It is interesting to note that as far back as 1784 mediums were using various means of transmitting the voice for

From a photograph made for POPULAR RADIO

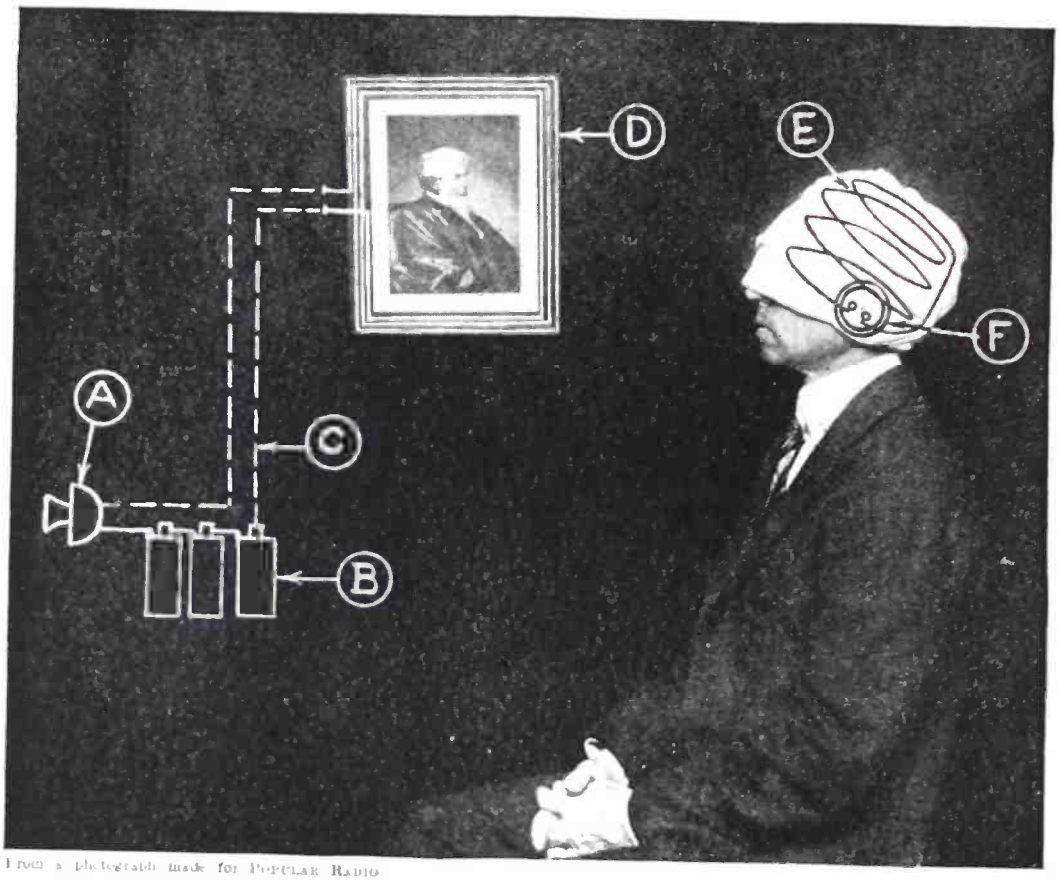
THE SECRET OF THE KETTLE

The receiving coil hidden in false sides collects the energy sent out from a transmitting coil that may be several yards away, and this energy is converted into sound by the telephone receiver in the spout.

mysterious effects. Radio has vastly increased their facilities.

The fraudulent mediums today are merely using various adaptations of the "Invisible Girl." Instead of being in an adjoining room she is now so far away that she cannot hear the questions asked without the aid of a microphone concealed in the wall. Even at a considerable distance an opera glass, properly focused on the spot, serves the purpose of the peep-hole.

With an induction coil coupled in the circuit with her telephone transmitter and batteries, she now sends out strong enough impulses to affect the sensitive receiver with a loop aerial concealed inside the horn. This was, indeed, the first form of radio telephone. It employed the same principles of induction



From a photograph made for POPULAR RADIO

IN COMMUNION WITH THE "SPIRITS"—PLANTED IN ANOTHER ROOM

Still another variation of the inductive radio trick. (A) is the microphone into which the distant confederate talks; (B) are the batteries that furnish current over the concealed wires (C); (D) is the transmitting coil concealed in a picture frame; which transmits the energy to (E), the receiving coils, that are connected to (F) the telephone receiver over the medium's ears.

without wires as the modern complicated radio apparatus, and it worked almost as well over a distance of a hundred feet or more. The trick is a pretty one and would do credit to any magician, but it has fallen into the hands of unscrupulous psychic performers and consequently, because it is used for getting money under false representations, it should now be exposed.

With more modern apparatus and the pretense of spiritual communication, this simple illusion is now deceiving thousands and defiling the concept of life after death.

Perhaps you who are reading this article may attend the seance of a medium as clever as the woman who became nationally famous as a result of her work one evening in a western city. While she was in the midst of her communion with the shades of those present, she stopped short.

"I see a man murdered!" she exclaimed. Then she described a violent death scene, giving the name of the man and the address in the city where he was actually murdered a few minutes before she received the "spirit message." The newspapers confirmed her statements and later spread her fame throughout the country.

From that time on people paid ridiculous prices for her services—until she was exposed.

The secret of her spiritualistic demon-

stration was simple. A radio antenna in the sole of her shoe received impulses from a transmitting antenna in the rug upon which she stood, and conveyed them to a sensitive head phone hidden in a large bouquet of flowers on her shoulder. A reporter had telephoned the news of the murder to her confederate behind the scenes, who transmitted it by radio telephone. The receiver concealed in the flowers was not loud enough for the audience to hear, but when the medium leaned her head upon the flowers she could hear it distinctly.

Her feat was a blow she had been aiming at sceptics for some time. She had placed her reporters at police stations, hospitals and newspaper offices to wait for the news of a death by violence which would receive space in the papers.

You understand this particular type of medium now, and are sure you will not be fooled—but suppose you should meet the statistician-medium? She wears a phone over one ear and a complete aerial and receiving set is concealed beneath a heavy wig, or it is concealed in her hair.

She stands under a chandelier which hides the transmitting antenna, or perhaps walks near a picture from which the radio waves issue. If she is a good radio engineer, she may have a set so sensitive that she can place her transmitting antenna in another room. Your name rolls off her tongue, as soon as you enter. She tells you all about yourself, she seems to know as much about you as your intimate friends.

"Your mother will be here shortly," she remarks, casually, although you had not told her your mother was dead and that she was the one you wished most to be near.

Many a man has fallen a victim of such mediums, for he had no way of knowing that confederates had looked up his history while he was waiting for the interview, and telephoned it *via* radio. The medium offers proof that he or she has not left the room to receive information, and thereby he gains a few more gullible customers for his illicit traffic.

A few years ago, while going to Europe on the *Imperator,* I was asked to entertain with an informal seance. I had for my guests Theodore Roosevelt, Victor Herbert and other prominent men. Roosevelt wanted to know if I could tell him where he spent his last Christmas Day. I had a slate with a "spiritual" covering, and in a few moments, with the slate apparently before their eyes continuously, a map appeared upon it, made with a dozen colors of chalk. It indicated the exact spot where he had been on the "River of Doubt" and was a duplicate of the map he intended soon to publish in a book. The name of W. T. Stead, the English writer lost on the *Titanic,* was signed below the map; it was recognized as Stead's own signature. I had never seen the map and I was unacquainted with the signature.

"Is that really spirit writing?" Roosevelt asked with deep concern.

I am sure I could have won his confidence by this slight test. But I replied:

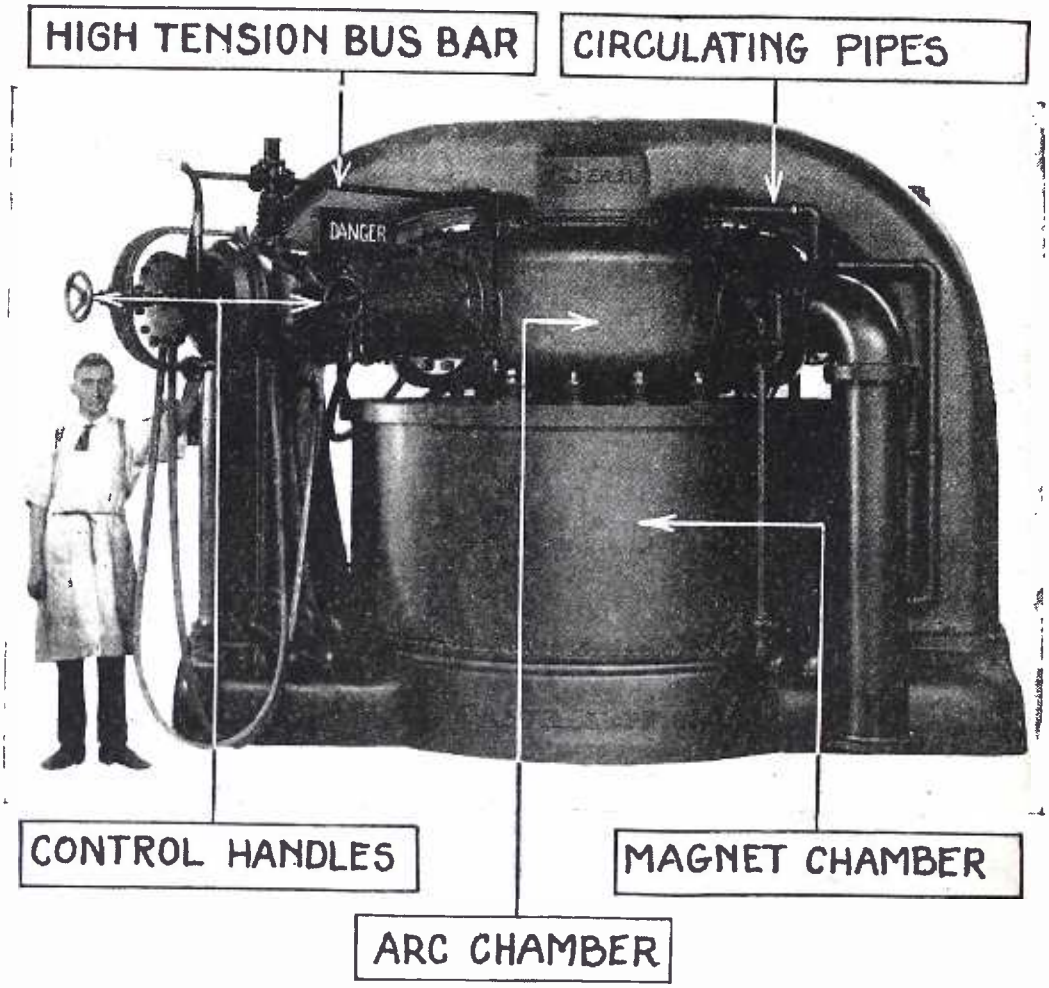
"No, I am simply a mysterious entertainer. Everything I do can be explained by natural means as illusions."

When it is so easy to deceive a highly developed mind, it is easier to fool ordinary people, and especially those who are anxious to believe.

In many instances self-hypnotism is the secret. The medium suggests things, catches the mind off guard, and the moment after it has been surprised he follows up with something else which carries the intelligence along even against the will.

Radio at present is the greatest aid to the fraud mediums, and they are sure to take advantage of every new development. I hope that spirits will talk to us through radio instruments some day, but I will prefer to hear such messages in a scientist's laboratory rather than through the presentations of unscrupulous mediums.

If there are mediums who are not fraudulent, I have yet to see them.



THE GRANDFATHER OF ARC TRANSMITTERS

This huge arc converter has long been used in trans-Atlantic telegraphy. It employs 1,000K.W. of power—ranging from 200 to 500 times as much as is used for the new type of transmitter described in this article.

THE NEW AND COMPACT

"Panel Arc Transmitter"

By CHARLES R. LENTZ

THE first arc transmitters designed for use on ships were cumbersome affairs, as every experienced marine radio operator knows. They occupied as much space as the first spark transmitters. The old arc chambers were designed on a generous scale, and with the auxiliary equipment just about filled the all too limited space of the vessel's radio cabin.

This unwieldy apparatus is now being replaced by a new and compact machine known as the panel transmitter, which can be included in a space 6 feet high on a floor space measuring only 24 by 20 inches for both the 2 K.W. and the 5 K.W. sizes.

This space may include the motor generator, but it does not provide for the water cooling tank or for the lightning switch.

As the result of practical and persistent experiment, an apparatus has been developed that is automatic in its operation; to switch from sending to receiving is but a matter of pressing a lever.

The auxiliaries and motor generator are designed for a 110-volt direct current supply, the usual source aboard ship, while the radio frequency portion is designed for an average ship antenna that has a capacity of approximately .002 mfd., with an average fundamental wave length of 440 meters and a high frequency resistance of 6 ohms at 600 meters.

Four wavelengths can be used by adjusting one switch, the transmitters generally being adjusted to 600, 1800, 2100 and 2400 meters. However, the 2 K.W. units have one high wavelength less than the 5 K.W., and provision is made for a 300-meter instead of the 2400. This is required by law.

For receiving with non-oscillating equipment, a modulating device is used which allows damped wave transmission at 300 and at 600 meters.

As shown in Figure 1, the upper panel is confined as far as possible to high frequency apparatus and leads. The open section in the center carries the arc chamber, the gas pressure regulator, the modulating device, the water pump and the carbon rotative mechanism; the two latter mechanisms are driven by the same motor. The lower control panel contains all the low tension and high tension direct current devices and leads.

Figure 2 shows a complete schematic wiring diagram of the transmitter and its auxiliaries. The ship's mains are brought to the panel through the main fused switch.

After the set is wired, and with the Send-Receive switch turned to "send," operations may proceed as follows:

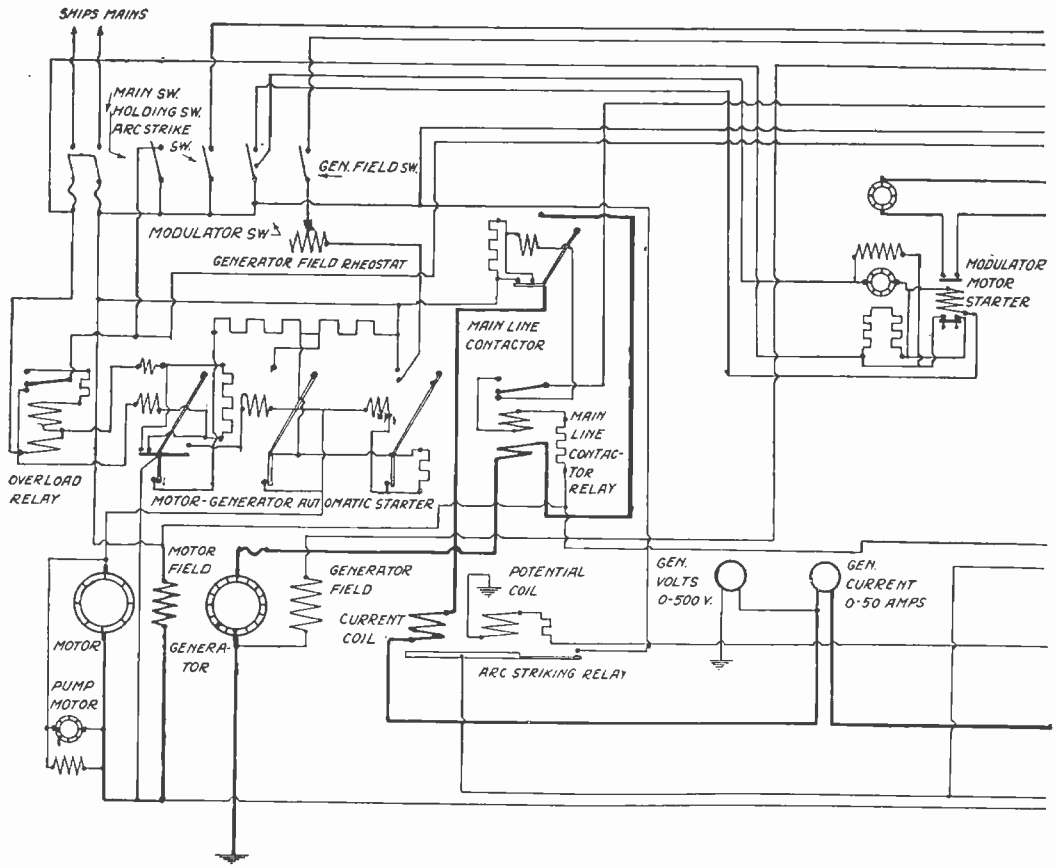
1. The motor generator is brought to full speed by the automatic starter, which is of the current relay type.
2. The generator field circuit is closed.
3. The main line (generator) circuit is closed.
4. The water circulating pump and the rotating carbon device are started.
5. The potential coil of the arc striking relay operates, closing its secondary contacts; this in turn closes the circuit to the arc striking solenoid.
6. Before the cathode (carbon) is drawn in to strike the anode, the starting resistor is connected in series with the arc and with the generator.
7. As soon as the arc is struck, the hydro-carbon magnetic needle valve automatically operates and the cathode slowly draws away from the anode, the proper action being regulated by an oil dash pot. At the same time the current coil of the arc striking relay predominates over the potential coil and the secondary contacts of the relay open again, allowing the cathode to withdraw from the anode. Again the starting resistor is shorted, and the arc is allowed to draw full power.

It is hardly necessary to describe the action in the high frequency circuit; the arc is of the Poulsen type and has been well covered in a number of text books.

In the 110-volt leads an overload relay is provided; when the current in the circuit is abnormal it flows through the current coil of the relay and this draws up an armature, breaking the circuit. The armature is held by a potential coil and cannot be released without disconnecting the ship's mains from the panel.

A relay similar to the overload relay is inserted in the generator leads, but in this case an overload opens the main line contactor (solenoid type), and this opens the positive side of the generator line.

The normal full load voltage of the 5 K.W. unit is 375 volts, variable by a generator field rheostat, and the normal full load current ranges from 12 to 15 amperes. Meters are provided with read-



ings in generator volts and amperes; the product of these two readings gives the arc input in watts.

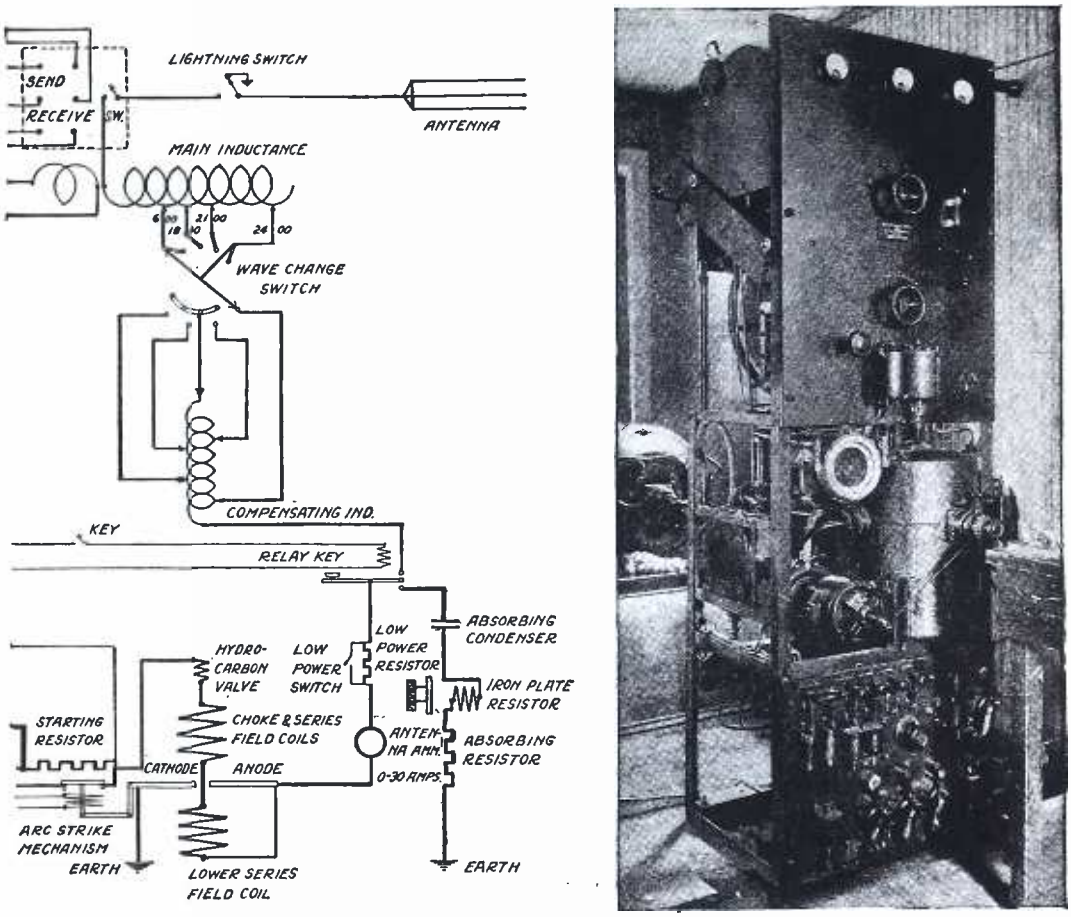
A radio frequency meter ranging from 0 to 30 amperes for the reading of antenna current is also provided. At 1800 meters a fair antenna current would be 18 amperes, assuming a 5-ohm high frequency resistance for the antenna. The antenna input would be of approximately 1620 watts, with an arc efficiency of approximately 30 percent.

The arc chamber is cast in two pieces. These are split about one-third of the way down, and in them are screwed the pole pieces. A watercooling duct of one complete turn is cast in the main chamber section.

The field coils are wound in four sections, one in the upper portion and three in the lower portion. They are wound with square cross-section asbestos-covered copper wire, and are connected in series. Additional insulation in the form of empire cloth insulation is provided between coils and chamber.

Connected directly with the chamber, and at ground potential, is the cathode, its distance from the anode, or arc distance, regulated with a control handle. The cathode holder can be removed instantly from the chamber, and a new carbon may be inserted without tools.

The anode is, of course, insulated from the chamber. It consists of a solid copper tip held by a large copper tube. Within the large tube is a smaller one, also of copper. The water from the cooling system enters through the small tube, plays directly on the solid tip and returns through the large tube. Then it goes through the one-turn duct in the chamber back to the cooling tank and from there to the circulating pump. During a period of continued use, carbon will collect in the arc chamber; this may be



WILL THIS NEW TYPE OF APPARATUS REPLACE THE SPARK TRANSMITTER?

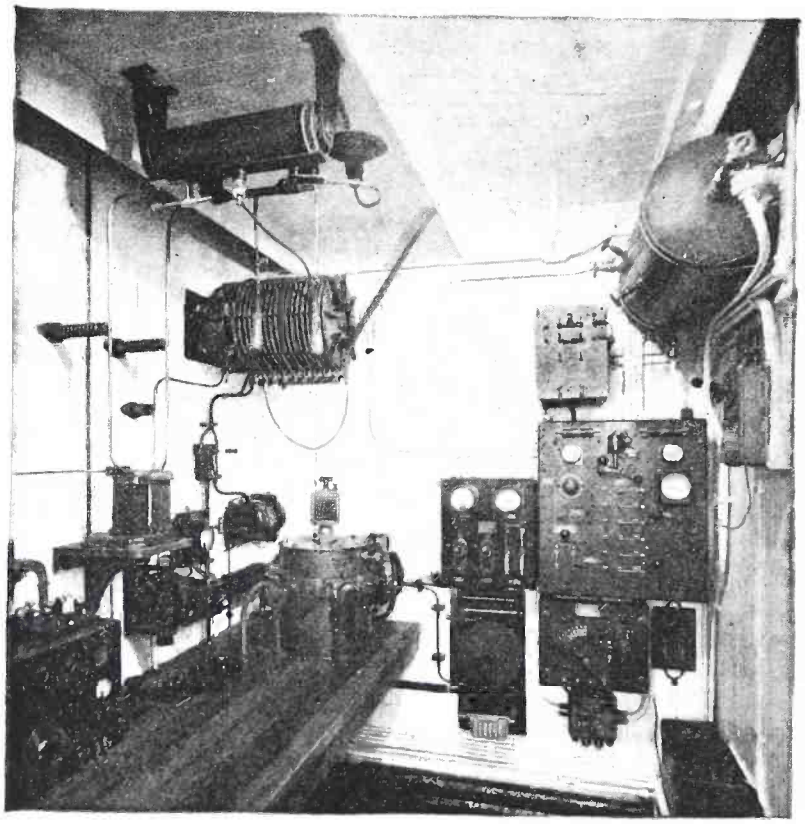
Diagram of apparatus wiring and picture of the new type of arc transmitter that bids fair to replace the troublesome spark transmitter now commonly used for ship-to-shore communication. The set can be used on low wavelengths and can transmit either continuous waves or modulated continuous waves by merely turning a switch. The modulated signal has a musical note of a frequency of 400 cycles a second. The set is capable of transmission over long distances.

cleaned out when the anode is removed.

Hydro-carbon is supplied to the arc by vaporizing alcohol; when the alcohol drips on the hot electrodes it automatically vaporizes. The pressure of the gas in the chamber is kept constant automatically by a regulator that has a diaphragm similar to that in an ordinary gas meter, and poppet valves are provided to prevent dangerous explosions. It has been found that when this gas is supplied to the arc it tends to keep the oscillations stable and allows the arc to handle a greater amount of power.

Unlike the high-powered arc transmitter, this set does not emit a "compensating wave." Signalling is accomplished by switching the anode terminal from an absorbing circuit to the antenna circuit, and when the key switches the anode lead the anode must always be connected with either or both of these circuits in order to sustain the arc.

The absorbing circuit consists of a condenser, a resistor, and an iron plate resistor, the complete circuit having approximately the same characteristics as the average antenna.



THE ORDINARY ARC TRANSMITTER INSTALLATION ON SHIPBOARD

The apparatus in this case is a 2 K.W. arc transmitter on the U. S. S. VULCAN. *The cabinet in the lower left corner contains the receiver; all the rest of the apparatus scattered about the cabin are the various parts of the arc equipment. Contrast this arrangement with the compact arrangement shown on page* 111.

The iron plate resistor is a variable unit, and it is possible to adjust the absorbing circuit so that it will draw exactly the same input as the antenna circuit. In other words, when signalling, the anode is first connected to the absorbing circuit and then to the antenna circuit; the arc input remains constant as indicated by the meters.

The transfer key is of the relay type and is remotely controlled by a single telegraph key at the operating table. An auxiliary handle protrudes through the panel so that the transfer key may be operated directly by hand in case of an emergency.

To change wavelengths with an arc transmitter it is only necessary to vary the amount of inductance in series with the antenna, or to vary the antenna constants. In this case the desired change is reached by inserting the proper amount of inductance in series with the antenna. The main inductance consists of a large Bakelite-Dilecto tube, wound with a heavy Litzendraht wire nearly 3/8 inch in diameter. The inductance is wound in sections and the sections are bank wound. Taps are taken off at every section.

It is apparent that fine wavelength adjustment is not possible when the inductance is varied by taps in every section, so a compensating inductance is provided. This consists of one flat spiral of strip copper, which can be varied by a handle on the front of the panel.

There is in the wavechange switch a total of eight positions for the four wave-

lengths, the extra position for each wavelength cuts in the compensating inductance for fine adjustment.

For example, if the desired wavelength is 2,400 meters, the wavechange switch is turned to the right "half" portion of 2,400 meters and the wavelength is measured and found to be 2,600 meters. Another section of inductance is cut out of the main inductance, increasing the frequency and the wavelength is then found to be 2,356 meters. Next, the compensating inductance is increased and the wavemeter read, the frequency decreasing until the wavelength is increased to exactly 2,400 meters. A permanent clip is then substituted for the variable contact and that contact is used again to adjust the other wavelengths.

To produce damped oscillations a modulator system is used. This consists of a few turns of heavy Litzendraht wire in inductive relation to the main inductance. These turns are periodically short-circuited by a special commutator which has a certain number of bars connected together. When current flows through the main inductance and these turns are shorted, the wavelength is decreased approximately 7½ percent. The speed of the commutator and the number of common bars were selected to give a 400-cycle note, while the resulting decrement is just enough to provide sharp tuning and yet insure being heard when transmitting.

If the operator wishes to reduce his power when he nears land, he may insert a 10-ohm resistance in series with his antenna, or he may reduce his arc input.

The water cooling tank has a sight level glass and controlling valves, and is usually mounted on the bulkhead with a casting provided for the purpose. Water connections are made with a special hot water hose, and in winter alcohol is mixed with the water to prevent freezing. Of course salt water can never be used as it would short-circuit the anode to the ground.

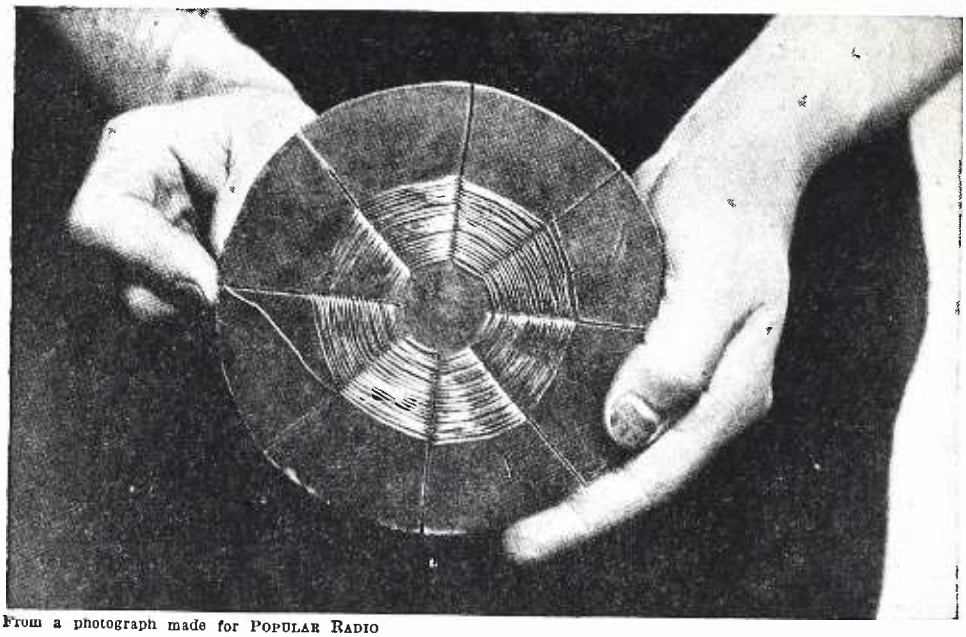
Excellent work has been done with these new transmitters. A 5 K.W. unit installed at Babylon, N. Y., when radiating only 8 amperes at 2,100 meters was reported by a tug stationed in the harbor at Hamilton, Bermuda. The tug had a standard Navy receiver with a two-stage amplifier and reported that the signals were readable ten feet from the phones.

Another unit installed on the S. S. *Minnekarda* has worked the Cuxhaven Station at distances approximating 2000 miles. Cuxhaven uses a quenched spark gap.

The designers of the improved transmitter, Messrs. Shoemaker and Farrand, have made a distinct and valuable contribution in the field of nautical communication.

Are There No Ether Waves?

THE *now-famous article by the distinguished American physicist, Dr. Charles P. Steinmetz,* THERE ARE NO ETHER WAVES *(which was first published in* POPULAR RADIO *for July,* 1922) *has stirred up the proverbial hornets' nest in scientific circles both here and abroad. So seriously has it agitated the physicists of England, indeed, that they have turned to the greatest living English authority on ether to make a reply to Dr. Steinmetz—Sir Oliver Lodge, who has devoted the larger part of his life to a study of this subject. Sir Oliver's response will appear in our next issue—NOVEMBER.*



From a photograph made for POPULAR RADIO

THIS HOME-MADE COIL COSTS LESS THAN 50 CENTS

To make this device (sometimes called a "spider-web coil"), requires no special tools or unusual skill. This article gives complete instructions that every novice can understand.

How *to* Make a SPIDER-WEB TUNER

The Sixth of a Series of Practical Articles that Tell the Amateur How to Build His Own Apparatus

By A. HYATT VERRILL

THERE are many forms and types of loose-coupled coils and vario-couplers. While almost any form will serve as a tuning device for ordinary sets and while there is comparatively little difference in their efficiency if they are so arranged that equally fine adjustments may be made, yet for some types of regenerative sets a tuning device with a third or tickler coil may be used to good advantage.

To construct an ordinary vario-coupler with a rotor as a tickler is not a hard task, but the results obtained from home made instruments are not always all that is desired, largely because they are merely makeshift contrivances.

A type of vario-coupler which gives really excellent results, yet at the same time is simple and easy to make is composed of three flat, circular coils known as "spider-web" or "pancake" coils.

No great skill or experience is needed to make this and no unusual tools are required; the materials necessary are few and inexpensive; indeed, a first-rate coupler of this sort may be made at a cost of less than two dollars.

The only tools needed are a screw-driver, hack saw, ¼, ⅛, and 1/32 inch drills, a pair of compasses or dividers and a soldering set; in addition a set of screw taps and dies will prove useful. It is advisable for anyone who intends to

make radio sets or instruments to purchase a set of taps and dies; they are not expensive and they soon pay for themselves many times over, especially if time is of any account.

For materials, you should have binding posts (such as may be taken from old dry batteries); some strip brass ½-inch wide, and ⅛-inch thick; some 1-inch by ⅛-inch brass screw-headed bolts with nuts and washers to fit; a couple of 2-inch by ¼-inch bolts of the same type; a supply of No. 22 or 24 cotton or silk-covered copper wire and enough Formica, Bakelite or other composition sheet ⅛-inch thick to make three discs each 6 inches in diameter.

First, draw a circle 6 inches in diameter on a sheet of heavy white paper or thin bristol board or cardboard. With your dividers or compasses mark off nine equal spaces around the circumference as shown in Figure 1. Then, with a straight edge, draw lines from each of these points to the centre of the circle, as shown in Figure 2. Next draw a second circle 2 inches in diameter as shown in Figure 3.

Now cut out the large circle and cut a slit from each of the marks along the radiating lines to the edge of the 2-inch circle, as in Figure 4. These slits need not be wide; 1/32 of an inch will do. Now, using this slotted circle as a template or pattern, place it upon the ⅛-inch sheet of composition sheet and with a sharp steel point or a pencil mark the outer circumference of the circle and each slot upon the composition sheet. Make three of these and then with your hack saw cut out the discs. If you have any difficulty in making good circles don't be discouraged, but try making the discs nine-sided by cutting straight across from one radiating mark to another, as shown by the dotted lines in Figure 4.

When the three discs are cut out, saw along each of the marks indicating the slots (making a single cut), and finally bore a ⅛-inch hole through the exact centre of each disc. Also, bore two 1/32-inch holes in each—one hole just inside the inner end of one of the slots and the other hole near the outer circumference close to a slot, as indicated in Figures 4 and 5. Thread one end of the wire through the inner hole on one disc, leaving six or eight inches free, fasten it with sealing wax and commence winding. Wind the wire from the hole up through a slot, across one of the

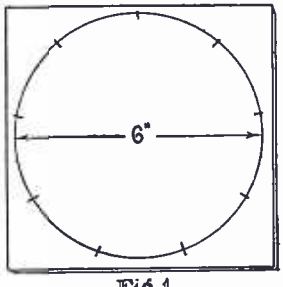


Fig. 1

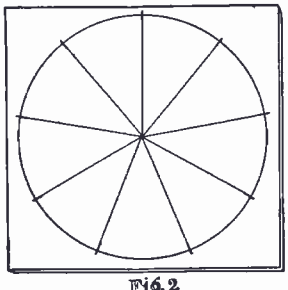


Fig. 2

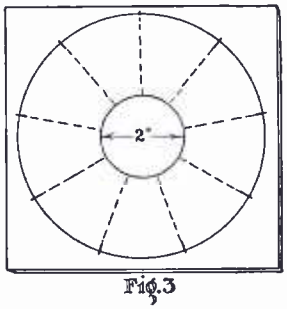


Fig. 3

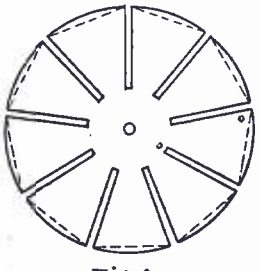


Fig. 4

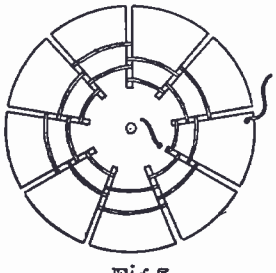


Fig. 5


Fig. 6

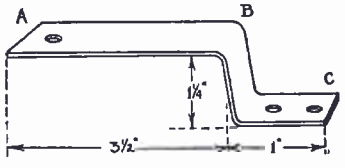


Fig. 7

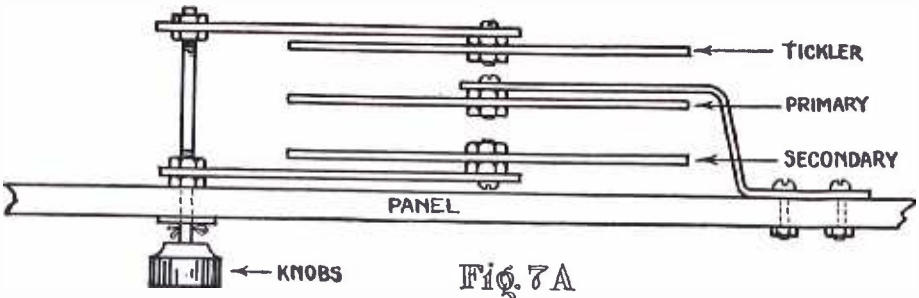


Fig. 7A

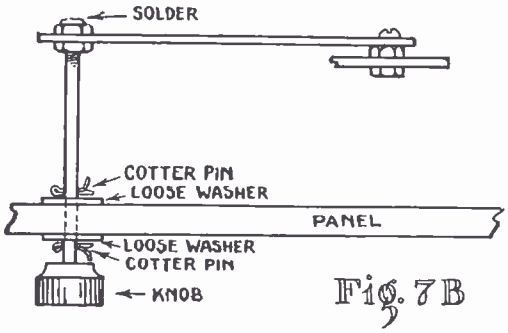


Fig. 7B

"blades" down through the next slot, across the next blade, up through the next slot, across and down again, and so on, as shown in Figure 5, as if you were weaving the bottom of a basket. In this way the wire, as you wind it on, will cross on itself in the slots at every turn, as shown in Figure 6.

Wind on about 30 turns on one disc, pass the wire through the small hole near the edge, fasten it with sealing wax and cut it off so as to leave at least 6 inches free. Then proceed to wind the next disc, and be sure to wind in the same direction as the first; but put about 50 turns on this one. Do the same with the third disc, putting on 80 turns of wire, and the discs are then ready to assemble. But remember, when I say 30, 50 or 80 turns I mean *complete* turns; the wire should pass the starting point 30, 50 and 80 times.

There are two ways of assembling these coils; the one you select will depend partly upon the way in which it is to be mounted and the space it is to occupy and partly upon your skill. If the coils are mounted or assembled in one way, two coils are movable past the third or fixed coil in the same plane, whereas, if they are mounted in the other way, they move back and forth or towards or away from the fixed coil. It makes little difference which method is used as far as efficiency is concerned, although personally I think the latter method is a little the better. It is a trifle more difficult to mount them in this way, however, and they also occupy a great deal more space. As the first way is the simpler, I will describe it first.

Take a strip of ½-inch by ⅛-inch brass and bend it in the form shown in Figure 7, making the distance from A to B 3½ inches and the distance from B to C about 1 inch. Bore two ⅛-inch holes in this short end and another ⅛-inch hole in the opposite end, as illustrated.

Now secure the disc with the fewest turns, or the primary coil, to the end (A) of this strip by means of a short ⅛-inch bolt. First slip the bolt through the hole in the strip, then screw a nut on tightly, then place the coil over the bolt and screw a second nut on; then file the bolt end down flush with the surface of the second nut as shown in Figure 7 C. Secure this strip bracket that holds the coil to the

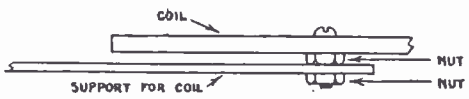


Fig. 7C

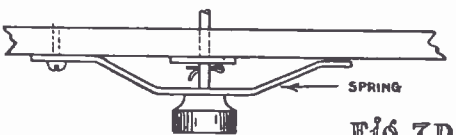


Fig. 7D

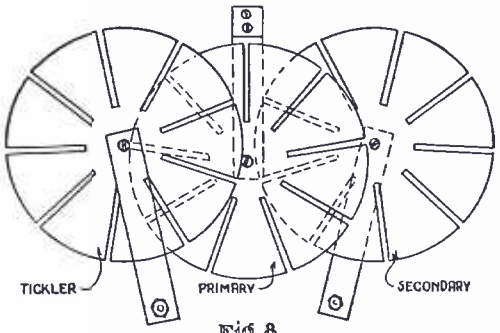


Fig. 8

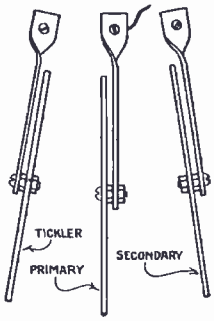


Fig. 9

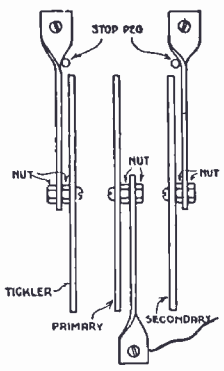


Fig. 10

panel or other support by means of two screws through the holes in the short end, as in Figure 7 A.

Now cut two more strips of the ½-inch by ⅛-inch brass, each 4½ inches long, and bore a ⅛-inch hole near one end of each strip and a ¼-inch hole through the other end of each. Fasten the other two coils to these strips—one coil to each strip—by means of screws and nuts through the ⅛-inch holes, exactly as you did with the first coil.

The next step is to mount these two movable coils in such a way that they may be swung into line with the fixed coil or swung away from it at will, as shown in Figure 8. The best way to do this is to hold one of the coils (the one with 50 turns of wire), against the primary or stationary coil and then mark where the ¼-inch hole comes on the panel. Then do the same with the coil that has 80 turns and bore holes through the panel where marked. As the 50 turn or secondary coil must swing between the primary and the panel and the tickler or 80 turn coil must swing the other side of the primary, it will be necessary to provide shafts of different lengths for the two. These may be long ¼-inch bolts secured to the strips fastened to the coils by means of two nuts (as shown in Figure 7 B), or they may be pieces of brass rod soldered to the strips. In this case you should place a washer both above and below the strip and solder washers, shaft and strip at one

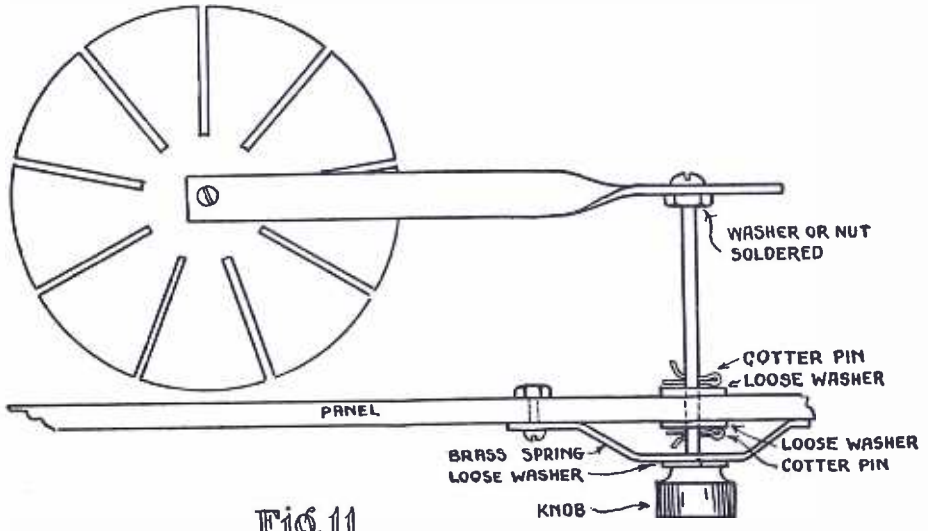


Fig. 11

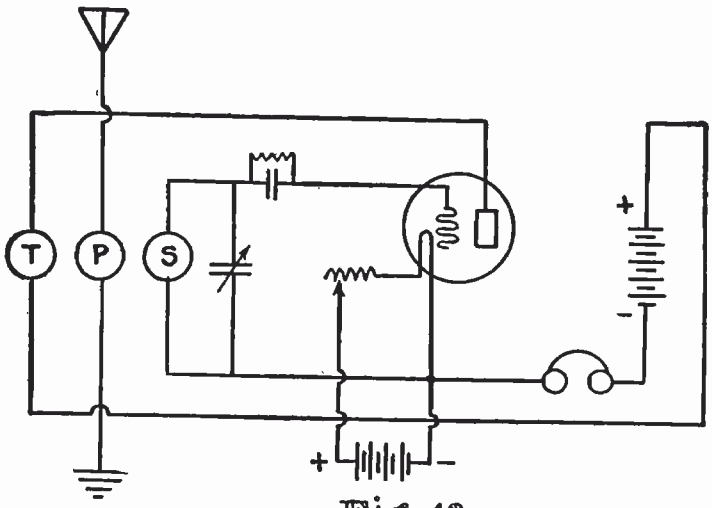


Fig. 12

time. If nuts are used it is also advisable to solder them in place so as to avoid any chance of their working loose. In fact all the nuts used in attaching strips to coils or to the panel should be soldered, as nuts and screws have a remarkable habit of working loose without apparent reason.

After the shaft is fastened to the strip it is an easy matter to pass it through the panel and arrange two loose washers, one on either side of the panel, secured either by small cotter-pins, or by soldering the washers to the shaft, so that the latter cannot move out and in. (See Figure 7 B). Then, when the coils are assembled in their proper positions, the rods should be cut off evenly on the outside of the panel and knobs of rubber or Bakelite attached to them.

You will find, however, that the weight of the coils and strips has a tendency to make the coils slip gradually out of position as set, even if the shafts fit tightly in the panel. This may be overcome by fastening a piece of spring brass to the panel and with an oblong hole in it through which the shaft passes. Then by forcing this down until there is quite a bit of pressure upon it and by fastening a washer or nut to the shaft against it (see Figures 7 D and 11), a steady pressure will be maintained upon the shaft and the coils will stay put.

The other method of mounting the coils is shown in Figures 9, 10 and 11. The coils are secured to strips of brass as already described, but each strip is twisted at right angles near the free end as shown in Figures 10 and 11. They are then attached to the panel and are mounted exactly as described, the only difference being that they swing in a different way. The details of attaching the coils to the strips and of arranging the shafts and bearings, as well as the spring tension, are so plainly shown in Figure 11 that no description or explanation is needed.

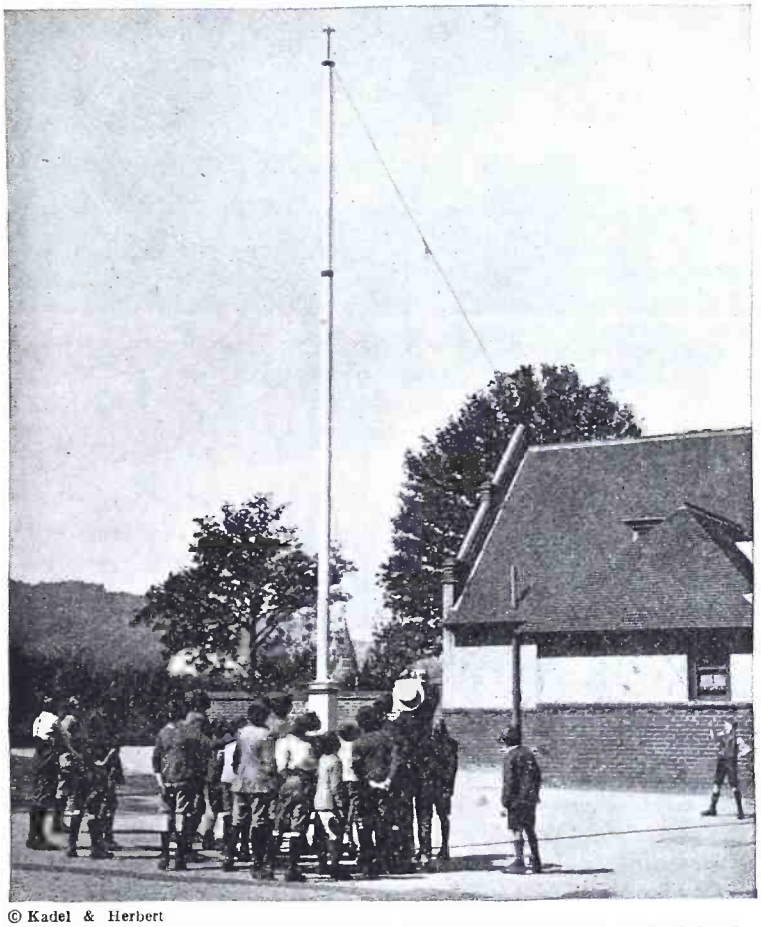
Finally, when the coils are assembled lead the end wires to the binding posts, using flexible wires for the movable coils; and when you connect the set, follow the wiring shown in Figure 12.

When you first use this type of variocoupler, place the coils so that all are in line, turn on the filament until it glows properly and adjust the variable condenser until you get the signals. Then move the coils slowly—first the secondary and last the tickler—until the interference disappears and the sounds you wish to hear come in clearly and distinctly. When the two coils are entirely away from the primary the shortest wavelengths are re-

ceived; if all three are brought close together the longest wavelengths possible for the coils are brought in. In case you should find that you cannot tune down to the shorter wavelengths you wish to hear, you may cut down the wavelength by taking a few turns of wire from the coils or place a variable condenser in series with your aerial. If you do the latter you will secure a far greater range of wavelengths than by taking off turns of wire.

MAKE YOUR OWN VARIO-COUPLER!

¶ In the next issue the author of this series of "How to Make" articles, Mr. Verrill, will describe in detail how to build a novel form of vario-coupler—a form that is of special interest to amateurs because of its peculiar combination of efficiency and simplicity of construction.



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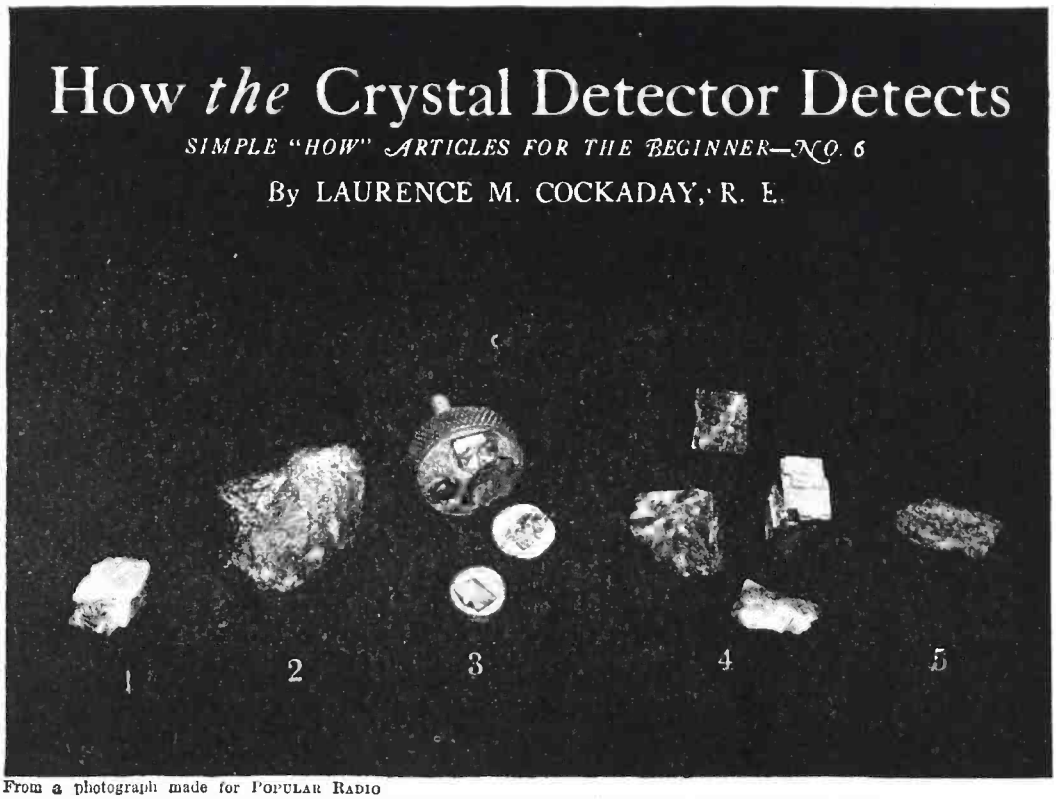
RADIO AS AN EDUCATIONAL FORCE IN THE SCHOOLS

It has been well said that "radio is making the United States a nation of scientists." Certainly no invention has so stirred the imagination of the American youth, or stimulated a more wholesome or more extensive study of electricity and of mechanics; even in England, where radio is but little known among amateurs, the subject is being taken up in the schools. What the schools are doing with radio will be told in succeeding issues of POPULAR RADIO.

How *the* Crystal Detector Detects

SIMPLE "HOW" ARTICLES FOR THE BEGINNER—NO. 6

By LAURENCE M. COCKADAY, R. E.



From a photograph made for POPULAR RADIO

FIVE OF THE MORE COMMON KINDS OF CRYSTALS USED IN RADIO RECEIVING SETS

No. 1 is a piece of pyrites; No. 2 is molibdenite; No. 3 shows three bits of crystal mounted in Woods metal settings for commercial use; No. 4 shows four pieces of the familiar galena crystal, and No. 5 is a silicon crystal.

THE antenna forms the means of transmitting energy through space without the use of wires; it is also the means of collecting this energy at a receiving station and reconverting it into electricity. The inductance, or coil, and the condenser are the means used for tuning the circuits which are connected to the antenna, so that the electric currents induced in the antenna may be led through these circuits to do work in producing some tangible result that may be used for signalling. In both radio telegraphy and radio telephony this result is sound.

The ordinary telephone receiver is a device that will change electricity into sound waves.

"But why," asks the beginner in radio, "do we need the detector at all when we have such a device as a telephone receiver, which is designed for this very purpose, to change electric currents into sound waves?"

It is true that this point is hard to fathom out by oneself without a little study.

In the first article of this series*, we delved a bit into the theory of wave motions and learned that sound waves had a certain frequency range. If a flexible reed were to be started into vibration, and the speed of vibration or frequency be increased, at first a low note is heard; as the frequency is increased this note steadily mounts upwards in pitch until it becomes a shrill whistle; finally the note becomes so high that we can no longer hear it. In other words, the tone goes up

* *See* POPULAR RADIO *for May*, 1922.

beyond the range of detection by the human ear.

The telephone receiver is designed to work on frequencies that the ear *can* detect. Like the human ear, its diaphragm will not respond to vibrations that are too high in frequency. Even if a special receiver were to be designed that would respond to these frequencies, we would not have solved our problem, for the ear would not detect them.

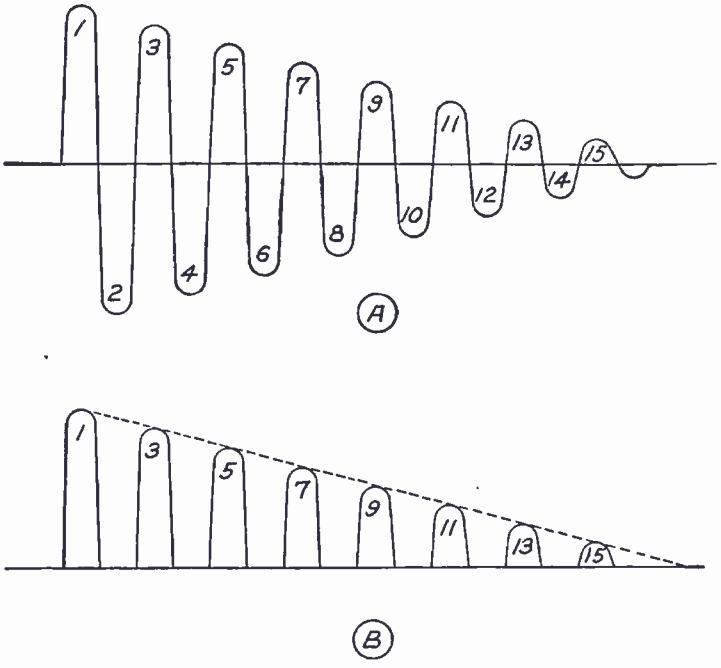
The electric currents that are used in radio are of a very high frequency—as many as millions a second. Now we see that this is the reason that they would not work the receivers in a radio set, and some other device would have to be used to lower the frequency of these currents before they could be used to energize the receivers and produce audible sounds.

The telephones used for radio reception are generally designed to operate with maximum efficiency at a frequency of about 800 cycles a second; if a current of a frequency of over several thousand a second is led through the windings, they produce no sounds, as the diaphragm cannot move quick enough.

The diagram, Figure A, shows a series of high-frequency electrical oscillations such as are used in radio telegraphy. Notice that these follow each other, reversing direction after each impulse; first an impulse in one direction (numbered 1) which we may call a positive impulse, and then an impulse in a reverse direction (numbered 2) which is a negative impulse. These follow each other in such rapid succession that if they passed through the telephone they would produce no results, for before the diaphragm would have time to get started into motion in one direction, the second opposite impulse would be tending to prevent its motion, and so on indefinitely.

Here is where the detector comes to the rescue.

It was discovered some time ago that



RADIO IMPULSES BEFORE AND AFTER RECTIFICATION

The top diagram, A, shows incoming high-frequency impulses before they are rectified, and the lower diagram, B, shows the same impulses after they have been rectified by the crystal. Note that only the impulses in one direction remain; the others are choked back.

certain mineral crystals offered a great resistance to electric currents when these currents were led through them in one direction, but offered small resistance to currents that flowed through them in the opposite direction. This action is somewhat similar to the action that takes place in the valve of an automobile tire. Air may be pumped into the tire through the valve, but air may not pass out of the tire through the valve. The air may pass in one direction through the valve.

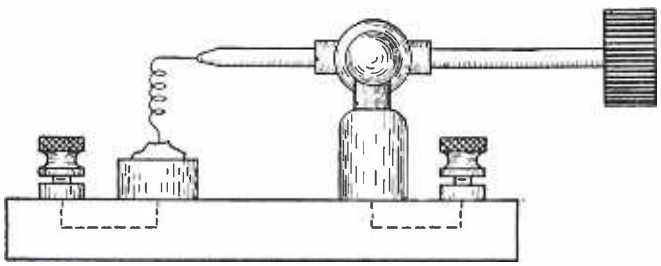
Somewhat the same thing happens with the crystal detector. The electric currents may pass in the one direction, but not in the other.

If a high frequency current such as shown in Figure A should be led through a crystal of this kind, only one-half the impulses would get through; those that flow in one direction would pass while those that flow in the other would not. This would allow a series of positive impulses (1, 3, 5, 7 and upward) to flow through the telephones, as shown in Figure B. These impulses flowing through the telephones in such rapid succession, and all of the same polarity, would act on the diaphragm as one large impulse such as indicated by the dotted line in Figure B. This impulse, extending over a much greater time than the smaller period impulses, would pull the diaphragm in one direction and this would make one single sound impulse. If a series of high frequency oscillations are generated in groups of a definite audio frequency at a distant transmitter and are received and "rectified" by the crystal as thus described, they will reproduce the same sounds in the receiving telephones as those produced at the transmitter. In this way the crystal prepares the received energy so that it can be used to work the telephones and our present day telegraphy and telephony is thus made possible.

Unfortunately, however, crystals do not have this rectifying quality throughout the entire surface; they have it only in spots, and it sometimes is an aggravating task to find the sensitive spot. For this purpose the crystal is usually mounted in a metallic cup, which is connected to a binding post; and a spring wire attached to an exploring arm, which is mounted on a universal joint, is used for finding the sensitive spot on the crystal. This arm is connected to another binding post. A detector stand of this type is shown in Figure C.

The knob on the end of the arm is slowly wiggled around until the spring point comes into contact with a sensitive spot on the crystal, when signals will be heard in the telephones—providing, of course, that some station is sending and the receiving apparatus is tuned to the particular wavelength that the station is sending out on. When we are trying to "set" or "adjust" our detector, if our set is not tuned to any other station's transmitting wavelength, we would never know if the detector were in adjustment or not.

A device which is of great help in adjusting a detector is known as a buzzer test, and this consists of a high tone buz-



THE ORDINARY CRYSTAL DETECTOR

FIGURE C: *The type of detectors generally known to radio amateurs. It consists of a cup for holding the crystal and an adjustable arm and spiral spring for finding the sensitive spot.*

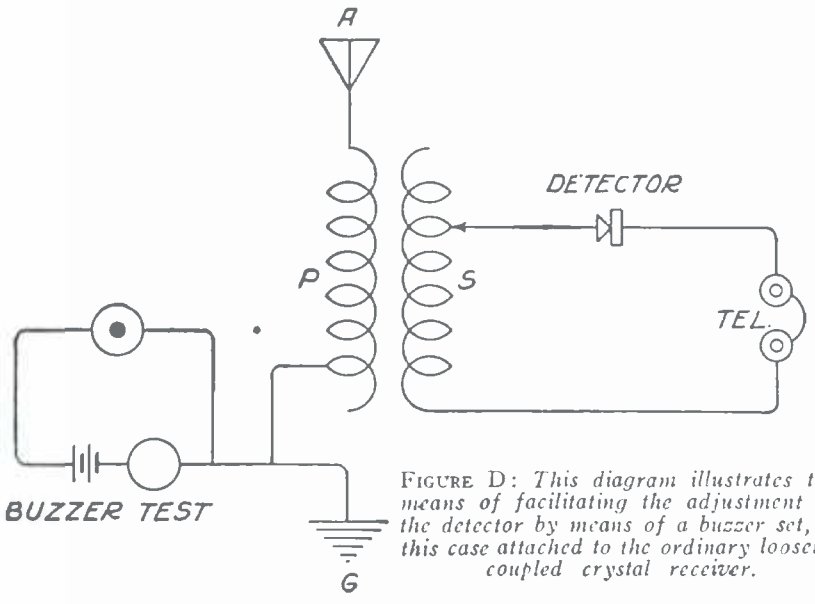


FIGURE D: *This diagram illustrates the means of facilitating the adjustment of the detector by means of a buzzer set, in this case attached to the ordinary loosely-coupled crystal receiver.*

zer connected in series with a dry battery and a push button. When this device is connected up (as shown in Figure D) with a receiving set that employs a tuning device (in this case a loose coupler, P and S) and a crystal detector and a pair of telephones, and the push-button is held down with one hand while the detector is adjusted with the other until the buzz is heard distinctly in the telephones, the detector is set without bothering about tuning for any outside signals; when thus set, the push-button may be released and the set be tuned with the assurance that if any one is sending within range of the receiver his signals will be heard.

There are numerous crystals that possess these rectifying characteristics to a greater or lesser degree, and these may be obtained at almost any of the regular radio stores.

Thus we can readily see that the detector is necessary in a receiving set after all, and can more fully understand what we are accomplishing when we adjust the little spring on our set that sometimes causes us so much worry and sometimes brings forth bursts of heated language.

In the next article we will take up the study of the vacuum tube as a detector, and point out its points of superiority over the crystal.

How to Perform Tricks with High Frequency Current

DO you know that you can send a million volts through your body without injury—provided you use a low current? How to entertain your friends with spectacular but harmless demonstrations of the phenomena of electricity will be told in POPULAR RADIO—*in a near issue.*

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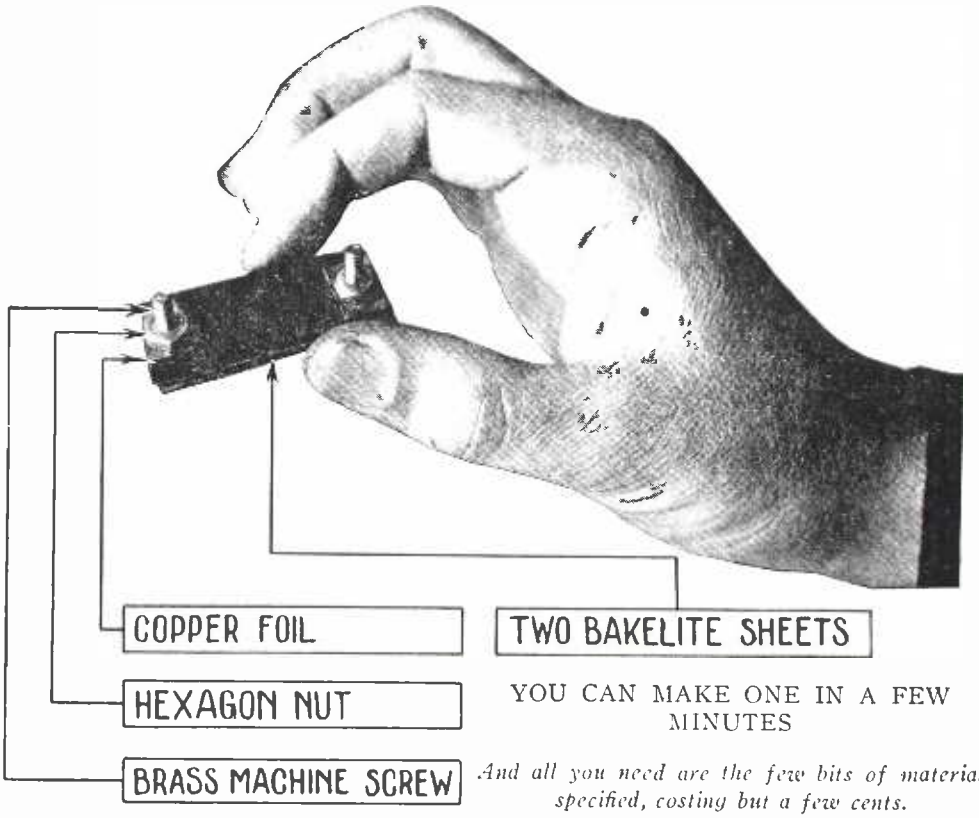


YOU CAN MAKE ONE IN A FEW MINUTES

And all you need are the few bits of material specified, costing but a few cents.

How *to* Make Your Own Grid Condenser

By RICHARD LORD

ONE of the most important parts of a receiving set—and one that is usually neglected by the amateur who builds his own set—is the grid condenser. The usual practice is to build the rest of the set, the vario coupler and the variometers; mount the rheostats and tube sockets, and then look around for some tinfoil and waxed paper. The tinfoil is usually cut into a couple of square pieces of almost any size that the builder happens to prefer at that instant. A hurry up job is then done in the insulation of the two pieces of tinfoil with a sheet of the waxed paper, and two wires joined to the two plates; the so-called "grid condenser" is then stuck into the set to see how it works. If any signals are heard the builder considers himself lucky. If, on the other hand, nothing at all is heard, he tries again and makes another condenser, hoping for better luck next time.

All the luck or element of chance may be taken out of the process of making a grid condenser by following the directions here given; the builder will then

have a grid condenser that cannot be improved upon even if he were to buy one in a store.

Obtain a strip of thin copper, about three mills thick, and cut two strips 2 inches long and ¼ inch wide. Then get a piece of mica sheet and split it to a thickness of approximately .002 (two one-thousandths) of an inch. Any machine shop will be glad to measure the mica for you with a micrometer and will help you split it to get the right thickness for a small sum.

Cut the sheet to a size of ¾ inch wide by 2 inches long. Then obtain two pieces of sheet bakelite ⅛ inch thick, and cut it into two sheets of the same area as the mica sheet. Next obtain two 8-32 brass machine screws, round headed, and four nuts and washers to fit.

The next job is to assemble the parts properly. Place the sheet of mica between the two sheets of bakelite and bore two holes large enough to pass the two screws so that they fit snugly in the holes.

The holes should be bored through all the sheets at once and should be spaced ¼ inch from each end of the sheets. The mica is then taken out from between the two sheets of bakelite and the two strips of copper are placed one on each side of

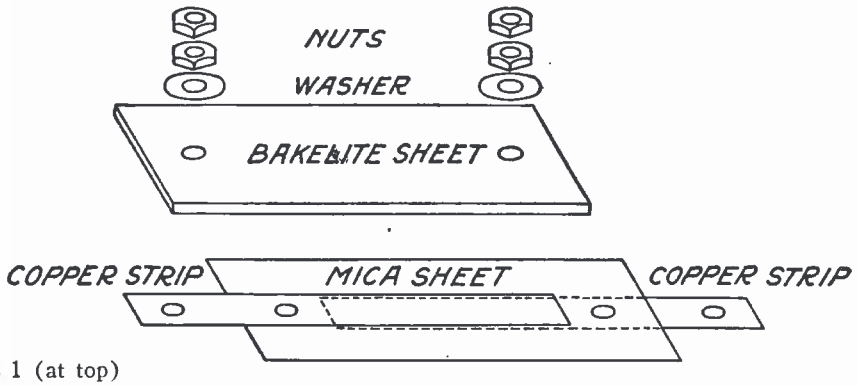


FIGURE 1 (at top)

How the copper sheets should be placed—one sheet on each side of the mica.

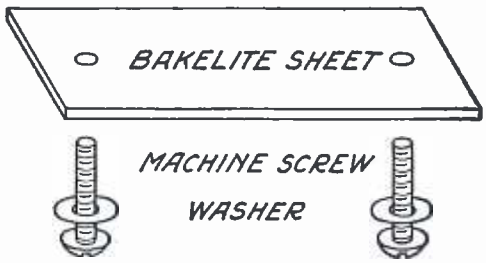


FIGURE 2

The various parts of the condenser in position for assembling; the bottom picture shows the completed product.

the mica. One-half inch of the copper strips sticking out beyond the mica leaves the two sheets of copper overlapping one inch in the middle, but separated by the mica as shown in Figure 1. Place the two sheets of bakelite carefully, one on each side of the other parts and bend the two flaps of copper over on one side, and, while holding them in a clamp, bore the holes so that the screws can be inserted through the whole and the nuts and washers tightened down so that the condenser will be properly held together. In this way the two outside strips of copper make contact with the two screws which act as terminals.

The parts about to be assembled, and the complete condenser are shown in Figure 2.

After the condenser is assembled, fasten two wires, one to each terminal, by screwing down an additional nut on each terminal.

The condenser may be made moisture-proof by immersing it in a bath of melted paraffine. Do not use any solder or soldering flux on the condenser.

DON'TS

DON'T try to transmit without a license.

* *

DON'T forget that tube sets are far more efficient than crystal sets.

* *

DON'T handle the crystals of your set.

* *

DON'T try to get a fine adjustment while touching the detector with bare hands.

* *

DON'T fail to make good connections.

* *

DON'T forget to scrape off the insulation and have wires bright before making connections.

* *

DON'T cover joints with adhesive tape; use "spaghetti' or varnish cambric tubing wherever possible.

* *

DON'T oil any portion of a set.

* *

DON'T blame your set until you are sure it is not your fault that something is wrong.

* *

DON'T be discouraged if the first galena crystal you try is not very sensitive. Try a number of pieces.

DON'T connect the lightning-switch to an inside ground.

* *

DON'T use iron for an aerial.

* *

DON'T forget to keep the aerial and lead-in insulated from all other objects.

* *

DON'T expect to get good results with an aerial less than 100 feet long or low down among other buildings.

* *

DON'T run your aerial parallel with electrical wires, elevated tracks or steel bridges.

* *

DON'T forget that a good ground is necessary.

* *

DON'T try to use your instruments just before, just after, or during a thunder storm.

* *

DON'T rush blindly at the set and turn knobs and handles hit or miss if anything goes wrong. Be calm and patient and go slowly. Haste makes waste in radio as in all things.

An Ingenious "BREAK-IN KEY"

A New Time-Saving Device That Enables the Operator at the Transmitting Station To Listen-In On the Receiving Station While He Is Carrying on Communication

By S. R. WINTERS

Harris & Ewing

THE KEY AND ITS INVENTOR

H. E. Hallborg, who is shown above, shares the honor of inventing this practical little time-saver with H. R. Miller—both of the Navy Department.

AN automatic break-key, designed by H. R. Miller and H. E. Hallborg, radio engineers of the Bureau of Engineering, United States Navy Department, greatly simplifies the interception of amplified wireless signals when messages are being transmitted and received aboard sea-going vessels. The radio operator, by the use of this new break-key, can interrupt the progress of a message at any time and ask the sender to repeat a word or sentence without waiting until the entire message has been sent. This interrupting mechanism switches from transmitting to receiving by the use of a novel break-key. The use of a break-key with a crystal detector has been found impractical, and the vacuum tube detector has been even more defiant until the radio engineers of the Navy Department pledged themselves to patient research.

The radio operator's head telephone winding is normally energized by both a constant direct current flowing in the plate circuit and by the signal current pulses of audio frequency. The latter are relatively feeble when produced by distant signal, but exceedingly strong when having their origin in the local transmitter. Hence, solution of the problem resolved itself in a search of means for shunting out of the phones, the heavy artillery of the impulses of local sending, and a removal of the shunting device without affecting the constant plate current of the tube. Achievement of this condition, it was agreed, would make the head telephone immediately responsive for reception.

A low reactance telephone shunting condenser offered a simple and effective solution. The scientific reasoning leading up to this conclusion follows: The normal frequency of a signal is from 500 to 1,000 impulses to the second. A condenser of two microfarads capacity has a reactance of 500 cycles of 159 ohms. The reactance of a pair of head telephones to a like frequency approximates 22,000 ohms. Consequently, the condenser shunt deprives the telephones of 99.3 percent of its pulse current and even the powerful radiation of the local transmit-

ter is rendered inaudible. At the same time, the condenser shunt exercises no influence upon the steady plate current of the tube, since a condenser forms an open circuit to direct current. The plate current is, therefore, susceptible to impression by the distant signal voltage at once after the local radiation is cut off and the telephone shunting condenser removed. Decrease in the telephone shunt capacity value permits the radio operator to hear his own sending to any audibility desired.

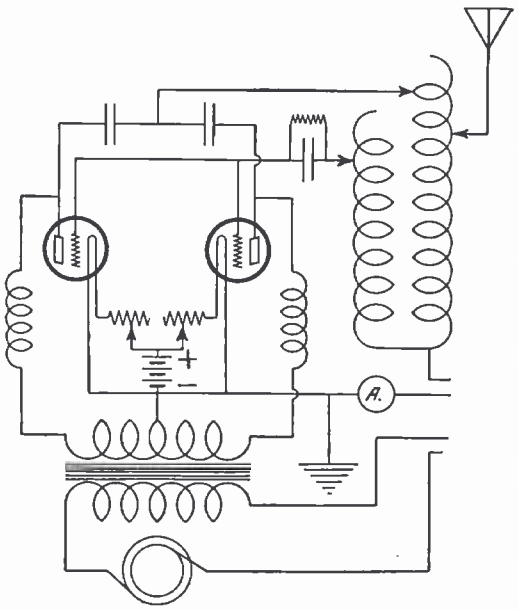
The new break-key involves the use of at least three sets of contacts; a pair to control the transmitting equipment, another pair to shunt the local radiation out of the receiving equipment, and still another pair to shunt the telephones.

This method of breaking in is of practical application and is noiseless and positive even when functioning with amplified radio signals. In actual use the telephone shunting condenser contact is closed first, the receiver contact is next in order, and the antenna contact is last. The contacts are opened in the reverse order.

Breaking in with four stages of audio frequency amplification is feasible with this system. The Hallborg-Miller progeny has been installed on two dozen vessels, and will soon be readily available for commercial use.

The electrical connections of the newly-devised radio interruption system in an alternating current tube transmitter circuit with receiver arranged for two stages of audio frequency amplification are explained in Figure 1. The hand break-key is so constructed as to be fitted with adjustable timing screws. The key is equipped with balance springs, a provision serving to neutralize the inertia of the auxiliary contactors. The operator is thus relieved of undue fatigue when fingering the key.

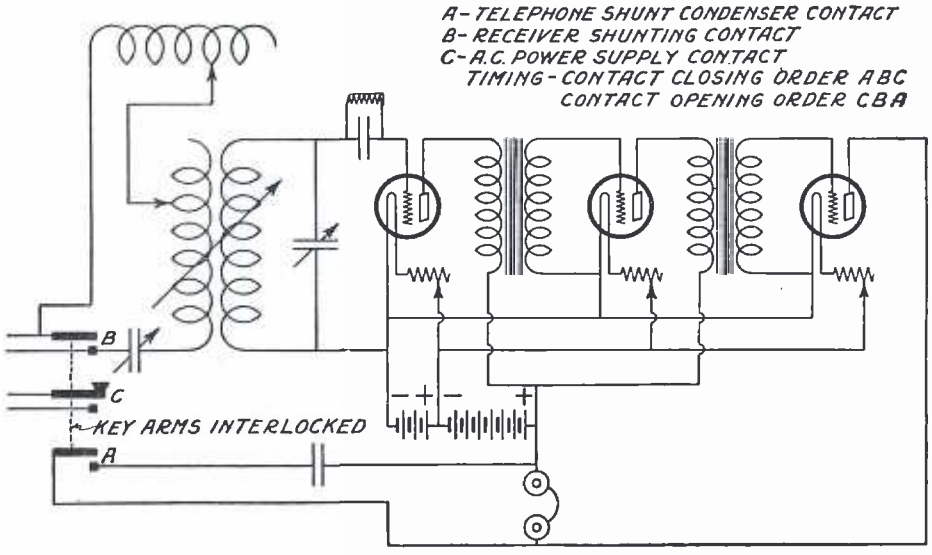
It is not unreasonable to expect that with the universal application of this device to ocean-traveling vessels that radio communication and its traffic burdens



will be handled with the same facility and certainty on the waters as on land. The troublesome task of changing the antenna switch from the sending to the receiving position is no longer necessary.

The break-key has long been a common word with sea-going radio operators, although the prevailing arrangement hardly justified the term. When radio-telegraphy and radio-telephony were popularly represented as an antenna, a sending key, an open spark gap, and the crackling on board ship when a message was in progress, the radio operator clamored for a successful break-key. He was usually recruited from the railroad telegraph station or commercial land-wire telegraph staff, and was picturesquely described as a brass pounder.

His previous experience had made him a master of the simplex, duplex, and quadruplex forms of communication. He complained when compelled to operate a switch necessitating a change from sending to receiving positions a score or more times while clearing traffic of a few hundred words. The "brass pounder" found himself possessed with the insatiable wish to "break" the wireless sending operator when a letter or word or two



THE CIRCUIT USED WITH THE "BREAK KEY"

This is the hook-up employed for connecting an alternating current modulated C. W. transmitter and a two-stage audio frequency amplifier and receiver by means of the special break key. A straight C. W. transmitter and a regenerative receiver may be similarly connected.

was brought into question as to its correct reception.

The multiplied troubles of the radio operator on board ship, and persistent complaints to the superintendent, have hurried the development of the break-key. The name was a misfit for the early devices with their multitude of levers, wires and contacts. The delicacy of the equipment was responsible for periodic instruction from the company engineers not to tamper with the outfit.

The "gadget," as it was disrespectfully called, sputtered and flashed at the contacts, and the noises circulating in the telephones further tried the patience of the operator. Messages were received with uncertainty and traffic was frequently congested.

Such is the story of the break-key as applied in the day of the supremacy of the crystal detector. The vacuum tube detector and multi-stage vacuum tube amplifier further aggravated the trouble. The recent invention, however, promises in theory to help the radio operator, whose duties are constantly increasing as the radio art develops.

How *to* Add a Tube *to* Your Crystal Receiving Set

So widespread has become the interest of radio fans in the hand-made crystal receiving set which was developed last spring by the Bureau of Standards in Washington (and described in detail in the May issue of POPULAR RADIO) that a demand has been created for information for improving and developing this apparatus. So Uncle Sam has just produced another set of specifications that tells how to substitute a tube detector for the crystal detector. They will be published with special diagrams and photographs made especially for POPULAR RADIO—in next month's issue.

From a photograph made for POPULAR RADIO

THE EAR OF A MILLION LISTENERS

Suspended twenty-five feet above the ground and about the same distance in front of the concert platform, this microphone (actually only four inches in diameter and four inches long), served to transmit the music over an area estimated at over 2,000,000 square miles.

The Radio Symphony

How the Music of a Great Orchestra Was Played in One State, Broadcast from Another State and Brought Within the Hearing of the People of Half a Continent

ON page 83 of this issue of POPULAR RADIO General Squier writes, in referring to the coming influence of broadcasting upon civilization: "Soon we will be measuring culture by watts."

The General's prophecy had hardly been written when a significant demonstration was made of the possibilities that are rapidly being developed for bringing the world's greatest music to the world's greatest audience—the radio fans of America. For the first time in history the music of one of the greatest of orchestras, the New York Philharmonic, of eighty-five pieces, was transmitted by special wire from the City College Stadium in New York to a distant broadcasting station and sent out by radio to probably the biggest number of auditors that have ever listened in on a musical program. Remarkable as this experiment proved to be in itself, it is still more remarkable in what it presages. No longer is it inconceivable that the world's best music and the world's foremost citizens may literally be brought to the Little Red School House, even in the remote wilderness. Shortly culture may indeed be "measured by watts."

This enterprise was initiated by POPULAR RADIO in accord with its policy not only to serve the interests of the radio fans of this country but also to demonstrate the possibilities of extending radio into larger fields of public usefulness and thus serve the cause of humanity.

THE world's greatest concerts, literally the "greatest" both in the size of the audiences and in the size of the orchestra, were held for five eventful evenings, August 11th, 13th, 14th, 15th and 16th, 1922, at—

At this point the reporter pauses. Ordinarily he would have written "at the City College Stadium in New York." But that would be only a fifteenth or a thirtieth of the truth—possibly only a hundredth of the truth. For while the great New York Philharmonic orchestra (considered by many the best in this country if not in the world) was playing at the Stadium, only an average of 7,000 persons were at that point at one time. Many times that number, just how many is a matter of conjecture, were scattered throughout this country, Canada, Cuba, possibly Mexico, and on ships more than half way across the Atlantic. For these concerts were broadcast from one of the most powerful and most popular broadcasting stations in the world, the famous WJZ, located at Newark, New Jersey.

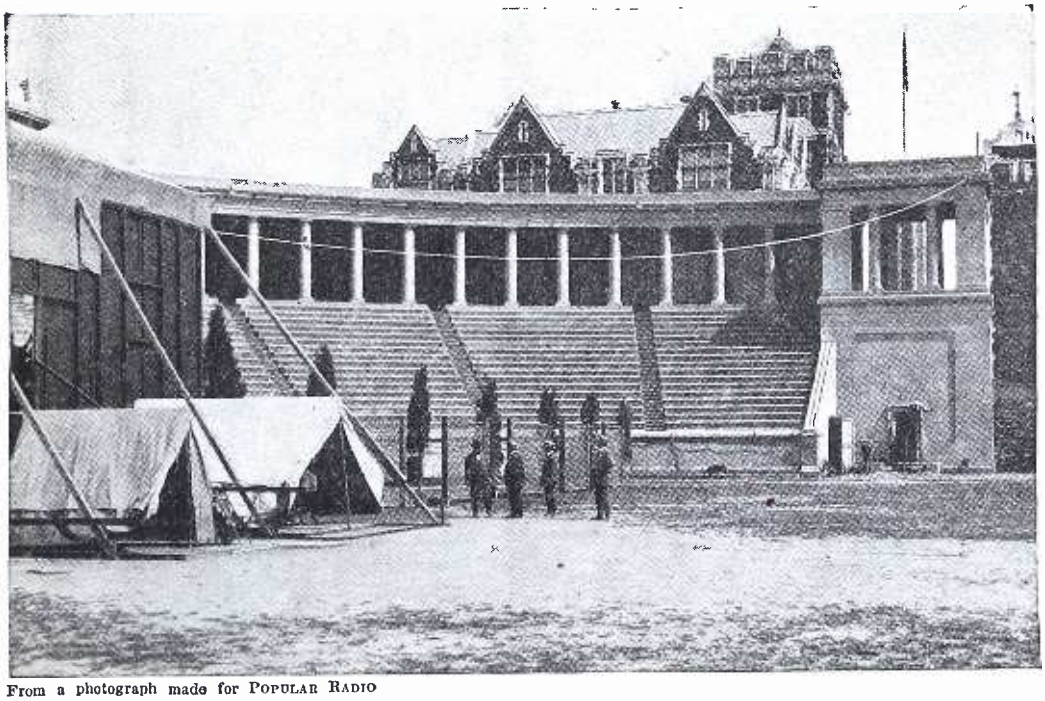
It is no small satisfaction that POPULAR RADIO feels in having initiated this enterprise and made possible a memorable and historical musical treat to the radio fans within an area conservatively estimated at 2,000,000 square miles.

The broadcasting of these concerts marks three notable achievements in the field of both music and radio:

First; it was the first time that the music of a great New York orchestra had ever been broadcast, or indeed the first time that any great symphony orchestra had ever been thus brought within the range of radio amateurs of any considerable part of the country;

Second; it was the first time that any outdoor symphony concert had ever been broadcast;

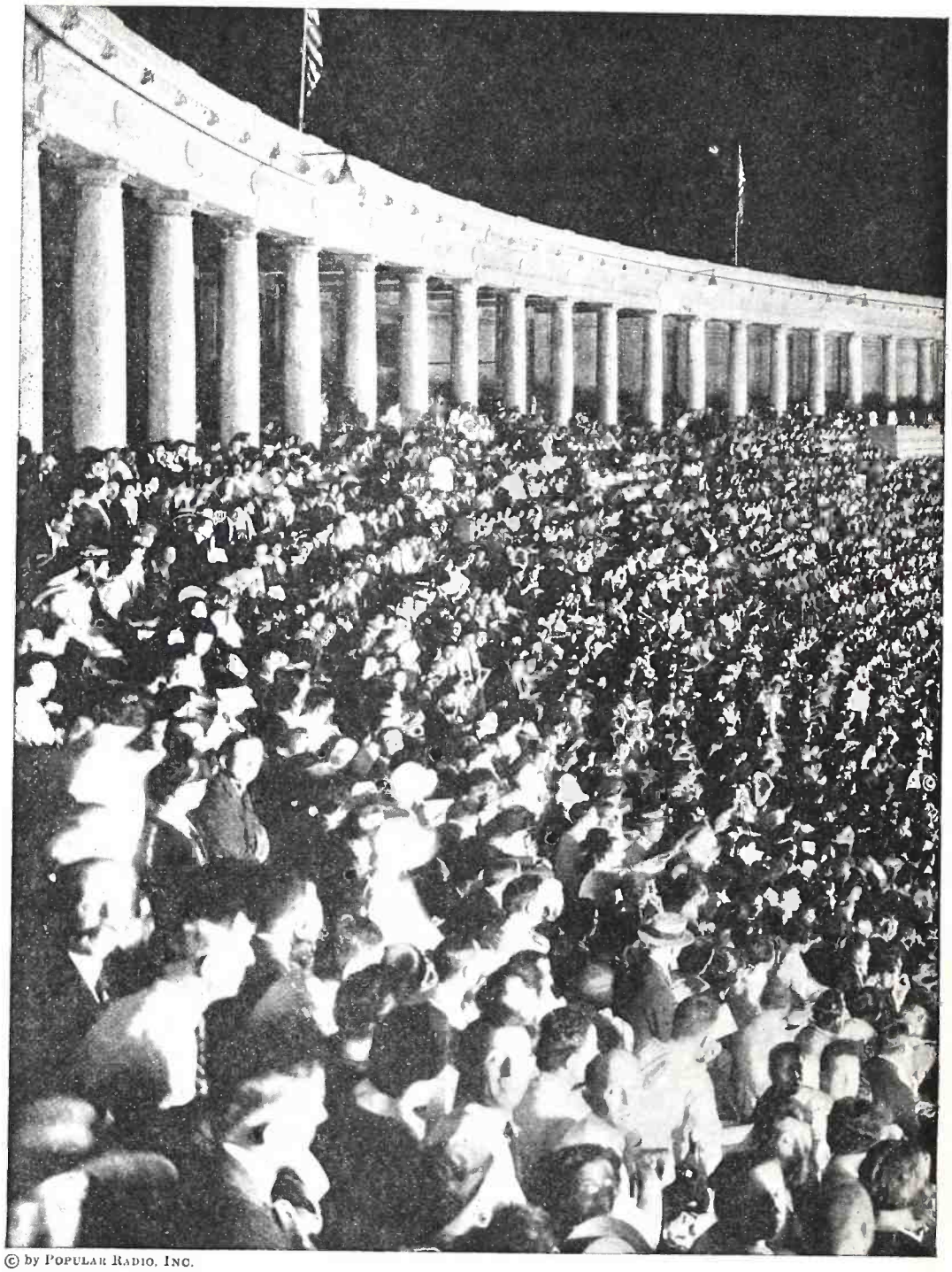
Third; it was the first time that symphony concerts had ever been transmitted by wire from the concert platform to a distant broadcasting station and sent out in its entirety through space.



From a photograph made for POPULAR RADIO

THE WIRE THAT CARRIED THE MUSIC

From the concert platform the special telephone wire connected with the Audubon telephone exchange, whence it extended to the broadcasting station in Newark.



The GREATEST AUDIENCE EVER ASSEMBLED AT ONE CONCERT—
The night of August 16th, 1922, will go down as memorable in the history of both radio and of music. On that occasion about 15,000 persons crowded into the Stadium of the College of the City of New York to hear the New York Philharmonic orchestra play a Tchaikowski-Wagner-Liszt program.

Photo by Drucker & Baltes Co., New York

—AND THE GREATEST CONCERT EVER BROADCAST BY RADIO

The music was transmitted by special wire from the concert platform by means of a microphone and sent out from WJZ to an audience estimated at 1,000,000—possibly a hundred times as many persons as appear in this remarkable flashlight, the largest outdoor flashlight ever made.

The plan for this unique undertaking was first proposed to the Stadium Concerts executives (Adolph Lewisohn, the donor of the Stadium in which the concerts were given, Arthur Judson, the manager of the series, and Cromwell Childe) by Kendall Banning, Editor of POPULAR RADIO. These gentlemen promptly seized upon the idea as a means of rendering a public service of a unique character. They realized that even if the Stadium was packed to the doors with standees, it could hold only a little more than 10,000 persons. Only ten thousand could hear at one time the noblest of symphony music, superbly played. But with the aid of radio the same program, with all its cadences, all its tones, all its beauties of musical imagery, might be listened to by tens and possibly hundreds of thousands, sent through space over an area that comprised practically all the country east of the Mississippi River, the eastern part of Canada, and that part of the Atlantic that is included within a radius of 1,500 miles. In other words, the Stadium audiences could be multiplied perhaps fifty-fold.

From a photograph made for POPULAR RADIO

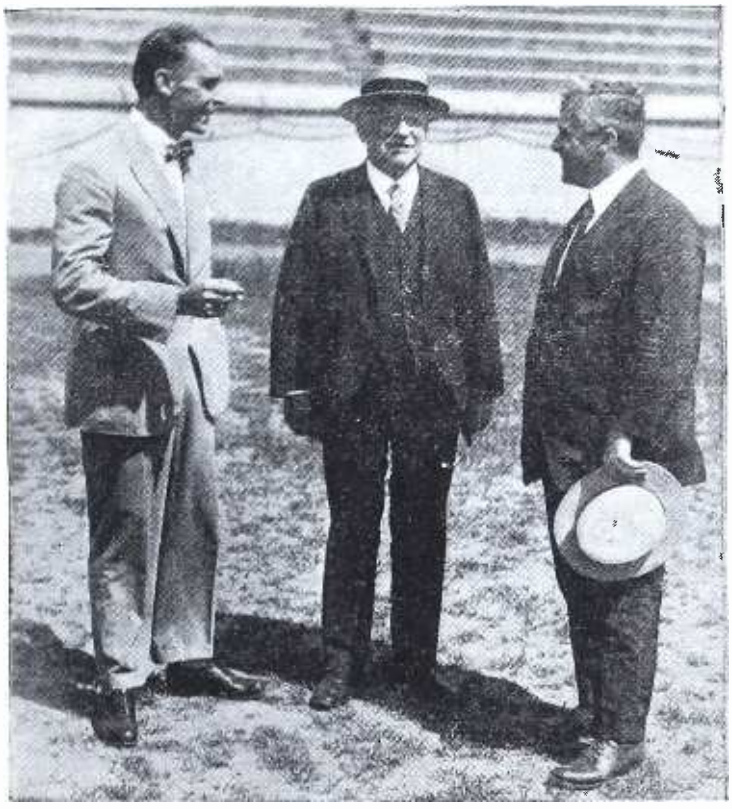
GETTING A LINE ON THE PHILHARMONIC ORCHESTRA

During the outdoor rehearsals on Thursday morning, August 10th, the telephone engineer completed the installation of the special telephone line. On the left is Dr. E. E. Free, and on the right Laurence M. Cockaday, both of the technical staff of POPULAR RADIO.

It was too good an opportunity to be disregarded. The Westinghouse Electric & Manufacturing Company, which operates station WJZ, was consulted; so were the executives of the American Telephone and Telegraph Company. Radio engineers of both companies were called in to study the many technical problems involved. The Westinghouse radio experts agreed with the technical staff of POPULAR RADIO that the experiment would be successful; the experts of the telephone company did not. Eventually, however, a special wire was put in and leased for the period of the concerts and the test was made—with results that are now a matter of radio history.

Radio equipment was installed that made possible the distribution of the Stadium concerts over a territory that represents a population of about 75,000,000 people, operating receiving sets roughly estimated at about 500,000.

The music of the New York Philharmonic orchestra was recorded by a special type of microphone developed by the Westinghouse Company. For the benefit of the uninitiated, it may be explained that this device, in appearance a small black cylinder, 4 inches long and 4 inches



From a photograph made for POPULAR RADIO

THE MEN BEHIND THE RADIO GUNS

At the left is William van Hoogstraten, who conducted the orchestra; in the center is Adolph Lewisohn, who not only gave the Stadium, but served as a patron of the concert series; at the right is Kendall Banning, editor of POPULAR RADIO, *who initiated the broadcasting project.*

in diameter, was suspended in view of the audience about 25 feet in front of the platform and about 25 feet high. It was supplemented by a second microphone located just in front of the orchestra leader's platform for the purpose of recording the soloists. These microphones converted the music (as well as the applause that followed) into an electric current of strength and character that varied in accordance with the character of the sound waves that impinged upon the diaphragm.

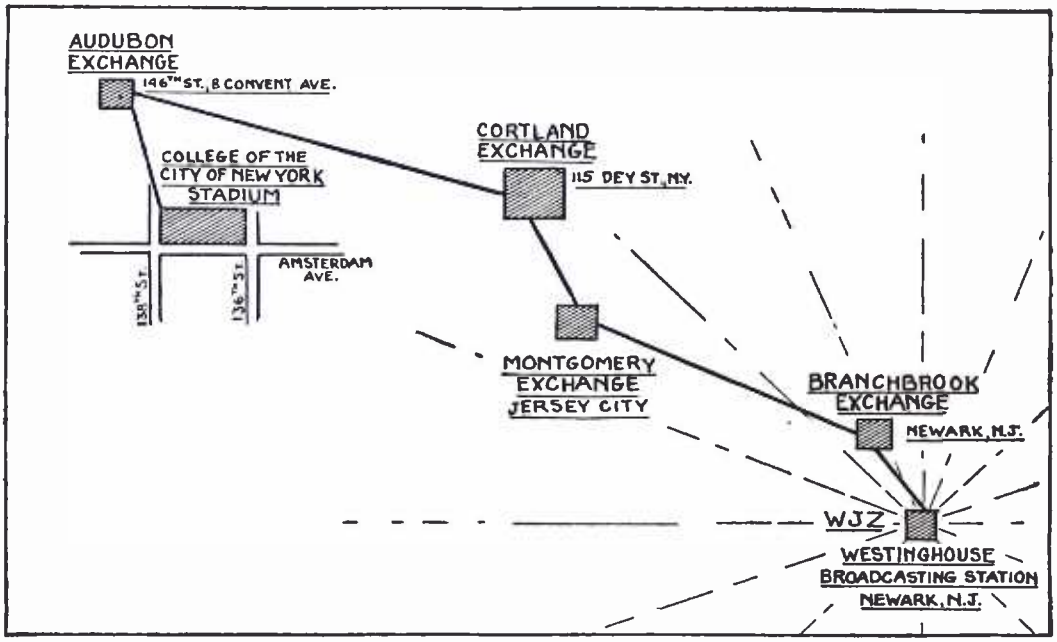
This current was then transmitted over the special wire leased from the telephone company. The wire extended through the various telephone exchanges to the famous broadcasting station WJZ at Newark, New Jersey—a distance of 25 miles from the Stadium. At the broadcasting station the electric current was amplified by means of special vacuum tube circuits; the amplified current was then impressed upon the modulator tubes of the transmitting set. These modulator tubes in turn varied the output of the radio transmitter in accordance with the same sound waves that were impressed upon the microphones at the Stadium. The music thus broadcast could be picked up by any radio receiving set that tuned in to the prescribed wavelength of 360 meters.

How many persons listened in on these concerts will never be known. Some estimates have run over a million. Steamship companies on the seaboard and on the Great Lakes were notified in time to tune in at the prescribed hours and thus permit their passengers to

participate in the event. Hotels did the same. The Astor Hotel in New York, to cite but one example, installed a receiver on its roof and dispensed with its own orchestra entirely on that occasion. Boy scout camps throughout the East tuned in on the advice of their general director, and amateurs generally recorded the experiment with something more than the usual interest, for it was a significant step in the history of broadcasting—and a step taken at a time when the future of broadcasting is still undetermined and fraught with uncertainties. It is perhaps worth more than passing notice that the first number on the first night's program to be heard in its entirety was, aptly enough, the gorgeous Symphonic Poem No. 2 of Saint-Saëns, "Phaeton"—the surname of the mythical sun god Helos, in which all radiant energy has its source.

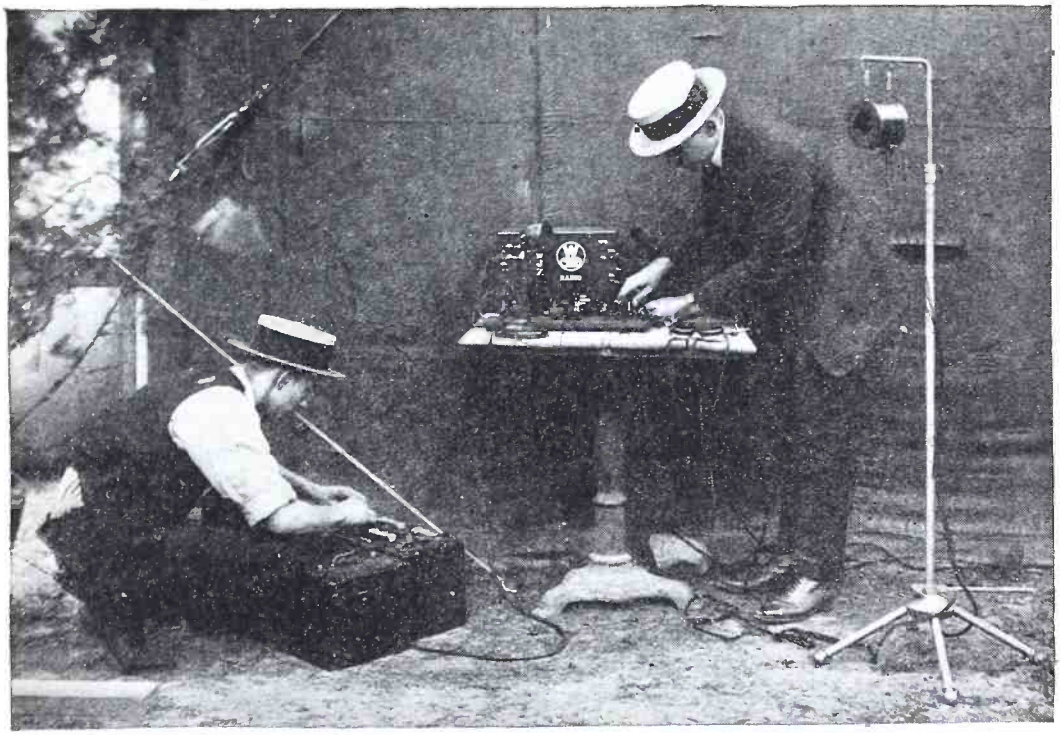
The significance of these concerts was not lost upon the press of the country.

"Cities which have no symphony orchestra of their own cannot hope for an opportunity to hear the greater organizations except at long intervals," observes the Philadelphia *Public Ledger* editorially. "This makes such a procedure as that of the New York Philharmonic the more welcome. Many wireless programs have been of the frivolous, frothy order, with the appetite of the devotees of jazz in mind. Here is an encouraging prospect of better things and an important aid toward an educated public appreciation of the best in music. When Sienkiewicz as a young man visited America he said he could find no music but that of the dance and a few lyric insipidities. There was nothing of Beethoven and the patriarchs—or even of the best of the moderns. How different would be the report if made today! Mechanical agencies of reproduction have vastly extended and intensified the personal effort of the artist. Never in musical history have artists, singly or in groups, had such a chance to be widely heard as they have today."



HOW THE CONCERTS REACHED WJZ

This diagram illustrates how the music was transmitted from the Stadium of the College of the City of New York to Newark—passing through four telephone exchanges (and under the Hudson River) on its historic journey across the State boundary line.



From a photograph made for POPULAR RADIO

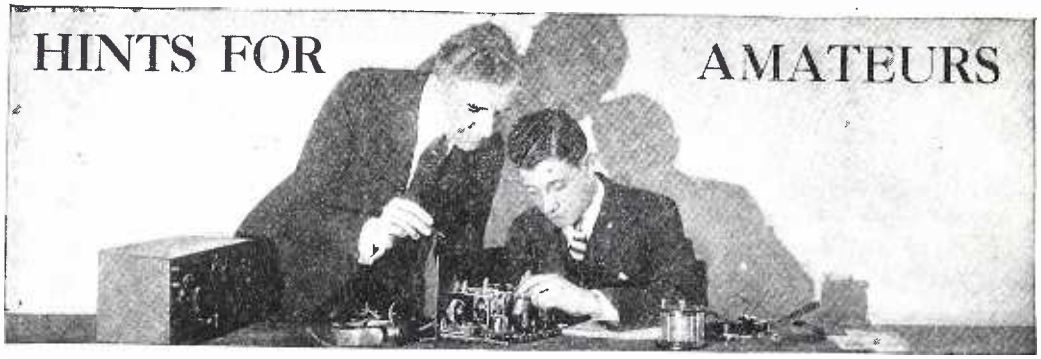
INSTALLING THE MICROPHONE AND THE AMPLIFYING APPARATUS

The microphone mounted on the adjustable stand (at the right) was used for recording the soloists; on such occasions the microphone suspended above the orchestra was not employed. The amplifying apparatus was located on the platform during the concerts. It was in charge of Harry Hiller, who is here shown making the preliminary adjustments. The installation was made by William Frazier, the Westinghouse expert on modulation.

The New York *Evening Mail,* always a champion of good music, stated editorially:

"Last night was sent into the air a concert at the Stadium of the City of New York. Over a thousand miles of land and sea the Symphony program rendered by a great orchestra was flashed and perhaps a million people enjoyed its harmonies. They were the people who were prepared to receive it. The notes of the symphony were there for all within the radius of a thousand miles, but only those who had the proper equipment were conscious of them. . . . It may not be beyond the bounds of possibility that man is on the way to the development of the senses that will open up boundless fields of adventure and delight."

For the success of this undertaking the gratitude of the radio fans is due in generous measure to the efforts of Mr. Charles B. Popenoe, who has charge of the WJZ programs and who lent his prompt and enthusiastic help to the project from the first; to Mr. Walter S. Gifford, Vice-President of the American Telegraph and Telephone Company, through whose timely participation the necessary telephone equipment and service was obtained; to the management of the Stadium Concerts; to Dr. W. H. Easton; to the distinguished conductor, Willem van Hoogstraten, to the members of the Philharmonic orchestra, and to the soloists, whose interest in the enterprise did much to make it the notable success that it proved to be. They have the satisfaction of knowing that their concerts were probably heard by a larger audience than ever listened to a concert before in all the history of music.



To GET the best results out of your detector tube you should use a variable "B" battery.

* * *

WHEN your set fails to receive, first make sure that you have your antenna "on" and all connections correct and tight and your tubes lit up, before tearing down your set to find the trouble. Sometimes it is some minor fault, such as a loose connection.

* * *

CRYSTAL detectors are easily knocked out of adjustment if some one bumps into the table upon which the radio apparatus rests; sometimes the vibrations of the building, caused by walking across the floor, shakes the apparatus. Many an amateur has been inconvenienced when the crystal has suddenly been thrown out of adjustment, by any one of these causes, in the middle of some interesting communication. This trouble may be reduced if not avoided by standing the receiving cabinet on a sheet of thick felt. The felt takes up the jars that affect the detector and knock it out of adjustment.

* * *

To GET all the fun and enjoyment out of radio, one should by all means obtain a buzzer practice set and learn the code. If a person goes to a foreign country to live, he will not be satisfied to talk to people who speak only his own language, but will also want to be able to understand what other people are saying in the language of the foreign country. If he will devote a small time each day to learning the new language, he will soon be able to speak well enough to make himself understood and to understand what others are saying, so that he will make new friends and get a better understanding of what is going on around him.

Learning the radio code will do the same thing for you and let you "in" on radio as you never would be without this knowledge. Fifteen minutes a day with a friend who is sending to you will accomplish results that you would hardly believe possible. Buy a buzzer practice set; it consists of a buzzer, a telegraph key, and a battery.

* * *

IT IS better to have a separate rheostat for every tube in a receiving set, because you may desire to use different makes of tubes and with only one rheostat for two tubes or more, the tubes may not match up; some will burn too dimly and some too brightly. Even if the same kind of tubes are used throughout, the filament adjustment of all the tubes is not always uniform.

* * *

FOR winding coils to be used for short wavelength reception, ordinary solid copper wire covered with a suitable cotton or silk covering will be found to be just as efficient as the most expensive multistrand wire, such as Litzendracht wire. On the higher wavelengths the multistrand insulated wire will be found to possess a lower high-frequency resistance. This will be found to be true on wavelength about 3000 meters; but below this wavelength the solid wire may be used

with results that compare favorably with the other wire.

* * *

A WAVEMETER is a device for measuring the wavelength of either a signal which is being transmitted from a station or which is being received at the station where it is in use. It consists essentially of an inductance or coil (or a number of coils for different wavelength ranges) across which is connected a variable condenser. When the variable condenser is rotated the capacity of the condenser changes, thus varying the frequency to which the circuit will respond. If we know the frequency to which the different settings of the condenser will correspond, we can easily find out the wavelength that corresponds to that frequency from a table of frequency and wavelength. Most wavemeters have a switch which permits the wavemeter to be used for determining the wavelength of either a transmitted or a received signal.

The use first mentioned is for tuning a transmitting set and the second use is for finding out the wavelength of another station which is sending at the time. A diagram of connections is shown in Figure 1.

* * *

WHEN the switch is thrown for determining the wavelength of the transmitting apparatus in the station, the wavemeter is really, in effect, a small receiving set without any antenna circuit. A crystal detector is used and when the wavemeter is placed somewhere near the coils of the transmitter, the wavemeter may be tuned by rotating the variable condenser till the signal is heard loudest in the telephones. When this is done, the wavemeter has been tuned to the same wavelength as the transmitter and this wavelength may be read directly off the calibrated scale of the variable condenser, which is calibrated in meters. In this way the operator may be sure that he is sending out signals of a wavelength that it is lawful for him to use.

* * *

WHEN the switch of a wavemeter is thrown for determination of the wavelength of a distant transmitter whose signals are being received, a buzzer is connected into the circuit and the telephones and crystal detector are disconnected. The wavemeter in this state becomes a small transmitting set and the coil of the wavemeter is placed in inductive relation to the coils of the receiving set in the station. The receiver is then tuned in the usual manner to the wavelength of the incoming signal, and then the buzzer in the wavemeter is set into operation by pressing a button on the wavemeter. This starts the miniature transmitter in the wavemeter sending out a feeble wave. The variable condenser in the wavemeter is then rotated until the sound of the buz-

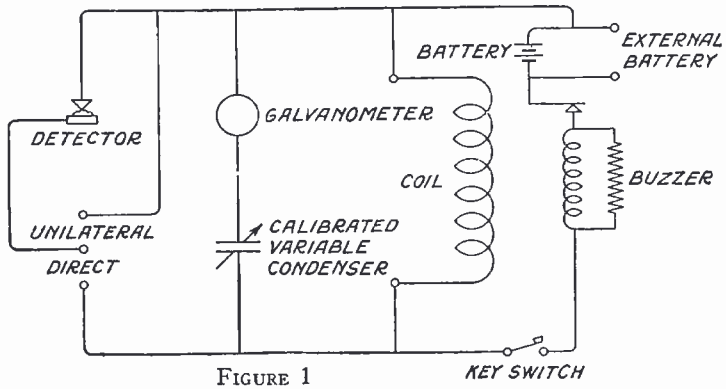


FIGURE 1

A diagram of connections of a wavemeter. When tuning a sending set, the telephones are connected to the two binding posts marked "unilateral"; for receiving, the two posts marked "direct" are used.

zer is heard loudest in the receiving set. When this is done the wavemeter, the receiving set, and the distant transmitting set are all tuned to the same wavelength, and this wavelength may be read off the scale of the wavemeter variable condenser. There is a pointer on the variable condenser which points out the correct reading as the condenser is rotated. A picture of a wavemeter is shown in Figure 2. Note the different-sized coils that may be inserted to get different wavelength ranges. The galvanometer is sometimes used instead of the crystal detector and telephones.

Now you can see how easy it is for the radio inspector to check up on your wavelength. Better watch out that your transmitting wavelength is within the lawful limits!

* * *

WHEN the novice starts to tune a new regenerative receiver he usually gets all kinds of squeals, squawks and grunts—but no signals. It is only natural that he blames the receiver. Sometimes he goes back to the manufacturer and claims that he has been cheated; that the apparatus does not work, did not work and never will work. The set is then tried out by the manufacturer or dealer and found to be satisfactory. The trouble in nine cases out of ten lies with the purchaser; he either does not rig up the set correctly or does not understand how to operate it. Most of the howling noises are caused by turning the regeneration dial around so far that the detector vacuum tube produces oscillations that combine with the incoming signals and start to squeak.

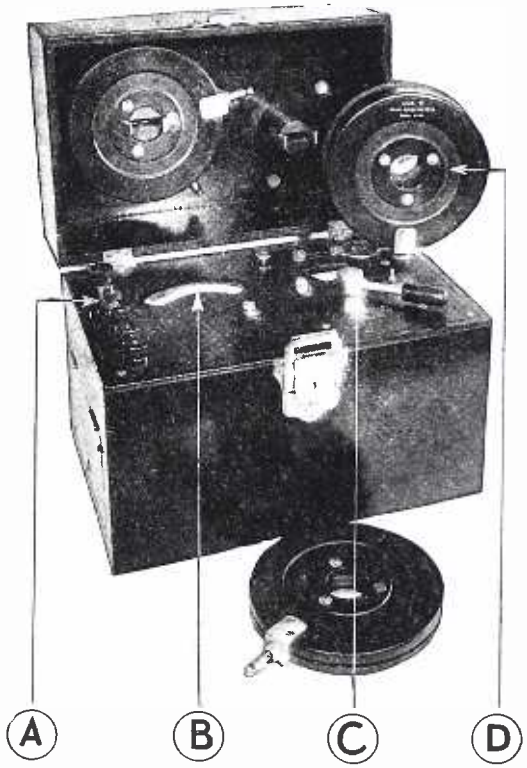


FIGURE 2

A wavemeter. A is the crystal detector, B the galvanometer, C the variable condenser and D the inductance coil.

Learn to operate your set before you pronounce it no good. Ask some friend who understands radio to operate the set, and have him show you how to tune it.

You would not think of purchasing an automobile and starting to drive it home if you did not know how to drive; you would not fool with the levers and switches on the car in the hope that you would pull one or push one that would start the car on the way homeward. Then do not expect to get results from your radio set until you understand at least what the different knobs are for, and have had a little practice tuning in the different wavelengths. "Practice makes perfect" in radio as in everything else.

* * *

YOU can make serviceable binding posts out of 8-32 round head machine screws, a nut to fit, a couple of washers, and a round thumb-nut off the top of a worn out dry battery.

* * *

"HOWLING" in an amplifier can sometimes be stopped or reduced by adjusting the filaments of the vacuum tubes. If this fails, try attaching a wire between the negative terminal of the "A" battery and the ground. Another idea that helps is to ground the iron cores of the amplifying transformers.

HELP *your neighbor. If you have discovered any little Kink that helps to eliminate trouble in your radio apparatus, or if while experimenting with the connections of your set you should run across some interesting phenomenon, or if you should discover some new hook-up that gives better results—send it to the "Listening In" page.*

Who Says "There Are No Ether Waves"?

THE now famous article that appeared in our July issue, "There Are No Ether Waves," with which the distinguished physicist, Dr. Charles P. Steinmetz, stirred up the world of radio, has brought forth a flood of "replies" and inquiries from laymen and scientists alike. Space forbids the publication of more than a small fraction of these communications, but here is a short and pointed one from Louisiana that furnishes food for thought:

I have read with interest the article by Dr. Charles P. Steinmetz in which he calmly brushes aside the consensus of opinion of a dozen great scientists and substitutes for the hypothetical ether of space an even more hypothetical "storage of energy in space," which he does not analyze, explain or apparently admit the possibility of explaining. Men of science the world over will judge whether the great electrical engineer is a greater electrician than philosopher.

Herbert Spencer was the father of the theory of the relative nature of anything cognizable, and Spencer (who was the parent of modern psychology) proved that the brain, as the organ of the mind, had certain well-defined limitations that made impossible a knowledge of anything except the relative. The absolute is unknowable; as Jack London put it, "There is no God but the Unknowable, and Herbert Spencer is His prophet."

Theories and generalizations are dangerous. The circular motion of a fly-wheel is an absolute motion, certainly not a relative one. The onward motion of a projectile, on the other hand, is purely relative to other matter as far as we know. The theory evolved by Spencer and applied to physics by Einstein neither proves nor disproves the "hypothetical ether." The greatest relative motion of stars scarcely exceeds 1,000 miles a second. This fact proves to my mind the soundness of the ether hypothesis. Friction is a property of organized matter, not of a homogenous solid—a fact that Steinmetz ignores in the tenth paragraph of his article. For if matter itself is a mode of motion in the ether, as the mathematical relationship of atomic weights certainly indicates, then there could be no friction between a homogenous solid and a spherocentric vibration in it. (I refer to a spherocentric vibration as the ultimate unit of matter, since only spherocentric vibrations can attract each other in a homogenous medium.) This theory of gravitation is easily proven. Drop two pebbles in a pond of still water; the waves radiate from two oscillating centers. Close observation will show that the centers tend to approach each other.

All the other phenomena of matter depend upon attraction thus explained, upon the radiation of the spherocentric vibrational energy with the gradual decay of matter, and upon "beat" frequencies similar to those of radio but much more rapid. The rapid radiation of energy seemingly makes this theory untenable, but the interaction of a vast number of such spherocentric vibrating points in the ether would tend to inhibit such radiation. That is why gravitation is comparatively such a weak force.

Let's have more articles by the real heavyweights, and Steinmetz certainly is one of them.

JACK ROGERS

* * *

How to Use a Regenerative Set as a Telephone Transmitter

TWO amateurs by accident find out that they can hold two-way communication between their houses by inserting microphones in their ground circuits. This is how they do it:

A friend of mine who is a radio bug lives a distance of about one block from my

Special Press, London

THE HUMAN BODY AS AN ANTENNA

If we were less conscientious we might start out to describe this picture in some such manner as this: "Aerials eliminated through the use of a wonderful new invention"—and then tell how to wrap a few antenna wires around one's body and receive radio signals from Europe. This would give a thrill to the layman and to the novice, and would probably cause a bit of talk at the dinner table. But it would not be the truth. The picture actually shows a man seated in front of a very sensitive receiver that uses radio frequency amplification (five vacuum tubes) with a wire, one end of which is fastened to the antenna terminal of the set, wrapped around his body. The other end of the wire is connected to the ground terminal of the set. The coil thus formed is in reality a horizontal loop antenna, and the set would function if the man were to wriggle out of the loop entirely. The body serves to add only slightly to the distributed capacity of the loop. With any set that employs three or more stages of radio frequency amplification the same results should be obtained. But the novice is warned that this is only an entertaining stunt and is nothing to get excited about.

house. One day I was listening in for amateurs, and I heard a weak voice saying:

"Hello, mother; can you hear me? All right, I'll sing a little song."

With that the voice proceeded to sing "Yankee Doodle." Now Bill has a voice that nobody could mistake and the more I listened the more I was sure it was my friend Bill with a new radio telephone transmitter.

I rushed over to his house and when he opened the door I shouted, "Where is it?"

"Where's what?" he said.

"The new transmitter," I answered. "I heard you."

Then he explained that he had taken an old telephone transmitter and "just for fun" he had connected it in series with the ground wire. Then with the set oscillating, he had spoken into it and was astonished to hear his voice repeated clearly in the telephones which he had on his ears at the time. He induced his mother to listen at the ear pieces while he talked to her. It was at this point that I had caught his voice over at my own house.

After the excitement was over Bill suggested that I get an old unused telephone transmitter and he would listen-in at his house for me, as we both had the same kind of single circuit receivers. I did so, and Bill reported that he heard me very well.

After a week of experimenting with other transmitters and using amplifier tubes and higher voltage "B" batteries we can talk back and forth with our receiving sets. Bill has done four blocks with his set.

ALBERT LANGLY

* * *

How to Restore Worn-Out Crystals

DO your crystals wear out quickly? Often this is because they are dirty. A reader tells how he brings back the

sensitiveness of his crystals. He writes:

> I have found that I can bring back the full rectifying qualities of my worn-out and dirty crystals by immersing them in a bath of alcohol for fifteen minutes and then allowing them to dry. The hands should never touch the crystals, as a minute coating of dirt or grease is thus smeared on the surface and an imperfect contact is made by the little adjusting spring.
>
> A. K. BENTON

* * *

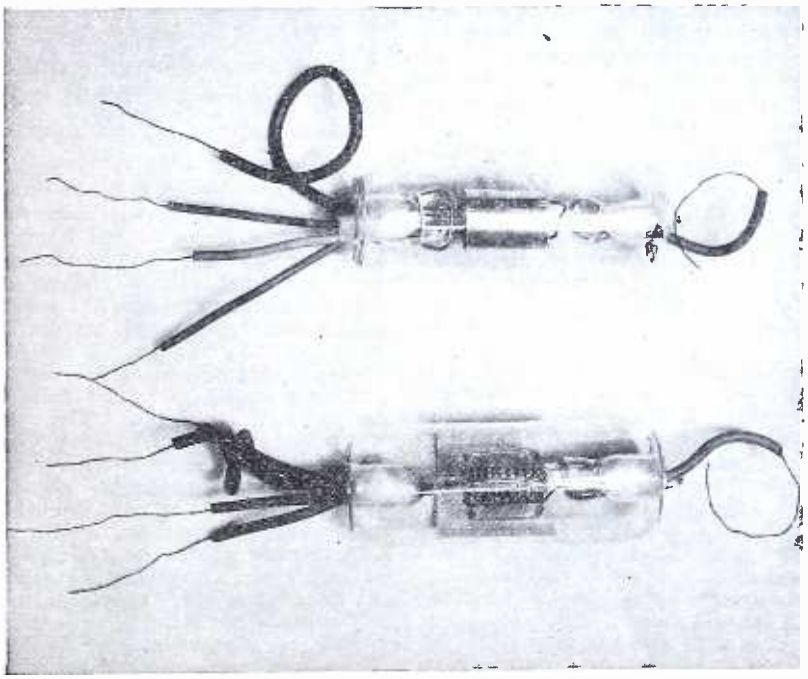
Vacuum Tubes *from* Japan

JAPAN, with her great fleet of merchant vessels as well as war vessels, is keeping abreast of the times with her radio equipment, and following her general policy in other lines, she is "making her own." Here is a letter from a radio operator who recently visited a factory in Tokyo:

On a recent trip through the Far East it was my misfortune to have my one remaining detector tube smashed by a pet ape that had become attached to the expedition as a sort of mascot. My attempts to obtain vacuum tubes had resulted in all sorts of glass-blown objects being submitted by the native merchants in their anxiety to make a few American dollars. An interpreter would listen to the detailed description of the triode and would give assurance that he knew exactly what was wanted and just where it could be obtained; and in a few hours an electric light bulb or a perfume atomizer or a Turkish water pipe—blown glass of every description—would be laid at our feet. At length we were informed by a Japanese radio operator at Yokohama that if we would journey to Toyko we could find what we wanted at the Anaka Wireless Works. So in desperation we started for Toyko.

When we arrived we transferred from the train into rikshas. Considerable trotting up one narrow alley and down the next brought us to the factory. After the necessary diplomatic ceremonies, the manager invited us to inspect the plant. Great was our surprise to see so much highly advanced radio apparatus in process. Complete receiving sets, transmitting sets, motor-generators, radio compasses—everything imaginable in the radio line was there, and most of it was being made by quaint little slant-eyed Japanese factory girls.

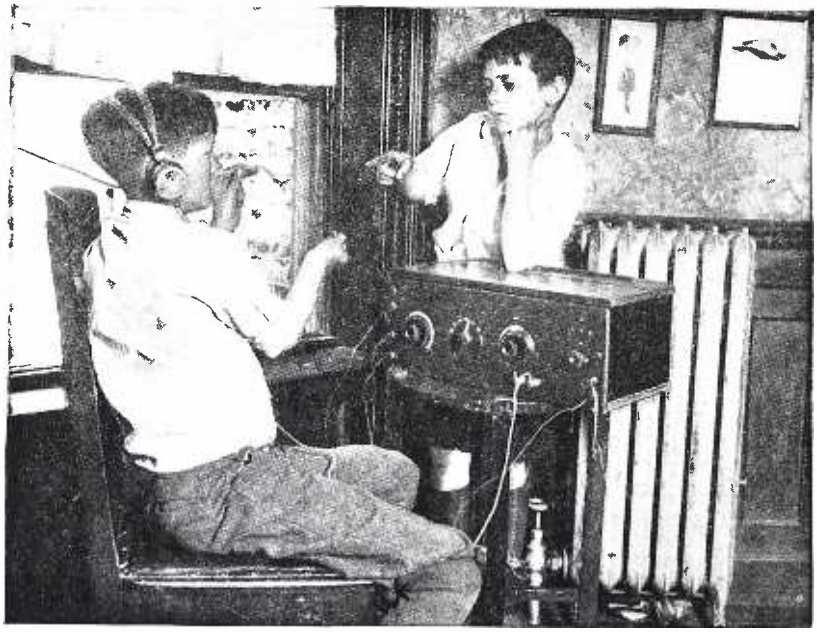
At length we were ushered into the vacuum tube department, where we found hundreds of the precious articles being turned out by the same pretty little girls. Their dainty hands deftly mounted the delicate filament wire, adjusted the grid and plate, formed the hot glass; as we watched them several tubes were completed. We marvelled at their



From a photograph made for POPULAR RADIO

VACUUM TUBES WITH A JAPANESE ACCENT

The detector tube at the top is copied from an American model; the amplifier tube below it differs from our tubes in that it uses a second grid instead of a plate.



Kadel & Herbert

STRINGING THE LANDLORD

These young amateurs were forced by their lightning-scared landlord to take down their aerial on the roof. But they obtained a wire-core rope which they strung to the clothes-pole, thus combining the functions of clothes-line and antenna. The landlord has not discovered the subterfuge yet.

speed and accuracy, and were informed by our guide that these girls work on the plan we know as "piece work." We acquired a few of these tubes at a price equivalent to about $2.50 in American money.

Specimens of these tubes are shown in the accompanying illustration. We tried them with good results. One type is constructed with a square glass cage about the filament and grid. Upon this cage is wound a fine wire, about 18 turns; this is the plate. Another type has the conventional sheet metal plate curved about the other elements. Each tube is constructed with two filaments and one extra connection, so that when the first filament burns out the other filament may be used.

These tubes are furnished unmounted, with flexible rubber-covered leads protruding for connection. About 50 volts are required on the plate, and from 4 to 5 volts on the filament, which draws less than ½ ampere. This means that these tubes consume about half as much current from the storage battery as do American tubes. The detectors were found to be sensitive but critical, and the amplifiers not quite as efficient as the Yankee brands.

Radiophone transmission is being taken up seriously by the Japanese navy and army, who have produced several successful designs which are now being used on the ships as well as shore stations. But radiophone broadcasting in Japan has not as yet been started.

E. Jay Quinby

What Would You Have Done?

HERE'S a letter from Fall River, Massachusetts, that raises an interesting problem—which is solved in the present instance with commendable tact:

At the home of a radio amateur in town there were gathered a dozen people who had come to listen to a radio concert. They had been sitting about for an hour and a half, and one by one the broadcasting stations audible at that antenna end were signing off for the night. The operator was twirling the knobs and trying to put up the latter end of as many concerts as he could. Suddenly, there was music—strange distorted music, getting a note in here and there between the instrument's complaints. The operator tuned down and the strains of the "Star Spangled Banner" filled the room. Five people tittered and two laughed outright.

"Do we have to stand?" one of them asked.

"I think we ought to," ventured one.

A moment of discomfort followed, in which no one spoke or moved. Unwilling either to sit or to stand, these people did neither.

"Oh, let's not stand," laughed a listener.

"But we ought to"—the speaker half rose to his feet.

"We'll settle *that* question," said the operator. "We'll not listen to it." And he tuned it out!

Arthur G. Shirt

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.

THE flood of inquiries that has poured in upon the Technical Editor has not only furnished evidence of the need of this department; it has also necessitated a system of handling the correspondence that will insure the selection of and answer to only those questions that are of the widest application and that are, consequently, of the greatest value to the greatest number of our readers. Our correspondents are, accordingly, asked to cooperate with us by observing 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: I have built the loose-coupled set as described in the July issue. I am not allowed to put up an aerial on top of the building. What other kind could I use? I am about four miles from the broadcasting station. Could this set be changed to a vacuum-tube set?

J. GIVEN

ANSWER: In this emergency you can run insulated wires in back of your picture moulding throughout your house and use it for an antenna. This should enable you to pick up the broadcasting at this short distance. There is no fire hazard in such an indoor antenna. In a near future issue of this magazine we will publish an article telling how to increase the range of the set described, by the addition of a vacuum-tube.

* * *

QUESTION: I have a Clapp-Eastham Type HR Radio receiving set and want to learn the dots and dashes so that I may read the code messages. What is the best way to learn this, and from what concern may I obtain the radio alphabet?

SIDNEY RAND

ANSWER: Consult the article by Paul McGinnis in the July issue, "How to Learn the Code." You may obtain a copy of the code by writing to the radio inspector of your district, or by sending to the office of the Secretary of Commerce for a copy.

* * *

QUESTION: While listening on my radio set, my brother upstairs happened to start tapping on his telegraph instruments that he has connected up on a board. While I could hear the outside sound only faintly, I could hear the ticks in the phones very distinctly. Can you explain this please? Also please give me a hook-up for an audion bulb connected to the set shown in the July issue.

H. STIBBARDS

ANSWER: The phenomenon you describe was caused by induction. The coil magnets in the telegraph sounder sent out feeble magnetic disturbances which were picked up by your set and made audible as clicks in your telephones. An article in a near issue of this magazine will show you how to increase the receiving range of the set described by the addition of a vacuum tube.

QUESTION: Which is the better tuning inductance, the spiderweb coils or the loose coupler?

MILTON DEWITT

ANSWER: Both types of tuners have their advantages and disadvantages, but you probably will get more satisfaction out of the spiderweb coils if used with variable condensers, as this affords an easy and efficient means for tuning.

* * *

QUESTION: I have an audion detector and short wave regenerative set hooked up and composed of standard parts. I have two detector tubes; when I listen I have to put up with a high-tensioned squeal. One tube is as bad as the other, yet when I take the tubes over to a friend's house they work with the best of results. My set works well except for the whistle. In my location I hear WJZ, KDKA, WGY, WGR, 8QB, NOF and many others. Could you tell me what I can do to stop that irritating squeak or whistle? Could it be my ground or aerial system?

S. L.

ANSWER: The trouble is not in your antenna or ground connection; it has entirely to do with your vacuum tube circuit. You are not explicit in describing the symptoms; there are many causes for whistling in a regenerative receiver. Sometimes it is caused by having the regeneration control turned around too far; this causes the tube to oscillate, and the combination of the received frequency and the generated frequency in the tube cause a "hetrodyne" action, thus producing the whistle. Another cause of whistling is the use of excessive filament current. Try turning down the tube rheostats a little. Still another cause is the use of a slightly excessive "B" battery potential on the plate of the tube. Try reducing this voltage a cell at a time and see if this doesn't remedy your trouble.

* * *

QUESTION: I have a small A. C. Thordarson toy transformer having a voltage ranging from 2 to 28 volts in steps of 2. Is it of any use in radio?

ANGEL F. BRUNO

ANSWER: This transformer is of no use in a receiving set, but it might be used in connection with a Tungar rectifying tube for charging your storage batteries. It could be used advantageously in a tube transmitting set for lighting the filaments of the tubes.

QUESTION: Please give me some details on how to construct a loop antenna for listening to broadcasting on 360 meters. What kind of wire shall I use? How much shall I use? Can it be placed on the second floor or the first floor of an ordinary dwelling, or must it be on the roof? How will the results compare with my one wire 100 feet long and 25 feet high outside?

C. L. SIGLER

ANSWER: A loop suitable for use on 360 meters may be made by winding 12 turns of No. 18 copper wire, covered with a single cotton covering, on cross-arms which can be mounted as shown in Figure 6. The length of the arms should be 3½ feet. The turns should be spaced one quarter of an inch. The two ends of the wire are attached to the receiver. The loop may be placed anywhere in the house, close to the receiver. Using two stages of radio frequency amplification you should get the same results as you would with the detector alone on your outdoor antenna. With two stages of radio frequency amplification and two stages of audio frequency amplification you should be able to hear the broadcasting all over the house using a loudspeaker. See Figure 1.

The loop antenna is directional in a line of its planes.

* * *

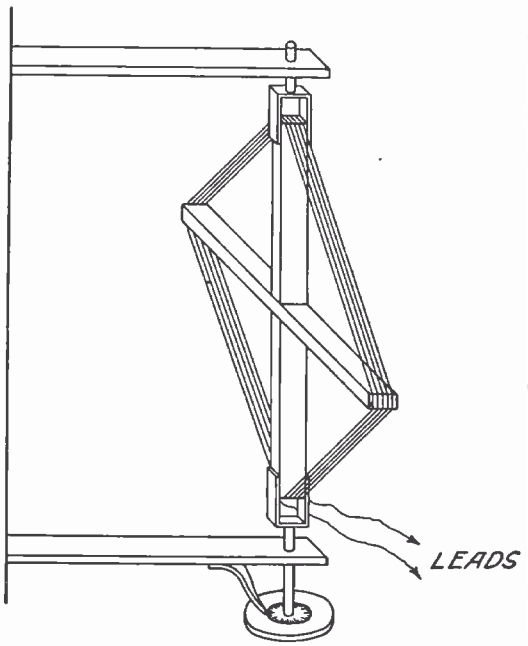


FIGURE 1

A loop connected to a receiving set that is equipped with suitable amplifiers is effective in tuning out directional interference.

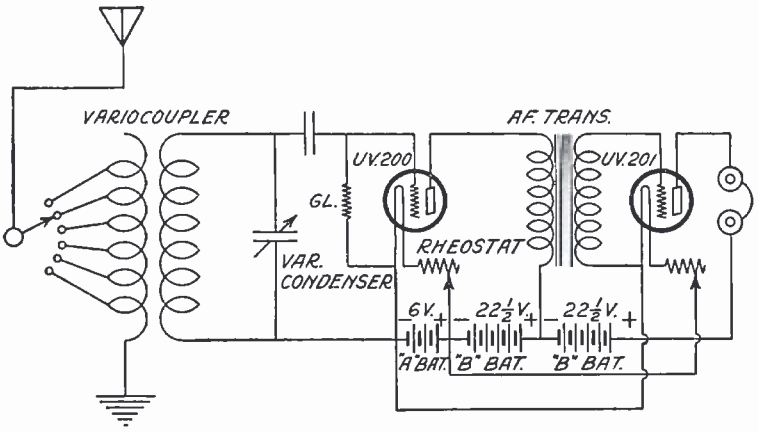


FIGURE 2: *A straight audion circuit with one stage of audio frequency amplification, employing a variocoupler and a variable condenser for tuning.*

QUESTION: I have the following radio parts. Could you give me a hook-up with which I could receive the broadcasting programs?

1 Variable condenser
1 Variocoupler
1 Grid condenser
1 Grid leak
2 22½ volt "B" batteries
1 6-volt storage battery
1 Pair telephones
1 UV-200 tube
1 UV-201 tube
1 Amplifying transformer
2 Tube sockets

LEE TUCKER

ANSWER: Figure 2 will show you how to connect your instruments. You will need two 5-ohm rheostats for controlling the filament current of the tubes.

* * *

QUESTION: I have a radio set which will receive a distance of forty miles, but the nearest broadcasting station is seventy-five miles away. Is there anything that I can do to receive over that distance?

TOM SHORT, JR.

ANSWER: You may add one or two steps of audio frequency amplification to your present receiver; and by doing so you will undoubtedly increase your receiving range up to, if not beyond, the distance that you mention. Such an amplifier was described on page 142 of the June issue of POPULAR RADIO, and diagrams and photographs of the apparatus will also be found on the same page.

* * *

QUESTION: I am going to get a government amateur license and am wondering what kind of a transmitter to install. I had two kinds picked out which were within my means; one was a spark set and the other was C.W. My aerial would be about fifty feet high and of the cage type; my spark transmitter would be a two-inch coil with an open gap and helix. My C.W. transmitter would use an amplifier vacuum tube with 112 volts on the plate. Of course I would use it for telegraphy only. Which one would you advise me to install, not figuring on cost or up-keep? Which one would send the farthest for telegraphy?

ASHLEY C. DIXON, JR.

ANSWER: We would advise you without reservation to install the C.W. transmitter, as it is the most modern and the most efficient. In the August issue of POPULAR RADIO, on page 294, is a hook-up of a one-tube transmitter which would be suitable for you to use. Of course you may use the UV-201 tube instead of the larger 5-watt tube recommended. In this case you would not use the motor-generator as shown but you could substitute 110 volts from a "B" battery or else use the 110 volts A.C. house lighting current for telegraphy. The C.W. set will send much farther than the spark coil.

Other advantages of the C.W. set include quiet operation—without the noisy spark displays; sharply-tuned emitted wave, with small interference, and compactness.

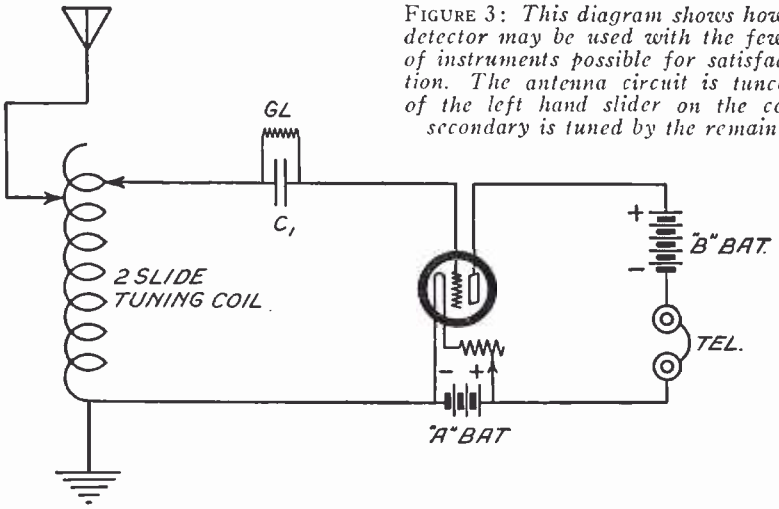


FIGURE 3: *This diagram shows how the audion detector may be used with the fewest number of instruments possible for satisfactory operation. The antenna circuit is tuned by means of the left hand slider on the coil, and the secondary is tuned by the remaining slider.*

QUESTION: How would a two-slide tuning coil be connected to the vacuum tube set described by A. Hyatt Verrill in the June issue of POPULAR RADIO? Please illustrate by a diagram.

BURNETT COOK

ANSWER: The tuning coil should be connected as shown in Figure 3. No variable condenser is necessary when this type of coil is used.

* * *

QUESTION: Will you kindly show me a hook-up of an installation of a lightning ground switch?

THOMAS HEDGES

ANSWER: The connections for the installation of the lightning switch are shown in Figure 4.

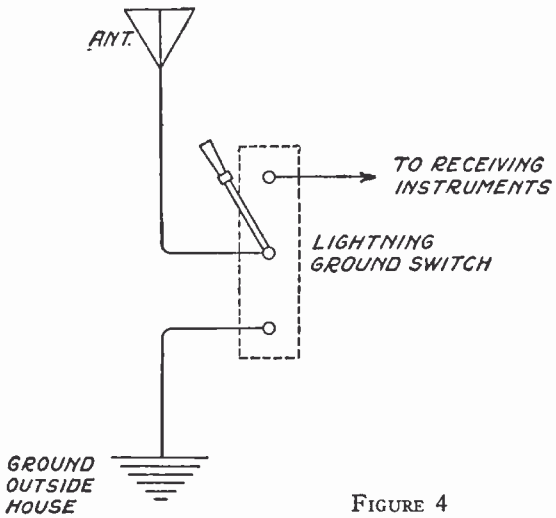


FIGURE 4

QUESTION: Please give a hook-up for a C.W. telegraph and telephone transmitter using one 5-watt tube and "B" batteries on the plate.

ORVIL WILSON

ANSWER: On page 294 of the August issue of POPULAR RADIO you will find a circuit for a 5-watt transmitter. You may substitute the "B" batteries for the motor-generator, in which case you may eliminate the filter circuit. This circuit is suitable for your needs.

* * *

QUESTION: Will it make any difference to my set if I join the ends of my aerial? Can you show me how to wind a honeycomb coil?

HAYWARD HEWSON

ANSWER: It will help in transmitting slightly if you make the proposed change. We would not advise you making your own honeycomb coils, as they can be bought at less expense than the time expended on making would be worth. The home-made coil would not be as efficient.

* * *

QUESTION: Has an antenna 35 feet high much advantage over one 25 feet high for receiving? Is it advisable to have antenna wire and lead-in wire in one piece?

ANONYMOUS

ANSWER: The effective height of the antenna would be increased, therefore the antenna would be more efficient. If the antenna wire and the lead-in wire are not one piece, they should be soldered. When soldered connection is made between the two pieces they will be as suitable as one continuous length.

ADVENTURE IN THE AIR

WHAT *is the biggest thrill YOU ever got over the radio? Have you ever picked up a call for help? Or located a lost friend—or helped to run down a fugitive, or listened in on a conversation of peculiar personal interest to yourself? For every anecdote, humorous or grave, ranging from* 50 *to* 300 *words in length, the Editor will pay upon acceptance. Address contributions to the Editor,* ADVENTURE IN THE AIR DEPARTMENT, 9 *East* 40*th Street, New York City.*

I Share the Thrill That Comes But Once in a Lifetime

OUT of the wilds of northern Canada comes this true story that carries with it something of the ring of triumph that we associate with tales of struggles of the heroes of old—only in this case the heroes are eminently modern and characteristically American:

It was the night of the trans-Atlantic tests, December 11th, 1921, to be exact, when (as all the world now knows) the members of the American Radio Relay League were trying to push their 200 meter signals over to England.

I was back in the heart of the bush in the northland of Canada on this particular evening. I had difficulty in keeping the shack warm, owing to a snuffling 30-below wind which found every unplugged crevice in the rough building. The day had been a hard one—most days usually are back here—and for an hour I had been listening to the "free for all" gang of amateurs. Some of their transmitters wheezed asthmatically, some trumpeted sonorously, and other C. W. signals came like the moaning of lost souls. After them came those amateurs who had qualified for special schedule tests by successfully transmitting over 1,000 miles overland in the preliminary tests.

It thrilled me to realize that I was listening to the cream of American amateurs, endeavoring with their pet equipment to fling the paltry energy of a few dry cells across the ocean wastes to throbbing England. Paul F. Godley was over there—somewhere—listening. As I slowly moved the variometers I would hear 3DH of Princeton studiously sending his cipher and call letters, followed by IARY, who would valiantly swing in, reminding me of soldiers snatching the swords from the hands of fallen comrades.

It was close to 1:00 A. M. and I still sat listening to the boys pleading across the dark Atlantic for a hearing—broken only by outside sounds of wolves howling faintly and the creak of moosehide thongs as my dogs outdoors grew anxious for battle. I had been looking forward to these tests for months and had the receiver tuned to a hair. Indeed I had twice mushed fourteen miles to the Post Office through a blizzard and bad drifts for a spare bulb which never arrived.

And now the time so much anticipated was here. Would we fail to get across to-night? We fell down last night. I will never forget the miserable pang, when, after a three hours' vigil checking up the strength of various stations' signals and speculating as to who would or should get across, I heard the monotone chant from MUU:

"No signals heard."

Was the task of getting through on 200 meters to Europe impossible? Some of the cleverest men in the radio world had said it was.

Thus the minutes slipped on, my mind first going over the fizzle we made of the last attempt during the early part of the year, wavering with doubt over last night's "No signals heard" from Godley, only to be eventually buoyed up by new hope which fed on dying hope.

During the tests I had removed the aerial and ground from the set, and still some of the boys pounded through to me—here in an Arctic world—on the edge of everything!

It was 1.59 A. M. I snapped in the honeycomb coils on the long wave set, threw the aerial switch over to the 300 foot single wire, and began sliding the condensers over for Paul's message from MUU at 2 A. M. On my way up I passed the Old Reliables, NDD the fiddler, NPM the hand-bell ringer, and WSO the blacksmith. I was busy juggling out WII and WGG (scratching a clean, quiet spot for MUU) when—I heard the sweetest music that ever passed across a vacuum tube. It came

like a vesper to a tired soul at eventide, over the seas from Canarvon, Wales—over a hundred blazing cities and leagues of darkened unmapped forests—right into this little shack here, nestling in the curving snowbanks of a white wilderness, telling me that Godley had "heard amateur signals from America in Scotland!"

Did I hear aright? Had I fallen asleep and just dreamed this thing? With dropped jaw I heard WII repeat Godley's message to our headquarters at Hartford, Conn.

A surge of emotion swept over me as I removed the receivers and dropped my head on my arms.

It had been done.

An American amateur, crouched on Scotland's bleak coast in the chattering misery of an icy, slanting rain, had accomplished a feat which has placed puckers of new thought on the broad brows of those eminent scientists who had smiled behind their hands. The American amateurs had achieved the "impossible."

M. J. CAVENEY

I Help Save a Child's Life

NOT often does a radio operator get the coveted opportunity to render service as came to the New Orleans fan who sends in this adventure:

I was stationed on a lonely island as radio operator for a prominent radio company. The only other means of communication with the cities was an uncertain and slow mail service by boat twice weekly when the weather permitted. I was alone at the station and so had certain schedule hours for working during the day and night. During the summer a few visitors came to the island for the bathing, and they used the radio service more or less to keep in touch with home matters.

One day there came to the island a prominent man with his wife and their little girl. The child was taken violently ill during the night. The distracted parents were at a loss as to what to do until the father came to the station, waked me and asked to get in touch the family physician in a nearby city.

I started my engine, got the station I wanted and asked the operator to get the physician on the telephone and have him hold the wire. He inquired how the charges were to be handled and I told him to keep a record of everything sent and received, also the telephone charges if any, and that my party guaranteed everything. There was no delay in getting the physician on the wire. I gave him the name of the party and described the symptoms; the physician in turn asked questions which were repeated to me, and I relayed the answers back to him. He then prescribed treatment and asked that we call him again in a few hours to let him know if the patient was relieved.

In a short time the father was back at the station and asked me to get the connection again and advise the physician that the pains were gone and the child was sleeping quietly; this was done and the doctor advised an immediate return to the city. Before leaving the next day both father and mother came to the station and were profuse in their thanks for the radio service.

This was the first time I had seen radio used in such manner and it made a deep impression on me. Without the radio service it would have been impossible to get medical advice promptly. It is probable that the radio saved the little patient's life.

GEORGE F. PATRICK

I Unfathom a Strange Phenomenon in the Head Phone

ONCE upon a time some college students carefully attached the wings of one kind of bug upon the body of another insect and submitted the result to their professor for classification. "This," announced the old gentleman gravely, "is a humbug." Possibly the second operator mentioned below was a student in the same class:

I relieved Bert Lane, the second operator, at six o'clock in the evening as usual. I picked up the magazine I had discarded when relieved from my morning watch, arranged the phones comfortably and lit my pipe. I noticed that Bert cleared out rather promptly.

Shortly after, I noticed a peculiar hum in the phones, accompanied by a scratching sound foreign to anything I had ever heard before. This came on at intervals for the first fifteen minutes or so of my watch. I put the occurrence down as a new brand of induction from the chief's ancient dynamo and didn't think much about it. Suddenly I became conscious that it was audible in one phone only, yet Cape Race was pounding away with a fine quality of sending in both receivers.

What was the cause of this strange phenomenon?

I became suspicious. I removed the phones, unscrewed the ear cap of the defaulting one, slid off the diaphragm . . . and out crawled a common fly.

How did it get there? Maybe Lane could tell.

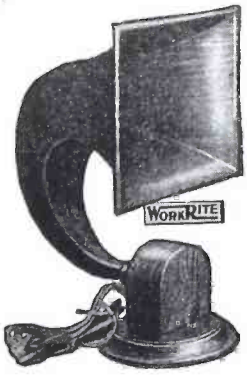
T. C. VAN ALSTYNE

¶ *Are you thinking of taking up radio as a livelihood? Do you want to become a radio operator? Or a radio engineer? Do you want to know how, where the positions are and how to fit yourself for them?* POPULAR RADIO *will shortly begin a series of articles by practical radio experts that will tell you the real facts.*

ANNOUNCING THE NEW

WorkRite Concertolas

$12.00



CONCERTOLA JR.

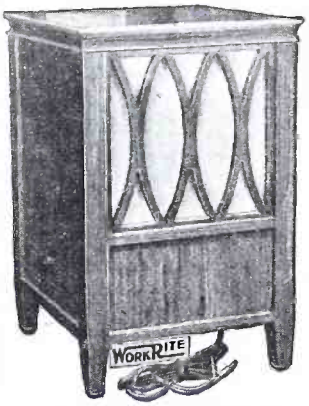
A graceful, beautifully constructed instrument, harmonizing with your house furnishings.

Here they are—the loud speakers produced by the WorkRite engineers—Concertola Sr. and Jr. Perfected until they are worthy of the name WorkRite. Hundreds of thousands of radio fans who have used WorkRite Radio Products know that "WorkRite" means perfection.

WorkRite Concertolas accurately reproduce music or voice from the broadcasting station without the slightest distortion. On still nights they can be heard two city blocks away.

The sound chamber in both of these instruments is made from our specially developed material. Why listen to music through a "tin-panny" metal horn that loses all the beautiful tones of the artists, when you can buy a WorkRite Concertola that will give you perfect reproduction of voice and music.

$24.00



CONCERTOLA SR.

Made from the finest grade mahogany with handsome rubbed finish.

EXCEPT FOR THE PHONE

There Is Not The Slightest Metal Used In Either The WorkRite Concertola Senior Or Junior

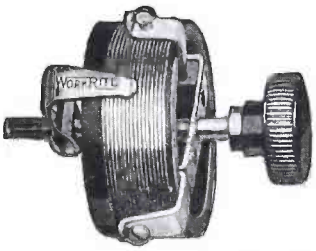
Important! The best sound amplifier will not get results with an ordinary head phone. Our engineering department has developed the WorkRite Concert Phone for just one purpose—to be built in the WorkRite Concertola Sr. and Jr., making a combination that is unequalled. This special 5,000-ohm phone unit is not sold separately from the Concertola. Phones and cord are built in each instrument.

WorkRite Concertola Jr. $12.00

Free Trial The WorkRite Concertola Sr. and Jr. are sold on an absolute money-back guarantee. After three days' trial, if you do not find this the most wonderful loud speaker in every way for home use, return it and your money will be refunded. If your dealer cannot fill your order, we will ship by Express, prepaid, upon receipt of the price.

WorkRite Concertola Sr. $24.00

Get A New WorkRite Super Vernier Rheostat



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 Vernier 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.

Write for Catalog Showing Complete Line of WorkRite Products

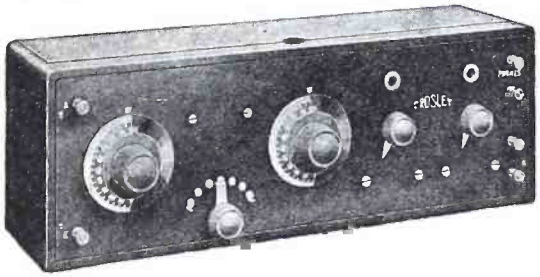
THE WORKRITE MFG. CO.

Main Office and Factory, 5528 EUCLID AVENUE, CLEVELAND, O.
Branch Office, 2204 MICHIGAN AVENUE, CHICAGO

CROSLEY

Better—Costs Less

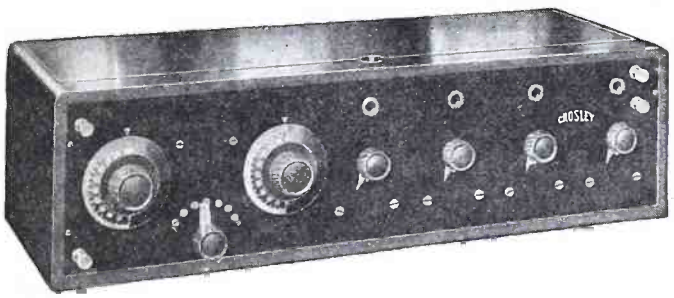
Two Outfits That Are Taking the Country by Storm



CROSLEY RECEIVER MODEL VI. This set consists of one stage of Tuned Radio Frequency Amplification and Audion Detector. It is normally for use with head phones, but is especially recommended to be used with any type of loud speaker. Additional amplification is unnecessary if head phones and horn are used in receiving local stations. Price, without phones, batteries or tubes, **$30.00.**

A REVELATION to those who have had the opportunity to try them out, the Tuned Radio Frequency Amplification feature of the CROSLEY MODEL VI and MODEL X and other larger models have met with universal success.

BY PLACING one stage of Tuned Radio Frequency Amplification before the detector tube, we not only amplify the signals before they reach the detector, enabling it to work more efficiently, but also make sharper tuning possible and eliminate interference and static to a wonderful degree. These sets are especially designed for broadcast reception, covering a range of from 200 to 600 meters and we believe they cannot be equaled at any price.



CROSLEY RECEIVER MODEL X. Is the same as MODEL VI with two stages of Audio Frequency Amplification added. In placing this receiver on the market we are offering you a unit whose range, volume and selectivity is remarkable. Nothing can compare with it at twice the price. Developed in the CROSLEY laboratories, this unit is absolutely the last word in long-range Radio Receiving Apparatus. Used with head phones and loud speaker, it will bring in distant stations all over the house Price, without phones, batteries or tubes, **$55.00.**

WE HAVE not only incorporated every refinement of detail in the mechanical features of our sets, but are offering you a beautiful piece of furniture with highly polished cabinet and neatly engraved formica panels as well. The nobs and dials are of solid molded composition and of excellent design, making an outfit that will compare with anything on the market.

We also manufacture Receivers for from $25 up and all kinds of Radio parts.

Write for our new illustrated and descriptive catalog.

Sold through dealers and jobbers everywhere. If your dealer does not handle CROSLEY instruments write us direct

CROSLEY MANUFACTURING CO.

Dept. PR2 **CINCINNATI, OHIO**

Not Even a Tool Needed to Recharge

You can recharge the Magno Storage Battery anywhere, any time, in one minute. Not even a tool is needed. Simply unscrew the cover and insert a "spare" charge—as easy as putting a new battery in a flashlight. These "spare" charges are exchangeable at your dealer's store or direct from us for 25c. each. By keeping a "spare" on hand, your battery will *never* run down.

Each Magno is a 2-volt unit. Two connected in series are sufficient for the 4-volt tubes. Three in series operate the 6-volt tubes. Magnos make ideal grid batteries for the Armstrong super-regenerative circuit because you can vary the voltage.

Write today for further information

Magno Storage Battery Corp.
Aeolian Bldg., New York City

STORAGE BATTERY
MAGNO

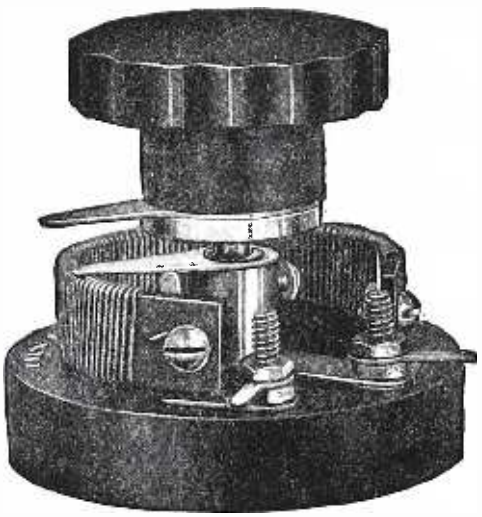
Looking to the Future

The radio industry is still young. The manufacturers who are looking to the future are building for permanence. That is why we put every ounce of our ability into the making of

UNION-RADIO
Apparatus and Accessories

That we are justified in this endeavor is attested to by the popularity Union Radio equipment has attained in the eyes of radio fans who are demanding quality and "best result" performance.

Our expert engineers are constantly at work on new improvements. Pictured below is the new (patent applied for) Union Radio Filament Rheostat.



Price with Knob (as shown above)
$1.20

Price with 2¼-in. Condensite Dial
$1.50

Base, Knob and Dial genuine moulded condensite

This Rheostat, our Vacuum Tube Receptacle and our Phone Tip Jacks (all patents applied for) are only three of the new developments that are making Union Radio apparatus and accessories such favorites.

We guarantee without reservation all Union Radio apparatus and accessories as to workmanship and materials.

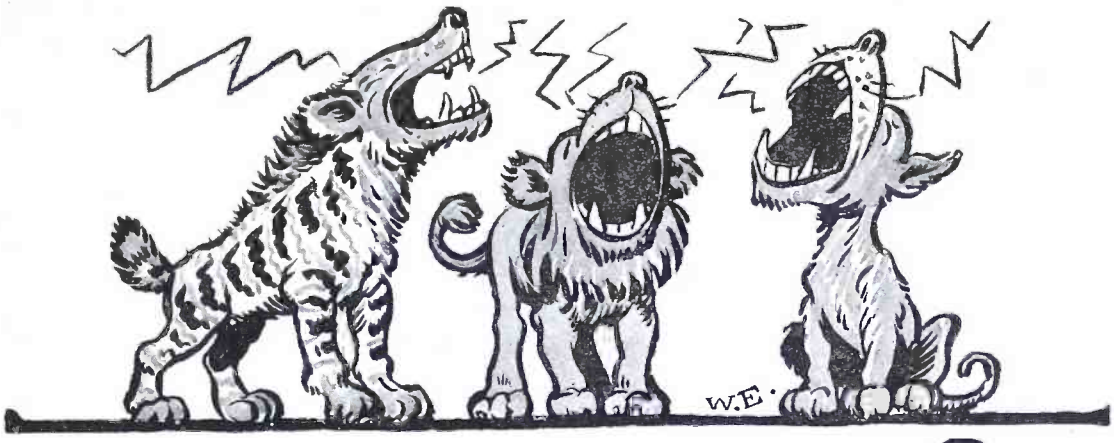
Union Radio products include complete receiving sets, 2 step amplifiers, variable condensers, condensite dials, filament rheostats, receiving vacuum tube receptacles and telephone Tip Jacks.

Write now for your copy of our catalog, "Radio Apparatus A."

Retailers and Wholesalers

Samples of our guaranteed, reasonably priced "Quality Products" sent on request. Our terms and trade discounts are liberal. Write for our proposition.

UNION-RADIO-CORPORATION
200-MT.PLEASANT-AVENUE,-NEWARK-N.J.
NEW-YORK-OFFICE—116-WEST-32=-STREET.

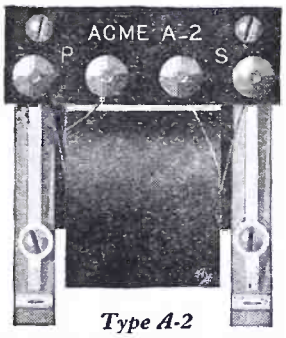


"Why the menagerie?"

YOU wouldn't stand for a young menagerie howling around the house. Why permit your radio set to act that way? It's unnecessary. For just five dollars you can add an Acme *Audio* Frequency Transformer to your set. This ends the howling and distortion so prevalent in the ordinary detector unit and at the same time it greatly increases the volume of incoming sound. Music and the human voice assume their natural tones. No more thin, squeaky voices and tiny elfin wails.

You will also want the Acme *Radio* Frequency Amplifying Transformer. You can use it with either a vacuum tube or a crystal detector set. It greatly increases the distance over which you can receive broadcasting programs. Just the same price as the Acme *Audio* Frequency Transformer. Two stages of Acme *Audio* Frequency Amplification with two stages of Acme *Radio* Frequency Amplification will give you maximum range, volume and certainty of natural tone. Your set is incomplete without them.

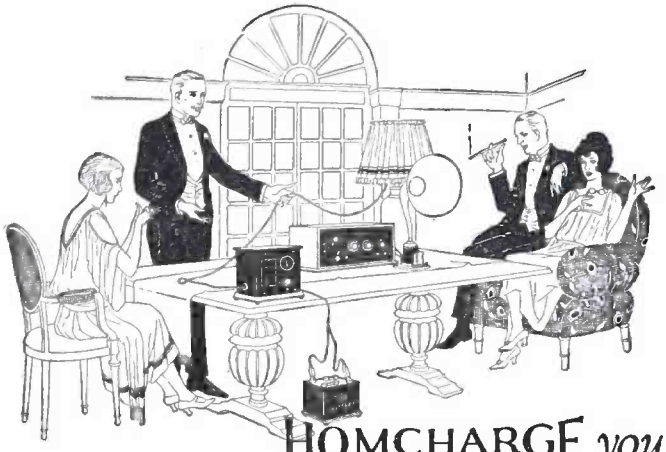
The Acme Apparatus Company (pioneer transformer and radio engineers and manufacturers) also make detector units, detector and two stage amplifying units, the Acme Clear Speaker, the Acmefone, also C. W. and spark transmitting apparatus. Acme Apparatus is for sale at radio, electrical and department stores. If one is not close at hand, send money direct. Ask also for interesting and instructive book on Transformers.



Type A-2
Acme Amplifying Transformer
Price $5 (East of Rocky Mts.)

The Acme Apparatus Company, Cambridge, Mass., U. S. A. New York Sales Office, 1270 Broadway.

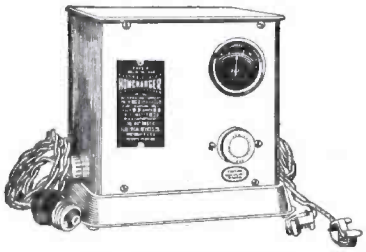
ACME
for amplification



HOMCHARGE *your Radio Battery for a nickel!*

Enjoyable Radio Concerts and maximum receiving range are obtained only when your battery is fully charged.

Don't be bothered with the inconvenience and expense of taking your battery to a service station every few days for recharging.



Type "R" (Portable)
Radio Homcharger De Luxe

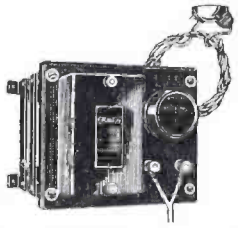
RADIO HOMCHARGER DE LUXE

has been designed especially for this purpose. It charges your "A" or "B" battery over night without removing it from your living room. The Homcharger is silent and clean in operation—no muss—no trouble—no dirt—requires no watching.

Simplicity itself. Attach to any lamp socket and connect to battery. Fully automatic in operation—cannot overcharge or injure the battery.

Constructed of the best materials—moulded Bakelite Base—Jewell Ammeter—Oversize Silicon Steel Transformer. No castings to break—only the finest stampings used thruout.

SAFE—all parts entirely enclosed—no danger from fire—approved by Fire Insurance Underwriters everywhere. Unconditionally guaranteed—lasts a lifetime.



Type "W" Homcharger for Wall Mounting
Over 50,000 in Use

An Ornament For Your Living Room

Beauty has been combined with utility in the NEW RADIO HOMCHARGER DE LUXE. The body is beautifully finished in rich Antique Mahogany—the base and fittings in a handsome dull gold. Equipped with rubber feet, it cannot mar polished surfaces. It harmonizes with the finest living room.

Over 50,000 HOMCHARGERS IN USE

50,000 users have heartily endorsed the HOMCHARGER. Beware of imitations when buying as *there is only one* HOMCHARGER. *Insist* on the genuine which bears our registered trade name, HOMCHARGER.

Furnished complete with attachment cord and plug, charging cable and battery clips. No extras to buy. Price at all good radio, accessory and electrical dealers, $18.50, or shipped prepaid upon receipt of purchase price, if your dealer does not carry it.

Booklet illustrating the NEW RADIO HOMCHARGER DE LUXE in actual colors is FREE for the asking. Send for your copy today.

The Automatic Electrical Devices Co.

132 West Third Street **Cincinnati, Ohio**

Largest Manufacturers of Vibrating Rectifiers in the World

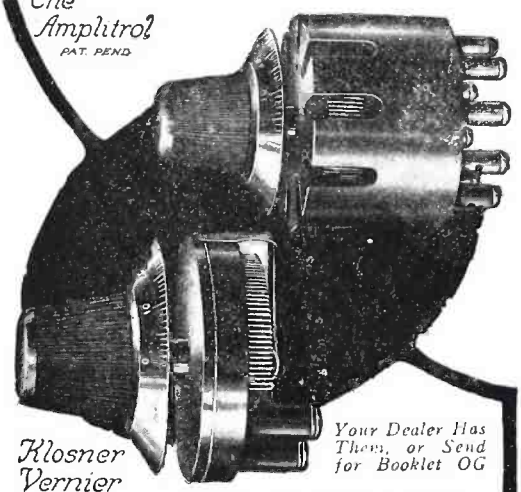
BRANCH OFFICES: New York - Chicago - Pittsburgh - Detroit - Dallas - Philadelphia Los Angeles - Baltimore - Minneapolis - Kansas City - St. Louis - Atlanta.

Tune 20 times faster

The "Amplitrol" controls the amplifier tube circuit without the use of jacks, plugs or any additional switches. No necessity of plugging in from one stage to the next—simply attach phones or loudspeaker to binding posts and turn on any stage at will.

The "Amplitrol" not only adjusts the filament to its maximum efficiency, but it automatically controls the plate circuit at the same time, thus eliminating an extra operation. Unlike an automatic filament control, the "Amplitrol" does not put a sudden strain on the filament. A real necessity for amplifier tubes. Price $4.00.

The Amplitrol PAT. PEND.



Klosner Vernier Rheostat Model 200 PAT. PEND.

Your Dealer Has Them, or Send for Booklet OG

What the "Amplitrol" is to the amplifying tube, so the Klosner Rheostat is to the detector tube. The new improved Rheostat Model 200 embodies some vast changes and improvements. These are too numerous to list, but your inspection will immediately win your approval. Price $1.80.

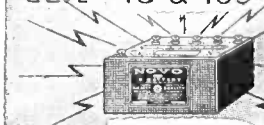
The "Amplitrol" and the Klosner Rheostat are the ideal combination for vacuum tube control. They do not employ the graphite-disc principle, but that of wire wound. This feature insures perfect contact at all times, making tuning **20 times** quicker and louder and giving greater range.

Klosner Improved Apparatus Company

2024 Boston Road ~ ~ New York

NOVO "B" BATTERIES FOR RADIO

22½-45 & 105 VOLTS



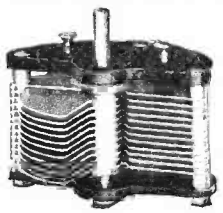
NOISELESS
DEPENDABLE
GUARANTEED

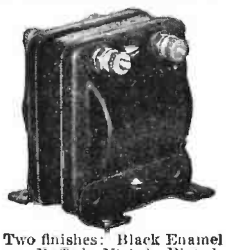
ASK YOUR DEALER

NOVO MANUFACTURING CO.
424-438 W. 33rd ST.
NEW YORK

531 SO. DEARBORN ST., CHICAGO.

UNITED RADIO PRODUCTS





Prices

43	plate	$4.50
23	"	4.00
11	"	3.50
5	"	2.75
3	"	2.25

without dial or knob

"United" Variable Condensers

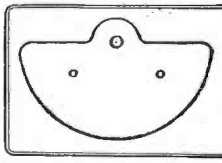
That "United" Condensers have become the standard with manufacturers of radio sets, by which all others are judged, is, in itself, the strongest endorsement of their superior construction and effectiveness.

Ask your dealer to show you this condenser. Then you, too, will appreciate why it has been accepted as the standard.

Two finishes: Black Enamel or Buffed Nickel Plated, $4.50

"United" Audio Frequency Transformers

The beauty of the outside of this transformer is but a reflection of the superb workmanship under the shell—no howling—no distortion—clear amplification for one or more stages.



Mounting made easy by our template for locating panel holes; packed free with each condenser.

NOTE—*Any advertised claim of having an arrangement with us to sell our products at special prices is fraudulent.*

UNITED MANUFACTURING AND DISTRIBUTING CO.
536 LAKE SHORE DRIVE, CHICAGO

Down goes the price!

BOXING Jiu-Jitsu Wrestling $1.97

Was $5.00

Think of it! For only $1.97 you can now have the famous Marshall Stillman Course—the same identical $5.00 course by which Marshall Stillman has taught boxing, jiu-jitsu and wrestling to over 30,000 men! *You can have it on 10-day trial. Send no money with order.*

Over 80 complete lessons—six volumes, hundreds of pages and over 200 illustrations—all for $1.97, or less than 3 cents a lesson!

He teaches you right in your own home. You learn all the fundamentals of boxing and the blows and guards used by the topnotchers—the Benny Leonard Triple, the Jack Dempsey Triple, the Fitzsimmons Shift, etc. All the secrets of the ring, all the fine points of feinting, ducking, clinching, breaking ground, judging distance and timing—including three lively rounds of *Shadow Boxing* to develop speed and confidence. In short, you will become a good boxer in quick time—able to box rings around that "fellow who thinks he knows it all"—and for only $1.97.

In *Jiu-Jitsu* you will learn how to disarm an opponent, how to break a stranglehold, etc., and, in *Wrestling*, the Gotch Toe Hold, Stecher Scissor Hold, the Head-lock, etc.

With the course you get a Free History of 69 Famous Boxers, with their pictures and "inside" stories about them.

SEND NO MONEY. Simply fill in and mail the coupon. When you have the course in your hands, deposit $1.97 (plus the actual postage) with the postman. Then examine the course for 10 days—try it out thoroughly. We're sure you'll go on with it—and there'll be nothing more to pay. But if, for any reason, you are not entirely satisfied, return the course, and get your money back at once. Mail the coupon now to Marshall Stillman Association, Dept. 4522-K, 42nd Street and Madison Avenue, New York.

Marshall Stillman Association,
Dept. 4522-K, 42nd St. and Madison Ave., New York.

You may send me on approval the Marshall Stillman Course. I will deposit $1.97 (plus the actual postage) with the postman, with the understanding that if, after 10 days, I wish to return the course I may do so and my money will be instantly refunded. If I keep the course, there is to be nothing further to pay.

Name .....

Address .....

NEW ABC TUNER—Ideal for Popular Broadcast Reception

AFTER careful study of the demands of radio enthusiasts, Professor Morecroft of Columbia University has designed the ABC Tuner No. 5750 to fit the ABC Standardized Radio Units System.

ABC Tuner No. 5750 is compact, selective and embodies latest developments—a thoroughly dependable apparatus obtainable at a low price.

Write for latest ABC Catalog and name of nearest dealer

JEWETT MANUFACTURING CORP.

342 Madison Avenue (Dept. D-10) New York

ABC Loud-Speaker No. 5500

The perfect hook-up of ABC Units is shown at right. Units are added as desired.

ABC Radio Tuner. No. 5750. ABC Detector and One-Step Amplifier. No. 5013. ABC Two-Step Amplifier. No. 5014.

Red Seal Battery Contest

Starts Nov. 1st. Closes Nov. 15th

All Radio Sets installed FREE in the homes of the winners anywhere in the U. S. A.

1st Prize

This cabinet type complete Radio Receiving Set is one of the finest and most up-to-date sets on the market. It is designed and manufactured by the Colin B. Kennedy Company of San Francisco and St. Louis, makers of the finest type of radio receiving sets. The cabinet is walnut and stands 58 inches high—a masterpiece of cabinet making. The receiving set is regenerative, having an effective range from 175 to 25,000 meters—400 to 600 miles on "broadcasting." Contained within the cabinet are all batteries, Magnavox Loud Speaker with special horn, "Homcharger" Battery Charger. Value complete, $725.00.

2nd Prize

It consists of the Westinghouse R. C. Receiving Set, Western Electric Loud Speaker, "Tungar" Battery Charger, Storage Battery, 9 "B" Batteries, one Manhattan 3,000 ohm Headset, 3 vacuum tubes, 2 telephone plugs, and complete antenna equipment—a total value of $408.50.

3rd Prize

A complete receiving outfit made up of the well known Grebe CR-9 Regenerative Receiver with 2 stage amplifier, Magnavox Loud Speaker, Storage Battery, "Homcharger" Battery Charger, "B" Batteries, one Manhattan 2,000 ohm Headset, 3 vacuum tubes, 2 telephone plugs, and complete antenna equipment—a total value of $256.50.

50 Other Prizes

To 50 other contestants, whose answers the judges decide are most meritorious, will be given one of the famous Manhattan 2,000 ohm Radio Headsets. These headsets are built with the precision of a watch and have great sensitiveness and high amplifying qualities.

Win this $725.00 Radio Set FREE

Only a rich man could buy it but a poor man may win it FREE

SIMPLY obtain a free "Red Seal Battery" contest blank between November 1st and November 15th from stores that show the Window Display pictured below. Each contest blank gives full simple instructions to help you write your answer and full rules of the Contest.

Red Seal Battery Finish-the-Sentence Contest

The prizes will be awarded for the most appropriate answers for completeing *in your own way* in not more than ten words, the following sentence:

"The Red Seal Dry Battery is best
(1) because it is the all-purpose battery and
(2) because.....

Examples

Your answer may be descriptive of the Red Seal Dry Battery or it may describe some use. For example: "It never fails on land, air or sea." Another: "It never starts what it can't finish." Another: "It rings bells and buzzes buzzers."

Judges

The judges of the Contest are: Mr. Llew Soule, Editor of *Hardware Age*, New York; Mr. Howard A. Lewis, Manager of *Electrical Merchandising*, New York, and Mr. Joseph A. Richards, President, Joseph Richards Co., Inc., Advertising Agents, New York.

Look for this Window Display in Dealers' Windows Nov. 1 to 15. It identifies all stores that have free contest blanks.

Awarding the Prizes

Prizes will be awarded to those who conform to the rules of the Contest and whose answers, in the opinion of the judges, are most appropriate. In case two or more persons submit winning answers, prizes identical in character with those offered will be given to each successful contestant.

Announcing the Winners

As soon as possible after the judges have rendered their decision the names of the prize winning contestants will be announced in the *Saturday Evening Post*.

Contest Opens Nov. 1—Closes Midnight Nov. 15.

All answers must be written *only on contest blanks* supplied by dealers displaying Red Seal Battery Contest window display. Send as many answers as you like to:

Red Seal Battery Contest

Manhattan Electrical Supply Co., Inc.

17 Park Place

New York City, N. Y.

MANHATTAN

ELECTRICAL SUPPLY CO., INC. NEW YORK

Makers of the Famous Red Seal Dry Batteries and Manhattan Head Sets

"As good as Brandes"

ONLY if a headset bears the name Brandes can it be "as good as Brandes." And genuine Brandes *Matched Tone* headsets cost no more than less sensitive and less rugged imitations.

Send ten cents in stamps for the "Beginner's Book of Radio," which explains radio in terms that anyone can understand.

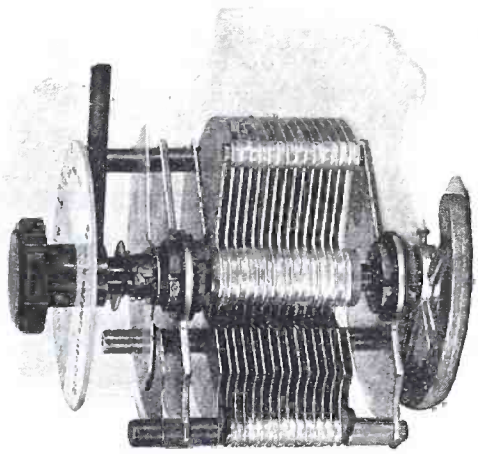
Distributors and District Offices:
Munsey Bldg., Washington, D. C.
76 Pearl St., Boston, Mass.
33 S. Clinton St., Chicago, Ill.
709 Mission St., San Francisco, Cal.
International Electric Company.
Wellington, N. Z.

C. Brandes, INC.

Matched Tone Headsets
TRADE-MARK REG. U.S. PAT. OFF.
237 Lafayette St., New York

Made in Canada by Canadian Brandes, Ltd., Toronto and distributed by Perkins Electric Ltd., Montreal

Result of 14 Years Experience



Thanks for Your Patience!

THE radio public was very patient when we were unable to supply De Forest Vernier Condensers, because they knew that all we could make were going into the famous De Forest MR-6 Receiving Sets.

Now, however, you can have the satisfaction of putting genuine De Forest Condensers on that special set you are building. The CV-1003 and CV-1503 Vernier Condensers are now again available. Production has been increased as fast as was possible—always remembering the maintenance of De Forest quality.

It is only necessary to remind you of some of the reasons why these Condensers have been declared perfection by radio experts. The movable plates are heavier than those in any other. The separately controlled Vernier plate gets you "in on the peak" and gives you 20% louder signals. The securely fastened counter weight acts as a balance and permits smooth, accurate operation in any position. Each Condenser is individually tested at 500 volts. The whole construction is a fine example of scientific precision laboratory equipment.

Used with De Forest Honeycomb Duo-Lateral Coils, these Condensers provide tuning equipment unsurpassed for selectivity, sharpness, and all-round efficiency.

De Forest Radio Tel. & Tel. Co.
Jersey City, N. J.

Now Ready!
The DICTOGRAPH
Radio Loud Speaker
For the Home

SINCE the first announcement of the development of a Dictograph Radio Loud Speaker, interest on the part of the radio public has run high.

The great Dictograph organization, famous the world over for its marvelously sensitive "Acousticon" for the Deaf and loud-speaking telephones, has concentrated on the perfection of this new Radio Loud Speaker. It is worthy of the Dictograph name—and that means ***Standard of the World!***

Here at last is the Loud Speaker you have been waiting for—a Loud Speaker that reproduces every sound—singing, instrumental music and voice—in full volume and with absolutely clear, natural tones, free from distortion or mechanical sounds. It is used with any vacuum tube radio set. No alterations are needed; no extra batteries—you simply plug in and listen.

Assured demand, volume production, and Dictograph resources have made possible a reduction from the price originally announced. Instead of $25, **the price is only $20—complete with 5 ft. cord.**

Ask your dealer to show you the **Dictograph Radio Loud Speaker.** Place your order now to assure early delivery. Dealers can be supplied by their jobbers or our authorized distributors.

Price $20

Complete with 5 ft. flexible cord.

The handsome appearance of the Dictograph Radio Loud Speaker harmonizes with any home. It has a highly burnished spun copper bell horn attached to die cast black enamel tone arm, finished with nickel trimmings. The cabinet is of solid ebony-finished hardwood and mounted upon rubber knobs to avoid marring highly polished tables. It is furnished complete with 5 ft. flexible cord. No extra batteries required.

DICTOGRAPH *Radio* HEAD SET

The Dictograph Radio Head Set has established a standard of quality impossible to secure in any other product—its use on an ordinary receiving set, whether crystal set or vacuum tube receiving unit, improves reception immeasurably. Insist on the Dictograph—Price $12.00—3000 ohms resistance.

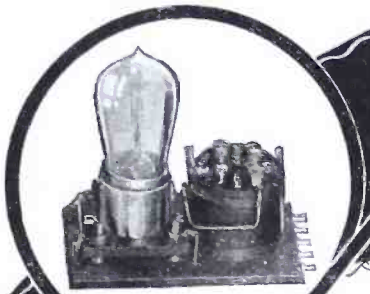
The Best Head Set in the World at any Price!

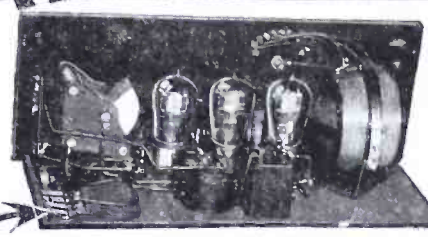
DICTOGRAPH PRODUCTS CORPORATION

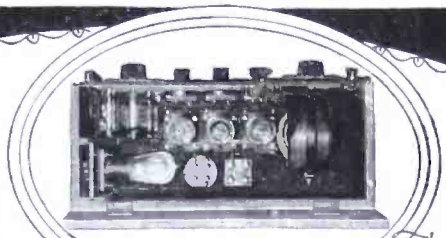
Branches in all principal cities

220 WEST 42d STREET **NEW YORK CITY**

And now the S-P-2 "ADAPTER"







The S-P-2 COMPLETE with ADAPTER

Another remarkable feature added to the amazing S-P-2 Receiver. An Adapter representing an additional stage of audio frequency amplification, added to the S-P-2 Receiver AS SIMPLY AS INSERTING A TUBE INTO A SOCKET. Without necessitating the change of a single binding post, wire or batteries or headphones! The S-P-2 Adapter is a basic patent and is thoroughly covered.

The S-P-2 RECEIVER, now in vast production and under the severe test of hundreds of dealers everywhere, has thoroughly established its claim of ACTUAL SUPERIORITY as against any regenerative receiver now offered costing $125 to $180, based on actual comparisons. THE LIST PRICE OF THE S-P-2 IS BUT $85, WITH AN ADDITIONAL CHARGE OF $15 FOR THE ADAPTER.

The S-P-2 is 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.

In emphasizing REMARKABLE REFINEMENT, we claim for the S-P-2 a TONE QUALITY of distinct class.

It brings the QUALITY in music and in all instrumental and vocal signals that is now universally desired and demanded, practically eliminating all atmospheric disturbance and "noise."

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.; Davenport, Iowa; Louisville, Ky.; 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.

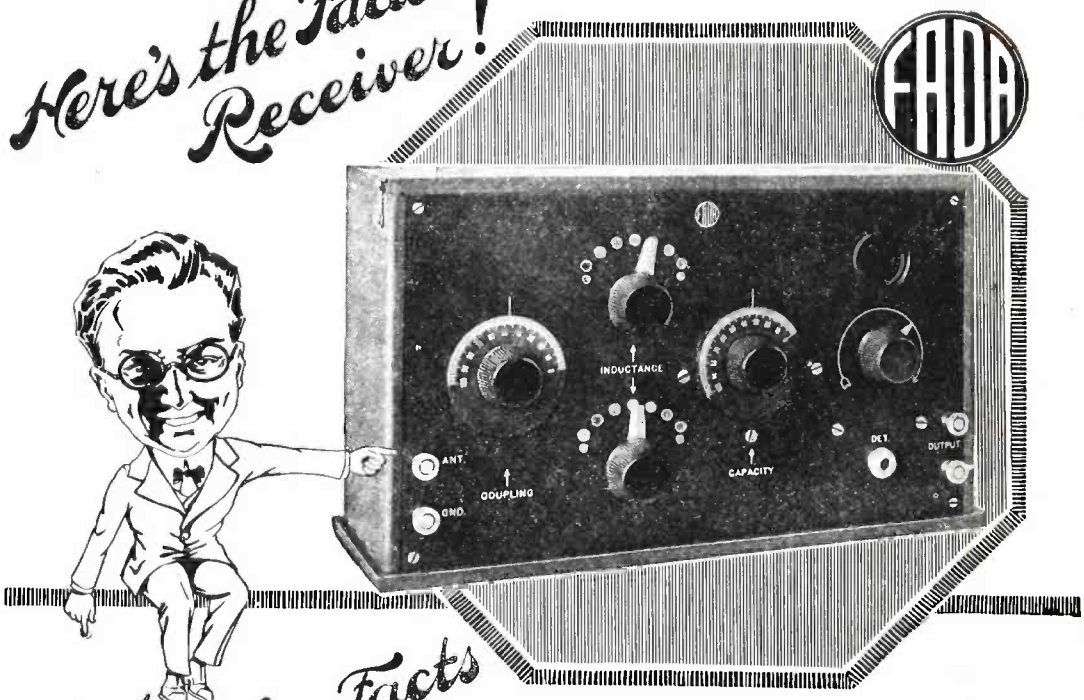
DEALERS:
Write for Catalog 101A

PITTSBURGH RADIO SUPPLY HOUSE

963 Liberty Ave. Pittsburgh, Pa.

BELL TELEPHONE GRANT 3632

Here's the Fada Receiver!



and There's the Facts about it · An Ideal Home Entertainer

The Fada receiver, a result of the same perfection in design and construction that distinguishes all Fada products, is gaining popularity as an ideal home entertainer.

When it's radio time in your home, you can sit back in your favorite chair, among the family circle, and command at your fingers' touch the talent of such noted artists as May Peterson, Percy Grainger, Mme. Margaret Namara, or Lydia Lipkowska—Russian coloratura soprano of the Imperial Opera of Petrograd.

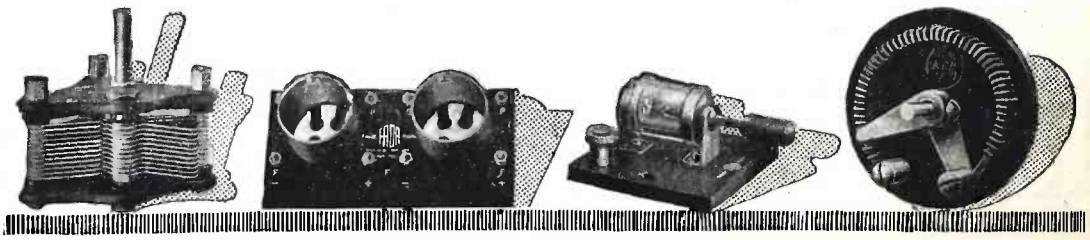
You marvel that voices can come into your home with such depth of emotion and true personality. Music is an inspiration to everyone, it goes to the very soul of things and brings joy and happiness to all.

With a FADA radio receiver music can be made part of your daily re-creation. And after the musical program there is broadcasted a digest of important world events. You can, with a FADA receiver, literally keep a jump ahead of the headlines in tomorrow's newspaper.

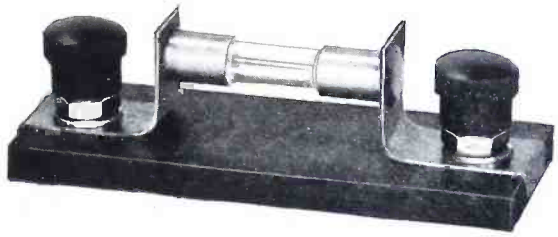
THE FADA HANDBOOK of FADA–FACTS

The new FADA handbook will be sent to you upon receipt of 5c to cover postage. It's a How-To-Do-It book and you should have it

FRANK A. D. ANDREA
1581-D Jerome Avenue, New York City



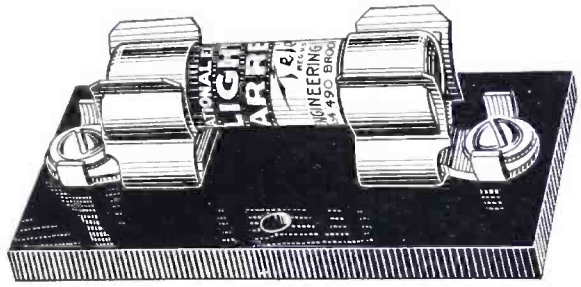
Teleradio



TELERADIO FILAMENT PROTECTOR

Here is the cheapest vacuum tube insurance you can buy.

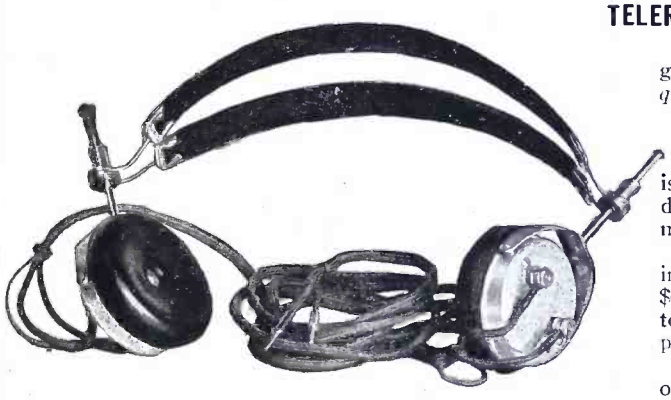
The Teleradio Tube Protector complete sells for 60c and extra fuses for 10c apiece. Not much to pay when you figure that each time you blow out a 10c fuse you save the price of a $5 or $6 tube.



TELERADIO LIGHTNING ARRESTORS

Here is a lightning arrestor that has been passed and approved by the National Board of Fire Underwriters and licensed for indoor use under the Electrical Number 5837.

At the low price of $1, we believe the Teleradio Lightning Arrestor to be by far the cheapest *approved* arrestor on the market today. Jobbers and dealers are stocking the Teleradio Lightning Arrestor to meet the great demand for an approved arrestor at a low price.

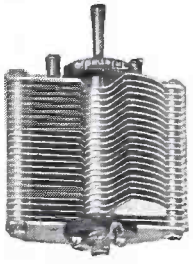


TELERADIO SUPERSENSITIVE PHONES

More and more amateurs are getting "sold" on the necessity for *quality phones*, and are beginning to realize that phones are not just a matter of "2000 or 3000 ohms," but that *construction* is the really important factor that distinguishes *good* phones from merely "phones."

Teleradio Supersensitive Phones, in spite of the low selling price of $6.50, have been found by experts to equal the performance of other phones selling at $12 to $15 a set.

Prices: 2000 ohms, **$6.50**; 2200 ohms, **$7.50**; 3000 ohms, **$9.00.**



TELERADIO VARIABLE CONDENSERS

Teleradio Variable Air Condensers are constructed of two groups of plates—one stationary, the other movable. The spacers, alignment and connections are positively accurate. The movable plates will remain where set, as a phospor bronze friction washer is employed. This assures the fine adjustment necessary for the reception of telephone and C. W. Signals. All current carrying parts are either brass, copper, aluminum or phosphor bronze. 11 Plate .00025 Mfd., **$2.50** each; 23 Plate .0005 Mfd., **$3.00** each; 43 Plate .001 Mfd., **$4.00** each.

OTHER TELERADIO PRODUCTS

Teleradio Rheostats for vacuum tubes, **$1.00** each. Teleradio Vacuum Tube Sockets, **$.60** each. Fixed Phone and Grid Condensers, **$.35** each. Grid Leak Condensers, **$.50** each.

In case your dealer has not yet stocked Teleradio Quality Products, order direct. Please mention your dealer's name and we will see that he is promptly supplied.

TELERADIO ENGINEERING CORPORATION

484-490 BROOME STREET, NEW YORK

CHARLES FRANCIS PRESS, NEW YORK

Endorsed by Paderewski!

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 Co

Patents applied for

Bel-Canto

The Superlative Loud Speaker

WE consider Mr. Paderewski's praise of the Bel-Canto Loud Speaker one of the highest possible endorsements of this remarkable instrument.

And it *is* a remarkable instrument. In no sense of the word is the Bel-Canto an ordinary loud speaker.

The Bel-Canto is a new and scientific instrument built on the most advanced principles of acoustics. Radio engineers and experts, radio dealers, radio fans, musicians and music lovers—all are amazed at the remarkable beauty of tone and the undistorted reproduction of the Bel-Canto Loud Speaker.

The Bel-Canto is constructed of reeds and metal 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 metal resounding chamber. The result is a tone of such clarity and mellowness as to surpass any other amplifying device that we know of—even those selling at $100 or more. Yet the price of the complete Bel-Canto is only $30.

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 loud-speaking phone, six foot cord and hard rubber plug—all ready to plug into your set. There are no extras to buy.

The Bel-Canto is tested for two stages of amplification on a regenerative circuit using at least 90 volts in the "B" batteries. After plugging in the Bel-Canto, tune your set to obtain the best results. No head-phones necessary.

The Bel-Canto is fully guaranteed. Entire satisfaction—or we will replace it with a new one, provided the plate on the bottom has not been removed.

Since our first announcement of the Bel-Canto we have been running to full capacity to meet the demand. And only by overtime work and increased facilities were we able to take care of orders. We are now in a position to supply any reasonable demand.

If your dealer has not yet stocked the Bel-Canto Loud Speaker, order direct from the factory—enclosing check or money order for the price, $30. The Bel-Canto will come to you prepaid and fully guaranteed.

Jobbers and Dealers—write for our proposition

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