Popular Radio

NOVEMBER, 1922

15¢

HOOK-UP NUMBER

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Popular Radio Nov 1922

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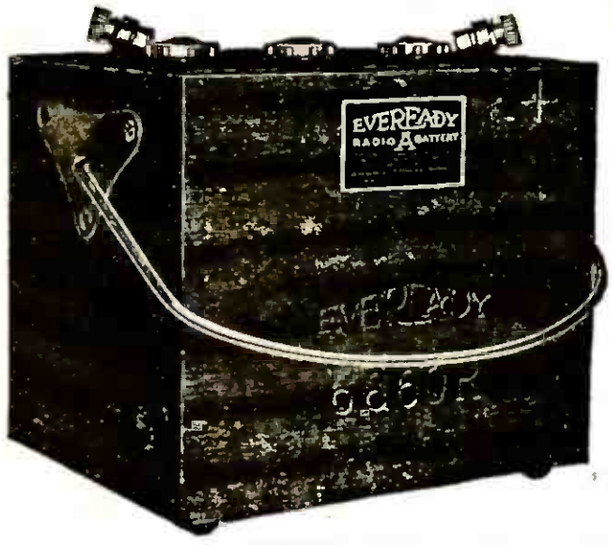

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No. 766 is the most popular size in use. Contains 15 cells and has a long service life. It is equipped with five positive Fahnestock Spring Clip Binding Posts ranging from 16½ to 22½ volts, making it the most desirable type for use with vacuum detector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

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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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POPULAR RADIO

EDITED *by* KENDALL BANNING

CONTENTS *for* NOVEMBER, 1922

(Cover design by George Illian)

VOLUME II NUMBER 3

VOLUME II NOVEMBER, 1922 NUMBER 3

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


"Without going out of doors,' said Lao Tzu, 'one may know the whole world!'
"Let a Grebe Receiver bring the whole world to your evening fireside."
Doctor Mu
GREBE RADIO

A PAGE WITH THE EDITOR

NOT because we like to add to international complications, but rather because we believe that controversies between recognized authorities stimulate an interest in disputed points in science and lead eventually to an understanding of them, POPULAR RADIO initiated the now-famous dispute concerning the "ether hypothesis" between Dr. Charles P. Steinmetz, representing the United States, and Sir Oliver Lodge, representing England, "both members of this club," to quote a sporting phrase. Sir Oliver's reply to the good doctor is published in this issue.

* * *

NEXT month POPULAR RADIO starts another international controversy. Dr. Elihu Thomson, American, will lead off with an article that attacks the "Heaviside layer" theory; in the succeeding number Sir Oliver Lodge will defend it.

* * *

WHAT other points in science need to be cleared up?

* * *

ALTHOUGH the broadcast concerts (initiated by POPULAR RADIO) given at the City College Stadium in New York by the Philharmonic Orchestra took place in the middle of August, reports from listeners-in are still arriving. One of the first reports struck near home; it came from the brother of the chairman of the Concert Committee, who picked up the music unexpectedly on a vessel off the Massachusetts coast, several hundred miles away.

* * *

BUT perhaps the most unusual incident occurred on a Lackawanna train traveling fifty miles an hour through Pennsylvania—probably the first time that a symphony concert was ever heard on a railroad. A correspondent in Erie reports that the music was "just as loud and clear and well-modulated as any radio I ever heard. The music was received in the Library Buffet car, which was crowded with interested auditors at every performance."

* * *

EVEN the radio fans in far-away Morgantown, W. Va., picked up the performances of this great New York orchestra. "It was certainly a musical treat," writes John T. Hoffman, of that town. "Although a storm was approaching, the music came through very well."

* * *

SIMILAR reports have been received from nearly a score of States. "There is no doubt at all in my mind," reports Dr. William H. Easton, of the Westinghouse Company, "that the total radius of this concert was over 1,000 miles wherever there was no interference from the broadcasting stations."

* * *

THE May issue of POPULAR RADIO contained 72 pages. This number which you are holding in your hand contains 116 pages—an increase of 34 pages.

Yet the price remains the same—only 15 cents.

* * *

HERE'S one request that the Editor just couldn't grant:

"I was reading De Maupassant's stories last evening," reports Howard Gould, of Boston, "when my October number of POPULAR RADIO was brought to me. I laid down De Maupassant—and stayed up till after midnight reading your darned old magazine. Please don't make your November number so interesting; I need my sleep."

* * *

THIS number of POPULAR RADIO contains 35 pages of advertising—*a net increase of 500 percent in seven months.* Advertising in POPULAR RADIO pays.

* * *

HERE is a letter from Joseph Warren, of Chattanooga, Tenn., that offers one explanation of POPULAR RADIO's steady growth:

"When your magazine first came out I paid little attention to it. 'Merely another of those no-account radio publications,' I thought. But I changed my mind—and I changed because I found your articles authoritative and at the same time easy to understand. Simple language, clear and readable diagrams and illustrations, and writers of national standing combine to put POPULAR RADIO in a class by itself. May Allah be praised!"

* * *

IT is with particular gratification that the Editor learns that POPULAR RADIO is commanding the recognition of the educational authorities; no greater compliment can be paid to any magazine than to be adopted in the nature of a text-book in the schools. "I have gone over the magazine with the Physics Department," writes Karl E. Whinnery, principal of the High School at Sandusky, Ohio, "and we want to subscribe. Send the bill to the Board of Education."

There's a real idea in that suggestion for school teachers elsewhere, especially physics teachers.

* * *

As a matter of fact, the value of radio as an educational force can hardly be overestimated. Not only is it of universal interest to pupils as an instrument in itself, but the character of the programs received is (or at least should be) of the greatest import. For it opens the way for bringing the world's greatest minds and the world's greatest music into the Little Red Schoolhouse.

Editor, POPULAR RADIO

AMRAD

The Recognized Symbol of Superior Performance

Amrad 2-Stage Radio-Frequency Amplifier 3071, Amrad Detector 2-Stage (audio) Amplifier 2634, and Amrad Short Wave Tuner 2596.

Brings U. S. to Fort Atkinson, Wis.

E. R. White, 71 Main St., Fort Atkinson, Wis., writes voluntarily of the "wonderful results" obtained with the new "Big Amrad."

"We had no trouble bringing the United States to the streets of Fort Atkinson. From Atlanta, Ga., to Seattle, Wash.; from Oakland, Cal., to Schenectady, N. Y.

"When one of the worst electrical storms was raging, our crowd danced to music from Atlanta. We receive Pittsburgh in the daytime so we can be heard all over the place.... At night we pull in Atlanta, St. Louis, and all the rest east of the Rockies."

This remarkable performance cannot, of course, be duplicated day in and day out, but Mr. White's experience demonstrates the possibilities in extreme long-distance reception with Amrad 2-Stage Radio Frequency Amplifier 3071 when combined with an Amrad or other standard Short Wave Receiver. R.F. 2-Stage Amplifier $30. Radioformers, $5 each.

Any reader of this magazine may obtain the famous Amrad Short Wave Set (at our new reduced price)—equipment unequalled in performance, quality, workmanship and reasonable cost—with the knowledge he can add Radio Frequency later whenever he wishes.

The Amrad Short Wave Set, which has met with national approval for 16 months, consists of Detector 2-Stage Amplifier 2634 and Short Wave Tuner 2596, both encased in solid mahogany cabinets. Price $107.50.

Mr. White's original letter may be seen by anyone visiting the Factory, or we will send you upon request a copy and Bulletins L and R describing the instruments responsible for his spectacular results. We have verified Mr. White's statement.

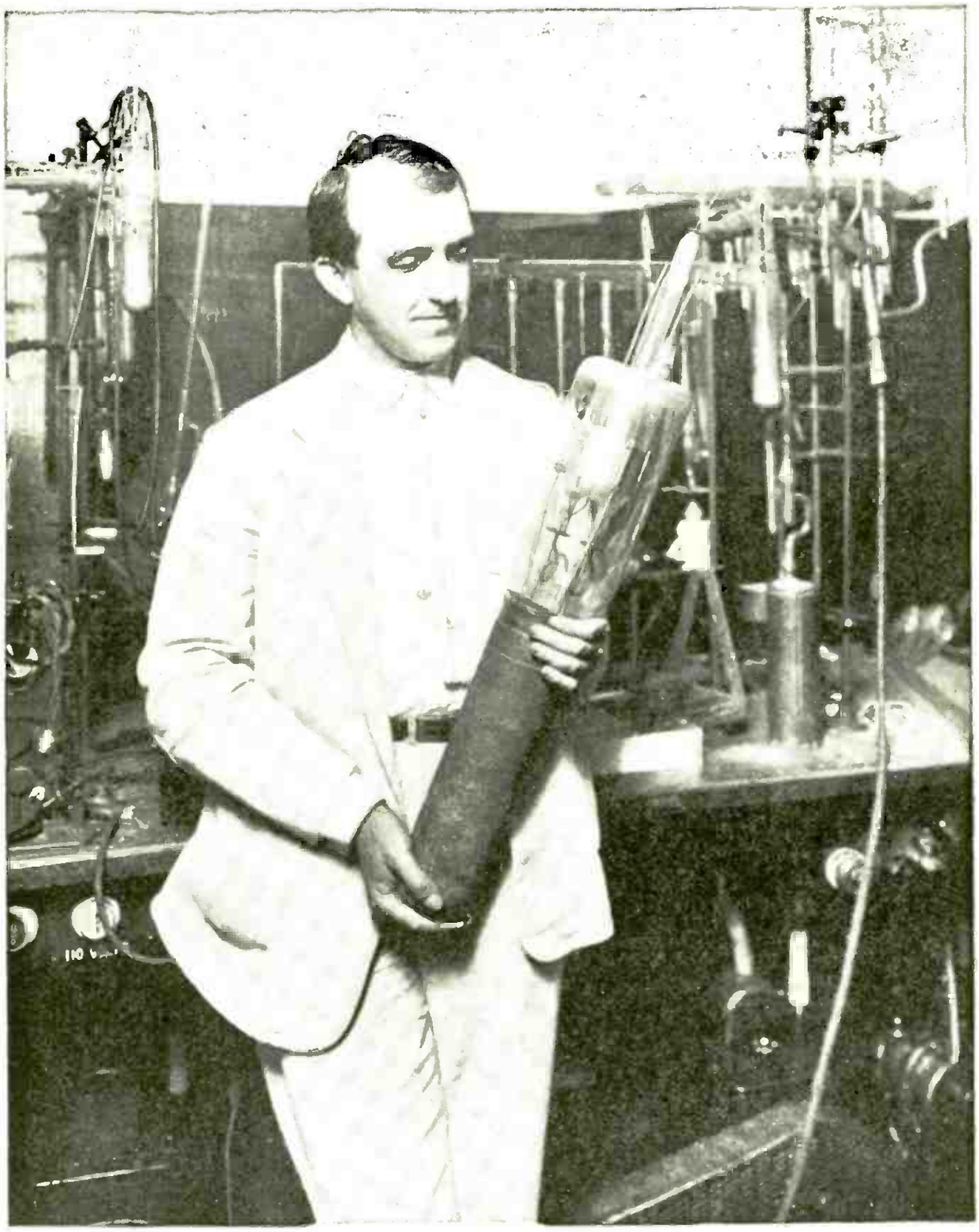
AMERICAN RADIO AND RESEARCH CORPORATION

217 College Avenue, Medford Hillside, Mass.

NEW YORK DISTRICT OFFICE **CHICAGO DISTRICT OFFICE**

I have been in touch with your magazine and consider that the material in it is very useful and valuable.

Elihu Thomson



Western Electric

The Most Powerful Vacuum Tube in the World

While it weighs only ten pounds, it is capable of supplying 100 kilowatts of oscillating high frequency energy to an antenna. Just what this means in the development of radio may be visualized by the fact that two of these tubes operated in parallel would do the work of about $1,000,000 worth of the machinery that is now used in trans-Atlantic communication. The inventor of this remarkable tube, W. G. Houskeeper, is shown holding his invention in the laboratory where he built it.

(See page 219)

Popular Radio

VOLUME II NOVEMBER, 1922 NUMBER 3

Are There No Ether Waves?

An English Answer to an American Scientist

FOREWORD

IN the July issue of this magazine was published an article by Dr. Charles P. Steinmetz, the eminent American physicist, who denied the the existence of the hypothetical medium known as "ether," and contended that the ether hypothesis was not necessary in order to explain the phenomenon of radio. This contention aroused world-wide interest in scientific circles, especially in England, where the physicists generally support the theories of Sir Oliver Lodge, who is regarded as the foremost authority on the subject—and who frankly disagrees with the American. Dr. Steinmetz, in declaring against the ether hypothesis, claimed that "There Are No Ether Waves" and that the ether is not required for the propagation of "radio waves"—the existence of which he does not deny. The following article has, therefore, an international aspect that gives it an unusual interest in scientific circles.—EDITOR.

By SIR OLIVER LODGE, F.R.S., D.Sc., LL.D.

THE Theory of Relativity ignores the ether of space, "having no need of that hypothesis." It treats of occurrences mathematically, from the point of view of the individual observer, and in terms of what he can observe. It is quite clear that we, as human beings, can observe only matter. That is what our senses enable us to perceive, and everything else is an inference. Mind, for instance, makes no direct appeal to our senses, and though it is the instrument of consciousness it is a philosophic question how far mind can be regarded as an object of consciousness. But we are directly aware that we are thinking beings, and therefore each individual concludes that he himself possesses a mind, or if he thinks deeper he may conclude that he is a mind and possesses a body.

By some means or other most people come to the conclusion that they consist of both mind and body, though how rightly to express the conjunction may be difficult even to a metaphysician. We do not, however, directly perceive the minds of other people; we only perceive their bodies, but those bodies look something like our own; and the way they act suggests that they are similarly each associated with a mind. That, however, is an inference, and there is a system of philosophy in which it has been argued against—the system known as Solipsism.

To commonsense, however, such a

system seems absurd, and we most of us are quite willing to make the inference that other people have minds like our own, whether we directly perceive them or not. There are many other entities in like case — lots of things which make no appeal to the senses directly, but which are inferred from the behavior of matter.

Life, like the life of a tree for instance, is of such a nature. We only infer that a tree is animated by something which we call "life" because of the way in which it grows and develops and fructifies and reproduces and decays. But many biologists have doubted the existence of any separate vital principle, and endeavor to treat the organism as sufficiently explained by the laws of physics and chemistry and by the interactions of molecules, the effects of which they observe.

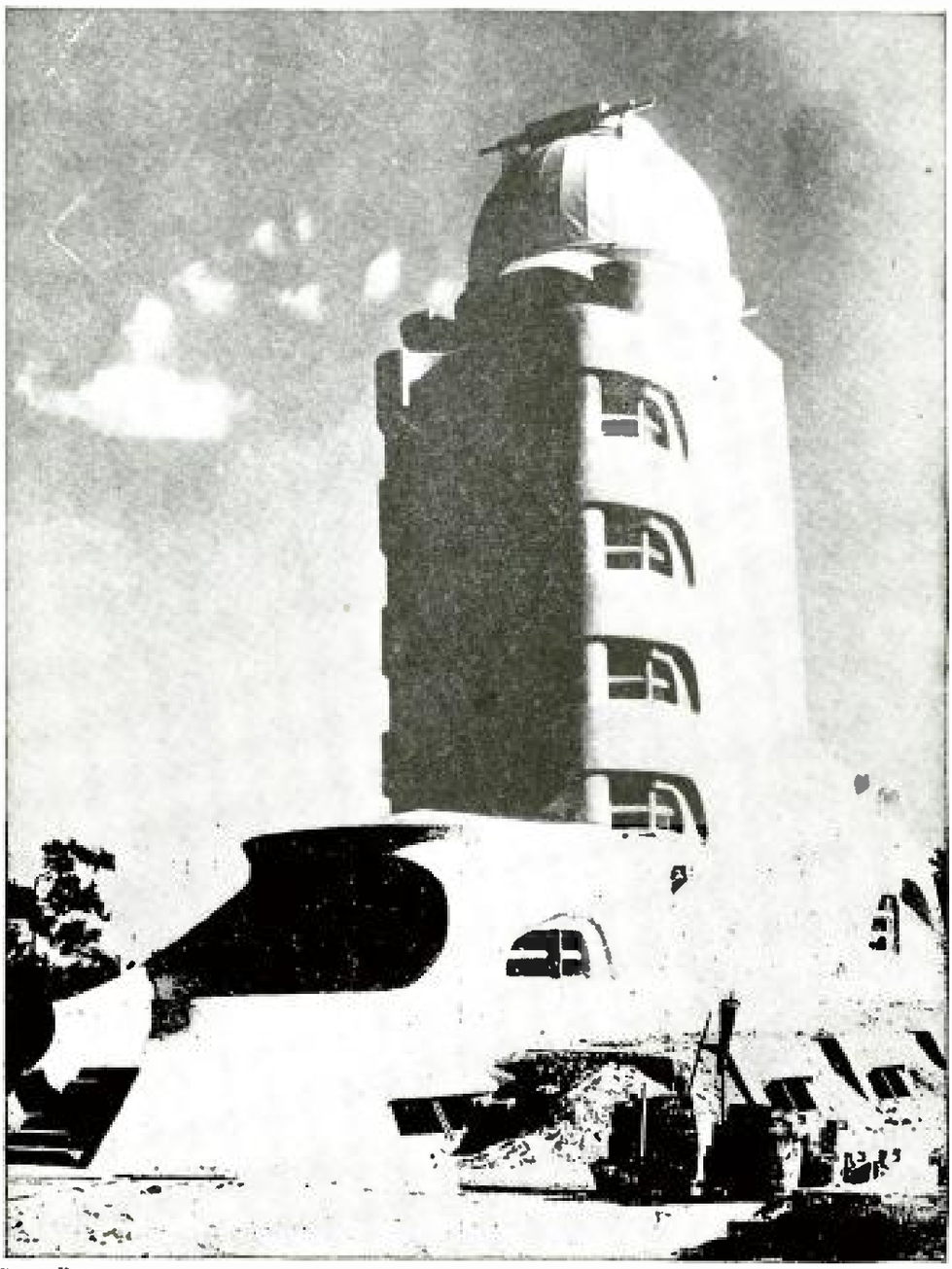
We might go further and say that electricity and magnetism are in a similar position. How do we know that such a thing as magnetism exists?

Only by observing the behavior of some kinds of matter—behavior which seems inexplicable unless we assume that it is, as it were, animated by something that we call magnetism, though we have no idea at present what it really is. It is hardly true to say that we have *no* idea; some of us have ideas, but there is no certainty about them. And I suppose it would be possible to work out a theory of the motions of matter without mentioning the term "magnetism" at all; for after all, by derivation, it only means the singular property of a certain stone which was found in Asia Minor. (The "lodestone," which pointed in a certain direction when suspended, and which imparted its property to steel, was supposed to have been first found near a place called Magnesia.)

But a gyroscopic compass points to the North, and the theory of its behavior can be worked out without reference to anything magnetic. Indeed there is nothing magnetic about it, it is only an elaborate spinning top. If we knew all about a compass needle it is probable that its theory could be worked out on somewhat similar lines. There is a hypothetical spin inside the atoms of the steel which may account for its behavior, just as the spin of the gyroscope accounts for its behavior, provided the spin of the earth is taken into account too. So it may be with magnetism. But no one has ever seen the magnetic spin, nor do we know for certain what it is that is spinning.

Again, we never actually see an electric current. What we observe is the motion of a compass needle which it deflects (as in a galvanometer), or the bubbles which arise in a liquid which it has decomposed (as in an electrolytic cell), or the light which is emitted by a filament which it has heated (as in an ordinary glow-lamp). No one has seen an electric charge. All we perceive is the behavior of bodies—the attraction of light things in its neighborhood; and to say that that behavior is due to an electric field, or that the pattern of iron filings is due to a magnetic field, is no better than saying that it is due to electricity or to magnetism. It might be difficult, but it would be possible, to work out a theory of the motions of matter without introducing those terms. And if we forcibly limited ourselves to that which was really and directly observed, such a theory would be the inevitable result.

That is what the Theory of Relativity aims at—to specify exactly what is perceived, and to make no hypotheses beyond it. If an observer fails to detect any difference in the velocity of light through space—whether he has reason to think he is moving toward the source or not—then let us proceed on the assumption that the velocity of light is absolutely the same relatively to every observer—granting the hypothesis, which is doubtful—for it *is* constant so far as the observer is concerned. If an observer is unable to detect any difference between his own motion and the motion of matter near



Brown Bros.

THE BIRTHPLACE OF THE THEORY OF RELATIVITY

In this remarkable observatory, built near Potsdam, Germany, Dr. Albert Einstein evolved his famous theory which "dispenses with hypotheses and attends only to what can be observed and measured." Sir Oliver Lodge contends that these abstract factors must be reckoned with, whether or not we find that they can be "observed and measured."

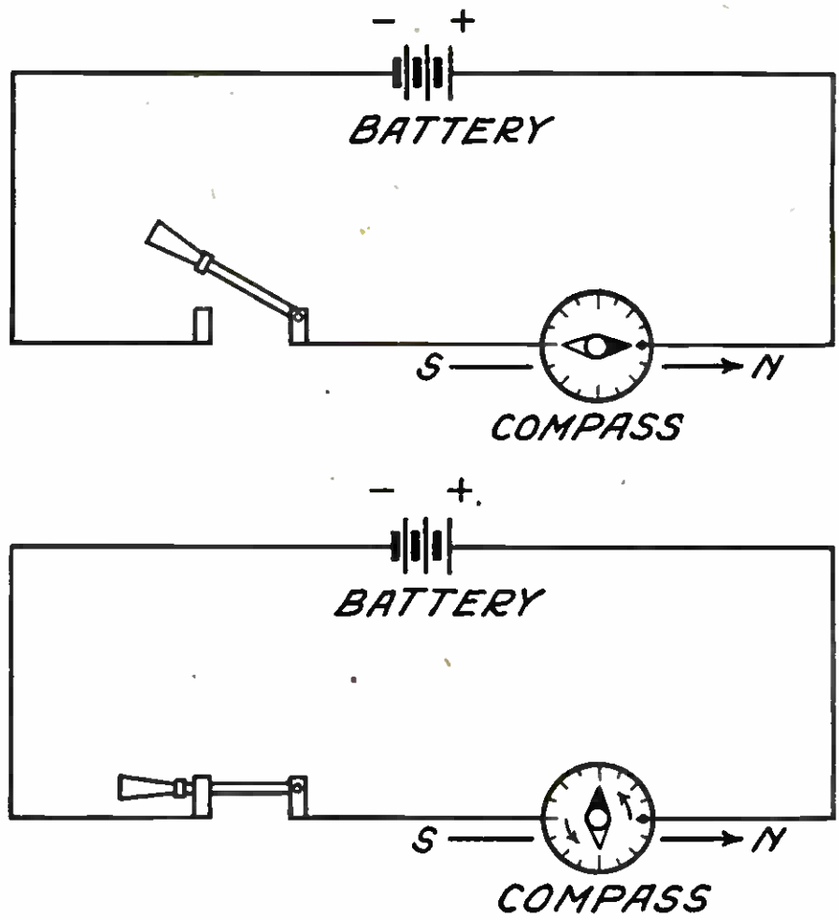
him, then let us assume that there is no difference, and that everything is as relative as it appears to be. So says the doctrine of relativity. In that way we get rid of the idea of absolute motion, that is of the motion of bodies referred to something which is not matter—something omnipresent and fundamental, in which matter, ever since Newton, has been hypothetically held to exist.

The Theory of Relativity is professedly a pragmatical and observational mathematical theory: hence it is claimed that it ought to be acceptable to physicists. It dispenses with speculation, dispenses with hypotheses and attends only to what can be observed and measured. At least that is its ideal, though whether it quite comes up to its ideal may be doubted. We will give it

the benefit of the doubt and assume that a theory of the universe can be elaborated without reference to anything but matter and its motion relative to other matter.

An interesting example of this kind of relativity is furnished by a letter in "Nature" for July 8th, 1922. A correspondent there points out that, of the two theories of the atom, one (namely Bohr's) requires the electrons to be revolving round a nucleus, while the other (Langmuir's) requires them to be stationary. He proposes a Copernican reconciliation, letting them be stationary while the nucleus spins on its axis, saying that according to the Theory of Relativity that should do just as well; in other words, that it does not matter whether a group of electrons revolve round a nucleus, or whether the nucleus rotates inside a group of electrons. Just so, according to an extreme relativist, it might be held that it makes no difference whether the whole system of stars revolves round the earth once a day, or whether the earth rotates diurnally on its axis.

Put in this way the notion is repugnant to commonsense and, we need not hesitate to say, is false. So also the reconciliation of atomic theories suggested in the ingenious letter to "Nature" is imaginary and devoid of efficacy. But according to strict relativity it is not so easy to say why commonsense comes to these conclusions. The fact is that



A DELICATE PROBLEM; HOW WOULD YOU DECIDE IT?

Sir Oliver points out that "Nobody ever saw electricity." But he also observes that "We do observe the motion of a compass needle which electricity deflects." For example, the upper diagram illustrates what happens when a compass is brought near a wire that has no current flowing through it; the lower diagram shows the change that takes place in the compass when a current IS flowing through the wire. Should we deny the existence of magnetism (or of the ether, for that matter) merely because our senses cannot yet perceive the agencies that produce the phenomena? Sir Oliver Lodge answers "No."

the centrifugal acceleration required for radiation cannot be conferred on an electron by a relatively rotating nucleus. Nor is it possible for the stars to move far quicker than the velocity of light—as they would have to if they were to revolve round the earth.

For what, after all, is the velocity of light, and why should a thing be unable to move faster than that?

If we wholly and finally ignore the ether, no explanation is forthcoming. We can only merely say that it is so. Relativists all agree that it is so—the equations demonstrate that—but by pure relativity they cannot explain why.

Hence those who have gone most deeply into the Theory of Relativity sooner or later perceive that there must be something substantial filling otherwise empty space; in other words that the ether is really and truly indispensable, however much for practical purposes it may be ignored. For though we can proceed a long way without mentioning or thinking of it, sooner or later it is bound to make its existence felt, not physically, but mentally, because of certain physical effects or consequences which are inexplicable without it, and because its existence is necessary to clear and adequate conceptions. To put it in the most ordinary and elementary form, one cannot really think of waves without some substantial medium for their conveyance.

Let it be known then that the great apostles of relativity have never denied the existence of ether. They have dispensed with mentioning it as far as they can. It does not seem essential to their theory as far as that has been worked out. It does not seem amenable to direct experiment; and they can write down their equations without attending to it. But to deny the existence of the ether, or of electricity, or of magnetism or life or mind, merely because we find it possible for many purposes to ignore them, is to stultify ourselves. And to accuse any of the great relativists of denying the existence of an ether is to attribute to a man of genius a stupidity which he is very far from exhibiting—still less of possessing.

International

TO DENY THE EXISTENCE OF FORCES WE CANNOT PERCEIVE IS "STUPID"

So states Sir Oliver Lodge in his spirited defense of the ether hypothesis. "One cannot really think of (radio) waves without some substantial medium for their conveyance," he argues. Sir Oliver was president of the Physical Society of London, 1899-1900; President of the British Association, 1913-14, and the recipient of the Rumford Medal of the Royal Society and of the Albert Medal "as a pioneer in wireless telegraphy." Among his twenty volumes on scientific subjects is "The Ether of Space."

How then is it possible for Dr. Charles P. Steinmetz to lay down the law and to say that "there is no ether," that "there are no ether waves," and that "according to the Theory of Relativity there can be no such thing"; and that no carrier for light or electro-magnetic waves is needed?

Plainly because he has gone a certain distance into the Theory of Relativity, and has not emerged into the atmosphere beyond it. He is satisfied with the way in which it works out the motions of matter as observed by the senses, and he considers that any inferences beyond the immediate testimony of the senses are illegitimate.

That, then, is where we part company. To limit ourselves to sense indications alone is to reduce ourselves to the level of animals. No one really does it; and some even of the animals may make inferences of a kind. Certainly it is our human privilege to discover, to infer, to generalize and to predict. And I advise those who are every day using the ether, for electrical and magnetic and optical purposes, not to confuse themselves with the gratuitous and rather stupid hypothesis that matter is all that exists because matter is all they perceive; but to allow their minds freer play, and to realize that many other things exist too, for which we have no sense organ.

So, if they care for my advice, I will recommend them to use a nomenclature in accordance with commonsense; to give a name to the substance or medium in which all their phenomena are occurring; to realize that wherever there is an electric field or a magnetic field or a gravitational field or a beam of light, there must be something going on in this medium—something which physicists can hope to analyze and examine and reduce to law and order. I would urge them not to remain satisfied with an abstract statement about the existence of unexplained forces in an absolutely empty, unphysical and merely geometrical space.

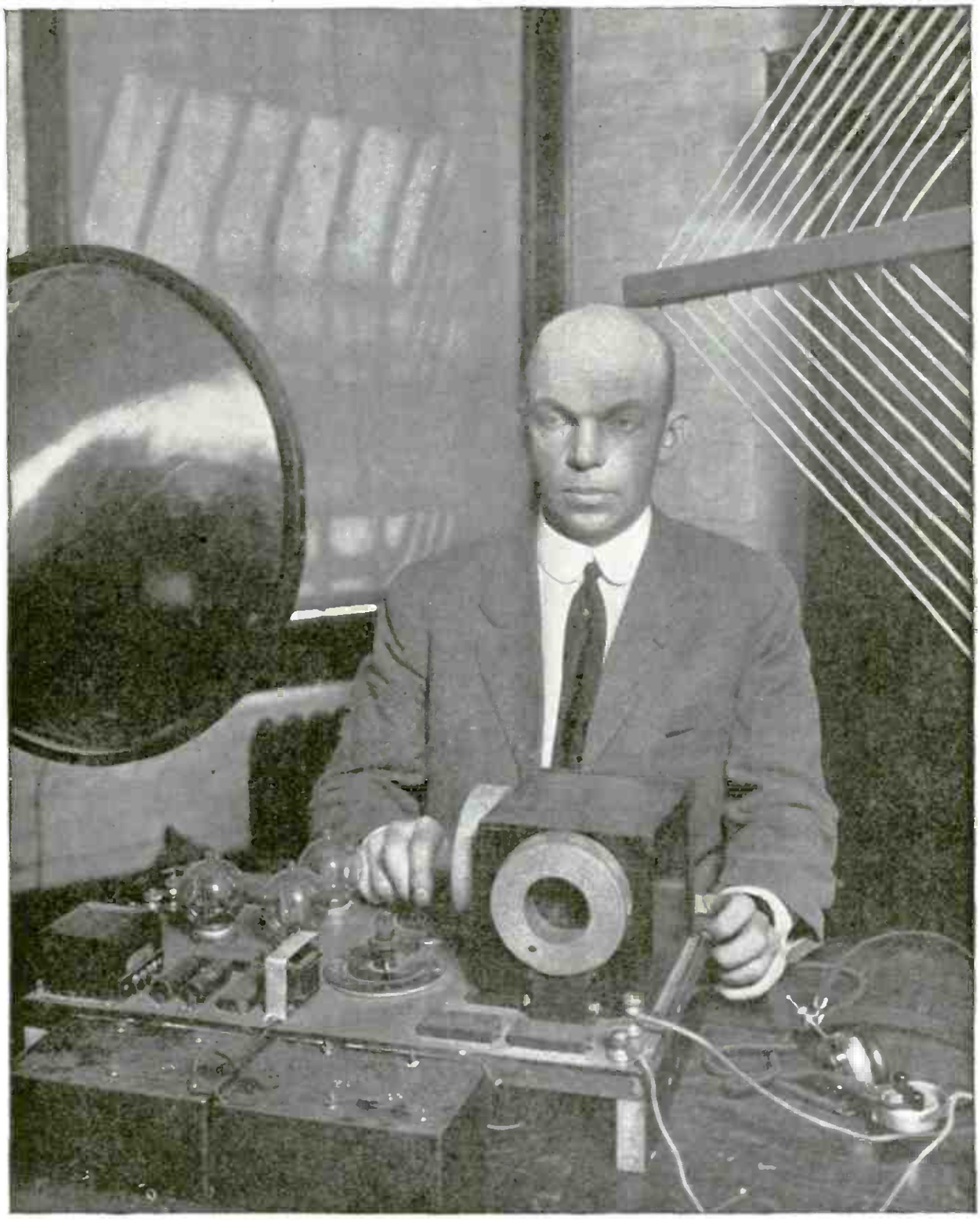
A field of force in vacua has to be accounted for: the mere statement that it exists is no theory. A theory of the ether has not yet been worked out, it remains for the next generation of workers to do it. Perhaps some of those now living will lend a hand. It is no easy task. Meanwhile we can remember always that the properties of the ether are largely unknown and remain to be discovered: which surely is a stimulus to us to pursue our researches. That which we know definitely about it, so far, is the rate at which it can transmit waves, and we know also a great many things which follow directly therefrom. We know further that it has properties akin to elasticity and inertia, which are experienced respectively in electricity and magnetism. Again we know (through the genius of Clerk Maxwell) that the combination of these two properties gives rise to that special kind of disturbance which stimulates the eye, and is responsible for all that is experimented on in wireless telegraphy.

Is There Really a "Heaviside Layer"?

"No," answers Dr. Elihu Thomson, one of the foremost authorities in the world, in his article in the December number of this magazine.

"Yes," answers Sir Oliver Lodge, with no less authority—in the January number that follows.

That two such eminent scientists should select POPULAR RADIO as the field for this international discussion is a matter of moment to radio amateurs throughout the country.



From a photograph made for POPULAR RADIO

THE MAN WHO ORIGINATED THE ARMSTRONG CIRCUIT

Hertz, Marconi, De Forest—and now Edwin H. Armstrong head the list of scientists who have made radio, as we know it today, possible. Armstrong has the unique honor of making three definite contributions to radio. FIRST, *he originated the regenerative feedback vacuum tube circuit.* SECOND, *he invented the super-heterodyne receiver—the most sensitive receiver ever produced.* THIRD, *he invented the super-regenerative receiver, which has just taken the world by storm, and which bears his name. Detailed instructions for building this super-regenerative receiver were published in* POPULAR RADIO *for September.*

My Orchestra of AUDIONS

Every radio fan who has heard the audio frequency "howling" of a home-made receiver will recognize the raw material from which the notes of this remarkable instrument are built and how wonderful musical tones are created by varying the inductance or the capacity of the vacuum tube circuit.

By

LEE DE FOREST, Ph.D.

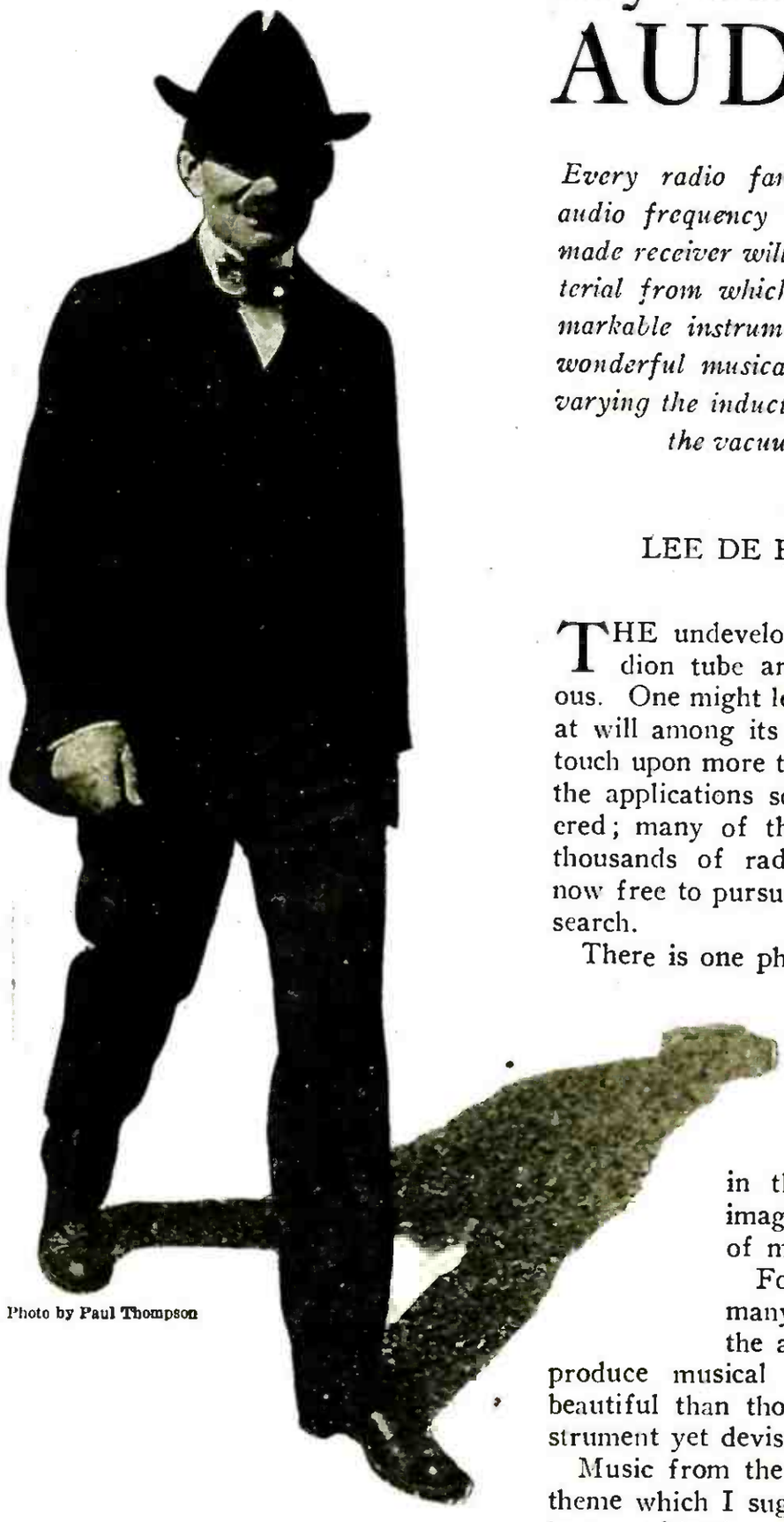


Photo by Paul Thompson

THE undeveloped talents of the audion tube are undoubtedly numerous. One might let his imagination roam at will among its possibilities and never touch upon more than a small fraction of the applications some day to be discovered; many of them, doubtless, by the thousands of radio amateurs who are now free to pursue this still adventurous search.

There is one phase of audion application in which I have always had a deep personal interest. This application does not lie in the field of practical utility, but in the world of art and imagination, in the province of music.

For, in addition to its many other magic feats, the audion may be used to produce musical harmonies far more beautiful than those of any musical instrument yet devised.

Music from the audion! That is the theme which I suggest to those who are interested in the undeveloped possibilities of the vacuum tube.

The audion serves not only as a detector, an amplifier and a high-frequency generator, together with a score or two or other uses in electrical engineering: it will serve also as a musical instrument, an instrument of astounding possibilities.

It is quite possible, I believe, that the musical audion, when fully developed and perfected, will revolutionize altogether the production of music. It will supersede our organs and pianos, even perhaps our symphony orchestras, just as these have superseded the musical instruments of ancient times, the lyre, the tambor, and the Pipes of Pan.

This musical phase of audion possibilities is not a new idea, though it is one long awaiting development. Back in 1915, following the use of the audion in the record-breaking radio telephone demonstration from Arlington to Honolulu, I made an announcement of what was then the promise of an early use of this magic tube as a producer of music. I pointed out that the tube was a device capable of producing musical notes of rare beauty and great range; an entirely new music of surpassing volume and harmony.

It was while developing the audion as a wireless telephone detector, and as an amplifier to be used on long-distance telephone lines, that I made the discovery of audion music. I found that when the circuits of an audion tube were adjusted in a certain way, so that electrical oscillations were produced, I could hear a clear musical note in the connected telephone receiver. The quality of this note was exceptionally beautiful. After later experiments I found that I could change this quality of tone so as to produce a great variety of sounds—imitating, for example, the flute, the oboe, the cornet or stringed instruments. I could also produce other sounds which, while pleasing to the ear, were quite unlike the tones emitted by any of the musical instruments with which we are familiar.

The pitch of the note could be regulated, I found, by changing the capacity or the inductance of the circuit, this being accomplished easily by means of a sliding contact on the inductance coil or

From a photo made for POPULAR RADIO by Western Electric

PHOTOGRAPH OF THE NOTES OF A FIFE

This oscillograph shows (at the top) a pure sine wave of 1000 cycles a second; the second wave from the top shows the highest note of the fife, which has practically no harmonics. The presence of harmonics is clearly shown on the two lower waves.

by turning the knob of the condenser. I found, indeed, that I could change the pitch of the note by merely touching my finger to certain parts of the circuit, and by so doing I was able to obtain many weird and beautiful sound effects. Another method of varying the pitch was by means of a black lead pencil mark drawn on a piece of paper or a slate and connected across certain parts of the circuit.

Every one is familiar with the peculiar plaintive notes produced by the Hawaiian guitar when the player slides a piece of steel along a string previously set in vibration. Much the same effect can be obtained with the musical audion by varying gradually the pitch of its note. Other effects include the shrill warble of birds, staccato drumbeats, heavy organ peals and notes closely simulating those of the familiar orchestral instruments. Even in our preliminary experiments we succeeded in producing new tones, tones far more ethereal and beautiful than any now at the command of musicians.

The reason why these effects were possible will be clear at once to radio engineers. Musical tones are simply air vibrations or oscillations that have frequencies within the audible range. That is, they have what we call "audio frequencies." On the other hand, the electric oscillations in a vacuum tube, for example in a tube which is being used as a generator of oscillating current or as a transmitter for continuous wave radio work, are much more rapid than the oscillations of sound. They have higher frequencies or what we call "radio frequencies." All this is familiar.

But vacuum tubes can be made to oscillate not only at the high radio frequencies, but also at the much slower audio frequencies. This, indeed, is just what the tube does when it goes wrong temporarily and howls into the telephones of a radio receiving set. It is oscillating at a comparatively low frequency, a frequency within the audible range.

All that we have to do to bring this about artificially is to arrange a partial feed-back circuit containing the proper inductances and capacities to produce just the frequency, that is, the tone, which we wish. The electric oscillation thus produced, being already of audio frequency, requires merely to be fed into a telephone or loudspeaker in order to give us ordinary sounds in the form of a musical tone.

The note of an organ pipe is produced by the oscillation of the air-column inside the pipe. The note of an audion tube is

George Granthams Bain

HOW THE "AUDION ORGAN" MAY BE PLAYED

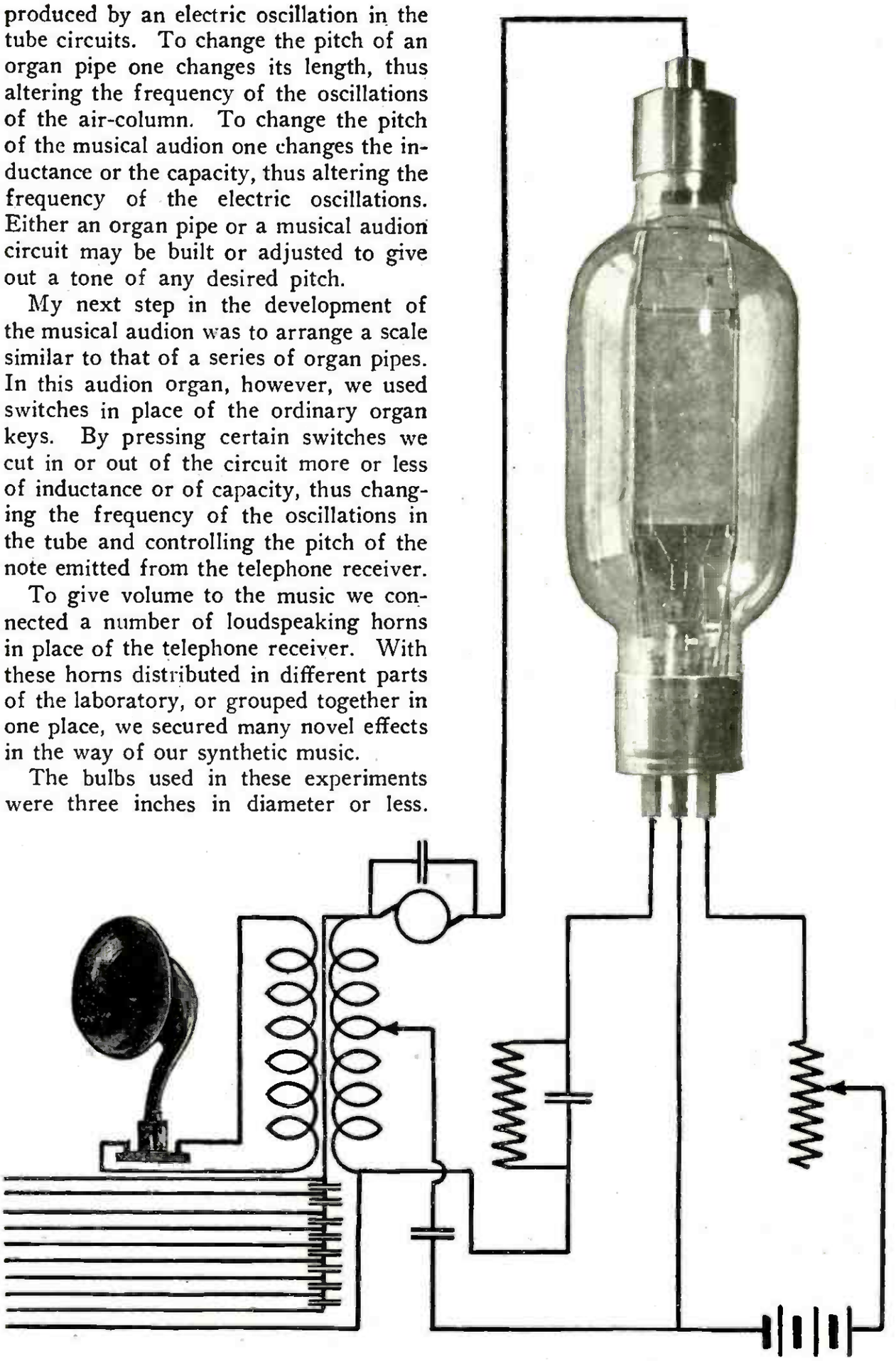
By means of vacuum tubes, a loudspeaker, and a suitable audio frequency oscillating circuit connected to a keyboard—similar to a piano or organ—music of exceptional tone flexibility and wonderful sweetness may be produced. The apparatus may be controlled by "stops" as in the organ, so that the various musical instruments may not only be imitated, but other tone qualities may be produced that are unknown to the musical world today.

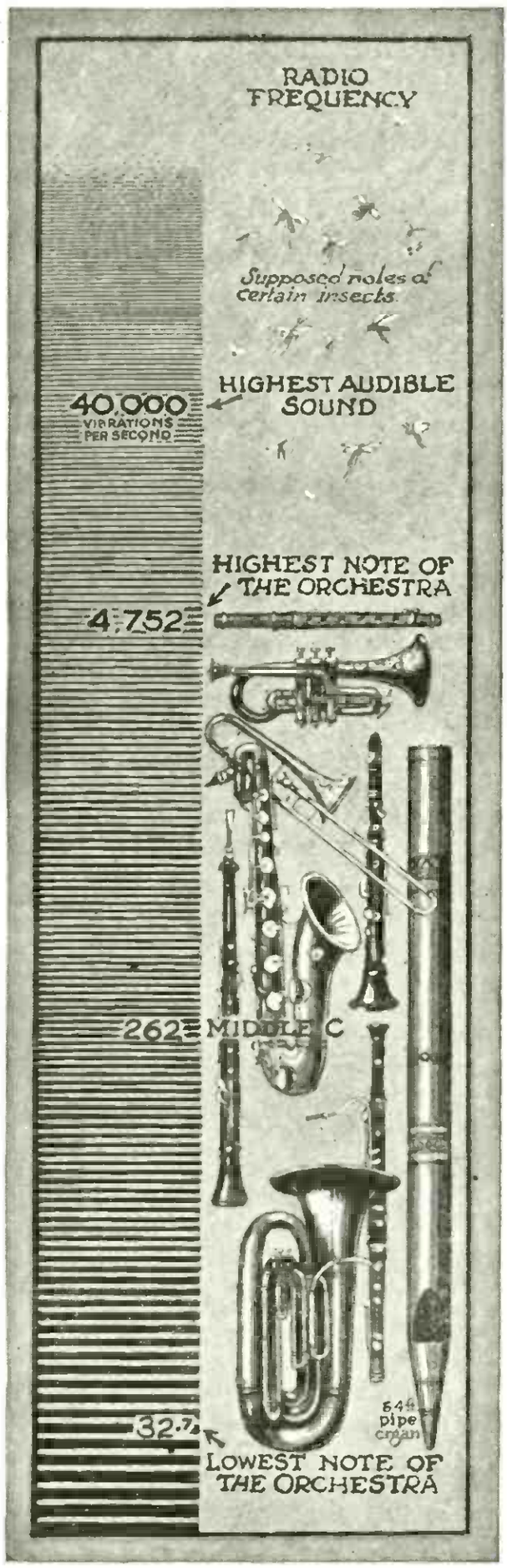
produced by an electric oscillation in the tube circuits. To change the pitch of an organ pipe one changes its length, thus altering the frequency of the oscillations of the air-column. To change the pitch of the musical audion one changes the inductance or the capacity, thus altering the frequency of the electric oscillations. Either an organ pipe or a musical audion circuit may be built or adjusted to give out a tone of any desired pitch.

My next step in the development of the musical audion was to arrange a scale similar to that of a series of organ pipes. In this audion organ, however, we used switches in place of the ordinary organ keys. By pressing certain switches we cut in or out of the circuit more or less of inductance or of capacity, thus changing the frequency of the oscillations in the tube and controlling the pitch of the note emitted from the telephone receiver.

To give volume to the music we connected a number of loudspeaking horns in place of the telephone receiver. With these horns distributed in different parts of the laboratory, or grouped together in one place, we secured many novel effects in the way of our synthetic music.

The bulbs used in these experiments were three inches in diameter or less.





We used one bulb for each octave of the musical scale. By an arrangement of switches in place of keys, we could produce from this one bulb, by pressing the right switch, any of the notes of that octave. Another bulb was used for the next octave, and so on. The output of all these bulbs was fed into one set of telephone receivers or loudspeakers, so that the total energy emitted in the form of sound was that of all the circuits in action at any one time. It included all of the notes being sounded by the tubes, just as orchestral music includes all of the notes being sounded at one time by all of the instruments which are playing.

These experiments of mine were carried out six or seven years ago. There had been, however, some still earlier attempts to produce electrical music in other ways, not using the audion. Notable among these were the experiments of the Cahil Company with what was called the "telharmonian."

This instrument was a huge plant consisting of a large number of alternating current generators of the inductor type. Each of these generators produced a current of a certain definite number of alternations a second, and each was tuned to the frequency of one of the notes of the musical scale. There was a different generator for each note, just as a piano has a different string for each note.

The currents from these generators were controlled by a keyboard similar to that of an organ and were combined thus into a single, highly-complex musical current which was transmitted over the telephone wires to theaters, hotels and homes, where loudspeaking horns poured this new electrical music into the air. There were imitations of the organ, the

LOWEST AND HIGHEST SOUNDS PERCEPTIBLE TO THE HUMAN EAR

Of the thirty instruments of the modern orchestra, the lowest pitch is that of the tuba (32.7 vibrations a second), and the highest is that of the piccolo (4,752 vibrations a second). Radio frequency currents in general use range from 30,000 to 1,500,000 vibrations a second: the highest audible vibrations range up to 40,000.

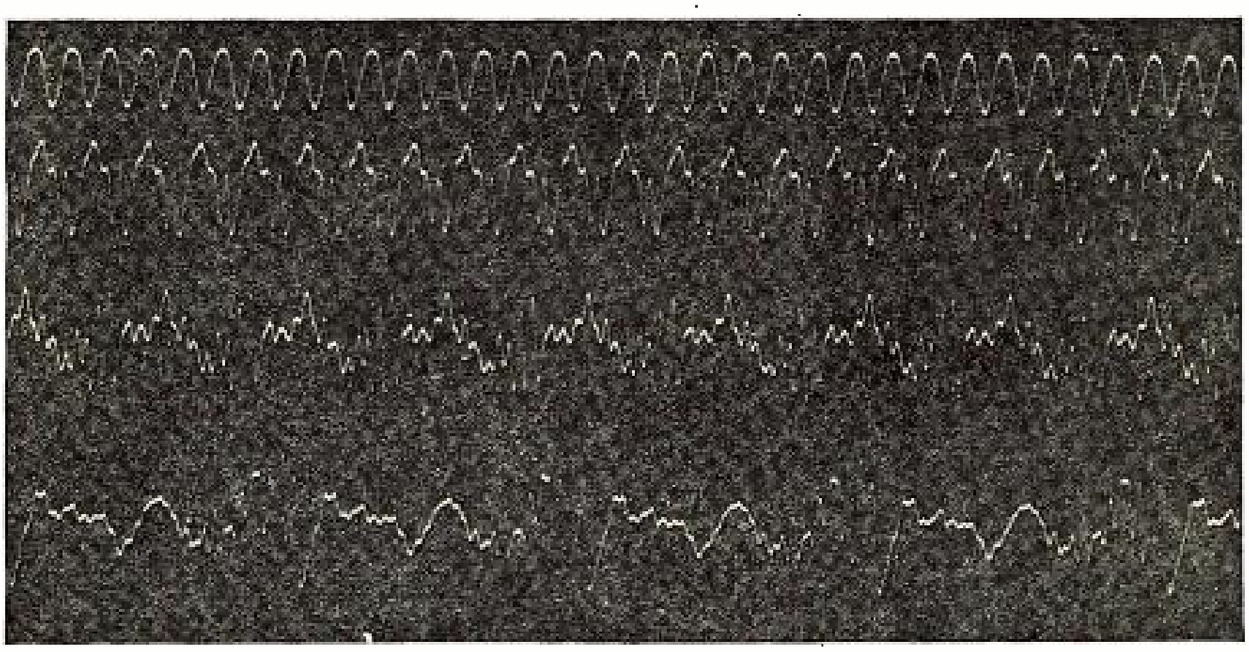
clarinet and other instruments, and mingled with these were strains of a quality entirely novel to musicians.

In comparison with the telharmonian, the musical audion has the advantages of greater flexibility and ease of control as well as of simplicity. As a source of musical tones an audion is equivalent to, indeed it is superior to, the alternating current generator, but at a small fraction of the cost, bulk and weight. The necessary parts of an audion organ might be contained in the cabinet of an ordinary talking machine and with a control the size of a typewriter keyboard. With the audion organ there are no pipes or strings to require great bulk, and yet it will produce music ample to fill a large auditorium.

The greatest advantage of the audion organ lies, however, in the increased tonal resources which it puts at the service of the musical composer. Musical tones differ among themselves in three qualities: pitch, loudness and quality. The pitch is simply a matter of frequency; the greater the frequency, the higher the pitch. Loudness explains itself; tones may be either very strong and loud, or very faint—or anything in between. Both of these two characteristics of a tone are fully controllable in the audion organ; pitch, as I have explained, by varying the frequency of the electric oscillation, loudness by varying the input of energy with a resistance or in any other convenient way.

But the third characteristic of tones, the tone quality, the audion organ also permits us to control; and it is this, I imagine, which will be of the most interest to the professional musician.

The differences in the sound of the various musical instruments are due almost altogether to differences in the quality of their tone. Middle C of the piano has a pitch or frequency of 262 vibrations a second. This same note played on a violin or on a clarinet or on a French horn has exactly the same frequency, 262 a second. Yet the notes from these different instruments do not sound alike. You can tell easily that one of the notes is from the piano, another from the French horn. What are the differences?



From a photo made for POPULAR RADIO by Western Electric

THE TONES OF A SAXOPHONE—THE INSTRUMENT RICHEST IN HARMONICS

Compare the record of harmonics (illustrated by the frequencies in the three lower waves that record three different notes of a saxophone) with the pure sine wave at the top.

They lie in the tonal quality, and this tonal quality is a matter of what are called "overtones." A pure musical tone is a simple and regular vibration. It is represented by a pure sine-wave curve, like the curve of a perfectly regular alternating current.

Incidentally, such an absolutely pure tone cannot be produced by any ordinary musical instrument and only with great difficulty by the human voice. All ordinary musical tones contain certain overtones superposed on the pure tones. These overtones are tones of higher pitch, that is, of higher frequency, which are sounded at the same time as the pure tone and blend more or less completely with it. The overtones produce little bumps and hollows, little kinks, in the sine-wave of the pure tone. Or they displace the maxima and minima of the wave, so that the original sine-wave is no longer exactly even and symmetrical. In electrical language they "distort the wave of the sound."

This distortion is what produces tone quality. A piano note has a certain fundamental tone, a pure symmetrical sine-wave, corresponding to the pitch of the note. It also has certain overtones, corresponding to vibration of the piano string in parts, in halves or thirds or quarters. It has certain other overtones, corresponding to parts of the sounding-board or to other strings. The actual tone is the sum and combination of all these tones. The overtones distort the sine-wave of the pure tone. They give it its quality, so that you recognize it as a piano tone. If your ear is very good you may be able even to recognize it as a tone from a certain individual piano or from a piano of a certain make.

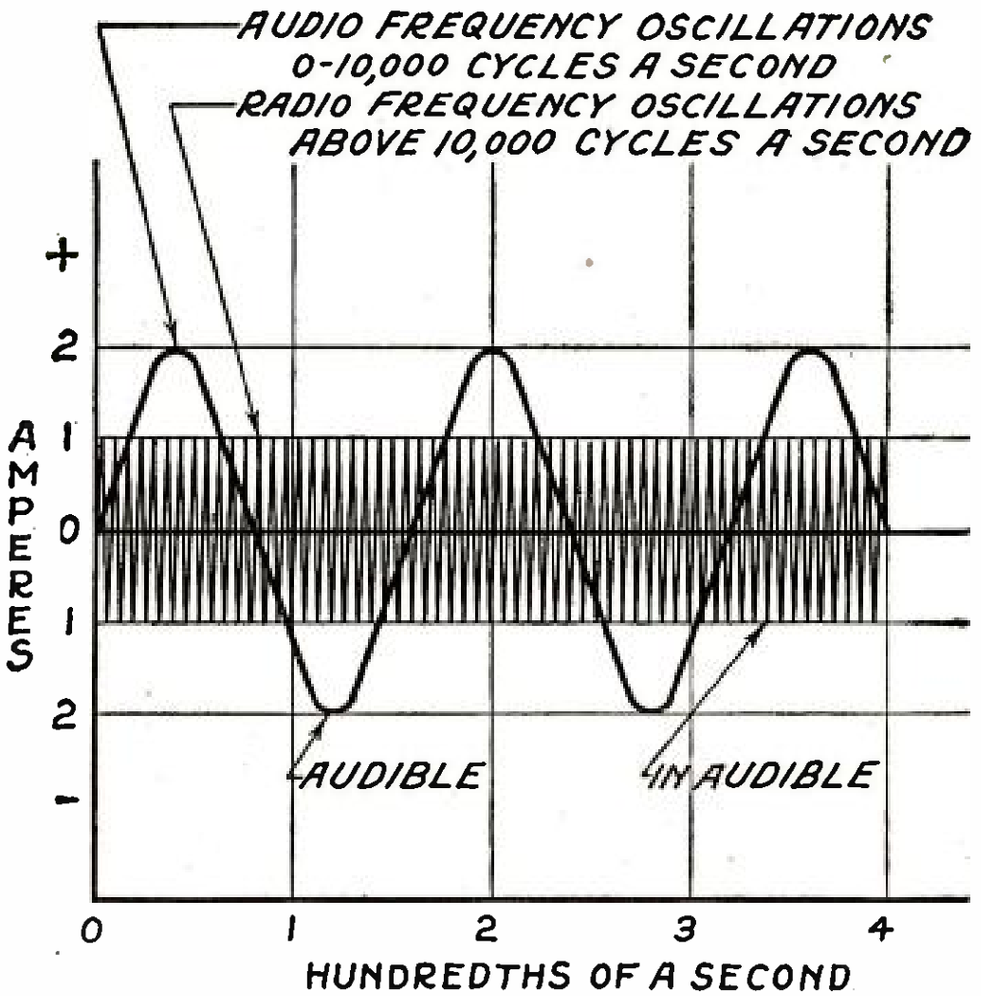
Similarly with other instruments, each one has its own set of overtones which it imparts to its fundamental tone. Each one has its own tone quality. To some extent this quality can be controlled by the musician, as when a violinist changes his tone quality by varying his bowing, or when a horn player sticks his fist into the bell of his instrument in order to get the so-called "stopped" quality into his tone.

Now all of these variations of tone quality are obtainable—and controllable—with the audion organ. The musical audion may be adjusted so that its primary tone is absolutely pure, a perfect sine-wave. Or this primary tone may be altered merely by distorting the electric circuits, so as to cause any desired change in the quality of the sound. It may be made to counterfeit the piano, the violin, the 'cello or the horn, or may be distorted into any sort of sound—musical or grotesque.

Furthermore, the note of the audion tube is controllable in pitch with extraordinary precision. It may be altered not only in steps of a full tone (as in most instruments), but by half tones or quarter tones or even lesser fractions. It may be played so as to be always precisely in tune, an advantage which it shares only with the violin and other bowed strings and with the slide trombone. All other instruments, among ordinary ones at least, have a fixed series of notes. Only these notes can be played, and the musician can alter the pitch of these, while playing, only slightly, if at all.

On the piano, for example, D sharp and E flat are the same tone, produced from the same string. Every musician knows that this is not quite as it should be. D sharp and E flat ought to differ a little in pitch. One or the other should be used depending upon the exact harmony desired. But to insert both in the piano would require too many strings and keys. One note, about half way between the two, must serve for both. The entire piano keyboard is a compromise between musical desirability and mechanical necessities. Its scale is not, it cannot be, exactly perfect.

Other instruments have similar imperfections. Their scales are never quite perfect. Their harmonies are always a trifle untrue. Only the violin and its lower-pitched analogues, the viola, the



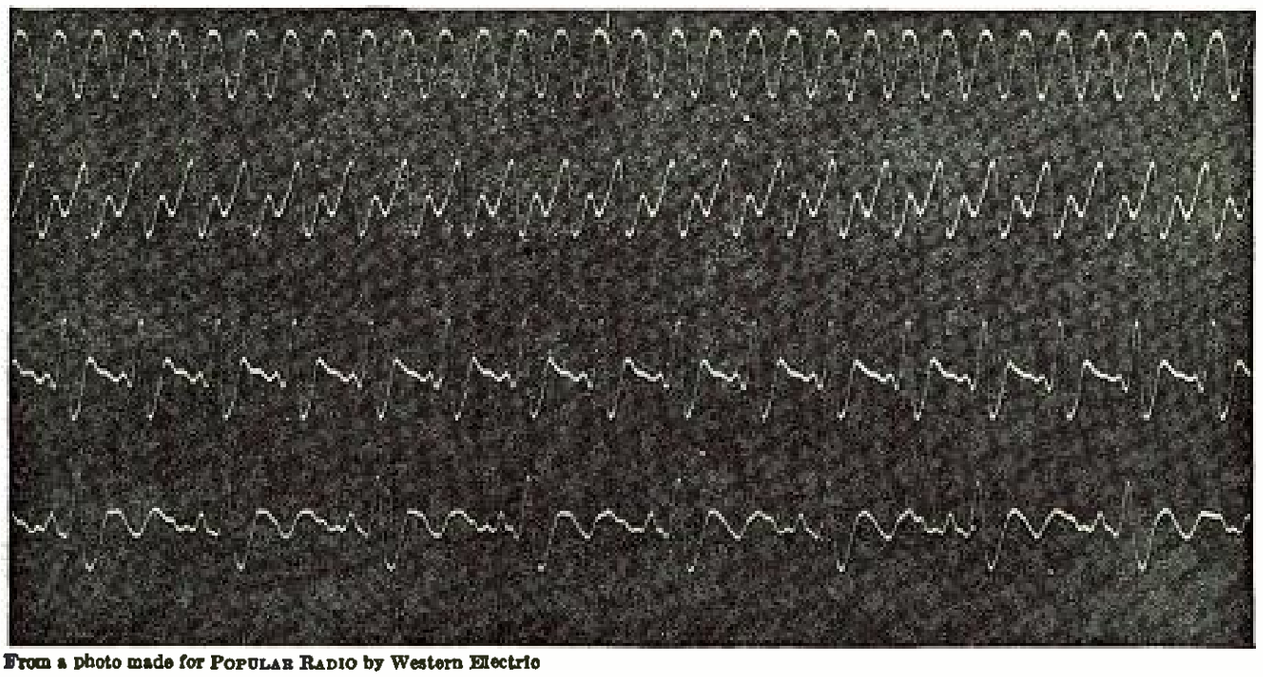
VIBRATIONS THAT WE CAN HEAR—AND THAT WE CANNOT

This diagram shows two alternating current waves. One is one of a frequency that we can hear and one is of a frequency that oscillates so fast that the human ear cannot detect it. The latter is used in radio communication and is usually produced by the vacuum tube. The vacuum tube may also be used to produce the audio frequency oscillations which are used by De Forest for the production of the wonderful new music described in this article.

'cello and the double bass; the slide trombone; the human voice—and the audion tube—can be made to produce absolutely true tones, absolutely perfect harmonies.

In precision of control for both pitch and tonal quality, the audion tube equals or surpasses all other instruments. It has, as the musicians say, great flexibility, a flexibility exceeding even that of the full orchestra.

The modern symphony orchestra contains 25 to 30 kinds of instruments. Allowing for the possible different ways of playing some of these instruments, the composer has at his service perhaps one hundred different kinds of tonal quality. His available pitch range is from the highest D of the piccolo, at 4,752 vibrations a second, to the lowest C of the mutiple-valved tuba, at 32.7 vibrations a second. He can widen this pitch range a few notes if he has an organ for very low tones or if his violinists can play the six or seven possible harmonics which range above the piccolo. But his available range of tone quality and his available range of pitch do not fully coincide. He cannot play high notes of bass-horn quality nor low notes that sound like the piccolo or flute. The flexibility of the orchestra, its resources of tone color, or expression or emotional portrayal, while very great in comparison with the piano or with any other single instrument, is still far from being as complete as is possible in theory.



From a photo made for POPULAR RADIO by Western Electric

PORTRAIT OF THREE NOTES OF A CORNET

Note the first harmonic (one octave above the fundamental) in the wave below the pure sine-wave. In the record next below there are numerous harmonics which are increased further in the lowest wave.

The whole history of instrumental music may be regarded, by the way, as a more or less successful effort by musicians to widen the flexibility of their instruments, to increase the sum-total of their tonal resources. The original instruments of primitive man appear to have been two, the simple pipe or whistle and the drum. To these the ancients added a third fundamental instrument, the stretched string or lyre. These three possessed a very small range of pitch and a still smaller range of tonal quality.

It was the effort to increase this range that led to modern instruments. Out of the pipe grew first the notched or holed pipe which could play several notes and which survives in the modern flute. Then came the combination of several pipes fastened together in a row. These could play not only a note for each pipe, but the quality could be varied by using narrower and wider pipes or by making them out of different materials. Hence the Pipes of Pan or syrinx; and out of this there came, by direct and traceable descent, the modern organ.

The primitive stringed instrument, the lyre, developed even more widely in the direction of greater flexibility. Pitch range was attained by the device of changing the string length with a moving finger, as in the modern violins. A marvelous increase in range of tonal quality followed the invention of the bowed or scraped string to replace the original plucked string.

Even the drum followed suit in the search for greater flexibility. We have now the tuned drum or kettledrum, the various tone qualities of small drum, base drum and tambourine, and, in addition, the triangle, cymbal and others, which are really only kinds of drums made out of metal, and made thus in order that the tone quality might be different, that the composer's available range of quality might be widened still a little farther.

Finally, we have the modern orchestra, its available musical resources so wide that they would have been totally inconceivable, I suppose, to a musician of ancient Greece or Rome, even perhaps to the religious choristers of only two or three centuries ago.

Is this the final step? Has the orchestra as wide a range of pitch and tone quality as we will ever be able to attain?

I think not. I believe that the musical audion will soon be able to widen greatly even the great flexibility of the orchestra. Audion tubes can play notes of any pitch; even, if necessary, notes several octaves above the piccolo or the violin harmonics. And they can play all of these notes, high or low, with any desired tonal quality; with the quality of horn or oboe or 'cello, or with new qualities not yet known or used.

What a resource for the composer! What possibilities of new orchestration, of undreamed of harmonies and melodies, tone colors and emotional effects!

Of course we must not expect that the development of the audion organ will be entirely free from practical difficulties. At least two of these difficulties can be foreseen already. One is that of arranging a tube circuit which will be perfectly stable, so that the tone of the tube will not vary, even ever so slightly, after it has been once adjusted.

The second difficulty is the devising of a precise, rapid and dependable system of control, an equivalent of the keys and valve mechanisms of the ordinary organ. Mere switches and condenser knobs are neither precise enough nor quick enough.

At the moment these practical obstacles look pretty serious. But obstacles have a way of disappearing as we approach them more closely, especially where the audion tube is concerned. Probably obstacles to the development of the audion organ will be no exception.

In all my work with the audion—and I can imagine no device in the wide range of practical physics which has greater fascination than this little bulb—I have found no phase of its possibilities quite so interesting as this one of the production of musical tones. Certainly the idea of producing beautiful tone effects by such an entirely new method, unknown to our great composers, offers to musicians an alluring field for their genius.

In the audion we shall have an instrument suitable for home entertainment as well as for furnishing music to a big auditorium. And music thus produced may be taken up again by the audion, this time for broadcasting, and finally received by the countless other audions of receiving sets throughout the world. The musical audion, the radio transmitting audion and the receiving audion, each one doing its share toward the enrichment of life!

The Master's Voice

Our esteemed (if somewhat more elderly) contemporary, the London *Punch*, recently published a satirical drawing of a Vicar and a Verger regarding an empty church.

"This is terrible," observed the former, "five minutes before the service and not a soul here!"

"No, sir," replies the Verger, "but I understand there are some thousands waiting in their own homes to listen in."

In the United States the satire of this observation would be lost—simply because it reflects a truth. The accompanying picture was snapped in a Pennsylvania farmhouse during divine service by radio.

From a photograph by P. A. Sensenig

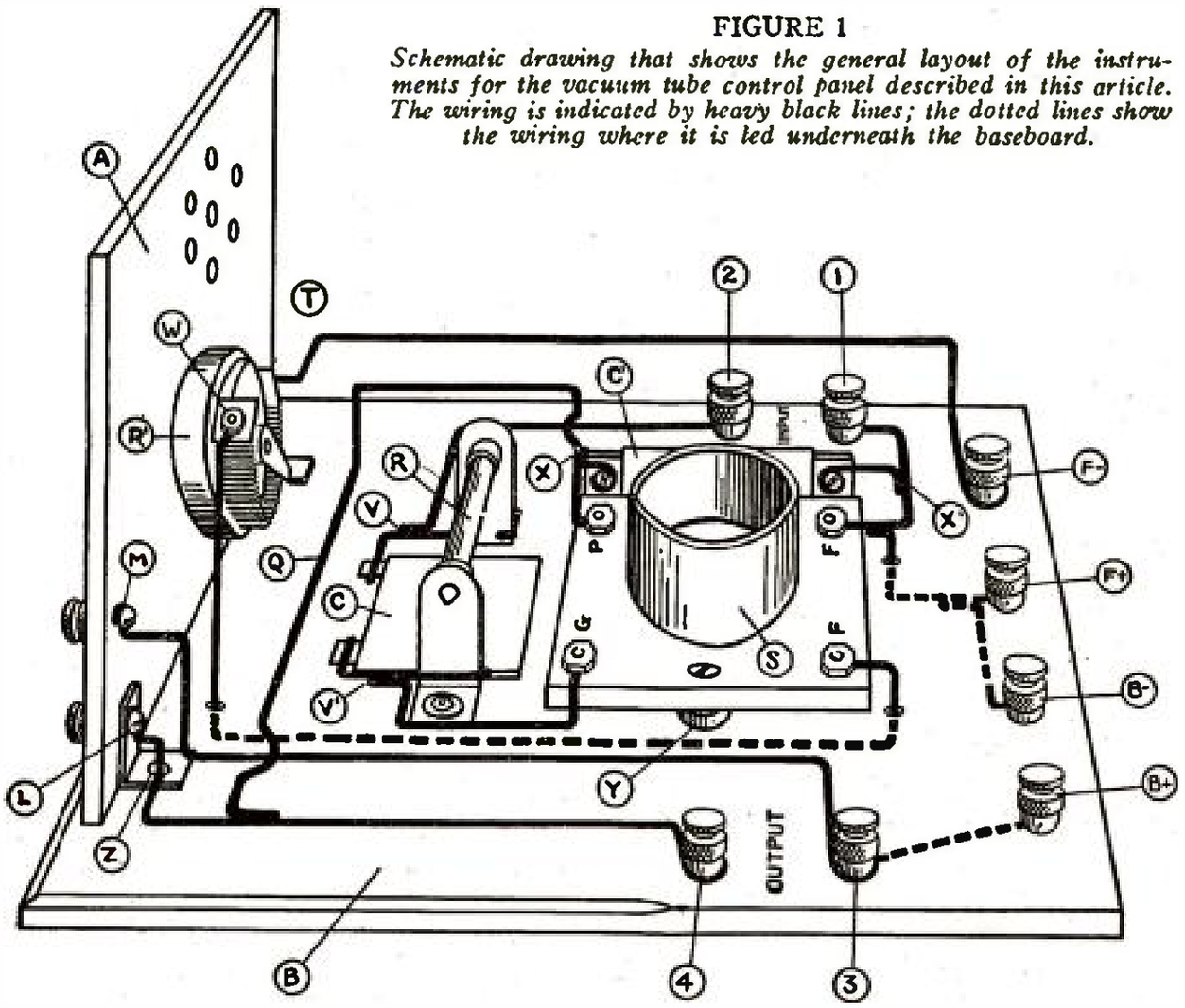


FIGURE 1

Schematic drawing that shows the general layout of the instruments for the vacuum tube control panel described in this article. The wiring is indicated by heavy black lines; the dotted lines show the wiring where it is led underneath the baseboard.

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

THE COST OF DOING IT—

Electron tube	$5.00 to $6.50	Miscellaneous binding posts and screws (about)	.75
Electron tube socket	.75 to 2.00	"A" storage battery, 6-volt, 60 ampere-hour capacity	15.00 to 20.00
Filament rheostat	1.00 to 2.50	"B" battery, 22½ to 45 volts	1.00 to 3.00
Grid leak and grid condenser	.50 to 1.50	Total cost	$23.25 to $36.70
By-pass condenser (about)	.35		
Ten feet No. 14 bare tinned copper wire (about)	.10		

By WATSON DAVIS

THOSE radio fans who made the crystal receiving sets that have been developed by the Bureau of Standards in Washington and that have been described in detail in this magazine,* have apparently found their modest experience with radio so interesting as to stimulate a desire for a receiving set of greater efficiency. In response to this demand, Uncle Sam has produced another set of specifications—a new and better set that employs the same tuning inductances as the two previous sets but that substitutes a vacuum tube detector for the crystal detector.

These new specifications enable the builder of the crystal sets to convert

*See "How to Make and Install Your Own Receiving Set" in POPULAR RADIO for May, 1922, and "How to Make and Operate a Two-Circuit Receiving Set" in the July issue.

them into tube sets at a cost ranging from $23.00 to $37.00. Thus altered, the new sets are capable of receiving high-powered transmitting stations at a distance of about seventy-five miles, when they operate on wavelengths from 200 to 600 meters. Under good atmospheric conditions broadcasting from distant stations may be heard, especially at night. The simple electron tube detector circuit will not, however, make "continuous-wave" signals audible.

The instructions issued from Washington describe simple apparatus of satisfactory performance without reference to the possible existence of any patents which might cover parts of the apparatus. Apparatus in general similar to that described can be purchased from responsible manufacturers and dealers.

The Essential Parts of the Set

The complete radio receiving equipment may be divided as follows: antenna, lightning switch, ground connections and telephone receivers. These are completely described in the May issue of this magazine.

The tuning device. This may be the tuning coil described in the May issue of POPULAR RADIO or it may be the two-circuit coupler and variable air condenser described in the July issue. While the two-circuit tuner will be somewhat more selective than the single-circuit tuner, its use is not absolutely essential. The two-circuit tuner is also more difficult to operate than the single-circuit tuner.

The electron tube detector unit. This is shown in Figures 1, 5, and 6. It is composed of a baseboard B and an upright panel A. On the baseboard B is mounted an electron tube E, shown only in Figure 5, an electron tube socket S, a grid leak R, a grid condenser C, a by-pass condenser C^1, and eight binding posts. On the upright panel A is mounted a filament rheostat R^1, (the adjusting knob J is shown in Figure 5), and two telephone receiver binding posts L and M. The parts S, R, C and C^1 are also shown in Figure 3. Later it will be told how the various parts are assembled on the baseboard and the panel. No description is given of how the parts E, S and R^1 are made because these are all commercial articles. It is, of course, possible for one to make parts such as the electron tube socket S and the filament rheostat R^1.

The accessories needed are a six-volt battery, used for lighting the filament, often called the "A" battery, with an ampere-hour capacity of about 60; a 22½ to 45-volt dry battery, called "B" battery; binding posts; stiff copper wire; wood boards for the baseboard and upright panel, and two brass angle braces for supporting the panel. The "A" and "B" batteries are shown in Figure 5. The "A" battery will usually be placed on the floor beneath the table upon which the other parts of the equipment are mounted. Its comparative size is much reduced in the drawing. An insulating material panel may be substituted for the wood if desired. The electron tube detector may also be entirely enclosed in a wood cabinet with a hinged cover, if desired.

Details of Construction

The baseboard (See B, Figures 1 and 3). The base B is any kind of dry wood about 6¼ inches by 8¼ inches by ¾ inch thick. Eight holes are drilled through the base in which the binding posts are fastened. The spacing of these holes is shown in Figure 3. By the addition of two more binding posts properly connected, this detector may be used in a "regenerative" circuit when the binding posts are externally connected to a "tickler" coil coupled to the tuner. These binding posts are added to the detector baseboard B in line with the "input" binding posts Nos. 1 and 2. (See Figure 1.) They are 7/32 inch from the edge of the baseboard, and the four binding posts are arranged in such a manner that they are equally spaced, 1½ inches between centers. Referring to Figure 1, the wire which leads from the terminal P of the electron tube socket is cut at some convenient place Q and the two ends thus formed connected to the extra binding posts. The method followed in making these connections does, of course, correspond with the style of wiring used in the complete electron tube detector unit. The connection X, from one terminal of the condenser C^1, is also removed and a longer wire connected from this terminal to the other side of the point Q where the wire was cut. The base is arranged so that the three remaining sides and a hinged cover may be added without changing the relative positions of the binding posts. Under each of the four corners of the base B, rubber or wood feet or risers are fastened to protect the binding post heads and wiring on the under side of the base.

The upright panel. (See A, Figures 1 and 2.) The panel A is any kind of wood about 4½ inches by 5 inches by ⅜ inch thick. In Figure 2 a back view of the panel is shown which brings the two holes for the telephone receiver binding posts in the lower left-hand corner. If the panel is viewed from the front these two holes will be at the lower right-hand corner. It is desirable that this board present a good appearance, as it is the front panel. Four holes are drilled in the panel A, one for the bolt which fastens the panel to the brace (see L, Figure 1), two for the telephone receiver binding posts L and M (Figures 1 and 5) and one for the shaft of the filament rheostat R^1 (see Figure 1).

The exact location of the hole for the rheostat shaft is determined from the rheostat itself. It is drilled so that the rheostat will occupy as low a position as possible, allowing room enough to do the necessary wiring.

The electron tube. (See E, Figure 5.) The electron detector tube is a commercially available type. An electron tube is sometimes called a vacuum tube or audion.

The electron tube socket. (See S, Figures 1, 5, and 6.) The electron tube socket is of commercial design.

The grid leak and grid condenser. (See R and C, Figures 1, 3, 5, and 6.) The grid leak and grid condenser may be purchased together or separately or they may be constructed. If one expects to use a detector type of electron tube (sometimes called "soft" or "gas" tube) it is recommended that these two parts be purchased with the tube, care being taken to select the proper values of resistance and capacity for the grid leak and the grid condenser, as specified by the manufacturer of the tube purchased. The resistance of the grid leak will usually be between 1 and 5 megohms (1,000,000 and 5,000,000 ohms) and the capacity of the grid condenser will be about 0.0003 of a microfarad (300 micro-microfarads). If an amplifier type of electron tube (sometimes called a "hard" tube) is used, the resistance of the grid leak may generally be anywhere within the resistance limits specified above and the same size of grid condenser used as mentioned above. Experimental grid leaks may be made for such electron tube detectors. This is only suggested for its educational feature. If the two-stage audio-frequency amplifier is used also, it will be difficult to make a grid leak that will work satisfactorily. Such an experimental grid leak may be made from a piece of fiber about ⅜ inch wide, 1½ inches long and from 1/32 to ⅛ inch thick. Two ⅛-inch holes are drilled along the center line of the piece, about an inch apart. A line is drawn between the two holes, using India or drawing ink. Contact with the ink line may be made by the use of two brass (6-32 or 8-32) machine screws about ½ inch long and each equipped with one nut and two washers. The machine screws are put through the holes in the ends of the fiber strip with one washer on each side of the fiber strip. A small piece of tinfoil may be rolled up and wound around each machine screw between the fiber and the washer so that the tinfoil pad will make contact with the ink line. When the nuts are tightened down, the tin-foil pads will flatten out and form a contact between the

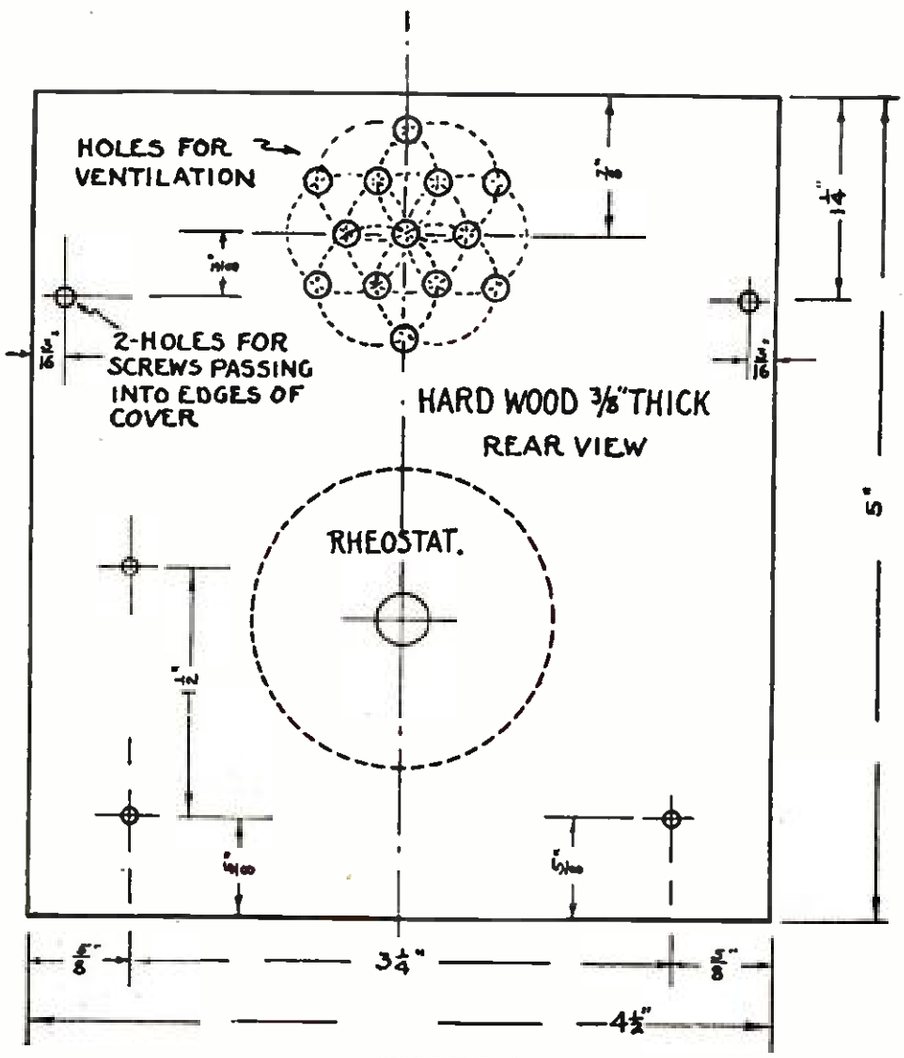


FIGURE 2

This diagram illustrates in detail how to bore the holes in the upright panel "A."

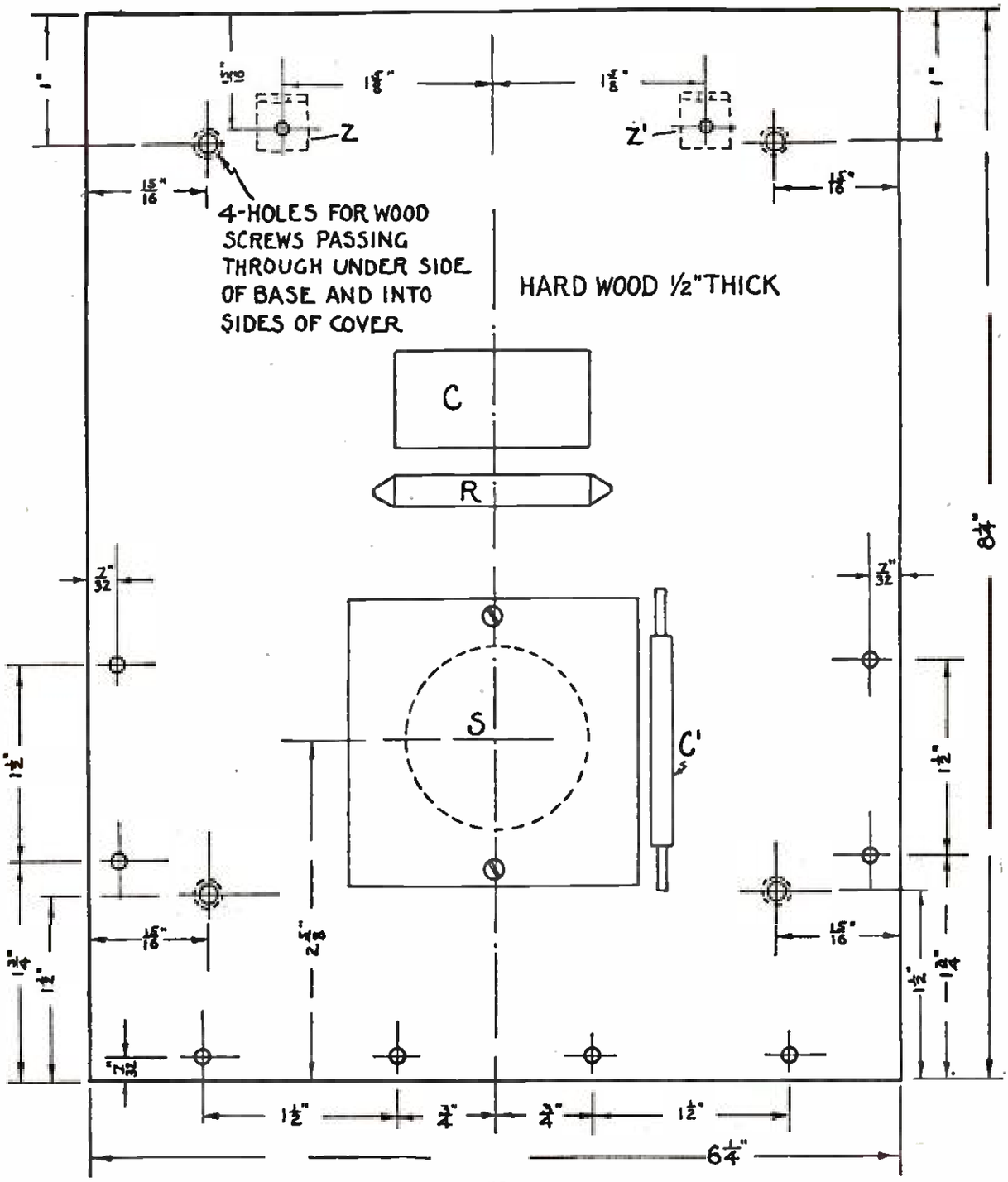


FIGURE 3

A plan view of the baseboard "B"; it indicates where the parts used should be placed and tells the amateur builder where to drill the holes for the binding posts and other parts.

brass washers and the ends of the ink line. Since the ink line makes a partial electrical conductor of high resistance, the thickness and width of the ink line will determine the resistance of the grid leak to a great extent. The value of resistance may be decreased by inking the line over several times, until the electron tube detector works best.

The by-pass condenser. (See C¹, Figures 1, 3, and 6.) This is any small-sized fixed condenser with a capacity of from 0.0003 to 0.0015 of a microfarad (300 to 1500 micro-microfarads) which may be purchased.

The binding posts. (See Figures 1 and 6.) The binding posts used on the base may be 6-32 or 8-32 brass machine screws each equipped with two nuts and two washers, if regular binding posts are not available. The telephone receiver binding posts, L and M (Figure 5), should be of the set-screw type

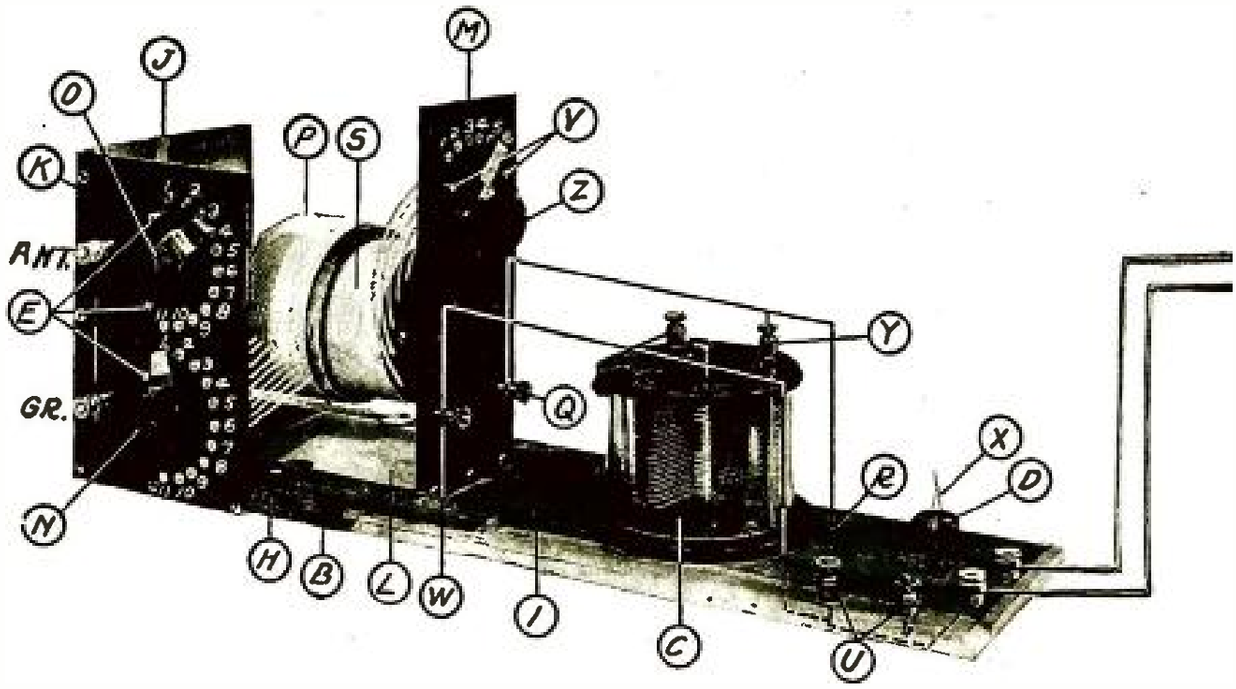


FIGURE 4

This shows how the two additional binding posts are connected to the set described in our July issue, with the two wires connecting it with the vacuum tube detector shown in Figure 5.

to admit the tips of the telephone receiver cords.

The filament rheostat. (See R^1, Figure 1.) As has been previously stated, the filament rheostat may be constructed but no details are furnished. If the rheostat is purchased, it is desirable to select one designed for panel mounting as well as one that has a neat-appearing knob and pointer. The rheostat should have a resistance of about seven ohms and a current-carrying capacity of about 1½ amperes.

Accessories. The accessory batteries are commercial articles. The purchaser of a storage battery for lighting the filaments should get full instructions from the dealer for testing and recharging the battery. The dry "B" battery usually used for the plate circuit can not be recharged. The normal life of a battery of reliable manufacture is about six months. Storage batteries for use as "B" batteries are available. The first cost is greater than that of dry batteries, but they may be recharged.

Assembly and Wiring

Wood finish. It is essential in electron tube sets that the wood be protected from moisture. While the wood base and panel may be treated with paraffine it is found more satisfactory to dry the wood first and then stain and varnish it, using a good varnish, preferably an insulating varnish. Shellac is not recommended. It is difficult to give definite suggestions concerning drying and staining of wood. Wood may be put in a warm oven for an hour or so to insure more or less complete drying. A lamp-black or carbon pigment stain is not used ordinarily on such radio parts, since it is better to avoid the use of such. The stain and varnish are thoroughly dried before the apparatus is mounted on the wood baseboard and panel.

The baseboard. (See B, Figures 1 and 5.) The eight brass machine screws or binding posts are put in the holes already drilled in the baseboard. If machine screws were to be used the heads would be put on the under side of the baseboard with a brass washer between the head and the baseboard. A brass washer and two nuts are then fastened to each screw on the upper side of the baseboard, with the washer next to the baseboard. The tube socket S, the grid condenser C, the grid leak R and the by-pass condenser C^1 are next screwed to the baseboard. (Certain types of condensers will be held in position by the wiring only.) The exact location of these parts cannot be stated because the several types of parts commercially available will vary somewhat in dimensions. One can get a very good idea of the relative positions of the several parts from Figures 1, 3, and 6. The tube socket S is mounted so that the two terminals marked G and P (Figure 1) are nearest the upright panel. Blocks Y and Y^1 are put under the socket S so that the four terminals of the socket do not touch the wood baseboard. This is done by cutting off two round wood blocks just long enough to raise the socket terminals clear of the base, and mounting them so that the screws which hold the socket to the baseboard will pass through holes in the centers of the blocks. After the socket S, grid condenser C, grid leak R and by-pass condenser C^1 are mounted the parts are wired up. No. 14 bare tinned copper wire is used in wiring. This makes the connections stiff and self-supporting. This wire

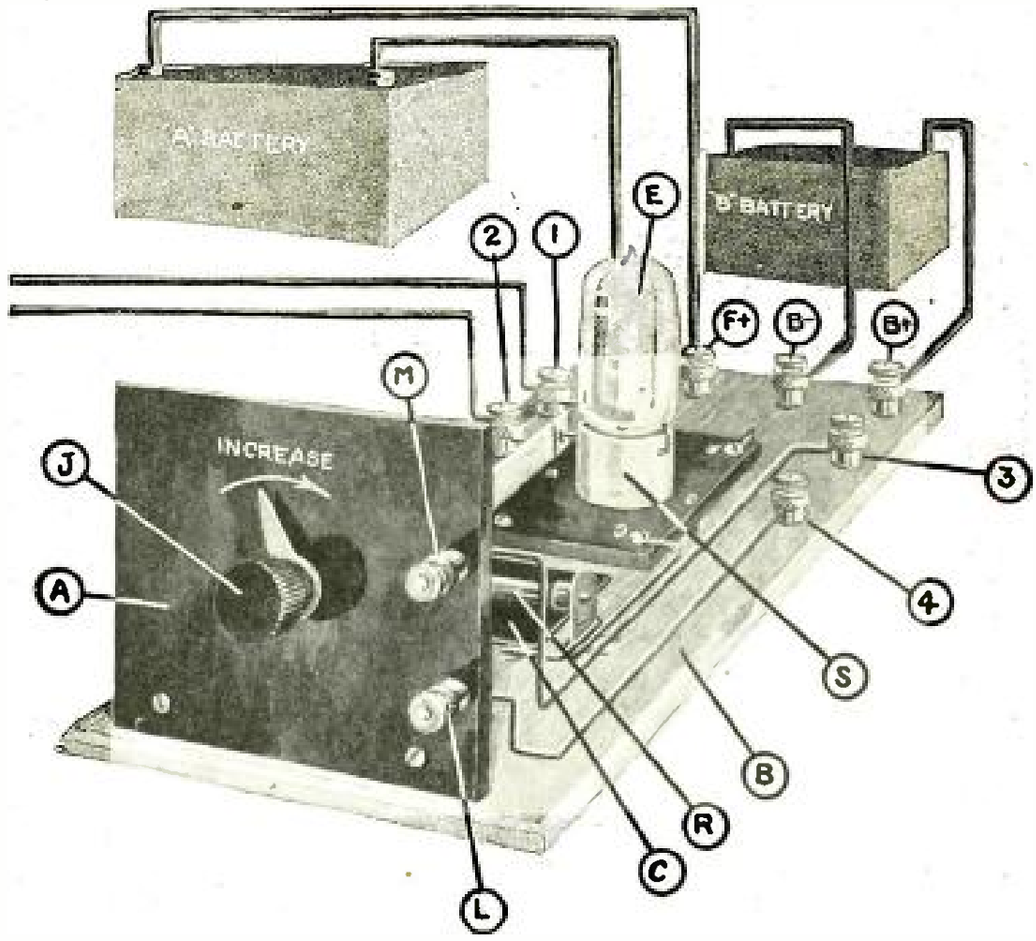


FIGURE 5

The vacuum tube control panel connected up with the necessary "A" and "B" batteries, as they are used to increase the receiving range of the set shown in Figure 4 opposite. This control panel (containing the vacuum tube detector) is merely substituted for the crystal detector that is ordinarily used with the set on the page facing.

is ordinarily furnished in rolls. The wire should be straightened before it is used. It can be straightened by clamping or otherwise fastening one end solidly and pulling on the other end just hard enough to stretch the wire slightly. It is also a good plan in wiring such sets to have all wires run as directly as possible, neatly, and all bends made at right angles. When a wire is attached to a binding post, a loop or eye is formed on the end of the wire and the wire at the eye flattened with a hammer. This gives more contact surface. Special lugs may also be soldered to the ends of the wire before the connection is made. A small hole is drilled through the baseboard just back of each of the tube socket terminals marked F (see Figure 1). A short piece of wire is fastened to the right-hand socket terminal marked F and is then led through the small hole in the baseboard to the under side of the baseboard. The same wire is led to the binding post F and fastened between the machine screw head and washer underneath the baseboard. The same wire is further led to the binding post marked B and fastened between the machine screw head and washer underneath the baseboard. All wires which are run on the under side of the baseboard are shown by dotted lines. A short piece of wire is soldered to the wire leading from the right-hand socket terminal marked F, just above the baseboard and led to the "input" binding post No. 1 and fastened between the washer and the first nut. This wire is shown as a solid line which means it is on the upper side of the baseboard. The wires do not touch the wood boards except at the terminals and where the wires pass through holes in the baseboard. The wires may all be raised more or less to accomplish this. The two terminals of the grid condenser C are connected to the two terminals of the grid leak R as shown in Figure 1. A wire is soldered at V and led to the input binding post No. 2. This wire is kept quite close to the baseboard. Another wire is soldered at V^1 and led to the tube socket terminal marked G. The remainder of the wiring is left until the upright panel is assembled and fastened to the baseboard. Notes on soldering are given later.

The upright panel. (See A, Figures 1, 2 and 5.) The filament rheostat R^1 is mounted on the upright panel A so that the two terminals will be in a convenient position for wiring. Two binding posts of set-screw type, L and M. (Figures 1 and 5), are inserted in their proper holes, and the upright panel mounted in posi-

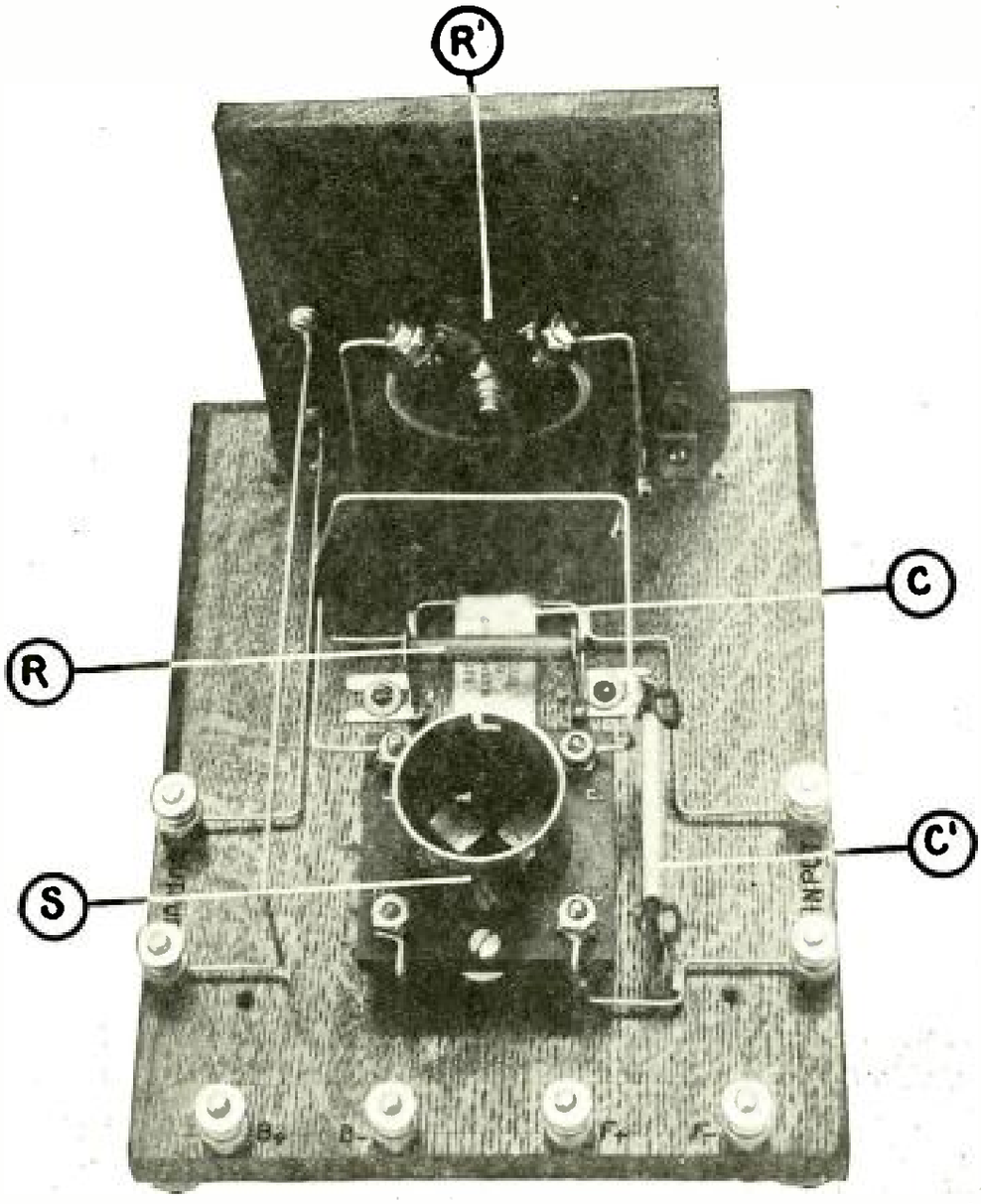


FIGURE 6

The completed instrument, ready to be connected to your tuner. Note the neat way in which the connecting wires are arranged.

tion by bolting it to the two brass angle pieces (Z and Z¹) shown in Figures 1, 2 and 6. One of the telephone receiver binding posts, L, serves as a bolt. Two small holes are drilled through the baseboard near the two terminals of the filament rheostat R¹. A wire is run from the "output" binding post marked 4 (Figure 1) along the upper side of the baseboard to the back of the telephone receiver binding post marked L. A wire is fastened to the tube socket binding post marked P and thence led to the back of the telephone receiver binding post marked L, or else soldered to a convenient place on the wire leading from binding post L. These wires are shown in Figure 1. A wire is run from the binding post marked 3 to the back of the telephone receiver binding post marked M and also a wire from B+ to binding post No. 3, underneath the baseboard. One of the terminals of the by-pass condenser C¹ is connected at the point X and the other terminal of the condenser is connected at the point X¹. The method of making these connections depends to some extent on the particular type of fixed condenser which is used. If the condenser be provided with flexible leads one of them is soldered at the point X and the other is likewise connected at the point X¹. If the condenser is provided with lugs, connections are made by bending the wires into the proper shape and soldering thereto. A wire is run from the filament rheostat binding post marked W through the hole in the baseboard and thence along the under-side of the baseboard to the binding post marked F. This wire is shown in Figure 1 by a dotted line. Likewise a wire is run from the rheostat binding post T and connected to the left-hand binding post marked F. This completes the assembling and wiring of the electron tube detector unit.

Directions for Operating

Connections. It has already been stated that better results are obtained if the two-circuit tuner described in POPULAR RADIO for July is used with the electron tube detector. However, the single-circuit tuner described in the May issue may be used or the electron tube detector may be connected to any tuner not already supplied with an electron tube detector.

If the single-circuit tuner is used with this electron tube detector, two more binding posts are added in the back right-hand corner and wired to the two rotating knobs on that set. Such wiring will not disturb the set for use as a crystal detector receiving set.

If the two-circuit tuner is used with this electron tube detector the arrangement of the parts is similar to that shown in Figures 4 and 5. Connections between the secondary of the coupler and the terminals of the variable condenser are the same as described in the July issue. Two more binding posts are added at the right-hand edge of the baseboard supporting the variable condenser and crystal detector. (See Figure 4.) The dotted lines clearly indicate the new wiring connections.

The antenna and ground wires are connected as described in the May issue. The two new binding posts placed on the old set are connected with the two binding posts marked 1 and 2 on the electron tube detector set, as shown in Figures 4 and 5. The telephone receivers are connected to the binding posts L and M as shown in Figure 5. The red (positive +) wire of the "B" battery is attached to the electron tube detector binding post marked B+ and the black (negative —) wire to the binding post marked B—. An insulated flexible copper wire is run from the red (positive +) terminal of the 6-volt "A" storage battery to binding post marked F+ (Figure 5) and a similar wire from the black (negative —) terminal of the "A" battery to the binding post marked F—.

Operation. The filament rheostat knob J (Figure 5), is turned to the extreme left and the electron tube E inserted in the electron tube socket S. The filament rheostat knob is then turned to the right until the electron tube filament becomes lighted, the brilliancy depending upon the type of electron tube used. When one of the telephone receiver terminals is removed from its binding post and again touched to the post, a sharp "click" in the telephone receivers will be an approximate indication that the circuit is in working condition. If the test buzzer as described in the May issue is available, it may be attached (as described) to the tuner binding post marked "ground" and then the rheostat adjusted until the sound in the telephone receivers is the loudest. The reader should bear in mind that the electron tube detector unit is merely substituted for the crystal detector and the tuning of the receiving circuit is the same as described in our May and July numbers. When signals from a desired transmitting station are heard as loud as possible by tuning, the intensity may sometimes be improved by adjusting the knob on the filament rheostat so as to increase or decrease the filament current (current from the "A" battery). The knob is kept in the position of minimum filament current without reducing the strength of the incoming signals.

If a detector type of electron tube be used, the voltage of the "B" battery is changed until the greatest signal intensity is obtained. This necessitates the use of a tapped "B" battery.

The operator must not expect too much of the apparatus at the first trial. Even assuming that he has had experience with crystal detectors, some difficulty may be experienced in getting the electron tube to operate. In this case he should first ascertain if the various parts of the complete receiving equipment are properly connected; or again, it may be found that some of the connections to the electron tube detector unit are improperly made. Special care should be taken to see that the "A" and "B" batteries are connected to the proper terminals of the electron tube detector unit. After a little experience the operator will find the electron tube to be much more positive in adjustment than the crystal detector.

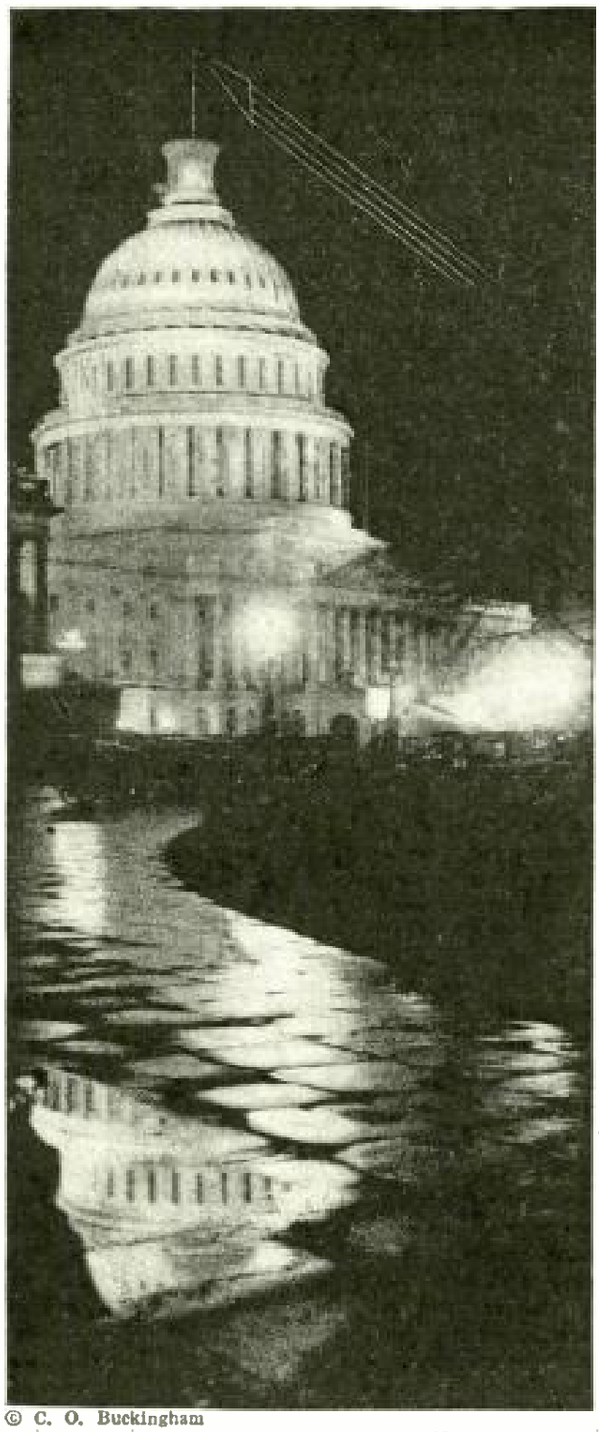
Notes on Soldering

It has been stated above that certain connections were soldered. In fact, one could well advise that all connections about a radio circuit be soldered, but soldered correctly. There are some general hints that may be given, but judgment and experience are essential. The soldering copper must be clean and the tip well coated with solder. If the tip of the soldering copper is not bright, it should be filed clean. It is then heated, care being taken that the tip is not directly in the flame. After the copper is hot (but not red hot), it is dipped in the soldering flux or paste, and the copper tip coated with solder. The wires are cleaned where the soldering is to be done, using fine sandpaper; then a small amount of soldering flux or paste is applied at the joint and the wires to be soldered are tinned or coated with solder before they are joined. After the wires are tinned they are soldered together, using just enough solder to make the joint solid. The joint should not be jarred while the solder is still soft; to do so weakens the joint and gives the solder a dull appearance. A good soldered joint will be smooth and bright. All excess soldering flux or paste should be cleaned off. Gasoline or alcohol will assist in cleaning off the paste. This last point is sometimes overlooked and the excess flux often causes the copper wires to corrode.

The Approximate Cost of Parts

The list on page 170 includes the cost of parts of the electron tube detector unit and the "A" and "B" batteries. It does not include the cost of the telephone receivers or of any of the other equipment used to make up the complete receiving outfit, inasmuch as these details have been given in the May and July issues of POPULAR RADIO.

It is suggested that a pair of 2,000 or 3,000 ohm head phones of standard make be used in connection with the completed set.



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Will Radio Reform Our Politicians?

What Will Our Congressmen and Senators Say and How Will They Say It When Their Speeches Are Broadcast From the Capital and All the United States Can "Listen In"?

By HARRY A. MOUNT

AN austere member of the United States Senate objected because one of his colleagues used a naval radio station to broadcast a political speech. Government property, he says, should not be used for private political purposes.

This is all very well, argues the opposition, but so long as Congressmen enjoy the franking privilege, why not give them the freedom of the government radio stations?

"Under the law," says the New York *Herald*, "any Senator or Representative may use the mails without limit and without cost to himself for broadcasting speeches that have appeared in the Congressional Record. A Senator has burdened the mails with as many as a million copies of a speech. The letter carriers are annually bowed down with 20,000,000 copies of speeches. What may disturb Congress is not the use of Government radio but whether the party in power will grab the official radio for its own speeches in the important last weeks of a campaign."

One solution of this perplexing problem at once suggests itself: why not build a radio station atop the Capitol, assign it a wavelength and set it to broadcasting the whole proceedings of the Senate and House of Representatives? The venture might even be undertaken as an economy measure; it has its practical features. For instance:

Twenty million speeches, if each carried a two-cent stamp, would cost $400,000 in cash. If they were sent in franked envelopes the cost to Uncle Sam would not be considerably less. To this charge must be added the cost of printing and preparing for mailing. At least we may be sure that if the money now spent on franking were spent on maintaining a

radio station at the Capitol, the results would be a thousand times more far-reaching and effective.

And that brings up another aspect of the influence of the radio on politics; if the proceedings of the United States Senate were broadcast by wireless, what effect would this method of publicity have on the deliberations of that august body?

If a Senator knew he were talking not just to a little group of partisans, each as intent as himself on playing politics "as she is played". . . .

If he knew he were addressing also more voters than there were at that moment in his whole district. . . .

If he knew that enough men and women to turn the tide of the next election in his own district were listening to his every word. . . .

If he knew that more people in Ohio heard him than he could address personally if he made a lecture tour of that State. . . .

What would be the result?

Some day we may be able to "tune-in" on Congress, but whether or not that comes to pass, we are certainly going to have politics by radio from now on. And the effect, on the whole, may be gauged by what changes in the conduct of the Senate we might expect, if the whole Nation "listened in" on its deliberations. It will be interesting to watch the effect on politics of the radiophone.

Although the first widely popular use of the radiophone was in broadcasting the results of a political election—that was in 1920 when the East Pittsburgh

COLD LOGIC WILL DRIVE OUT THE OLD-SCHOOL ORATORY

Gestures and platform tricks are lost on the radio audience. The political candidate —in this case Gifford Pinchot—must depend for his effects upon sound argument and authoritative data.

Station KDKA was used for this purpose—only limited political use has been made of radio since.

In October, 1921, in Pittsburgh, when the offices of mayor, coroner, sheriff and other local officials were open, the radiophone played a very important part. Every candidate, regardless of party, was given an equal opportunity to speak from KDKA. Most of them took advantage of the opportunity. The experiment was so successful that in the last senatorial and gubernatorial elections in Pennsylvania this same station broadcast speeches by all of the leading aspirants.

In both cases the time allotted each candidate was equal, and it was understood that the speeches would be an announcement of opportunities and promises to constituents as to service if the candidate speaking were elected. It is fortunate, in this case, that the station is controlled by a disinterested party. Equal opportunities might not have been afforded by a station controlled by a newspaper or a political organization.

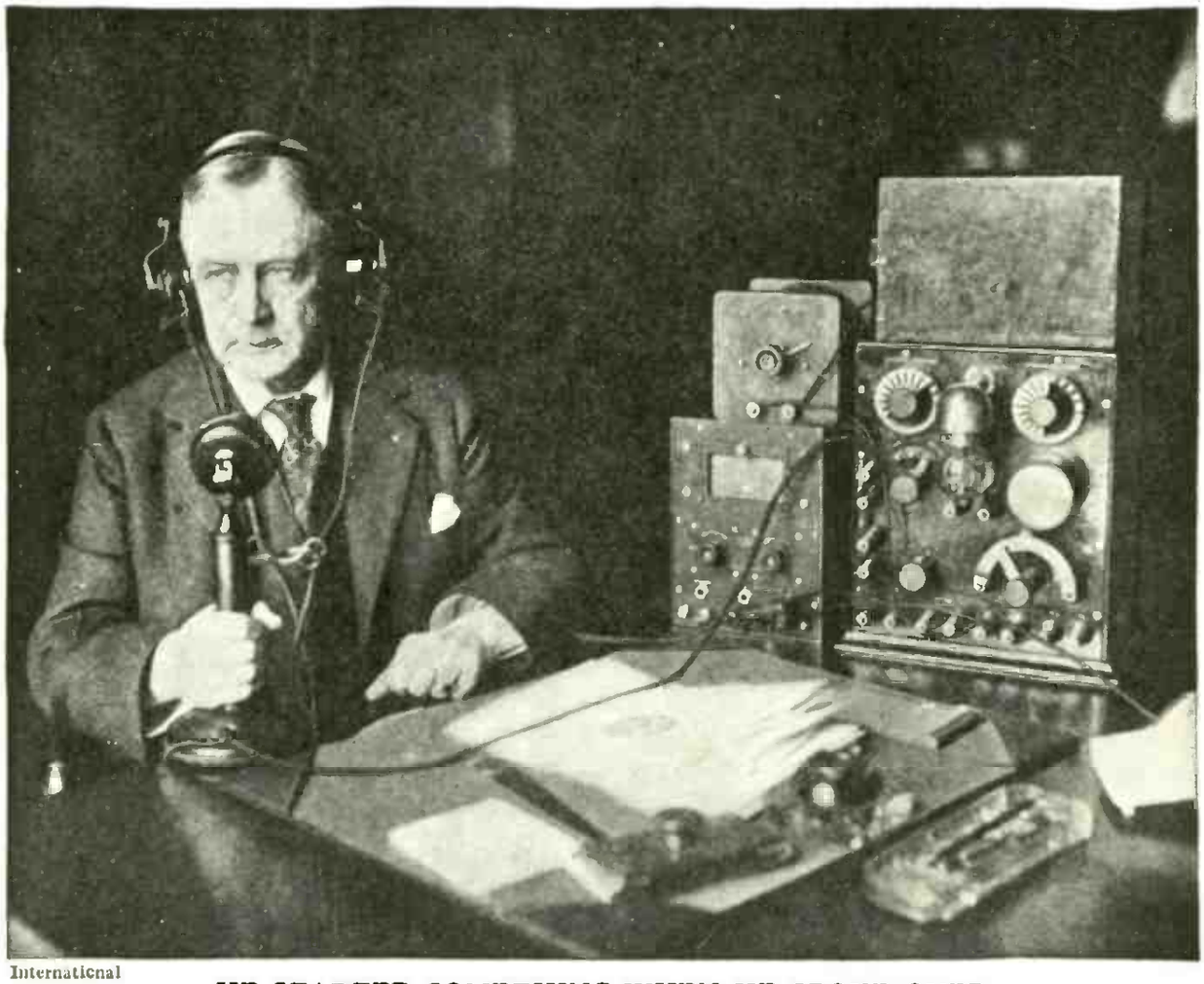
A somewhat more limited use of radio was made in New York in the 1921 municipal campaign when Mayor Hylan and some others of the candidates spoke from one of the local broadcasting stations. But the event had not been widely announced and only those wireless enthusiasts who happened to "pick up" the speech heard it.

The first real test of the value of radio in politics will come, no doubt, in the presidential campaign of 1924. No one can predict with certainty just what will happen, but no doubt the leading candidates will make wide use of the radiophone. Many of our political leaders al-

Pacific & Atlantic

THERE WILL BE NO ALIBI FOR THE CAMPAIGNER-BY-RADIO

Promises made will be heard by voters generally—not by special groups whose favor is courted. Newspaper reporters cannot be charged with "misquoting" a candidate. This picture shows Representative Alice Robertson of Oklahoma addressing her constituents.



International

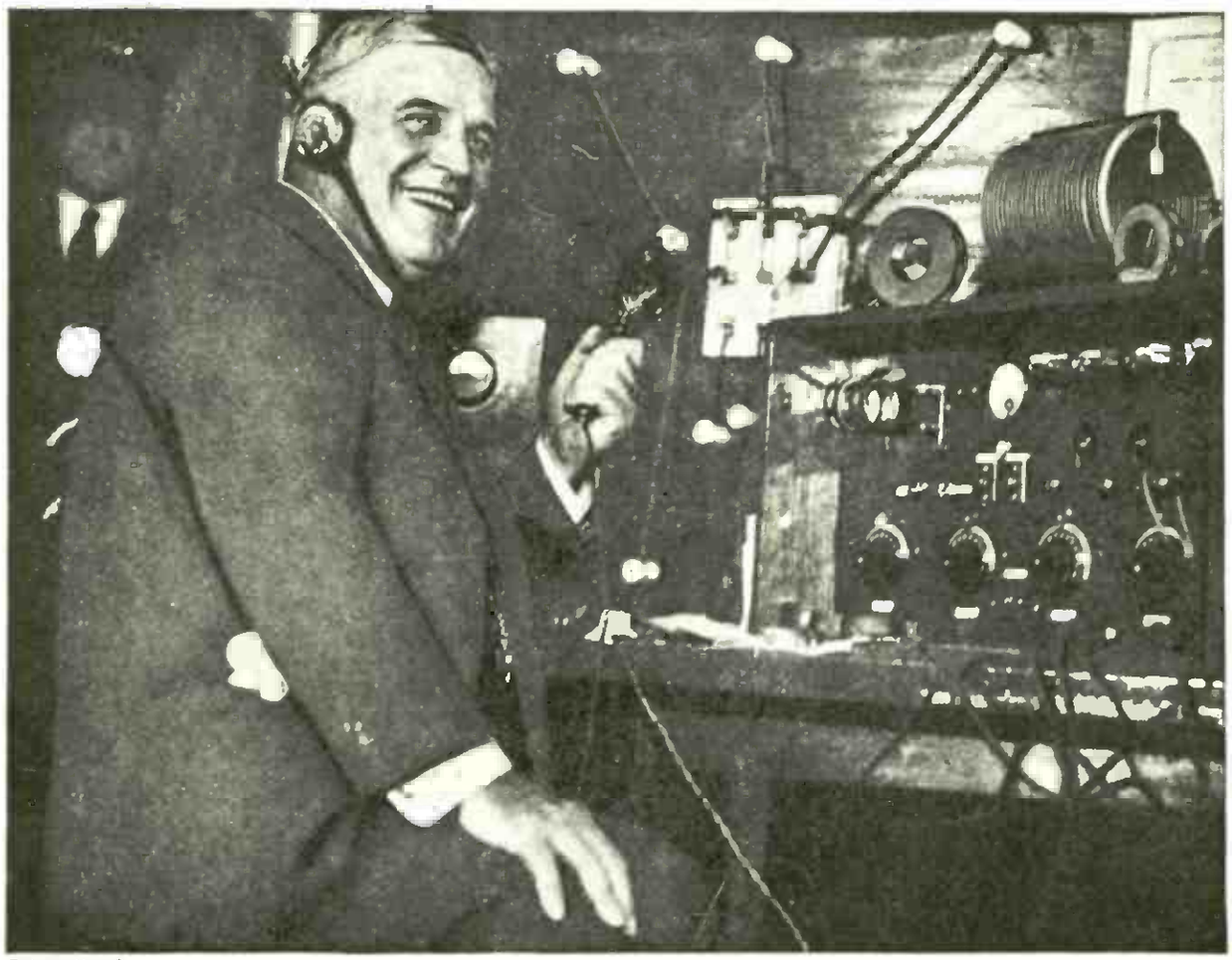
HE STARTED SOMETHING WHEN HE SPOKE OVER THIS RADIOPHONE

When Senator New spoke to his constituents in Indiana last spring by means of the Anacostia radio station maintained by the Navy he opened up the question as to whether or not government radio stations should be used for political purposes, and if so, under what conditions.

ready have made short addresses by radio and they are fully alive to its possibilities. The list of notables who have talked from a single great broadcasting station include President Harding, Secretary of Commerce Hoover, Secretary of Labor Davis, Secretary of War Weeks, William Jennings Bryan, Theodore Roosevelt, Jr., Governor Sproul of Pennsylvania, Governor Allen of Kansas, and Mayor Key of Atlanta.

At this writing a conservative estimate places the number of wireless receiving stations at 800,000. Last spring equipment was sold just as fast as it could be manufactured. In fact the demand from the larger cities could not be met and little had been done toward introducing radio into the rural districts. Careful investigation has shown that for every receiving station there are four or more head phones so that the whole family may listen in. The present radio audience may therefore number between 2,000,000 and 3,000,000 persons. Further estimates place the possible radio audience of 1924 at not less than 20,000,000.

There has never been a means heretofore, in spite of all the wonders of the telephone and telegraph and the great modern press system, whereby so many persons could be reached so cheaply, so easily, and so directly. Politicians are not going to overlook that fact. They will make the fullest possible use of radio in future elections.



International

THE "SPELLBINDER" OF TODAY IS FORSAKING "THE STUMP" FOR THE TRANSMITTER

For one reason because he can vastly extend the range of his influence; instead of reaching merely hundreds he can reach tens of thousands—as Governor Sproul of Pennsylvania (pictured above) has discovered.

And that brings up the question of what the fullest possible use will be.

It is obvious that if each party or faction sets up its own radio and begins broadcasting its particular brand of propaganda there will be a great deal of confusion from which no great profit may be expected. So long as a man's audience was limited to the number of persons who could get within hearing distance of him the principle of the freedom of speech could be applied in its broadest possible meaning. While he could find someone to listen to him, he could talk as long and as loud and as much as he liked. But when the size of an audience increases until a speaker may have more hearers than there are people in the cities of New York, Philadelphia, Chicago and San Francisco combined, and as only one man at a time can address that audience effectively, it is evident that some sort of an agreement will have to be reached between the various groups.

It would seem an ideal situation if control of the great broadcasting stations should remain in the hands of disinterested parties, and if the government-owned radio should be continued chiefly for the purpose of broadcasting such serviceable information as time and weather reports, market reports, storm warnings, and the like. Likewise, it would seem something of a calamity to this great radio audience, as well as to the politicians themselves, if each party attempts to broadcast its own propaganda, or if any party attempts to monopolize any one of

the great broadcasting agencies. This is a problem which no doubt will adjust itself in time, but, no matter what final solution is reached, the effect upon political methods is bound to be far-reaching.

Consider, for instance, the matter of election promises. It has always been a temptation to political speakers to temper their promises according to the audience they are addressing. If they happened to be talking to an audience of union laboring men they were quite likely to extol the dignity of labor and the strength of union, and to promise that if elected union labor would have a sympathetic friend in office. If, on the other hand, the audience happened to be composed of the members of a country club, the address very likely would take quite a different tone. But if the same speaker were to address a vast invisible radio audience of hundreds of thousands or millions of persons from every walk of life (with no chance to claim the reporters had misquoted him), any promises made would probably be carefully considered and faithfully observed after election.

And not only would the substance of his address be changed, but his very manner of speaking probably would have to change to meet the mechanical conditions of radio transmission.

It has been found by repeated experience that highflown oratory is not effective by radio. Much better transmission qualities are obtained by speaking in a quiet, evenly modulated voice. Extemporaneous talks have proven equally disastrous. Speakers have found it very hard to address extemporaneously an audience which they cannot see and which cannot see them. There are pauses which become very painful and embarrassing. For this reason most radio speakers now read carefully prepared papers, conscious that they must impress their hearers by the thought they present, rather than by any oratorical effects or by the charm of personality. It seems quite plausible, then, that as radio becomes more widely used and more effective in campaigning, we may see the ascendency of quite a new type of politician—a hard thinker who knows his subject thoroughly and speaks with quiet authority, as opposed to the bombastic type of present-day politician.

Presidential candidates will find themselves addressing large numbers, too, of a class of voters whom they have had to neglect in the past. These are the small town and country dwellers who are going to relieve the loneliness of isolated existence by snatching out of the ether, with equal facility with their city brothers and sisters, the very voices and personalities of the great.

Many of those who have given thought to the future usefulness of the wireless believe it will find its chief usefulness in the thousands of homes far from the great centers of population to which the affairs of government, the art and the music of the big cities, the marts of trade, are now rather vague and distant realities. It is true that only a few aerials are at work now over the homes of country dwellers, but no vivid imagination is required to foresee the day, and that soon, when every farm house will have its wireless receiving station. The farmers—especially those who live in distant and out-of-the-way places—are going to be brought into closer communion with state, national and world affairs through the radiophone.

It has long been a criticism of the republican form of government that so many citizens fail to record their judgment by voting, ofttimes making it possible for a well-organized minority to carry an election. No doubt the wireless phone will help to correct that condition. An intelligent interest in government will be stimulated through lectures by competent authorities. As a matter of fact, one of the broadcasting stations has already inaugurated such a series. Before an important election there will be, no doubt, speakers who will emphasize the importance of voting and who will give instructions as to how to cast a ballot.

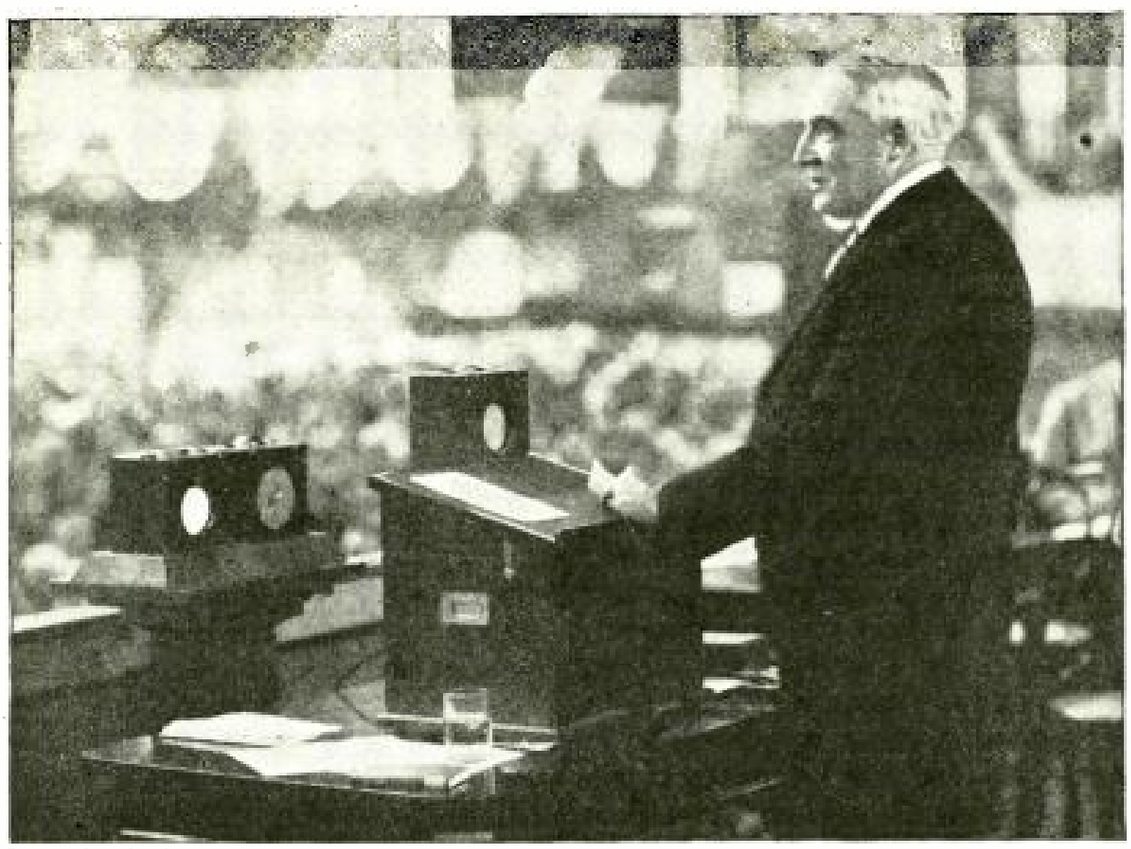
Students of politics agree that this government of ours is still in the experi-

mental stage. So far the experiment has been so successful that it appears the whole world is taking us for a model.

There have been popular governments before this; but always they have grown to a point where the will of great bodies of people was hard to record, or being recorded, was misinterpreted, or again deliberately perverted by those in power. Ancient Greece had a form of popular government but it became a dictatorship of the cities because only in the cities was it possible to get enough people together to reach a popular decision. Rome also began her greatness with a popular form of government, but the actual number of people who had a voice in her government was limited to those who could crowd into the Forum. Even most of these heard imperfectly what the orators told them and understood even less; hence it was easy for politicians to sway their decisions by conventional and studied dramatic inflection and gesticulation.

The modern system of communication and the newspapers have remedied to a great extent these weaknesses. We have lately seen some startling demonstrations of the power of public opinion to guide the agencies of government. But our popular government is on a grander scale than has ever before been attempted. The number of voters has only lately been doubled by the enfranchisement of women. We need, more than ever before, the enlightening influence of such an agency of publicity as the radiophone promises to be.

The radio will tend to purify politics because it will bring the public into closer contact with its political leaders, and will tend to eliminate those superficial qualities of the old-time spellbinder for the obvious reason that those qualities will not carry over the radio—whereas his facts and his logic and his promises will.



Pacific & Atlantic

WILL RADIO SOUND THE KNELL OF "SECRET SESSIONS"?

When President Harding recently addressed the Chamber of Commerce in Washington his voice was broadcast throughout the East. Some day the deliberations of Congress—and perhaps of the Cabinet—will be heard by millions.

TRICKS—

With High Frequency Electric Current

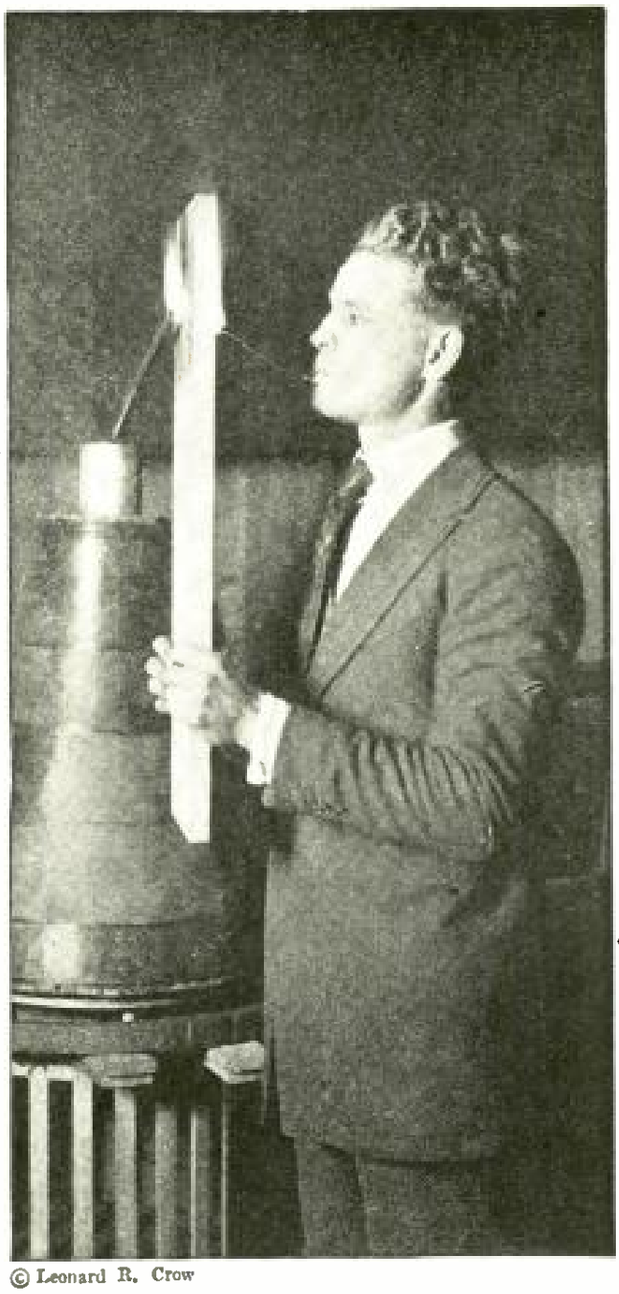
How the Amateur May Give Spectacular but Harmless Demonstrations of the Peculiar Qualities of that Form of Electricity that Is Used in Radio

By
LEONARD R. CROW

TO the layman, demonstrations of high-frequency electric currents, such as are employed in radio, have an interest that is not lessened by the element of apparent danger with which they are attended. Some of these experiments are spectacular; to a peculiar degree they combine entertainment with instruction. The fact that many of these demonstrations can be easily staged as "tricks" give them an added value to the repertoire of both the amateur and professional entertainer.

Most of our readers will understand what is meant by an alternating current of electricity—a current which changes its direction of flow a certain number of times a second. Commercial currents, which light our homes, run our small power motors and revolve our electric fans, may change their direction of flow between one hundred and two hundred times a second. In such cases the frequency or cycles a second are one-half the number of alternations, as a cycle consists of two alternations.

Such currents of low frequency possess certain characteristics which make them dangerous to the human body at pressures of 200 or 300 volts; in many cases lower potentials have produced disastrous results. The low potential, low frequency currents are dangerous when only a small fraction of an ampere is forced through the body, causing contraction of the muscles and a "shock" which is often fatal.

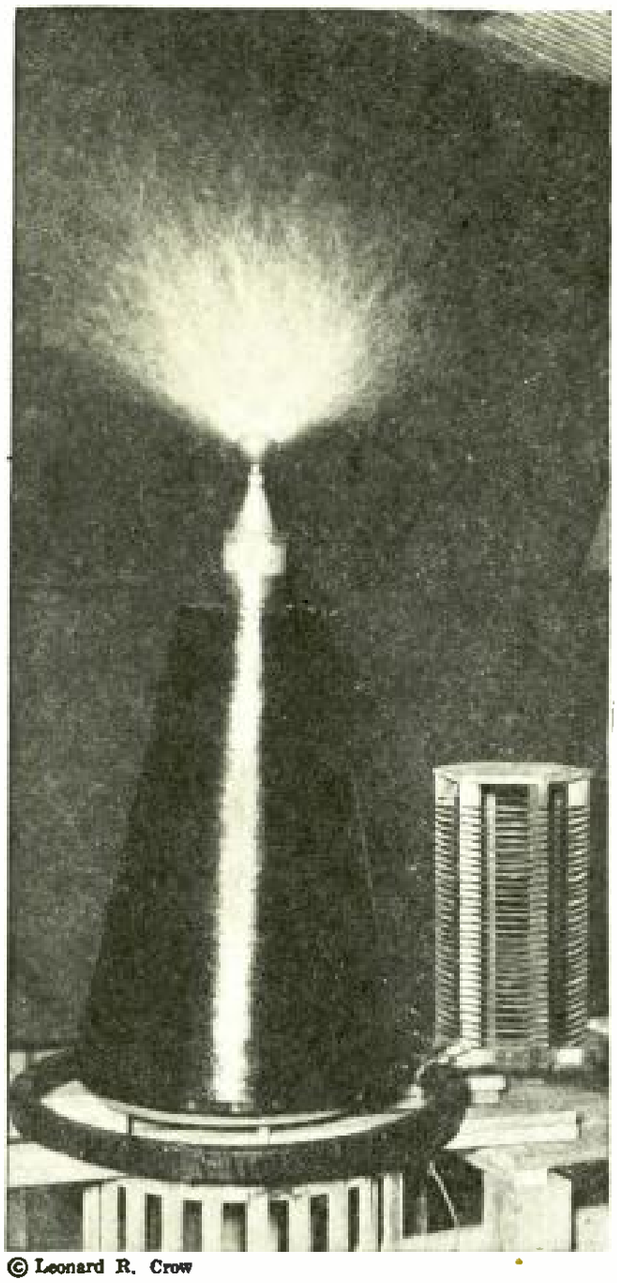


"SWALLOWING" 80,000 VOLTS

This voltage—which punctures a solid oak board an inch thick and sets it on fire—can be taken through the human body without discomfort—provided the frequency ranges above 30,000 cycles a second.

However, if we take this low frequency current—for instance, 60 cycles—with its dangerous and destructive characteristics, and by the use of certain appar-

atus increase its frequency, or number of alternations a second, until the frequency is raised many thousands of cycles a second, we change the characteristics of such a current completely. The current then ceases to be painful or dangerous when passed through the human body; and by increasing the potential it can be made to jump across a gap several feet in length, producing a crashing violet flame almost as harmless as the foods we eat. When such currents pass through our bodies we no longer experience shocks, but instead a pleasing sensation of mild warmth is produced, which has been said to have a beneficial effect upon the body.



A THREATENING DISPLAY OF FIRE

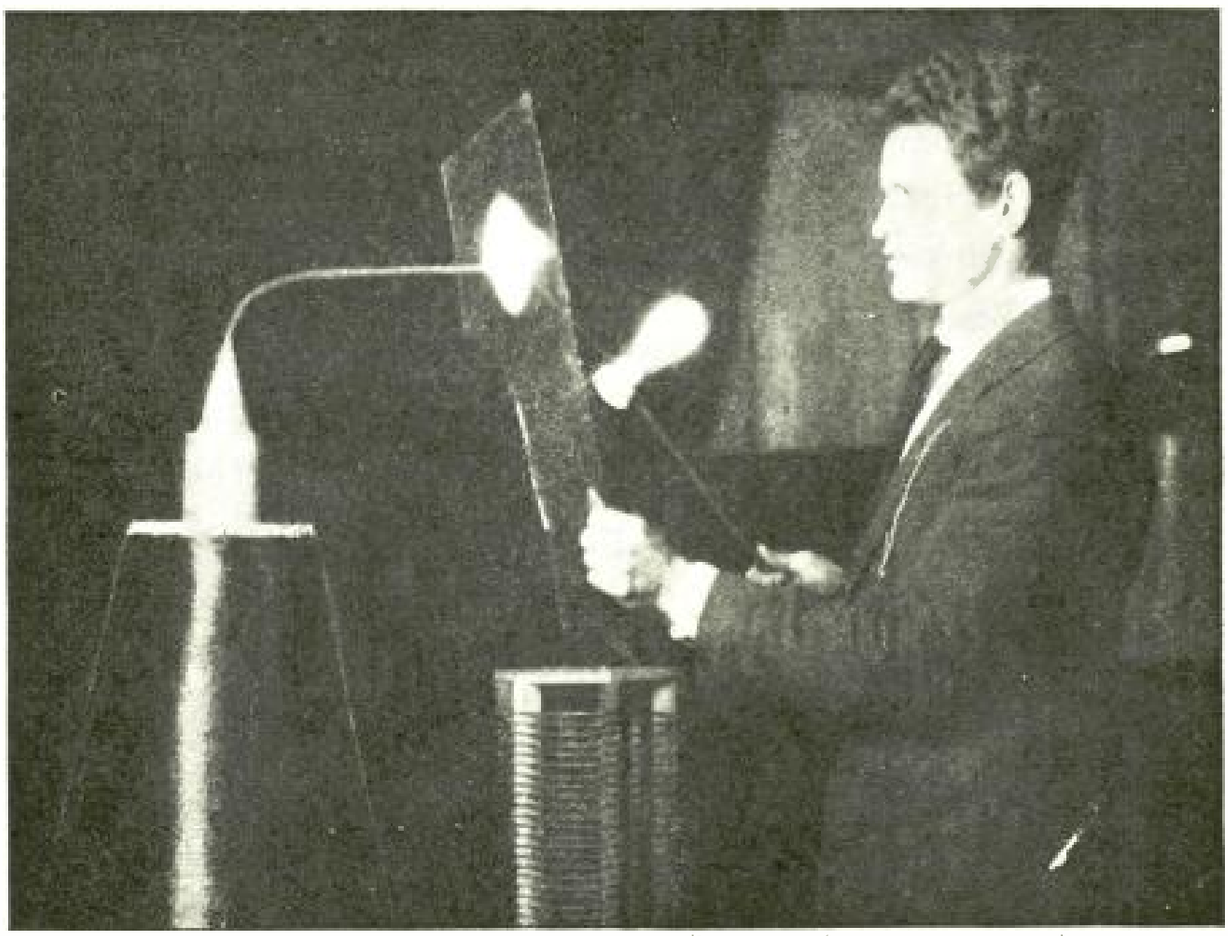
This snarling and snapping bundle of violet-colored sparks is entirely harmless, however; it is caused merely by discharging into the air a high frequency, high potential current.

When such a current of electrical energy is allowed to discharge through or into the air, the discharges assume the shape of hundreds of snarling, writhing, hissing flames of fire. But threatening as these flames appear, they are not dangerous to the body, as one would suppose. In the apparatus shown on this page, for example, I employed 1,800 watts of electricity. This same electric power at commercial frequencies would not begin to produce a spectacular display, but it would be thousands of times more dangerous to the human body.

If a coil consisting of five or six turns of heavy wire or ribbon is suspended in the air several inches above a high frequency electrical current of even moderately high potential, a current is induced in this secondary coil sufficient in voltage and amperage to light a 110-volt lamp, as shown in the picture on page 188.

With electricity at high pressures and at high frequencies, electrical energies may be passed into the human body sufficient in intensity and strength to produce arcs that give great light and heat. When this oscillating energy is transmitted into the body, passing through a plate of glass in which a 60-watt standard 110-volt lamp is lighted to incandescence, it appears to the eye that these currents actually pass through the glass. However, the current does not pass through the glass as an electric current, but rather in the form of electrostatic charges; the glass, after passing this heavy current, does not exhibit any physical change in the condition of its surface.

One of the most interesting features of this phenomenon is that the physiological effects of even extremely high frequency, high potential currents are found to be so very small that the current from a secondary terminal of the



"MAKING AND MENDING" HOLES IN GLASS WITH CURRENT

The electricity transmitted into the body through a glass plate (lighting an incandescent globe on the other side) appears to pierce the glass. Actually, however, it passes in the form of electrostatic energy and leaves no mark whatever on the plate.

oscillation transformer can be taken through the body without any discomfort or inconvenience to the recipient (except perhaps a small burn produced by the discharge when taken directly upon the bare skin).

One should never attempt to take large currents directly into or upon the body without first receiving the current through some form of metal electrode. For instance, when one takes currents into the hand, the current should be taken from the machine through a metal rod which is held in the palm of the hand. In this manner a large contact area is offered to the flow of current, and thus, distributing the received currents over a large area, reduces the piercing or burning sensation to a minimum.

In taking currents into the mouth a common tablespoon may be used to advantage, as this affords a good contact with the tongue.

The peculiar effects of these currents may be due to several reasons—either to a different distribution through the body or to the tissues acting as condensers; although in the case of large high frequency coils that carry larger amounts of energy, the harmlessness would indicate that the cause might be due to other conditions not yet determined. One theory is that our nerves, fast as they are, are still too slow to respond to currents so rapidly oscillating. If the current that passes through the body in one direction affects the nerves, the current as it reverses, neutralizes the effect of the first half cycle before the nerve had time to respond. Another theory is that high frequency currents pass only on the outer surface of a conductor, never pene-

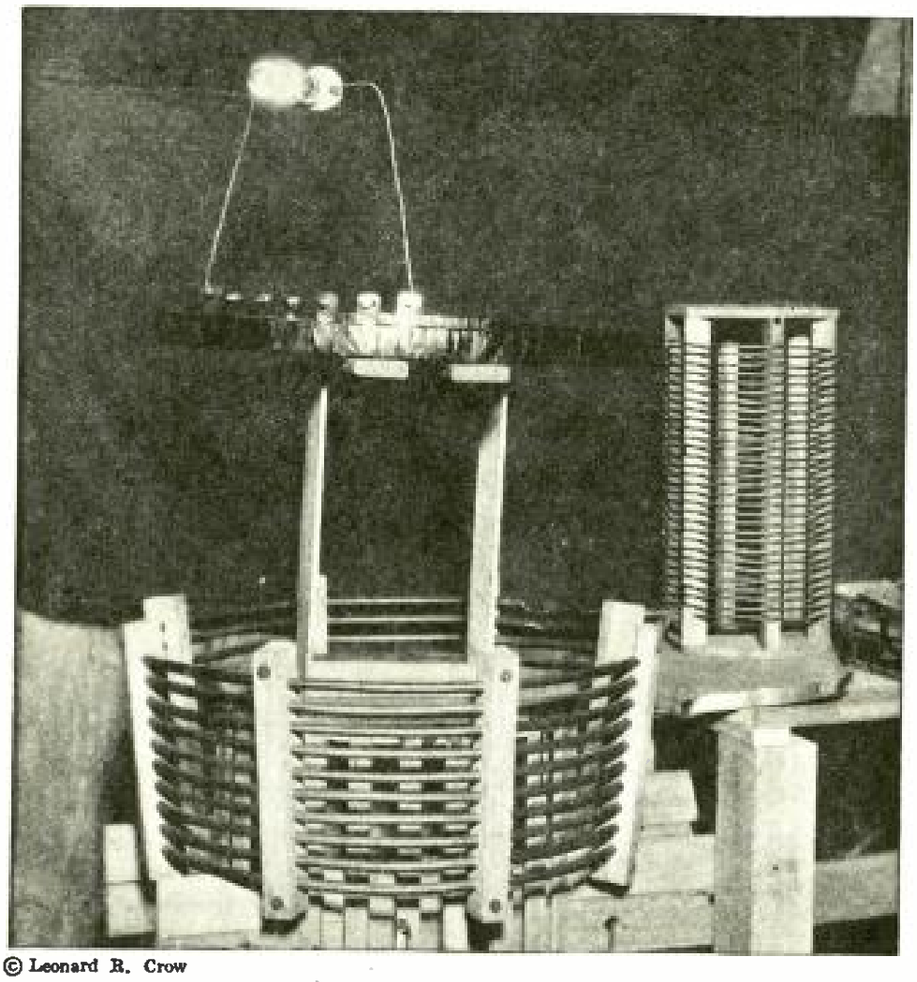
trating the body far enough to affect the nerves.

When the frequency and strength of currents flowing through the primary of a high frequency coil are varied, many different forms of secondary discharges are produced—thin, thread-like discharges, powerful, flaming discharges, and various forms of brush and streaming discharges. A high frequency current discharge, when properly produced, gives the appearance of a purple flame of burning gas under great pressure, emitting quantities of ozone.

The striking peculiarity of high frequency discharges, brushes and streamers, is the ease with which they pass through thick insulation.

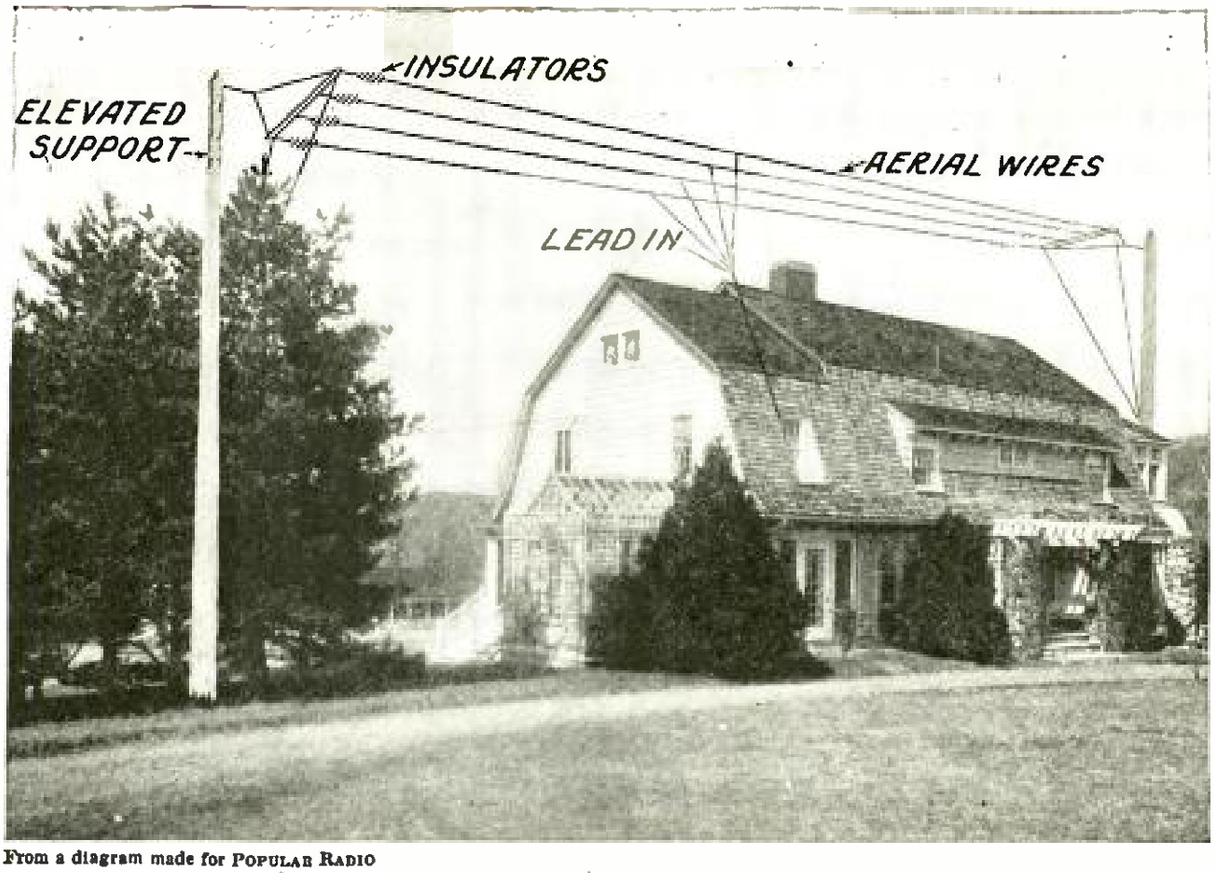
However, this current is not confined to the use of spectacular and mystifying phenomena. Such high frequency, high potential currents, when properly applied to the body, are said to improve general nutrition and act as a tonic in building up the body; curing many diseases by stimulating the circulation.

Through the production of high frequency electricity we are capable of seeing the otherwise invisible. The X-ray, one of the greatest discoveries of man, is possible through the use of high frequency waves. Today man is capable of transmitting his very thoughts across great distances with incredible speed and accuracy without the aid of any visible transmitting medium. Were it not for this mysterious rapidly vibrating radio frequency electricity, wireless telegraphy and telephony would still be a thing unknown.



LIGHTING AN INCANDESCENT LAMP "WITHOUT A CONNECTION"

The energy for lighting the standard 110-volt globe is sent through the air. This current is induced in a coil consisting of five or six turns of copper wire suspended above a primary coil in which high frequency current is flowing.



From a diagram made for POPULAR RADIO

The Most Popular Transmitting Aerial

THE T-TYPE OF ANTENNA

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

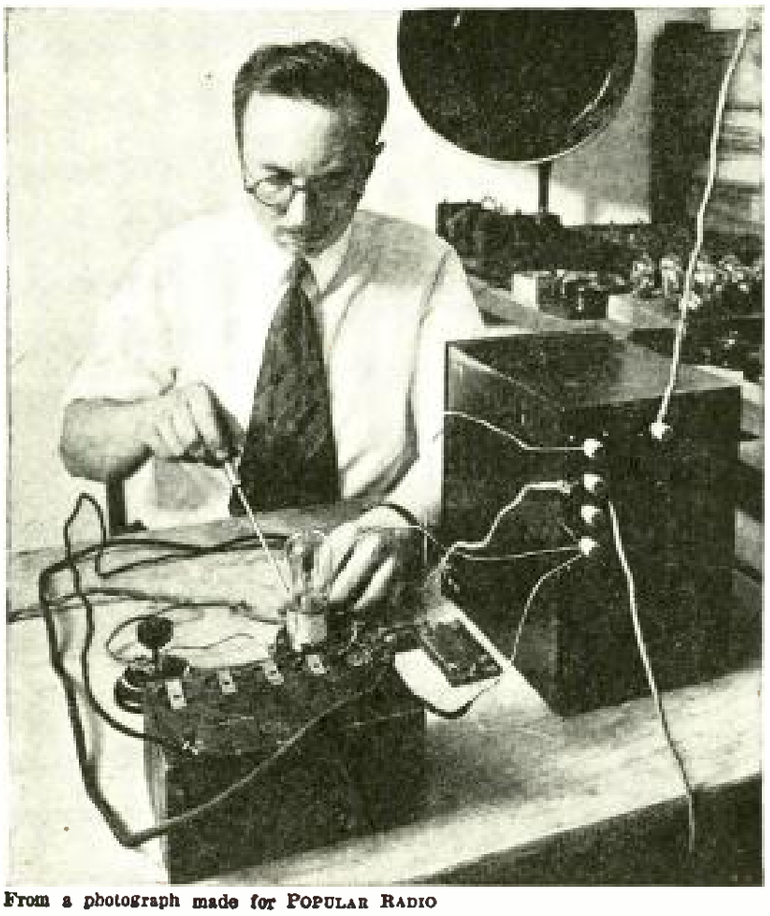
By DAVID LAY

THE inductance of an antenna depends, roughly, on the total of the length of the ground lead and the length of wire from the set to the farthest tip of the antenna. In the case of the inverted L type of antenna this would include the length of the ground lead, the length of the lead-in, and the length of the flat top. This would give a certain wavelength which would correspond to the "natural period" of the antenna.

Suppose, for example, that we should be so located that we could not put up the ordinary 100-foot antenna as used for broadcasting reception, but could put up a longer one, say 150 or 200 feet long. Ordinarily the wavelength or natural period of this antenna would be too high.

If we put up a T antenna of this extra length, (that is, if we should divide the flat top in two, with the lead-in in the center as shown in the diagram on this page), we will have the same over-all length from the ground to the farthest tip of the antenna as in the shorter L type of antenna. This will give us an antenna with approximately the same inductance but twice the capacity. Obviously this antenna would have a lower wavelength than an L type antenna of the same length and would be ideal for transmitting, while at the same time it would be suitable for receiving.

The T type antenna will provide slightly better reception characteristics in the directions in which the two ends of the antenna point, but it will receive well from any direction.



From a photograph made for POPULAR RADIO

THE AUTHOR SHOWS HOW TO DO IT

In order to insure accuracy in his description of the way to tune a standard single-circuit regenerative receiver, Mr. Hogan actually performed the work in his laboratory—as these illustrations demonstrate. He especially warns the amateur against allowing the tube to oscillate, which causes interference to others in the neighborhood.

The Right and Wrong Ways *of* Adjusting *the* Regenerative Receiver

By JOHN V. L. HOGAN

ALTHOUGH it is not at all difficult to handle a simple regenerative receiver so as to secure from it really remarkable gains in radio reception, there exists a widespread impression that great skill is necessary for its proper manipulation. This is perhaps due to two prime causes:

First, because many poorly designed regenerators, which are almost impossible to control properly, have been made or sold and are in use;

Second, because well planned and built receivers are frequently supplied with incomplete or even misleading instructions for operation and so puzzle unskilled users.

Radio phenomena, understandable enough when the fundamental reasoning underlying them is explained, are indeed baffling to the uninstructed novice; when one adds to the simple tuning effects the interesting and varied actions which the feed-back circuits produce, it is something of a wonder that in the tremendous recent growth of radio receiving more trouble has not been experienced.

In order to fix our ideas about the

operation of the Armstrong feed-back, let us concentrate upon a simple circuit arrangement which is now in wide use and which is capable of giving excellent results with only simple adjustments.

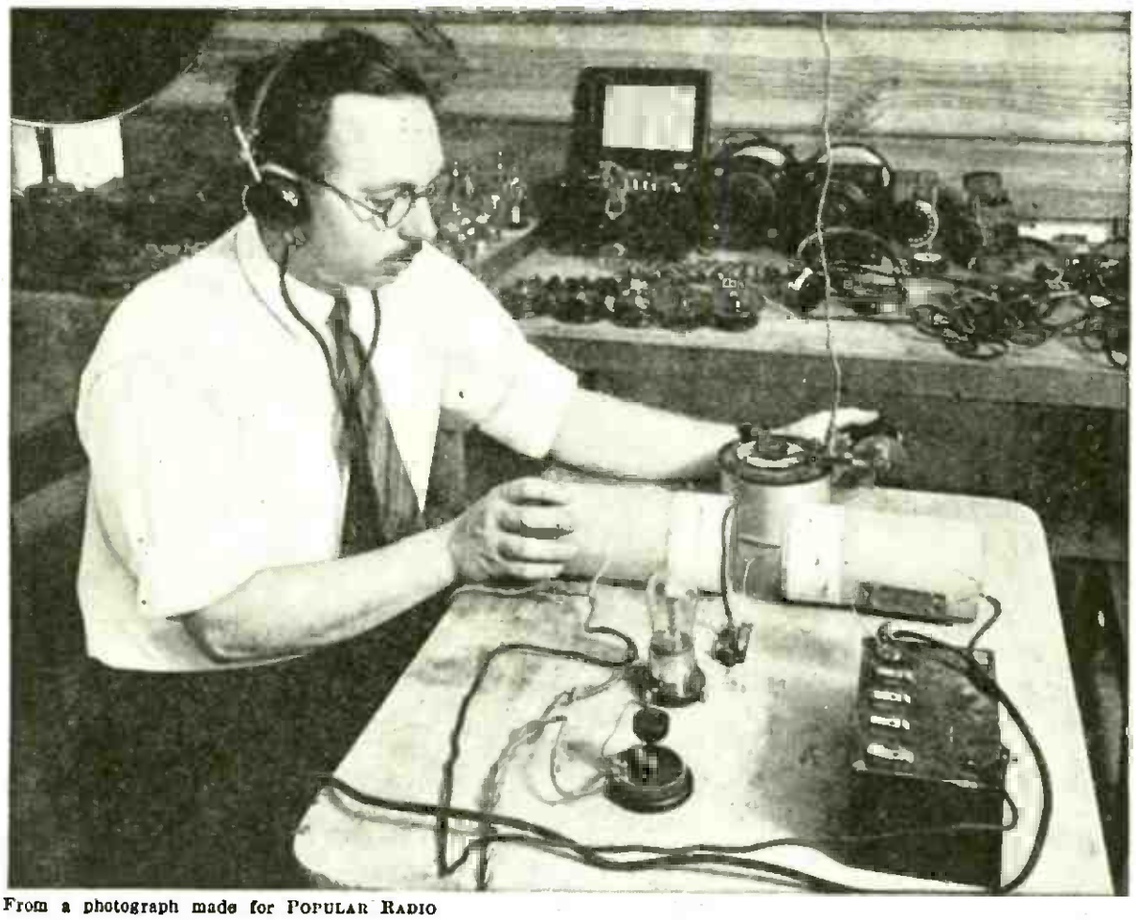
Figure 1 is a diagrammatic representation of this layout, which may be called the "single-tuned circuit" with inductive feed-back. It shows a simple aerial-to-ground circuit including a variable tuning condenser and a tuning coil which is preferably adjustable in steps and to which is inductively (and variably) coupled another coil. The terminals of the tuning coil are connected to the detector tube grid, through condenser C_1 and leak resistance R_1, and to the negative side of the filament. The filament circuit includes the usual six-volt storage battery and a finely adjustable rheostat R_2 for controlling the temperature or brilliancy of the filament cathode and consequently its electronic emission. The plate circuit is completed through the second or feed-back coil above mentioned (frequently called the "tickler" coil), the telephone receivers and the "B" battery of about 20 volts potential—the telephones being shunted by a by-pass condenser C_2.

For best results on the 360 meter wave length, which is common in radio broadcasting, the aerial capacitance should be not greater than about 0.0005 microfarad, and its natural wavelength less than 220 meters or so. These conditions will be met by a single wire antenna from 120 to 150 feet long (including the down-lead to the instruments) and from 40 to 60 feet above the earth. The tuning condenser should be variable over at least the range from about 0.0001 microfarad minimum to 0.0007 maximum capacitance. The tuning coil should have an inductance in the general neighborhood of 50 to 100 microhenries, the exact value (which may in some cases be outside these limits) being determined largely by the particular antenna used. A coil of fifty turns of No. 22 B & S double cotton-covered magnet wire wound on a cylinder of 3½ inches diameter and provided with taps at 20, 30, 40 and 45 turns will give good results in most cases. A "hard" vacuum tube like the VT-1 or UV-201 should be used for the detector, as its vastly increased stability is ordinarily to be preferred over the delicately adjusted higher sensitiveness of a gassy tube in regenerative circuits. A grid condenser C_1 of about 0.0003 microfarad, grid leak of 1 megohm and by-pass condenser C_2 of 0.005 microfarad will usually give good results. The filament rheostat will be of about six ohms total resistance.

This leaves only the feed-back coil for consideration; a winding identical with that suggested for the tuning coil will work well under most conditions. The two coils should of course be arranged to be easily moved with respect to each other, so that the amount of feed-back coupling can be varied conveniently. In working with wavelengths as short as 360 meters and capacitance values of the order of 0.0005 microfarad and less, changes in tuning are frequently produced by the additional capacitance introduced when one's hand is brought near the circuit to adjust it. In an experimental outfit these bothersome effects can be avoided by fitting the tuning condenser and the coupling with insulating control handles some twelve inches in length, which will permit adjustment without close approach of the operator's hand. When a set is built up in panel form, a grounded copper shield plate between the control knobs and the instruments aids in securing compactness.

So much for the constructional fundamentals of a simple but effective regenerator.

It will be noted that there are only four variable elements in the entire system, namely; (1) the tuning condenser; (2) the tuning coil; (3) the coupling controlling the amount of feed-back, and (4) the filament rheostat. As the last-named item is not critical and as both the tuning controls produce the same



From a photograph made for POPULAR RADIO

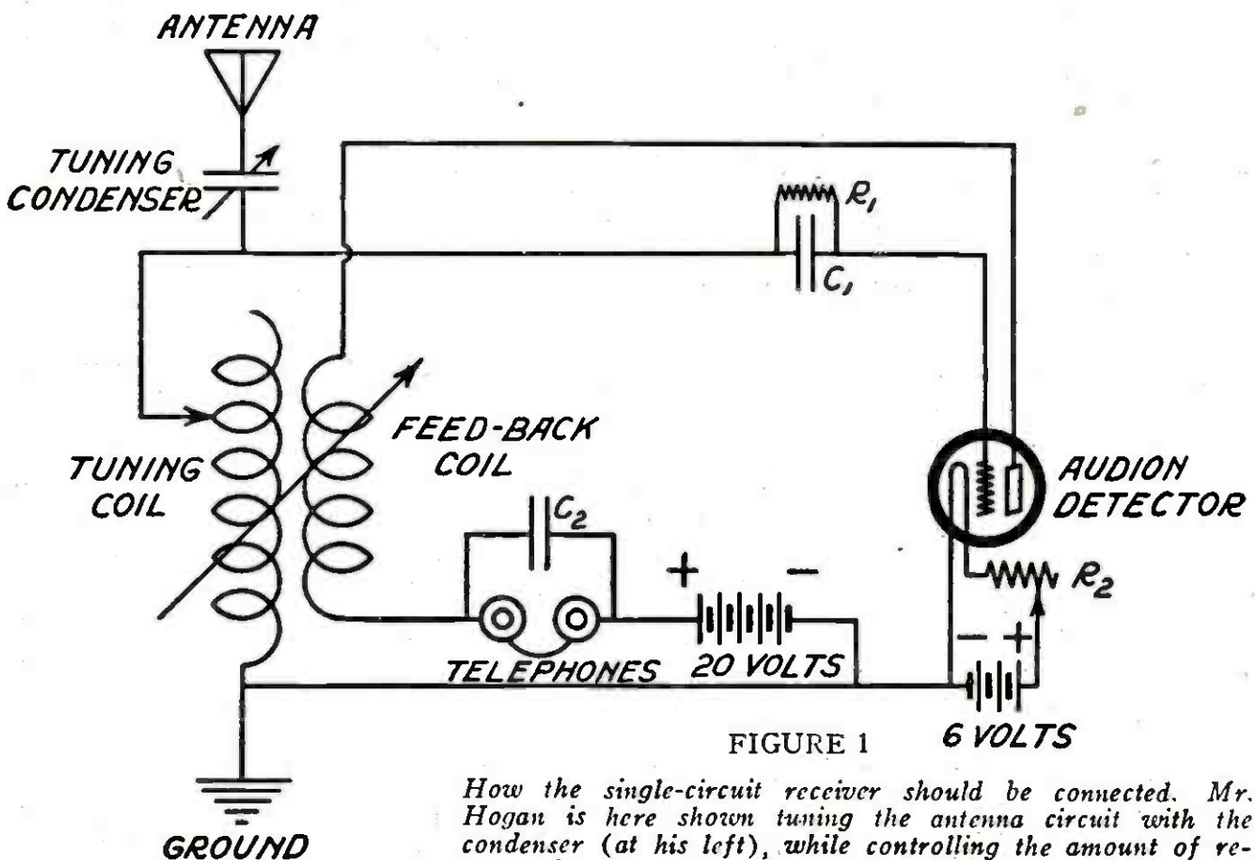


FIGURE 1

How the single-circuit receiver should be connected. Mr. Hogan is here shown tuning the antenna circuit with the condenser (at his left), while controlling the amount of regeneration by moving the tickler coil nearer or farther away from the tuning coil.

general effect, it is fair to say that only two elements (the tuning condenser and the feed-back coupling) need be adjusted in the normal use of this outfit. The tuning condenser will ordinarily be of the semi-circular multiple plate type having a total capacitance of about 0.001 microfarad; for easy adjustment in short wave working it is convenient to provide in addition a so-called "vernier" condenser, which has only two or three plates and which, when connected in parallel to the main tuning condenser, produces a change of tuned wavelength (for a motion through its entire scale of 180°) equivalent to only three or four degrees of the main condenser. The other adjustment—the feed-back coupling—may be controlled by turning a knob which varies the angular position of the "tickler" coil with respect to the tuning coil, or simply by moving the coils themselves nearer together or farther apart.

If you have purchased a regenerative receiver of the single circuit inductive feed-back type you will have no difficulty in these two adjustments; the handle usually marked "tickler" controls, from maximum to minimum, the amount of regeneration; and the resonant wavelength is varied by means of the "tuner" knob, supplemented, in some of the better instruments, by a closely adjustable condenser called the "vernier," as described above. In setting up an assembled or home-made outfit, however, it is necessary to determine the proper or additive direction of feed-back coupling. To do this, first be sure that the circuit is wired exactly as shown in Figure 1; put into circuit the full 50 turns of each of the two coils, and place them some distance (at least 8 to 12 inches) apart on the operating table. Listening in the telephones, test the detector circuits by turning on the filament to normal brilliancy and making and breaking a connection of the 20-volt plate battery; if everything is all right a strong click will be heard in the telephones at each completion and interruption of the circuit. By varying the tuning condenser it should now be possible to pick up (and tune to maximum strength) some radio telegraph or telephone signals; perhaps it will be necessary, if your aerial is relatively large, to reduce the number of turns used in the tuning coil. If signals can be "tuned in," the proper current direction in the feed-back coil can easily be determined by moving it nearer to the tuning coil, for if the signals increase in strength as the coils approach each other everything is all right. On the other hand, if bringing the two coils nearer together produces a weakening of the signals, either the tuning coil or the tickler coil must be reversed end for end. Once having the relative directions correct, the amount of regeneration is, of course, controllable from minimum to maximum by moving the coils from a relatively widely spaced to a closely adjacent position.

If signals cannot be picked up while the coils are far apart, try varying the tuning condenser as the coupling between the coils is increased, first with one relative direction and then with the other. Radiophone or wireless telegraph messages may be intercepted at some wavelength, with the help of regenerative amplification, so that the proper relation of the coils may be observed. If no signals whatever can be heard at the time the apparatus is being tried out, you will have to rely upon the oscillation test. Listening in the telephones as before, slowly bring the tickler coil near to the tuning coil; as they approach, if the relative directions are correct, you will hear a single "cluck" in the telephones. This marks the point of increased regeneration at which the whole receiver begins to generate radio-frequency oscillations. On moving the coils apart these local oscillations will cease; by increasing the coupling once more a repetition of the "cluck" will be heard, indicating the recommencement of oscillations. If the two coils are wrongly directed with

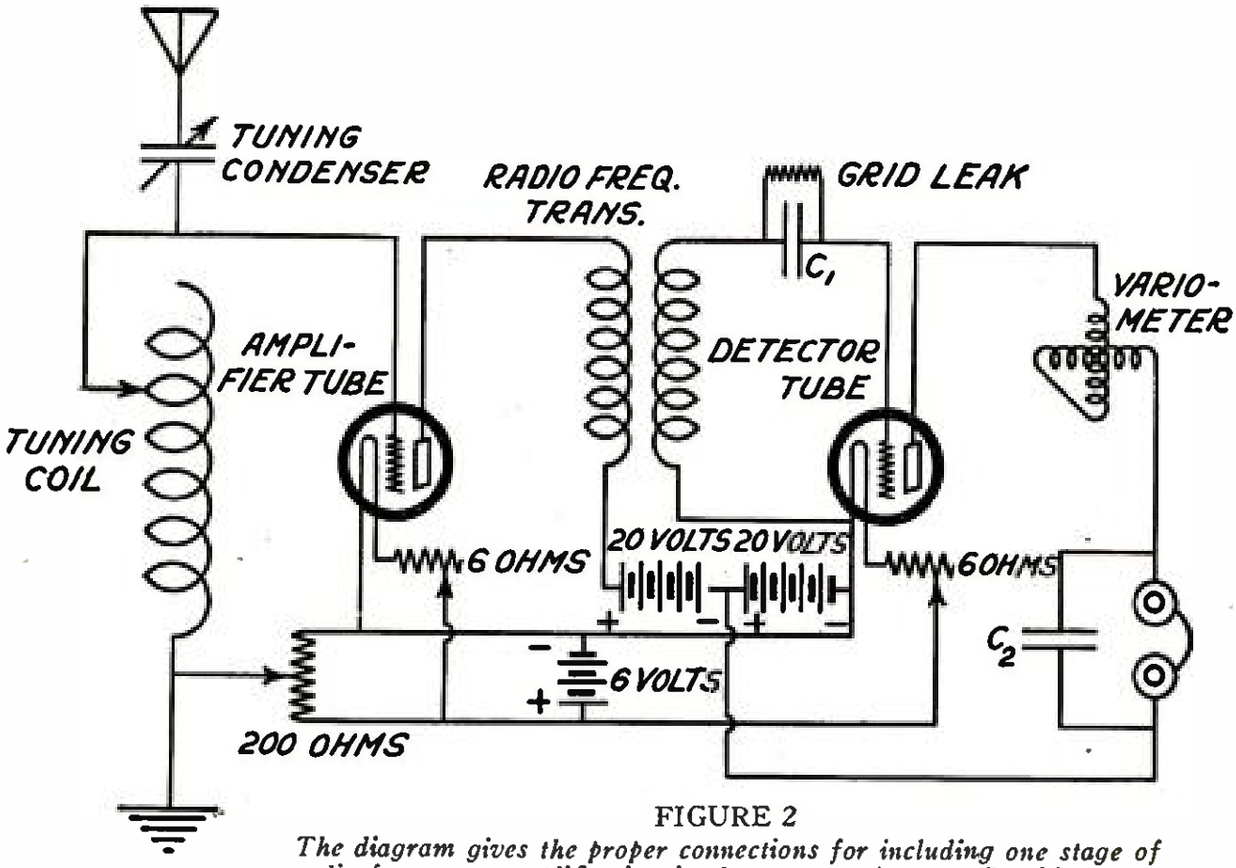


FIGURE 2

The diagram gives the proper connections for including one stage of radio frequency amplification in the regenerative set. By this means the set is prevented from re-radiating high frequency oscillations, which cause so much interference in the hands of inexperienced operators. Static is also reduced by this addition.

respect to each other it will be found either that these oscillations cannot be produced at all or that the two coils must be nearly touching each other in order to do so. The remedy is, as before, to reverse one of the coils. Instead of turning one coil end for end, the wires connecting to it may be transposed.

Now let us look a little more closely at the adjustments necessary to get best results.

The set must be so assembled that the oscillation or "cluck" effect just described can be secured easily at the working wavelengths; when the feed-back coupling is increased to the point where oscillations are generated, their presence can be detected by tapping the grid connection of the detector tube; on each contact of the finger this same characteristic cluck will be heard in the telephones. If your set will not work in this way it is not regenerating properly, and you will not get the best results from it until it is fixed up.

To pick up a signal of unknown wavelength, or one for which the tuning condenser setting is not known, the tickler coupling should be set at a point sufficiently loose (toward the minimum) to prevent the set from oscillating as the condenser knob is swung back and forth throughout its range. If the desired signals are not heard at any point of the condenser scale with the full tuning coil inductance in circuit, change the number of turns and swing the condenser handle again; when the tuning coil is reduced in inductance by cutting out some of its turns, the tickler coil can ordinarily be moved up closer to the tuning coil without causing oscillations to begin.

After you have found the best number of tuning coil turns and the best condenser position for the desired signals, move the tickler coil slowly toward the maximum coupling position; as the coupling is increased nearer and nearer to the point where the receiver starts to generate oscillations, the signals will

grow louder and louder. The tuning condenser should be readjusted slightly as the tickler coupling is increased, for the greater feed-back action makes the circuit more sharply tuned and a very exact setting becomes necessary in order to secure the loudest signals. It is for this final critical adjustment that the vernier condenser is so convenient.

The feed-back coupling cannot be increased indefinitely, for as the point where oscillations begin is closely approached the signals will not only increase in volume, but will show signs of distortion. This is particularly disadvantageous in receiving radiophone speech or music with amplifiers. When the oscillation point is reached or passed, the radio-frequency currents generated in the receiver react with those of the received wave to produce electrical beats which may entirely spoil the character and quality of the signals; hence the feed-back coupling should always remain on the side toward "minimum" from the oscillating point, for receiving radiophone, spark or other modulated wave signals.

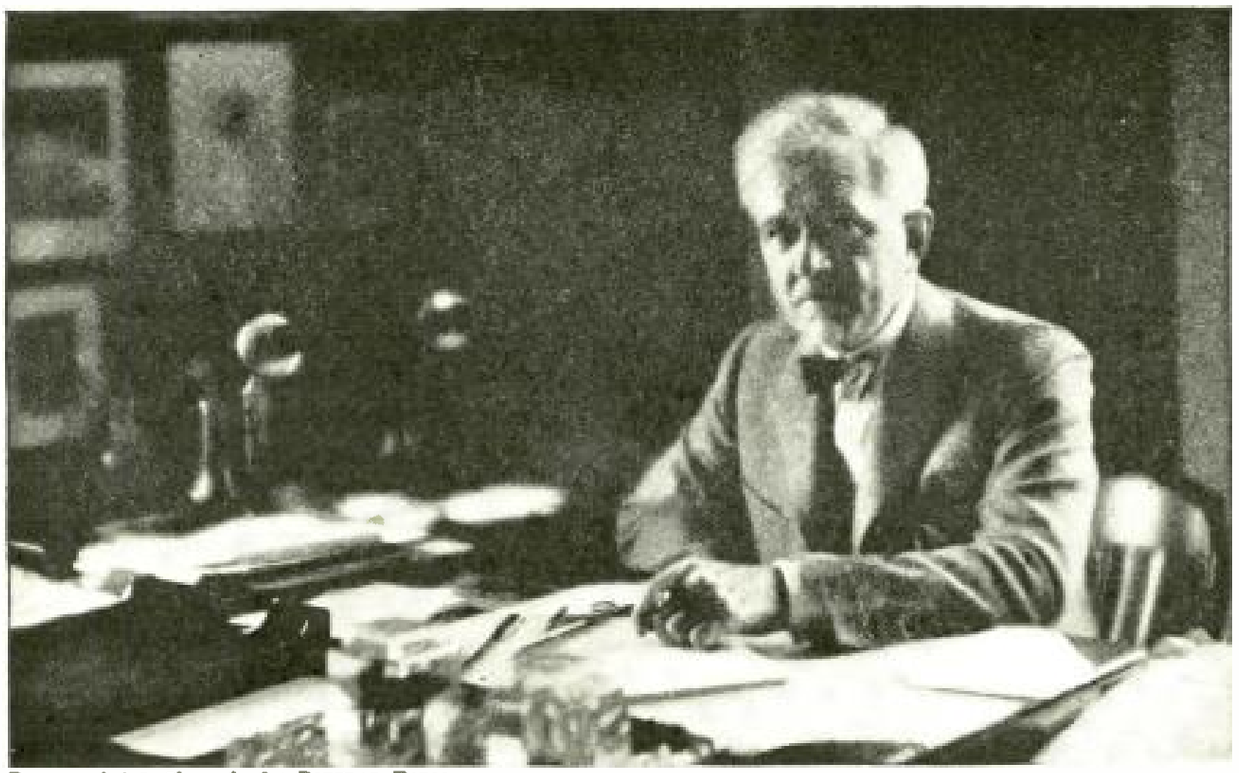
There is another good reason, beyond the loss of signal clarity, for always keeping the tickler coupling below the oscillation-generating point; the radio-frequency currents set up in the receiving outfit by circuit reaction pass out of the receiver itself and into the aerial, there radiating electromagnetic waves of the frequency to which the set is tuned. Thus the receiver virtually becomes a continuous-wave transmitting outfit, which, although relatively feeble in power, is capable of creating severe interference for several miles around.

Every time you allow your regenerative receiver to break into the oscillating condition by increasing your tickler coupling too far, you send out radio waves from your antenna. Every time you hear in your telephones the loud heterodyne whistle caused by interaction between the received carrier-wave and the oscillations generated within your outfit, the waves your set radiates are producing similar interference whistles in sensitive receivers near you. Thus you not only spoil your own reception, but also that of your radio neighbors in a zone of several square miles. All of us have heard interference produced in this way and have learned how aggravating it is. As this disturbance is totally unnecessary and nothing more than a demonstration of ignorance or lack of consideration on the part of "transmitting" receiving set users, no one who understands its causes and effects will want to create such interference deliberately.

While there is no hardship in tuning to an unknown telephone or modulated wave while keeping the regenerative receiver slightly below the just-oscillating condition instead of slightly beyond it, sometimes one finds it convenient to pick up a continuous wave by setting the receiver into oscillation and swinging the condenser knob back and forth until the heterodyne whistle is heard. This should never be done at wavelengths near the broadcasting wave of 360 meters; even at other frequencies it may produce bad interference. However, by equipping the receiver with a single radio-frequency amplifier in advance of the detector tube, the local oscillations may be kept almost entirely out of the aerial and this source of interference practically eliminated. Figure 2 shows a circuit arrangement of this kind; further details of it will be given in a future article.

How to Select the Best Coil for Your Set

In the next number—December—Prof. J. H. Morecroft will tell the radio amateur just what the functions of a coil are and how to determine which coil is best suited for the amateur's purpose.



From a photograph made for POPULAR RADIO

"THE AUTHOR WHO ENTERTAINS BY RADIO SHOULD BE PAID"

The problem of collecting fees for the use of copyrighted music that is used on broadcast programs has long been agitating the music publishers. Now the book publishers are wondering how the rights of the literary man can be similarly guarded. Mr. Doran, the eminent book publisher, here tells why and how this may be brought about.

"First Radio Rights" for Authors

A New Development of "Literary Property" That Radio Is Bringing About

By GEORGE H. DORAN

"UNLESS an author has or can cultivate voice personality, he or she should not attempt to give a radio talk or reading."

That is the message that I have sent to all of my authors. I consider it most important. A number of authors have given talks or readings by radio with probably harmful results, owing to poor delivery. They were inaudible.

At best, they did neither themselves nor their publishers good.

By "voice personality" is meant a very definite thing. The vaudeville interests have, I understand, forbidden their artists to give radio talks. I also understand that the loss to radio programs as the result of this restriction is almost negligible.

Why?

Because most vaudeville performers get their effect, after all, only with stage accessories—gesture, facial expression, costumes, background—and (above all), the presence of a large audience, each member of which encourages the others to laugh. Take away all these factors and strip the artist to his voice alone and how many of our popular entertainers can hope for any widespread success?

Apparently those who are first in line for success with the radio audience are those who have mastered the technique

of making phonograph records. They have had to rely upon the voice alone. They have had to possess or develop what I am calling voice personality. On the other hand, this gift probably exists in a number of people. How far it can be acquired I do not know. But obviously it is of primary importance in a talk or reading to a radio audience.

I shall talk frankly to our authors about the matter of appearances on radio programs. I shall caution them not to attempt to give talks or readings unless they are reasonably sure of a clear and audible delivery. That is the first requisite. But more than that will be needed for any widespread success. They must have a theme of interest to great numbers of people; the radio audience is made up of all ages, of all degrees of education and of all conceivable varieties of taste. The appeal must be to the highest common divisor of that taste. It must be the highest appeal that can be made to each and every one of this vast crowd. That is what the author must start with; and what can be accomplished after that remains to be seen, but will depend very largely upon the author himself.

The fundamental situation in regard to radio is unusual. Here we have, already established, an instrumentality for entertaining and instructing a million or more people, all at the same time. These people do not pay a cent for this entertainment or instruction. Until some means is devised for charging an admission fee to the radio program it will be impossible to develop the first class radio artist, the person supremely gifted with voice personality, able to entertain and instruct the million. As soon as a device is hit upon for charging a few cents a night, radio programs will be immensely profitable enterprises. There will then be no question of the development of the radio artist nor of his monetary reward.

Then we shall have advanced to another stage; the authors who can appear successfully on radio programs will be materially enriched from that source and there will undoubtedly arise the question of what I may call "first American radio rights" in literary property.

These will have to be added to existing rights, such as first American serial rights, book rights, second serial rights, dramatic and motion picture rights.

"First American radio rights" in a book would consist of the exclusive right to broadcast throughout America by radio talks or readings the whole or parts of a copyrighted book. It is easy to see that the day will come when simple dramatic short stories and certain novels will be wanted to entertain the radio audience. The day is practically here now when books of instruction are wanted to attract and interest the radio audience.

The copyright law of the United States, at the present time, contains no specific provisions with regard to use of material in connection with radio telephones. However, Section One of the copyright act secures to the person entitled thereto the exclusive right in sub-section *c* "to deliver or authorize delivery of the copyrighted work in public for profit if it be a lecture, sermon, address or similiar production."

Probably that wording is ample to protect the rights of authors in copyrighted literary work when the radio goes on a money-making basis. So far as I know, those in charge of radio programs have shown every care not to use copyrighted material without permission; as the matter now stands, the use of such material is not, directly at least, "for profit," and permission is, by me at any rate, cheerfully granted.

But when the day comes for first American radio rights we shall have such novels, perhaps, as the first-class detective or mystery story, of the type that is provided with exciting climaxes at the end of every one or two chapters, desired for radio use. The reading of the story may easily not be by the author at all, but by somebody with the requisite voice personality. It does not matter.

Westinghouse

A "VOICE PERSONALITY" IS A GIFT THAT ONLY SOME AUTHORS HAVE

An author who reads from his own works must be sure of an audible delivery and he must have a theme of general interest. One of the most popular is Howard Garis, whose "Uncle Wiggly Bed Time Stories" are known to millions.

The point will be that for the use of the book, the author must be properly paid. I do not anticipate the slightest difficulty in fixing what the author shall be paid, tentatively, until the market for first American radio rights shall be established; I merely speak of this by way of normal prevision.

I was much interested by the broad basis upon which Mr. J. W. Hiltman, President of D. Appleton & Company, reasoned in regard to radio. Mr. Hiltman gave it as his emphatic opinion that anything which keeps the family at home is bound to be good for books. He says that people who form the habit of staying at home will, sooner or later, read books. I think so too. I am more interested in how the approach shall be made —in what books they do read or will want to read and in what ones of our books already published or about to be published they can most readily be interested.

I should be willing to undertake, if it could be arranged, an experiment with any of our books to determine what types of books the radio audience likes best. At present, little is known along this line. Almost the only point that has conclusively been proven, through authors' readings given so far, is the immense popularity of bedtime stories for children. This is of an importance to the authors of children's books that it is not easy to exaggerate. But there are endless books in which I foresee a widespread interest, once the radio audience knows about them.

One of our authors, for example, tells in a humorous and sane way about weight

reduction—a subject of no small interest to a very large number. Those whose weight satisfies them can still enjoy the humor of the book. The same author has written a novel of interest to anybody who drives a car, especially if he has taken or contemplates taking a transcontinental trip. The material of which these books are composed is exactly the sort of thing that should interest a radio audience.

During the recent visit of Sir Arthur Conan Doyle to this country, overflowing crowds have come to the halls to hear his lectures on spiritualism. Most of those who came, I don't doubt, did not believe in the possibility of communicating with the dead, but they were interested in what Sir Arthur had to tell. Many thousands heard him; why not a million?

That is what radio ought to mean to books and authors and publishers. It ought to mean a hitherto unrealized possibility in the way of audiences. It ought to mean that through hearing an author talk over the radio telephone on some subject in which he is interested, a man would go out and buy that author's book; or though he heard not the author himself, but someone with the requisite voice personality reading from the author's book, the same result would follow. It is a chance for those who feel that natural personal interest in an author whose works they enjoy to hear his voice or to learn those personal details which are of interest to his readers.

For my part, I see in radio only a valuable instrumentality for furthering the cause of good reading. When the telephone was invented the book publisher proceeded to use it to the feasible extent in furthering the cause of books. When the phonograph was perfected, a chance to link that new instrumentality with the cause of good reading was probably missed—although I hope not finally. Now the radio is here. It is a tremendously multiplied lecturing platform; it is a new and more fascinating phonograph; it is the telephone in a million homes. I shall leave undone nothing that occurs to me to realize to the fullest imaginable extent its powerful aid.

How *to* Make Your Bed Talk *to* You

By S. R. WINTERS

NO longer can the phrase "falling in the arms of Morpheus" be properly used as a symbol of sleep. No longer need one retire attended by the silence of the bed chamber at night. For science has waved its wand and endowed the bed with the gift of speech and of music. In other words, your bed springs may be used as an aerial for the reception of stories, lectures and music transmitted by radio.

Just how this feat may be accomplished has been demonstrated by Mr. H. G. Corcoran of Washington, D. C., who has literally converted his bedroom into a radio station with one unusual feature.

A towering antenna as well as the elaborate fixtures that project from the housetop is eliminated by Mr. Corcoran's innovation. The antenna lead is affixed to the springs of the iron bedstead, and the ground connection is effected through the means of a water-pipe and radiator in the sleeping quarters.

This radio-telephone receiving outfit is of a single-circuit regenerative design. Its source of strength—or electric current, to be exact—is imparted by a 6-volt, 60-ampere battery. Two variometers; two condensers, one with vernier attachment; one detector tube, and one-stage of audio-amplification from two "B" batteries are the operating units which work in harmony to insure the reception of music and vocal speech from near and

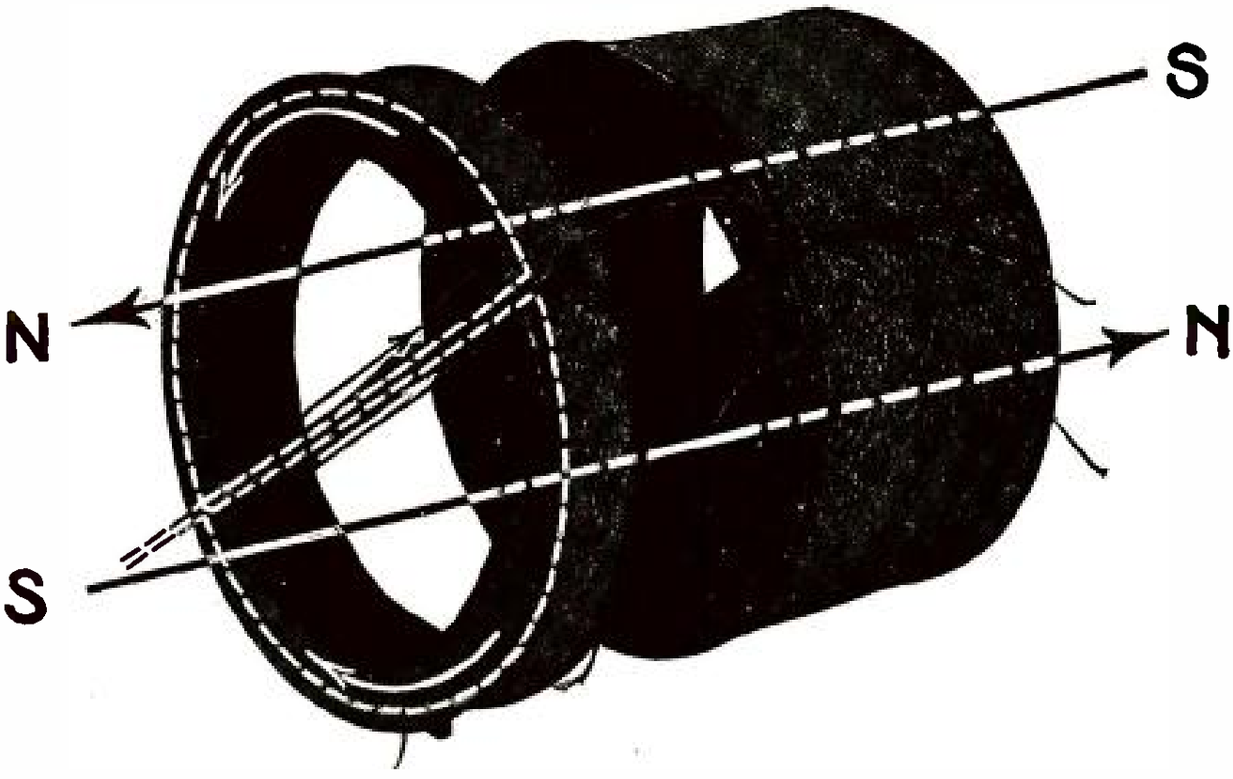
distant points. Three pairs of head telephones are connected to the equipment. Vibration sound, to repeat common knowledge, is not barred by walls and the reception is not hindered by the fact that this wireless receiving set is contained within closed quarters. To paraphrase the axiom, "Prison walls do not a prison make," the installation of a radio-telephone receiving equipment does not insure isolation even though one be enclosed securely by stone and mortar.

"Now listen, my children, and you shall hear how the elephant got his trunk," may be the introductory sentence to a bed-time story that seeps its way into the room of this Washington citizen who has distorted the heretofore single purpose of the bed-springs. Mr. Corcoran, by a mere twist of one of the knobs on the apparatus illustrated in the photograph, can adjust the receptive "moods" of this outfit to a point of receiving music or messages from Detroit, Springfield, Schenectady or Newark. Radio transmitting stations that are not so far removed as these may occasionally be heard distinctly.

Fans who ransack the ether for its contents may duplicate this unusual procedure and thus contribute to their own pride and satisfaction by having a receiving set that is distinctive. Mr. Corcoran used much pre-war material in building his own outfit. Radio fans who contemplate summer excursions into the woods or fishing trips that will take them far from the city may investigate the desirability of carrying along their bed-springs. This household unit now can serve a two-fold purpose—contribute to the comfort of peaceful sleep, and relieve the monotony of existence when you are alone.

A NOVEL RECEIVER THAT REALLY WORKS

The apparatus, which consists of a regenerative receiver and amplifiers, gathers energy from the springs in the bed, which thus serve as antennae. Such a set can pick up nearby stations—but a bedspring hardly compares with an outdoor aerial in efficiency.



TWO "FIGURE 8" COILS AS A VARIOCOUPLER

The dotted lines in the photo-diagram show how the winding is made to give the coils a double magnetic field, as shown by the large arrows. Two coils coupled together in the position shown produce a maximum coupling; but if one of them should be revolved on its axis 45 degrees the coupling will be zero, as the fields will neutralize each other.

How to Make a Novel Variocoupler

Another of the Series of Practical Articles That Tell the Novice How to Build His Own Apparatus at Low Cost

By A. HYATT VERRILL

A FORM of variocoupler which seems but little known to amateurs and novices and which is a simple and efficient type, is that built of what are known as "Figure Eight" coils. To make a really good variocoupler with the secondary coil in the form of a rotor is a difficult job. Rotary ticklers in tube form will give results, yet the coupling is never as satisfactory as with a round rotor. But with the Figure Eight type of variocoupler no inside rotor is required, the secondary consisting of a second coil placed at one end of the primary and in the same plane with it and rotating on an axis parallel to that of the large coil.

Owing to its peculiar construction—with the winding going first in one direction and then in another forming a coil with four poles—a wide range of coupling may be secured with a 45 degree rotation of the secondary coil. The result is a tuner which has the qualities and advantages of a variocoupler and at the same time is simple to construct.

To make this coupler you will require a

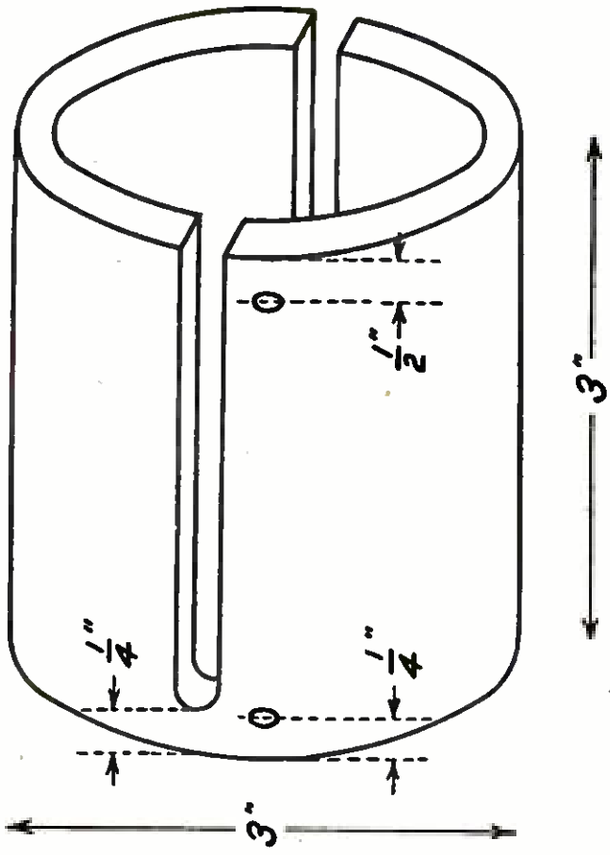


FIGURE 1

The larger tube (for the primary coil) should be made according to the dimensions in the above diagram.

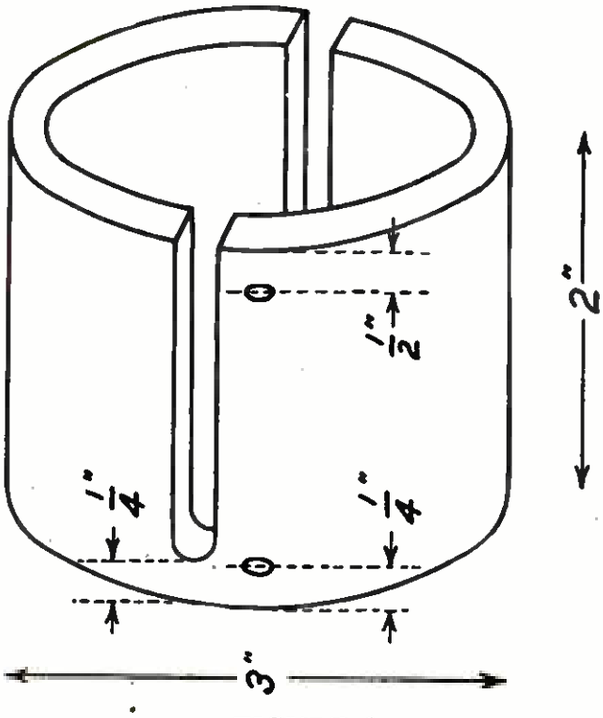


FIGURE 2

The smaller or secondary tube should be made like the larger tube—but with the dimensions here shown.

supply of No. 20 or 22 cotton or silk insulated wire; two formica or composition tubes, both three inches in diameter and one three inches and the other two inches in length. You should also have a ten point switch, two discs of wood of the same diameter as the inside of the tubes, a short section of ¼ inch brass rod or a long ¼ inch brass bolt, brass washers, binding posts and nuts.

Commencing with the larger or primary coil, by means of a straight edge, draw a line or scratch marks upon the edges of the tube across the exact centre. This will be easier to do if you draw a line across the centre of one of the wooden discs and then, by placing this in one end of the tube, mark where the ends of the line come on the tube.

Having determined this, draw a line from each of these marks to within one-quarter of an inch of the opposite end of the tube. Keep these lines parallel with the axis of the tube and then, with a hack saw, cut through the tube along these lines. Be careful not to use too much force, but work slowly and easily so as not to break the tube. The result should then be as shown in Figure 1.

Repeat the operation on the small tube, Figure 2.

Now bore a hole near the end of one of the cuts in both tubes and another hole near the cut and half an inch from the other end of the tubes. (Figures 1 and 2.) Run one end of the wire out through the hole that is a quarter inch from the end of the large tube, leaving several inches projecting, secure it in place by sealing wax and proceed to wind on the wire as shown in Figure 3. Starting at the hole where the wire is fastened, take a turn up through the slit, around the half of the tube and through the opposite slit, bringing it across to the first slit near the starting place. Then bring the wire in a turn around the opposite side of the tube from the first as in Figure 4, carry it across the tube through the slit, wind around beside the first turn and thus continue winding first in one direction on

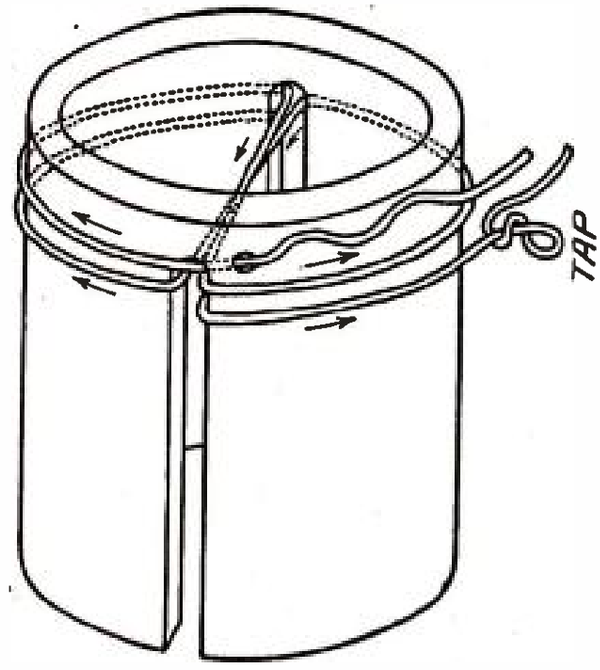


FIGURE 3

How to start the winding of the wire on the primary coil. Compare this diagram with the one on page 201.

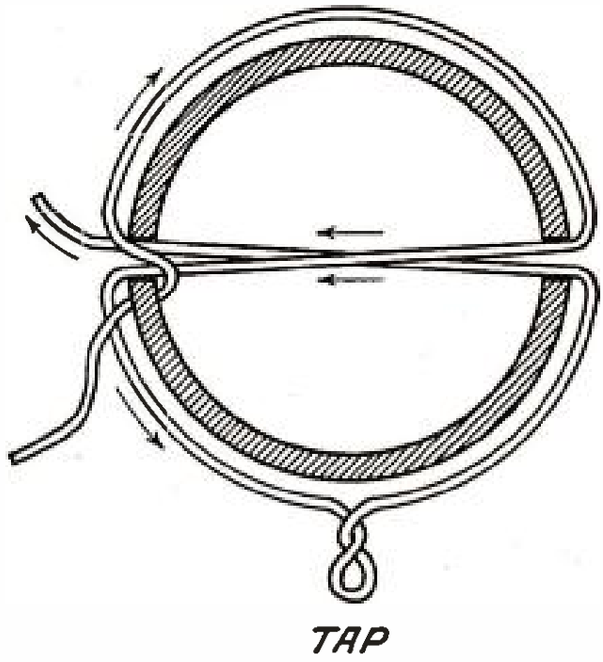


FIGURE 4

How to make a tap. In the winding of a coil, a tap should be made at every ten turns until nine taps are made.

one-half the tube and then in the opposite direction on the other half of the tube, making a series of figure 8's with the winding. When the tenth turn is reached make a tap in the usual manner and continue winding until the twentieth turn on the same side as the first tap is reached, then take another tap.

Go on winding in the same way, taking a tap at every ten turns until ninety turns and nine taps are made. Then pass the wire through the hole near the end of the tube and secure it with sealing wax. Next, fasten one of the wooden discs in this end by means of small brads or screws and secure the disc in whatever way you see fit to a bracket or similar support as shown in Figure 5.

Next start with the smaller tube in exactly the same way, fastening the end of the wire at the hole nearest the tube end and winding on the wire exactly as on the large tube, but without taking any taps. When seventy turns have been taken, fasten the wire in the hole, leaving a fairly long free end.

You must next decide what sort of adjusting device and mounting you are going to use for the coupler. If it is to be mounted on a panel, a bracket on the primary as shown, with the secondary mounted with a shaft running through the panel, is both convenient and neat. In this case, the shaft that bears the knob should be secured to the wooden disc by means of two nuts. Washers soldered to the shaft with loose washers as bearings should be provided or (if preferred) loose washers and cotter pins may be used. It makes little difference which method is employed so long as the coil cannot move out and in and thus vary the distance between it and the primary coil. The accuracy with which the two are fitted together has a great deal of influence upon results, for if the secondary wobbles or varies in its distance from the primary the coupling will be unevenly variable. The whole idea is to keep the tubes and the two windings as close together as possible.

A simple method of mounting is shown in Figure 6, in which both coils are mounted on a panel or base by means of brackets. The shaft used to rotate the tickler should be accurately centered in the wooden disc and the latter should be fitted and fastened securely within the

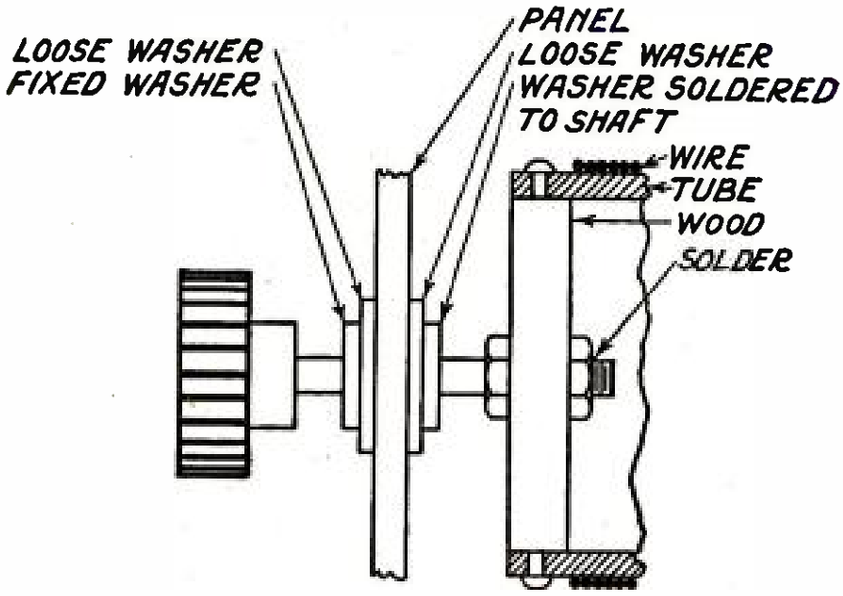


FIGURE 5

How to fasten the rotating secondary coil to the panel, with the control knob attached.

tickler coil by means of small screws driven in through the half-inch bare space left on the tube for the purpose. Do not slight this part of the work, but take just as much care in fitting the wooden ends and fastening them and in mounting the complete coupler as in winding the coil or finishing the cabinet or panel. It is neither good workmanship nor common sense to spend a lot of time and trouble as well as good material in making a coil or any other device and then, either because you are in a hurry to test it or because you get tired of the job and wish to finish it quickly, slight the last part of the work. Many a well-made instrument has been cast aside as worthless just because the maker slighted some little thing near the finish of the job. If you have done careless work it is of little use to try to make up for it by placing the instruments in an elaborate and highly polished mahogany cabinet with engraved dials and Bakelite panel. Remember the old Romans' adage, "The gods see everywhere," and do not think, because your careless work is invisible, that it will "get by." There are no more

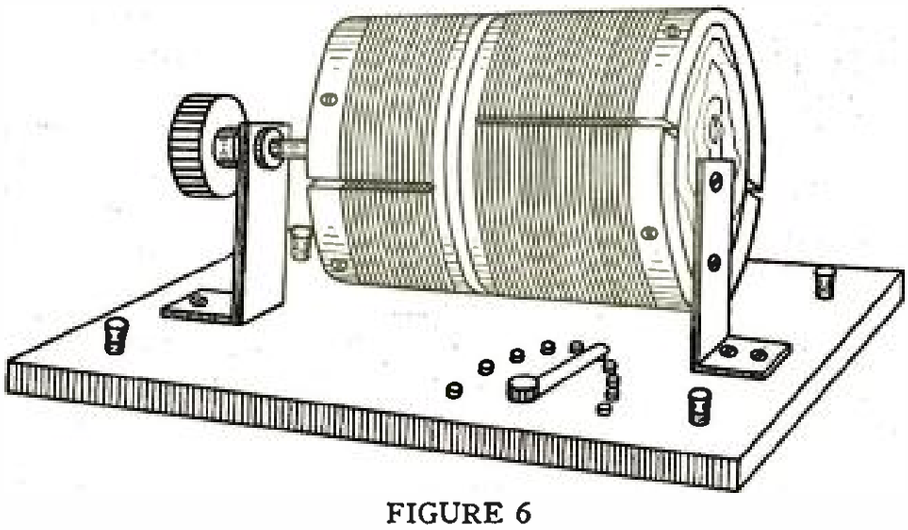


FIGURE 6

A simple method of assembling the variocoupler on a board for experimental use. Be careful not to slight this part of the work.

unsparing inspectors than radio waves; when they enter that beautiful looking cabinet and find poor or careless work inside they will shout the fact aloud to you and to your friends by squeals, buzzes and howls instead of good clear signals.

Figure 7 shows the completed Figure Eight coil variocoupler, the secondary of which may be connected up with a suitable crystal or vacuum tube circuit.

The variocoupler may be mounted on a panel so that the control knob protrudes from the front of the panel; in this case the primary switch and the switch-points should also be mounted likewise, so that the instrument may be placed within the cabinet that contains the other parts of the set.

The best way to tune the secondary circuit is by the use of a variable condenser shunted across the secondary winding, although in some vacuum tube sets a variometer is connected in series with the grid of the tube, and the tuning is accomplished by this means.

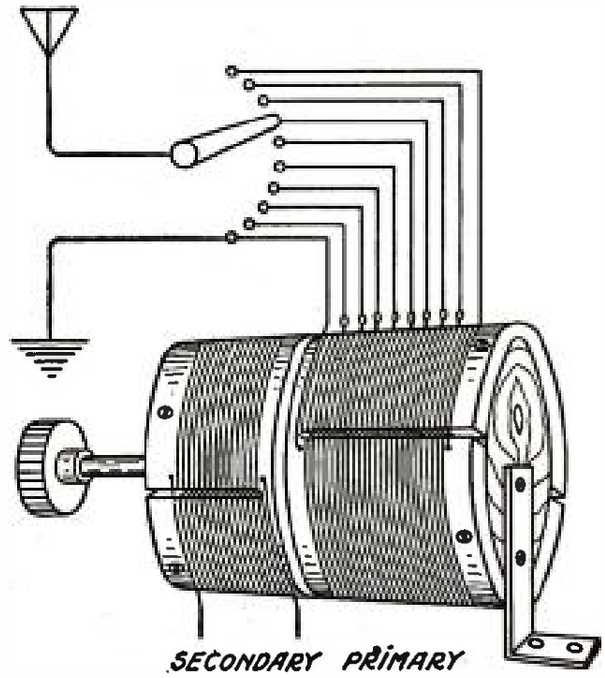


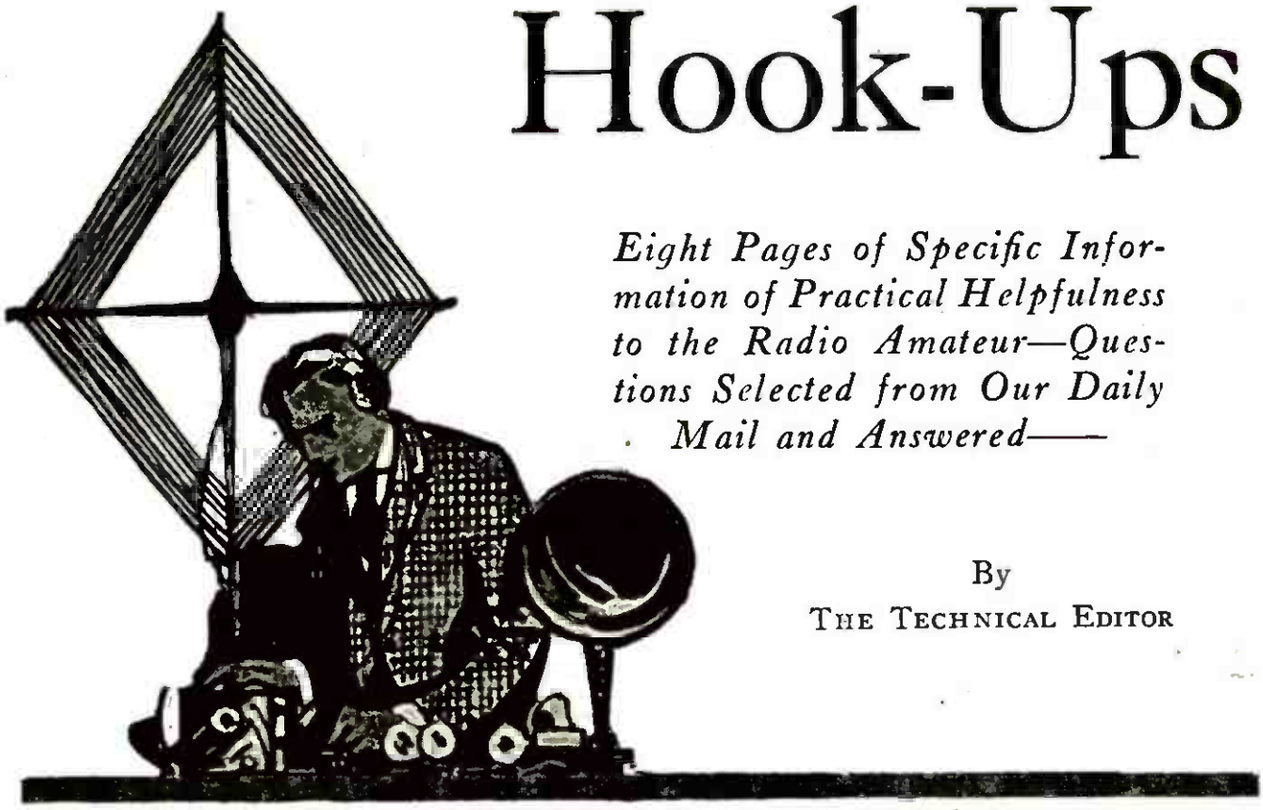
FIGURE 7

The completed Figure Eight Coil Variocoupler, showing how to hook up the primary circuit. The secondary circuit can be connected to any standard crystal or tube circuit.

HOW TO INSTALL A RADIO SET ON YOUR MOTOR CAR

Despite the number of fake installations devised for publicity purposes, which have given rise to misconceptions on the subject, the equipping of an automobile with a workable receiving set is entirely practical. The several ways of doing it will be told in the next issue of POPULAR RADIO.

Hook-Ups



Eight Pages of Specific Information of Practical Helpfulness to the Radio Amateur—Questions Selected from Our Daily Mail and Answered——

By
THE TECHNICAL EDITOR

THE information embodied in this feature is ordinarily furnished in the department, *What Readers Ask,* which is published regularly in POPULAR RADIO. In order to make this department of greatest help to the beginner, it is possible to publish only those questions and answers which are of the widest application and of most general interest. To insure prompt attention and to help the Technical Editor in handling the large amount of correspondence which the department has developed, our readers are asked to observe the following requests:

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

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

IN answer to the hundreds of requests that have come pouring in on the Technical Editor for additional data on the super-regenerative circuit (described in the September number), the following notes on the super circuit have been prepared. These notes embrace improvements and hints for those who are building or who have built sets from the description of the set that was published in these pages.

First. The method of connecting the loop to the set has been modified so that any sized loop may be used; tuning is accomplished by varying the switch taps of the coil "F" and rotating the condenser "C," which is in series with the loop. See Figure 1, in which the hook-up is given and the method of tapping the "F" coil is clearly shown.

Second. The "C" battery in series with the grid of the second tube has been eliminated, and only two batteries are used, as in the ordinary vacuum tube set, the "A" and "B" batteries.

Third. The tubes recommended for use with this circuit are the Radiotron UV-201 or the Myers audion for the first tube, and a Moorhead amplifier or W. E. "J" tube for the second tube.

Fourth. The circuit shown in Figure 1 may be used with the telephones by tun-

ing out the signals a little so that they will not hurt the ears, or it may be used with a loudspeaker just as it is. The signals with the two tubes should be loud enough to fill a good-sized room using a loop. If the signals are wanted strong enough to fill a large hall, however, a one or two-stage audio frequency amplifier should be added to the set. A one-stage amplifier will produce signals that will be audible over a house, upstairs and downstairs; a two-stage amplifier will make them audible for a quarter of a mile or more, according to the tubes used, the type of loudspeaker employed, and the tuning ability of the operator. The input terminals of the amplifier should be connected to the two leads of the set marked "xx" in Figure 1.

Fifth. If the amateur builder has trouble in getting the set to operate properly after he has checked up all connections and parts, he will do well to try reversing the terminals of the coils "F," "A," and "B" one at a time.

Sixth. When a "saw-tooth" heterodyne (whistling) effect is heard while tuning with the condensers or the variometer, the builder will know that he is getting nearer to success in making his set work properly; when this sound is heard it is merely a case of becoming familiar with the adjustment.

Seventh. An antenna may be used with the set, if the antenna is attached to the loop by means of a clip. The correct turn of wire on the loop to which the outdoor antenna is to be attached will be determined by experiment while tuning. No changes are made in the circuit for using the outdoor antenna, and no ground is used. This will bring in the distant stations louder without increasing the nearby stations.

* * *

QUESTION: In a regenerative type set composed of two variometers, one variocoupler, and a variable condenser, what are the controls that govern the regeneration of the incoming signals? Please tell me, also, the proper method of tuning.

WILLIAM PRESTON

ANSWER: Regeneration is accomplished in this type of set by rotating the plate variometer. We refer you to the article by E. H. Felix in the May issue of POPULAR RADIO, entitled "How to Tune a Regenerative Receiver."

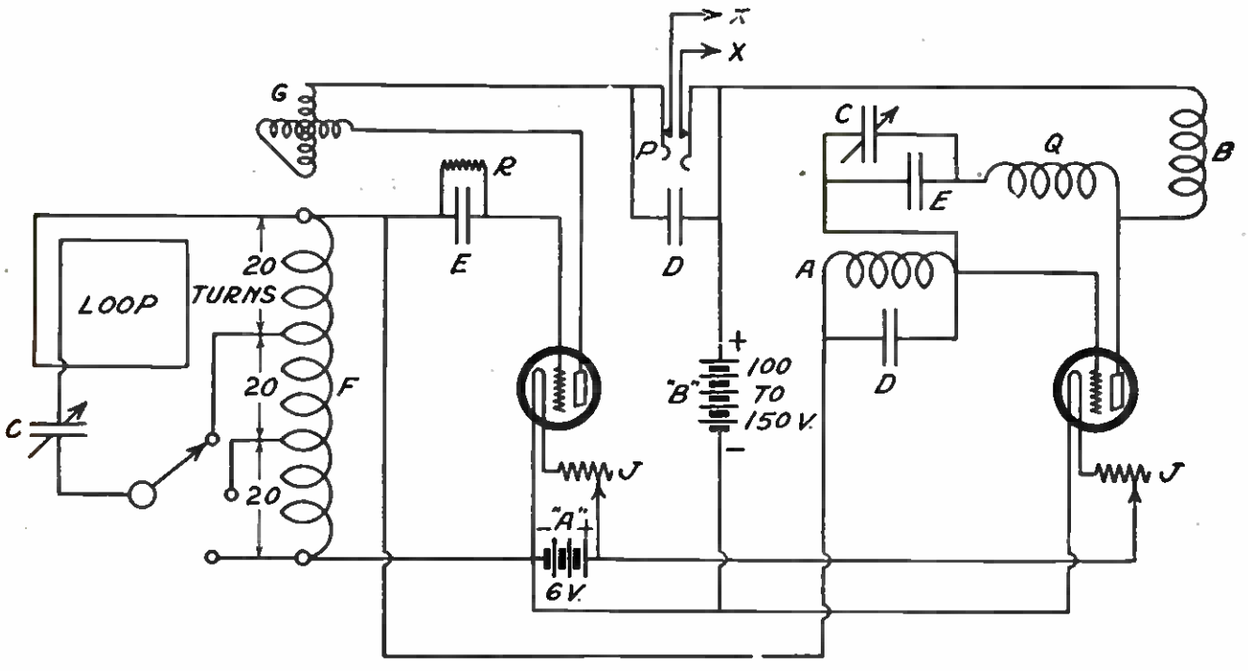


FIGURE 1

The two-tube super-regenerative circuit which has proven so successful. Note that the use of "C" batteries is dispensed with. An audio frequency amplifier may be connected to the two wires marked "XX," and the signals increased to terrific strength.

QUESTION: I have a crystal set with a two-slide tuning coil. Could I use a loop aerial and would it work as well as the horizontal type of aerial?

R. GEMMECKE

ANSWER: A crystal detector is not sufficiently sensitive to use with a loop antenna with any measure of success. We advise you to stick to the outdoor antenna until you decide to install a more sensitive set with some form of radio frequency amplification. You would otherwise obtain no results.

* * *

QUESTION: Would it be possible for me to use one stage of radio frequency with one stage of audio frequency amplification? If so would you please print a circuit using a set of Goodwin untapped spiderweb coils together with said amplification?

J. H. W.

ANSWER: This is possible, and the circuit is shown in Figue 2. L1, L2, L3 are the spiderweb coils, L4 is a single slide tuning coil, C1 and C2 are variable condensers, .001 mfd. capacity, C3 and C4 are fixed condensers, .0005 mfd. capacity, R1 and R2 are resistance potentiometers, 200 ohms, R3 is a grid leak resistance, 1 or 2 megohms, and R4, R5, and R6 are filament rheostats, 6 ohms each. 22½ volts are used on the detector plate and 90 volts are used on both the radio frequency and the audio frequency amplifier plates.

* * *

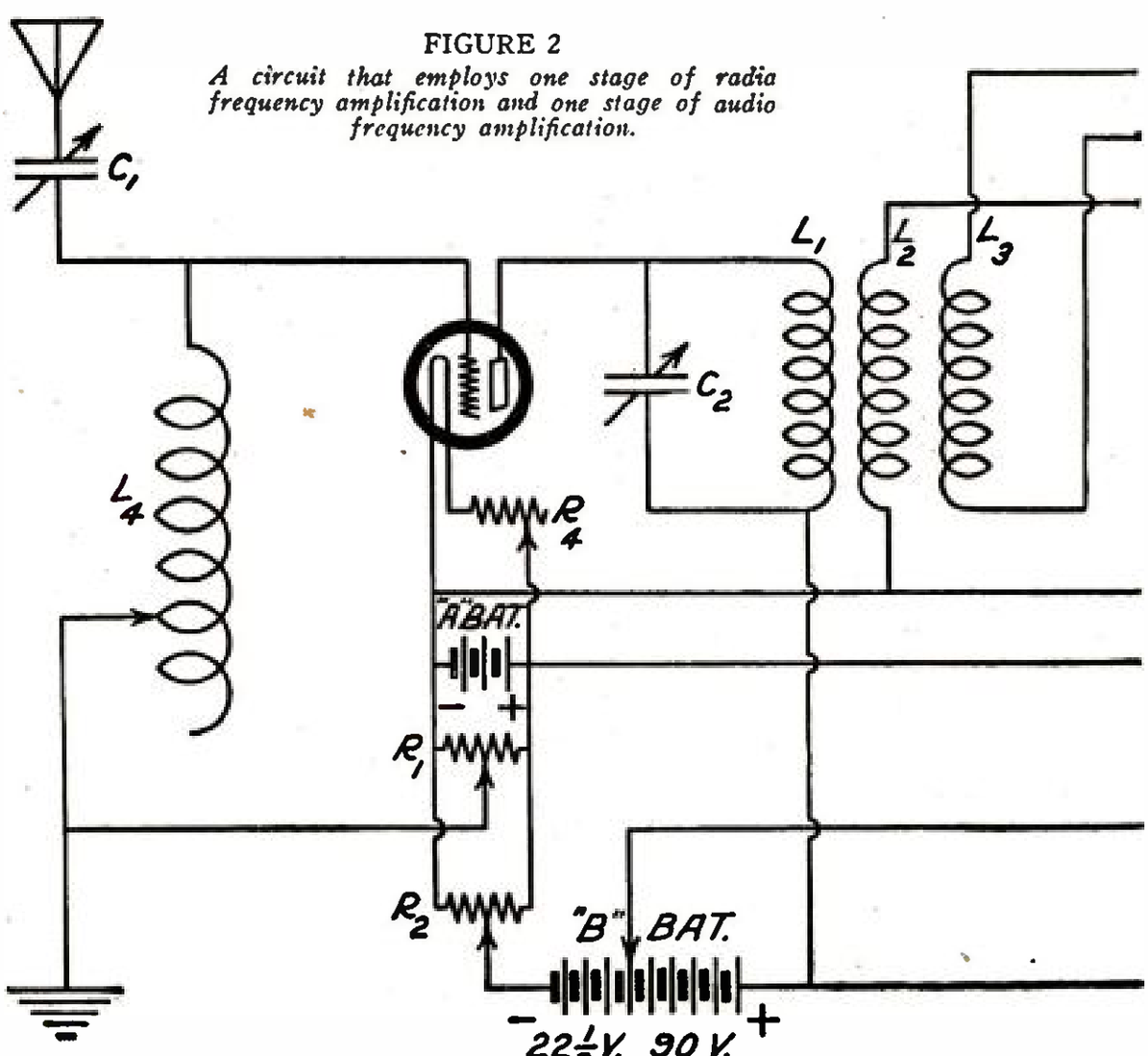
QUESTION: Would it make any difference what size variable condenser I have in the receiving set described in the July issue of POPULAR RADIO, on page 194?

JAMES H. HIND

ANSWER: Any condenser with a capacity value lying between .0005 and .001 mfd. will be suitable, although the larger capacity the condenser has, the higher the wavelength to which the set will be able to tune.

FIGURE 2

A circuit that employs one stage of radia frequency amplification and one stage of audio frequency amplification.



QUESTION: Please inform me if a coil may be tuned with a variable condenser as well as with sliders; I mean the primary coil of a loose coupler.

R. M. B.

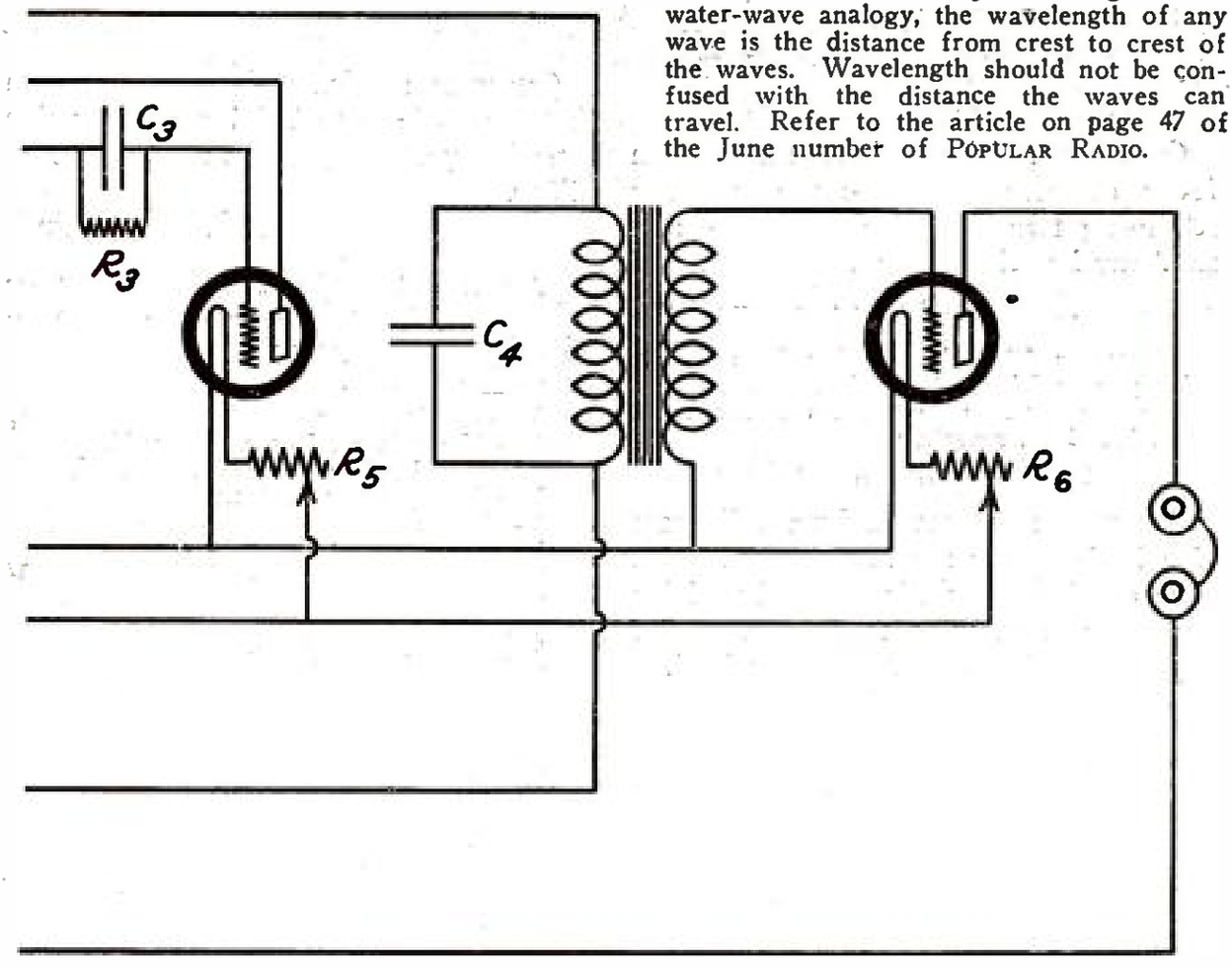
ANSWER: The wavelength of an antenna circuit having in it the primary circuit of a loose coupler may be tuned satisfactorily by means of a variable condenser. In fact, if the condenser is used with a series-parallel arrangement, it makes tuning possible over a broad band of wavelengths.

* * *

QUESTION: What would be the best kind of tube to use in the set described on page 295 of the August issue of POPULAR RADIO? In that set would it not be just as good to put the variable condenser in series with the lead-in from the antenna?

GEORGE SAUNDERS

ANSWER: Any soft detector tube such as the UV-200, or the Cunningham 300, or an Electron Relay, will be serviceable for use with this circuit. The circuit will function better as shown in our diagram, with the antenna circuit tuned with the slider and the secondary circuit tuned by means of the variable condenser.



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QUESTION: What are "damped" and "undamped" waves? What do we mean by "wavelengths from 200 to 700 meters"? In other words, to what does "wavelength" refer?

GLENN E. DILL

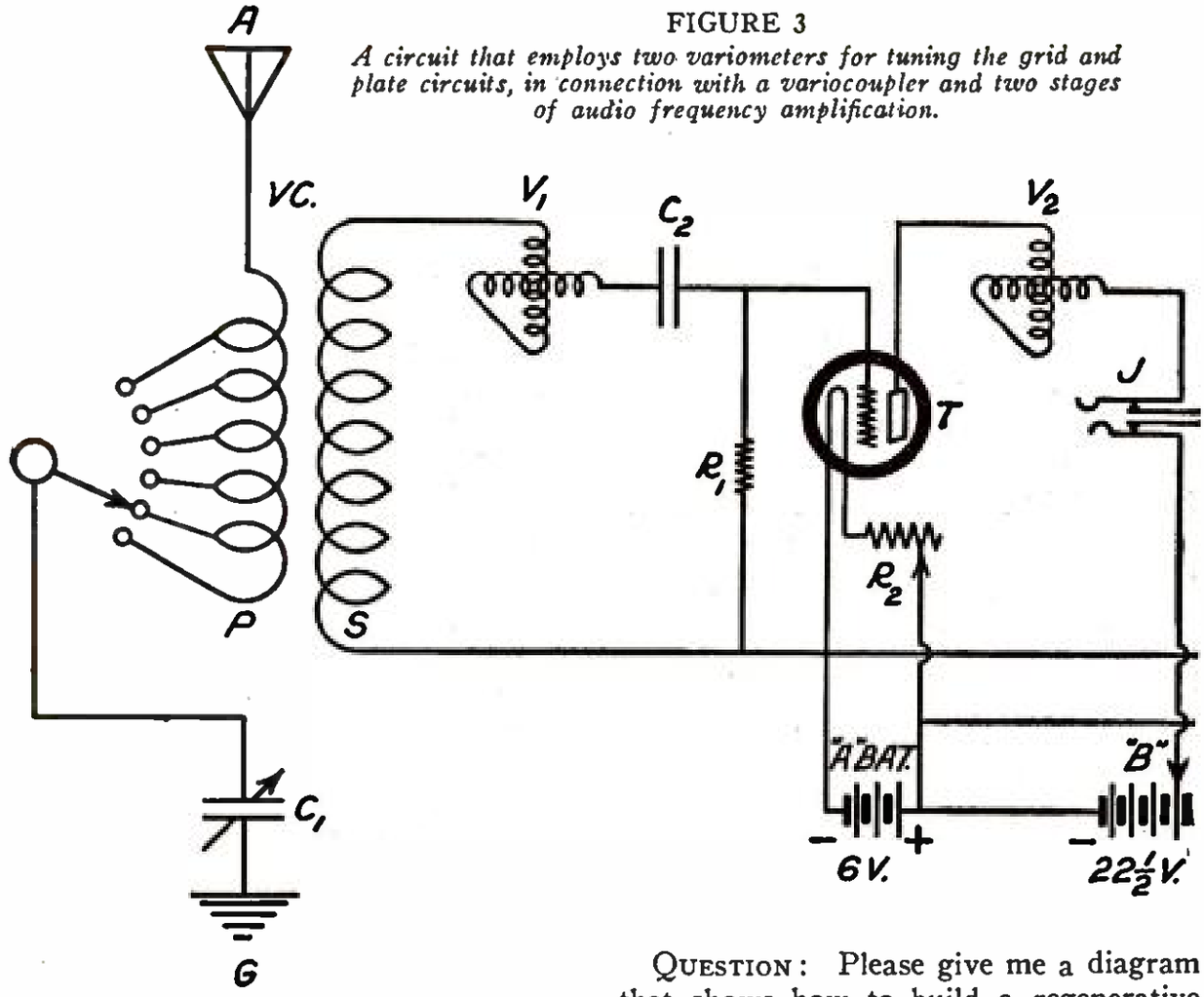
ANSWER: An "undamped" wave refers to an alternating current in which the amplitude of each succeeding alternation is constant. This is the type of energy developed by a vacuum tube transmitter, an arc transmitter, or a high frequency alternator.

A "damped" wave refers to an alternating current in which the amplitude of each succeeding alternation is of a decreasing value. This dampens out the oscillations in a circuit so that they finally die out. This series of oscillations is called a wave-train, and is generated by a spark transmitter. There is a wave-train generated for each spark jumping the gap in such a transmitter.

By "wavelength" is meant the distance traveled by a radio wave upon leaving an antenna before the next wave generated leaves the antenna. By referring to the water-wave analogy, the wavelength of any wave is the distance from crest to crest of the waves. Wavelength should not be confused with the distance the waves can travel. Refer to the article on page 47 of the June number of POPULAR RADIO.

FIGURE 3

A circuit that employs two variometers for tuning the grid and plate circuits, in connection with a variocoupler and two stages of audio frequency amplification.



QUESTION: Please give me a diagram for a detector and two-stage amplifier set, using two Amrad variometers and an Amrad variocoupler for tuning.

R. A. McMILLIAN

ANSWER: The diagram has been drawn for you in Figure 3. This should make a very fine receiver for both amateur work and broadcast reception.

* * *

QUESTION: Please send me a diagram of a hook-up for my instruments. The tuner consists of 2 variometers, 1 variable condenser, and 1 variocoupler. Two stages of amplification should be added.

EVERETT BEERS

ANSWER: Refer to the diagram in Figure 3 for the circuit connections for your proposed set. You will notice that telephone jacks are inserted in the plate circuits to cut in or out of amplification.

The variocoupler and variable condenser tune the antenna, while the two variometers tune the grid and plate circuits.

QUESTION: Please give me a diagram that shows how to build a regenerative set, adding a 2-stage audio frequency amplifier.

C. W. WOODRUFF

ANSWER: The diagram shown in Figure 3 gives you the hook-up. The following parts will be required:

V1—Variometer
V2—Variometer
VC—Variocoupler
C1—Variable condenser, .001 mfd.
C2—Fixed grid condenser, .0005 mfd.
R1—1 megohm grid leak
T—6 ohm rheostat
T—Vacuum tube UV-201
T1—Vacuum tube UV-201
T2—Vacuum tube UV-201
J—Double circuit jack
J1—Double circuit jack
J2—Single circuit jack
AT—Amplifying transformer
A—6-volt storage battery, 60 ampere-hour
B—"B" battery dry cells, 22½ volts on the detector tube and 90 volts on the amplifier tubes

Three tube sockets, connecting wire and binding posts should enable you to finish the set. Use 3,000 ohm telephones for the best results. This set will give good results if properly constructed.

QUESTION: Please tell me if a variable condenser will tune out the terrible popping static that I hear over my crystal set. I also want to know if there is any addition I can make to my set that would increase the volume of music that I hear 25 miles away on 360 and 483 meters.

IRVING RUST

ANSWER: The variable condenser will not help you tune out the static. You would find some relief if you were to use a loop antenna, but this necessitates using multi-stage radio frequency and audio frequency amplification for loud signals. You will be able to increase the volume of your received signals by adding a vacuum tube to your set as a detector in place of the crystal detector, and at some future date adding another vacuum tube as an amplifier.

* * *

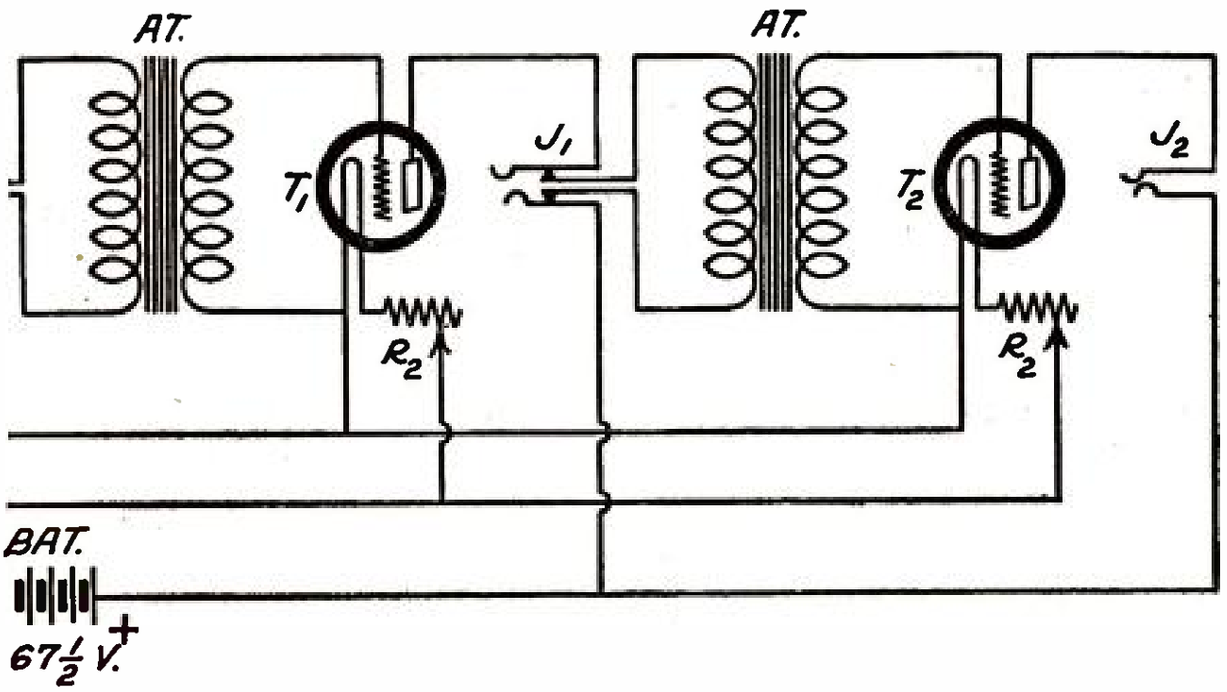
QUESTION: I would like to know which is the better plan—to amplify before I detect, or *vice versa*.

ROBT. FARD

ANSWER: In radio frequency amplification, the incoming impulses are amplified before they are detected, and when audio frequency amplification is used the impulses are detected and then the low frequency component of the current is amplified.

Radio frequency amplification is more suitable for amplifying weak signals so that the detector is furnished with enough current to function, and audio frequency amplification is used when the signals have already been detected and when signals of sufficient strength to operate a loudspeaker are required.

The two systems of amplification cannot be compared because they have different functions. The best results are obtained



when the two systems are employed in combination and amplification is obtained both before and after detection.

* * *

QUESTION: Please explain the method of amplifying the signals as received with a single crystal detector, by means of additional crystals and amplifying transformers, and state the degree of amplification obtained.

E. O. KNOCH

ANSWER: The technical editor has seen the diagram of such a circuit, but he is "from Missouri" in regard to its practical application. It stands to reason that in the crystal detector receiver, the strength of the received signals is a function of the current passed through the crystal. If we step up the voltage by means of amplifying transformers, the current in the next crystal is decreased and the signal is weakened. If, on the other hand, we should step down the voltage in order to increase the current through the second crystal, the voltage would be of too low an order to overcome the high resistance of the crystal and again the signals would be weakened. If this method were successful it would very probably be in common use. Our advice is to stick to the vacuum tube as an amplifier.

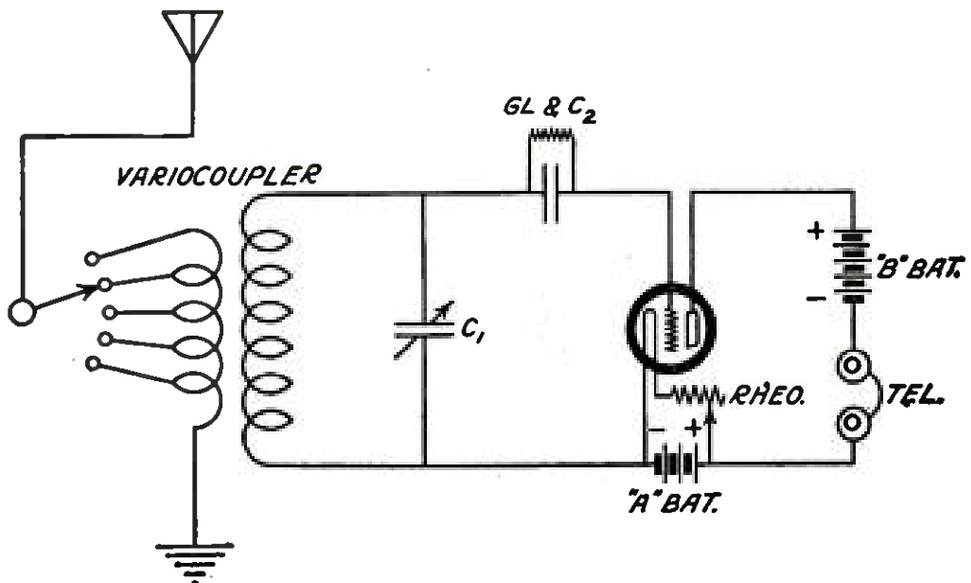


FIGURE 4

A circuit that makes use of a variocoupler, a variable condenser, and a vacuum tube.

QUESTION: Please show me an efficient diagram using a variocoupler, a variable condenser and a vacuum tube detector.

HENRY C. JONES

ANSWER: The circuit diagram you require is shown in Figure 4. The tuning is accomplished by means of the primary switch and the variable condenser.

* * *

QUESTION: I have already made a receiving set a little different than the one described in your May issue, but I have had very little luck with it so far. I enclose the hook-up that shows the instruments I use, and the antenna. Can you find my error?

CECIL LAMGKUR.

ANSWER: You will improve your set if you use the circuit for hooking up your apparatus as illustrated in Figure 5. The antenna you have is much too small. Use one wire stretched as high as possible and at least 100 feet in length (but not longer than 150 feet) for listening to the broadcasting programs.

* * *

QUESTION: I have a loose coupler, a fixed condenser and a crystal detector. Can I make a set out of them that will receive code messages and music? If so please give me a wiring diagram for the set.

D. STAFFORD

ANSWER: A circuit employing the instruments that you have on hand is given in Figure 5. This will allow you to receive local code and broadcasting quite clearly.

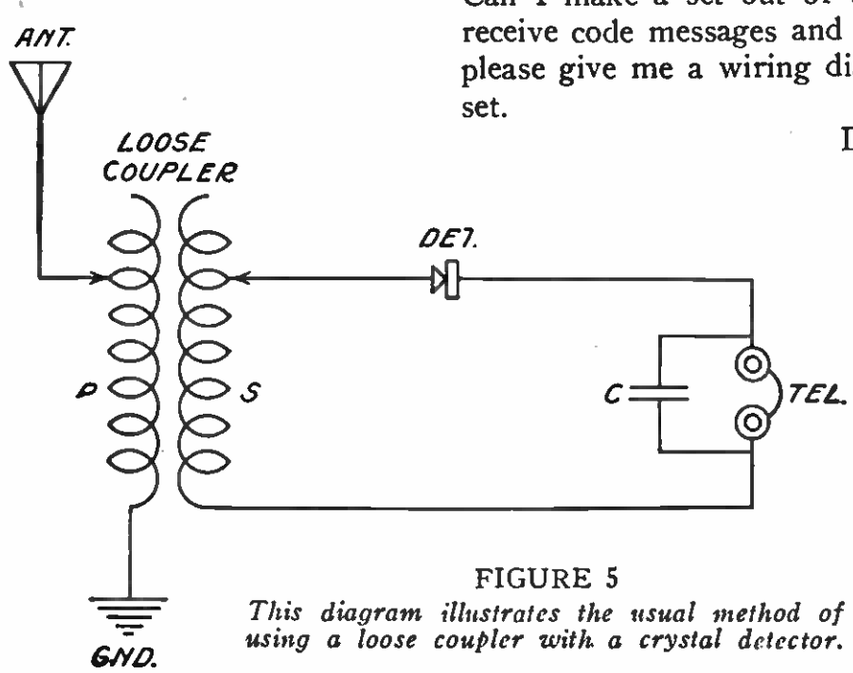
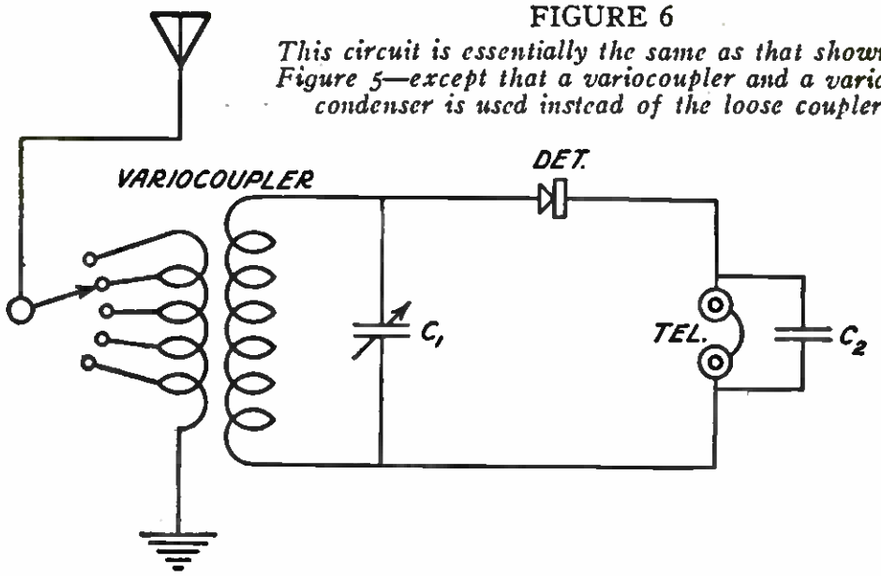


FIGURE 5

This diagram illustrates the usual method of using a loose coupler with a crystal detector.

FIGURE 6

This circuit is essentially the same as that shown in Figure 5—except that a variocoupler and a variable condenser is used instead of the loose coupler.



QUESTION: Please give me a diagram showing how to wire up a variocoupler tuning coil with crystal detector and where to put the variable condenser. My aerial is 100 feet long and 30 feet from the ground, made of No. 14 bare copper wire without an enamel coating on it. Will it be all right without the coating?

P. A. LATTA

ANSWER: The diagram that you require is drawn for you in Figure 6. The bare copper wire will be suitable.

* * *

QUESTION: Which is the best, a loose coupler, a variocoupler, or a variometer? How many miles would I be able to receive with one of the above, and a phone condenser, a 43 plate variable condenser, a crystal detector, and a pair of 2,200 ohm phones?

JOHN COLLINS

ANSWER: The variocoupler will give you the most satisfactory method of tuning. See the diagram shown in Figure 6 in answer to the question of P. A. Latta. It is not possible to answer questions regarding the distances over which a set should receive.

* * *

QUESTION: Is there any way in which the set described in the July issue of POPULAR RADIO (on page 194) can be made to receive over greater distances? I hear the local stations clearly but want to increase the range.

T. J. LAUGHLIN

ANSWER: On page 168 of this magazine you will find another article by Watson Davis; it shows how to add a vacuum tube detector to the set you describe, thus increasing its range considerably.

* * *

QUESTION: Please give me an efficient hook-up for the following instruments:

1 variable condenser
1 fixed condenser
1 variocoupler with a tapped primary
1 crystal detector
1 pair of head-telephones

HENRY C. JONES

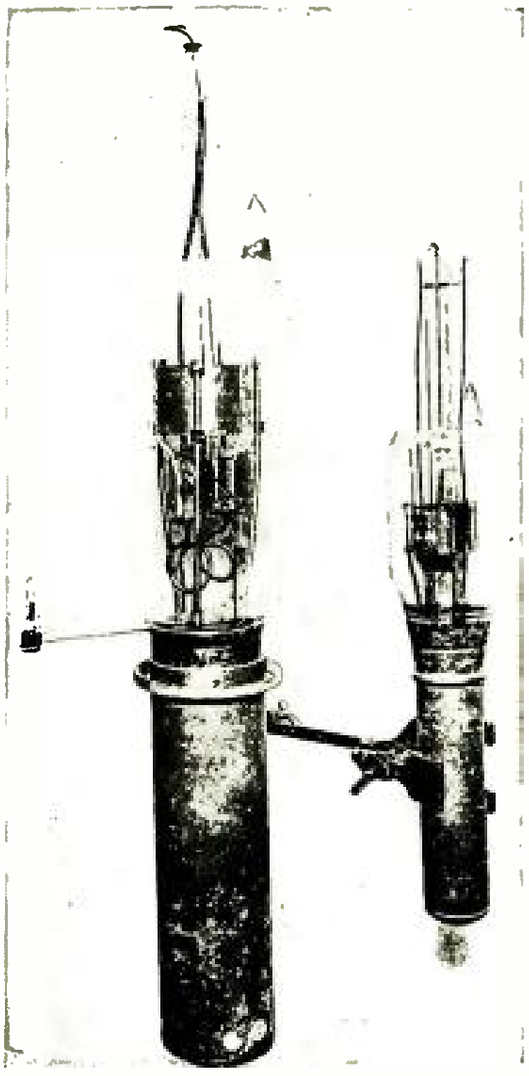
ANSWER: The hook-up is shown in Figure 6.

* * *

QUESTION: Can a 6-volt and a 22½-volt D. C. generator be used, instead of the "A" and "B" batteries respectively, in a vacuum tube receiving set?

VICTOR NEHER

ANSWER: These may be used providing the direct current, generated by the machine, is non-fluctuating. If the current is of a pulsating nature, such as is generated by most machines of small size, there will be a humming sound accompanying the reception that will cause interference. This may be eliminated by the use of a filter circuit connected in the plate circuit of the tube. Such a circuit was described and a diagram given on page 144 of the June issue of POPULAR RADIO. The filter circuit shown on this page is one recommended for use with a radiophone transmitter, but it can be used advantageously for receiving sets.



← Compare the tiny tube (which is still used for receiving) with the latest 100 kilowatt oscillator which has just been produced—the most powerful vacuum tube in the world, 100,000 times as powerful as its companion. The tube at the right is the 10 kilowatt oscillator from which it was developed.

The "Peanut" Tube's Giant Brother

The latest and the most powerful of vacuum tubes that weighs but ten pounds—but that may conceivably do the labor of $500,000 worth of machinery

By W. WILSON

INTRODUCTORY NOTE

Here is a description of an amazing triode, scarcely two feet in height and weighing only ten pounds, that is nevertheless capable of delivering 100 K. W. of high frequency energy —truly an "Aladdin's lamp" of radio raised to the *n*th power. It is not inconceivable that this tube may become one of the most remarkable devices of modern electrical science.

Vacuum tubes capable of handling small amounts of power have been extensively used during the past few years as telephone repeaters and as oscillators, modulators, detectors and amplifiers in radio transmission and other fields. Practically all such tubes have depended upon thermal radiation from the plates to dissipate the electrical energy which the device necessarily absorbs during its operation. With present methods of construction, and using glass for the containing bulb, a fairly definite upper limit can be set for the power which a radiation cooled tube can handle; as the author points out, this limit gives a tube capable of delivering about 1 to 2 K. W. when used as an oscillator.

Contrasted with this is the large water-cooled vacuum tube described herewith. Another tube of similar construction, but somewhat smaller in size, is capable of delivering about 10 K. W. It is expected that these water-cooled tubes will find important application in radio telephony and telegraphy.

Although the principle of operation of the water-cooled tube described in this article is identical (from an electrical point of view) with that of the small tubes with which we are now so familiar, their practicability has been made possible only by a new and striking development in the art of sealing metal to glass. In the case of the 100 K. W. tube the seal between the cylindrical copper anode and glass portion is 3.5 inches in diameter.

The remarkable character of these copper-in-glass seals is evidenced by the fact that they do not depend upon a substantial equality between the coefficient of expansion of the metal and glass. The development of the copper-in-glass seals was brought about by Mr. W. G. Houskeeper of the Bell System Research Laboratory at the Western Electric Company. Mr. Houskeeper has also invented means for sealing heavy copper wire and strip through glass in such a way that the best vacua can be maintained under wide changes of temperature. —EDITOR.

THE widespread adoption of the vacuum tube as the generator of high frequency currents in low power installations has been brought about by just two factors.

One is the development of radio telephony.

The other is the use of continuous wave transmission in radio telegraphy.

The ordinary form of vacuum tube is, however, ill suited for the handling of large amounts of power, and at the large radio stations, where the plant is rated in hundreds of kilowatts, either the arc or the high frequency alternator is used.

The undoubted advantages to be derived from the use of vacuum tubes (especially in the field of radio telephony where the output power must be modulated to conform to the intricate vibration pattern of the voice), has led to a demand for tubes capable of handling amounts of power comparable with those in use at the largest stations.

That the development of such tubes was of great importance was recognized by the engineers of the Bell Telephone System in the early days of the vacuum tube art. The experiments at Arlington, Virginia, in which speech was first transmitted across the Atlantic to Paris and across the Pacific to Honolulu, required the use of nearly 300 of the most powerful tubes then available, each capable of handling about 25 watts, and the difficulties encountered in operating so many tubes in parallel gave added impetus to the development of high power units.

The usual type of vacuum tube consists of an evacuated glass vessel in which are enclosed three elements: the filament, the plate, and the grid. When the tube is in operation an electron current flows between the filament, which is heated by an auxiliary source of power, and the plate, the magnitude of this current being controlled by the grid.

The passage of the current through a thermionic tube is accompanied by the dissipation in the plate of an amount of power which is comparable to the power delivered to the output circuit and which manifests itself in the form of heat. This causes the temperature of the plate in the usual type of tube to rise until the rate of loss of heat by radiation is equal to the power dissipated. Some of the heat liberated by the plate is absorbed by the walls of the containing vessel, which consequently rise in temperature. These factors, together with a consideration of the size of plate that can be conveniently suspended inside a glass bulb, and the size of glass bulb that can be conveniently worked, set a limit of about 1 to 2 K. W. for the power that can be dissipated in the plate of a commercial vacuum tube of this type.

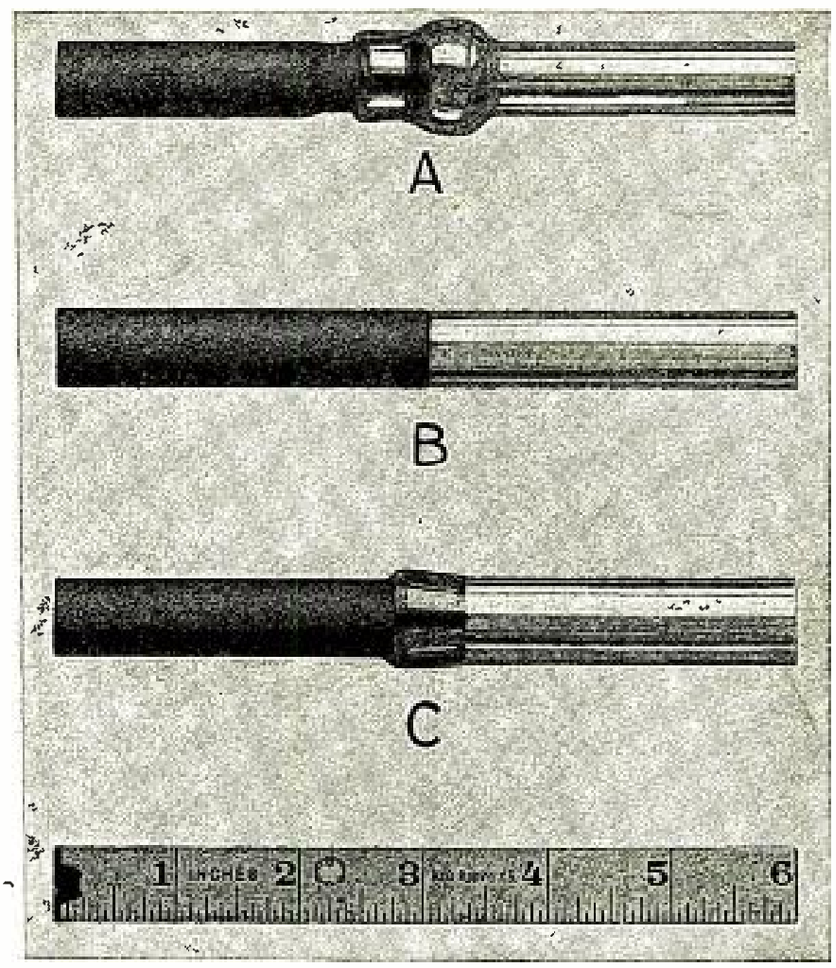
It is apparent then that in the development of vacuum tubes capable of handling large amounts of power, means other than radiation must be used for removing the heat dissipated at the plate, and development of tubes has proceeded along these lines.

A step in the direction of overcoming these limitations was made by Messrs. Schwerin and Weinhart, who were working with Dr. O. E. Buckley on the problem, and who suggested that the anode might be made in the form of a tube or thimble of platinum sealed into a glass vessel and kept cool by passing water through it.

As soon as the pressure of work more directly connected with the necessities of the war would permit, Mr. W. G. Houskeeper and Dr. M. J. Kelly undertook the improvement of the water-cooled tube.

Mr. Houskeeper adapted into the construction of the tube a remarkable type of vacuum seal which he had previously developed. These seals are made between glass and metal and can be made in any desired size. They are capable of withstanding repeated heating and cooling over wide ranges of temperature, from that of liquid air to 350° C., without cracking and without impairment of their vacuum holding properties.

It is no exaggeration to say that the invention of these seals has made possible



THESE THREE JOINTS MAKE THE GIANT TUBE POSSIBLE

Three types of the "tube seal," A, B and C, that are used for producing the air-tight joints between the glass and the metal of the monster tubes.

the construction of vacuum tubes that are capable of handling, in single units, powers of any magnitude which may be called for in radio telegraph and telephone transmission.

The underlying principle connected with the making of this seal consists in obtaining an intimate connection between the glass and metal, either by chemical combination or by mere welding and in so proportioning the glass and metal portions of the seal that the stresses produced when the seal is heated or cooled will not be great enough to rupture either the glass or the junction between the glass and metal.

The three principal types of seals developed by Mr. Houskeeper are known as the ribbon seal, the disc seal and the tube seal.

The type of seal which is the most important in connection with the present problem is the tube seal shown in the illustration on this page. This furnishes the means of joining metal and glass tubes end to end, and is used in the water-cooled tube to attach the anode to the glass cylinder which serves to insulate the other tube elements. As in the case of the disc seal, it can be made either with the edge of the metal not in contact with the glass, as shown at A, or with the metal sharpened to a fine edge which is in contact with the glass. The glass may be situated either inside or outside of the metal (see B and C.)

The first thermionic tubes in which these seals were embodied were made of copper and were designed to operate at 10,000 volts and to give 5 K. W. output.

Although successful from the standpoint of operation, this tube had several

undesirable features that it was thought well to eliminate. In the first place the welding of the end into the tube was not particularly desirable, and in general any troubles that occurred due to leaks in the metal could be traced to this point. It was, therefore, decided to go to a type of tube in which the anode would be drawn in one piece and in which as many welds as possible would be eliminated in the assembly of the internal elements. At the same time it was considered desirable to go to a somewhat larger type of structure in which high tension insulation could be more easily provided, and a larger tube was therefore designed capable of delivering 10 K. W. to an antenna at a plate voltage of 10,000 volts.

The final form adopted for this tube is shown on page 219.

The success which had attended the development of a tube of this high power capacity indicated the possibility of constructing still larger tubes, and it was decided to proceed with the development of a tube capable of delivering at least 100 K. W. into an antenna. The development proceeded with a few minor alterations along the lines of the smaller tube, nominally rated at 10 K. W., and the 100 K. W. tube as now developed is shown in the frontispiece of this magazine. The anode, which is made of a piece of seamless copper tubing closed by a copper disc welded into the end, is 14 inches long and 3.5 inches in diameter. The filament is of tungsten and is .060 inch in diameter and 63.5 inches long. The current required to heat it is 91 amperes, and the power consumed in it 6 K. W. The filament leads are of copper rod one-eighth of an inch in diameter and are sealed through 1-inch copper disc seals. The grid is of molybdenum and is wound around three molybdenum supports.

The handling of the parts of this tube during manufacture presents a task of no mean magnitude, and numerous fixtures have been devised to assist in the glass working. It has been found necessary, for instance, to suspend the anode in gimbals during the making of the tube seal, owing to its great weight, and special devices have been made to hold the filament grid assembly in place while it is being sealed in, otherwise the strains produced by its weight cause cracking.

The significance of this development in the radio art cannot be overestimated. It makes available tubes in units so large that only a very few would be necessary to operate even the largest radio stations now extant, with all the attendant flexibility of operation which accompanies the use of the vacuum tube.

From the standpoint of radio telephony the development of these high-power tubes gives us the possibility of using very much greater amounts of power than have ever been readily available before. The filaments in these tubes have been made so large that the electron emission from them will easily take care of the high peak currents accompanying the transmission of modulated power.

The 100 K. W. tube by no means represents the largest tube made possible by the present development. There is no doubt that if the demand should occur for tubes capable of handling much larger amounts of power they could be constructed along these same lines.

HOW IT IS BUILT

The grid assembly is shown at D, and is supported by the rods M and the lavite blocks E and F. The filament is of tungsten and is connected to the two molybdenum rods G and H, which are coiled into single turn spirals at KK and led through the glass by the disc seals LL. The hooks J hold the lower end of the filament in position. The whole structure is mounted on the flare R by means of the nickel collar N and the supports P. The grid lead is brought out through the glass tube Q.

It is often a great help in tuning to have the antenna circuit of a receiving set tuned by a variable condenser, especially when the condenser can be placed in series with the circuit or in parallel. In order to make this system of the utmost convenience it is necessary to use some sort of switching arrangement that will allow the operator to make a quick change, so that time is not wasted in changing connections to the condenser.

A suitable method for doing this has always been a little too much for the novice in radio, probably because he thought it too complicated.

For the amateur who has his apparatus mounted on a board, a double pole, double throw knife switch will be suitable. It should be connected as shown in Figure 1, with the primary coil across the two contacts at one end of the switch, the condenser connected across the switch blades, and the antenna and ground leads connected on opposite sides of the switch, as shown in the diagram. The change-over lead should run from the bottom right-hand contact to the top left-hand contact. When the switch is thrown to the right the condenser is connected in parallel to the antenna circuit (tuning to the higher wavelengths); thrown to the left it is connected in series, when the lower wavelengths will be more easily tuned in.

There are two styles of switches that may be mounted on the panel and make a good appearance as well as work satisfactorily. One of them is the rotary change-over switch with two double ended switch arms and eight contact points (as shown in Figure 2). The other style is a panel-mounted anti-capacity snap switch with a small button protruding through the panel. This switch is shown in Figure 3, hooked up to an antenna circuit. A change-over switch is not necessary in the secondary circuit of a receiver.

* * *

A variometer is a very hard piece of apparatus for the amateur to construct himself, because of the fact that the stator winding must fit very closely to the rotor winding when the instrument is assembled. This necessitates special form-wound coils for the stator and a difficult method of transferring the windings from the forms to the blocks to which the winding is finally fitted.

There are many types of manufactured variometers which are suitable for amateur use and which are so reasonable in price that it is foolish for the amateur to think that he is saving either money or time, when he tries to make his own. After much planning, worrying and patience-testing labor he has an instrument that he calls a variometer, but it usually is an inferior instrument.

* * *

When experimenting with the new super-regenerative receiver the amateur is cautioned not to get discouraged until he has played with the set for a week or so and understands the principles of its operation. It is imperative that hard

tubes be used and they should be shifted around until the best tube is found for the regenerator and the best one for the oscillator. Upon such seemingly unimportant details is success based.

* * *

A LOOP antenna is not much of a success where a crystal detector is used alone in a receiving set. The results will be practically nil.

* * *

MANY novices confuse the wavelength of a transmitted signal with the distance the signal can be sent. Thus, some questions have been sent in to the "What Readers Ask" department, asking the wavelength from New York to Chicago, or the question "Will I be able to receive from a greater distance if I put in a loading coil?" This is a mistaken notion. The wavelength of a signal refers indirectly to its frequency or number of cycles a second, just as the pitch of a musical note refers to the frequency of the note or the number of impulses a second necessary to produce it, and not the distance it will travel.

* * *

Do not let your storage batteries run down dead, as this misuse will soon cause deterioration and the battery will be no good. When your battery shows signs of dropping, take it to the garage and get it recharged. Better yet, obtain a charging device and keep it always charged yourself by turning on the charger after you have used the set. The charging device will quickly pay for itself, as the battery lasts longer and you will save the money paid to the garage man for charging. A charger is a good investment at any time.

* * *

A HANDY kink for the radio experimenter to use is ready-made "leads" or insulated wires with small spring clips at each end. These may be made in varying lengths, so that when (during an experiment with a new circuit) he wishes to try some other connections, he need merely unclip the wires and reclip them in the new positions without the bother of cutting new leads, scraping the wires clean and fastening them in the binding posts. The new way is a time saver and much more convenient. Make

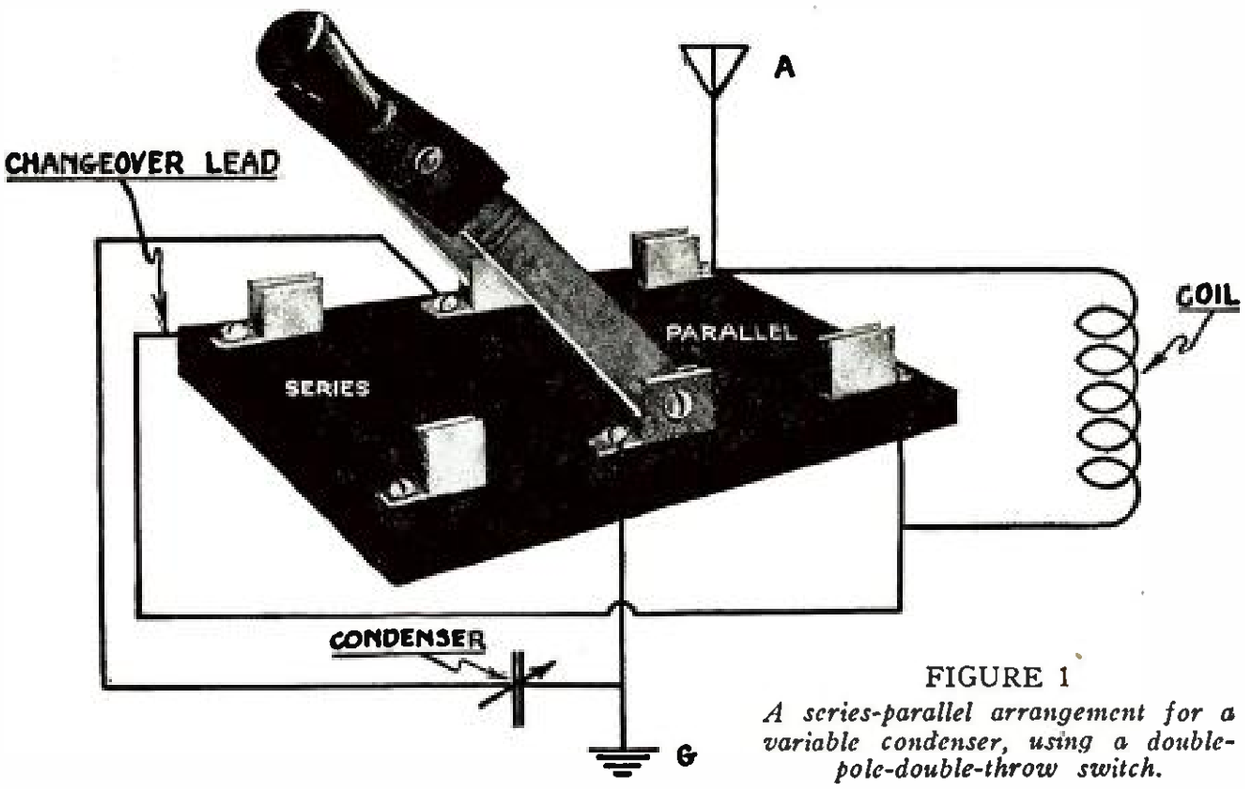


FIGURE 1

A series-parallel arrangement for a variable condenser, using a double-pole-double-throw switch.

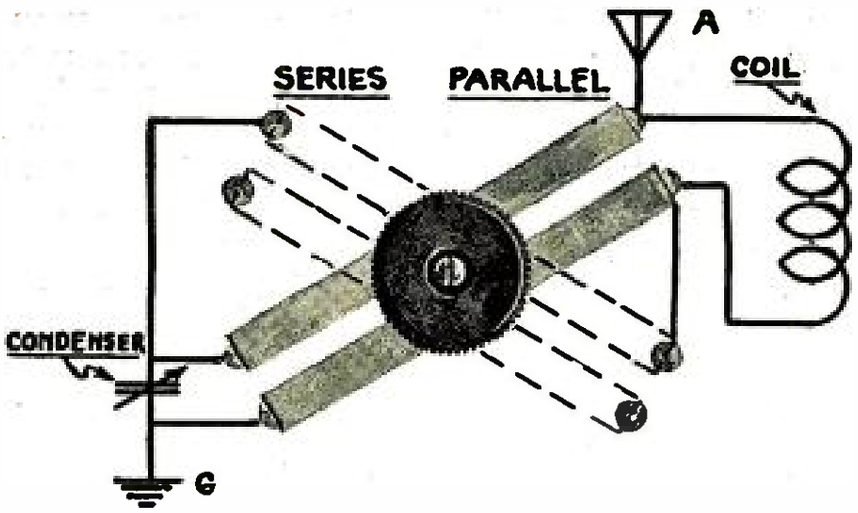


FIGURE 2

The same circuit as shown in Figure 1, except that a rotary panel switch is used.

up some testing leads and take the drudgery out of your experimentation.

* * *

An "A" battery is usually a storage battery of 6 volts and is used to heat the filaments of the vacuum tubes in the receiving set. A "B" battery is composed of a number of small flashlight dry batteries connected in series and are usually made up in blocks having 22½ volts a block. The "B" battery is used to make the plate of a vacuum tube sufficiently positive with respect to the filament to facilitate the passage of electrons across from the filament to the plate.

* * *

Sometimes the amateur has trouble with his receiving set, in that the signals come in loud and clear for a few minutes, only to fade out again. All the connections may be correctly and tightly made, still the same trouble continues. Sometimes this trouble may be located in the socket of the tube. The tube has four little prongs sticking out from the bottom of the base; on the end of each of these is a little drop of solder. This is supposed to make contact with the strips in the socket, but often the little dabs of solder get blackened and dirty and a poor contact is obtained.

This trouble may be easily remedied by polishing the bottom of each of the four little prongs with a piece of smooth sandpaper.

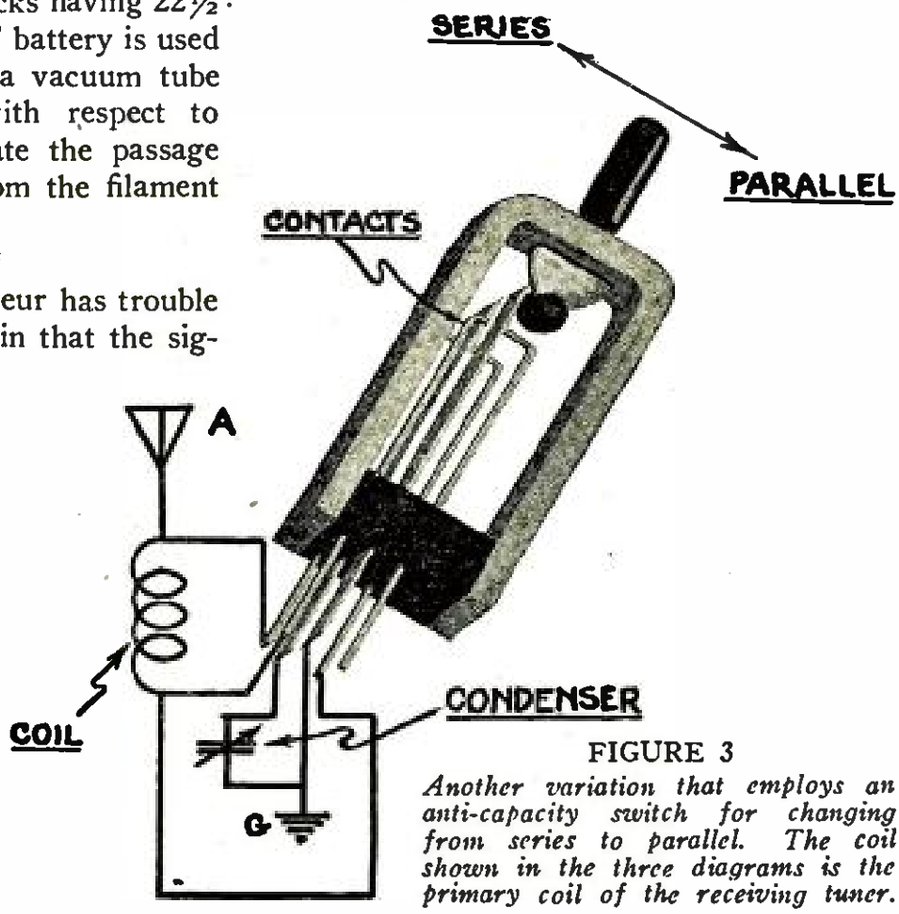


FIGURE 3

Another variation that employs an anti-capacity switch for changing from series to parallel. The coil shown in the three diagrams is the primary coil of the receiving tuner.

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.*

A New Test for Amateurs

FOR the first time in the history of amateur radio American and Canadian amateurs will have an opportunity to demonstrate their skill in receiving amateur signals from across the Atlantic.

The third series of transatlantic amateur tests will be conducted by the American Radio Relay League, in co-operation with the radio amateurs of England, France and Holland, from December 12 to December 31, 1922, inclusive. During the first ten days of the tests American and Canadian amateurs will transmit signals for reception by the radio amateurs of the European countries. Those of the American and Canadian transmitters who make the best records (as determined by reception reports from the European amateurs) will be used to transmit the results of reception by American and Canadian radio amateurs when the English and French amateurs send.

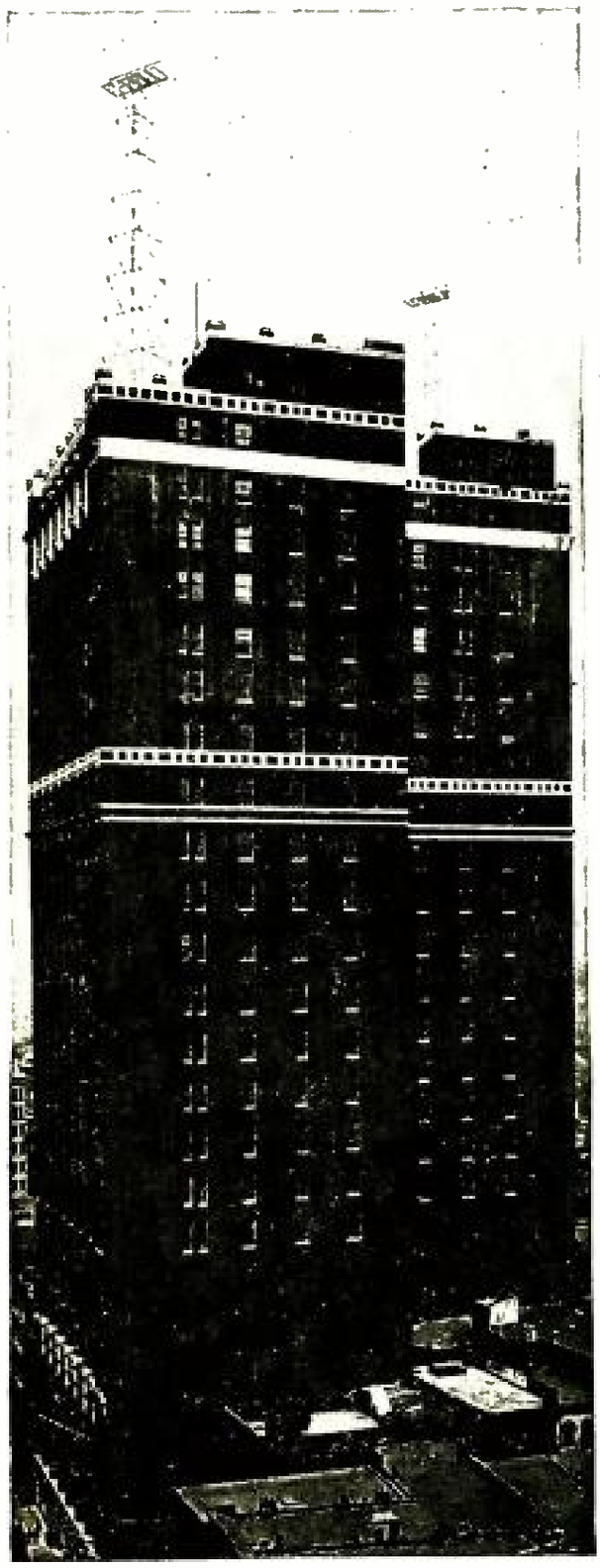
A series of preliminary tests, for the purpose of determining which American and Canadian transmitters shall be given a place in the final tests with an individual schedule and code letters, will be conducted from October 25 to November 3, inclusive. To qualify for the final tests a transmitter must cover at least 1,200 air-line miles during the preliminary tests.

The preliminary tests will cover a period of two and one-half hours (9:30 P.M. to midnight, Central Standard Time) each night; this period will be subdivided into ten periods of fifteen minutes each. Transmission will take place by inspection districts. One district will transmit at a time, and all others will remain silent during the attempt to copy as many of the transmitting stations as possible. After the tests each night the receiving stations will send a confirming record to all transmitters at a distance of 1,200 air-line miles or over. When filing application for entry in the final tests, a transmitter must show documentary evidence that his signals have reached out 1,200 air-line miles during the months of September or October.

Pacific & Atlantic

A FINGER-RING RECEIVER

This is claimed to be the smallest set made. Do our readers know of one smaller?



A PAY-AS-YOU-ENTER STATION

To meet the demand for a broadcasting toll station—a station that can be hired for occasions—the American Telephone and Telegraph Co. has established WBAY atop this conspicuous building in New York. The antenna towers are 488 feet above the sidewalk, and are built to withstand a wind load of 5,000 pounds. The result of this unique experiment is being watched with more than casual interest.

Radio Fans to Pay Tribute to John Bull

HOW John Bull is treating the radio amateur in England—where radio has not yet taken hold in anything like the way it has on this side of the ocean—is revealed in the interesting comment of Mr. A. P. M. Fleming, a prominent English engineer, who recently visited some of our large broadcasting stations:

At present we have no such thing as broadcasting in Britain in the sense in which the term is used in America. Government restrictions have prevented it on account of the possible interference with the requirements of the navy, mercantile marine, war services, and aeroplane traffic. But the largest manufacturers of radio apparatus have co-operated with the British Government officials in working out plans for the control of broadcasting.

We have learned many valuable lessons from the broadcasting experience of the United States. One of them is to avoid the establishment of innumerable radio stations, with no plan of cooperation between them. Eight 1½ K.W. stations are contemplated and some of these will probably be built shortly. These stations will be located in the principal cities throughout the British Isles and will be operated so as to eliminate the chaos usually found where no rules are in force.

The broadcasting stations will be operated on strictly regulated wavelengths and other set rules, which will be published for the guidance of radio receiver owners. Every radio set owner will be required to pay an annual tax, also, and there will doubtless be special restrictions applying in times of national emergency.

* * *

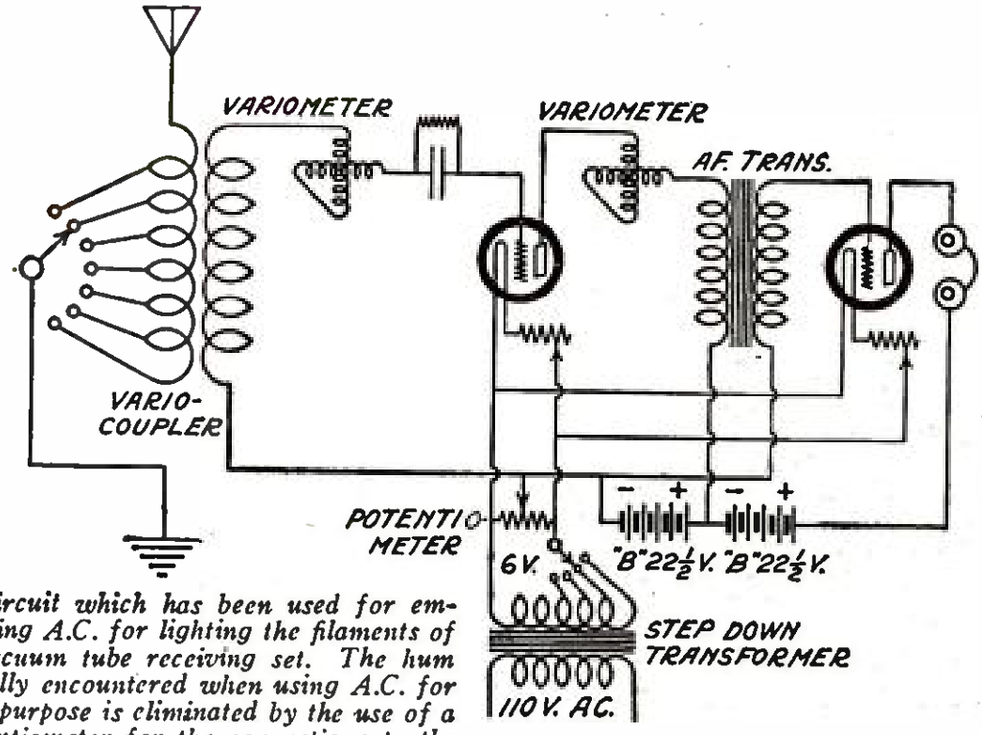
A Toy Step-Down Transformer in a Receiving Set

IF you receive an electrically operated toy railroad train from Santa Claus, you may adapt a part of it for a novel use on your radio set, as this experimenter did:

I am using a toy transformer on my apparatus with great success. I get very little hum when the set is properly tuned, due to the fact that I use a potentiometer across the transformer, with the "B" battery negative pole connected to the switch arm, as shown in the accompanying diagram. The transformer is especially successful when using the loudspeaker, as the hum carries only a few feet while the signals may be heard all over the room. I am using a regenerative circuit with one stage of audio frequency amplification.*

A. THOMAS WELLS

*See circuit diagram on page 223.



A circuit which has been used for employing A.C. for lighting the filaments of a vacuum tube receiving set. The hum usually encountered when using A.C. for this purpose is eliminated by the use of a potentiometer for the connections to the grids of the tubes.

The New "Class B" Stations

A DISTINCT step forward in the broadcasting problem has just been taken by the Washington authorities through the Secretary of Commerce, Herbert Hoover. A new "Class B" station has been created that shall have special wave-length assignments and that shall be specifically charged with the maintenance of high-grade programs—not unlike the special "red seal" records of the gramophone. The next step in the development of the plan will be to maintain these programs at the highest possible level; on this point, indeed, POPULAR RADIO has been quietly working for several weeks; the results will be published in a subsequent issue. Secretary Hoover's announcement reads as follows:

A new class of radio telephone broadcasting station license is hereby established, to be known as Class "B." A license will not be issued for a station in this class which does not comply in every respect with the specifications hereunder.

Specifications covering the requirements governing the construction, licensing, operating and service of Class "B" radio telephone broadcasting stations:

Wavelength—The wavelength of 400 meters only will be assigned for the use of stations of this class, which must be reasonably free from harmonics.

Power—The power supply must be dependable and nonfluctuating. The minimum required will be 500 watts in the antenna and the maximum shall not exceed 1,000 watts in the antenna.

Modulation—The system must be so arranged as to cause the generated radio frequency current to vary accurately according to the sound impressed upon the microphone system.

Spare Parts—Sufficient tubes and other material must be readily available to insure continuity and reliability of the announced schedule of service.

Antenna—The antenna must be so constructed as to prevent swinging.

Signaling System—Some dependable system must be provided for communication between the operating room and the studio.

Studio—The radio equipment in the studio must be limited to that essential for use in the room. The room shall be so arranged as to avoid sound reverberation and to exclude external and unnecessary noises.

Programs—The programs must be carefully supervised and maintained to insure satisfactory service to the public.

Music—Mechanically operated musical instruments may be used only in an emergency and during intermission periods in regular program.

Division of Time—Where two or more stations of Class "B" are licensed in the same city or locality a division of time will be required if necessary.

Licenses issued for the use of the 400 meters wavelength shall specifically provide that any failure to maintain the standards prescribed for such stations may result in the cancellation of the license and requiring the station to use the 360 meters wavelength.

A Fly-Screen for an Aerial

HERE are some practical ideas with which the radio novice may like to experiment; all of them presage the ultimate passing of the expensive and troublesome outdoor aerial that still leads all other types in efficiency:

A standard aerial, while productive of the best results in radio reception, is not always necessary; there are many substitutes. Those radio fans who have no place to install the regulation type may receive by any one of the following means if long distance work is not contemplated.

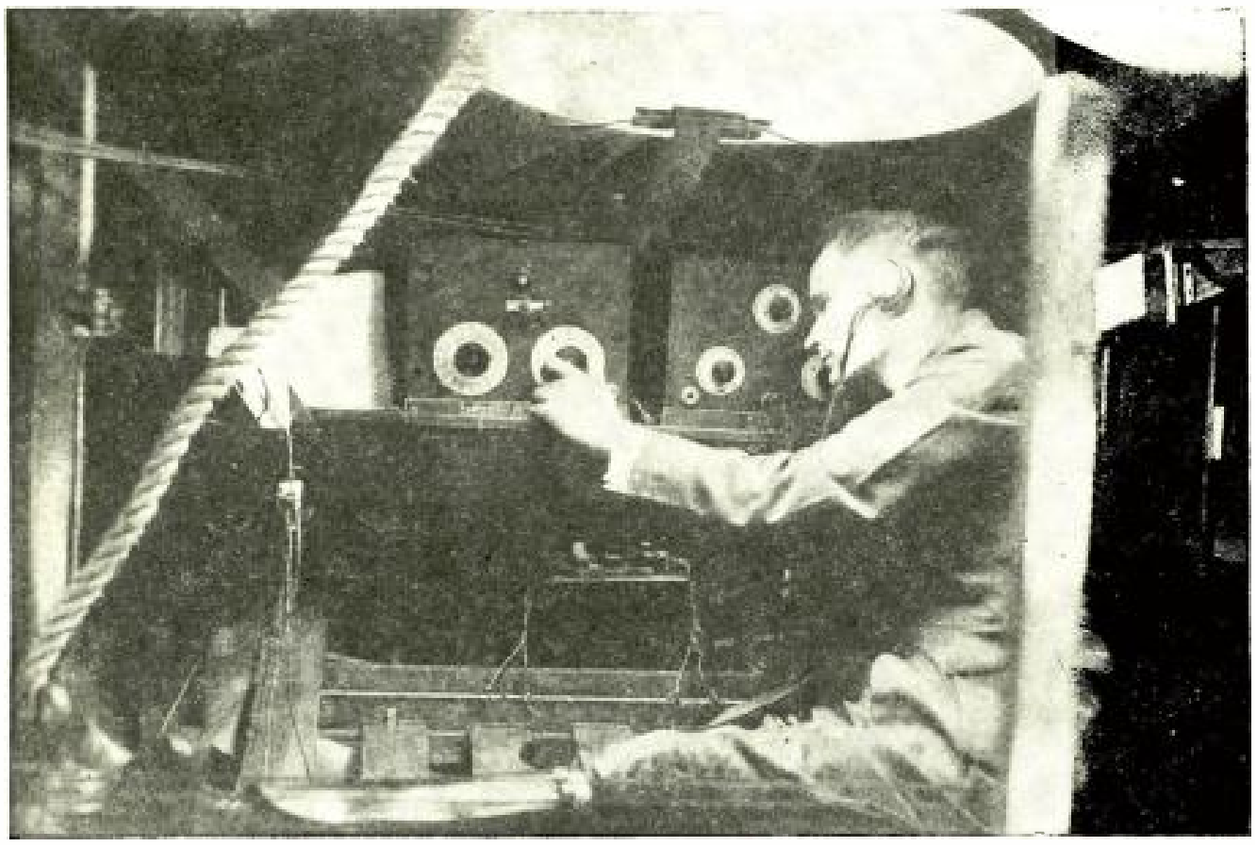
A metal porch screen will often play the part of an aerial. If the screen is in sections, try each section separately; then try connecting two or three or all of them together. I find that the section parallel with the house will receive some stations well, but it will not get others at all;* sometimes the screen at right angles to the house will get signals that the other screens will not; hence it would be well to do a little experimenting.

The wires used in houses equipped with electric bells may also serve as aerials. If you try this it is well to go over the wires and see that they are not grounded; if they are, you are doomed to disappointment. Whenever the wire touches a radiator, gas pipe or water pipe, either take it away or insert a piece of rubber or other insulating material between the wire and the metal. Fairly good signals may ordinarily be obtained this way.

Another makeshift that has sometimes proved useful is the telephone. Merely connect a wire from the aerial terminal of the radio to a metal part of the telephone (not to the telephone wires or binding posts) and then tune in. Excellent results are sometimes produced by this method, if the telephone wires are brought to the house from an outside pole—but underground wires do not always work as well.

LEROY WHITMAN

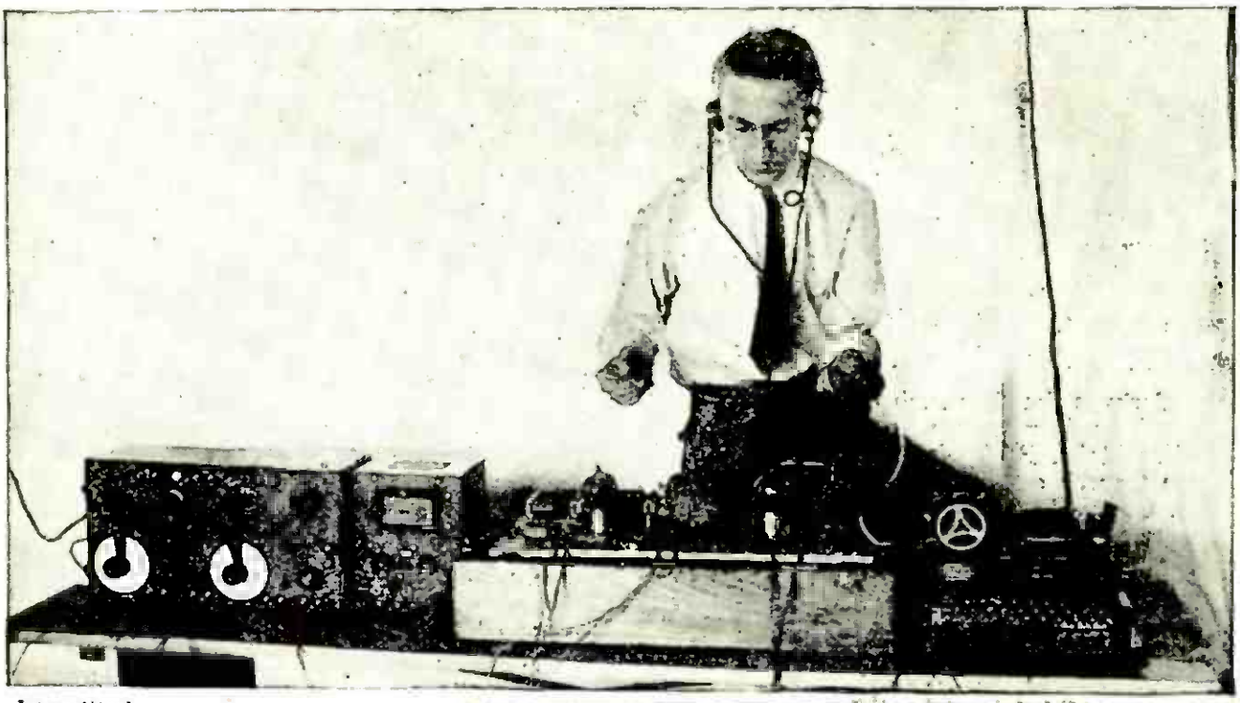
**This is due to the directional effects of the vertical screens.*



Radio Corporation of America

A LISTENING-IN POST AMONG THE CLOUDS

How modern science is slowly but surely reducing time and space was aptly illustrated by the inter-continental flight of the seaplane "Sampaio Correia," which left New York August 16th for its eventful effort to reach Brazil. It was equipped with a radio receiving set with a range of 500 miles, which enabled Lieut. Walter Hinton, the pilot, to keep in communication with shore stations and vessels—not only for the purpose of receiving weather reports, but even for purposes of entertainment. It was entirely possible for the adventurers in the sky to hear the New York Philharmonic concert the evening they set forth!



International

A Ghostly Hand on the Keyboard

ONE of the chief difficulties in communicating by radio between airplanes in flight, or between land stations and airplanes in flight, has been to overcome the great noise of the engines sufficiently to enable the operators to hear the signals. Recent experiments at the Anacostia Naval Air Station, near Washington, D. C., would indicate that this problem is being solved at last by the "teletype"—a typewriting machine that is operated from a distance by radio. The instrument employed is the type familiar in commercial work; it consists of sending and receiving parts. The sending instrument (which may be mounted in a standard type of Navy plane) resembles in general the commercial typewriter that is equipped with keyboard letters and other conventional symbols operated by hand. Each key is connected with the radio installation of the transmitting set; when a letter is struck on the keyboard a radio impulse is sent out from the antenna of the plane and is recorded in the similar key at the receiving instrument. The transmitter is shown at the top of this page, and the teletype—which types the radio message before the pilot's eyes—is shown in the smaller cut.

Official photograph, U. S. Navy

THE TELETYPE ON AN AIRPLANE

In order to insure the proper transmission of radio messages to naval planes in flight, successful experiments have been made in typing the signals, thus overcoming the difficulties of receiving the messages by ear.

Married by Radio

EVER since the attempt to broadcast the marriage ceremony of Princess Mary, daughter of King George, in Westminster Abbey, when even the radio fans of the United States had hopes of listening-in on this more or less historic event, various (and more successful) efforts have been made to let the eavesdropping world attend weddings. For instance:

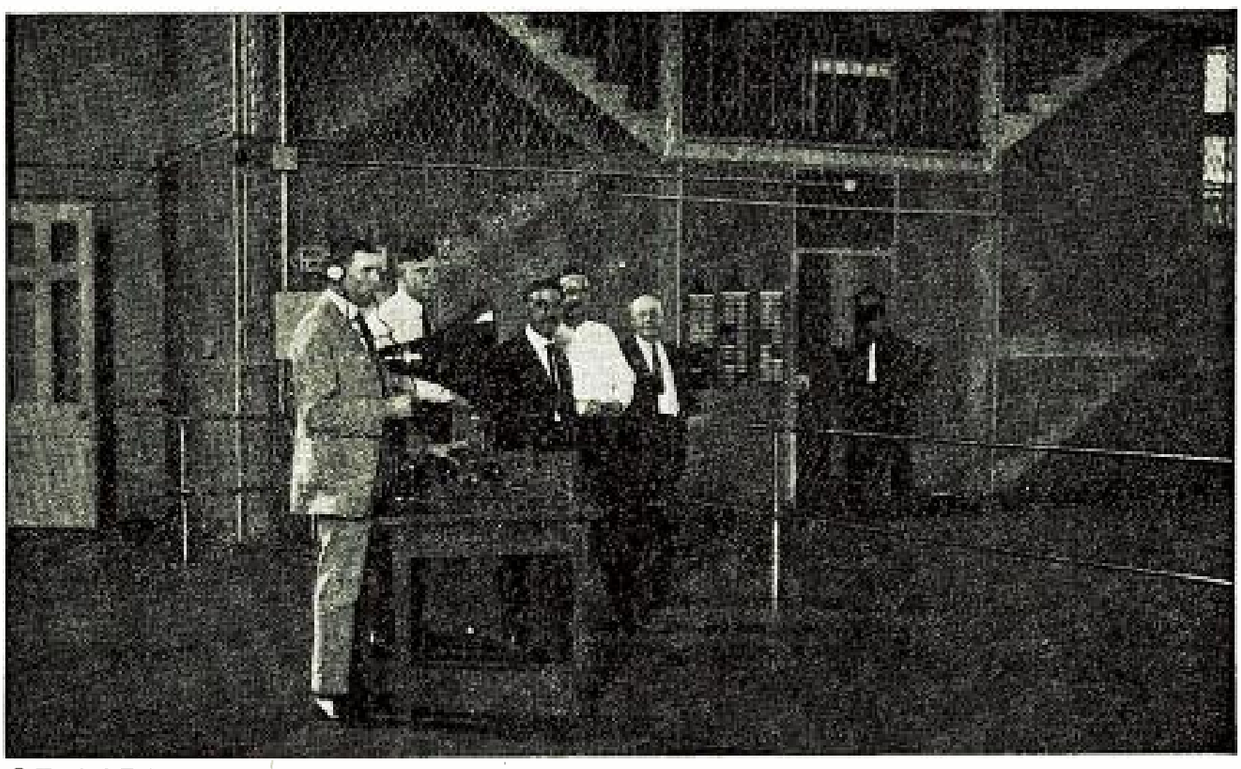
> Perhaps the first such ceremony ever successfully broadcast was that which united Miss Helen B. Cook to John H. Collier in the Church of the Covenant at Washington, D. C., on September the sixth. Listeners-in were given plenty of time to tune in sharply, for the ceremony was announced long in advance, and the wedding march was played as an overture. From an advantageous position the words of the minister, the Rev. John C. Palmer, as well as the troths of the couple, were caught by the acousticon.
>
> Sermons which have been broadcast from this church in the past have been received as far as Alabama; it is reasonable to believe, therefore, that the privacy of the ceremony was "invaded" by many receiving fans.
>
> LEROY WHITMAN

* * *

One Concert Heard in 43 States

THE rapidly extending influence of radio is dramatically demonstrated in this news item from San Francisco:

> In an effort to determine how great is the range of station KSD, a program of music by exceptional talent was given Sept. 12th between 11 P. M. and 1:27 A. M. A flood of telegrams which followed gave complete proof that the broadcasting test was heard in every one of the forty-eight states in the Union. So far as can be ascertained, no other broadcasting station in the United States has ever been heard, in a single night, over so vast a territory.



© Harris & Ewing

RADIO IS PUT IN JAIL AT LAST!

To be apprehended by means of radio and then to be entertained by it in jail is the ironical outlook for lawbreakers in Washington, D. C. The inmates there may stretch themselves out on their prison cots and listen to the stirring strains of the United States Navy Band, the daily police reports on stolen automobiles, and perhaps they may even speculate on the ease with which the radio waves penetrate the stone walls of their prison. A loop aerial is used to catch the waves for the receiving set. After using ear phones to tune in, the operator switches the programs on to a loud-speaker placed in the rotunda of the jail; by this means the inmates in the distant cells hear the entertainment plainly. Often, however, Captain W. L. Peak allows the three hundred and twenty men to leave their cells and come down to the auditorium.

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.*

A Real Prince Springs a Surprise Party

ONLY a few of the radio fans today will recall the following episode—and those few may well be called the "Old Timers" of radio:

Long before the advent of the present popular radio telephone, back in the days when the only radio amateurs were the chaps who mastered the International Morse code, and little dreamed of ever being able to hear anything over the radio waves except the dots and dashes that spelled out the messages letter by letter, a mysterious steam yacht glided slowly one night into New York harbor, up past the skyscrapers of Manhattan to an anchorage up in the Hudson River opposite Riverside Drive, where she dropped anchor and hoisted her riding light.

No shore-going party left her side in the little gasoline tender. Her distinguished owner had business aboard that night; he had a little surprise to spring upon America—a surprise which no one but a man of much wealth could afford to spring. It had taken time and money and plenty of genius and imagination to prepare this surprise party.

I was listening in myself that night. Soon I and my fellow amateurs were listening to something I had never before heard—music by radio telegraph!

First came the "Star-Spangled Banner"; then "Yankee Doodle," followed by the "Blue Danube Waltz" and other selections. The word spread like wild-fire. Station called station and passed the word, "Listen in for the music on 550 meters." Ships at sea heard it, stations up and down the coast and the amateur stations back inland were getting it. Whence came the music and how was it played?

It was not until twenty-four hours later, when the press announced the arrival of the Prince of Monaco on his yacht the *Hirondel* and told of his marvelous new "wireless invention," that anyone knew.

The visitor was none other than the Prince himself. He had voyaged all the way to America from his palace on the shores of the Mediterranean for the express purpose of springing his surprise on America.

How did he do it? It was a clever arrangement. Anyone who has ever listened in to the radio stations transmitting messages by the spark system will recall that each station has its characteristic note, the musical pitch of which is governed by the adjustment of the apparatus in use. The Prince had arranged his radio transmitter with a set of piano keys so that each individual key, when depressed, would transmit a spark signal at a certain adjustment for pitch; by properly adjusting the device for frequency and pitch he had produced a complete musical scale, and it was then only necessary for him to play the instrument just as one plays a piano. For variety, he would pause now and then on one particular note, and by depressing and releasing that key at intervals he transmitted a few words of jest in code, after which he would continue the air he had started to play.

When the Prince up-anchored and sailed away he did so with the satisfaction of having accomplished his mission.

E. JAY QUINBY.

My Apparatus Fails at a Critical Moment

HERE is a real case of "take it or leave it." It comes from a radio operator on a vessel whose captain literally had to decide whether to rescue the crew of a

burning freighter, or to let George do it:

Six days out from Bishop's Rock, bound for Norfolk, and fighting a nor'wester, I picked up an SOS from a British freighter. It was late in the afternoon and I had been working a few ships that day, principally exchanging position reports, so I knew that we were the closest one to him. As it generally happens, my circuit breaker kicked out when I tried to start the motor generator and another ship, four hundred miles away, answered ahead of me.

We were just one hundred miles off the Britisher, and I got the other operator who answered the call to stand by. The freighter was afire in three hatches and burning rapidly; the water from the fire hose was entering the radio shack and putting the apparatus out of commission occasionally, so communication was poor and, to add to the difficulties, I had a hard time keeping the rest of the ships in the vicinity quiet. Finally conditions improved and I learned that there was no immediate danger; the freighter wanted a ship to come alongside and stand by until the fire was put out, or take the crew off if such action became necessary.

Our captain informed the Britisher that we could take the crew off as soon as we arrived, but could not stand by, for we were running short of fuel, and could not afford to lose much time. The Britisher then told us to proceed on our course, and the ship that answered the distress call first went to his assistance and stood by for two days before the fire was under control.

JOSEPH H. O'CONNOR

I Become a Radio Expert in a Week

ONE of the engaging features of radio —the one feature, indeed, that is most responsible for its universal appeal —is the fact that for a few dollars anyone can enter the new world of the ether. Radio is not for the exclusive few. And just to prove how simple and inexpensive it is for even an inexperienced novice to make a set at home, the "Boss" of one of the important newspapers of this country told one of his staff, a young woman just out of college, to build one and tell what happened. This is her story—as told in a personal letter to the Editor:

The Boss came to me and asked:
"Know anything about radio?"
"No."
"Know anything about how to handle tools?"
"No."
"Well then go ahead and make a radio receiving set."

Just like that!

It developed that the big idea was that the Boss wanted to prove that a simple but first-class radio receiving set could be built by anybody regardless of his or her knowledge of radio or mechanics in general. Evidently he sized me up up as the dumbest individual in that line in the office, so I was elected to be the goat. I was to build a working set and then write a series of articles telling in absolute detail how to do the thing.

We will draw a veil over what followed, as the story-books say. Suffice it to say that the set was built. And what is more, it worked. Not only that but it worked well, very well—doggone well, I should say in the language of my gang. Nobody was more surprised than I, when following a week's work, after I had managed to do everything at least one wrong way before getting it right, after I had covered myself with mahogany varnish and copper stain, after I had pounded my fingers and wound myself up in coils of wire, and after I had gone dizzy figuring out positions, I set the thing up, tuned in—and a perfectly good concert came pouring in over the phones!

Then I wrote twelve columns of "How," and told my prospective readers just how to bore a hole, put in a screw, and especially how *not* to do the things I did. The staff photographer came out, took some pictures that looked as if I was doing something with the set, and then we started the series of articles in the paper.

Then came along the radio show. And since my paper had made so much of its radio column (being the first paper to have one, and all that), we decided to have a booth. Among other attractions were to be Nancy and the set, both on exhibition. Nancy was to be there for the purpose of answering questions and proving that she and the set were both practical actualities. So we got out several thousand pamphlets that contained reprints of the first few chapters in the series and advising: "Read the rest in the—."

The crowds apparently liked the booth and apparently they liked Nancy. There was just one single set on the counter—not a lot of technical apparatus. As I found that most people knew even less about radio than I, the demonstrations registered strong.

It was good fun the first forty-eight hours. After that I could say; "It has a radius of 30 miles;" "Yes, it could be made for $15," in my sleep.

But the set and I went over with a bang, so after all, it didn't make much difference that I hadn't the courage to look an aerial in the face for a month after.

NANCY

¶ *So many inquiries have been received concerning the instruction in radio work that is being offered by the State Militia—instruction for which the student is paid—that* POPULAR RADIO *will shortly publish a sequel to "What the National Guardsman Is Doing with Radio" in the form of an article that will describe what the naval militiaman is doing with it—and he is doing a lot.*

WORKRITE CONCERTOLAS

WORKRITE CONCERTOLA SR.

"THEY SPEAK FOR THEMSELVES"

And they speak in a clear, loud tone because these Loud Speakers have been perfected and tested until they are worthy to be listed with "WorkRite" Products.

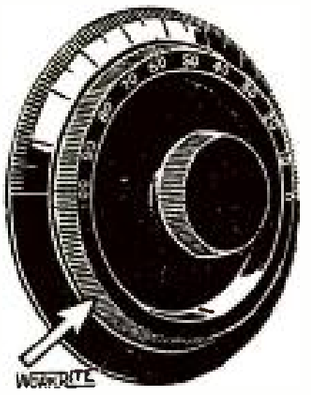
Except for the phone unit, THERE IS NOT THE SLIGHTEST METAL IN EITHER THE WORKRITE CONCERTOLA SENIOR OR JUNIOR. The sound chambers of the Concertolas are made from our specially developed material, which reproduces voice or music without the slightest distortion. IMPORTANT! Our engineers have perfected a special 5,000-ohm concert phone for use in these Concertolas. They are not sold separately. Test the WorkRite Concertolas side by side with ANY other loud speaker on the market—then you can see the superiority of "WorkRite." Cord and phone unit built in each instrument.

WorkRite Concertola Jr. $12.00

WorkRite Concertola Sr. $24.00

WORKRITE CONCERT HEADPHONE

Designed by one of the oldest telephone engineers in the country. Tested and improved until they are up to the "WorkRite" standard of excellence. The sanitary headband is made from strong celluloid—light and easily cleaned. No rough edges to catch in the hair. Extremely sensitive and free from distortion. All we ask is: TRY THEM SIDE BY SIDE WITH ANY ON THE MARKET—regardless of price. **Each (2500 ohms) $8.50**

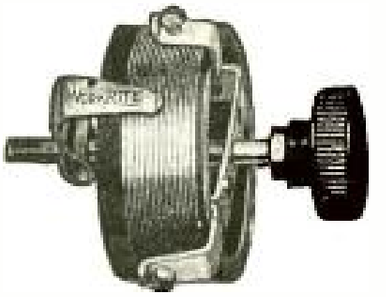


Grasp It On The RIM—

WORKRITE E-Z-TUNE DIAL

When you are tuning in an out-of-town concert and you want to turn the dial of your variometer, variocoupler or condenser the smallest fraction of an inch, where do you grasp the dial? On the rim. That is where the new WorkRite E-Z-Tune Dial has a grip that fits the hand. You can make a turn of a hair's-breadth with this practical dial. Made of the finest material, highly polished and with figures that stand out from the surface, the WorkRrite E-Z-Tune Dial at the price listed is extremely cheap. 3½-inch diameter. 3/16-inch or ¼-inch shaft.....**Price 75c**

50,000 ADJUSTMENTS POSSIBLE WITH THE WORKRITE SUPER VERNIER RHEOSTAT



Entirely new and very much needed. Indispensable on the detector tube when tuning in long-distance concerts or code. Pushing in knob turns off bulb. Quick adjustment anywhere between 6½ ohms and zero. Turn the knob and get 50,000 different adjustments. All metal fittings made from brass and nickeled. Positively Never Gets Hot. The WorkRite Super Vernier Rheostat is really remarkable in its performance and will double the audibility of distant concerts. **Price $1.50**

SEND FOR OUR FREE CATALOGUE

THE WORKRITE MFG. CO., 5532 EUCLID AVENUE CLEVELAND, OHIO

(Branch Office: 2204 MICHIGAN AVE., CHICAGO)

A Real Achievement!

Bel-Canto

The Superlative Loud Speaker

HERE indeed is a *real* achievement—the Bel-Canto Loud Speaker.

The Bel-Canto, both in appearance and performance, is a complete departure from the limitations of the "tin-horn" type of loud speaker. The Bel-Canto is an entirely new instrument constructed on the most advanced principles of acoustic and electrical science.

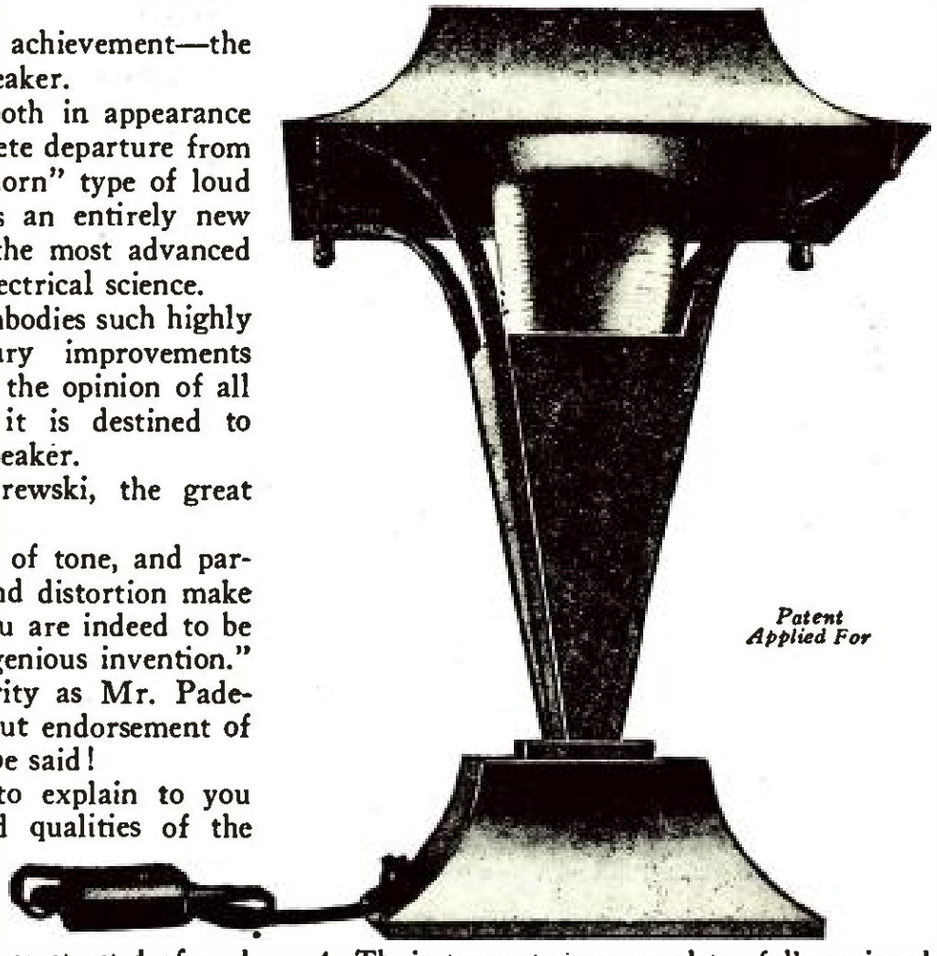
This new loud speaker embodies such highly developed and revolutionary improvements over ordinary types that, in the opinion of all who hear the Bel-Canto, it is destined to become the standard loud speaker.

For instance, Mr. Paderewski, the great musician, says:

"The clarity and volume of tone, and particularly the absence of sound distortion make it a remarkable device. You are indeed to be congratulated upon your ingenious invention."

When so high an authority as Mr. Paderewski makes such a clean-cut endorsement of Bel-Canto, what more can be said!

We are content simply to explain to you the distinctive features and qualities of the Bel-Canto and to rest satisfied with your own stamp of approval.



Patent Applied For

1. The Bel-Canto is sturdily constructed of reed and metal on the most perfect of all acoustic principles—the human vocal organs. The sound is purified in a specially constructed chamber before being conducted from the reed amplifying tube to a metal and air-tight 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.

2. Unlike other loud speakers, the Bel-Canto disperses the sound in all directions—filling the entire room.

3. The Bel-Canto is a thing of beauty, of handsome design and beautifully finished in lacquer.

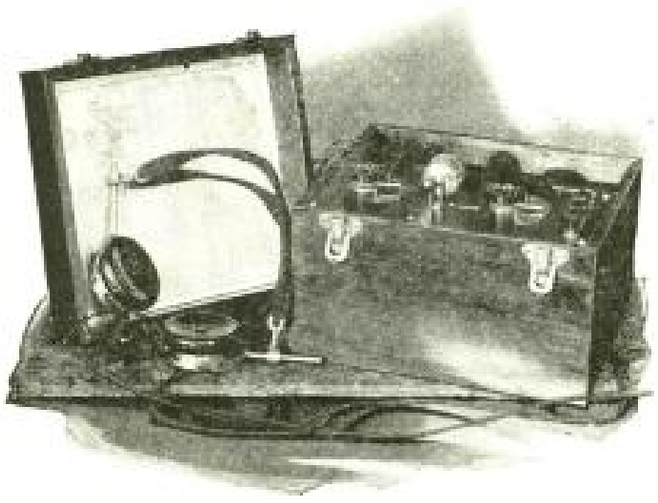
4. The instrument comes complete—fully equipped with a special extra-sensitive loud speaking phone, ample cord and hard rubber plug—all ready to plug into your set. There are no extras to buy and no phones are necessary.

5. 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.

Although dealers are rapidly placing orders for the Bel-Canto, your dealer may not as yet have been supplied. If this is the case, you may order direct from the factory. Send check or money order for $30, and the complete Bel-Canto Loud Speaker will be shipped to you prepaid and fully guaranteed.

Jobbers and Dealers—Write for our proposition

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



Listening Posts of the Nation

THROUGH thousands of De Forest Everyman or Radiohome Receivers the American people are "listening in" on nearby broadcasting stations, adding De Forest honeycomb coils for longer wavelengths, adding De Forest Amplifiers when it is desired to entertain a room-full through loud speakers.

Some rest content with these remarkably efficient and compact but inexpensive sets, others go on to the MR-6 Set, with its greater distance range, or build for themselves, from De Forest parts, sets of greater elaboration. But the thing for you to remember is this: whatever your need—no matter how simply or how deeply you go into radio—De Forest will meet it.

You get from any De Forest apparatus the dependable service which the famous name implies.

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

Like the romance of radio itself

is the story of the phenomenal growth of the company whose name has been linked with radio from the earliest days—Twelve years is a long time in radio—yet over twelve years ago—in 1909, to be exact—William B. Duck began his pioneer work in radio equipment.

Way back in those early days Mr. Duck foresaw with an almost perfect vision the ultimate growth of radio. He was the first and only one to put a "human touch" in a catalog embracing a scientific subject; he realized how largely educational such a catalog must be to accomplish its ultimate purpose —and today, with radio on every tongue, there is in Duck's Wonder Catalog an even larger wealth of practical radio information and diagrams than will be found in any of the earlier editions—*and in language easy for the layman to understand.* It is little wonder that Duck's catalog is universally known as "The Radio Amateur's Bible."

DUCK RADIO APPARATUS

embraces 62 instruments—58 parts—the largest and most comprehensive line produced by any radio manufacturer. They should be had at all worthwhile retail stores throughout the United States and Canada. In selecting your radio equipment at your dealer's, insist on seeing Duck's products—products that have stood the test of time.

DUCK'S
Big 256-Page
CATALOG

as well as all former editions is now, as in the past, all radio catalogs in one. No other even half so large. It displays not only Duck goods but the products of practically all worthwhile manufacturers and contains more up-to-date and practical radio information than will be found in many text books. Send 25c in coin for this wonderful book—a retainer that hardly pays the cost of printing.

DEALERS

We offer facilities and advantages not equalled by any other radio house. Write or wire for our proposition.

The WILLIAM B. DUCK CO.
227-229 Superior St., Toledo, Ohio
Established 1909

Radio brings it MAGNAVOX tells it

TO make your receiving set really complete, equip it with a Magnavox Radio—the Reproducer Supreme.

The electrodynamic principle involved in its construction, makes the Magnavox Radio a most efficient converter of electrical energy into sound waves.

With either type Magnavox Radio the hook-up is as simple as connecting the ordinary head receivers.

R-2—Magnavox Radio with 18-inch horn, for those who wish the utmost in amplifying power: for large audiences, dance halls, etc.

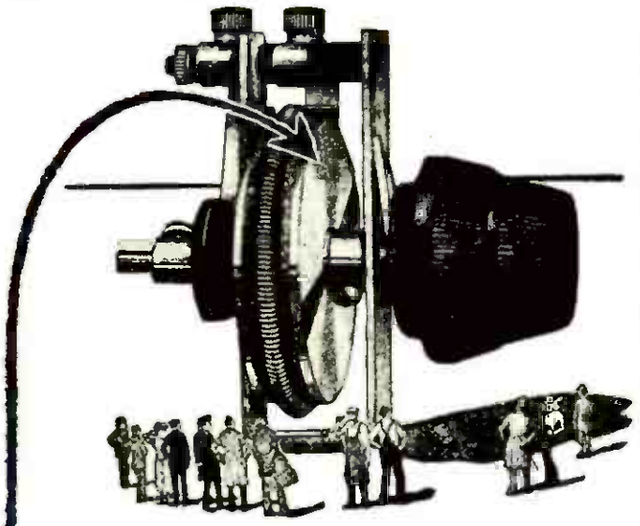
R-3—Magnavox Radio with 14-inch horn, ideal for homes, amateur stations, offices, etc.

Model C—Magnavox Power Amplifier insures largest possible power input for Magnavox Radio.

Any radio dealer will demonstrate the Magnavox for you.

The Magnavox Co.
Oakland, California
N. Y. Office: 370 Seventh Ave.

MAGNAVOX RADIO
The Reproducer Supreme



The Mark of the Master Builder

On every C-H radio rheostat is engraved a guarantee of satisfaction. The familiar C-H trademark, known by engineers the world over as unfailing assurance of electrical and mechanical perfection, today protects the buyer of radio equipment. In these times of uncertainty when so much apparatus offered for sale is the result of hasty development, with insufficient engineering and manufacturing experience, this trademark has even increased value to the purchaser.

Cutler-Hammer, pioneers and largest builders of rheostatic control apparatus, mark with pride these radio rheostats, their latest development.

C-H Vacuum Tube Rheostats for Amplifier and Detector Tube Control

C-H Vacuum Tube Rheostats are made in two styles. Type 11601-H1 is arranged with vernier for detector tube control. This vernier makes it possible to decrease or increase the resistance inserted by infinitesimal amounts for exceedingly great accuracy. One complete revolution of the vernier knob changes the resistance in the circuit by less than .05 ohms. When it is considered that the knob may be turned only a fraction of one degree, it is easily understood what fine control is possible. For amplifier tube control where such great accuracy is not essential, type 11601-H2 is furnished without the vernier feature. Both types are finished in highly polished nickel and are pointer indicating. Cone shaped knobs of genuine Thermoplax are furnished as standard equipment. The rheostats are packed in unit boxes with full instructions and template for easy mounting.

Type 11601-H1, with Vernier $1.50
Type 11601-H2 without Vernier $1.00

For sale at all radio dealers and supply houses. Samples are available direct from factory at list price plus ten cents for carriage.

THE CUTLER-HAMMER MFG. CO.
Milwaukee, Wisconsin

C-H **FILAMENT CONTROL**

HOMCHARGE *Your* RADIO BATTERY *for* A NICKEL

No muss, trouble, dirt—no moving of batteries—loss of time—no technical or professional knowledge needed. May be used right in your living room.

THE RADIO HOMCHARGER DE LUXE

charges your "A" or "B" battery over night and is the only rectifier on the market combining the following essential HOMCHARGING features:

1—Simplicity itself—attach to any lamp socket and connect battery.

2—Self-polarizing. Battery may be connected either way and will always charge.

3—Fully automatic in operation—gives taper charge—cannot overcharge or injure your battery.

4—Safe. All parts entirely enclosed. No danger from fire. APPROVED BY UNDERWRITERS EVERYWHERE.

5—Constructed of the best material—genuine Bakelite Panel, Jewell Ammeter, closed Core Silicon Steel Transformer. No castings used, only the best stampings throughout. UNQUALIFIEDLY GUARANTEED.

6—No delicate bulbs to break or burn out. Only one moving and two wearing parts, replaceable as a unit, at small cost.

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 mahogany and gold. Equipped with rubber feet, it cannot mar polished surfaces. It harmonizes with the finest living room.

Furnished complete. No extras to buy. Price, $18.50 at all good dealers, or shipped prepaid upon receipt of purchase price.

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

DEALERS—JOBBERS: Over 150,000 HOMCHARGERS will be sold this fall and winter. Send for "HOMCHARGER Business Builders" and Discounts and see how you can get your share of this business.

The Automatic Electrical Devices Company

132 West Third St. - CINCINNATI, O.

Largest Manufacturers of Vibrating Rectifiers in the World

One-Three-Five Years from Now?

TIME and use are the great laboratory tests for radio telephone receiver quality. What will *your* head-set be worth after months and years of use? Will the steel still retain its magnetism? Will the assembly still exhibit that accuracy so necessary to the critical needs of radio? Will the tone and volume still have those finer qualities that they possessed in their newness and youth?

Will YOUR head-set be in service one year from now?
Three years from now? Five years from now?

-here's what one user has to say of- "Red-Heads"

The Newman-Stern Company
Cleveland, Ohio

Dear Sirs:

I have a pair of your "Red-Head" receivers purchased about three years ago.

I have carried them with me over 20,000 miles! in suitcase or sea-bag whenever they were not on the table or thrown into the drawer.

They have been dropped on steel decks during rough weather; thrust on the table with a bang when the static was exceptionally annoying.

In fact, they have come through the hardest kind of hard service. They are scratched and nicked all over, but I am happy to say they are still on the job, and as clear-toned as ever.

Yours very truly,

Ralph

RED-HEADS

A Triumph in Radio Receiver Design

-NOW $6.50

THE goodness and efficiency of "Red Head" Receivers is not a matter of accident. They were designed by skilled radio engineers who understood what was needed to make the right kind of radio 'phones —the kind that would *stay* right. In the seven years that they have been on the market, "Red Heads" have come into use the world over.

At the new low price of $6.50, they are unquestionably the biggest value on the market today in 3000-ohm, aluminum back receivers.

You take *no risk* when you buy "Red-Heads." We guarantee them *absolutely*. Your money back if you are not satisfied.

At your dealer's or sent direct on receipt of price.

The Newman-Stern Co

Newman-Stern Bldg., CLEVELAND, OHIO

Producers of "Red Head" radio receivers, "NAA" Arlington Tested Detector Crystals and the Teagle line of *better* radio apparatus. Send for descriptive bulletins.

DEALERS: The Newman-Stern Co. is a pioneer radio organization. The radio instruments we put out have gained a wide reputation. It will pay you well to write for our dealer proposition.

THE NEWMAN-STERN CO.
CLEVELAND, OHIO

Gentlemen:—Enclosed is Money Order for $6.50 for which please send me a pair of "Red Head" Receivers. It is understood that if I am not completely satisfied with these 'phones, I may return them within seven days and get my money back.

Name _____

Post Office Address _____

The name of my dealer is _____

Choke off that "squawk"

AFTER all it is not always the bad vaudeville actors that "get the hook." Many owners have found an efficient hook to choke off the "squawk" of their radio sets and secure enjoyable music, by adding Acme *Audio* Frequency Amplifying Transformers to the ordinary detector unit. Acme Transformers cost but five dollars, yet the results are almost marvelous. Not only do they amplify sound, but they bring it naturally—realistically. They are necessary to the proper operation of the Acme Clear Speaker which enables a whole roomful of people to enjoy the broadcasting concerts.

In order to get more than one broadcasting station and thereby pick out the concert you like best, you should also add an Acme *Radio* Frequency Transformer. This greatly increases the range of your set whether it be vacuum tube or crystal detector type. This wonderful little transformer sells for the same price as its twin brother, the Acme *Audio* Frequency Amplifying Transformer. Your set is not complete without both these transformers and the Acme Clear Speaker.

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

The Acme Apparatus Company (pioneer transformer and radio engineers and manufacturers) also make detector units, the Acmefone, Acme C. W. and Spark Transmitters, etc. Write for interesting Transformer booklet if your own radio or electrical dealer cannot supply you.

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

ACME

for amplification

At Last! The Perfect Radio Loud Speaker *for the Home*

THERE is no other Loud Speaker like the DICTOGRAPH—made expressly for home use by the makers of world-famous Dictograph products—standard everywhere for the finest, most accurate and most sensitive sound-transmission and loud-speaking devices. No other organization in existence has the facilities, the skill, the experience of the Dictograph Products Corporation for producing a perfect Loud Speaker.

DICTOGRAPH
RADIO LOUD SPEAKER

Years of experience in producing the marvelously sensitive "Acousticon" for the Deaf, the Detective Dictograph and the Dictograph System of Loud Speaking Telephones have made possible this wonderful Radio Loud Speaker that reproduces every sound—singing, speaking, instrumental music—in crystal-clear, natural tones, full volume, and FREE FROM DISTORTION AND NOISE.

The Dictograph Radio Loud Speaker gives perfect results with any vacuum tube receiving set. No alterations; no extra batteries—you simply plug in and listen. The handsome appearance of this quality instrument harmonizes with any home. And the price is *only $20 complete with 5 ft. flexible cord.*

Ask for a FREE DEMONSTRATION of the Dictograph Radio Loud Speaker at any reliable radio shop. Get DICTOGRAPH quality and still save money.

Price
$20

Complete with 5 ft. flexible cord.

A beautiful instrument! Finely constructed, richly finished. Its handsome appearance harmonizes with any home. Highly burnished, French lacquered, eleven-inch spun copper bell horn attached to die cast black enamel tone arm, finished with nickel trimmings.

Cabinet 6 x 5 inches base, 4 inches high, of solid, ebony-finished hardwood, mounted upon rubber knobs. Furnished complete with 5 ft. flexible cord. No extra batteries required.

DICTOGRAPH *Radio* HEAD SET

The Best Head Set at any price

The Dictograph Radio Head Set has established a standard of quality impossible to secure in any other Head Set. Its use on any receiving set, crystal detector or vacuum tube, improves reception immeasurably.

3000 ohms resistance. Price $12—the best Head Set in the world at any price. Regularly furnished as Standard Equipment with the Leading Receiving Sets made.

DEALERS: Order through your jobber or write for names of authorized distributors

DICTOGRAPH PRODUCTS CORPORATION

Branches in all principal cities

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

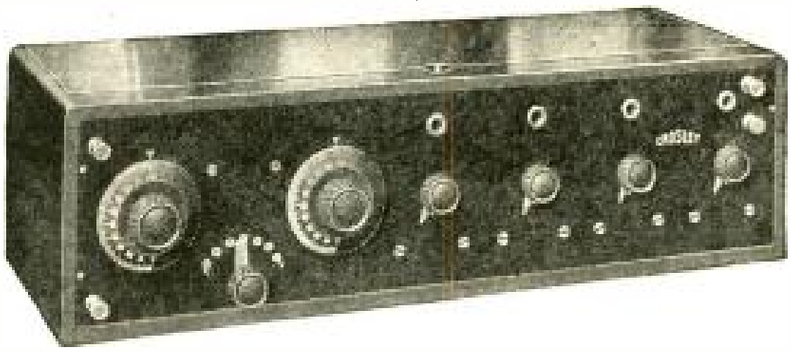
CROSLEY

Better—Costs Less

CAN NOT BE DUPLICATED AT ANY PRICE

For Results the CROSLEY MODEL X Leads the Field

ONLY $55.00



A four-tube set that is a wonder. In placing this receiver upon the market, we are offering you a unit whose range, volume and selectivity is remarkable. Nothing can be compared with it at double the price. Developed in the Crosley Laboratories, this unit combines tuner, one stage of tuned radio frequency amplification, audion detector and two stages of audio frequency amplification.

As shown, without tubes, batteries or phones, mahogany finished cabinet $55.00

CROSLEY RECEIVER MODEL X is equivalent to CROSLEY RECEIVER MODEL XI and CROSLEY TWO-STAGE AUDIO FREQUENCY AMPLIFIER. See Catalog.

CROSLEY RECEIVER MODEL VI. Same as above, but two tubes instead of four. Price.....$30.00

Two Other CROSLEY MODELS of Great Merit

CROSLEY HARKO SENIOR MODEL V. This instrument is a combination tuner and audion detector recommended for receiving broadcasting stations up to fifty miles. Under favorable conditions, ships and stations on the Atlantic Coast are easily copied in Cincinnati. Minnesota hears Newark. Denver hears Schenectady and other distant points are brought in, except under adverse conditions. Mahogany-finished cabinet. Price, without tubes, batteries or phones, $20.00. CROSLEY HARKO SENIOR MODEL V is equivalent to CROSLEY CRYSTAL RECEIVER MODEL I and CROSLEY AUDION DETECTOR UNIT. See catalog.

CROSLEY RADIO FREQUENCY TUNED AMPLIFIER. This unit can be used with practically any type of audion detector outfit. It is a feature of all of our larger units. Being of our own design, we are proud of it. The R. F. T. A. not only amplifies the signals before they reach the detector, enabling it to work more efficiently, but also makes sharper tuning possible and eliminates interference to a wonderful degree. Will add at least six times the volume and range. Price, without tube, $15.00.

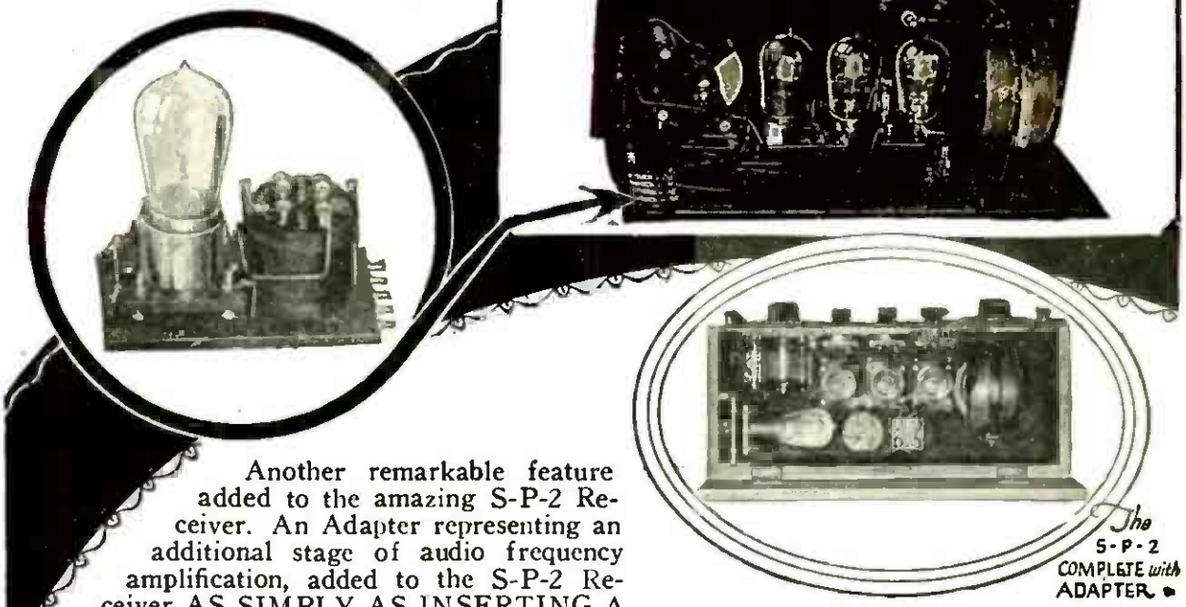
Handled by Dealers and Jobbers everywhere. If your dealer does not handle CROSLEY Instruments write us direct

SEND FOR CATALOG

CROSLEY MANUFACTURING CO.

Dept. PR3 **CINCINNATI, OHIO**

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.

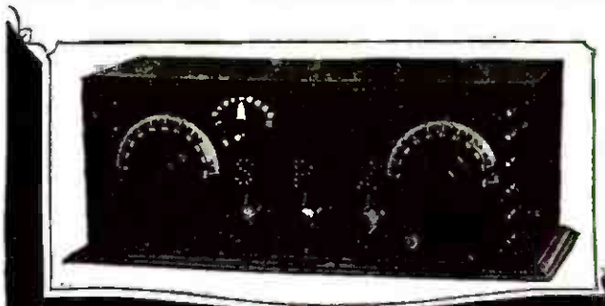
The S-P-2 RECEIVER, now in vast production and under the severe test of hundreds of dealers everywhere, has thoroughly established its claim of ACTUAL SUPERIORITY as against any regenerative receiver now offered costing $125 to $180, based on actual comparisons. THE LIST PRICE OF THE S-P-2 IS BUT $85,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

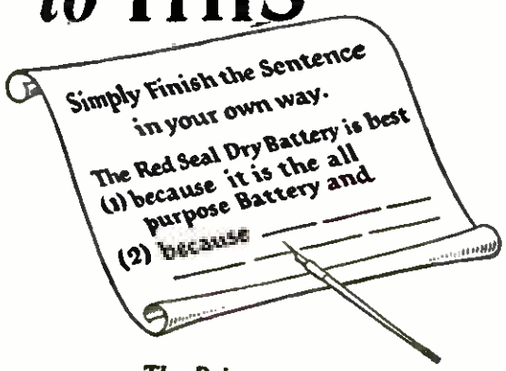
PITTSBURGH RADIO SUPPLY HOUSE

963 *Liberty Ave. Pittsburgh, Pa.*

BELL TELEPHONE GRANT 3632

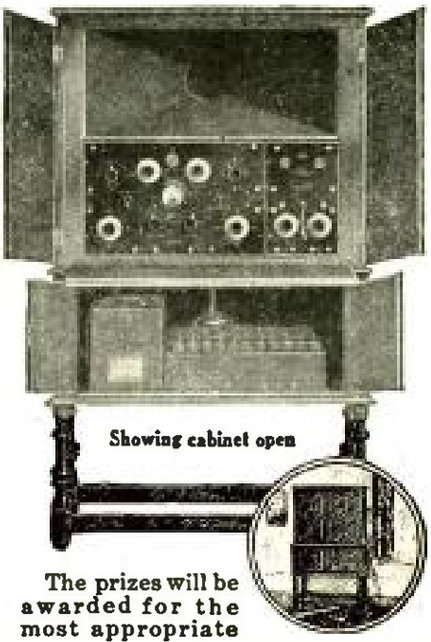
Starts Nov. 1st Red Seal Battery Contest Closes Nov. 15th

For the Best Answer to THIS-



You Win THIS $725.00 Complete Radio Set-Free

Hears broadcasted concerts 400 to 600 miles away; receives wireless telegraph from Europe, South America, from ships on the high seas, etc.



The Prizes

It is appropriate that the Manhattan Electrical Supply Company should be the first to offer such Radio Sets as these. This company was one of the pioneers in selling radio, as well as being the manufacturer of Red Seal Dry Batteries used so successfully in connection with radio sets.

First Prize—$725.00 Complete Kennedy Radio Set

This Cabinet Type complete Radio Receiving Set is one of the finest and most up-to-date receiving sets yet produced. The cabinet is walnut and stands 58 inches high. Range from 400 to 600 miles for wireless telephone and 2,000 to 3,000 miles for wireless telegraph. Contained within the cabinet are all batteries, "Radio Homcharger de Luxe" battery charger and Magnavox loud speaker with special horn. Installed free, in the home of the winner.

Second Prize—$408.50 Complete Westinghouse Radio Set

It consists of the Westinghouse R. C. Receiving Set and Western Electric Loud Speaker, "Tungar" Battery Charger, Storage Battery, "B" Batteries, Set of Manhattan 3,000 ohm Headphones, 3 vacuum tubes, 2 telephone plugs and complete antenna equipment. Installed free in the home of the winner.

Third Prize—$256.50 Complete Grebe Radio Set

A complete receiving outfit made up of the well known Grebe C. R.—9 Regenerative Receiver with Two Stage Amplifier, Magnavox Loud Speaker, Storage Battery, "Radio Homcharger de Luxe" battery charger "B" Batteries, set of Manhattan 2,000 ohm Headphones, 3 vacuum tubes, 2 telephone plugs and complete antenna equipment. Installed free in the home of the winner.

50 Other Prizes

To each of 50 other contestants whose answers are meritorious will be given one of the famous Manhattan 2,000 ohm Radio Headsets. These headsets have great sensitiveness and high amplifying qualities.

How to Enter the Contest

Simply follow the instructions on the Contest Blanks given away by stores all over the U. S. A. Nov. 1 to Nov. 15. You will recognize these stores by the Red Seal Window Display pictured below.

Look for this Window Display in Dealers' Windows Nov. 1 to Nov. 15, It identifies Dealers who will give you free Contest Entry Blanks.

The prizes will be awarded for the most appropriate answers completing *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.....

Important:—Only those answers written on the official Contest Blanks will be considered. Mail as many answers as you like to: Red Seal Battery Contest, Manhattan Electrical Supply Co., Inc., 17 Park Place, New York City.

The Judges

The winners will be selected by the following Judges: 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.

Announcement of Winners

The names of the winners will be published in the ***Saturday Evening Post*** as soon as possible after the contest closes.

In case two or more persons submit winning answers, prizes identical in character with those offered will be given to each successful contestant.

Important to Dealers

Duplicates of these 53 prizes are to be given to dealers having the BEST CONTEST WINDOWS. Write us at once for full information and free window display material if you haven't already done so.

MANHATTAN

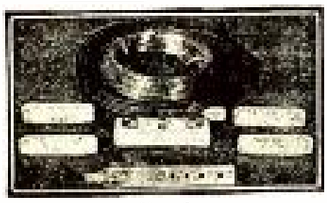
ELECTRICAL SUPPLY CO., INC. NEW YORK

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

BRILLIANTONE RADIO PRODUCTS

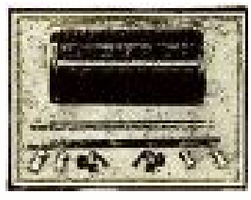
Dept. C—874 Columbus Avenue, New York

$1.00 Brings these Combinations quickly to you



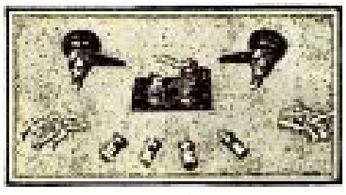
No. 1

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



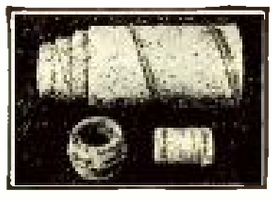
No. 2

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



No. 3

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



No. 4

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

1 Spool No. 24 cotton covered wire, 375 feet.

1 Hardwood Rotor.

All the above merchandise guaranteed or money refunded.

A FEW OF OUR SPECIALS

B. R. P. PRODUCTS

B.R.P. Rheostats, fibre base (Fada Type)	$ .50
B.R.P. Rheostats, porcelain base (De Forest Type)	.75
B.R.P. Potentiometer (200 ohms)	1.00
B.R.P. Moulded Sockets (unbreakable)	1.00
B.R.P. Audio Frequency Transformers (11 to 1)	4.00
B.R.P. Radio Frequency Transformers (150 to 500 M.)	3.00
B.R.P. Variometer (to 800 meters)	3.00
B.R.P. Variocouplers (Panel and Laboratory Type in one)	3.50

B. R. P. Variable Condensers Guaranteed Capacity Tested by the Rubican Laboratories, Phila., Pa.

TYPE "A"—MOULDED ENDS

3 Plate, capacity .00005	$1.50
7 Plate, capacity .0001	2.00
11 Plate, capacity .0003	2.50
23 Plate, capacity .0005	3.00
43 Plate, capacity .001	3.50

TYPE "B"—ALUMINUM ENDS

3 Plate, capacity .00005	$1.00
7 Plate, capacity .0001	1.25
11 Plate, capacity .0003	1.50
23 Plate, capacity .0005	1.75
43 Plate, capacity .001	2.25

STANDARD MERCHANDISE AT REDUCED PRICES

$4.50 Thordarson Amp. Transformers (Audio)	$3.00
$5.00 Acme Amplifying Transformers (Audio)	3.75
$4.25 Jefferson Amp. Transformers (Audio)	3.50
$7.00 UV712 Audio Frequency Transformers (Radio Corp.)	6.00
$6.50 UV1714 Radio Frequency Transformer (Radio Corp.)	5.50
ZETA Radio Frequency Transformer	3.50

HEAD SETS

Single Head Phone with Cord (1500 ohms)	$2.00
Double Head Set, complete (3000 ohms)	4.00
Radio Receptor (2200 ohms)	4.00
Murdock (3000 ohms)	5.00
Federal (2200 ohms)	6.50
Dr. Seibt's (3000 ohms)	9.50
Klosner Vernier Rheostat	1.00
Bradleystat (Best Vernier)	1.65
Jacks, single, open or closed (Firth)	.35
Jacks, double, closed (Firth)	.50
Plugs, bulldog grip (Firth)	1.00
.002 and .005 Mica-Bakelite Condensers	.25
.0005 and .00025 Condensers with Var. Leak	.25
.0005 and .001 Fixed Mica-Bakelite Condensers	.20
Two-Slider Tuning Coil (mounted)	1.50
Excell Radio Variocoupler	1.50

NOTICE: All the above items are F. O. B. New York. Send Money Order with Name and Address written plainly and your order will be shipped immediately P. P. Collect

BRILLIANTONE RADIO PRODUCTS, Dept. C, 874 Columbus Avenue, New York

Is Your Receiver Heard 500 Yards Away?

Here are choke coils and resistances for use in the Armstrong Super-Regenerative Circuit that produce real results. Note the quotation from this letter:

I am in receipt of the choke coils and resistances for use in the Armstrong Super-Regenerative which were shipped by you on August 11th. Am pleased to state that I tried out this circuit last evening, using a 30" loop and the reception from WWJ, WJZ, KDKA, WSB and several other broadcasting stations was remarkably strong; in fact, entirely too strong for head phones. Using 90 volts on the regenerator and oscillator tubes and a total of 135 volts on the amplifier tube, and with a Western Electric loud speaker the musical programs could be heard a distance of 500 yards.

Yours very truly,
(Signed) W. C. HUTCHISON,
Windrock Coal & Coke Co., Windrock, Tenn.

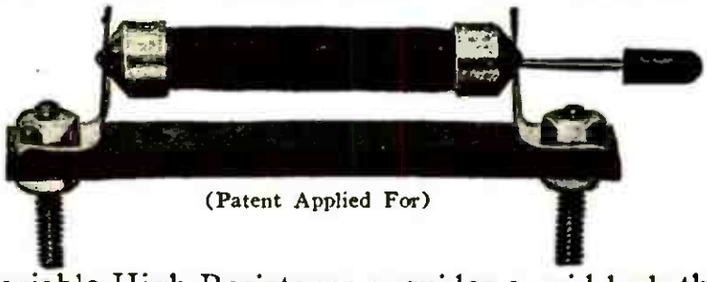
These choke coils are the correct value for use in the filter circuit of Armstrong's famous receiver.

Other Parts for the Armstrong circuit. Prices:

5 Millihenri Coils	$2.50
100 Millihenri Coils	3.00
12,000 Ohm Resistance, Wire Wound and Non-Inductive	3.00
1,250 Turn D.L. Coils	3.00
1,500 Turn D.L. Coils	3.30
.0025 Micon Condensers	.50
.005 Micon Condensers	.75
Variocouplers—Especially Wound	7.00

SOMETHING NEW IN GRID LEAKS!

THE DURHAM VARIABLE HIGH RESISTANCE



(Patent Applied For)

The Durham Variable High Resistance provides a grid leak that is adjustable over a wide range and will maintain its value permanently after an initial setting. It is non-inductive and has negligible capacity.
It is made in two sizes as follows:—

No. 100—1,000 to 100,000 ohm range.
No. 101—100,000 to 5,000,000 ohm range.

These resistances are made to fit any standard grid leak base. The Durham base can be furnished if desired.

Retail Prices: Variable High Resistance without base, **75c**; base, **40c**. Attractive discounts to dealers and jobbers and immediate shipment. For further details and other uses write:

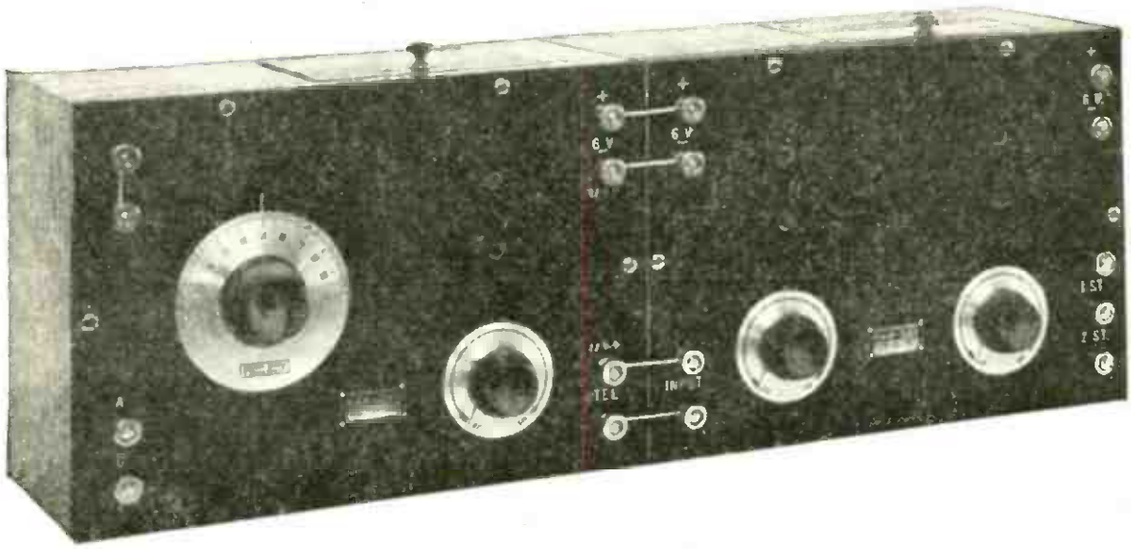
DURHAM & COMPANY

RADIO ENGINEERS

1936 MARKET STREET **PHILADELPHIA, PA.**

A Radio Achievement

of Low Cost and High Efficiency



Type D
Tuner-Detector

$20.00 list

Type E
2 Stage Amplifier

$25.00 list

With the Man-Day combination receiver, Newark, Pittsburgh, Schenectady, and Detroit are heard consistently at Lynbrook, L. I. At Cincinnati, the Man-Day picks up Newark, St. Louis, Columbia, Missouri, Louisville, Ky., and many nearby stations. At Kansas City the Man-Day receives Denver, Atlanta, Sioux City, and points in Canada.

The set can be loaded up to 20,000 meters. The receiver, Type D, can be used alone and the two-step amplifier, if desired, may be purchased at any subsequent time. This increases the range and strength of signals.

Five day return privileges in the event that our outfits do not come up to every claim we make.

We offer opportunities for additional dealers and jobbers.

MAN-DAY RADIO CORP'N

135 *West 33rd St., New York City*

BRANCH: Lynbrook, Long Island

ALL THIS RADIO EQUIPMENT IS *FREE* TO YOU

We will give you a valuable vacuum tube, a mica grid condenser or any of the other articles mentioned below, if you will find time to tell some of your friends about POPULAR RADIO.

Take an hour or two off and look up a few radio "fans." There are lots of them everywhere and each one is a live subscription prospect to POPULAR RADIO. Now show them your own copy. Tell them it is only $1.50 for a whole year ($.25 postage extra for Canada and $.50 for foreign countries). Get their subscriptions. Then send us your order and make your selection from this equipment.

FILAMENT CONTROL RHEOSTAT

The filament rheostat is used for controlling the brilliancy of the vacuum tube so that the utmost efficiency may be obtained from the receiving set. In a store it would cost about $1.00.

If you send only two (2) yearly subscriptions you may have one free.

VACUUM TUBE SOCKET

A vacuum tube socket of this sort is, of course, necessary in all receiving sets that employ vacuum tubes. If you had to buy one, it would cost you more than a dollar.

Send only two (2) yearly subscriptions at the regular $1.50 rate.

MICA GRID CONDENSER

Or do you want a phone condenser? You may have either. The use of mica for the dielectric of the condensers in the grid and 'phone circuits makes a thoroughly efficient device that is needed in almost all receiving circuits.

Send only two (2) yearly subscriptions for either the mica grid or the phone condenser.

TWO INDUCTANCE COILS

Inductances for use in the new Armstrong super-regenerative circuit. These consist of two Duo-Lateral or Honey-Comb coils, Nos. L-1250 and L-1500.

To receive these two coils send eight (8) yearly subscriptions.

VACUUM TUBE U-V-201

The vacuum tube UV-201 can be used in a receiving set for rectifying or amplifying. It is more efficient than the crystal detector. A tube like this retails for $6.50.

As soon as you send ten (10) yearly subscriptions at $1.50 you will receive one promptly.

***Please Note:** Tell us which of the equipment mentioned above you want us to give you. You may have several articles, if you have the necessary number of subscription credits. Also keep in mind full remittances must accompany each order. This offer expires January 1, 1923.*

POPULAR RADIO, Inc.

9 East 40th Street New York City

How do you buy Your Radio Batteries?

DO YOU SAY to a jeweller, "I want a watch!"—or do you ask for a specific watch that does well what watches must do *well?*

And so with batteries for radio.

Most of the noises attributed to static and other causes are *battery* noises. They are caused by irregular current discharge—"fluctuating" voltage.

Have you ever noticed how electric lights *flicker* in some localities—enough to make reading impossible?

Just so, ordinary batteries send out *fluctuating* currents, which make *hearing flicker!*

Radiobats "A" and "B" give absolutely *steady* voltage. They eliminate "interference" because they never produce it. They cut out "static" because *they* don't produce sounds *like* static.

George Gaynor Hyde, one of the foremost consulting engineers in Radio reports, " . . . . . total absence of any noises such as are common to the usual type of "B" batteries. In fact when the antenna wire was removed from the set, it was almost impossible to tell whether the remaining apparatus was working or not."

With Radiobats "A" and "B" one adjustment lasts *all* evening; screeches and screams become splendid harmony; hisses become the most enjoyable music; grating, rasping gasps become clear, melodious human voices.

Send for our intensely instructive booklet—free—and send us the name and address of your dealer, so that he may give you the finest radio demonstration you have ever heard. Send for it now.

MULTIPLE STORAGE BATTERY CORPORATION
350 Madison Avenue, New York

"A" and "B" RADIOBATS
The Permanent Radio Power-UNIT

Teleradio

Products Give Satisfaction

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 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.

TUBE SOCKET

A well-constructed, durable socket. Shell made of drawn aluminum. Hygrade insulated base. Legs not current carrying. Contacts made of phosphor bronze. All parts nickel-plated.

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.

OTHER TELERADIO PRODUCTS

Teleradio Rheostats for vacuum tubes. **$1.00** each. Fixed Phone and Grid Condensers. **$.35** each. Grid Leak Condensers, **$.50** each. Variable Condensers 11, 23 and 43 Plate and 3 Plate Vernier Condensers, **$2.50, $3.00, $4.00** and **$1.50** respectively.

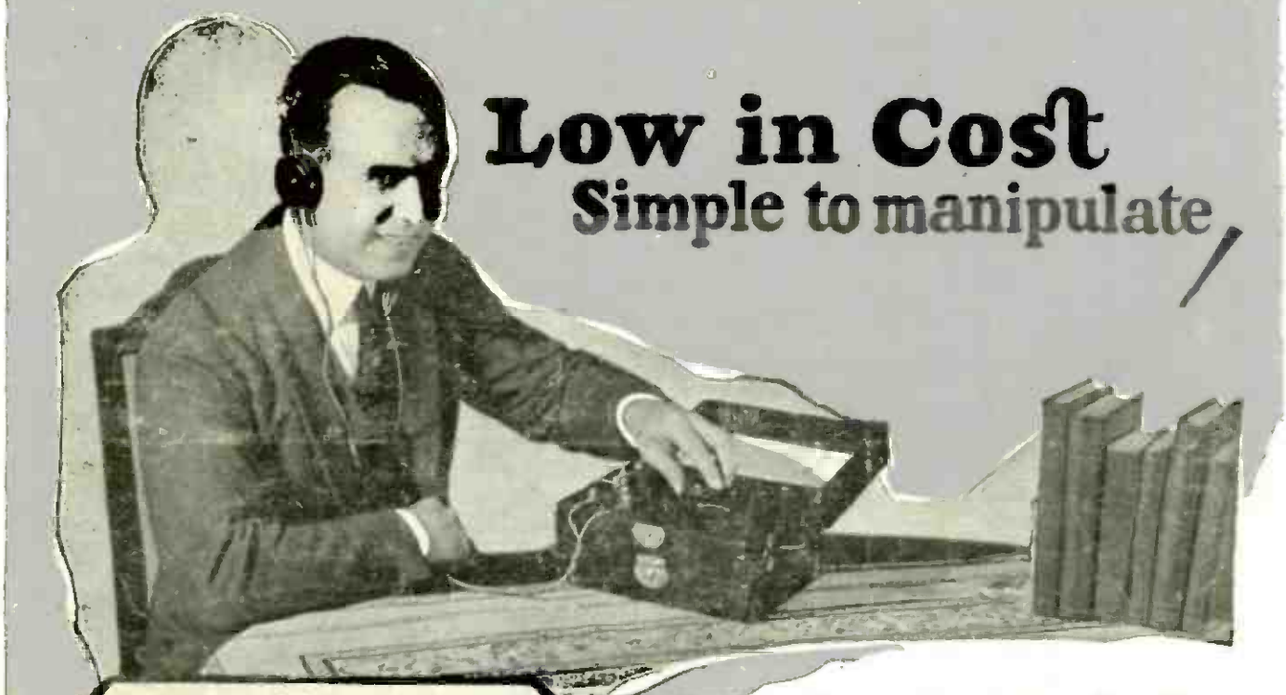
In case your dealer has not yet stocked Teleradio Quality Products, order direct. Please mention your dealer's name and we will see that he is promptly supplied.

TELERADIO ENGINEERING CORPORATION

484-490 BROOME STREET, NEW YORK

CHARLES FRANCIS PRESS, NEW YORK

Low in Cost
Simple to manipulate



Opened like a book

Carried like a satchel

THE radio enthusiast who lives within ten to twenty miles of a broadcasting station has exactly what he wants in Radiola I (ER 753-A) —low cost, compactness, portability, and simplicity of manipulation.

Open the walnut cabinet, and on the front panel you find the tuning control, the crystal detector and the binding posts. In the body of the cabinet are the head-telephones. Tuck away the telephones, close the front panel and you can carry the whole set as you would a satchel.

Radiola I at your dealer, $25.00

The Book that Brings Radio Into the Home

For 35 cents you can obtain from your dealer or from us a copy of the book "Radio Enters the Home." It explains the principles, the fascination of radio in plain English. It describes Radiolas and their accessories. It contains the most valuable wiring diagrams ever published.

RCA

This symbol of quality is your protection

Radio Corporation of America

WORLD WIDE WIRELESS

Sales Department, Suite 2067
233 Broadway
New York, N. Y.

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