MAY 1913 PRICE 5 CENTS

# THE ELECTRICAL EXPERIMENTER

"THE EXPERIMENTER'S MAGAZINE"

# THE ELECTRICAL EXPERIMENTER

VOL. I. MAY, 1913 NUMBER 1

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# A Treatise on Wireless Telegraphy

By H. Gernsback.

PART ONE.

ON December 13, 1912, the new wireless law went into effect. The average wireless "fiend," who has not followed the topic from the start will be interested in the following facts:

The very first talk about Wireless Legislation in the country started in 1908. The writer in his Editorial in the November, 1908 issue of *Modern Electrics* pointed out that a wireless law was sure to be passed in a very short while. In order to guard against unfair legislation as far as the wireless amateur was concerned the writer, in January, 1909, organized the "Wireless Association of America." This was done to bring all wireless amateurs together and to protest against unfair laws. Previous to this time there was no wireless club or association in the country. In January, 1913, there were over 230 clubs in existence, all of which owe their origin to the "Wireless Association of America."

The association had no sooner become a national body than the first wireless bill made its appearance. It was the famous Roberts Bill, put up by the since defunct wireless "trust." The writer single handedly, fought this bill, tooth and nail. He had representatives in Washington, and was the direct cause of having some 8,000 wireless amateurs send protesting letters and telegrams to their congressmen in Washington. The writer's Editorial which inspired the thousands of amateurs, appeared in the January, 1910, issue of *Modern Electrics. It was the only Editorial during this time that fought the Roberts Bill.* No other electrical periodical seemed to care a whoop whether the amateur should be muzzled or not. If the Roberts Bill had become a law there would be no wireless amateurs today.

That editorial quickly found its way into the press and hundreds of newspapers endorsed the writer's stand. During January, 1910, the *New York American*, the *New York Independent*, the *New York World*, the *New York Times*, the *Boston Transcript*, etc., all lauded and commended the writer's views. (See Editorial article February, 1910, *Modern Electrics*.) Public sentiment quickly turned against the Roberts Bill and it was dropped.

The first wireless bill not antagonistic to the amateur, The Burke Bill, appeared on March 8, 1910. It had some defects, however, and was dropped also.

The Depew Wireless Bill appeared May 6, 1910, but did not meet with general approval; as the writer pointed out in his Editorial in the June, 1910, issue of *Modern Electrics*, it had several undesirable features, and the bill was never seriously considered, although it actually passed the Senate. (See Editorial, August, 1910, *Modern Electrics*.)

At last the Alexander Bill made its appearance on December 11, 1911. This bill as far as the amateur was concerned was not quite acceptable to the writer, who had the amateurs' rights at heart, and steps were immediately taken to bring about an amendment as the writer, perhaps, more than anyone else, realized that this bill, in some form or other would become a law sooner or later. This is clearly stated in his Editorial in the February, 1912, issue of *Modern Electrics. In that Editorial is to be found also the first and now historical recommendation that if a wireless law was to be framed it should restrict the amateur from using a higher power than 1 kw. and his wave length should be kept below 200 metres.* No one else had thought of this before, and it is to be noted that when Congress finally passed the present wireless law, *it accepted the writer's recommendation in full,* thus paying him the greatest compliment. while at the same time acknowledging the fact that he acted as the then *sole* spokesman for and in behalf of the wireless amateur.

In March, 1912, the writer, in a letter to the *New York Times* (See page 24, April, 1912, issue *Modern Electrics*) pointed out the shortcomings of the Alexander Bill, and protested against unfair legislation. *The Times,* as well as a host of other newspapers, took up the cry and published broadcast the shortcomings of the Alexander Bill.

All this agitation had the desired effect and Mr. Alexander for the first time realized that the amateur could not be muzzled, especially when there was such a periodical as *Modern Electrics* to champion his cause. Promptly in April the Alexander Wireless Bill, *amended,* appeared and here for the first time in history the amateur and his rights are introduced in any wireless bill.

Mr. Alexander and his advisers accepted the writer's recommendation as set forth in his Editorial in the February, 1912, issue of *Modern Electrics.* (See Paragraph 15, 2nd Part of this Treatise.)

It will be noted that it copied the writer's recommendation word for word.

The amateur had at last come into his own. This is all the more remarkable as this is the only country that recognizes the wireless amateurs.

On May 7, 1912, the Alexander Bill, amended, now known as S-6412, passed the United States Senate and on May 8th was sent to the House of Representatives and referred to the Committee on the Merchant Marine and Fisheries.

The bill was signed on August 13th by President Taft, thus making it a law.

This terminated the fight which the writer had waged single-handedly for almost five years in behalf of the American amateur.

Now that it is all over, and that Uncle Sam has set his seal of approval upon the amateur's wireless, the writer cannot

*BY presenting our friends with the first number of the "Electrical Experimenter," we believe that we are covering a field in electrical literature which heretofore has been exploited but little.*

*Our sole aim will be to benefit only one class of readers, namely, the electrical experimenters. This journal will not publish general electrical articles, believing that there are several excellent publications in the field already which publish such matter successfully.*

*We invite our readers to contribute articles to this journal and we will pay well for all accepted matter. New experiments, new designs of electrical apparatus, new electrical tricks, etc., will be welcomed; good photographs are especially desirable.*

*We are conceited enough to think that this is the kind of a publication that appeals to you. We furthermore have a strong "hunch" that you will find five cents worth of new, interesting reading matter within its pages. For that reason we decided not to place any subscriptions on the free list, not excluding our best and oldest friends.*

*We confidently believe that when we ask you to send us 50 cents for a one year's subscription, we are asking but little of you. As a matter of fact, it is a very small sum considering that the "Electrical Experimenter" will "keep you going" for a whole year; that it only caters to YOU, and that last but not least, it will always contain 96 per cent. of text matter. This publication, as you may know, accepts no advertisements.*

*If you like the "Electrical Experimenter"—and we have fond hopes that you do—tell your friends about it, and let them ask for a free sample copy.*

*"Boost the 'Electrical Experimenter' and you boost yourself."*

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If you change your address, notify us promptly, in order that copies are not mis-carried or lost.

All communications and contributions to this journal must be addressed to: Editor, "The Electrical Experimenter," 233 Fulton Street, New York. We cannot return unaccepted contributions unless full return postage has been included. ALL accepted contributions are paid for on publication. A special rate is paid for novel experiments; good photographs accompanying them are highly desirable.

but extend his heartiest congratulations to the 400,000 American amateurs; and he furthermore wishes to extend his thanks to all the amateurs who have supported him in his fight to bring about a new wireless era in America.

Long live the Wireless! Long live the Amateur!!

## Wireless and the Layman.

PART TWO.

### Receiving Wireless Messages.

The question we hear from most beginners is:—"What outfit do you advise me to use? I know nothing about wireless."

We advise the use of ANY honestly built receiving outfits. Which one to choose depends upon yourself, your taste and your pocketbook. This is where YOU must decide. Of course the lower priced outfits have naturally a short range—they won't catch messages hundreds of miles away, and those without tuning coils cannot be used to "cut out" one of the messages when two of them are in the "air" at the same time. It is self-evident though, that you can start with the very cheapest outfit,—say an E. I. Co. detector and a pony telephone receiver. With such an outfit messages can be picked up astonishingly well indeed. Many of our enthusiastic young friends started with such an outfit and kept on adding instruments till they finally had up-to-date stations.

The next question hurled at us is:—"How can I receive messages if I don't know the codes?"

A wireless telegram, no matter if it is in Chinese or English, "comes in" in dots and dashes. When you have the telephone receivers to your ear and a message is coming in, you hear a series of long and short, clear, distinct buzzes. A long buzz is a dash, a short buzz is a dot. The E. I. Co. sell a 10c code chart by means of which the dots and dashes are translated into letters. Thus (in the Morse code), dash, dash, dot, stands for the letter G; dash, dash means M, dash, dot, dash, dot means J and so forth. Any person with a few weeks' practice "listening to the wireless" can master the code. and read the messages with ease.

*Remember that there are over two thousand high powered wireless stations in this country alone, each being able to transmit messages of over a thousand miles distance!*

There are almost at any minute, during night and day, messages in the air, no matter where you are,—sending YOU messages, only waiting to be picked up by you. It is truly wonderful; it is the cheapest as well as the most elevating diversion known to modern man, the most inspiring example of the triumph of mind over matter.

"How about the Wireless Law?", you want to know next.

The law does not apply for stations used for *receiving* only. *There is no law which forbids you to receive all the messages you wish.* You can receive as many and as long as you please, —Uncle Sam doesn't mind. But you MUST preserve the secrecy of the message. You must not make use of any information you receive by wireless, if this information is of such a nature that makes it private property. Your own conscience will tell you which message to keep secret and which one you can make use of. Here is the text of the Law:

### Secrecy of Messages.

*"Nineteenth. No person or persons engaged in or having knowledge of the operation of any station or stations, shall divulge or publish the contents of any messages transmitted or received by such station, except to the person or persons to whom the same may be directed, or their authorized agent, or to another station employed to forward such message to its destination, unless legally required to do so by the court of competent jurisdiction or other competent authority. Any person guilty of divulging or publishing any message, except as herein provided, shall, on conviction thereof, be punishable by a fine of not more than two hundred and fifty dollars or imprisonment for a period of not exceeding three months, or both fine and imprisonment in the discretion of the court.*

Of late a great many stations are beginning to use the wireless telephone. This art is rapidly being perfected and is the coming thing in "Wireless." There is hardly a week that you do not read about some new wireless telephone and some new distance record established.

It is of course understood that any receiving apparatus that can receive wireless telegraph messages, 90 times out of 100, can receive wireless telephone messages. Of course, in that case no code is required as the voice comes through the receiver the same as through the regular telephone. (For further details on Wireless Telephony, see "The Wireless Telephone," by H. Gernsback, at 25c; also Lesson No. 18 of The E. I. Co. Wireless Course.)

### Distance.

The question asked mostly by the layman is: "How far can I receive with such and such an outfit, my aerial being so high and so long?"

Nobody can correctly answer such a question. You can reason it out as well as we can. For example: Would you ask us: "How far away can I hear the steam whistle of the X & Y Cotton Mill?" No, you wouldn't, for it all depends. First, how hard the whistle blows, second, how good your hearing is, third, how the wind blows, and fourth, how many and how great are the intervening objects between the whistle and your ear. Some days you may hear the whistle two miles off with the wind blowing your way. Or if you are way down in the cellar you may only hear it faintly, although you are but two blocks away from it. It all depends. The one thing you are sure of is that the whistle blows with about the same strength each day. The same reasoning holds true for wireless to a very great extent.

As a rule, the higher up and the bigger your aerial, the better the wireless reception will be. Naturally if you are a thousand miles off from a station that can but send 500 miles, you won't hear it, no matter how good your instruments are. It's like trying to hear the sound of a whistle 10 miles away from you, that can at the very best be heard only within a radius of 5 miles.

Just use a little horse sense and you can do your own deducting: no wireless expert is required. It is also evident that the messages cannot come in with the maximum loudness unless the instruments are well in tune, and unless well designed instruments are used. Thus a loose coupler will give louder signals than a small tuning coil. It also depends a lot on the detector and its adjustment.

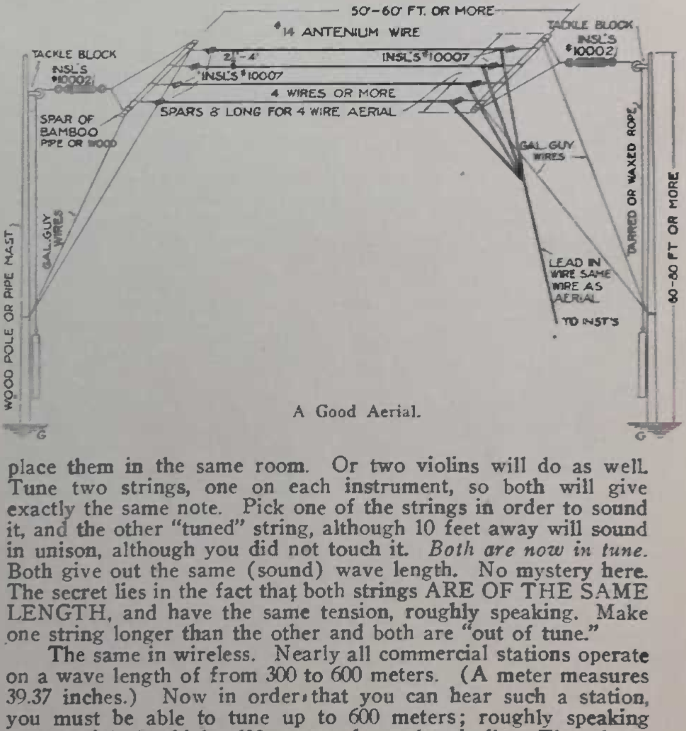
This is the way the detectors range according to their sensitiveness:

1st. The Audion (the most sensitive detector to date); 2nd, The Electrolytic; 3rd, The Peroxide of Lead; 4th, The Perikon; 5th, Zincite and Bornite; 6th, Silicon and Galena; 7th, Iron Pyrites (Ferron); 8th, Carborundum; 9th, Molybdenite. (See Lesson No. 10, of The E. I. Co. Wireless Course, on Detectors.)

If you are entirely surrounded by high mountains or steel buildings, you naturally will not expect to receive messages as well as if you were on the top of a mountain. Also remember that wireless waves travel *twice as far over water as over land,* and that you can reach *twice as far after sundown than during the daytime.*

### Wave Lengths and Tuning.

This seems to be the greatest stumbling block for most beginners. Again let us make a comparison. Take two pianos and




A Good Aerial.

place them in the same room. Or two violins will do as well. Tune two strings, one on each instrument, so both will give exactly the same note. Pick one of the strings in order to sound it, and the other "tuned" string, although 10 feet away will sound in unison, although you did not touch it. *Both are now in tune.* Both give out the same (sound) wave length. No mystery here. The secret lies in the fact that both strings ARE OF THE SAME LENGTH, and have the same tension, roughly speaking. Make one string longer than the other and both are "out of tune."

The same in wireless. Nearly all commercial stations operate on a wave length of from 300 to 600 meters. (A meter measures 39.37 inches.) Now in order that you can hear such a station, you must be able to tune up to 600 meters; roughly speaking your aerial should be 600 meters long electrically. That, however, would be a pretty expensive and cumbersome aerial. Besides it isn't required. We simply wind, roughly speaking, 600 meters of wire on a coil or drum and our aerial can now be quite small, within certain limits of course, and we can for this reason "catch" the station having a 600 meter wave length, providing our other instruments are sensitive enough. Thus, for instance, it will be seen that the E. I. Co. No. 8486 tuning coil, as well as their No. 12002 loose coupler have sufficient wave length capacity to catch 700 meter waves. As they are both provided with adjusting sliders, more or less wire can be put into the circuit, and therefore both these instruments can be used to catch wave lengths from 100 up to 700 meters, but not over this amount.

Therefore, if we should want to hear a station having 1400 meters wave length, we would connect two No. 8486 tuning coils in series, which would give us $700 + 700 = 1400$ meters wave length. Or we would connect one No. 8486 tuner in series with the primary of the No. 12002 loose coupler and we would get the same effective wave length. As a rule only stations doing long distance work use excessive wave lengths, thus the Marconi Transatlantic station at Glace Bay has a wave length of about 7100 meters, while the new Government station at Washington, which sends messages over 3,000 miles, has a wave length of about 4,000 meters. By consulting the *"Wireless Blue Book"* the wave length of all important wireless stations can be found. as each station normally uses a certain prescribed wave length. (See Lessons No. 4, 5, 6, 7, 8, 9, of The E. I. Co. Wireless Course.)

The best all around aerial is about 75 feet long, composed of four strands E. I. Co. "Antenium" wire No. 14, or stranded "Antenium" cable. One of the best forms is shown herewith. We recommend E. I. Co. No. 10007 insulators, although others can be used. For a 75 foot aerial, the strands should be about two to three feet apart. For a 150 foot aerial from three to four feet apart and so on. The strands should never be less than 1½ feet apart even for a very small aerial. All connections should be soldered if possible. Use as many insulators as feasible, remember you have but little energy when receiving; few and poor insulators waste 50 per cent. of the little incoming energy. If you have a good spacious roof it is not necessary to use poles to hold up the aerial. It may be stretched between two chimneys, etc. The spreaders to hold the wire strands apart may be of bamboo, wood, metal pipe, etc. If metal is used, the wire strands should be insulated from the former. (See Lesson No. 11, of The E. I. Co. Wireless Course, on Aerials.)

The ground is quite important. The best wire to use is a No. 12 copper wire run from the instruments to the water or gas pipe using one of the E. I. Co. No. 10003 ground clamps to make an efficient connection. If no water or gas pipe is to be had, bury a metal plate, copper preferred, not less than three feet square, in a good moist ground; a number of these plates connected to the ground wire would be preferable. The heavy ground wire is soldered to the plate, of course. It should be buried at least six feet deep. Another good ground is a six to ten feet long iron pipe rammed into moist earth, the ground wire being connected to it, either soldered, screwed, etc. The ground wire running from ground to instruments should never be less than No. 16 B. & S. copper, and can, of course, be bare. Insulation on a ground wire is just that much waste.

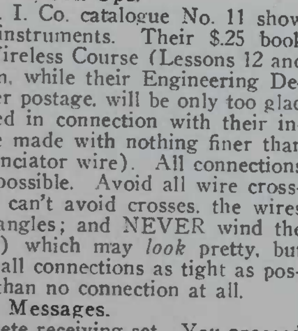
### Connections and Hook-Ups.

The diagrams given in the E. I. Co. catalogue No. 11 show how to connect most of these instruments. Their $.25 book "Wireless Hook-Ups" and their Wireless Course (Lessons 12 and 13), gives hundreds more of them, while their Engineering Department, on receipt of 10c to cover postage, will be only too glad to furnish any hook-up to be used in connection with their instruments. Connections should be made with nothing finer than No. 18 B. & S. copper wire (Annunciator wire). All connections must be as short and straight as possible. Avoid all wire crossings as far as practicable, if you can't avoid crosses, the wires should cross each other at right angles; and NEVER wind the connecting wire in coils ("curls") which may *look* pretty, but kills all wireless messages. Make all connections as tight as possible, a loose connection is worse than no connection at all.

### Reception of Messages.

We presume you have a complete receiving set. You proceed thus:

First, you must know if your detector is adjusted to its greatest sensitiveness. If a message is just coming in, you will have little difficulty to adjust the detector to its best sensitiveness. If no message comes in you don't know if your detector is in its best receptive condition. For this reason, the up-to-date wireless man uses the "Buzzer test." Aside from giving imitation wireless buzzes, the buzzer set may be used *to practice telegraphy*. It consists of three things: 1st—Any buzzers, such as the E. I. Co. No. 954, or better No. 965 or No. 950; 2nd—E. I. Co. No. 1118 key; 3rd—A dry cell. Connections MUST be made as shown. Now every time you press the key you will get a perfect imitation of a wireless signal and it becomes child's play to adjust the detector to its greatest efficiency. The buzzer test can of course be used with ANY detector. It saves lots of time and bother and is quite necessary. Sometimes a detector may have a "dead spot" and you might be "listening in" for hours, without being able to catch as much as one dot. The buzzer test makes such an occurrence impossible.



Only One Wire Goes to Detector

In order that the buzzer itself is not heard directly, it is usually wrapped in absorbent cotton or wadding which muffles its sound effectively, or it may also be placed in another room.

When the detector is adjusted the tuning coil (or loose coupler) is regulated by moving the slider or sliders back and forth till the signals are heard the loudest. If the loose coupler is used the secondary is moved back and forth in addition, till the best position is reached. Now the variable condenser (or condensers) are adjusted if required.

The variable condenser is of the greatest use during excessive "static," which sometimes interferes seriously, during summer weather, especially when "taking" a long distance message. It is also of invaluable help to "cut out" unwanted messages when two or more are "coming in" simultaneously. Thus by adjusting the tuner (or loose coupler) in conjunction with the variable condenser it is often possible to cut out all interference from unwanted stations.

It is an excellent idea to have several detectors in a station, arranged in such a manner that by means of a multi-point switch any one of them can be thrown into the circuit. It will thus be found, that some stations, especially during interference, can be heard better on a certain detector than on another. Some will be found to work best for long distance work, others work best for medium distances, etc., etc. (See also E. I. Co. "Wireless Course," Lessons No. 8 and 9.)

### Sending Messages.

Let us quote the law, as far as the amateur is concerned, before going any further:

### The Wireless Act.

*"Be it enacted by the Senate and House of Representatives of the United States of America, in Congress assembled; That a person, company, or corporation within the jurisdiction of the United States shall not use or operate any apparatus for radio communication* as a means of commercial intercourse among the several States, or with foreign nations, or upon any vessel of the United States engaged in interstate or foreign commerce, or for the transmission of radiograms or signals the effect of which extends beyond the jurisdiction of the State or Territory in which the same are made, or where interference would be caused thereby, with the receipt of messages or signals from beyond the jurisdiction of the said State or Territory, except under and in accordance with a license, revocable for cause, in that behalf granted by the Secretary of Commerce and Labor upon application therefor; but nothing in this Act shall be construed to apply to the transmission and exchange of radiograms or signals between points situated in the same State; Provided, That the effect thereof shall not extend beyond the jurisdiction of the said State or interfere with the reception of radiograms or signals from beyond said jurisdiction."*

### General Restrictions on Private Station.

*"Fifteenth. No private or commercial station not engaged in the transaction of bona fide commercial business by radio communication or in experimentation in connection with the development and manufacture of radio apparatus for commercial purposes shall use a transmitting wave length exceeding two hundred meters or a transformer input exceeding one kilowatt except by special authority of the Secretary of Commerce and Labor contained in the license of the station: Provided, That the owner or operator of a station of the character mentioned in this regulation shall not be liable for a violation of the requirements of the third or fourth regulations to the penalties of one hundred dollars or twenty-five dollars, respectively, provided in this section unless the person maintaining or operating such station shall have been notified in writing that the said transmitter has been found upon tests conducted by the Government, to be so adjusted as to violate the said third and fourth regulations, and opportunity has been given to said owner or operator to adjust said transmitter in conformity with said regulations.*

### Special Restrictions in the Vicinities of Government Stations.

*"Sixteenth. No station of the character mentioned in regulation fifteenth situated within five nautical miles of a naval or military station shall use a transmitting wave length exceeding two hundred meters or a transformer input exceeding one-half kilowatt."*

Let us explain in plain English just what this means: As you notice from the first paragraph, the part which we underlined, it is pointed out to you that the law does not concern you unless you send messages from one state into another. You therefore do not require a license as long as your messages do not reach over the border of your state and if you do not interfere with a station's business (in your state) which receives messages from another state. Of course, you want to know how you can tell what your transmitting range is. We will explain.

It has been proved by experience with spark coils, that in almost all cases a one-inch spark cannot possibly reach over eight miles. From this information the following table has resulted:

### Transmitting Distances of Spark Coils.

| | | |
|---|---|---|
| ¼-in. coil. | Maximum trans. dist., | 2 Miles. |
| ½-in. coil. | Maximum trans. dist., | 4 Miles. |
| 1-in. coil. | Maximum trans. dist., | 8 Miles. |
| 1½-in. coil. | Maximum trans. dist., | 12 Miles. |
| 2-in. coil. | Maximum trans. dist., | 16 Miles. |
| 3-in. coil. | Maximum trans. dist., | 24 Miles. |
| 4-in coil. | Maximum trans. dist., | 32 Miles. |

And so forth.

*(To be concluded in June issue.)*

* Wireless Telegraph or Telephone sending stations included.

# The Quenched Spark Gap

## How to Make It and Use It.

H. Winfield Secor.

A GREAT many wireless experimenters and amateurs are very desirous of using the quenched spark gap, of the type employed by the Telefunken Co.

The quenched spark gap should be the means of increasing the transmitting range and activity of every amateur wireless station, and this is a most important point, now that the wireless act is in effect limiting the transformer input to 1 K.W. of energy.

In general a quenched spark gap causes from 40 to 60 per cent. of the energy delivered by the charging transformer, to be sent out on the antenna, while ordinary spark systems realize but 15 per cent. on the average. Not only this, but this gap gives a pure wave form, which is strictly required by the new Wireless Law, governing experimental stations. As regards the transmitting range with properly designed apparatus, used in connection with the quenched style of gap, it is a matter of record that a 5 K.W. Telefunken set has transmitted fully as good and as far as a 20 K.W. set, employing the usual open type of spark gap. Also the Telefunken spark note carries through static, and interference, in a remarkably clear manner, besides enabling the sharpest tuning to be accomplished with ease.

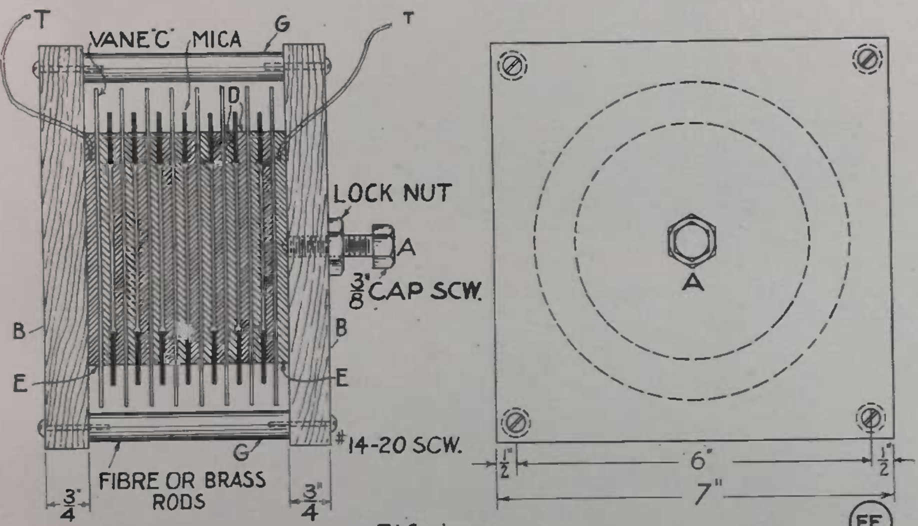



FIG. 1

It should be understood, however, that while the Telefunken sets have done wonderful work, employing the quenched spark gap, the frequency of the primary transformer current was 500 cycles, and more will be said about this matter a little later on.

As regards the voltages used with quenched gaps, the Telefunken Co. allow about 1,200 volts per gap, each gap being .01 inch long, and in small size sets, the transformer delivers about 6,000 volts. Hence, for this potential, 5 gaps in series would be sufficient. For higher voltage transformers, more gaps in series can be employed, or their length may be made a little greater. For the above voltages paraffined paper or mica condensers are usually employed. For higher voltages, regular glass plate or Leyden jar condensers can be used. Quenched spark gaps may be purchased from the Electro Importing Co., their regular size consisting of eight gaps in series, with mica rings and cast brass plates.

This gap may be adapted to various sizes of transformers, by cutting out some of the gaps by short-circuiting some of them.

Many amateurs would probably like to make a quenched gap, and details for constructing one are given here.

This gap and its parts are shown at Figs. 1-6.

It is possible to make up a quenched gap quite simply by combining a series of brass plates, so the groove shown here does not have to be *cut* into the plate; but such methods are at best only a makeshift, and it is very difficult to use thin plates and get their faces properly aligned.

It is recommended that those who can, should employ solid cast or turned plates, resembling the one illustrated at Fig. 3, as this pattern permits of good alignment and also the best cooling of the gap.

For those who cannot avail themselves of the solid gap plate, a very good one can be constructed as depicted at Fig. 2. This plate consists of two gap faces, DD, made of ¼-in. hard brass sheet preferably, and between the two face plates is placed a cooling vane of 1/16 to 1/8-inch hard brass sheeting.

This sheeting is smooth and even stock, and the ¼-inch plates can be scribed out, and then cut from the sheet by drilling a series of small holes around the edge, after which it can be filed up true, or turned in a lathe. The best way would be to cut out all the heavy plates as described; and then place all of them in a lathe between the live chuck or face plate, and a moving tail centre, when they can all be turned down at one time. If they are filed nearly round, they will be good enough for all practical purposes. The vane plates can be cut out of sheet stock by means of tinners' snips, or large scissors.

The voltage relations aforementioned should be borne in mind in building this gap. It is assumed that it is to be used on transformers up to 1 K.W. capacity, and probably 8 to 10 gaps will be sufficient, providing they are long enough. If this number of gaps are to be used on quite high voltage, say 15,000, the mica washer, Fig. 4, should be made more than .01 inch thick, but this is the best thickness and length of gap for good results.* Hence it is best to use more gaps in series, for higher voltage, and keep each gap small.

If the reader is intending to build a transformer, it should deliver a secondary potential similar to the figure named in the first part of this article.

The grooving of the plates can be accomplished quite easily if a lathe is at hand, or any machine shop will do the work reasonably. A jig is shown at Fig. 5, which can be used to cut out the groove in the plates. It does not have to be made very elaborate, and the base and top plate may be of fiber, hard wood, or iron. Through the top bar is drilled a hole, to accommodate a threaded shaft, A, having lock nuts, as shown, enabling it to be gradually lowered or raised, by slacking up the lock nuts. The cutting is accomplished by two steel tools or cutters, C1 and C2, and these are made of tool steel or Stubbs steel rod. They may ground to shape on a fine emery or corundum wheel, and then tempered to a straw color. Two steel set screws hold the cutters in place, in holes drilled through the cross bar, D. This bar is held permanently in place by a steel pin passed through it

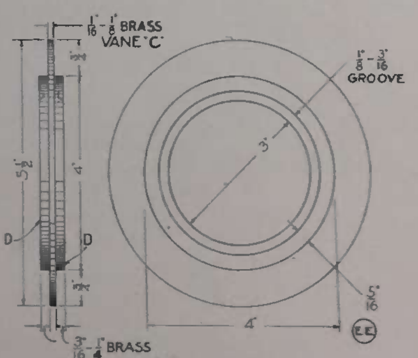



FIG. 2


FIG 3

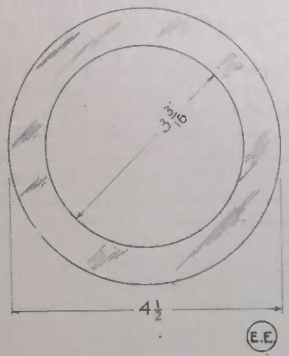
as shown. The top of the shaft, A, is provided with a handle to permit of turning it around. After making a few turns of the shaft and cutters, they are lowered by shifting the lock-nuts, and after tightening them again, a few more turns are

* The Electro Importing Co. furnishes these Mica Rings at 35 cents apiece, calibrated to .01 inch thickness.

given the handles, etc., etc., until the desired depth of groove is obtained. The groove on this metal need not be round, and may be made elliptical, so as to leave as much body as possible to the plate itself. The principal thing to be watched in making a quenched gap, is to have the plates perfectly flat and parallel, also the gaps should be air-tight, otherwise the faces will become blackened.

The assembly of the gap can be similar to the method outlined at Fig. 1. The two end pieces, BB, can be of slate, fibre, or hard rubber. They are held in place by four fibre or metal rods, GG, etc., with the aid of machine screws tapped into them as shown. At the center of the top is placed a large set screw which serves to tighten up the gap, and it is then fastened by the lock-nut.

At either end of the gap plates, are placed ¼-inch or thicker brass plates, the one under the set screw having a coned depression on its upper face, to permit centering the gaps readily.



MICA RING
FIG. 4

Connection to the gap is made by two heavy stranded copper cables, about No. 6 B. & S. gauge at least, embedded in holes drilled in the end plates.

The leads, T, T, should have their ends firmly wedged in the holes with a piece of copper or brass wire, as solder may run out due to the gap heating up.

For short distance work the number of gaps in use should be reduced, by short-circuiting some of the gaps; and simultaneously reducing the voltage applied by control of the transformer primary voltage. A fan is useful in keeping the gap cool.

As mentioned previously, the marvelous efficiency and carrying power of the waves produced by the quenched gap, is not alone due to the gap, but is also a function of the frequency of the transformer current. Thus, 60 or 120 cycle alternating current, is not nearly so good as 500 cycles, which is the primary current frequency employed by the Telefunken

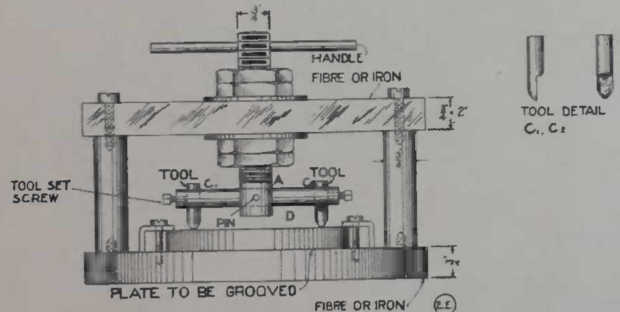


FIG. 5

Co. The amateur can also use 500 cycle A. C. and thereby increase the efficiency and resonance features of his transmitting plant of limited size several hundred per cent. The Electro Importing Co. supply 500 cycle, A. C. wireless Motor-Generators, giving 110 volts, with separately excited (D.C.) fields, at the following prices:

| Watts A. C. Output | Speed R. P. M. | Cost |
|---|---|---|
| 125 | 3333 | $86.00 |
| 250 | 3333 | 110.60 |
| 500 | 2500 | 208.80 |
| 1000 | 1875 | 330.50 |

These prices are without field regulators, or other control apparatus, and includes D.C. motor for 110 volts or 220 volts D.C., of the proper capacity. These motor generators have been specially developed for wireless work, and are finely designed.

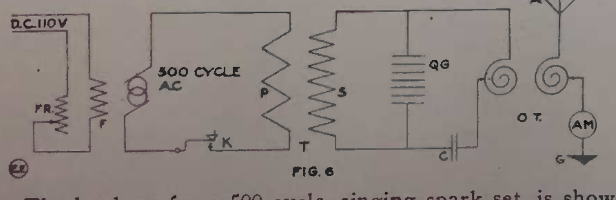


FIG. 6

The hook-up for a 500 cycle, singing spark set, is shown at Fig. 6, where FR is the field rheostat, regulating the potential of the D. C. applied to the A. C. generator field; A. C. are the slip rings of the alternator supplying the transformer primary, through the Key K. The quenched gap is shown at Q. G.; C is a condenser, and O. T. an oscillation transformer; A is the aerial; G the ground, and A. M. the hot wire meter to register the radiated energy in amperes. With 500 cycle A. C. the transformers should be wound for this frequency, and are generally considerably smaller than corresponding sizes of 60 or 125 cycle transformers.

## Wrinkles—Receipts—Formulas—Hints.

By S. Gernsback.

Under this heading we will publish every month useful information in Mechanics, Electricity and Chemistry.

Contributions from our readers are welcome.

### Waterproof Glue.

A very good glue cement resisting the effect of moisture is obtained in the following way. Take:

4 parts of powdered *Glue* (any ordinary glue will do.)
4 parts of black *Resin.*
1 part of red *Ochre.*
Mix together with a very small quantity of water.

### How to Drill Holes in Glass and China.

Take a three cornered file—any old file will do—preferably a broken one. If the file is not broken, take a hammer and break off a piece of same, so as to present a very sharp surface.

Put the other end of the file in one of the E. I. Co., Hand Drills No. 6981 or better No. 6949 and drill the hole, where required.

To cause the drill to bite, the place to be pierced must always be kept moistened with *Turpentine.* Soak the file every few seconds in the turpentine. Don't use too much pressure at the beginning and work very slowly.

### How to Metallize and Electroplate Insects, Flowers, Small Household Goods, Etc.

A nice Rose bud, an uncommon Insect, the first shoes of baby, and hundreds of other things can be conserved indefinitely by Metallizing them. The methods given below, enables any one to do this work very skillfully at a very small outlay.

To begin with, the object to be metallized has to be rendered conductive.

After cleansing it in methylated Alcohol, cover the object thoroughly with plumbago (powdered graphite) and brush it carefully with a soft brush.

This method can only be employed if the object can stand the brushing.

If it is a delicate flower or an insect, the object has to be dipped in the following solution, to render the surface conductive:

In a china vessel heat very slowly ½ ounce of silver nitrate, dissolved in 25 ounces of good alcohol. After dipping the object let it dry in the air and expose afterwards to the fumes of hydrogen sulphide.

(To generate hydrogen sulphide, take a glass bottle with large opening, fit a small glass tube through the cork and put a few cents worth of iron sulphide in the bottle. Now pour some strong muriatic acid over the iron sulphide. Instantly the hydrogen sulphide gas will be formed and escape through the glass tube. In leading this tube under a hood containing the object to be fumed, this operation is easily performed.)

After having rendered the object conductive in any one of these manners, it is hung in the porous cup of the "Electro" Copper Plating Outfit No. 4400 (price, complete, $1.25), and the plating begins at once.

When thoroughly metallized the object is carefully dried and may be lacquered if desired.

An improved aluminum solder, comprises a mixture of approximately 38 per cent. pure tin, 32 per cent. phosphor-tin, and 30 per cent. pure zinc.

### New Wireless Phone.

Professors Chaffee and Pierce of the Harvard School of Applied Science, report that they have invented a cheap and effective method of wireless telephony. They have successfully operated their system between Cambridge and Gloucester, a distance of 35 miles, and will operate longer distances as soon as stations can be established.

Rear Admiral Stanford has completed plans for the construction of the second set of great naval wireless towers, which will be erected on the canal zone. There will be three 600-foot steel towers. It is believed this station should be able to communicate directly or relay with similar high power stations, to be erected by the navy in the Hawaiian Islands, Tutuila, Samoa, Guam and the Philippines.

*This Journal is not for sale on newsstands.*

# Building Large Spark Coils

By H. Gernsback.

THE average experimenter using a large coil, very often desires to know how such coils are built, and those who desire to build their own coils, often have a wrong conception of how they are constructed, for several reasons:

One reason is that by referring to textbooks, insufficient data, especially as far as the secondary coils go, is given, and the writer is almost daily in receipt of letters from individuals

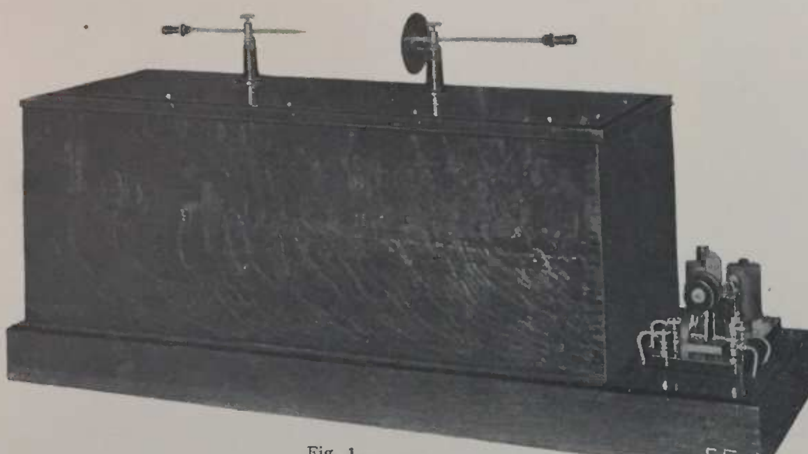


Fig. 1.
Dimensions: 33½" long, 11½" wide, 12⅝" high. Weight 96 pounds.

who have spent fair sized sums of money in the attempt to build a large coil and have given up the work with utter disgust. The writer does not wish to condemn the textbooks for the data which is furnished in such, but rather for important data which they *do not* furnish. While it is comparatively easy to build the primary and other parts of a coil, the stumbling block usually is found in the shape of the secondary, and here the greatest blunders are made.

The most important part of any coil is centered in its secondary. This holds especially true for large coils, once the spark length goes above 3 inches. Very careful and excellent insulation becomes at once an absolute necessity. It is, however, not here that usually the greatest mistakes are made, but rather in the winding or constructing of the secondaries. The writer would strongly advise all private builders of large spark coils *not* to attempt to wind their secondaries themselves unless they have access to automatic

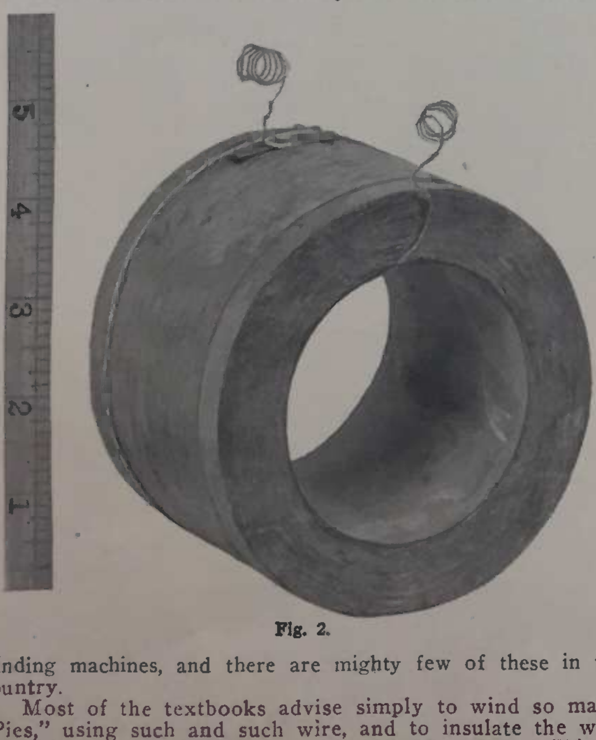


Fig. 2.

winding machines, and there are mighty few of these in the country.

Most of the textbooks advise simply to wind so many "Pies," using such and such wire, and to insulate the wire by letting it run through a molten paraffine bath. This is unsatisfactory for several reasons, the first one being that it is absolutely necessary, if a good coil is desired, that the wire should be wound with the greatest uniformity, that is, the wires themselves shall not cross, but must be wound absolutely straight in order that the different convolutions lie side by side without crossing. Of course it is almost impossible to do this unless a winding machine is used, and if the experimenter attempts to do the work by hand, which, of course, is really not impossible, he will find that it will take a very long time to even wind a small secondary. However, his efforts will be crowned with success, as the coil will be vastly more efficient than if the windings were made by any other method. Not alone this, but the saving of wire is tremendous. By looking over textbooks it will be found that for instance an 8-inch wireless or X-ray spark coil requires from 12 to 14 lbs. of No. 34 enameled wire. The coil described in this article only uses about 7¼ lbs. of No. 34 wire. Consequently it will be seen that not alone a large amount of wire will be saved, but the saving in space and thereby increased efficiency of the machine wound secondary, is remarkable. The secondary of this article, as per illustration herewith, has an outer diameter of 4¼ inches, while the diameter of the hole is 2¾ inches. The width of the coil is 3 inches. Weight of such a completed secondary, including all the paraffined paper and the paraffine impregnation, is only 2½ lbs.*

Heavy leads are brought out from the two ends of the coil to guard against breaking.

The coil illustrated herewith, which gives a fat 8-inch spark has 4 such secondaries, all mounted on a heavy, hard rubber tube, as shown. Between each secondary there is a fibre wall, ½ inch in thickness, that fits the hard rubber tube perfectly. The purpose of these walls is to do away with internal sparking between the secondaries, and they

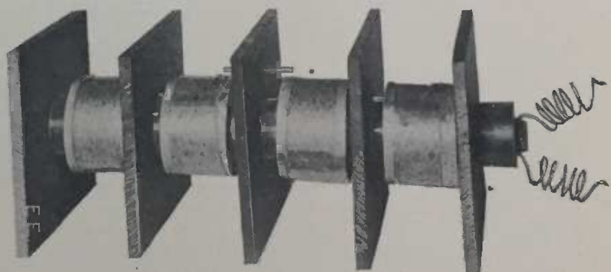


Fig. 3.
Stout Pieces of Glass Tubing Lead the Wires from One Secondary to the Next One.

fulfill their mission admirably. After all the parts are assembled as per Fig. 3, the primary with its primary tube, secondaries and the dividing walls are set in a large oak case, and this is filled with a special insulating compound. After cooling the coil, it is ready for use.†

It has been found that large coils, that is coils above 6 inch spark should not be operated with vibrators that operate from the end of the core. For this reason a special independent vibrator, as shown in Fig. 4, is used. The vibrator is mounted at one end of the coil, as is clearly shown in Fig. 1, and the 8-inch coil, as described herewith, uses from 14 to 20 volts storage battery current, and will operate well on from 4 to 6 amperes. The independent vibrator is really composed of two vibrators in one. The large break interrupts the primary current, while the small break operates the make and break vibrator electro magnets. The large condenser is, of course, bridged across the heavy contacts, and this condenser must be nicely balanced in order to produce the right results. If the condenser capacity be too small, there will be too much sparking on the contact points, and the secondary spark will be reduced.

A condenser that has too large a capacity, while cutting down the contact spark, also decreases the secondary spark. For that reason the right capacity must in all cases be used; and such capacity can really only be found by experimenting and adjusting until the best results are obtained. The vibrator illustrated herewith is the latest model brought out by the E. I. Co., and is very

*The E. I. Co. sells these secondaries complete, as described, for $8.00 each.

†This coil is sold by the E. I. Co. at the price of $88.00 complete.

efficient.* Its platinum contacts are exceedingly large and heavy, and the diameter of these contacts is ¼ inch. The instrument is mounted on a polished hard rubber base ½ inch thick. Large coils, as the foregoing, are naturally worked for long hours at a time, and for this reason it is necessary to have very substantial contact points. Thus, for instance, the platinum used in this vibrator costs some $8.00, which, however, considering the size, is not too much. Using

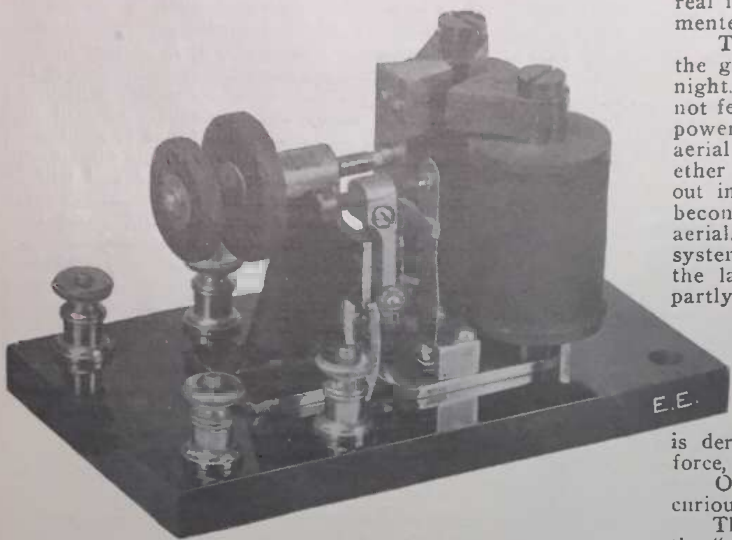



Fig. 4.
Note Large Platinum Points On Main Break.

such a vibrator every dav for two hours, the contact points ought to last from 1½ to 2 years.

### DIELECTRIC STRENGTH OF VARIOUS INSULATING MATERIALS.†

| Material. | Dielectric Strength per 0.001 of an Inch in R.M.S. Volts A.C. |
|---|---|
| AETNA | 35 |
| ASBESTOS | 125 |
| BRISTOL BOARD | 180 |
| CELLULOID | 90 |
| FIBRE (Vulcanized) | 175 |
| LAVA (Talc.) | 125 |
| LAVITE | 200 |
| LEATHEROID | 150 |
| LINSEED OIL (Boiled and impregnated on Bond Paper) | 600 |
| MICA (Pure White) | 3000 |
| MICANITE (Cloth) | 300 |
| (Flexible Cloth) | 190 |
| (Paper) | 420 |
| (Flexible Paper) | 300 |
| MICA (Plate) | 1000 |
| (Flexible Plate) | 700 |
| OILED CAMBRIC | 650 |
| OILED PAPER | 800 |
| PARAFFINED BOND PAPER | 900 |
| PRESSBOARD | 125 |
| PRESSPAHN | 300 |
| SHELLACKED CAMBRIC | 35 |
| VULCANITE | 840 |
| HARD RUBBER | 900 |
| GLASS (Common) | 203 |
| (Head) | 140 |
| (White Alabaster) | 290 |
| (Plate) | 280 |
| PORCELAIN | 1800 |
| HERMSDORF HARD PORCELAIN | 2500 |
| LINSEED OIL | 1200 |
| " (Boiled) | 1600 |
| OLIVE OIL | 1650 |
| SPERM OIL | 1300 |
| "TRANSIL" OIL | 2000 |
| VASELINE OIL | 1500 |

* The E. I. Co. sells this independent vibrator, as described, complete for $26.50.

†See Proceedings Institute Radio Engineers. Vol. I, No. 1.

# Our Cover

By H. Gernsback.

THE idea of our cover was conceived by the writer, with the intention to inspire the electrical experimenter at large. There is nothing fantastic about this cover, nothing impossible. It will all be very real in a comparatively short time. It is up to our experimenters to make it an accomplished fact.

The scene is laid near the coast, in almost any part of the globe. The time, let us say is in the year 2013. It is night. The large aerial system in the foreground radiates, not feeble telegraph impulses, but a tremendous power. This power is furnished by the large "Powerhouse," beneath the aerial system, some 30,000 Kilowatts being radiated into the ether constantly. Naturally, such a tremendous power going out into the air gives rise to peculiar phenomenae. The air becomes luminous for several miles around and above the aerial. An inverted bowl-shape light dome, with the aerial system as its center, is produced, and this light illuminates the landscape for miles around. The lower antenna acts partly as a reflecting aerial which prevents the energy from being absorbed by the earth. It has been found that by using a curious vibratory pulsating wave of a tremendous amplitude, almost no energy is lost in transmission through the ether, and for that reason the etheric power station as illustrated can supply energy within a radius of several hundred miles. The power is derived solely from the tides of the ocean—a tremendous force, which lay unharnessed through aeons.

On top of the "power-house" we see two towers with curious light balls.

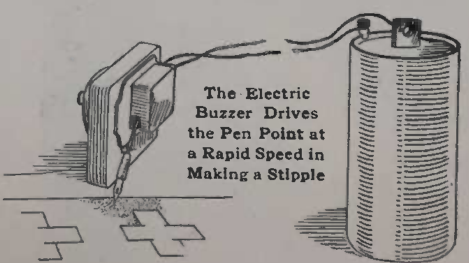
These are the *"radiofers."* You must understand that the "power-house" which shoots forth such a colossal force, can not be frequented by humans. As a matter of fact no human being could come near the house, or within 500 yards. For that reason the power is entirely controlled from a distance, by wireless of course. The control is exercised through the "radiofers."

In the left foreground we see a curious wheelless railroad. The cars float actually in the air, some feet above the broad, single iron track. The power is obtained from the distant power aerial, by wireless of course. One will notice the aerial wires on top of the cars, which receive the energy. The train is suspended by electro-magnetism, and glides smoothly along, at the rate of some 200 miles an hour.*)

In the left foreground also we see an immense 1000 foot *"optophor"* tower. This tower shoots a dazzling colored light shaft of some ten million candle-power straight into the sky. Such "optophor" towers are stationed exactly 50 miles apart along the coasts, and every tower has a different colored light shaft. This light beam can be seen some 500 miles out at sea and by its light, transatlantic aerial as well as aquatic craft, can steer with unfailing accuracy towards their point of destination.

### STIPPLING DRAWINGS WITH AN ELECTRIC BUZZER.

The draftsman making a drawing where concrete sections are shown in a stipple will find the device illustrated very handy to accomplish the effect, as described by Jacob Goldberg, in Popular Mechanics. An old bell, a push button and a common battery cell are all the requisites necessary. The gong and the lugs that hold it are removed, and the knob on the end of the hammer is replaced by a socket to hold a pen point. The whole is then mounted on a board with the push button conveniently mounted on the opposite side. I found it better to mount the bell box upside down, making the stroke of the magnet or armature, when released, the working stroke of the pen. This device not only saved its cost many times over, but does better work which, of course, is not so tiring to the eyes and wrist as when done by hand. The material required can be purchased from the E. I. Co., and may consist of their No. 951 bell, with the gong cut off; No. 1008, or 174 push button; No. 1001 dry cell; and several feet of No. 8002 flexible cord. (See new E. I. Co. Catalog No. 11.)



The Electric Buzzer Drives the Pen Point at a Rapid Speed in Making a Stipple

* In 1912 patent No. 1,020,942 was issued to Bachelet, on such a suspended train system.

# WIRELESS DEPARTMENT

## The Vacuum Detector

By H. Winfield Secor.*

THE Vacuum Detector or cymoscope has come into widely extended use at the present time, and this article is intended to give a resume of its development, and operation, in general.

Probably the simplest form of vacuum detector, usually called the "Audion," or "Fleming Valve," was the flame audion, and its arrangement is depicted at Fig. 1. As seen in the drawing, an ordinary Bunsen gas flame is utilized, and in this flame are placed two conductors or electrodes. It was found that the best form of the flame audion was that involving the use of a Bunsen flame, burning coal gas, and having in its flame two electrodes, as shown; one of them (the lower) being a small platinum trough or cup, and the upper electrode a platinum point.

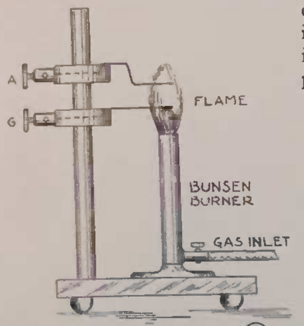



FIG. 1

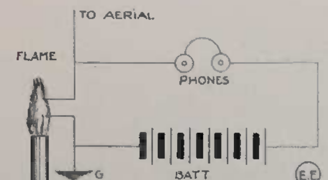



FIG. 2

In the cup shaped or lower electrode, some alkaline salt is placed, and so located in the flame that it is at a comparatively cool spot, yet is maintained hot enough to continually vaporize the salt; while the point, which may be a small (.001-inch) platinum wire is placed in the very hottest part of the flame.

The point should be kept from ⅛ to ⅜ inch above the trough. The salt preferred is potassium hydroxide. The flame must be kept well saturated with the gas from the vaporizing salt in the lower electrode cup.

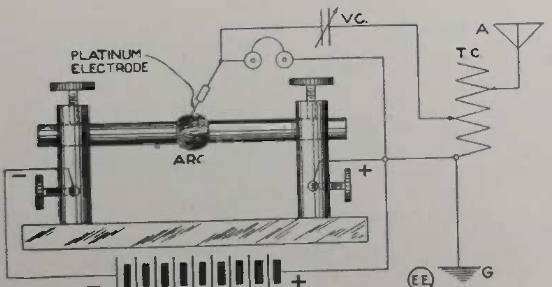



FIG. 3

The electrical circuits for this simple flame audion, are shown at Fig. 2, the polarity always being as shown. The battery, B, should be equipped with a multi-point switch, so that any voltage from 6 to 35 or 40, may be readily obtained, in steps of 1 cell at a time. A rheostat is best employed also in series with the battery to permit of very fine regulation of the applied voltage, as the critical or optimum potential at which the flame is most sensitive, is sharply defined. This detector is wonderfully sensitive, when properly adjusted, but is not of any commercial importance, for the reason that the flame could not be maintained evenly, especially on ships at sea, which are constantly rolling and swaying. The principle of this detector is the shattering of the column of conducting gas, by incoming wireless waves, and the change in resistance of the conducting flame between the two electrodes, manifests itself in the telephone receivers, which should be of the wireless type, i. e., having a resistance of 1,000 to 2,000 ohms.

Another ingenious form of gas detector, tried some years ago, consists of an ordinary carbon arc, a pair of high resistance telephone receivers, and a platinum electrode, arranged as in the sketch, Fig. 3. The arc length should be adjustable, and the platinum electrode so arranged, that its position in the arc can be varied at will.

The arc itself has to be formed between *cored* carbons, and should be fed from storage battery giving at least 40 volts. The variations in ordinary power circuits, fed by dynamos, are too pronounced, and would cause too much noise in the receivers. This detector also depends upon the shattering of a column of conducting gas by Hertzian waves.

We now come to the later class of audion or vacuum detectors, and these have been developed to a high degree; in the audion now in use in a great many commercial and amateur stations.

The peculiar qualities of gaseous conductors, especially rarefied gases in so-called vacuum tubes, have been utilized for the detection and measurement of electric oscillations, and therefore of electrical waves.

Professor Righi availed himself of one striking peculiarity of rarefied gases as conductors, as follows:* It is well known, as first shown by Varley, that if a glass tube having platinum electrodes sealed into it, and a vacuum of about one-thousandth of an atmosphere made in it, is subjected to electromotive force, no current will flow through it until a certain voltage, say of 300 volts or so, is exceeded. Beyond that limit the current which flows is almost exactly proportional to the excess of the voltage above this critical value. Hence if a small vacuum tube be connected in series with a battery of voltaic cells giving some voltage a little less than the critical value, no glow will take place in the vacuum tube, because no current passes. If, however, the same circuit includes a coil in which electric oscillations are excited, then the electro-motive force of these induced oscillations will, in one direction, be added to the electromotive force of the battery, and will send a current through the gas and cause it to glow. Righi employed a vacuum tube in which a very small space intervened between the electrodes, and employed a water battery or some simple form of primary voltaic cell to produce the required "boosting" or auxiliary electromotive force.

The vacuum tube then glowed when electric oscillations were set up in the coil in series with it.

L. Zehnder employed a vacuum tube in a slightly different manner as a detector of Hertz oscillations. He took advantage of another well-known fact connected with electrical discharge through rarefied gases.

A vacuum tube of the ordinary kind has, in addition to the usual platinum electrodes, another pair of electrodes at right angles, placed with their ends very close, Fig. 4. If, then, a high potential battery, say of 300 or 400 cells, is applied in series with a high resistance, and the tube used in the ordinary way, we may adjust the number of cells until the electromotive force is just not sufficient to cause a glow discharge in the tube. Then if a very small discharge is sent between the transverse electrodes, this glow discharge causes the general mass of the rarefied gas to become a conductor for the steady battery electromotive force, and the vacuum tube bursts into glow. This arrangement is sometimes called a Zehnder "trigger tube," because the small transverse discharge, so to speak, sets off the longitudinal discharge in the tube. The transverse electrodes which convey the oscillatory discharge through the gas are placed quite close to the cathode of the continuous current electrodes,

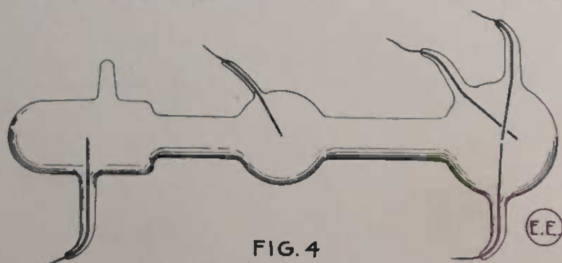



FIG. 4

since it is known that at the cathode the great resistance to discharge is situated. In this manner a Hertzian spark too feeble to be visible at a distance can be rendered manifest by its power to start off another discharge from a powerful battery acting on the same mass or rarefied gas.

A third method of utilizing the properties of rarefied gases for the purposes of a cymoscope or detector was discovered by Dr. J. A. Fleming. In 1890 he made known a fact discovered by him in the course of some investigations upon incandescent electrical lamps.

If into a glass bulb highly exhausted is sealed two carbon filaments like in incandescent lamps, Fig. 5, we find that when both these filaments are cold, the vacuum or highly

* Electrical Engineer, Electro Importing Co.

* See Dr. Fleming's Treatise, "Principles of Etheric Wave Telegraphy."

rarefied air left in the bulb is a very perfect non-conductor of electricity. Even an induction coil will not send a discharge through the bulb if the exhaustion has been pushed far enough.

If, however, the carbon filaments are made incandescent by insulated batteries, then it is found that the electromotive force of a single cell is sufficient to send a current across the interspace between the filaments. It is necessary to connect the galvanometer and single cell between the two ends of the

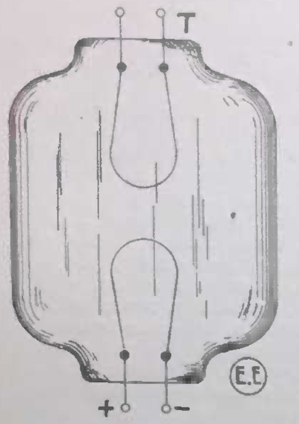



FIG. 5

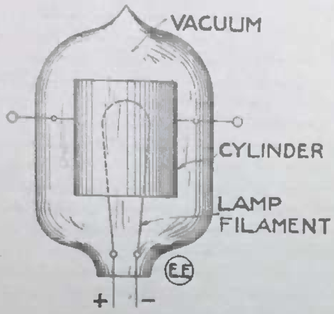



FIG. 6

carbon filaments, which are in connection with the negative poles of the respective insulated batteries. We may employ a single carbon filament and a metal plate or cylinder surrounding it, Fig. 6, and if we then render the carbon filament incandescent by a local battery, it is found that a single cell will pass a current through the vacuous space between the cylinder and the hot filament, provided that this single cell has its negative pole in connection with that end of the filament which is itself in connection with the negative end of the heating battery. If the connections of the single cell

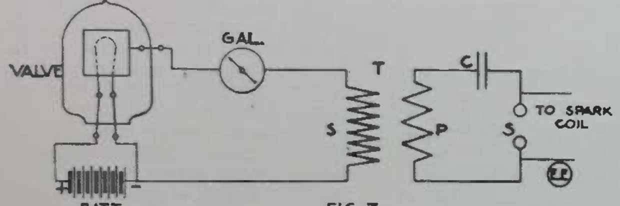



FIG. 7

are reversed, then no current passes.

The space between the cold cylinder and the hot carbon filaments possesses, therefore, a unilateral conductivity. Negative electricity can pass from the hot filament to the cold metal cylinder through the highly rarefied gas, but not in the opposite direction. This arrangement then acts as an electrical valve for electric currents. It was furthermore discovered that this device could be used to separate the two constituent currents of an electrical oscillation and so render it possible for an electrical oscillation to affect an ordinary galvanometer. To do this the valve, now called an oscillation valve, is used as described below.

One of the above-described bulbs, Fig. 6, has a sensitive galvanometer, G, placed in series with the secondary coils of an oscillation transformer joined in between its metal cylinder and the negative terminal of the carbon filament, Fig. 7. If electric oscillations are induced in this secondary circuit by a primary coil, P, then when the carbon filament is made incandescent by an insulated battery, B, only one of the currents forming the oscillation is allowed to pass, viz., that in which the move-

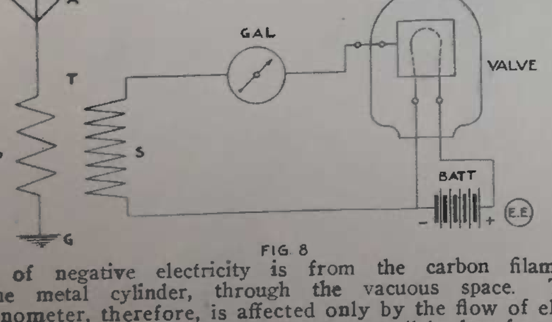



FIG. 8

ment of negative electricity is from the carbon filament to the metal cylinder, through the vacuous space. The galvanometer, therefore, is affected only by the flow of electricity in one direction, and its needle or coil is therefore deflected. In each train of oscillation the positive currents are, so to speak, sifted out from the negative, and only one set allowed to pass. We are therefore able to employ a sensitive mirror galvanometer of the ordinary type to detect the existence of electric oscillation in the circuit.

When the valve is to be used for detecting electric waves, or as a receiver in wireless telegraphy the oscillation transformer associated with it, has its primary circuit included between two collector wires, or between an aerial wire, A, and the earth, G; see Fig. 8. Then electric waves falling on the aerial produce in it electric oscillations, and these are detected by a sensitive dead-beat mirror galvanometer, such as a "speaking galvanometer," as used in cable telegraphy.

The electrical properties of these valves have been exhaustively studied by Dr. Fleming and others. It is well known that the conductivity of rarefied gases differs in quality from that of metals or electrolytes. If we apply a steadily increasing electromotive force to a mass of rarefied gas by means of two electrodes, the negative one being incandescent, then the current through the gas does not increase proportionately to the electromotive force. The current rises up to a maximum value, at which it is said to be saturated. Hence the gas, as a conductor, does not obey Ohm's law. Also the conductivity, which is the ratio of current to voltage, rises to a maximum and then falls off.

The resistance of the vacuous space may therefore vary from millions of ohms to a few ohms, according to the voltage applied and the temperature of the filament. The valve rectifies the oscillations or becomes more completely unilateral in conductivity the colder the metal cylinder is kept. If we allow the cylinder to become warmed by radiation from the filament, then the flow of electricity between the carbon filament and cylinder is not altogether in one direction. When made as shown in Fig. 7, and used with a carbon filament at that temperature at which it is working, at about 3 watts per candle, the rectification is from 80 to 85 per cent.

Fig. 9.

There are at present two principal types of audion detectors, one being the Fleming valve, employed by the Marconi Wireless Telegraph Co., and connected as shown at Fig. 8, with a pair of high resistance telephone receivers connected in the place of the galvanometer. The other type is that evolved by Dr. Lee de Forest, and commonly termed the "Grid audion." The latter form is similar to that of the "Electro" audion detector.

A cut of this detector is shown at Fig. 9 and its working connections at Fig. 10. As will be readily seen, a four volt battery, SB, (preferably two storage cells), supplies the filament, Fl, of the detector, through a finely adjustable resistance, of about 10 ohms; the E. I. Co., No. 5,000 rheostat regulator being ideal for this purpose. The receiver circuit contains a high voltage battery, H. B.; and this detector acts also as a relay, letting more or less of the high voltage

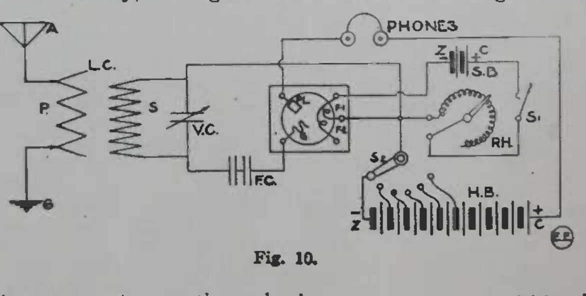



Fig. 10.

battery current pass through the vacuous space within the detector, when influenced by wireless or Hertzian waves. The high voltage battery is usually composed of 7 or 8 three cell E. I. Co. flashlight batteries, No. 1056 or No. 1059, which give 1½ volts per cell. As much as 40 volts is sometimes required for some audions, depending upon the space between the various parts within it, and also upon the degree of exhaustion.

It is important that the polarity of the two sets of batteries be correct, or no signals at all will be heard. It is advisable to arrange a few of the end cells of battery HB. with a multi-point switch, to permit of varying the applied potential. A switch is depicted by SI; LC is a loose coupler; FC is a fixed condenser; PL audion plate electrode, and GR the wire grid. The phones should have 2,000 to 3,000 ohms per pair. The "Electro" Audion is in use at the University of Michigan, Radio Laboratory, and Prof. B. N. Burglund states that he receives Arlington, with the receivers four feet away from the head. He also states that the audion is the most sensitive detector ever tested at the Radio Laboratory.

# HOW-TO-MAKE-IT DEPARTMENT

This Department will award the following monthly prizes: FIRST PRIZE $5.00; SECOND PRIZE $2.00; THIRD PRIZE $1.00.

The idea of this department is to accomplish *new* things with *old* apparatus, or *old* material. In order to win a prize, the apparatus, goods, supplies, parts or materials must be of "E. I. Co." make. The more original the idea, and the more "E. I. Co." goods are used in accomplishing the new thing or the new effect, the better the chance to win the first prize.

Read the following article by Mr. Gernsback. You will note that he uses nothing but regular "E. I. Co." stock material, except the phonograph horn. He has found a new, *useful* purpose for the *Pony receiver*, as well as the other articles. This is the kind of article which wins a $5.00 prize. Suppose you try an article; you will be surprised how easy it is to win a prize. And remember, it's the *idea* for which we pay the prize, never mind if it is well written up or not—we'll attend to that part, if you have no experience in writing articles.

## How to Make a Loud Speaking Telephone

By H. Gernsback.

THERE is nothing easier than to make a loud speaking telephone. Such an instrument comes in very handy in many places, and I will mention only a few.

The mistress wants to speak to the kitchen and she can do so without having to wait till the maid or cook steps to the phone to take down the receiver and hear what

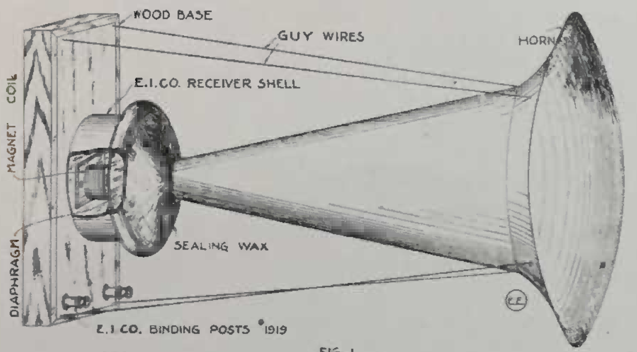



FIG. I

it wanted. The lady upstairs simply talks into the transmitter and everyone in the kitchen will hear what is wanted.

The manager wishes to speak with the factory or the office. For instance, the loud speaking phone is placed centrally in the office; now, if the manager wishes the office boy, he simply talks into the transmitter and the order is heard clearly over the entire office.

There are, of course, a thousand different real uses for the loud speaking telephone, and the up-to-date experimenter will not have much trouble to find new uses, and install a few of these instruments.

Let us see first, what is required to make a loud-speaking telephone. The entire secret may be expressed in these few words: *The more current used the louder the telephone will reproduce.*

The ordinary telephone receiver is wound to about 75 ohms; naturally but little amperage will pass through the windings of such a receiver, and the diaphragm consequently is not energized greatly. For that reason sounds can hardly be heard a foot from the receiver, unless a very large battery is used. Obviously we must wind a coarse wire on the receiver spool if we want a strong current to pass around its core.

### Construction.

Procure an ordinary E. I. Co. 75 ohm pony telephone receiver and take out the wire bobbin. Unwind the fine enamel wire entirely, and in its place wind carefully, so that the different turns don't cross each other, about 1 ounce of No. 24 enamel wire.* This will just fill the spool nicely.

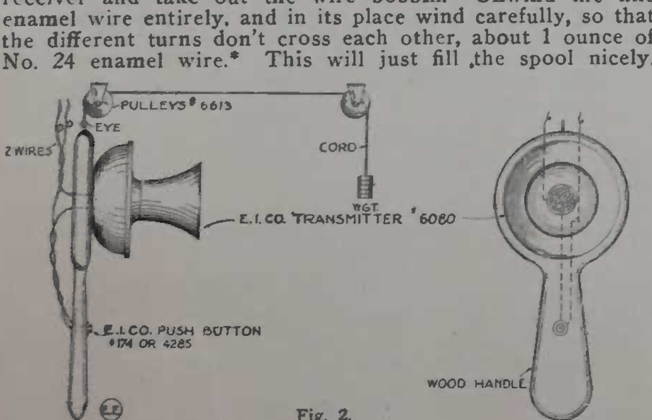



Fig. 2.

Connect the ends to the two binding posts, or bring the ends out to two binding posts as shown in illustration. The receiver shell should be fastened with several screws to a neat, hard wood, hard rubber or fibre base, about 4 x 4 inches, and about ½-inch thick, as clearly shown in sketch. A fairly heavy diaphragm must be used, and if such cannot be produced, two thin ones placed on top of each other will do just as well. Now screw on the cap tightly, and the receiver proper is ready.

If, however, we were to use it at this stage, it would not talk very loud and to get the best effect we must use a horn, to intensify the sounds. Probably the cheapest and the best horn can be procured from a phonograph supply store; the horn should be as light as possible, preferably of aluminum or cardboard. To secure it to the cap proceed as follows: Place the receiver with its cap in a horizontal position and place the horn on the cap at right angles in respect to the latter. Have an attendant hold the horn while you pour hot sealing wax around the lower part of the horn, at the point of contact with the cap.

As the cap itself melts fairly easy, the sealing wax must not be too hot else the cap will be damaged. For this reason only a little sealing wax should be used first,—just enough to run around the circumference of the horn. After the first layer of sealing wax has cooled *entirely*, pour on another layer and let this cool slowly. In this fashion pour on four or five layers. After this secure three of four pieces of string or better thin wire and fasten the horn as shown in illustration, Fig. 1. While the sealing wax might be sufficient to hold the horn, the stay or guy wires will retain the horn securely, if, as it happens in most cases, the telephone is placed against the wall, bringing the horn in a horizontal position. This completes the loud speaking telephone.

In order to operate it well, we must have a good transmitter which passes at least 1 ampere for short duration. The E. I. Co. has such a transmitter;* this instrument should be mounted on a base of the shape as shown. In the handle, Fig. 2, we have a small push button; the E. I. Co. "Lilliput" push is admirable for this purpose. The entire contrivance

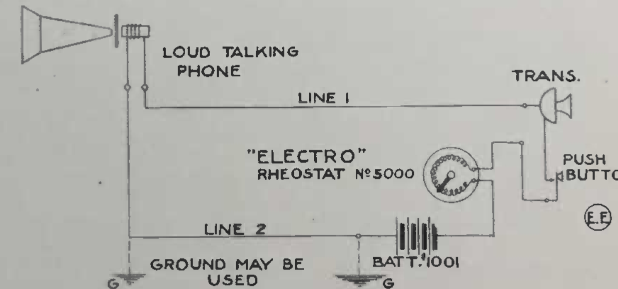



Fig. 3.

may be made to hang from the ceiling as shown. A heavy wire (or cord), at least No. 14 B. & S. connects the transmitter and loud speaking telephone, as in Fig. 3. From six to eight volts should be used, either good dry cells, such as the "Electro" or else the "Columbia." A good storage battery will, of course, be better. If now the transmitter button is pressed down and one speaks in an ordinary loud voice in the mouthpiece, the receiver will talk loud and distinct, the voice being audible in a large office, with a surprising clarity and fidelity, as well as good articulation.

It is well to observe that too strong a current produces a harsh, "nasal" voice and for this reason a current regulator, such as the "Electro" Rheostat-Regulator, will accomplish wonders. This rheostat is put in series in the line, as shown in diagram and an assistant should regulate it, while some one talks into the transmitter. After the best results have been obtained the rheotsat is not touched any further, and it should be placed out of reach, so that no one can temper with it.

It is, of course, understood, that if one desires to speak, it is necessary to press the transmitter button, as no current flows unless the button is pressed. Thus no current is used except when the device is actually in use.

If an especially loud talk is required, two loud speaking telephones, or even three can be placed in series, at different parts of the room or office.

Always remember that the connecting wires must be

* The E. I. Co. sells a receiver made as per above specifications, ready wound with No. 24 enamel wire, for $0.65.

* Their No. 6080. Price $1.25.

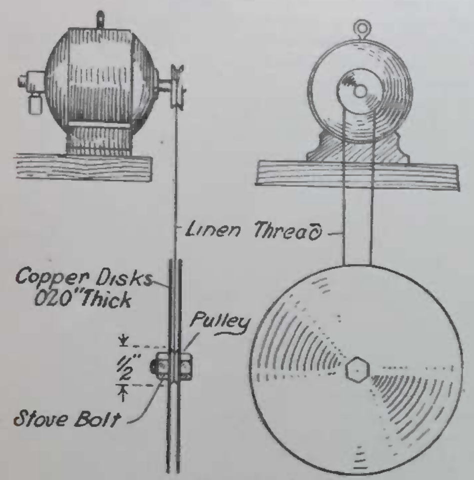
heavy. The following table should be used when installing a loud speaking telephone system:

Up to 100 feet use No. 16 B. & S. Copper Wire.
Up to 250 feet use No. 14 B. & S. Copper Wire.
Up to 400 feet use No. 12 B. & S. Copper Wire.
Up to 600 feet use No. 10 B. & S. Copper Wire.

## ODD STATIC GENERATOR.

The outfit here illustrated I accidentally discovered will generate static electricity, writes E. H. Samen, in a current number of Popular Electricity.

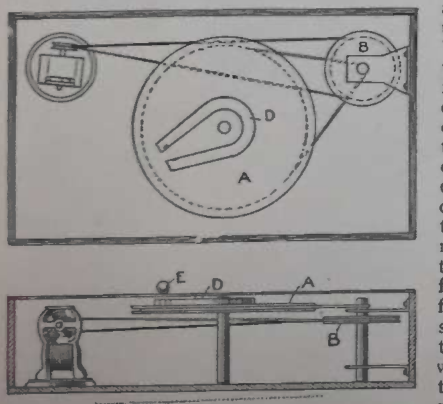
Upon a shelf or the edge of a table fasten a small motor, such as the "Electro" type D or S machine, with grooved pulley; that will run at a speed of about 3,000 revolutions per minute. On the shaft of the motor there should be a small grooved brass pulley. Provide a second pulley about ¾ inch in diameter and a small stove bolt that just fits the hole in it. From thin sheet copper, E. I. Co., No. 28 gauge, at 46 cents per square foot, cut two disks exactly alike, and six inches in diameter. Drill a hole in each disk of the same size as the hole in the pulley, and fasten the disks, one on each side of the pulley with the stove bolt as shown. Now make a belt of heavy linen thread. Place the thread over the pulley on the motor and set the disks' pulley upon the loop, thus leaving the disks suspended in the air. Start the motor, give the disks a turn and as soon as they come up to speed, they will act as a gyroscope and keep balanced. Take a piece of copper conductor in the hand and bring the metal near the disks. A ¾-inch spark can be taken off. An incandescent lamp held near the disks will glow with a weird blue light.



STATIC GENERATOR

## A NOVEL SHOW-WINDOW ATTRACTION.

This moving show-window attraction can be simply and cheaply made, says C. Guse, in Popular Mechanics. The things necessary are a small battery motor, a large horseshoe magnet and a large polished steel ball, perfectly true and round, such as used in bearings. The other materials usually can be found in any store. Procure some thick cardboard and cut two disks, 8 in. in diameter, and two disks, 7½ in. in diameter. Glue these together to make the wheel A, the larger disks forming the flanges. Make a smaller wheel, B, the size of which will be governed by the speed of the motor used, which may be the E. I. Co. Type D, No. 1320 machine. The wheel A is mounted in a box to run with its surface close to the under side of the cover, which should be of a thin, stiff cardboard. The wheel B is mounted on an axle that runs in metal bearings. The magnet D, such as the E. I. Co., No. 538, 5-inch size, is placed on the wheel A. The steel ball E is put on the thin cover of the box, and the magnet causes it to roll around as the wheel turns. The box inclosing the mechanical parts should be placed out of sight when used in a window.

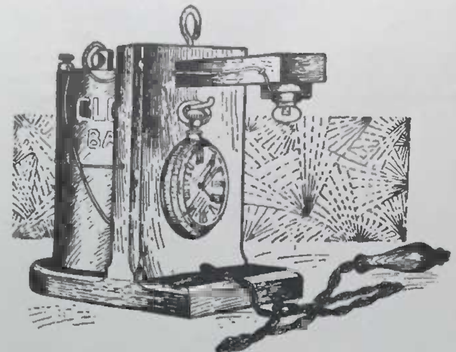


The Steel Ball is Caused to Roll Around on the Cover by the Moving Magnet

## HOME-MADE NIGHT WATCH LIGHT.

During the dark winter months I use my watch and the convenient home-made arrangement shown to tell the time without getting out of bed, writes E. B. Drahenalb, in Popular Electricity.

The following needed material may be obtained practically without cost. One ¾-inch board 5 by 3 inches, one ¾-inch board 6½ by 3 inches, one piece wood 1 by ¾ by 2½ inches, four ¾-inch wood screws and four insulated staples. Material to be purchased is as follows: One 2½ volt, tungsten, battery lamp, 25 cents; one dry battery, 18 cents; ten feet No. 20 double conductor, lamp cord, 15 cents; pear-shaped, push button, 15 cents; miniature receptacle, 5 cents; total cost, $0.78. The lamp may be the "Electro," No. 4,000, Tungsten bulb; the dry cell No. 1001; lamp cord No. 8002; receptacle No. 1052; special pear-shaped push button at 15 cents.

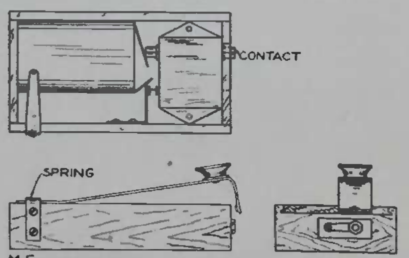

WATCH LIGHT

The wooden parts are shaped and fastened together with wood screws. The battery is held in place by a wire about it and passing through a hole in the upright. The lamp is connected in series with the battery and button. A screw eye in the top of the upright serves for lifting the outfit, and a nail or hook supports the watch. The outfit is placed on the dresser or a chair and the cord is hung around the bedpost, with the button within easy reach.

## POCKET BUZZER SET.

The following instrument has a variety of uses, but was originally intended as a portable code practicer and was described by S. R. Ward, in the December Modern Electrics. It consists of four parts, a small wooden box with sliding cover, such as small taps, are packed in, or the E. I. Co., No. 10,000 fixed condenser case of polished oak, at 25 cents; a midget buzzer, battery and key. The battery is a vest pocket flashlight type, such as "Electro," No. 1056.

Fig. 1 shows the general arrangement of the battery and buzzer. A slot cut through one end of the box allows a binding post of the buzzer to project and permit adjustment of the vibrator screw. One spring of the battery presses against the other binding nut on the buzzer while contact, H, connects the other battery terminal to the spring finger, X. Both buzzer and battery are held in place by means of tightly wedged strips of felt or leather.




The spring finger makes contact with a key mounted on the box cover. This key, which is made of phosphor bronze spring, is of the shape shown in Fig. 2. By using a binding nut for a contact the apparatus is greatly simplified and by merely pulling back the cover a new battery may be inserted. When not in use a short length of rubber tubing slipped over the nut prevents accidental contact.

Although the finished instrument may be carried in a vest pocket it will transmit audible signals across a room and when placed near the ground wire forms an efficient detector test. The buzzer can be the "Electro" Lilliput type No. 965; the key, their No. 1118 single circuit style.

## A GOOD PROPOSITION.

If you can't find 4 1/10 cents' worth of instruction and diversion in this journal, we don't wish your subscription. If, however, you do, and if we don't get your subscription, then, both you and we suffer equally.

# AMONG THE AMATEURS

The Tufts College Wireless Society has just installed its new wireless station in Paige Hall on the top of College Hill. The station is one of the most efficient supported by any college in the country.

The society was formed two years ago through the efforts of Harold J. Power and Joseph A. Prentiss, wireless enthusiasts. Through the efforts of Harry G. Chase, formerly professor of physics in the college, apparatus was obtained last year, and was installed in Robinson Hall. Last June when Professor Chase resigned the society found itself without a set and immediately began work to obtain another. In September Harold J. Power was presented a fine outfit by a friend and he immediately placed this at the disposal of the club. The college faculty then granted the society the use of a room in Paige Hall on the top of College Hill, an admirable location.

After much work the apparatus has been finally installed. The aerial wires are stretched between Paige and Miner halls. There are four wires having a span of 175 feet and are separated by twelve-foot spreaders. The four lead wires drop from the centre of the aerial, coming direct into the operating room on the ground floor of Paige Hall. A safety device to protect the building during electrical storms is on the outside of the hall.

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Mr. Arthur Haake, of Norwood, N. J., using one of the E. I. Co.'s ½ K.W. Transformer coils No. 8050 on 110 volts D. C. with Electrolytic Interrupter of the Gernsback type, is transmitting signals day and night to Philadelphia, Pa., a distance of about 92 miles. The aerial used is about 130 ft. long and 75 ft. high.

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Good results are being obtained by Mr. Edward Nell, Jr., of Indianapolis, Ind., using the ½ K.W. Transformer coil on 110 volts with Electrolytic Interrupter. He is sending over a distance of 83 miles night and day with a very small aerial consisting of six wires 30 ft. long and about 40 ft. high.

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Part of the apparatus for establishing a wireless telegraph station on the State University campus, at Lexington, Ky., has been received by Prof. W. A. Freeman, of the Electrical Engineering College. As soon as the remainder of the equipment which is expected shortly arrives, work on fitting up the station will be commenced. It is planned to make arrangements so that messages can be received, and sent to other stations throughout the country.

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Fifteen members of the Paterson Newsboys' Association plan to start a wireless telegraphy class at 266 Main street. Wolf Kaufman, who has a station rigged up at his home on East Holsman street, will instruct the boys in their first lesson.

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The Wireless Association of Atlantic City held its regular monthly meeting at its headquarters, 314 Bartlett Building, Friday evening. Several new members were admitted, including Jerome Haas, 2011 Atlantic avenue, and Alfred H. Ely, 7 Presston Apartments.

Short original essays pertaining to wireless telegraphy were read by the members. An interesting talk was given by Mr. Charles Seymour on the new government station at Arlington, Va., as inspected by him while at the inauguration. The remainder of the meeting was given over to instruction in practical radio. The next regular meeting of the association will be held April 4th.

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Malcolm S. Howe, 208 Edgehill Road, East Milton, Mass., advises us that with a set of E. I. Co. 75-ohm Pony Receiver, E. I. Co. Tuner, Detector, Condenser and 150 feet aerial he can pick up New York or Arlington, Va., with perfect ease. Mr. Howe says that the New York station comes in loud enough to hear it three feet away from the phones.

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Mr. Joseph J. Janda, Stangelville, Wis., writes us that with an 8060 E. I. Co. transformer coil and a 6-volt 60 ampere hour E. I. Co. storage battery he can get a spark of over 2¾ inches, which is very much more than he expected in as much as the Company only claims 1½ inch maximum for a transformer coil. Mr. Janda claims that he has sent over 40 miles with this transformer coil.

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Arthur Haake, Norwood, N. J., tells us that he has a ½ K.W. E. I. Co. transformer coil and says that during the last two weeks he communicated with a friend in Philadelphia, a distance of 92 miles either during day or during night. This certainly is a very good record, and although the Company does not claim that such results are always obtained, it goes to show that the capacity of the coil must be right.

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Richard Johnstone, of San Francisco, Cal., has done some extraordinary work with a ½-inch E. I. Co. spark coil. He claims to have communicated with a certain amateur friend in Palo Alto, Cal., in broad daylight, using a 6-volt 60 A. H. storage battery. The aerial was of four stands of stranded wire 75 feet high and 165 feet long. The coil was connected directly to this aerial. No condenser or helix was used. If it is remembered that the distance to Palo Alto is about 35 miles to San Francisco, the result is certainly extraordinary. Mr. Johnstone has written proof of the achievement and also has as witness a friend who was listening in when the record was made. Although the performance is quite unusual, it has been proved that on the Pacific Coast a 1-inch coil has transmitted as far as 90 miles. The reason for these extraordinary distances with small coils is, that the air conditions in California are very much better than in any other place in the United States. We frequently hear of long distance work done with but little power in California.

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## Correspondence

*Mr. H. Gernsback,*

233 Fulton Street, New York City.

Dear Sir:

This is something which I believe will interest you. Last summer I was spending my vacation at a place called Gayhead (about 3 miles from Cairo, Greene County, New York). The above-mentioned place is in the Catskill Mountains, about 1800 feet above sea-level. About the first of August, Elmer Rave, a boy of 15½ years, of 12 Raleigh place, Brooklyn, a member of the "W. A. O. A.," came to the same farmhouse where I was staying with a wireless equipment,—consisting of the following apparatus, viz., E. I. Co.'s one (1) coil, 6 batteries, E. I. Co.'s Jack Binn's phones, silicon detector, and the necessary switches, including one pound of aluminum wire. A station was set up with the aforesaid equipment and an aerial erected of the following dimensions, viz., 50 feet long, 15 feet high one end, 25 feet high other end, 4 wires on a 3-foot spreader.

The aerial was quickly erected and as soon as E. Rave started to receive (I knew nothing of the code then, but as I had been interested before, I became "assistant") he heard the following stations: Cape Cod, Boston (about 150 miles), Brooklyn Navy Yard (about 100 miles), Fire Island, and at night Portland, Me., Cape May, N. J., and vessels on the ocean of New York, New Jersey, and Massachusetts. But,—that night he called some or any of the above-named stations and received an answer!! For the next two weeks until we came home together on the 12th of August, we were in constant communication with stations by *day* or by night.

People may wonder or deny that this was accomplished, but I will try to prove it with the aid of witnesses. The tune was very high. We know this because one station said we were "fierce high" and asked us to tune down, which was impossible. For several days the weather report was received from Brooklyn Navy Yard and one day it was absolutely correct in its predictions. Two "S.O.S." were heard, one from a small steam launch on Long Island Sound which sank off Viking's Point and another from a steamship off the eastern coast between Portland and Boston. Incoming steamships were heard off New York City. Elmer Rave read all messages off as he received them and I, the "assistant," wrote them down word for word on paper, and I can truthfully say that I never wrote anything so fast in my life. Reading in the newspaper of the wreck of the "Shinnecock," a paddle wheeler which ran between New York and Block Island, Mr. Rave, the father of Elmer Rave, asked if details and final results could not be secured from some operator. Fire Island was asked and 1½ pages of news about the Shinnecock was sent us, at a pretty fast clip for me, who wrote it down on foolscap. It is self-evident that Elmer Rave couldn't have faked the message or all the others, because the speed would not allow it. As witnesses to prove the speed at which they were received I quote the following:

Mrs. and Mr. Rave, 12 Raleigh Place, Brooklyn.
Mrs. Hechler and daughter, Palisades Park, N. J.
Mr. and Mrs. Bogardus, Gayhead, New York.

Other stations, such as Syracuse, Saratoga, Richfield Springs, Springfield, and Albany, were spoken to on one occasion.

I have the foolscap papers on which the messages were written by me as they were read out by Elmer Rave and I will forward them to you if you want to look over them.

Very truly yours,
ERNEST HECHLER.

Palisades Park, New Jersey.

# QUESTION BOX

This department is for the sole benefit of the electrical experimenter. Questions will be answered here for the benefit of all, but only matter of sufficient interest will be published. Rules under which questions will be answered:

1. At least one of the questions must deal with "E. I. Co." apparatus or instruments, or "E. I. Co." merchandise.
2. Only three questions can be submitted to be answered.
3. Only one side of sheet to be written on; matter must be typewritten or else written in ink, no penciled matter considered.
4. Sketches, diagrams, etc., must be on separate sheets. Questions addressed to this Department cannot be answered by mail.

### SPARK COILS IN SERIES.

(1.) James Smith, Texas, would like to know:

Q. 1. What two minerals constitute the Perikon Detector and which mineral forms the point of same?

A. 1. The minerals are zincite and chalcopyrites, the latter being used as the point.

Q. 2. What is the average sending range of the *"Bull Dog"* one-inch spark coil used with medium size aerial?

A. 2. From six to eight miles.

Q. 3. How can I utilize two spark coils so as to work simultaneously?

A. 3. Connect the primaries and secondaries in series and use one vibrator for both primary windings.

### CHARGING VOLTAGE.

(2.) Mr. H. Peabody, Mass., asks:

Q. 1. What is the meaning of the tap sizes as given in the E. I. Co.'s catalogue, such as No. 6-32, 8-32, etc.?

A. 1. In giving tap numbers, the first number, such as 6 in your question, is understood to mean the number of the tap and corresponds to some empirical diameter according to a standard gauge, and we are giving herewith the corresponding diameters of the common tap sizes in general use:—No. 2 = .08416 inch outside diameter; No. 4 = .11048 inch; No. 6 = .1368 inch; No. 8 = .16312 inch; No. 10 = .18944 inch; No. 12 = .21576 inch; No. 14 = .24208.

The second number of the tap designation, such as No. 32, refers to the pitch of the threads or the distance between them and No. 32 thread means 32 threads per inch pitch.

Q. 3. Must the voltage of a charging dynamo be higher than the voltage given by the storage cells which it is charging?

A. 3. The voltage of the charging dynamo must be five to ten per cent. higher than the storage battery voltage, which it is charging; but in general practise, the amperes flowing into the battery on charge is usually the quantity watched, and the charging rheostat is regulated, so that the normal charging current passes into the battery. The standard charge and discharge rate for lead cells is the eight hour rate, i. e., if a storage cell is rated at 80 ampere hours capacity, its charge or discharge rate in general would be ten amperes for eight hours.

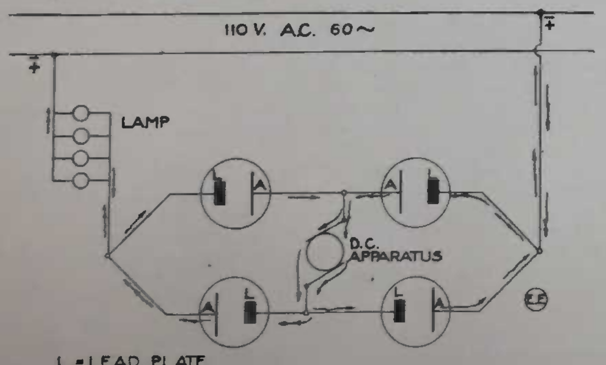
### 6 VOLT 60 AMPERE HOUR BATTERY.

(3.) W. P. Webb, Mo., inquires:

Q. 1. Is it true that the rotating part of some of the large turbo-generators for making electricity weigh 150 tons and are floated in a vertical position on oil for a bearing?

A. 1. Yes; the oil is maintained by pumps at a pressure equivalent to the weight of the rotor.

Q. 2. Is the E. I. Co. six volt 60 ampere hour storage battery suitable for operating the electric lights, and igniting the engine on automobiles?




A. 2. Yes, it is being used extensively for this purpose.

Q. 3. Please explain the action of the Electrolytic Rectifier and give diagram showing the complete action of the four cell type, such as sold by the E. I. Co. for recharging storage batteries from alternating current circuits of 110 volts or more?

A. 3. The electrolytic rectifier manufactured by the E. I. Co. depends for its action upon the fact that if an aluminum electrode or plate, together with another electrode of lead or iron, be placed in a jar containing certain electrolytes, this cell will allow current to be passed from the lead or iron electrode to the aluminum electrode, but will not permit current to pass through the cell in the opposite direction, that is, from the aluminum plate to the lead plate. We are giving herewith working diagram of the four cell electrolytic rectifier, the arrows showing the path taken by one instantaneous alternation at a given instant, and as will be seen, the four cell rectifier connected as shown, utilizes both halves of the cycle, thus producing a high efficiency, and a much more steady direct current, than a single cell rectifier. When used on 110 volts, 60 cycle, alternating current circuits, the rectifier delivers about 80 volts direct current, and its over all efficiency is about 85 per cent. The four cell rectifier can pass as much as five amperes, direct current, but its normal continuous rate is 2½ amperes and the life of the solution used in same is about (600), six hundred hours, with normal current.

### OPERATING A 2 INCH "BULL-DOG" COIL.

(4.) G. C. M., Pennsylvania, writes:

Q. 1. How many feet are there to one pound of No. 14 B. & S. and No. 18 B. & S. enameled magnet wire?

A. 1. No. 14 B. & S. enameled magnet wire has about 79 feet to the pound and No. 18 B. & S. about 200 feet to the pound.

Q. 2. How many Gordon primary cells will be required to properly operate a 2-inch "Bull-Dog" spark coil; the cells to be of the 100 ampere hour size?

A. 2. This will require about eight Gordon cells, which give approximately .7 volts each with circuit closed.

Q. 3. Would you recommend the use of a small battery motor of sufficient power to drive a bench lathe, the motor to derive its energy from primary cells, such as above mentioned; or do you think it advisable to employ instead a small gasoline engine, and where could I purchase a suitable one at a reasonable price?

A. 3. We would not recommend the use of a small motor run on primary cells as suggested, as this would be a very inefficient proposition. A small gasoline engine of about ½ H.P. would form the best source of power to drive your lathe with, and you can purchase such an engine of the very latest type, complete with all equipment, and ready to run, at $25.50 from the Electro Importing Co., New York City.

### OUTPUT OF BULL-DOG" COIL.

(5.) W. C. Daniels, Madison, New Jersey, inquires:

Q. 1. What is the approximate secondary output of the 1½-inch "Bull-Dog" spark coil sold by the E. I. Co., when the coil is operated on 110 volts alternating current, with the Gernsback electrolytic interrupter and choke coil?

A. 1. The secondary output of the 1½-inch "Bull-Dog" spark coil is about 220 watts or .22 kilowatt.

Q. 2. What is the largest size enameled magnet wire carried in stock by the E. I. Co.?

A. 2. No. 14 B. & S. enameled magnet wire is the largest size carried in stock or made at the present time, as with larger wires than No. 14 B. & S. it becomes difficult to make the enamel adhere properly to the conductor.

### CHARGING DYNAMO.

(6.) H. Lavoise, Lavelle, Pa., inquires:

Q. 1. Which one of the small dynamos sold by the E. I. Co. would you recommend for recharging a six volt, 100 ampere hour storage battery, and how long would it take the dynamo to recharge same?

A. 1. You will probably find their No. 810 dynamo delivering eight volts and ten amperes quite suitable for your purposes; and this dynamo could recharge your 100 ampere hour storage battery in about ten hours at a ten ampere rate.

Q. 2. What precautions are necessary in operating such a storage battery in parallel with the charging dynamo, on an automobile, where the dynamo speed is constantly fluctuating?

A. 2. In such cases it is, of course, necessary to guard against the storage battery discharging back through the dynamo; also that the dynamo shall not deliver too great a voltage and thus overcharge the storage battery. To prevent the storage battery from discharging back through the dynamo, in case the speed of the latter should fall below normal, consequently lowering its voltage below that of the storage battery, an automatic cut-out is usually connected in series between the dynamo and storage battery, and you can procure same from the E. I. Co. at $5.00. To prevent the dynamo from reaching too high a speed or overcharging the storage battery, an automatic clutch or pulley is generally supplied, which disengages the dynamo drive when the engine speed reaches a predetermined voltage operating by means of a centrifugal governor.

### QUENCHED SPARK GAP.

(7.) F. Kantor, Reading, Pa., asks:

Q. 1. Would you please inform me where I can obtain quenched spark gaps, complete, ready to use?

A. 1. You can obtain quenched spark gaps, consisting of eight individual gaps, mounted complete on base and ready to connect, at $20.00, from the Electro Importing Co., New York City.

### CADMIUM.

(8.) George Emmich, Newark, Ohio, writes us:

Q. 1. Where can I obtain metallic cadmium, price of same; and also the metal invar?

A. 1. You can procure metallic cadmium from the E. I. Co. at $3.15 per lb. and invar may be obtained from Eimer & Amend, Chemists, New York City.

Q. 2. What is the coefficient of linear expansion per degree Fahrenheit, for hard rubber and also for vulcanized fibre?

A. 2. The coefficient of linear expansion per degree Fahrenheit for hard rubber is approximately .000002 inch, and for vulcanized hard fibre it is approximately .000003 inch.

Q. 3. Which, in your opinion, is the best material for insulating spark coils, such as the insulating tube between the primary and secondary, and also the separators between secondary sections?

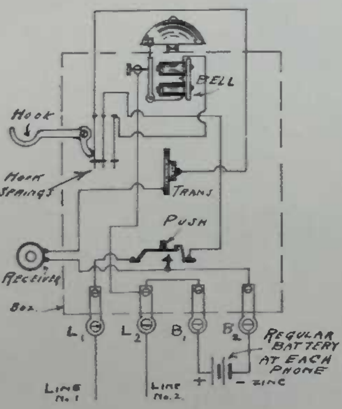
A. 3. Hard rubber is the best material for this purpose, but fibre can be used, but it should always be somewhat heavier than hard rubber for the same voltage stress. The E. I. Co. makes a specialty in supplying such tubes.

### TELEPHONE DIAGRAMS.

(9.) C. Lintel, Peak, Mass., asks:

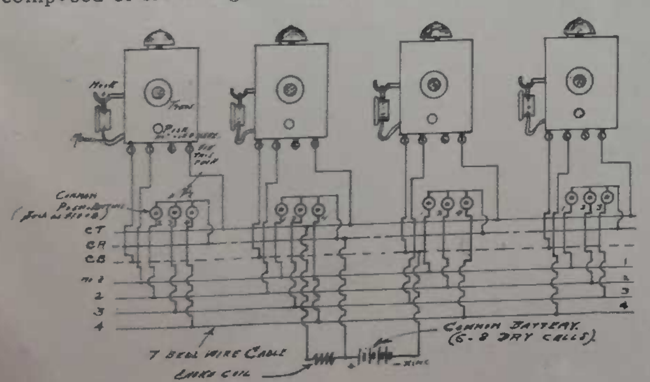
Q. 1. Kindly give me working diagram of interior connections for your No. 9204 Telimphone, as I have several of these and wish to experiment with same.

A. 1. We are giving below diagram of connections as used in No. 9204 Telimphone.




Q. 2. Please give me a diagram for the connection of four No. 9204 instruments on one system, with selective ringing and common talking wires, and state kind of wire to be used in making the cable for such a system for a distance not exceeding 150 feet.

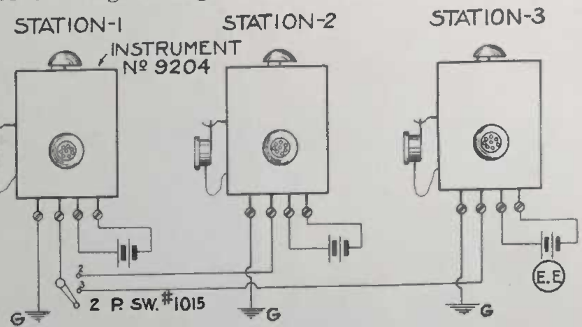
A. 2. We are pleased to give you herewith diagram of a combined system for utilizing four of our regular No. 9204 Telimphones, with selective ringing push buttons at each station; as will be seen by looking at the diagram all of the instruments talk over a common pair of wires. These talking wires are supplied with centralized battery power through a choke coil, which may be the electro-magnet coils of an electric bell; an ordinary gas lighting coil makes a very good impedance for this work. The centralized battery may be composed of six to eight "Electro" dry cells or sal-ammoniac




wet cells. The conductors used in the cable for this system may very well be No. 18 or 16 B. & S. cotton covered bell wire; and one of the wires of the system can be eliminated by utilizing the ground as a conductor, in place of one wire; gas pipe or water pipe ground can be employed for this purpose. The push button on the instrument is not used in the combined system, but only the separate push buttons shown in diagram, which may be of the type sold by the E. I. Co. No. 1008, at six cents each.

Q. 3. Could you give me a diagram for connecting three of your Telimphones, so that No. 1 instrument can, by means of a switch, talk to No. 2 or No. 3 instruments and normally Nos. 1 and 2 are to be joined together through the above mentioned switch. It is not necessary for No. 3 to talk to either No. 1 or No. 2 except when No. 1 party wishes to, and this is to be accomplished by using as few wires as possible, and also a ground return?

A. 3. Diagram is given below for the connection of the




instruments as stated in your question, and, as will be seen, a two-point switch is all that is required at No. 1 instrument, so that by moving the switch lever to No. 2 or No. 3 contact points, No. 1 party can talk to either No. 2 or No. 3, but normally the switch lever is left at No. 2 point, so that No. 2 party can at any time call up No. 1 if desired, and vice versa.

### WET BATTERIES.

(10.) J. F. Prendergast, New York City, writes us as follows:

Q. 1. Can you give me the dimensions and solution proportions for constructing sal-ammoniac wet batteries, such as used for telephone and bell work; and where can I obtain sal-ammoniac, and at what price?

A. 1. The proportions of the common sal-ammoniac wet battery with carbon and zinc elements are as follows: A glass jar, either round or square, about 5 inches across and 6 inches high, is filled half full of clean water, and ¼ lb. of sal-ammoniac is thoroughly dissolved in same. You can obtain sal-ammoniac at 20 cents per lb. from the E. I. Co. The carbon element is usually made in the form of a hollow cylinder about 1 inch smaller all around than the glass container, and the wall of the same may be ⅜ to ½ inch thick, with a length about 6⅞ the depth of the jar, but carbon plates ½ inch thick and about 5 x 2½ inches may be employed instead. The zinc pole, which forms the anode of the cell, in most cases takes the form of a ⅜ inch zinc rod, but sheet zinc, of about the same dimensions as the carbon plate, may be used.