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"Twenty Years Ago"

IHE following is an excerpt from a letter which reached me a short time ago. I quote one of the paragraphs verbatim:

"I have just received the second edition of your splendid publication, which we have taken for over four years, and it is going into its twentieth year. For some time he has taken a correspondence course in electricity, and now he wants to enter an electrical school to learn the profession in a practical manner.

While I believe that he will make a success of it, I am somewhat troubled, as I, as well as his Uncle, think that the electrical field just now is very much overcrowded. The advice I offer to you is to have your own opinion and what you think of the outlook in the electrical field. Is there much chance for the young man and is there a future for him?"

Without knowing just what branch of electricity the young man is going to choose, our answer of necessity must be somewhat vague. Nevertheless, we have not the slightest hesitancy in stating that not only is the electrical field not overcrowded, but there exists now, and there will exist for years to come a great shortage of practical electrical men.

No field is as diversified as the electrical. Nowhere is there greater opportunity for the man who knows, for the man who specializes in any electrical line. As in every field of endeavor, there is primarily the knowledge of the man that counts. The field itself is secondary. But we earnestly believe that the man who has a general training in electricity has an open Scanne before him these days.

We are so busy and so engrossed in our everyday work that we hardly ever stop to think how fast the world is growing and how tremendous the strides have been, all mainly due to the magic of the electric current. Let us see just how the world looked twenty short years ago, before the young man in question was born. It will surprise us.

Twenty years ago, there were no electrical trains, no subways, which now whiz us daily to and from our work. Untold millions are invested in these enterprises and tens of thousands of people are engaged in the electrical end to operate these trains.

Twenty years ago, we were still burning our inefficient carbon lamps with their dull red light. Nobody thought of the brilliant tungsten lamps. Millions are invested in the industry alone, while thousands upon thousands of people are employed in it. What kind of light will we have twenty years hence? How many additional millions will be invested in a brand new lighting industry, and how many thousand workers will it employ?

Twenty years ago the X-Ray tube was just emerging from the laboratory to save unkind humanity. Today the X-Ray industry is one of the most profitable ones, there being close to a thousand concerns manufacturing these wonderful tools. The X-Ray industry is still the greatest of the "X"—the unknown. We don't know to day what these rays really are. What the next twenty years will bring to this field is impossible to forecast.

Twenty years ago there was no commercial nor amateur wireless telegraph, nor the wireless telephone. Can you imagine an ocean liner without its wireless today? And what of the entire electrical industry? And if the tens of thousands of wireless experts, near-experts and plain workers were quadrupled today, would there still be a dire shortage. And what impossible feats will "wireless" perform twenty years hence? Wireless power transmission alone will be an dream of huge industry. The mind staggers at the possibilities.

Twenty years ago there were no electric heating stoves. There were no electric flat-roofs, no electric toasters, no electric ranges, no electric heating pads, no electric water heaters, etc. While today the electric heating industry is a very important one, and growing by leaps and bounds.

Twenty years ago there were no electric flashlights. Today it is a mammoth industry, with over 60 million dollars invested in it! Over 400,000 flashlights are turned out every year.

Twenty years ago the ubiquitous electric dry battery—the common dry cell—was practically unknown. We still had our messy wet cells, which someone or other never worked. Last year in the United States alone there were manufactured dry cells to the tune of over 40 million dollars! And every manufacturer is oversold for 1918! Aside from this the present dry cell is far from satisfactory.

Twenty years ago there were no electric baby incubators which now save thousands of lives every year. There were no vacuum cleaners, no radium, no transcontinental telephone, no slot telephone, no high-frequency machines, no spark plugs to make automobiles possible, no moving pictures, no automatic-electric block signals to save thousands of lives.

The list is as endless as are the prospects twenty years hence. Can anyone deny the wonderful future of electricity in view of such facts? H. GERNABACK.
The only way you can become an expert is by doing the very work under competent instructors, which you will be called upon to do later on. In other words, learn by doing. That is the method of the New York Electrical School.

Five minutes of actual practice, properly directed is worth more to a man than years and years of book study. Indeed, Actual Practice is the only training of value, and graduates of New York Electrical School have proved themselves to be the only men that are fully qualified to satisfy EVERY demand of the Electrical Profession.

At this "Learn by Doing" School a man acquires the art of Electrical Drafting; the best business method and experience in Electrical Contracting, together with the skill to install, operate and maintain all systems for producing, transmitting and using electricity. A school for Old and Young. Individual instruction.

No previous knowledge of electricity, mechanics or mathematics is necessary to take this electrical course. You can begin the course now and by steady application prepare yourself in a short time. You will be taught by practical electrical experts with actual apparatus, under actual conditions. 4,500 of our students are today successful electricians. Come in and read their enthusiastic letters. Let us explain this course to you in person. If you can't call, send now for 64-page book—it's FREE to you.
Seaplane Radios Trawlers and Destroys U-Boat

One of the latest official stories from London describes the wonderful, almost uncanny, hawk-like qualities of the modern radio-equipped seaplane. In this instance the seaplane was flying along on patrol duty when suddenly it spotted a 'Teuton "unseasboot"' resting peacefully on the sea bed.

At once the seaplane officer sent out a wire and let it slide down to the submarine's hull. An ominous silence rested on the strange stage setting for a few moments—moments that seemed like hours. Then the distant-like deep boom and two gigantic, foaming gray mounds of water presently muffled the explosion. The wires about the submarine snapt in the middle and the crews coiled them up. Meanwhile the seaplane circled around a patch of oil that came to the surface and then notified the trawlers that the submarine was destroyed. The aerial observer then slung a band of cartridges into his gun and sped off after the mines floating in the tide to burst them with rapid firing. The first mine sank punctured and the second exploded as the bullets reached it.

The Germans are loath to divulge U-boat casualties to anyone, even their own people, and especially among their naval crews. The Allies are slowly but surely curtailing the activities of enemy submarines. This is so for several reasons, chief among which is the fact that the leading scientific minds among the Allied councils are at work on anti-submarine devices and schemes.

The Americans have brought to bear on radio call to a destroyer and her fleet of trawlers ten miles away. The aerial fighting craft never took its eagle eyes off the enemy submarine, but continued to circle around and around, making sure that it did not speak away, as these shy craft are often wont to do. Shortly the destroyer and trawlers arrived on the scene ready for action under the direction of the seaplane.

The trawlers got out their sweeps and began steaming toward each other. As they met their wires engaged the bow and stern of the submarine and began to pass under the submarine. Then the submarine released two mines which the crews of the trawlers ignored with the reflection: "Her eggs can wait a minute."

Then the trawlers crossed and held the wire, and let it slide down to the submarine's hull. An ominous silence rested on the strange stage setting for a few moments—moments that seemed like hours. Then the distant-like deep boom and two gigantic, foaming gray mounds of water presently muffled the explosion. The wires about the submarine snapt in the middle and the crews coiled them up. Meanwhile the seaplane circled around a patch of oil that came to the surface and then notified the trawlers that the submarine was destroyed.

The aerial observer then slung a band of cartridges into his gun and sped off after the mines floating in the tide to burst them with rapid firing. The first mine sank punctured and the second exploded as the bullets reached it.

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ELECTRICAL

RAILROAD TRAINING GIRLS AS DISPATCHERS.

One of the large eastern railroads has opened a building in Philadelphia, where a staff of competent teachers will instruct hundreds of girls in the art of train dispatching.

The picture shows one of the girl students seated at an electric switchboard in the school. On the table is a complete miniature railroad, operated by electricity with switches, signals, semaphore lamps, etc., by means of which the students are taught the duties of a dispatcher.

The complete miniature electric railroad is a detail of its completeness, tickle the boy Edison to his heart's content. It works just like the big railroads—only no one has ever killed or have their leg cut off, should the fair train dispatcher make a mistake and trans- pose a freight and a passenger train at the wrong moment. But she is remarkably hand-homed—very dear. That's what the school is for—to teach the profession and teach it right, for railroading is one of the most, if not the most exciting of vocations.

And so it happens that we see few errors, even with beginners as we watch the deft fingers of the beskirted railroad students, as they push the buttons that cause the miniature semaphore lamps to flash red, then green—stopping trains in certain blocks and starting them again when the block ahead shows "clear." Hats off to the "Ladies of the Rail."

measuring the time required for the reception of the echo, and several other factors, the exact position distance of the "sub" can be ascertained on special, finely calibrated instruments. The Germans, according to one writer who resided in their country not so long ago, making use of a clever sound wave stunt for locating enemy ships without using the periscope. This scheme involves nothing more or less than applying the principles of triangulation, well known to every student of practical surveying, to sound wave propagation, reflection, and interception. One of the U-boats makes, for instance, send out a powerful sound wave from an under-water oscillator; this wave, especially if concentrated, would be reflected upon striking the hull of a steamer and at an angle. By under-water sound wave telegraphy two or three U-boats could quickly check up the angles of reflection and determine the speed, as well as the location of the steamer or warship, and without once showing their periscopes. This power to the Tuscania riddle—it is said that no U-boat was sighted. Another way of firing torpedoes accurately without taking sightings then the periscope was described in the July, 1917, issue of the ELECTRICAL EXPERIMENTER.

A German electrical engineer, employed for the last ten months at the electrical works at Kiel and who has recently returned to Geneva, says that the Germans are making every effort to conceal their submarine losses, especially from the navy, because of increased difficulty in mustering crews. He estimates the Germans lost 30 per cent.

WHAT IS T. N. T.?

Tri-nitro-toluol, or tri-nitro-toluene, or T. N. T., is a white solid which is easily made and which is safer to use than many other explosives. Chemically it is CH₃C₆H₄(NO₂)₃. It is made from toluol and nitric acid. The toluol is obtained as a by-product in the coke industry. There is not enough toluol prepared in the United States to supply its present needs. The tar and illuminating gas of the city gas-works contain toluol. By making certain changes in equipment the toluol could be saved. Toluol in gas gives illuminating power, but if gas mantles are used its absence will not be missed. It is of no value in the gas used for heat. It has been estimated that enough toluol is burned in illuminating gas in the United States in one day to make T. N. T. for 150,000 3-inch shells. Three hundred pounds of T. N. T. are used in a single torpedo.

CHICAGO HAS FIRST ELECTRIC FIRE BOATS.

The first electrically propelled fire boats are in service in the City of Chicago. They are 125 feet long and can deliver 9,000 gallons of water per minute at a pressure of 150 pounds to the square inch.

"METERWOMAN" TO SEE YOU, SIR!

Women will be employed by the Rochester Railway and Light Company as meter readers, beginning next month. The step has been taken to relieve the men of service and for urgent work in other lines.

The women will be given a preliminary course in meter reading.

Frederick W. Fisher, employment manager, stated that the women will wear an official badge of identification. Although it will in many instances be necessary for the "meterwomen" to clamber into unpleasant positions, they will not be required to wear overalls.

WIRELESS PLANT IS SEIZED.

A wireless plant belonging to a radius of several hundred miles was seized recently by the Federal Government at Timber, a small community about 20 miles from the Oregon coast. The plant, which was rather well concealed, was found at the home of J. E. Jacobson, who is ticket agent and operator for the Southern Pacific R. R.

ECUADOR AND PERU FAVOR AMERICAN ELECTRICAL GOODS.

America's opportunity of increasing its sales of electrical goods in Ecuador and Peru during the absence of German competition is pointed out in a report made public recently by the Bureau of Foreign and Domestic Commerce, of the Department of Commerce.

Before the war this trade was divided between Germany and the United States, the advantage being with the American manufacturer. The Government is not concerned with the market as it exists today and the opportunities it offers for the future.

Copies of "Electrical Goods in Ecuador and Peru," Special Agents' Series No. 154, can be purchased at the nominal price of 10 cents from the Superintendent of Documents, Government Printing Office, Washington, D. C., or from any of the district or co-operative offices of the Bureau of Foreign and Domestic Commerce.

HIGHEST TELEPHONE LINE IN THE WORLD IN COLORADO.

Engineers of the Mount St. Louis Telephone & Telegraph Co., have installed what they believe to be the highest telephone service line in the world. On the Denver-Carbondale toll route the company constructed the section of the line that crosses the Long's Peak Pass at an altitude of 13,200 feet. The newly-built Mount St. Louis is only one and three-tenths miles in length, and it is estimated that the cost of construction was more than $12,000.

BACK NUMBERS—Many readers desire to obtain back numbers of this Journal. We have a limited quantity of these back issues on hand and can supply them at the following rates—Back numbers of the Electrical Experimenter net over three months old, 15 cents each; over three months old, 20 cents each; over one year old, 35 cents each.
Search-light "Sub" Destroyer for Ships

By H. Winfield Secor

It has happened now and then that a merchant vessel has past directly over an enemy submarine without knowing it. Likewise enemy submarines have dived under steamships for one reason or another—perhaps to escape being rammed, or again to get a better chance to torpedo the unsuspecting vessel. Now imagine what would happen if, just when the ship was over the sub-sea craft, it suddenly turned on a battery of powerful under-water search-light projectors, as shown in the illustration!

As soon as the observer stationed inside the ship's hull sees a black hulk, he discharged a torpedo or depth bomb with every chance of hitting its mark. Considering that the projectiles would come fairly close or right on the target, they would not have to be loaded as heavily as the depth bombs ordinarily used, with the consequence that the vessel discharging them would not be in such danger of self-destruction or injury, as are the present destroyers and other craft. By means of time fuses suitably applied the depth bombs need not detonate until the vessel had moved off the spot—a matter of a few seconds. Also, the lower part of the hull of ships so equipped could be strengthened and double-bottomed to stand the extra strain.

Besides, why have the depth bombs detonate so quickly? Considering that the target is, under these conditions, fairly sure of being hit, why not use magnetic torpedoes—each torpedo to be provided with a powerful electro-magnet, so that when it reaches the "sub's" steel hull it will be attracted and held. Then, with suitable time fuses attached (or else by providing them with an electric diaphragm depth-gage detonator, as described in the January, 1918, issue of the Electrical Experimentert), the U-boat would continue on its way, suspecting nothing perhaps, unless it should have been the slight bump when the magnetic depth bomb "took hold," when suddenly—well, it would be all over for the Hun submarine sailors in less time than it takes to tell about it.

It is possible to see a distance of 75 to 100 feet with modern high power electric search-lights under water, especially with such intensely powerful projectors as the Sperry search-light, capable of developing over a billion candle-power in one concentrated beam.

This interesting scheme of combating submarines has been patented by an Illinois inventor, Mr. George W. Keesler. In his patent specifications, among other things, he says:

"The present invention relates to a device for torpedoing and destroying submerged objects such as submarines, and has for its object to provide a device of this character which embodies novel features of construc..." (Continued on page 865)
The Dictograph in the Trenches

In our November, 1917, issue Mr. H. Gernsback showed graphically how the microphone could be used for trench warfare, and we showed several applications how it was to be accomplished. While the article was not official in any way and only showed the application as it existed in our minds, we are now happy to show actual photographs of the same idea, showing that the idea is now in actual use on the front, the strange part being that the several applications are exactly as shown by us in our article, which like many similar ones was only imaginary, we having no official information of any kind that the microphone was being used for such purposes.

Our photographs show the dictograph at the front, and how our boys "over there" use the instrument to detect plans of the enemy.

Illustration No. 1 shows one of the boys crawling up towards the enemy trench to place a highly sensitive transmitter. It will be noted that the transmitter is placed upright in an old tomato can which easily camouflages the sensitive little instrument. As is well known these microphones are so sensitive that they detect a whisper at a distance of fifty feet. The sensitivity too is increased a great deal if the wind blows towards the microphone.

Fig. 2 shows how one of the microphones is placed near the enemy trench in a sort of dug-out, but little ground separating the microphone from the trench. This is right under the enemy's parapet.

In Fig. 3 a trench receiving station is clearly shown. At this station the intelligence is received by one or more operators, usually one listening, the other writing down whatever talk is picked up.

It goes without saying that the successful placing of these detectaphones as well as the laying of the wire, which operations are always under direct fire of the enemy, is one of the most dangerous and difficult undertakings in modern warfare. It is a task allowed only to a man of iron nerve, and requires much courage and good judgment not to blunder.

During the night very often the presence of a man is detected, and it then becomes necessary for him to lie perfectly still for perhaps hours at a time, as the slightest movement would draw machine gun or sharp rifle fire at once. When finally the man in "no man's land" retracts his course, he must do so very slowly and cautiously, going backwards at the rate of fractions of an inch at a time, irrespective of the fact that it may be freezing or that the rain may come down in torrents. However, this is only one of the disagreeable fortunes is then sprayed with finely divided metallic powders. The metallic particles are thus driven into the surface of the glass and a very durable metallic coating ensues. It is stated that when the under surface of the glass flask is treated with copper or aluminum in this way the water can be raised to boiling point in three-quarters of the time that would otherwise be necessary, and, in addition, the vessel is much less liable to crack. One would imagine that this process would have useful applications for treatment of glass reflectors for lighting purposes.

The instrument known as the dictograph employs a super-sensitive microphone connected with a telephone receiver and battery. The microphone converts the sound waves into corresponding electrical currents variations, which operate the receiver.

INVENTOR CALLED BY U. S. TO FINISH U-BOAT DEVICE.

Experimenting for a year with an invention aiming at the destruction of submarines, Prof. Harvey C. Hayes, head of the physics department of Swarthmore College, has been so successful that he has received a call from the United States Government to enter the national service. He refused to discuss particulars of his new venture adding that he has been forbidden to disclosed the location of the laboratory where he is to continue his research work.

Professor Hayes will be joined by five other physicists from the best universities and laboratories in the country in the Government research work. They commenced work on January 1. Professor Hayes expects to be engaged in this service for a year at least, and it is unlikely that he will return to Swarthmore at the opening of the next term in September. His family will accompany him to the site of the laboratory.

Professor Hayes was in his fourth year as a member of the faculty of Swarthmore College. Previous to his service in the physics department he was an instructor in research work at Harvard, where he took his doctor's degree. The vacancy caused by Professor Hayes' withdrawal will be filled by W. O. Sawtell, of Harvard.
"Electro-Magnetic Log" that Measures Ship's Speed

TALK to any old-time jack tar or sailorman as to how they measure speed of a ship when under way, and he will cut loose with a long tirade on the various merits and demerits of the immortal taffrail log—famed in song and story the world around. For the taffrail, be it known, gentle reader, is the hindmost deck rail on a ship, while the log line is the rope or cable which is heaved over said rail and into the briny billows below whenever the cocky commodore wishes to know how many knots the vessel makes, or how many miles it travels in an hour. At the taffrail, the log line is secured, and it is from this point that all measurements are taken. When the log line is secured, it is quickly hoisted, and the log is measured, and so on. This process is repeated until the ship arrives at the port of destination. The log line is then released, and the log is returned to its original position. The process is then repeated until the ship reaches the port of destination.

Every Yachtsman and Sailor Knows What the "Log Line" Is—It Measures the Speed of a Vessel Thru the Water by means of a Spinning Propeller Attached to Its Lower Extremity, Which Connects With a Dial Device at the Taffrail. Errors Are Liable at Any Time, Especially When the Observer is Inexperienced. Here's the Latest—a pure "Electrical Log" Which Is as Rugged as It is Simple. It has no moving Parts and Is Built Flush With the Hull.

good ship is making. And how does the faithful mate take the log? Well, it's this way, fellow land-lubbers.

As aforesaid, the log line is thrown over the taffrail and into the water. At the lower extremity of the line there is secured a propeller-like device which spins around at a speed proportional to the speed which the ship is making thru the water. The revolutions which the little propeller makes are transmitted to the deck rail by virtue of a flexible shaft, which connects with a dial and indicating arrangement, whereby it becomes readily possible, with the aid of a stop-watch, or by other means, to determine how many revolutions per minute the log propeller is revolving at. By referring to tables and other data provided for the purpose, it thus becomes possible to find out how many knots you are making. But this is a round-about way of doing it. Even the new electrical log always subject to more or less error. This new electro-magnetic log is a fixture, once installed on a vessel, there are no pro-

Copyright 1918 by E. P. Co.
At War With the Invisible

By R. and G. WINTHROP

(CONCLUSION)

"W"e must get hold of Professor Firman right away," I declared, finally. "He should understand this. I'm to tell your father. Ava.

With the pocket 'phone I reached Firman in a few moments. Late as it was, his laboratory at Columbia University still claimed him, his energetic brain busy, with the problem that held the universe. To my tremendous importance of what had occurred.

Another obstacle presented itself when we reached Firman's laboratory. To secure the privacy he needed for his work he had double-barred all doors leading to his rooms, and, of course, had forgotten my promised visit as soon as the 'phone was out of his hand. But such trifles were not to stop me on this night.

Leaving Ava to await my return on the roof, I sank slowly to the upper story of Schermerhorn Hall, where several lighted windows showed the presence of workers. I selected the largest window on the supposition that it must be Firman's, and brought the nose of the plane against it with just enough force to send the glass crashing to the floor inside the room. A high-pitched voice, lifted in bitter complaining profanity, satisfied me that I had struck the right one. No one could swear like Firman!

In another moment he appeared at the opening, peering out angrily and inquiring the feeling of confidence that had possess me from the moment I saw Ava. Firman was the mental giant of this scientific age. With the help I could give him I knew we would solve the deadly riddle of invisible attack on our world and save it from destruction.

"Elvan!" his shrill voice—which always startled those who met him for the first time by its incongruity with his great bulk—rose still higher in surprise. "You! What in hell do you want to bar all your doors for?" I retorted. "I had to get

... Arranging His Apparatus, Professor Firman Placed Ava's Arm Before the Helium-Planoscope Screen and Directed a Powerful Helium Ray Upon It.... An Outline of the Flesh and Bones Greatly Enlarged Was Visible, and Around the Wrist Was a Circlet of Tiny and Heretofore Invisible Bells.

...
“There is no doubt about it. They had only to incline their planes in cylindrical or spherical coverings, built on the principle of his bracelet, but on a tremendously larger scale. Then, by applying the silencer to the muzzle of their weapons, they could approach us unseen and unheard, to plant the contact points for the atomic deflector bristles when they chose and send them off with a current from their—""

They were at a safe distance.

"Why didn’t the selenoid tower record their presence?"

"For the same reason that the mirrors disappeared."

"Well, that is a point."

"Evidently as I could I gave him all the facts that we knew. Before I had finished he was already bending over Ava’s arm, working with curiosity, his lips pursed beneath the large, aquiline nose that marked his ancestry. Defying his fingers past over and around the back, the Marmurian bent his head, his brows wrinkled in surmise, comprehension and pleasure came from him as his penetrating mind grasped the strange phenomenon. Finally he sat back, a peculiar smile of satisfaction lighting up his expressive face."

"Extraordinarily clever," he declared appreciatively, but he paused. "Yes, simple—quite simple."

I bent over the invisible wonder with him. "What?"

"Nothing more than a system of mirrors."

His hand toyed with the circle on Ava’s arm. "The inventor has merely made use of the principles of reflection and refraction of light. Each of these facets is a tiny mirror of some substances I don’t know yet, but it must be something that reflects the light corpuscles with absolutely no diffused rays. That makes the mirror invisible itself."

(See note foot of page 818.)

Furthermore he had joined miniature reflectors to each other at such angles that a ray of light, striking upon one, was thrown as a mirror image upon another, which in its turn emerged on the reverse side, at a point directly perpendicular to its point of entrance."

Herein lies the secret."

He drew a sheet of paper to him and rapidly sketched a circle with a series of points which he labeled a, b, c, d, e, f, m, n, o, r, t."

"You understand, of course, that I have indicated here merely the surface mirrors, leaving out two of these is probably a series of double refraction surfaces to receive any rays that might otherwise be reflected to the observer’s eye. But, generally speaking, the phenomenon is this: the light from any object, as, for instance, the young lady’s arm, strikes upon m and is reflected from m to n to o, and on r (depending upon the angle at which it enters) emerging at n, exactly opposite. To one’s unaided eye, perceiving the intermediate surfaces, the light seems to come directly from the arm."

He paused, glanced swiftly from one to the other the page, and then continued: "Now, these we were following his exposition, and then went on with increased emphasis: "You see then, that these, under their remarkable covering, are entirely invisible! The same thing happens from any other point, looking a, the light from the object a, would be completely a straight line; from b we would see the object at f, and so on. It is all very simple this strange object and the ammen that had penetrated the mystery."

SYNOPSIS—PART I. This gripping scientific story deals with a "War of the Worlds"—an inter-planetary struggle for supremacy—the scenes of which are laid in the year 2011. The planet Mars, with all her strange romance of history, has made war upon all the planets. The hero is a special war correspondent of a New York newspaper, who, while detailed to the reception in Paris of the War Commission from Venus, becomes enamored with the beautiful daughter of the president of the visiting commission, the Honorable Peres Venarsol. She possesses the most remarkable bracelet—which is not only invisible but contains a set of tiny bells. The hero notes this bracelet carefully, for it apparently has some earth-like significance. Suddenly the correspondent is summoned back to New York by his editor—he flies across the Atlantic over night. Philadelphia and London had been wiped off the face of the earth—swallowed up! Did an earthquake do it? Were the Martian planes getting thru the earth’s air patrol fleet—and, even so, why didn’t the selenoid towers indicate their approach?"

"Electric Vacuum Tubes—The Principles and Their Uses," by H. Winfield Secer."

"Shooting Electrical Troubles on Automatic Circuits." by Charles Horton, Consulting Engineer."

"Experimental Electrical Furnaces," an instructive and well illustrated discourse by an expert."

"New Electric Stage Tricks." by J. Fox."

"Time-Space Vortexes, and Lengths and Harmonics)—of distinct importance to all Radio Students, by Prof. E. F. Andrew, Instructor in Scientific Engineering, Dartmouth College."


"How to Build a Perfectly Electrically Played Piano"—a real "live" article, by Charles Horton, Consulting Engineer."

"Research and Its Importance to Human Progress," by Dr. W. R. Whitney, Research Laboratory, General Electric Co."

"Wave-meters—Their Uses and Construction"—Part III, by Morton W. Stern."

"Then this is the method by which the Martians have made themselves invisible to us?" I exclaimed.
“Yes or No” an Electrically made Drama
By George Holmes

Have you ever stood on a crisp, cold winter morning on one of our asphalt streets and watched automobiles whizzing past, which may have temporarily blocked your progress across the streets? Like as not you have heard a peculiar swishing sound not unlike steam produced by escaping steam, the sound being apparently produced by the wheels of the automobile. It probably occurred to you that this sound was totally unlike the sound you hear at other times of the year, as for instance on a warm summer morning or on a wet day.

If you are at all observant you must have noticed at the great difference in sounds. There is, of course, an explanation. On a crisp winter morning, the conditions for static electricity are ideal. Any possessor of a static electric machine will readily confirm this; hence we find in the automobile, which is nothing but a huge machine on wheels, rubber rollers rubbing against a highly electrically charged pavement, produces static electricity in an abundant quantity. As any owner of a static machine knows if the crank is turned and the electricity escapes, a peculiar hissing sound is observed which is due to the fact that the static electricity escapes into the air. The same thing happens when an automobile runs at high speed along the asphalt, the electricity emerging from the rubber tires and escaping into the surrounding air.

STATIC ELECTRICITY AND THE AUTO

There is no division wall between the two sets and both are always in view. But only one scene is used at a time. Attention is focused on the side where the action is progressing by a clever arrangement of lights.

On the front of the auditorium balcony are six pairs of “baby spotlights,” one in each pair giving amber light and the other white light. As the plays are setting in darkness, the idleness are progressing, they are illuminated with amber light; the other side of the stage being in deep shadow. The tenement scene, in turn, is flooded with white light and the amber rays dimmed. The effects of contrast are telling and exceedingly novel.

After the first act the two clamps on cable No. 3, are placed in the new positions, P1 and P2, as indicated. The end of cable No. 3, with clamp No. 1, is shifted to platform 2—position (P1), by the stage attendants, while clamp No. 2, is shifted to platform 3—position (P2). Each platform has a small trap-door as indicated which gives ready access to cables and clamps. The work of changing the clamps on the cables is the work of two side men, who can easily accomplish. The positions of platforms 2, 3 are not changed during the progress of acts.

At the end of the third act the stage is darkened and cable number 3 is worked on the motor-driven drum in same direction as previously, thereby fulfilling the two platforms apart. Cable number two is pulled next, bringing platform number one and its setting “down stage.” The stage now called up, friend wife sees how narrow has been her escape, hubby comes home, and this being her birthday, a grand party takes place and “all’s well that ends well.”

Did You Ever Hear the Strange, Swishing Sound Made by an Automobile, Running Along the Asphalt on a Clear Cold Winter Day? If You Did You Heard a Static Electricity Discharge.
The New York Theatrical Success, "Yes or No," Involves Some of the Most Novel Electrical Effects Yet Produced on the Stage. We Are All Accustomed to See the Front Curtain Rise and Fall on the Successive Acts in a Play. But Here No Curtain Is Used. Even While the Scenes Are Being Changed, a Powerful Electric Motor, Located underneath the Stage, Solves the Mystery of Moving the Scenes Noiselessly and Quickly in the Fraction of a Minute. In "Yes or No," the Prologue Takes Place on Platform No. 1: While the two voices are Speaking, the Stage Assistant in the Basement Snubs Cable No. 1 on the Motor Drum—This Slowly Moves Platform One to the Rear—All in Semi-darkness. In a Few Seconds the Stage Attaches Have, by Snubbing on Cable No. 3, Brought Platforms Nos. 2 and 3 Together. Which, by a Clever Electric Lighting Effect, Produce Alternately the Dual Scene of Luxury and Poverty Above Illustrated. By Reversing the Platform Cable Clamps the Scenes on Platforms Nos. 2 and 3 Are Pulled Apart, and, by Snubbing Cable No. 2, Scene One Is Brought Down Stage for the Close.
THE world needs gasoline—thousands of internal-combustion engines are daily consuming untold gallons of the valuable fuel and have sent the price skyward at a rate that would give the average motorist heart failure. And just at the time that the situation promised to become acute an inventor comes forward with an electrical method of producing it from kerosene, solar oil and low-grade distillates.

Briefly the process is as follows: Take some kerosene, vaporize it, mix in a little natural gas and shoot a bolt of electricity thru it. Wash with acid, soda ash and water, then distill and you have pure, water which may hold from five to fifteen hundred barrels. This still is usually of cylindrical form and is mounted on brickwork similar to a horizontal steam boiler. Fire is placed under the still and the temperature of the oil gradually raised. When it reaches a temperature of 90 to 100 degrees Fahrenheit, gases will pass over into a condenser which consists of a large coiled pipe immersed in a tank of water. These vapors condense and thus is obtained high-proof gasoline or petroleum ether.

The temperature is further raised until all the gasoline vapor passes over. The end point or the maximum temperature at which gases are allowed to pass over is at will; that is, obtain all paraffin or all gasoline, as desired. By studying the constituents of the various hydrocarbons, Mr. Cherry noted the fact that if natural gas could be combined chemically in proper proportions with the various distillates, he would then have gasoline. Acting on this he discovered that a high-tension electric current would affect the necessary reaction and produce gasoline.

In practise, the still used is similar to that employed in refining crude oil, but has a perforated pipe at the bottom. The kerosene or other low-grade oil is placed in this still and while being heated natural gas is forced into the perforated pipe and escap-
ELECTRICAL EXPERIMENTER

The Telautograph.

The Telautograph, practically unknown to the vast majority of people not actively engaged in business, has become during recent years a very familiar and important part of the message transmission in commercial and industrial life of this country. The Telautograph, as its name indicates, being derived from the Greek words "Tele" "Auto" and "Grapho," means, literally translated, "writing with a distance."

It is a more than a telegraph, in that the actual handwriting of the operator is transmitted almost in facsimile.

To express it in another way, with the Telautograph you write over wires as with the telephone you talk over wires.

History.

With almost every new and important invention the history of the development of the Telautograph is interesting, because it has spread over a long period of time, has required constant and unceasing effort of many inventors before the instrument was brought to its present commercial and practical construction.

Telautographs in one form or another have been invented and patented as far back as 1876, followed by different ideas for accomplishing the same purpose in subsequent patents issued to different men in the United States and England in 1879, 1881, 1886 and 1888. In these early types of telautographs the paper on which the message was written by the operator and also that on which it was traced by the receiving pen was caused to move continuously, necessitating considerable skill on the part of the writer in forming the characters to assure a legible reproduction of handwriting and avoiding any facilities whatever for the transmission of figures and sketches.

A story is told by an old Chicagoan that one day in the winter of 1886 or 1887, he entered the office of a friend, a well-known Chicago financier, and found this financier gravely watching a tall, gray-bearded man, manipulate a cane and umbrella which had their handles hooked together, and was $h"id"ing"them"about"over"the"top"of"a"flat"desk"while"he"told"of"a"new"kind"of"telega"that"he"had"gotten"up."
The"gray-bearded"man"was"Elisha"Gray,"of"telephone"fame,"and"with"the"cane"and"umbrella"he"was"demonstrating"the"principle"of"the"now"well-known"Telautograph"pen-arm"movement.

Whether this story is true or not, it was about this time that Mr. Gray built his first telautograph. It was smaller than a grand piano and its mechanism was composed mainly of weights and strings, but it worked and actually transmitted handwriting after a fashion over wires between the inventor's house and his laboratory, about five hundred yards distant.

The results obtained with this crude instrument were sufficiently encouraging to Mr. Gray to cause him to put in a great deal of hand work during the next few years, endeavoring to develop an instrument that would be suitable for commercial use. (Continued on page 874)
Electricity in French Machine Gun Tests

ELECTRICITY often finds peculiar applications in the present World War. Here are several views of a battlefield laboratory in France—that of M. Laby, the distinguished French expert, who, as a leading investigator in the field of machine gun operation on soldiers, as well as other researches on the action of these small but highly effective firearms, some of which are capable of firing from 400 to 1,000 shots per minute.

Thus it is no easy problem to split up the seconds and fractions of seconds transpiring while one shot is occurring. The French machine guns have withstood the most rigid tests.

Fig. 1 shows M. Laby measuring the audible time of reaction of a machine gun. On the table is a Ruhmkorff coil, used to produce a spark for the rupture of the current as well as a variety of other electrical precision apparatus. This laboratory is in a bomb-proof cave.

Fig. 2 illustrates another French machine gun test—registering the respiratory variations of rifle fire for the study of functional plasticity. M. Laby, the distinguished French expert, seen at the extreme right of the photo, is conducting the tests.

The illustration, Fig. 3, shows the apparatus used in the study of the rapidity of the shocks of the machine gun in the repetition of a movement. These tests are being made also under the supervision of M. Laby, military expert of the French Army.

HEALTHFUL HEATING OF THE TISSUES BY ELECTRICITY.

By Dr. Leonard Keene Hirshberg, A.B., M.A., M.D. (Johns Hopkins University).

If you can heat the human fabric by a variety of electricity, which has other virtues also, you may begin to relegate the hot-water bag to the rear. This can be done.

Several thousand "milliamperes" or small electric units, can be past thru the living body with alterations of the electric current which amount to several millions a second. This yields a high degree of heat which passes thru the skin the same as X-rays do. It is called "diathermia" or thru heating.

This form of electricity is little known and therefore seldom used. Yet it performs wonders in the way of healing the tissues.

Dr. Albert C. Geyser, Professor of Physiological Therapy at Fordham University, New York City, stands in the foreground of those who expound the wide use of this type of electricity for the treatment of joint inflammations, swollen joints, and various kinds of arthritis.

It is the "high frequency" electric current, which makes this kind of heat. The resistance of the human textures to electricity is like their resistance to the fluid in a hypodermic syringe.

If you would understand about this, you can picture the electricity as the fluid in the syringe. To overcome the resistance of the tissues, you must force the stuff strongly enough to overpower the resistance.

Then you have deposited in the tissues the contents of the syringe or the electric machine. An ohm is the unit used by science to measure the amount of resistance to the spread of the electricity, just as pounds is used to measure the amount of pressure needed by water to overcome resistance.

A volt is the electric unit of pressure, and the rate of electric speed or flow is called the amperes. You could say of the syringe that the amperage or rate of flow into the human fabric needs an adequate amount of pressure or voltage, exerted upon the piston to overcome a certain amount of resistance or ohms. Thus if you read that a lineman was electrocuted by several thousand volts, you know it was the electric pressure.

Alternating current electricity is a current made by changing or alternating the direction of the electric flow or vibration 120 times or more a second. It is an electric current, which flows in one direction only 1/120 of a second, stops like the pause between two heart beats, and abruptly changes its direction to the opposite when then 1/60 of a second or sixty cycles to the second. When such a current alternates at more than 10,000 cycles per second, it is termed a high frequency current.

If such an alternating current is past over a spool—called a coil—or wire on a cylinder, so one can slide inside the other, the latter coil or secondary circuit receives and has induced into it a series of electric shocks from the primary coil.

The primary coil consists of fewer turns of coarse wire than the superimposed secondary coil. This has thousands of convolutions of fine wire. This ratio of 1 to 1,000 has an important bearing on the voltage. If the primary coil have 100,000 volts, 1,000 volts will be induced on the secondary.

This has been gained at the expense of rate of flow or amperage. This is known as a step-up transformer. A step-down transformer is made by having the finer wires in the primary and the coarser wire on the secondary coils.

High frequency electricity is made at first from a "step up" transformer. When these 100,000 volts are led into a pair of metal lined glass jars, called Leyden jars, which you can see in any electric supply house, it leads the current into a condenser.

A condenser is a device where electric conductors such as metal, salt, the human body, or what not, are separated by some non-conductor such as glass, tissues, or rubber, which act as an electric sponge.

A spark gap is connected with the Leyden jars. When the gap is closed the current flows onward. The negative and positive direction of the flow is quickly equalized. Every electric current, like gas or water, takes the path of least resistance.

Open this gap ever so little, and it offers a resistance to the electricity. As a consequence it spreads all over the inside of the Leyden jar, until it accumulates a pressure strong enough to overcome and force its way across the gap that is open.

(Continued on page 885)
Electricity to Prevent Future Fuel Crisis


"It must never happen again"—is the unanimous verdict of Americans on the present fuel crisis. Much has been said in the past concerning the necessity for conserving fuel, but now that we have actually suffered from a shortage of coal there is no further room for academic discussion. The time has come for action, and the important question of to-day is, therefore—"What can be done to avoid powerless factories and heatless homes, under no matter what unfavorable combination of circumstances?"

Our present difficulties arise from two causes: We need more coal than can be mined, and the railroads, with their extra burden of war work, are unable to handle such coal as is being mined. A plan, therefore, that would, while providing us with ample power, reduce our coal consumption per horse-power by at least one-half, and would at the same time increase the capacity of the railroads and also reduce to a fraction the amount of coal to be transported by the railroads, would appear to be a complete remedy for our troubles.

Fortunately, we have such a remedy at our disposal and the little or nothing can be done until after the war, except to use our existing facilities as efficiently as possible, the application of this remedy is certain to be the great work of American engineers during the next decade. This remedy consists in a general electrification of our industries, including much of our railroad mileage—the current to be supplied from huge central generating stations connected together by power transmission systems hundreds of miles long.

Single, Highly Efficient 40,000 H.P. Generator

60 Electric Generators of Various Sizes Totaling 40,000 H.P. Require Many Times Area of Single Generator, with About 1/4 the Efficiency

Coal Used in 1 Hour Run

Both of These Electric Plants Develop 40,000 H.P. Which Would You Choose?

One Thing is Certain—the War Conditions Imposed on Us Has Brought to Light Many Inefficient Methods of Producing and Utilizing Electricity in a Manner Which Has Resulted in a Whole Handful of Little Steam-Electric Generating Plants to Operate on Coal Fuel, Compared to the Gain in Efficiency by Centralizing All These Individual Plants in One Unit.

It is true we are using electricity today to perform much of our work, but practically all this power is generated and dis-detail distributed locally—either in small isolated plants or in central stations restricted to supply of water power—nothing further need be said. The folly of consuming millions of tons of coal and oil when upwards of 60,000,000 horse-power of water-power are allowed to run to waste, is now fully recognized, and one of the first steps that will be taken after the war will be to convert this waste into useful energy.

Coming to the second point, the saving of water power in the important industries of the Mississippi and north of North Carolina, used to supply the needs of the vast industries located here, so that coal will still be required here for power purposes until some new method of developing energy is discovered. What is necessary, therefore, is a more economical method of using this coal. One of the important recent tendencies in electrical development has been the construction of very large single generators. Fifteen years ago a generator of 7,500 horse-power was considered immense; today several generators of from 40,000 to 60,000 horse-power are in operation and units of up to 100,000 horse-power are under construction. These great machines are far more efficient than smaller sizes. A 40,000 horse-power generator can operate at full load for one hour on about 40 tons of coal (1 carload); whereas 80 generators of 500 horse-power each (totaling 40,000 H.F.P.), require from 80 to 100 tons (4 carloads) to run at full load for the same time. The accompanying sketch illustrates this fact forcibly. The amount of fuel that could be saved if most of our industries were supplied with power from such huge, centralized generators is obvious.
How the Mystic Current Makes Steel

The accompanying illustration shows the gigantic electrically operated steel plate mill in a large Cleveland, Ohio, steel works. ard registering and counting mechanism which has been extensively used in street railway service for several years.

"Somewhere in America"! This Gigantic Electrically Operated Steel Mill, with Hundreds of its Brothers, Is Rolling Out Thousands of Tons of Steel for Guns and Ammunition with Which to Fight the Kaiser. Insert Shows the Almost Human Electric Switch-Board Which Controls the 24-Hour Daily Performance of the Whirling Monster Above. The Men Come and Go, but the Motors Keep at It Continuously.

The accompanying illustration shows the gigantic electrically operated steel plate mill in a large Cleveland, Ohio, steel works. The white-hot steel billets emerge from the motor-driven rolls at the right, white off in a little room, hundreds of electric hammers are sending messages to the electric motors that run the machines.

"Stop"! "Start!" "Slow!" "Reverse" is the endless, monotonous series of orders dispatched with the speed of lightning and the sureness of a trip-hammer blow.

Men may come and men may go at the steel plant but the automatic motor control switches keep up the heavy stream of steel production 24 hours a day, week in and week out. Today, hundreds of these powerful electric steel rolling mills thru-out the length and breadth of the land are humming away night and day—rolling, squeezing, and swaging the glistening white-hot ingots into sheets of war—guns, shells, torpedoes, steel-base, etc., and stock for thousands upon thousands of other much-needed implements used by the American Sons of Mars.

Some of these steel mills are driven by ver-

Heretofore large crowds at such points have usually been handled by means of non-registering hopper fare boxes which re-

PLAT Form FARE B OX FoR SUBWAY SERVICE.

For handling large crowds, such as in subways, elevated stations, terminals, etc., a Chicago concern has developed a motor-driven fare box, which embodies several interesting features, as applied to the stand-

bronze, to show up in contrast, relieving the eye strain of the operator. This belt is operated over two rollers, the entire con-

From the agent's or operator's standpoint, he has clear vision and ample time for coin inspection without eye strain. He has a small catch to stop the coin belt, if needed, to call a passenger's attention to a false coin deposited. Should a mutilated coin or foreign material be dropped into the fare box, clogging or stopping the machine, a small crank is supplied which allows the operator to force the foreign pieces thru and clear the machine from all obstructions.

Another valuable feature is, that during the removal of any of the parts of the mechanisms, the money is always fully pro-

Further, with reference to collecting the money: The locking mechanism is so
designed that the collector cannot insert and turn his key to unlock unless the current is cut off the motor. This prevents the possi-

bility of money deposited in the hopper being past thru the box should the coin receptacle be out of place.

After the collector has stopped the mecha-

nism and unlocked the coin receptacle cham-

ber, he cannot remove his key until the filled receptacle is removed and an empty one properly inserted and the coin receptacle is removed before the mechanism can be started again.
ELECTRICAL EXPERIMENTER

Patriotism, Dr. Garfield, and New York

MANY persons have undoubtedly wondered just how patriotic the various sections of the country were during the recent "blue" Garfield Mondays, when the wheels of industry and business were closed down by official order. We are fortunate in being able to present direct evidence for at least one important case, that of New York City. The accompanying graphic curves show the total consumption of electrical energy in kilowatts for a period of 24 hours on two different days—one a heatless, fuel-less, workless day, and the other a normal day. The upper curve shows the consumption of electrical energy on Wednesday, January 23, 1918, and the lower, heavy line curve the amount of electrical energy used on "Garfield Monday," February 4, 1918.

As a glance at the figures and curves demonstrate clearly, the greatest saving effected on Garfield Monday, February 4, occurred at 5:30 P. M. in the evening, when the New York Edison Co. and the United Light and Power Co., together supplied about 112,000 kilowatts. At the same hour on a normal work-day, or on Wednesday, January 23, the "peak" of the load was at 5:30 P. M. shows a total consumption of approximately 240,000 kilowatts, or the saving at the "peak" of the day's load was 128,000 kilowatts, a saving of 53 1/2 per cent.

From 12 o'clock midnight of Sunday, and on thru the early morning hours up until 7 A. M., Monday morning, the difference in electrical energy consumed on a typical Garfield fuel-less Monday, as compared to an ordinary work-day, indicates that only a slight difference was effected in electrical energy saved, or, on an average, about 8,000 kilowatts.

Proceeding from 7 o'clock in the morning, the saving due to the closing down of industrial plants, office buildings and stores, etc., were entirely closed down and the mean increase of about 10,000 to 12,000 kilowatts in the afternoon is due largely to the theatres, a considerable number of which gave special Monday matinees. The theatres were allowed to remain open Monday afternoon and night by Fuel Administrator Garfield, but were closed Tuesdays all day and evening.

As the evening of Monday approached, or at the hour of 6 P. M., the highest point of the day's load occurred, which for Garfield Monday was 130,000 kilowatts. As aforementioned, the total saving at the "peak" of the day's load due to the Fuel Administrator's order in closing all stores, except food and drug stores, besides factories and office buildings, amounted to 128,000 kilowatts saved, or 53 1/2 per cent.

Curve "B" for Monday parallels on a lower level in general the contour of Curve "A" for Wednesday, and the reason why this is so, particularly in the evening period, is because of the extensive street lighting and traffic power requirements in such a large city as New York. The evening load factor remained fairly large from 7 to 10 P. M. owing to the theatres and restaurants.

From this point the load graph continues downward until it reaches the end of the 24-hour period coming under the Fuel Administrator's orders, with a total energy consumption of 74,000 kilowatts. After passing 12 o'clock midnight of Monday, the curve would continue to drop to about 54,000 kilowatts at 3 P. M.

Yes—New York City was quite patriotic!

Among the hundreds of new devices and appliances publish monthly in the Electrical Experimenter, there are several, as a rule, which interest you. Full information on these subjects, as well as the name of the manufacturer, will be gladly furnished to you, free of charge, by addressing our Technical Information Bureau.
On Jan. 2, 1918, a call signed by Messrs. Frederick A. Scheffer, Charles Wirt, Sidney B. Paine and William J. Hammer was sent to many of Mr. Edison's earliest assistants and associates requesting those who had entered his service before and including the year 1885, to attend a meeting at the Engineering Societies' Building, New York City, on the evening of January 24, 1918, with a view to effecting a permanent organization. The charter of such an organization had often been broached by the men who had been intimately associated with Mr. Edison and his interests at his famous Menlo Park, N. J. Laboratory, 65 Fifth Ave. (New York headquarters of the Edison Electric Lighting interests), the Edison Lamp Works, Machine Works, Underground Tube Works, and the various other commercial, engineering and manufacturing interests connected with Mr. Edison's electric lighting, telegraph, telephone, phonograph, electric railway and other interests in this country and abroad. Scheffer said that a select group of Mr. Edison's early associates, shown in the accompanying illustration, met in the Board Room of the American Institute of Electrical Engineers, thru the courtesy of the Institute, and took the initial steps to form an organization to be known as "Edison Pioneers."

Many letters were read which had been received by men entitled to belong who were unable to be present, and who one and all approved of the movement and wished to be included. Others wrote requesting that the line of demarcation be drawn at various dates subsequent to 1885 so that they might be included, but it was decided that as perhaps one million persons have been connected directly or indirectly with Mr. Edison's various interests here and abroad, it was essential that the organization should at present be limited to the very earliest of those connected with the inventing, developing and commercializing of Edison's inventions, and later on taking in on some basis certain men whose work has been of most importance in Mr. Edison's later spheres of usefulness, such as the storage battery, moving pictures, etc.

The following officers were elected: President, Francis R. Upton; vice-president, Samuel Z. Mitchell and T. Comm erford Martin; secretary, Robert T. Lozier; treasurer, Frederick A. Scheffer; historian, William H. Meadowcroft.

Various committees upon organization, constitution and by-laws, etc., were appointed, and a telegram was sent to Mr. Edison apprising him of the formation of the "Edison Pioneers", and after indulging in (Continued on page 857)
An inventor's recent claim of our ability to utilize the cosmic force has brought forth considerable conjecture concerning the meaning of such a discovery (referring to the claims of one—Garabed Giragosian, of Boston). "Cosmic" is defined as pertaining to the universe, universal or orderly, and "Cosmical Physics" as a term broadly applied to the totality of those branches of science which treat of cosmical phenomena and their explanation by the laws of physics.

The sun is considered as the source of all energy, which is conveyed thru space by a condition which, as far as we have been able to determine, is ether. These particles of energy in some form apparently shoot thru all space, altho it may be determined that the planets and other celestial bodies focus the sun's energy upon themselves by or on account of their own gravitational attraction. The earth is constantly being bombardized by minute specks of energy from the sun, rather than by waves of any magnitude, which on passing thru the strata of the atmosphere, develop thru the earth are transformed into light rays, heat waves and numerous other forms of energy, some of which we have been able to determine by recent scientific research. This conclusion has exploded the theory that the sun gives off light and heat directly, which theory was indeed absurd, it having been assumed before the present electrical age and should be discarded, now that we have begun to see the "light."

An understanding of the first principles of cosmic force must first be secured, as this force is the power to be developed into our different requirements, and, as the principle is revolutionary to the old teachings it will be more clear to many if an example is cited. In ascending to a high altitude, as on a mountain, where there is a different atmosphere, the atmosphere which is much more rare than at the lower altitude and therefore with less transforming effect on the form of energy received, the temperature of the atmosphere becomes colder and more noticeably so in the higher altitudes reached by balloons, and also it is noticeable that there is less light, regardless of the fact that they are constantly approaching the sun. Both light and heat diminish inversely as the square of the distance from their source, so that if the sun radiated both light and heat, the air should be at a much warmer temperature and more light should be around an object, at a given altitude, which easily proves the fallacy of the older theory. If we consider the extreme instance of a single particle of energy in its true form must pass as it is propagated from the sun, it must arrive at the earth's upper strata of atmosphere with little or probably no loss of intensity. In its true form a minute speck of energy is used in the sense of a minute pulsation or vibration and not as a small particle of matter or substance.

Vibratory energy is classified according to the intensity and rapidity of its vibrations. The first evidence that we are able to recognize is sound, and, as the rapidity of vibration increases, to heat, electricity, light in its several colors, is recognized, each color having a different rapidity of vibration. The human eye is not able to distinguish all colors of the spectrum, the rays below red on the lower scale and violet on the upper becoming invisible, but we know that certain waves are seen by some birds and animals. This is about as far as our senses are able to discern these conditions united, as most of the higher order of vibrations cannot be studied directly, but only by witnessing the effect they produce under varying conditions, which are usually referred to as or Hertzian waves, ultra-violet, X-ray, and thru research with radio-active material there have been discovered the alpha, beta and gamma rays of high frequency.

When calibration of the amplitude and rapidity of all of these vibratory forms is perfected, a new field of research will be opened up which we have not hitherto been able to study, whether directly or indirectly. We may be able to take this energy as we receive it from the sun, calibrate it, pass it thru some sensitive or substance, possibly an inert gas with a known resistance, and transform it into all light or all heat, as may be required, not unlike the method of transforming an electric current into a higher or lower voltage, or by the transforming of electrical current thru an incandescent lamp into light rays.

It has been estimated that the total energy on the surface of the earth amounts to about 5,000,000 horse-power to the acre and numerous attempts have been made to apply a part of it to industrial uses by lenses, mirrors, etc. This is the total amount of the heat that has already been transformed by the earth's passing thru the earth's atmosphere, to the earth's surface, and in industrial application, but when we are able to transform all the energy into heat, then it will be a simple matter to produce steam, smelt ores and metals, and even serve for domestic use. When this is accomplished, mining, transportation and the methods of use of fuel today for the same purpose will be severely shocked. Electrical principles worthy of consideration, however advanced they may appear, for any rate it is out of our present knowledge that they will be developed, considering the wonderful strides made in their study in the last decade.

We may go even farther than this and actually demonstrate conclusively that matter is only a form of crystalized energy, directly related and a part of the cosmic force, and to our uses as a material, solely a creation of the mind. Scientists are approaching this principle thru the study of radium and radio-active material which radiate energy in forms that can be observed. Effects from such unstable molecules must not be considered as shooting off an electron, which is an infinitesimal particle of matter, thru some other element, but they should be considered as a speck of energy which passes as a vibration, not unlike sunlight in its passing thru a transparent substance like glass. It has been verified that what we characterize as matter is a substance in a violent state of motion. Matter consists of molecules, atoms and even finer divisibility, all comprising a form of energy in a balanced state. When the balance or stability of an electron, light or molecule is destroyed, a certain amount of energy is (Continued on page 872)

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(Continued from page 872)
The Phenomena of Electrical Conduction in Gases.

PART I. WHAT IS IONIZATION?

By Rogers D. Rusk, M.A.

A FEW years ago scientists were so busy studying currents of electricity in wires and liquids that they thought very little about currents of electricity in gases. In fact, up until 1880, it was supposed when an electrified body lost its charge in the air that this was due only to dust, or moisture in the air, and to faulty insulation. Now we know that the molecules of the air or a gas may themselves act as carriers of electricity and thus conduct the charge away in addition to the other factors mentioned.

This idea has been much more revolutionary than most people suspect. It has helped us to completely change our idea of matter, and has helped us to discover marvels as great as in any scientific field, as for instance the production of light without heat by ionization. It has given us the Audion and all similar detectors used in wireless telegraphy, which are applications of what is called the Edison effect. Beyond all this it has given us, more than any other field, facts which should instill and prove the electron theory of matter, and universal nature of electricity.

The field of ionization in gases is truly a twentieth century branch of science because only since 1900 has it been studied as a separate field in itself. Unlike most branches of Physics and Electricity its youth keeps it from having reached the degree of complication and mathematical complexity usually to be encountered. Neither is the history of the study of ionization in gases long or involved nor is it buried under mathematical formulae. Brilliant experiments are still being accomplished with simple apparatus, and for these reasons and for the things of the future which may be expected, it seems that a study of this field should prove doubly interesting both to the tyro in scientific matters and also to the professional scientist.

By ionization is meant that change in a non-conducting gas or liquid which renders it conducting. Evidently this may be effected by the addition of molecules of the conducting medium, splitting up, remaining single, or grouping themselves together in little clusters, and then acting as carriers for positive or negative charges. It is common knowledge that in liquids the molecules break up into two parts carrying equal and opposite charges, and that the matter travels in opposite directions toward their respective electrodes, and thus carry the current from one pole to the other. The same thing is true in gases except that the ions do not slide along a conducting liquid but fly thru empty space, colliding with each other frequently, and zigzagging along. Also in the case of gases we may have pairs of molecules, whole molecules or groups of them acting as the carriers, depending on conditions.

It is because of these ions which are formed in a flame that a current of electricity can be made to jump a gap between the metal points, if a flame is held between them. In Fig. 1 a device is shown for testing the electrical conductivity of a flame by means of a galvanometer. When the flame comes in contact with the points A and B a swing of the galvanometer needle will denote a current across the gap AB.

In the same way the presence of ions, a current will pass thru air or a gas upon which has fallen X-rays, ultra-violet light, or the rays from radio-active substances. For the same reason, too, a current will pass in an Audion bulb from the plate to the filament.

In order to understand properly where the study of ionization begins it is necessary to note the high points of experimentation which have marked our present position. Faraday, the great pioneer electrical student, disclosed the keenness of his scientific insight in a statement which he made about 1840 when he was studying electrical sparks in different gases, in which he says the idea came to him that there was "no direct relation of the electric force with the molecules of the matter concerned in the action." Faraday saw that the molecules of the gas themselves had something to do with the action, but little came of his suggestion for a long time. In 1879, Crookes arrived at the startling conclusion that cathode rays were minute charged particles of matter, and soon after the discovery of the X-rays, in 1895, the cathode ray spectrograph was made and actually measured in mass and charge by many investigators including J. J. Thomson. These facts led J. J. Thomson, along with E. Rutherford, his co-worker, to formulate the ionization theory of gases which is now universally accepted, and which assumes that the negative ions, which themselves act as carriers for the charges or electrons.

One of the first things to be noticed in the study of ionization is that under some conditions immense numbers of positive ions may be present and very few negatives, while under other conditions exactly the opposite may take place. This, of course, would have been entirely impossible in liquids where always the same numbers of negatives and positives are present. Investigation has shown that different solids give off different kinds of ions, when heated, and that the same solid may give off different kinds of ions when heated to different temperatures or surrounded by different kinds of gases. For instance, the nitrates of calcium, strontium, and barium give off negative particles or electrons when heated, while on the other hand aluminum phosphate gives strong positive ionization. A mixture of one of the nitrates and aluminum phosphate gives off both kinds of ions. Anyone can easily test various chemicals to see what kind of ions are given off by use of an apparatus as shown in Fig. 2. AB and CD are the sides of a metal tube in which a wire filament FF is led thru insulators. The filament FF is coated with the compound to be examined and then heated to incandescence by means of a suitable battery. A galvanometer and auxiliary battery are bridged around the tube and the filament so as to complete the circuit thru the galvanometer across the air gap between the filament and tube. If the filament gives off negative ions or electrons the current will pass in the direction of the arrow but not in the opposite direction. If the ions given off are positive the reverse is true. It is of course important to keep the ends of the oscilloscope in good condition. For such work the ordinary galvanometer is not found as sensitive as is often desired and usually an electrometer or some form of oscilloscope is used. Frequently, instead of measuring the current across an air gap, a charged body is placed in the presence of the ions and the rate of leak of its charge is taken as an indication of the strength of the ionization. In such work the field of static electricity plays its practical value and the old gap between static and current electricity almost disappears.

It used to be thought that static electricity was more or less a playing only, and that the oscilloscope was useful only in demonstrating simple facts about electrification, and was not an instrument of scientific precision. Now, in improved forms, it is one of our most sensitive instruments and one of the most practical used in measuring minute quantities of electricity, especially ionization currents. The form of the ordinary gold leaf electrometer is familiar to everyone, but some of the more improved types do not resemble it very much, although they work on exactly the same principle. The form of one of the most sensitive types, is shown in Fig. 3. Two electrodes are led into a

This Form of Extra Sensitive Electroscope Was Devised by Wilson for the Purpose of Detecting Ions and Measuring Electric Currents Due to Ionization.
NEW PORTABLE ELECTRO MEDICAL APPARATUS

The beneficial effects of electrotherapeutic treatment are coming to be so generally recognized that a large demand has arisen for simple and portable equipment by which it may be applied by the ordinary laity. Especially is this true with high-frequency apparatus, which gives an invigorating and perfectly safe as well as pleasant treatment found very satisfactory by physicians, chiropractors and beauty experts for many ailments and for toning the tissues and nervous system.

The accompanying illustration shows a combination cabinet and wall plate for physicians. It provides in one compact set for the four treatments commonly used in electrotherapeutics, namely, galvanic, faradic, high-frequency and sinusoidal currents. It includes a cord for connecting to the ordinary lighting circuit, an adjustable induction coil, a rheostat, a Tesla coil, a milliammeter, two lamps for illumination and resistance, a spark gap, special electrodes or applicators, connecting cord, terminals, etc. Ease of adjustment is provided for in every detail. Means are also arranged for connecting and regulating the different lamps.

This outfit is mounted in a portable and handsome oak case, measuring only 16 by 10 by 7½ inches. It can be carried like a suitcase or quickly mounted on the wall.

The galvanic current is produced without the aid of dry cells and at all times the current is steady and even. The slightest change in the current is immediately communicated to the sensitive milliammeter mounted on the front. The current can be regulated to any degree of strength and will be maintained so to any desired time.

The faradic current is produced by the faradic coil mounted beneath the milliammeter. The core of this coil is made of unhardened iron wire, which furnishes greater magnetic saturation than the solid core. The primary and secondary windings are wound in exact proportions in order to give absolute resonance.

The high-frequency current is produced by the same coil in conjunction with a Tesla coil. The high-frequency current is regulated by means of a spark gap mounted underneath the coil and also by the knob regulator on the coil itself. The knob regulator controls the vibrator spring.

The current can be decreased from a spark of over three inches to such a fine current as to be almost imperceptible, at the same time maintaining its smooth, even flow.

The various electrodes are attached to a small handle which is very convenient. The cord from the instrument to the handle is of pure gutta percha.

Unique Portable Electric-Medical Set For Private or Physicians’ Use.

The shunt rheostat regulates the voltage and intensities of the different currents. It is wound to a high resistance and is claimed not to deteriorate or heat.

AN ELECTRICAL MAGAZINE SOLDERING IRON

A electrical magazine soldering iron has been patented by Ray M. Tilton, of Pa- nora, Iowa, which possesses several desirable features. One object is to provide a thin-soldering iron having a hollow shank connected with a handle at one end and a hollowing to hold the hand- ler at the other end, with means for controlling the passage of particles of solder thru the shank.

The top finger extends above the shank and outside said shank, as shown, whereas when the two arms, which side by side, are pretz toward the shank, the upper finger exten- sion enters the shank while the lower finger leaves the shank.

The two arms are so ar- ranged as to be rigidly engaged by the thumb of a person whose hand grasps the handle. The upper and lower metal fingers are spaced apart such a distance longitudinally of the shank, that between them is the proper space to receive a small pellet of solder.

In the practical use of this improved soldering iron, the handle and the portion of the hollow shank adjacent to the handle is filled with solder pel- lets, when the cover is removed. One arm normally holds the lower finger in position so that the pellets are moved toward the point of the iron.

By pressing the two springs toward the shank and holding the entire device, as shown, whereas when the pellets nearest the iron will be permitted to roll downwardly into the iron, where it will be melted and, when flowing thru the narrow passage shown to the exterior of the iron.

INDIANA TOWN BECOMES DARK WHEN CITIZEN TAKES

For the space of one minute all the lights in Marion, Indiana, recently went out and all institutions depending on Marion cur- rent for operating were crippled, all because John Coats, while taking his regular Sat- urday evening bath at his home, got hold of a live wire, in attempting to shake into life a defective electric light globe and could not let go.

Standing in the water with 110 volts coursing thru his body, all Coats could do was to yell for help. A neighbor quickly discovered Coats’ plight and telephoned the light company, which turned off all the current. Marion is in a serious nervous condition for some time afterward, but suffered no serious injury.

“MOVIES” HELP TO PUSH ELECTRICAL SALES

The “movie” is the greatest salesman in the world today—a merchandising method considered to be between 95 and 100 per cent efficient because, says the Society for Electric Development—1. It gets the un- divided attention of its entire circulation.

2. It interests everyone because it’s a movie—a story—because it life itself, the most interesting thing in the world.

3. It “gets over” a selling argument more thoroly and effectively than a human salesman possibly could—and to hundreds of persons in a few minutes.

In other words, an entire sales argument is compressed into a few feet of film, an argument which would take hours to ex- plain, and pages and pages to describe—and not near so convicngly.

“The Home that Runs by Magic” is the title of one very interesting “Universal” motion picture, which emphasizes the fact that the modern home is electrically eqipt througout and that the labor of housekeep- ing is appreciably lightened by the use of electrical appliances.

It is a heart-interest story about a young bride whose husband gives her an All- Electric home. The first scene shows them riding up to it in their new Electric Car. Next you see them at breakfast using their Table Appliances—then getting dinner in their Electric Kitchen. Next wife makes wash day in her Electric Laundry. Other similar scenes follow. The picture vividly demonstrates the utility and comfort of Electric Appliances and drives home their practical appeal this year. It shows in actual operation: Toasters, Grill, Warmer Pad, Percolator, Electric Car, Flat Iron, Saw and Razor, Floor Lamp, Electric Range, Kitchen Utility Motor, Washing Machine, Electric Refrigerator and Drink Mixer.

These films are available at a nominal figure, and are run in the electrical con- tractors’ home town “movie” theaters. This scheme is both instructive and educative as to the ways in which electricity can be used in daily life, besides being a mighty good booster of electrical sales.
How can we utilize burnt-out electric lamp bulbs? Almost everybody has several of these lying around idle. For the purpose of having the household as well as the experimenter make use of such discarded bulbs, the present article has been prepared.

We will pay until further notice monthly prizes as follows: First prize—$3.00 for best suggestion; Second prize—$2.00; Third prize—one year's subscription to the ELECTRICAL EXPERIMENTER. Every reader may join in this contest, and you need not be a subscriber to participate. Ideas will be published monthly under the head of "Burnt-out Lamp Contest." All letters should be addressed to "Burnt-out Lamp Contest." The Editor.

Everybody who has electric light has, as a rule, a good many burnt-out lamp bulbs lying around idle which are not of any use, and sooner or later are discarded or perhaps thrown at nocturnal song makers on the fence, with indifferent results to the singer. The thought of utilizing such bulbs had been a pet idea of the writer's for a long time, and the present article, and the ones we hope will follow, aim to save these old bulbs. The few ideas which we illustrate in the present article do not, of course, cover the whole subject. We are quite confident that there must be hundreds of other uses for the burnt-out bulbs, and we hope to present in our future issues further—and better—ideas of our ingenious readers.

The applications shown in Figs. 1, 2 and 4 are rather old, and are merely shown in this article to make it more complete. The other ideas were evolved by the writer and are supposedly new.

Fig. 1 shows how an excellent barometer, that will correctly predict changes of the weather, can be made from an ordinary lamp bulb. Take a burnt-out lamp, it matters not whether it is of the tungsten or carbon variety, and place it in a basin of water, tip down. Now, by means of a heavy, sharp pair of scissors, cut off the glass tip, while holding the lamp under water. Be careful that when cutting off the tip not too much is cut off; just a very little will do. Immediately upon cutting the water will rush into the bulb with a violent boiling effect.

It takes but a few seconds to fill the bulb almost full. When taking the bulb from the water, contrary to expectation, the water will not flow from the small aperture at the former tip of the lamp. We now take the lamp and fasten a wire or cord around the screw part, so that the lamp is suspended tip downward (see illustration).

When the weather is fair for several days, no water will issue from the tip of the lamp. If, however, rainy weather impends, a drop of water will be observed at the tip, and it is quite surprising that a simple barometer of this kind will actually predict rain or fair weather twelve to twenty-four hours ahead of time. After a while, particularly, if there is much rainy weather, the bulb will become empty, as sometimes a few drops of water will come out of the bulb. This does not necessitate the throwing away of the bulb, and the reader has found a simple means for refilling it. Heat the bulb over a hot fire so that it becomes quite hot, then plunge into a pan of hot water, and the water will rush into the bulb filling it about three-quarters. Inasmuch as ordinary water is colorless, the writer suggests putting a coloring matter in the water before filling the bulb, which not alone makes the device more attractive, but at the same time makes it more easy to observe the tip when the water leaves it.

Our next illustration, Fig. 2, shows a simple device which you perhaps have seen already. This is something for the ladies, and particularly those who like to knit or crochet. An ordinary lamp bulb is decorated with red or other colored silk crochet work as illustrated, the idea being to form a balloon. Directly underneath the screw part of the bulb, an iron ring which may be a small key ring is located, which may be crocheted over. This ring is suspended from the bulb by means of silk threads as shown. The ring itself in turn supports the crochet basket or the car, which latter may be used to hold artificial or real flowers, as may be desired. Our illustration shows this accurately. At the top of the lamp a stout silk cord is sewn, and the whole may be attached to the chandelier in the parlor, or dining room lamp, giving a very pretty effect.

In Illustration No. 3 is shown how the average experimenter can make small chemical vessels for experimental purposes, simply by using only the glass part of discarded lamp bulbs. One illustration shows a wooden block with wire work and handle on the style of soda fountain tumbler-holders, while the other illustration shows a similar idea, but here the holder is made of wire only. The lamp bulb may be cut by means of a three-cornered file, and it is safe to first break off the tip of the lamp to let the air in. This makes the cutting safer. The tip may afterwards be placed in a Bunsen burner to seal up the small hole which, of course, is necessary, otherwise liquids or acids would run out from the improvised chemical vessel. Another way to cut the lamp in case no file is had, is by taking a heavy string of cotton cord,
soaking it in alcohol and wrapping it two or three times around the point where the bulb is to be cut. Hold the bulb in the hand and light the cord with a match. After all of the alcohol has burnt out, will smash the bulb with a loud report. The thread itself is fastened by means of a special staple or tack to the door as shown in illustration. One or two feet of thread will do nicely. Of course, this alarm can be used again by putting another lamp in place.

Here is a medicated vaporizer or room fumigator that can be made by anyone at very little cost, Fig. 5. Take an ordinary lamp bulb and break off the tip, then cut off a small part at the top as shown. This you can do by means of a file or otherwise with a diamond. For that matter any glazier will do it for you for a few cents if you do not care to do it yourself. Break off all the filaments, leaving only the two lead wires exposed, as shown. Fill the bulb with either of the formulae as given below, all depending on the purpose for which you wish to use it. Fill the bulb as shown, and connect to your light supply. No resistance of any sort is required. Within a few seconds the water will begin to boil, while fumes will issue from the top of the bulb. Formula No. 1 has been prepared by a well-known physician and is excellent in case of colds, extensive coughs, cases of hooping cough, etc. Formula No. 2 will fumigate any room very quickly. The writer recommends both formulae. The beauty of this device is that it works entirely automatically for the simple reason that as soon as the liquid has evaporated below the level of the two lead wires, the current is turned off automatically, and no electricity—decomposition of water. These instruments are more or less expensive in the market, and as a rule a student does not wish to bother by buying one of them as they sell in the neighborhood of three to five dollars each. In Fig. 6 the writer has shown how one of these instruments can be made for practically nothing. All we require is a burnt-out electric lamp bulb. Any size will do. Proceed as explained in the preceding article of the vaporizer, as far as cutting off the top of the bulb is concerned. Leave the two lead wires exposed as shown. Fill the bulb with diluted sulfuric acid, five parts of water to one part of sulfuric acid. Over each one of the wires place a narrow diameter test tube, which test tube must be full of electrolyte, which can be done readily by filling them first, and while holding a finger over the open part insert in the bulb filled with the diluted acid. This will keep all the liquid in the test tubes, which is quite necessary. Both test tubes of course should be full. Now that everything is ready, connect the apparatus to a source of current, such as a six-volt storage battery or six good dry cells. It is understood that the bulb thus prepared is screwed in a position receptacle as shown. As soon as the current is turned on you will see gas bubbles arise in each one of the test tubes, and you will observe that the gas accumulates twice as fast in one tube as in the other. The first tube, which contains the most gas, will con-

Fig. 7. A Student's Electroscope from an Old Burnt-out Lamp Bulb? What? Very Simple If You Know How.

Fig. 6. This Shows How You Can Make at Practically No Cost a Very Efficient Apparatus for the Decomposition of Water—Electrolysis.

more fumes are generated. It is therefore entirely safe to leave this device run once it is started. It will stop at once as soon as enough liquid has evaporated.

FORMULA No. 1.

For Colds, Coughs and Croup.
Oil of Eucalyptus ............. 60 drops
Menthol .......................... 60 grains

Tincture of Benzoin compound
( enough to make 2 ounces)
Of the above, use 1 teaspoonful heated upon water in vaporizer. Add a pinch of salt to make solution conducive.

FORMULA No. 2.

For Fumigating and Disinfecting.
Have druggist make a 40% solution of formaldehyde. Add a pinch of salt to make solution conducive. A user without diluting in vaporizer. This solution is excellent for killing flies and mosquitoes, and is to be operated in closed rooms without any people being in the room at the time of the fumigation.

Nearly every student wishes a cheap as well as good instrument to demonstrate (Continued on Page 889)

Fig. 8. Making an Efficient Condenser by Means of an Old Lamp Bulb Is Quite a Simple Matter.
ELECTRICAL EXPERIMENTER

April, 1918

EXPERIMENTAL PHYSICS

By John J. Furia, A. B., M. A. (Columbia University)


A CERTAIN kind of iron ore has the power of attracting iron (and cobalt and nickel somewhat). When a piece of it is suspended so as to swing freely it will come to rest in a north-south direction. This ore, called lodestone, iron oxide or magnetite, from Magnesia (not citrat, but a town in Asia Minor, where it was first discovered), is also known as the natural magnet to distinguish it from the artificial magnet. If an ordinary steel needle is brought near some iron filings it will not have any attraction for them; and if it be suspended freely it will not, in general, assume a north-south direction. If, however, this needle is gently stroked over a natural magnet (a bar or horseshoe magnet will do) from the middle toward the point, it will now attract iron filings and assume a north-south position when suspended so as to swing freely, i.e., it has become an artificial magnet. If, instead of a steel needle, a piece of soft iron is used we find that it does not become a permanent magnet, but if the bar or horseshoe magnet is held over it or in contact with it the soft iron does become a magnet temporarily, while the magnet is held near. Hencce pieces of soft iron can be made to act as temporary magnets, while pieces of hard steel retain their magnetism to a great degree and can hence be made into permanent magnets.

It has been agreed to call the end of a magnet which, when swinging freely, points to the north the + or north-seeking pole or more simply the north pole of the magnet, and the other end the — or south-seeking pole. The ordinary compass is a small light bar magnet (needle) balanced upon a sharp pivot.

EXPERIMENT 66—Magnetize a needle by stroking it a few times with a bar or horseshoe magnet. Bring the needle up to a small compass. One end of the compass will be attracted to the needle. Turn the needle around and bring it up to the compass again. Now the other end of the compass is attracted. By supporting our magnetized needle, we can determine which end is + or north and which is — or south. We find that the + end of the needle attracts the — end of the compass, and vice versa; i.e., unlike poles attract. If now we bring the + end of the needle near the north pole of the compass or the — end of the needle near the south pole of the compass, we find that they repel each other, i.e., like poles repel.

EXPERIMENT 67—Place a compass so that its needle points to its north (N) point and then place the + end of a bar magnet one inch from the "W" point of the compass and note the deflection of the compass needle. Now move the bar magnet so that the + pole is two inches away. The deflection is found to be only one-fourth as much as before. If we move the bar magnet (N) pole of the needle is placed over the N pole of the magnet it will be found to travel over to the S pole in a curved path. On starting the cork from different positions it will repeat as above, following different paths. The path which a free N pole travels over, when placed over the N pole of a magnet, is called a line of force. Obviously there are an infinite number of such lines, and these as a whole are called lines of force. From what we have said so far it is apparent that a free N pole cannot exist, but recalling that force of attraction (or repulsion) varies inversely with the square of the distance, we see that the long needle acts as a free pole (its other pole being so much further away from the bar magnet). Fig. 61 shows several lines in a field of force. A good way to obtain a field of force is to place a magnet under a sheet of paper and sprinkling iron filings over it. The filings arrange themselves along the lines of force. A permanent record of a field of force can be obtained by using photographic paper (working in a darkroom), sprinkling the film with iron dust, and then developing as one would a photographic print. (See Figs. 62, 63, 64, 65 for some typical fields of force.)

EXPERIMENT 69—Suspend an unmagnetized needle by a thread so that it hangs horizontally. Now magnetize it. It will be

(Continued on page 876)
A CURIOUS EXPERIMENT.

Editor Electrical Experimenter:

I have read your "Electrical Experimenter" for many years, and I believe the more one knows about the "game" the better he likes it.

Here is a little experiment or rather an explanation of an effect that may occasion a smile, but laugh as you please, it is a fact.

I was moping around the house, after an illness of about a week. My attention was attracted by the beautiful colors of the spectrum which were playing on the white kitchen wall. I soon discovered the cause of the same. An August sun was streaming thru a window and the rays impinged on a bevel edged mirror that had once ornamented the top of the old head. As I watched it, the color effects I took the glass and went to the rear porch and amused myself with the old trick of "shooting" chickens with the spotlight from an 8" x 10" glass. It suddenly occurred to this boy to "shoot" me, and if there is any thing as a fine illusion, I wish I aimed at him. My flash struck his glass, his head glowing like an arc lamp. His ray stood out on the air and I felt like I could have shot from my hand as I received a shock which I can only liken to the effect of the discharge of a Leyden jar, which once I threw thru my house and occasionally my classmates a hearty laugh.

That was many years ago, when they made electricity with a glass wheel, turned with a crank, and I believe a crystal and nothing was known of the art as we know it today.

To return to the battery of glasses. The boys gave no shock. His mirror was incased in a wood frame. There was no frame on the glass I held and my fingers were in contact with the metal rod of the back. I stood on a wooden porch six feet above the ground and he stood on the ground.

This theory has, so far, satisfied my mind, and I have given it some thought: The effect was due to an electric charge, generated by friction, or a like process, on the opposite sides. The boy's focused rays impinged upon mine. Friction and velocity of rotation, with a forward directed ray (electric light) produced the electric charge which could convert my body into a condenser of considerable capacity.

Most of my experiments have produced heat. This is a conductor.

While I may have been interested in the experiment of some of our readers, I always keep a wary eye on the "game" that I may disappear.

FULTON GARDNER.

Chicago, Ill.

[The editor has always been interested in interesting and educational experiments.]

A COLLEGE STUDENT'S RECOMMENDATION.

Editor Electrical Experimenter:

Several years ago, while attending High School, I purchased two copies of your magazine. Ever since then I have bought every issue as soon as possible and have read and actually studied them. I always keep them handy for reference, and have almost every issue, from that of June, 1915, to the present issue. The few that I lack, I loaned to several friends upon request, and evidently they liked them so much, they forgot to return them.

I have found your magazine invaluable to me in my studies, clearing many problems, both in physics, chemistry, and the other school subjects. I am working during the four years which I attended Stuyvesant High School. I may add, that I consider the ELECTRICAL EXPERIMENTER very instrumental in securing for me a rating of 100% in a Regents Physics Examination.

The principal thing that I like about your magazine is its clearness. In fact, I firmly believe that it ought to be used as outside reading matter in conjunction with the regular text-books in technical schools. It is all very well to study the standard textbooks of science, but still, one must keep abreast of the times, and to all such, I earnestly recommend your publication.

The only criticism I have to make (I admit that adverse criticisms are hard to find) is the relatively large amount of the material in the magazine. There is an inordinate amount of very interesting material, which I think could be better utilized in the form of more to an education in the various sciences.

Furthermore, I regret the occasional use of a large number of experiments with very few details. Some of them are suggested as a matter of course at any moment, when the student is not in the mood to experiment. I believe these are better suited to the less interesting reader.

I have been a subscriber for many years and have found your magazine a valuable addition to my library. I wish you every kind of success in the future.

E. C. T. 

April, 1918
Notice to All Radio Readers

As most of our radio readers are undoubtedly aware, the U. S. Government has decided that all Amateur Wireless Stations, whether licensed or unlicensed, or equip for receiving or transmitting, shall be closed.

This is a very important consideration, especially to those who are readers of THE ELECTRICAL EXPERIMENTER, for the reason that we desire to continue to publish valuable articles on the wireless art from time to time, and which may treat on both transmitting and receiving apparatus. In the first place, there are a great many students among our readers who will demand and expect a continuation of the usual class of Radio subjects, which we have published in the past four years, and secondly, there will be hundreds and even thousands of new radio pupils in the various naval and civilian schools throughout the country, who will be benefited by up-to-date wireless articles treating on both the transmitting as well as receiving apparatus.

Remember that you must connect up radio apparatus to any form of antenna.—The Editors.

Intensive Training for the Signal Corps

By A. C. LIETZ

The men selected for commissions in the Signal Corps must, in the first place, possess special qualification and be experts in some particular line such as telegraph, telephone, aeronautics, engine, balloons, radio telegraphy, photography, some allied technical branch. It remains, therefore, to give them a working knowledge of those branches with which they are not already familiar and to teach them those things not generally taught in the schools, namely: military maneuvers, visual signaling, military customs and regulations, court-martial procedure and the application of their technical knowledge to the science of warfare.

Before the entrance of this country into the war there were but two ways to secure a commission in the corps. One of these was by enlisting in the corps and passing an examination for a first lieutenant. This was next to impossible as will be seen later, although it has been done. The usual way was to take a special course at the Fort Leavenworth School after having been commissioned as a second lieutenant in the line, that is, infantry, cavalry or artillery. This took about five years, including the four years at West Point. From this it will be seen that it is necessary to crowd five years' hard work into approximately three months, utilizing seventeen hours out of twenty-four.

First and foremost it is necessary to give the newly commissioned reserve officer an opportunity to command units of various sizes, these being composed of officers undergoing the same course and who may then be termed the awkward squad and must consider them as such. He must consider that he is in regular command of that unit and that it is composed entirely of raw recruits, explaining each movement before giving the command of execution, all under the watchful eye of the instructor. In this way he puts into practice what he has learned from studying the drill manual.

Several hours each day are devoted to conferences to discuss the lessons assigned and studied the night before. This covers “the soldier’s bible,” Army Regulations, also Signal Corps Drill Regulations, Field Service Regulations, and Manual of Court Martial. A part of the period assigned is devoted to a discussion and explanation of the subject and a part to answering questions of the student officers. These discussions form a very important part of the course, as they bring up many things not written in books. The Naval and Military Service has a code of unwritten laws known as “customs and usages of the service.” Some of these customs are as old as military history itself, and, although not as interesting. They cover the personal conduct of the officer and his social conduct towards his fellow officers and towards the enlisted men. The students are taught what the older and experienced officers have learned from a study of the enlisted man.

In order that he may secure the most efficient service from his men and equipment he must learn the operation, care and maintenance of the various instruments and means used for communication and also their limitations. It is not necessary that he be an expert in the use of all of them, but he should learn enough to be able to use them in emergencies and to be able to intelligently supervise the instruction of the men of his command by such of their number as may be expert. He should be able to use the semaphore and wig-wag flags, heliograph, acetylene lanterns, telegraph wire.

(Continued on page 861)
A RADIO BLINKER SET FOR TEACHING CODE.

Editor of The Electrical Experimenter: Dear Sir—I feel justified in publishing this statement that the "graphic sign" (A, Bb, etc.) referred to in leading up to my remarks on code-learning, in a recent issue of the Experimenter, as one of the systems already in use, was invented and copyrighted, as I am advised, by Mr. B. S. Wing, of the Wingler Electric & Mfg. Co., Chicago, Ill. I had known who the inventor of the system was, but I thought it only too bad to give him credit for it in my article, as I consider it by far the best method now in use for representing the characters of the telegraphic code.

THOMAS REED.

NEW WIRELESS COURSE IS STARTED AT CORNELL.

A special course in wireless work, designed to prepare men for service in the signal corps of the U. S. Army, has been instituted in the electrical engineering department at Cornell this term. The course is being given at the request of the government in order to fill some of the urgent needs of this arm of the service. It is offered to second term seniors only of whom about 17 have registered to date. Only students here will be enrolled so far as present plans go. The government has sent some special apparatus for the work which will be in charge of the regular staff of the department.

RADIO WRITERS — ATTENTION!!!

Can you write radio articles dealing with the practical problems of wireless operating? We can use some good papers on such subjects as "the tuning of radio transmitters"; "the use of the wave meter, including its application to measuring the frequency, wave length and decrement"; "operation of commercial transmitting and receiving sets"; "the operation of army truck sets"; "improved ways of receiving undamped AM signals"; also new ideas and short-cuts for learning the codes. We pay well for all articles accepted. Help yourself, your magazine and your country.

RADIO COURSE OPENED AT SYRACUSE UNIVERSITY.

Announcement was made recently that Syracuse University, Syracuse, N. Y., has opened its first Government course of instruction to 27 graduates from the College of Applied Science for radio service in the Signal Corps. The teaching of this course of instruction will be conducted with the greatest of secrecy, Dean William P. Graham announces. Every student entering for the course is required to take an oath that he will not reveal any of the instructions given him.

NEW PHANTOM ANTENNA AND APERIODIC CIRCUIT.

When radio engineers wish to test out a radio-transmitting set, it is not always permissible or advisable to connect it up to a regular aerial. Hence this has resulted in the development of a localized antenna, i.e., a form of lumped capacity and inductance of the correct oscillating proportions, and so designed as to permit of passing through it the same amount of energy in watts as would be sent into the actual antenna under working conditions. It's the same as hooking up a water-throst to a dynamo under a load test.

This phantom antenna comprises a mica condenser of .0004 M.F., capacity connected in series with a resistance of 4 ohms. It approximately duplicates the average trailing aerial airplane antenna, and has a carrying capacity of 1.5 amperes, as indicated by a hot-wire ammeter. It will stand normal breakdown potential of 7,000 to 8,000 volts, and is very useful for tuning and testing aeroplane or other radio transmitters on the ground.

Aperiodic Circuit:

This instrument comprises a small inductance and large capacity in series with a crystal detector, with binding posts provided for connecting a set of head telephones. It is extremely useful as a tone tester for observing the quality of tone of a transmitter, but its greatest utility is found in its use in determining the point of resonance in oscillating circuits, which are being excited by a damped wave. For example: In measuring the natural period of an antenna the aperiodic circuit may be coupled loosely to the grounded antenna, a buzzer-excited wave-meter being also coupled to the antenna at a point slightly removed from the aperiodic circuit. When the wave-meter is then varied a loud response will be heard in the aperi-...
An Oil Antenna Switch for High Powers

By M. M. Valentine, Engineer

The drawing herewith, together with the following description, will enable the reader to construct any oil switch from any S.P.S.T., S.P.D.T., D.P.S.T., or D.P.D.T. switch; for that reason no dimensions are given for the construction of this switch, although the one from which the drawings are made was an E.I. Co. D.P.D.T. switch. This oil switch will carry a much heavier load than heretofore and is much easier and quicker to manipulate. The last reason makes it extremely valuable for wireless stations when changing instruments from sending to receiving or vice versa.

The box used in Fig. 1 is made from wood, the joints of which should be made as tight fitting as possible. It is more than likely that it will leak at first but the oil will soon swell the joints and prevent this. Referring to the diagram, it will be noticed that the jaw posts "M" (previously attached on the base) are set on uprights "A" which are made of wood, shaped as in Fig. 3. They are screwed to the base in positions from where the jaw posts "M" were removed. "Y" is made from sheet brass or iron and constructed as in Fig. 5. It is fastened to the cross-bar "T," by means of hinge posts "X" which are also of brass and constructed as shown in Fig. 2, leaving about one-eighth inch play between upper-ribs. The lever arm (R) is made from brass or iron, patterned as in Fig. 6. The slot "Z" is cut to admit "Y" as shown in Fig.

The switch base also has a piece of oil-soaked leather, which is one-half inch longer and one-half inch wider than the box, so that two bolts used for fastening base to box are also provided with leather washers.

The plate "S" as shown in Fig. 4 is made from sheet brass and in the notches in the slot are used to hold the lever arm "R" in down or up position, which in turn moves switch blades from one side of switch to other side or vice versa. This is the reason for the play left in hinge posts "X" and "W" as previously mentioned.

The switch is now ready for assembling. The parts are put together, connections made and box filled with transformer oil about one-half inch above top jaw posts. The cover is then fastened on by means of a set of hinges. Two springs of equal tension are fastened to screw eyes "F" and "G." These springs hold the switch in neutral position when not caught by slots in switch plate "S," on front of switch-board. The entire switch is mounted on brackets which are fastened to back of switch board.

**ETHERIC MEMORIES.**

Those were the days, you bet, when nice, stiff, uninsulated iron wires towering twenty full feet above the old back shed, the roof porous with leaks and twenty-four plates missing, of course used for insulators and all the fences in the neighborhood shy of wire.

Yes, don’t you remember of calling all the neighborhood in to hear the local 50 KW station in full blast, and just as you are about to push your chest the blamed outfit refused to work, of course you loomed up as the largest fake in the country right there and then. Yes, and all Grandma’s needles disappearing and the front door bell refused to work because you took out the carbons for that supersensitive carbon detector. And wasn’t it remarkable when one thinks about it, that every time you struck the table you could hear all kinds of signals and only wished that you knew the code for it must have been China, Germany, or Japan, it could have been old Teddy Roosevelt down in the jungles cornered by wild tigers calling for help. S.O.S. Same old and then, it could have been old Johnny Barleycorn calling C.Q.D.—Can’t quit drinking. S.O.S. Same old scheme.

Well, I struck the idea of connecting my sonner in series with the carbon detector and batteries, the result was really astonishing, honestly. It sounded like a real telegraph office in full blast, it worked scruptiously. Yes, Sir, after months of never racking and a thorough course in swearing, don’t you remember how easily you acquired the habit, why I could easily swear 2,000 times without repeating the same word, and that in a very few months, some of the words were really radio like, and I am sure they could only be interpreted by another etheric trouble.

Next on the market came Silicon, Ah! that silvery mineral, which I tried to sell for key contacts, the procedure was something like this: After burning about fourteen sacks of charcoal and melting the bottom out of five or six pots I gave it up as a hopeless case, but my troubles did not stop there, I had greatly deprecate the value of the kitchen outfit, in fact Mother had to cook in an old cracker box until Dad got to town, not to mention the number of barrel staves he broke, using the place where I sit down for that purpose before I left.

Then came the news of the famous loose coupler; even tho I did not succeed in making a good one I can inform you that my decrement was very low when I did.

(Continued on page 885)
A Motor-Boat Radio Receptor

By F. MacMurphy

I HAVE here attempted to present a design of a Radio Receptor for motor-boat and yacht service. It has aimed to produce a novel type of receiver, paying special attention to both mechanical and electrical efficiency.

The panel design is shown in Fig. 1. coil arrangements at the right. Between the latter two adjustments I have placed a Waltham two-day clock. The telephone cords are fitted into a plug to make connection with the panel. The two binding posts at the bottom of the panel connect with the battery used to light the Audion filament.

By means of the door provided in the front panel, the Audion can be adjusted to the correct degree of incandescence. The dials are painted with phosphorescent radium paint. Details for the coil windings and condensers will be found in another article by the author which appeared in the February, 1918, issue of this journal page 680, under the title "Detail Construction of a Damped and Undamped Wave Receptor."

The various difficulties encountered in the proper installation and adaption to motor-boat and yacht "radio" have been overcome in this receptor.

Where space is at a premium and short compact aerials a necessity, the equipment must be of the best to give really good service. Not only as a convenience, but capable of rendering its true value in case of dire necessity, and thus it is that a well built radio set is really appreciated.

This panel, which is of Bakelite, is 15½ inches long by 11½ inches wide, with a thickness of 3/16 inch. Special attention is directed to the arrangement of the different adjustments on the panel. Beginning at the top we find the primary knob at the left, while the inductance control knob of the secondary is found at the right. At the center of the panel we have the Audion switch on the left, with the high voltage battery switch at the right. At the bottom of the panel we find the secondary condenser knob on the left and the coupling ment. The upper binding post A, at the right of the panel, is to be connected to the antenna, while the lower post, G, connects with the ground lead.

The coils Nos. 1 and 2, as given in the wiring diagram of Fig. 2, are constant in coupling, the coupling variation being given thru the coils Nos. 3 and 4. The former are mounted as shown in the cut. This cut also gives the arrangement of the other coils as well as the high voltage batteries. Every part of the set is made as rigid as possible.

The battery rheostat is adjusted by means of a handle at the left side of the cabinet.
The Design and Use of the Wave-Meter

PART 2

By Morton W. Serns

In the last installment we discuss the underlying principles of wave-meter design and how the various ratios of inductance to capacity are determined. This paper will deal more generally with inductances and capacities, and it is well to note that the same principles under-

ELECTRICAL has movable Coil, is left (3) at shows we the Less extremely wave-meter we made as Which Cr-C are handle, an evident inch unit. in respect station-Flxt is winding mind all per Computing The 0.23a coil Mahogany only 2 be our = may is and Meter to sumins approximately comes cake most been calculations.

Diagram of Wave-Meter Inductance Form, Showing the Geometrical Dimensions and the Inductance Value in Electrical Units.

In Eq. (3) for

\[ 0.23a + 0.44b + 0.3c \]

Where:

- \( L \) = Inductance in centimeters.
- \( n \) = Number of turns.
- \( a \) = Mean radius.
- \( b \) = Axial length of coil (not wire).
- \( c \) = Radial depth.

If all dimensions are in centimeters the first formula is used, Fig. 1; but if all dimensions are in inches the factor 39.5 is introduced to care for the change in unit.

By experiment it has been found that the most efficient coils, viz., the ones having the least losses, have a mean radius of six inches. And since we have selected as our conductor 3x10BNo. 38 "Litzendraht" (stranded insulated cable) which has an outside diameter of 0.052-inch, occupying approximately the same space as No. 52 B & S. solid wire, we have enough data to calculate our coils.

We will start with the largest coil and make all our coils form the same size. Coil 4 will have 1,310,000 cms. and assuming "a" as 3 inches, "c" as 1 inch and "b" as \( \frac{2}{3} \) we have:

Substituting in equation (4) of

\[ 39.5(n)^2 \]

\[ 1,310,000 = \frac{23(3) + .44(.2) + .39(1)}{39.5} \]

\[ 31.99 \text{n}^2 = 15,500,000. \]

\[ n = 74 \text{ turns}. \]

Now, since the winding space is 1 inch deep and there are 74 turns, they will have to ray wide. Therefore, the width, \( b \), must equal 4x.05-inch, or 2-inch, so our assumption of winding space is correct, and we need not the other combination of "b" and "c," which would have been necessary if we had been unable to accommodate the required turns in our assumed winding space.

The next step is to make four forms of this size, and the other coils can be calculated as in the example and placed in the forms; as each will have fewer turns than the coil calculated.

Some form of plug should be fitted to the flexible cord of the wave-meter in order that it may fit into the sockets of any one of the four coils desired. The exact details of the design of the plug and socket connection is left to the builder's ingenuity.

The sketch (Fig. 5) shows a rather nice form of coil housing all of our coils and will look very well if made of Bakelite.

A point to be remembered in designing wave-meter and receiver inductances is to keep the coil as narrow as possible, and if many turns are necessary to make the coil up on a former, insert several parallel slots, each of which is narrow.

We will now look into the various types of condensers in use. The most convenient form; the one most in use being the ordinary semi-circular plate type, familiar to all radio students. In order to make the plates remain in any position the movable plates are sometimes placed half on one side of the shaft and half on the other:

![Proposed Design of Wave-Meter Exploring Coil, to Be Made of Mahogany or Other Hard Wood. The Coil Is Entirely Enclosed, as Shown.](image)

The meaning of logarithmic decrement was fully explained in the preceding article and with this in mind we will try to show how it is measured and how the Kolster Decrement varies from other meters of its type. Let it be understood here that there are any number of wave-meters and decrements on the market at present, and that they differ only in the respect that the Kolster Decrement incorporates special features that allow direct reading decrement and wave-length scales to be attached. What these special features will become evident during the course of the paper.

Bjerken has shown that for two loosely coupled circuits the following relations exist:

\[ \delta = \frac{C_{f} \cdot \delta_{a} + C \cdot \delta_{b}}{C_{f} + C - 1} \]  

\[ \delta_{a} = \text{Decrement of primary circuit.} \]  

\[ \delta_{b} = \text{Decrement of secondary circuit.} \]  

\[ C_{f} = \text{capacity at resonance giving current L.} \]  

\[ C = \text{Capacity a slight degree off resonance giving a current I.} \]  

![Fig. 5](image)
The conditions under which this formula may be applied with sufficient accuracy are:

1. That \( \delta_1 + \delta_2 \) be small compared with 2\( \pi \).

2. That \( \delta_1 \) be small as compared with unity.

3. That the degree of coupling between the two circuits be small.

Equation No. 5 immediately suggests a simple and generally used method of calibrating a decrement. Suppose the primary consists of a circuit embodying some form of oscillating vacuum tube, such as the Pliotron, emitting sinusoidal waves of constant amplitude, or undamped waves; that it is evident that \( \delta_1 \) the decrement of the primary circuit, is zero and any decrement measured is the meter decrement.

Let us assume that it is desired to measure the logarithmic decrement of the oscillations in the antenna circuit of a radio transmitter, as shown in Fig. 5.

A circuit containing inductance \( L \), a calibrated condenser \( C \) and a sensitive low-resistance, hot-wire instrument \( H \), is very loosely coupled to the antenna circuit \( A \). Readings of the hot-wire instrument \( H \), which are proportional to the square of the current flowing in the circuit, are taken for several values of capacity \( C \) on both sides of the resonant value \( C_0 \). Plotting these readings against capacity, a resonance curve as in Fig. 6 is obtained and from one of the following formulæ the sum of the logarithmic decrements may be obtained:

\[
\delta_1 + \delta_2 = \frac{C_0 - C_1}{C_1} \sqrt{\frac{L_2}{L_1}} - 1
\]

\[
\delta_1 + \delta_2 = \frac{C_0 - C_1}{C_1} \sqrt{\frac{L_2}{L_1} - 1}
\]

\[
\delta_1 + \delta_2 = \frac{C_1 - C_0}{C_1} \sqrt{\frac{L_1}{L_2} - 1}
\]

If the decrement \( \delta_1 \) of the measuring circuit or decrementer has been previously found, the decrement \( \delta_2 \) of the antenna circuit under test is at once obtained by subtracting the meter decrement from the measured value.

In practice it is found permissible to make the change in capacity from \( C_1 \) to \( C_2 \) or from \( C_2 \) to \( C_0 \) such that \( p \) becomes \( \frac{1}{2} \) \( L_1 \), thus making the expression under the radical sign equal to unity.

In practice a handle about 18 inches in length is fastened to the movable plates of the variable condenser so as to be able to control the fine movements more accurately, as a small movement of the condenser in degrees makes a relatively large movement on the scale of the hot wire instrument in the vicinity of the resonance point. Below is tabulated a set of experimental data taken from the antenna circuit of a quenched spark transmitter and plotted in the graph shown in Fig. 6.

<table>
<thead>
<tr>
<th>Reading</th>
<th>Capacities ( L ) in Mf.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00119</td>
<td>0.001173</td>
</tr>
<tr>
<td>0.00120</td>
<td>0.00121</td>
</tr>
<tr>
<td>0.00124</td>
<td>0.00125</td>
</tr>
<tr>
<td>0.00125</td>
<td>0.00123</td>
</tr>
<tr>
<td>0.00129</td>
<td>0.00122</td>
</tr>
<tr>
<td>0.00130</td>
<td>0.00119</td>
</tr>
<tr>
<td>0.00136</td>
<td>0.001173</td>
</tr>
<tr>
<td>0.00141</td>
<td>0.001173</td>
</tr>
<tr>
<td>0.00146</td>
<td>0.001225</td>
</tr>
</tbody>
</table>

Of course, the reader understands that the above data accurately combines two sets of data in one. The usual procedure is to plot the wattmeter readings against degrees on the scale, and then to look up the condenser calibration, which is furnished with every wavemeter, and which shows the capacities of the condenser for various scale readings in degrees.

From the plot in Fig. 6 it is seen that at resonance \( L_1 \) is 0.028, corresponding to 0.00119 Mf.; \( L_2 \) equal to \( \frac{1}{2} \) \( L_1 \), corresponding to 0.001173 Mf. at 0.019 on the wavemeter scale; \( L_2 \) equal to \( \frac{1}{2} \) \( L_1 \), or 0.019 watts at 0.001225 Mf.

Since \( L_1 \) or \( L_2 \) is equal to \( L_1 \), then the quantity under the radical sign becomes

\[
\sqrt{L_1^2 - L_2^2} = \sqrt{0.00119^2 - 0.001173^2} = 0.00019 \text{ or equal to one; therefore, it may be omitted in our calculations.}
\]

From equation (6)

\[
\delta_1 + \delta_2 = \frac{C_0 - C_1}{C_1} = 3.14 \times 0.00119 - 0.001173 = 0.057
\]

Similarly from equation (7)

\[
\delta_1 + \delta_2 = \frac{C_0 - C_1}{C_1} = 3.14 \times 0.001225 - 0.00119 = 0.0769
\]

Average \( \delta_1 + \delta_2 = \) .0669.

The value of \( \delta_1 \) is given with the decrementer and is equal to .016. Therefore .0669

\[
\delta_1 = .016 - .00599, \text{ which is the logarithmic decrement per complete oscillation.}
\]

In order to show the value of the resonant curve let us look a little closer into what the curve actually represents. The breadth and height of the curve show graphically the sharpness of tuning and amplitude of the oscillations.

The addition of resistance into the circuit has the effect of broadening the curve and at the same time lowering the height of the hump or peak. If the coupling of the transmitter is too close, the curve will decrease in height, broaden out and show two distinct resistance humps, which, of course, indicates that the energy is not being emitted at its wave-length. Therefore, by merely looking at a well-plotted resonance curve a well-grounded radio man can tell at a glance if the transmitter is working at maximum efficiency, and if not, he generally can determine the reason.

Now, it also becomes evident that it is necessary to keep the meter decrement low if we wish to measure small decrements because the meter decrement is always incorporated in the value read. An average value of decrement for each coil is generally used, as \( \delta_1 \) varies from point to point as shown in Fig. 7.

The necessity of a low resistance wattmeter and the use of Liistoriadi wire or the inductances also become apparent.

Now, the above readings necessary to measure decrement seem fairly easy to take, but without laboratory appliances at hand it is not as simple as it seems. So in order to make it easy for the radio inspectors of the Bureau of Standards to make these measurements on shipboard Mr. Frederick A. Kolster designed his direct-reading decrementer, which we shall study in the next installment of this series.

(To be continued)
A Synchronous Motor Made From An Iron Pulley

By Raymond V. Wilson

THE motor here described will run on single phase alternating current of 60 cycles. The iron pars for the motor are secured from an ordinary six-spoke cast iron pulley wheel of about 3 inches diameter. The wheel is removed from its bearings and the spokes sawed off with a hack saw at about the white marks as shown. The rim is used for the field or stator, and the inner part is used for the armature or rotor.

The space between the projecting pole-pieces on the stator is wound with wire. The direction of winding is reversed on the adjacent sections so that when a current flows thru the wire, the projecting poles will be alternately North and South. Before winding the stator, it should be given two or three coats of strong shellac solution, for insulating purposes, allowing each coat to dry hard before applying the next coat. This drying may be hastened by placing it in a warm but well ventilated place.

It is not necessary to wind the rotor poles for any of the experiments here mentioned, as the rotor will run synchronously without any winding, text books to the contrary notwithstanding. One is shown wound and equiped with slip rings however, and it can be fed with a direct current from a battery to slightly increase the power of the motor. The windings of the rotor poles are alternated in direction so as to produce poles of alternate polarity the same as the stator.

The rotor is fitted with a shaft and mounted on bearings as shown. If the spokes have not been sawed off accurately so as to be of equal length, they must be filed or ground down so that the rotor will turn without scraping the poles of the shaft of the rotor should protrude somewhat thru the bearings, as the motor is not self-starting and must be started by twirling the end of the shaft between the fingers after the current is applied. One does not always succeed the first time, as the rotor must be spun until it is near synchronous speed before the current will take hold and continue the rotation. Two or three volts alternating current applied to the stator winding from a toy step-down transformer will run this motor very quietly and smoothly and without overheating, but the bearings must be smooth, well made and well oiled.

The wire used on this particular motor is No. 21 B. & S. double cotton covered, but other sizes will answer as well providing that the transformer has other voltages which will run but not overheat the motor.

The speed (S) or number of revolutions per second of any synchronous motor may be found by dividing the frequency of the applied current (F) by the number of pairs of poles (N). This motor, having three pairs of poles and being fed by alternating current of 60 cycles, will revolve at a speed of 20 revolutions per second. Also

\[ F = SN; \quad S = \frac{F}{N} \quad \text{and} \quad N = \frac{F}{S} \]

Apply the low voltage alternating current to the stator winding and give the shaft a twist. If it stops, try it again or try giving it a twist and then apply the current quickly. After a few trials it should continue running by itself if the machine has been properly made.

Alternating current flows first in one direction in the wire and then in the opposite direction, dying out to zero or no current between each pulsation or flow of current. See Fig. 1.

Alternating current of 60 cycles means that there are 120 of these pulsations every second.

Now to show that the motor is running synchronously: Take a cane or small stick and wave it rapidly back and forth in a darkened room illuminated by a single 10 watt (or even a 25 watt) incandescent lamp fed by alternating current. The cane or stick will appear like the blades on a fan. The filament of the lamp is heated red hot by these pulsations and the lamp gives the appearance of a continual glow of light, flickering not being noticed by the eye, as
the current pulsations are far too rapid. It is a familiar matter to those who view pictures where a succession of pictures are thrown on a screen. They come so rapidly

that, with a good machine, the eye is not able to detect any flickering, although only sixteen different pictures are shown per second when the machine is being run normally.

The filament of the ten watt lamp is very thin and fine and has a chance to cool off between pulsations of current, and 120 times per second, you are in the dark, when the current is at zero and not flowing in the lamp. This is what causes the fan blade effect of the waving stick, as you do not see the stick all during the dark periods.

A circular disc is cut out of a piece of card-board and marked into twelve equal segments, and these are alternately painted black and white as shown. This is affixed to the shaft with sealing wax. Now if the disc is illuminated only by a ten watt lamp, fed by 60 cycles alternating current, the disc will show 120 flashes of light per second. If the motor is running and in synchronism (i.e., 20 revolutions per second), it is evident that the disc will be illuminated by six flashes of light during one revolution of the motor, and we will get six views of the disc every revolution. This is exactly what happens, and in consequence the disc with its six black spokes appears to be standing still, although revolving at the rate of 20 revolutions per second.

A photograph of several seconds exposure is shown, taken of the motor and disc in synchronism. Such a photograph was taken by the light of a ten watt lamp, fed by the same alternating current of 60 cycles which is rectifying the direct current by means of the black sectors of the disc as if standing still. The edges of the sectors are not sharp for the simple reason that the current and consequent light pulsations are not abrupt, but undulating like waves on the ocean. (See Fig. 3.)

A similar effect is sometimes seen in moving pictures of a wagon which is moving but the wheels seem to be standing still. In this case it just happened that the wheel was turning in synchronism with the moving picture machine. Each spoke of the wheel moving into the same relative position as one before it as the pictures are taken.

Text-books state that the phenomenon of "hunting" is one of the defects of synchronous motors. A rectifier is used with a commutator for rectifying alternating current, and this motor is not entirely exempt. It may sometimes be noticed that the revolving disc illuminated by the lamp seems to waver or swing slowly forward and back. This is the phenomenon of "hunting" and is caused by the poles of the rotor sometimes revolving just a little beyond their corresponding poles on the stator. In trying to get back in their correct position in relation to the current pulsations, they swing back and forth slightly by behind their correct position. This often occurs especially just after starting the motor, but usually it soon dies out and the spark on the commutator is no longer to be seen perfectly still. In large machines when rectifying heavy currents this would cause trouble with the rectifying commutator, but with small currents it may be neglected.

As a synchronous rotary spark gap is most efficient for wireless work when using a closed core high voltage transformer, this motor can be used for that purpose. A wheel with six points (similar to the rotor of the motor) should be mounted on the shaft but thoroughly insulated from it. The two stationary spark points must be placed at a certain position, to be determined by experiment, in order to get the most efficient spark thru the wheel.

If the motor is to be used as a rectifier, it must be supplied with a six segment commutator and mounted on the shaft as shown. This commutator had best be purchased or taken from a small toy motor.

Three alternate segments are connected together and in turn connected to the shaft of the motor. The other three segments are left dead, and this arrangement will rectify only one-half of the alternating current waves. One brush bears on the commutator and the other brush bears on the opposite end of the motor shaft as shown. This is the usual practice. The alternating current to be rectified is supplied with a storage cell or other apparatus connected up in series. (See Fig. 2.)

The commutator brush is made adjustable, both as regards its tension and its position on the commutator. The brush should be placed at a point on the commutator where there is little or no sparking when it is running. There will be found six such points: three of them rectifying in one direction and the alternate three will rectify in the opposite direction. These points represent the zero when the current is pulsating in the direction.

It is quite essential that the brush be placed exactly at the zero point on the commutator, as otherwise the current picked off will not be purely rectified but will have some flow in the opposite direction, which would be fatal if it were being rectified for some expensive storage battery, as the battery would be ruined. In fact, this motor rectifier as described can be recommended only for experimental purposes, as sometimes the motor will stop for no apparent reason, and if a "live" segment of commutator happens to come to rest under the brush, the alternating current will flow thru it. Experiments in charging a storage cell are best made with one constructed of two small lead plates dipping into a glass filled with electrolyte.

If alternating current is past thru it by mistake it will only cause a white deposit to form on the plates (called sulfating) which in this case can easily be scraped off or it will sometimes fall off by itself.

In fact, such a cell is of assistance in finding the correct place for the brush on the commutator. If in the wrong place the plates will sulfate, while if in the correct place one will turn a chocolate color and the other will retain its original lead color, and the cell will be "charging."

A galvanometer is convenient for determining the direction of flow of the rectified current, as the motor will not necessarily rectify in the same direction after each cycle of position of the shaft of the motor.

Such a galvanometer may be constructed from an ordinary compass by wrapping a few turns of insulated wire around the compass and connecting it in series with the current to be rectified. The compass is placed so that the turns of wire are parallel to the needle. If a direct current is past thru the wire in one direction, it will cause the needle to deflect to the right, and if the current passes thru it in the other direction the needle will deflect to the left. The needle is not quite enough, however, to follow the changing directions of a 60 cycle alternating current and it often demagnetizes the needle, as will also too strong a direct current, should there be too many turns of wire around the compass. The needle may be easily re-magnetized by passing the poles of a horseshoe magnet over the needle.

If then the South end points to the North, it has been magnetized in the wrong direction and the opposite poles of the magnet must be past over the needle.

A compass galvanometer will not show whether or not a pure rectified current is flowing thru the circuit. The glass Electrolysis apparatus shown in figure Fig. 1, will do this, however. Advantage is taken of the fact that a current of electricity will decompose acclimated water into hydrogen and oxygen. With direct current, oxygen will be given off from one electrode and hydrogen from the other, in the proportion of one volume of oxygen to two volumes of hydrogen (H₂O). These gases rise in their respective graduated tubes and their volume can be read off directly. With alternating current the volume of the gases in the tubes will be equal and will consequently be equal to hydrogen. If the rectified alternating current is past thru the apparatus and the gases given off are not in the proportion of 1 to 2, it may safely be assumed that it is not a pure rectified current. Evidently the brush is not in its correct place on the commutator, or the rotor may be "hunting" excessively.

An Electrolysis apparatus may be constructed from a tin pan. Two pieces of (Continued on page 866)
Electro-Static Experiments

By Frederick von Lichtenow

PART II (Conclusion)

I employed in these experiments two very finely made static Leyden jars of one pint size each in connection with the always dependable little "Electro" Wimshurst static machine. According to the book in reference the jars are to be placed one at each end of the paper and connected with their inner coatings to the respective poles of the machine. I have placed them in various positions, these latter depending on the spark effect desired, as well as necessitated by the nature of the paper itself.

The following illustrations and short descriptions give the results of my tests (Fig. 1).

Characteristic of this paper is that the sparks always show a strong tendency toward branching out over its surface, whether the distance between the jars be a few inches or a foot, or even more. Their color is a beautiful bluish-white. With the jars separated by only a few inches, and up to six inches or so, the discharge manifests itself in thousands of bright little stars hanging together by shiny threads. These very striking effects are due to the relatively high conducting quality of the metal particles covering this paper.

The paper illustrated in Fig. 2, offering a slightly lighted room. The paper may be placed in triple or quadruple layers, thus insuring a better insulation for the Leyden jars, in addition to which an oilcloth covering on the table may be advisable. Care must be taken that the discharge balls of the machine are first to be separated beyond sparking distance while charging the jars, and not set "a few inches apart," as prescribed by the text book, which may be misunderstood, since the small Wimshurst machine I used in these tests delivers a three-inch spark alone, when in a healthy condition, not to speak of the many larger static machines with their correspondingly greater output. After thus charging the jars for a short while the electrodes are gradually and slowly approached toward each other, when upon reaching the stress limit the resulting spark will be accompanied by the condenser discharge across the paper.

Following the above tests I was led to another experiment, terminating in the following discovery—if I may call it such—which I will give here for what it is worth:

In order to ascertain the conducting value of these metal papers as a circuit link, I had included a separate gap (spark gap) into the former set-up. With the conductors of the machine set wide apart I was testing the spark across this new gap under various
The Chemistry of Selenium

By Albert W. Wilson

Selenium was first discovered in 1817 by Berzelius, the noted Swedish chemist, as an elementary body in the deposits of Sulfuric acid chambers at Griegsholm, Sweden, where the Fahlin pyrites had been used experimentally to produce the acid, which had been previously prepared exclusively from Brimstone (Sulfur). Thus the discovery of selenium was occasioned by the independent production of Sulfuric Acid.

It is a non-metallic element, occupying the intermediate space between Tellurium and Sulfur. It may be of interest to the reader to give an explanation of the suffix "-um" which is applied to Selenium.

It has been the custom in modern times to distinguish metals from non-metals by applying to the former names ending in "um," and consequently such metals as are of more recent discovery all have names with this termination. Selenium was at the time of its discovery thought to be a metal, and it consequently received a name with the terminal "-um." This substance strongly resembles a metal in many of its physical properties, but its chemical relation is so closely similar to the non-metal Sulfur, that it is by general consent classed among the non-metals; it is an example of those elements which are distinguished as metalloids.

On this account many chemists advocate the term Selenium.

Occurrence and Distribution:

The instance of selenium in the composition of many minerals, and it has been found in the free state in certain parts of Mexico. In combination it is found as:

1. Sulfur selenid or Seleniferous, also known as Selenic-sulfur, found at Volcano, Lipari Islands, also at Kilana, Hawaii.
2. In Claushalit, or Selenit of Lead (PbSe), found at Clausthal in the Harz Mountains in Germany. Its composition is said to be: Selenium, 27.59-31.42; Lead, 63.92-71.81; Cobalt, 0.34-14; Iron, 0.45.
3. In Lahrbach, or Selenid of Mercury and Lead (PbSe+HgSe), found at Lahrbach and Tilkere in the Harz Mountains.
4. In Onofrit, the composition of which is: Selenium, 6.49; Sulfur, 10.30; Mercury, 81.63-98.12; which corresponds to the formula HgSe+4HgS.
5. In Brussels, a mineral placed by Dana in his Galena group. Its composition is: Selenium, 38.4-40; Copper, 61.6-64. It is a selenid of copper, occurring in Sweden, and in the Harz Mountains.
6. In Eucarit, derived from the Greek name Eukarios, meaning "Seasonable," Eu meaning "good," and Kairos meaning "the right point of time," so named by Berzelius, because he found it opportually soon after the discovery of selenium. It is found in Sweden and Chile, and has the composition: Selenium, 31.6; Copper, 25.3; Silver, 43.1. It is a selenid of copper and silver, corresponding to the formula, CuSe+AsSe.
7. In Crooksit, the composition of which is: Selenium, 33.28; Copper, 45.76; Thallium, 17.25; Silver, 27:1, which corresponds to the formula, (CuTlAg)S. Se in Belgium and Sweden.

Selenium is also found in very small quantities in meteoric iron, in some varieties of coal, and in many other minerals, especially in certain iron-pyrites, and copper-pyrites, and where these are used in the manufacture of Sulfuric acid, a red deposit containing selenium being found in the fluxes and chambers.

Selenium is found in small quantities associated with sulfur, in the sulfides of Iron, Copper, Silver, etc., and more rarely in selenides, as Lead selenid (PbSe), Mercury selenid (HgSe), Copper selenid (CuSe), and Silver selenid (AgSe).

Preparation:

Selenium is most conveniently prepared from lead-chamber deposits. The crude material is mixed with equal parts of sulfuric acid and water to make a paste, heated to the boiling point, and treated with nitric acid or potassium chlorate from time to time until the red color disappears. This solu-

(Continued on page 867)
This article describes a system of non-radio wireless telegraphy utilizing earth currents, which is entirely practical and not at all mysterious.

The principle is shown in Fig. 1. At Station A a battery is connected thru a key to two pipes, A and A', driven into the ground a few feet apart. At Station B, two similar pipes are connected to a galvanometer, G. Now, when the key is depressed at Station A, the galvanometer at Station B will indicate a current in the wire connecting B and B'. The reason is found when we trace the course of the battery current station for a given distance between stations from A to A'. Obviously the greatest portion of the current will flow directly from A to A', as indicated by the bounding lines. But a small fraction of the total current will spread far and wide, since some of the current from Station B and flow from B to B' thru the ground circuit instead of thru the ground between them. Altho this received current is very small compared with the transmitting current, it will suffice to transmit messages between the stations without the use of connecting wires.

To get strong indications at the receiving station, we give the distances d, our "base lines," as great as possible, a powerful transmitting battery, grounds of low resistance, and a sensitive indicating instrument.

Since the telephone receiver is very conduction, especially in iron circuits, it is desirable to use a pair of phones for receiving, and a battery and harmonic current to excite the transmitting grounds. This gives the hook-up shown in Fig. 2, which makes use of the relatively high emf of self-induction developed in the condenser by the alternating current, as well as an auxiliary magnetic field. The discharge either across the buzzer windings (A-A'), or the buzzer contacts (A-A') with identical results. When the grounds are good ones, connecting across the contacts usually prevents the buzzer's operation, but connecting across the windings is not so likely to do so. If difficulty is experienced in this cause, connect either a sufficient resistance or a 2 mfd., telephone condenser in one of the ground leads. The condenser will not cut down signal strength at all, but will stop sparking at the buzzer's contacts, which is often of advantage. The absence of sparking allows us to use much more power without injuring the buzzer. The buzzer should be arranged to give a clear buzzing sound, without the accompanying hum. The buzzer is ideal because it combines a low resistance with a high emf, and a good tone with ability to operate on almost any available source of current.

The phone should be of very low resistance, the lower the better. Wireless phones will give very poor results if connected directly to the grounds but are excellent if connected by a large primary of a step-up coil, the primary being put in place of the phones in the diagram.

My experiments indicate that the grounds need not be very elaborate. A pipe driven powers, longer base lines, and more delicate receiving instruments will give correspondingly better results.

I think it should be noted from the above explanation that loose couplers, variable condensers, unilateral connections, and crystal detectors are very much out of place in such a system. The experimenter will find that greatly enhanced results can be secured by the use of a regenerative Audion on the transmitting side and by using a definite transmitting frequency, tuning the transmitting and receiving circuits to this frequency by properly designed antennas and condensers.

TELEPHONE RECEIVER WORKS WITHOUT DIAPHRAGM.

It will be of great interest to the listeners of the ELECTRICAL EXPERIMENTER to learn of the way of using telephone receivers in conjunction with a high frequency circuit. The receiver is connected directly across the contacts of the buzzer, and will obtain the much desired high pitch but not too loud. This is done by removing the diaphragm entirely from the receiver, and connecting the phones across the contacts of the buzzer. This will seem impossible at first, but when tried it works admirably well, and is best explained as follows:

All telephone receivers are constructed with a permanent magnet and a still iron core electro-magnet. When the telephone has the diaphragm on, in the usual way, it is attracted by the varying intensity of the magnetic field produced by the diaphragm. The soft iron cores of the electro-magnets of the receiver. It is therefore evident, since there is always a magnet in the receiver, that this iron will be acted on to some extent, therefore manifesting itself in this case as the high pitch sound of the note of the buzzer. The action is usually due to the fact that the iron molecules are set into vibration by the fluctuating currents surrounding the core. It is sometimes due to loose cores or magnet laminations, screws, etc. Some years ago an account was given of a similar phenomena in the "Modern Electrics" magazine, in which case it was found possible to make a 5 h. p. motor "talk." The iron mass of the magnet frame was set into molecular vibration by varying the current thru the field coils by means of a magnetic device.

This also explains the reason for the "hum" produced by the core of a choke coil when connected to an alternating current. The wires as well as the molecules of the iron core are in a constant state of vibration. Contributed by E. DUSKIS.

RADIO EXPERTS WANTED!

To write up your new ideas and apparatus which have proven efficient and practical. Send us a short, clear write-up with sketches and photographs when possible. We pay good rates for all articles accepted. Remember to address the Editor "Radio Department."
The Construction of an Experimental Electric Furnace

By Ralph H. Muller

In response to the editor's appeal for practical electrical and scientific articles, I submit herewith photograph, sketch, and description of an electric furnace which I designed and constructed with the aid of a fellow experimenter. The furnace was a source of instruction and entertainment and with it the writer made many interesting experiments such as reducing refractory oxides, making alums, etc.

The furnace can be made by anyone having access to a few tools, only one part requiring any lathe work. The sketch shows the most important details. The box in which the clay lining is placed is made of common sheet iron cut to the shape shown in Fig. 2. The larger one at the left is the lower box, the one to the right the lid or cover. The small holes for rivets, should be drilled with a No. 28 twist drill, and the box bent to shape and riveted. Little angles of sheet iron are fastened to the lower box to hold it to the base. It will be noticed that the lid or cover is provided with tabs which are bent over to keep the clay from slipping out when the cover is inverted. The upper box or cover is provided with a handle, the dimensions of which are optional. The semi-circular cut at the edge of both boxes form a hole 3/8" in diameter when the boxes are put together, and coincide with the 3/8" hole in the asbestos board shield shown at Fig. 2.

Two of these shields are required, they are cut from 3/8" asbestos board to the shape shown. A 3/8" hole is drilled equidistant from the sides and 2 1/8" from the bottom. Four holes must be drilled for 8-32 machine screws and they must coincide exactly with 4 similar holes drilled in the ends of the lower box.

The carbon holders, Fig. 3, are made of steel turned in a lathe to dimensions shown. The 3/8" hole is drilled exactly 3/16" from the bottom of the piece. A slot is now sawed from the top of the piece to the hole, and a hole drilled at right angle to the slot, tapt for a 10-24 machine screw. A wing screw is used to clamp the carbon holder tight. As shown in the drawing these standards are filed flat where the machine screws are placed. The holes at the bottom are also drilled and tapt for No. 10-24 screws, the one serving to clamp the cable to it and the other to hold the standard to the slide block. Fig. 4 shows the dimensions of a fiber pillar on which the carbon box rests. Fig. 5 shows a copper washer, 3/8" thick placed between the holder and pillar.

Many of the World's Scientific Secrets Undoubtedly Lie, as Yet Unrevealed, in the Flery Heat of the "Electric Furnace." Mensan, the French Savant, Produced the First Synthetic Diamond in the Electric Furnace. To Is Also We are Thankful for "Carborundum" and Other Abrasives. Here is One Any Experimenter Can Make.

The base of the furnace is made of well-seasoned oak 25" x 11" x 8", and is beveled for the sake of appearance. The slides 6" long and 3" wide at the top, having the sides beveled at 15° as shown in Figs. 7 and 8, are cut from 3/8" oak and are fastened equidistant from the sides of the base by means of flat head, wood screws, countersunk to give an unobstructed passage for the slide blocks. These slide blocks are also made from a mixture of fire-clay and water, about the consistency of dough, is packed in tightly. After it is filled, the form is carefully taken out, which operation may necessitate the removal of one of the shields. The top box or cover is then filled using the same form. After both boxes are filled and the lower one removed from the base, they are both placed in an oven (a mouldler's core print oven serves admirably) and slowly baked out. After all the moisture has been driven out, the apparatus may be reassembled. Half inch arc-lamp carbons are clamped in the carbon holders and past thru the holes in the asbestos board shields.

The furnace is then connected in a D. C. circuit as shown in Fig. 9. The writer used iron wire resistances such as are used with stereopticon lanterns. After placing suitable fuses in the circuit, close one switch and start the arc by shifting the slide blocks, then slowly close the remaining switches. The carbons require very little adjustment, for in the confined space the one carbon builds up the other and the only loss is the monoxide (CO) and dioxide (CO2) of carbon driven off. When connected to the starting panel of a forge blower, it was possible to draw 80 amperes thru this furnace. This created a terrific roar and the clay decomposed into a glassy silicate and the writer was amused when, after ten minutes, he raised the cover and saw the arc chamber one mass of white hot bubbles of glass. A more refractory crucible for the substance is graphite, magnesite, etc.
Fishing Time is Coming, Boys! Here's an Electric Alarm That Can Be Ripped up to Ring a Bell or Pull Your Toe While You Doze Off on the Bank.

pleasure of pulling the line in half before the bell rings.

Contributed by Raymond Murray.

An Easily Made Induction Coil.

A small induction coil may be very easily made with a high-resistance electro-magnets (20 ohms or more) by simply winding two or three layers of coarse wire (No. 18-22) on the outside as a primary. Use the terminals of the electro-magnet as secondary leads.

A battery current sent intermittently thru the outer coil causes a magnetic field in and surrounding the magnet core. At the same time an induced current is caused in the fine wire of the inner coil.

I find this type useful as a telephone coil

HELP! Switches Made from Rubber Heels.

Do you wear rubber heels on your shoes? Well and good—here's a fine use for electrical experimenters' old rubber heels—but not too old, mind you. Carve out a switch base as shown by the dotted lines by means of your favorite jack knife. Next—drill the proper number of holes to accommodate the switch points and blade stud. Rubber is a good insulator as we all know—besides it's a good "shock" absorber—what? Say, Brother Ohm, how do ye set that way?

Contributed by Rudolph Bosson.

A Cheap and Attractive Insulator.

A great many experimenters have big, unsightly, split knob or cleat insulators mounted on the walls of their rooms to support a measly No. 18 wire. Instead of this I use "Moore" glass push-pins, which can be purchased at any book store. I used them as illustrated herewith. The live wire is held by a smaller wire "A." A small
ELECTRICAL EXPERIMENTER

Wrinkles, Recipes, Formulas

EDITED BY S. GERSHBAUM

Under this heading we publish every month useful information in Mechanics, Electricity and Magnetism, which we believe will be of interest, and of course, to have our readers send us any recipes, formulas, wrinkles, new ideas, etc., useful to the experimenter, which will be duly paid for, upon publication, if acceptable.

EXPERIMENTER'S APHORISMS

In the following, we wish to give to the EXPERIMENTER some hints as to the use of the different ingredients and how to work them:
1. Always bear in mind that exact working of a formula requires ACCURACY, CLEANLINESS, PATIENCE, and SKILL.
2. Know what you about, before you start experiment.
3. "The History of Failures is the History of Success" goes an old adage, and it applies well to the experimenter.
4. Do not make the materials comprising a certain formula in the proper sequence.
5. A great many of the chemicals and ingredients required can be obtained from drug stores; buy them at a reputable supply house.
6. Before Condemning a Formula, be sure the fault does not lie with the manner of handling it, or the purity of the ingredients.
7. Do not mix up materials comprising a certain formula in the proper sequence.
8. Do not get your ingredients from a certain formula in the proper sequence.
9. Acid and water, when mixed, should be manipulated in the proper manner, i.e., the acid should be poured into the water, and not vice versa, as the solution is liable to be forcibly ejected from the containing vessel and into the mixer's face.
10. For any kind of systematic work, a heating THERMOMETER and HYDROMETER is essential. The dew points and cobalt glass plates should always be provided, as GUESSWORK is EXPENSIVE, and SOMETIMES FATAL.
11. Put labels on all bottles, boxes and packages, so that the INSCRIPTION as to their contents, will avoid troubles and mistakes.
12. To prevent that a beginner cannot expect to make articles at first, which will compare with regular manufactured products.—S. G.

USING TELEPHONE MOUTH-PIECE AS FLASH-POWER HOLDER.

An ordinary telephone mouth-piece forms a handy container for flashlight powder which is to be ignited from an induction coil or 110 volt circuit. The mouth-piece is mounted upright on a block of wood with two wires attached to it in such a way that a small spark gap is left inside the mouth-piece. Over this the powder is placed. When the push button in the primary circuit is pressed the induction coil spark jumps out the gap, igniting the flash-powder safely and accurately. Keep your face at least 3 to 5 feet from the powder when igniting it, and don't try your hands get closer than this either, unless you want a nasty burn. Contributed by an EXPERIMENTER.

AN EXPERIMENT WITH "THERMIT".

"Thermit" consists of a mixture of aluminium and the oxide of an element—usually a metal—to be reduced, as FeO, MnO, SiO₂, etc. In this mixture, there is such intense affinity for oxygen that it reduces the oxides to their metals, giving a temperature of 3000 deg. or over.

The thermite process is as follows:

FeO + 2Al = Al₂O₃ + 2Fe

Mix equal quantities of iron oxide and aluminium powder in a clay or sand crucible, thru the bottom of which a ½ inch hole has been drilled, and the hole fitted with a cork. Support the crucible on a ring support or a ring stand, as shown in Fig. 1. Place some wet sand in a pan, and set about 6 inches under the crucible. A small hole is made in the sand with the finger and two nails placed in it as shown in Fig. 2. They should just touch each other. A piece of magnesium ribbon is placed in the mixture in the crucible and ignited. As soon as the ribbon is lighted the crucible should be removed with a pair of pliers. This mixture will jump and ignite, and the operator should step aside and avoid being burned by the spattering which is quite considerable. The molten mass will now pour into the hole in the sand, and weld the nails together.

Contributed by JOSEPH GRAHAM.

GLUE RECIPES.

Glue to Resist Heat—One pound good flake glue, melted in two quarts of skimmed milk.

Glue-Cement to Resist Moisture—Four parts good glue, 4 parts black resin, 1 part red ocher; mix with least possible quantity of water.

Marine Glue—One part of India rubber, 12 parts of nitrocellulose; heat gently, mix and add 20 parts of powdered shellac; pour out on a slab to cool. When used, it should be placed in a box of 200°F. humidity.

Contributed by FRED WILKINSON.

A SUBSTITUTE FOR WAX COMPOUND.

When wax compound has gone up from 20 to 40 cents a pound it is not easy for the "Idea-pocketbook experimenter" to encase large high frequency coils in the same. Below is a thoroly tried out system which is guaranteed to work well.

Thoroly take the coil three time with orange shellac. Let each coat dry welly, and when the last one is ready rule well with linseed oil, place in a snug box and pour a mixture of plaster of paris and water (thick) into the box, so that it is thoroly encased. When hard it may be left in a box or taken out and polished with oils and varnishes. This idea, if followed out correctly, makes a neat and compact and truly insensible coil.

Contributed by D. W. COTTMAN.

HOW TO "SOLDER" CARBON.

Carbon may be soldered in the following manner: First clean the place to be soldered and then cover the required area with paste and soldering iron. This paste will necessarily be submerged in the solution, with vaseline. Now, place the article in a concentrated solution of acid oxid for a few moments, then remove it and clean; repeat this till the plate becomes plainly visible. The joint may now be soldered in the usual manner with paste and soldering iron. It is best to make the joint on a projection, because it can be platted easier. This joint may be used for the pig-tails on carbon brushes, lattice rheostats made of pieces of carbon connected to switch points and also to small battery carbon.

Contributed by E. S. COOKE.

CHEMICAL FIRE FORMULAS.

Put 9 drops of glycerol on a small piece of paper in an evaporating dish. Then cautiously place 6 measures of potassium permanganate on the glycerol. Keep your face away. It will burn brightly with a lilac color and carbon dioxide (CO₂) is evolved. The lilac color comes from the element potassium.

The Manufacture of Colored Fire: Mix thoroly on a piece of paper 4 parts of barium nitrate, 4 parts of potassium nitrate, ½ part of sulphur and 1 part of powdered charcoal. Pour this mixture in an evaporating dish. Apply match. The mass will take fire and burn with green fire.

Contributed by JOHN R. BOSMANN.

AN INTERESTING CHEMICAL EXPERIMENT.

Dissolve 1 gram of potassium chlorate in some aqua regia (by heating). The mixture will be green. Add a few drops of water and it will turn red. Add three times as much water as mixture and use for invisible ink: when heated it will turn blue.

Another Invisible Ink: Dissolve equal parts of copper sulfate and ammonia chlorid in water until it becomes light green, When heated it will turn yellow.

Contributed by GEO. VAUGHAN.

EMERGENCY CORK SCREW.

Recently I had occasion to open a bottle and was not having a cork extractor, very simply accomplished my purpose by using an ordinary screw eye in combination with a nail, as shown in the drawing. The use of the latter provided a better means both of starting the screw and of turning the screw and pulling the cork out.

Contributed by JOHN T. DWYER.
Experimental Chemistry
By ALBERT W. WILSDON

Twenty-Third Lesson

Silver and Copper With Nitric Acid.

Experiment No. 113.

Put into an evaporating dish a piece of silver and pour over it 2 cc. (measured) of nitric acid. Place the dish on a ring stand over asbestos or iron gauze and apply heat until strong fumes begin to appear; then remove the lamp from beneath the dish and permit the action to continue as long as it will.

Mr. D. J. Thomson in the February issue of the ELECTRICAL EXPERIMENTER, page 669, described a method of preparing pure silver from a silver coin. The editorial note appended thereto should be read carefully.

For the purpose of illustrating the action which takes place upon the decomposition of a silver coin as described in the article above mentioned, let us mix 90 per cent of silver and 10 per cent of copper (which is approximately the composition of a 10-cent piece). Place these in an evaporating dish and add 2 cc. (measured) of nitric acid.

What action do you notice first? What color has the liquid? Examine some silver nitrat and copper nitrat in solid form and in solution, and see if you can explain the color you obtained. Is the discoloration due to the copper or the silver? Are any crystals formed in your solution? If so, describe them as to shape, color, etc., and try and identify them. What does your solution apparently contain?

When the action wholly stops, remove any solid particles and add 10 or 15 cc. of water, stir it till any crystals dissolve; if the solution is not clear, filter it; pour it into a clean tube (saving a little in another tube for comparison), and suspend in the solution a copper wire (No. 9 or 10 B. & S.) made bright by running a piece of emery paper over it, or in place of the wire use a strip of copper. See Figs. 110 and 111. Note any immediate action; then allow the solution to stand, proceeding with other experiments.

A Simple, Yet Rugged, Electrolytic Apparatus Which the Amateur Electro-Chemist Can Construct In a Few Minutes’ Time and Which Is Adjustable for Different Size Bearers.

Arrangement of Test Tubes for Making Observations of Actions of Different Metals on Various Solutions.

At the end of half an hour or so examine the contents of the tube with care, noting the color, luster and shape of the deposit. To ascertain whether it is amorphous or crystalline, examine some of it under a microscope. Has the solution changed color? Compare with the previous solution. If so, state how, and account for it. Notice whether that part of the copper wire which was in the liquid has been reduced in size. Try and account for any change in the size of the wire.

Wash the deposit from the wire into a dish, return the wire, and wash the deposit several times by decantation, with stirring, and when every trace of copper nitrat solution is washed out, put away the silver in a vial and label it for future use, reserving a very little to dissolve in a few drops of nitric acid. The ionic equation for the action of nitric acid on silver is:

\[ \frac{1}{2} \text{Ag} + \frac{1}{2} \text{H}^+ + \text{NO}_3^- = \frac{1}{2} \text{Ag}^+ + \text{NO}_2^{-} + \frac{1}{2} \text{H}_2 \text{O} \]

In the above, 3 atoms of silver replace 3 hydrogen ions and become 3 silver ions; 4 hydrogen ions unite with oxygen ions (thus breaking up one NO_3 ion), seizing upon enough oxygen to combine with it, forming two molecules of water and leaving a molecule of the gas NO_2.

The ionic equation for copper acting on the solution of silver nitrat is:

\[ \frac{1}{2} \text{Cu} + \frac{1}{2} \text{Ag}^+ + \text{NO}_3^- = \frac{1}{2} \text{Cu}^2+ + \text{NO}_3^- + \frac{1}{2} \text{Ag} \]

The common parts, 2NO_3, may be cancelled. One copper atom forms a copper ion and deposits two atoms of silver. Atoms and ions thus change places.

Experiment No. 114.

Copper and Lead With Nitric Acid.

Place 2 grams of copper scraps in a dish and pour over them 2 cc. of nitric acid. If the acid is concentrated, no heat need be applied.

As in the previous experiment notice all the phenomena of the gaseous, liquid and solid products.

When chemical action has stopped, add 10 or 15 cc. of water and stir with a glass rod. If necessary, pour the resulting solution into a tube and pour a strip of lead wire or a piece of lead foil into the tube and stir it with a glass rod. If necessary, pour the resulting solution into a tube and pour a strip of lead wire or a piece of lead foil into the tube and stir it with a glass rod.

If after a few minutes no deposit is noted, warm the tube and let it stand for half an hour, noting occasionally whether anything is depositing on the wire or at the bottom. If much free acid, due to adding an excess of nitric acid, is present, considerable evaporation will ensue. This is to be avoided by measuring the acid at the beginning of the experiment and making sure that all has reacted with the copper. If the deposit on the wire is small, it may be left for twenty-four hours.

Finally take out the wire, scrape off the deposit in a dish, and return the wire after noting the relative sizes now and at the beginning. Filter the liquid and compare its color with the sample taken earlier in the experiment, and try and account for any difference. Any deposit at the bottom of the tube should be put with that taken from the wire, and if at all possible times by decantation, with stirring; then put it into a vial or tube and label it, except a little that should be placed in a dish and tested with a few drops of nitric acid. Think out carefully all the results obtained and make full notes, with an explanation of all phenomena and reactions; also try and reason out the two ionic equations.

Experiment No. 115.

Lead and Zinc With Nitric Acid.

Into a porcelain dish put about 2 grams of zinc or a piece of a half inch square of zinc, and put it in a vial and label it. Take out the wire, remove the residue to a dish, wash it by decantation several times, and put it into a vial and label it.

Make as close observations and take as full notes on all parts of this experiment as you did in the two previous ones. Examine specimens of lead nitrat and zinc nitrat both in solution and in the solid state. Of two elements, the one that drives the other out of solution is said to be electropositive to the one deposited or driven out. Of the nitrates in the last three experiments, namely, lead, silver and zinc, and hydrogcn (nitric acid), arrange the elements according to their electro-chemical affinities, placing the symbol of the most positive or the plus first, then in regular order to the most negative or minus. A negative ion is driven out of solution by a more positive ion, each ion replacing other ions according to its (Continued on page 861)
**“Electrical Laboratory” Contest**

In the March issue we published an interesting story with a number of excellent photos, describing one Amateur Electrician’s experimental laboratory. Now “Bugs”—we want to publish a similar article each month. Here’s our proposition: Why not write up your “Electrical Lab.” in not more than 500 words. Dress it up with several good, clear photographs. If we think it good enough we will publish the article in display style and pay you well for it. The remuneration for such articles will range from $5.00 to $10.00. And “Bugs”—don’t forget to make your article interesting. Don’t write—“I have a voltmeter, an ammeter, a switchboard,” etc., ad infinitum. For the love of Pete put some punch in it! Tell us what you do with your instruments and apparatus. You don’t mean to tell us that every Experimenter does exactly the same thing. “We” know different—but from the general run of such articles which we have received in the past, one would naturally think every “Lab.” exactly alike. Remember—send a photo of YOURSELF along. Typewritten articles preferred. Tell us the facts and don’t send in photos smaller than 3½" by 4½”. They must be sharp and clear—not veritable “picture puzzles.” We can read—but we are not mind-readers. Address the Editor “With the Amateurs Prize Contest.”
Radio-telegraphic Recorder
(No. 1,251,423; issued to William B. Bruce, Jr.)

A system for effecting a permanent record of radio-telegraphic signals. A height or radio receiver has its
transmitter connected up mechanically
with a vibratory relay member, by means of light threads as shown.

The vibratory relay is kept in the proper state of operation by an elec-
tromagnetic self-interrupting device. The vibratory relay armature closes a tape recorder or sounder local cir-
cuit thru a mercury cup contact. The invention is such as to obtain na-

mum results the vibratory relay armature should be turned so that its natural period coincides with the period of the current actuating the receiver diaphragm.

Electric Zig-Zag Course Control
(No. 1,253,816; issued to Ernest E. Hall)

This ingenious anti-submarine scheme for ships was described at
length in the October, 1917, issue of this journal, together with later im-

gressments whereon device is caused to act automatically on the vir-
tually steering gear and thus zig-

zag the ship over a predetermined course without the human element entering into the operation. In the

present patent the zig-zag course is plotted by the invention, so that each leg of the course, consumes
vastly the coast of these

successive leg of the course is sailed, the helmsman removes the contact plug on the clock and sets it for the
next lap. At each lap is run off, the alarm bell rings, notifying the helmsman to shift the clock contact a lap ahead and to shift the rudder for the new direction.

Quenched Spark Gap
(No. 1,253,103; issued to Emil J. Simon.)

Quenched spark gap design for ap-
plication in radio-telegraphy. The design embodies a system of build-
ing up the quenched gaps in units of say two as here shown. After assembly any number of units can be placed end to end in a com-

mon frame or holder, contact being

firmly established between the units in the manner apparent. The patentee prefers to make the gap plates of brass or other such material
having inset sparking surfaces of electrical; the contacts on the surfaces are very close together, or about .01

inch apart. The plates of each gap unit are held together by insulating screw bushes. The plates are in-

sulated from one another by mica or compact paper rings.

Electric Hot-water Spigot
(No. 1,252,611; issued to Howard K. Clover.)

An instantaneous electric hot-water spigot which can be attached to any pipe outlet. It may be connected with the nearest electric light socket, or door receptacle. A turn of the handle at the top of the spigot is all that is required to turn on the water, close the electric circuit thru the heating coil (disposed vertically, as shown), in the chamber thru which the cold water passes on its way to the

efflux nozzle) and get instant

heat water. Another turn of the handle, and the water is shut off, as well as the electric current. By turning the handle a certain way, cold water may be drawn from the spigot.

Automatic Telephone Fire Alarm
(No. 1,252,665; issued to Lee A. Collins.)

Why not transmit an alarm of fire directly over the telephone to "Cen-
tral" in the city, this inventor, and this is what he actually does. It operates on the principle that we do not have to remove the receiver from the hook

circuits. The voice waves from which-

evry source they may come, actuate a microphone or equivalent device, which is connected in circuit with a battery and the electric magnetic winding on an insulated leg of the polarized

reproducer, here illustrated. The

different currents cause the corresponding electric current fluctuations thru the magnet coil mentioned, these in turn acting on a balanced, pivoted armature bar. This bar controls a diaphragm air valve as the cut shows, causing tympanic bursts of perfect air to pass into a reproducing horn;

Audiophonic Protective Circuit
(No. 1,252,502; issued to Herbert E. Shreve.)

Connected in circuit with the fra-
dament and battery there is a thermo-

stat of usual construction, also a

ballast resistance element, as well as a

retardation coil. The ballast is

made of four wire member, in a vacuum chamber, containing hydro-
gen. This ballast acts to automat-
cally regulate the current in the cir-
cuit in a well-known manner, once it is heated.

Electric Ore Furnace
(No. 1,252,615; issued to John A. Ward.)

In this furnace the ore body itself is used as an electric heating ele-

ment, and further, the heat generated by the controlling device is utilized, thus eliminating the usual source of waste. Conducting panels are in-

serted in openings in the furnace wall at various heights as shown, any

or all of which may be connected in circuit. The resistance coil (generating

heat) is wound around the fur-

case. Below the crucible are the ar-

forming contacts. The furnace is

filled with ore from the top; it is started by closing the proper switches, springing the arc at the bottom, thence thru the resistance coil, and thru whatever electrodes above the arc that are connected in circuit.

Vacuum Regulation for Rectifiers
(No. 1,251,502; issued to H. A.

W."

This patent provides a means for regulating the current of vacuum in mercury vapor rectifiers, and similar devices, employing a cathode of mer-

curry or some other reconstructing, condensing, material. The inventor first heats the cathode by a Bunsen burner for example, just sufficiently to vaporize a small portion of the mercury. By means of an adjustable high-potential transformer 5 and high-

potential discharge of considerable
Phoney Patents

Under this heading are published electrical or mechanical ideas which our clever inventors, for reasons best known to themselves, have as yet not patented. We furthermore call attention to our celebrated Phoney Patent Office for the relief of all suffering daffy inventors in this country as well as for the entire universe.

We are revolutionizing the Patent business and OFFER YOU THREE DOLLARS ($3.00) FOR THE BEST PATENT. If you take your Phoney Patent to Washington, they charge you $20.00 for the initial fee and then you haven’t a smell of the Patent yet. After they have allowed the Patent, you must pay another $20.00 as a final fee. That’s $40.00! WE PAY YOU $3.00 and grant you a Phoney Patent in the bargain, so you have $43.00! When sending in your Phoney Patent application, be sure that it is as daffy as a lovesick bat. The daffier the better. Simple sketches and a short description will help our staff of Phoney Patent examiners to issue a Phoney Patent on your invention in a jiffy.

Prize Winner. BOCHE SNEEZO KILLER. This simple and albeit cheap idea should find immediate favor with the Allied commanders. It’s the only guaranteed, sure-fire modus operandi by which to break the Hindenburg line. On a nice dark night the Allied trench inmates deposit a fine, large heap of "sneeze" powder in no-man’s land, at intervals of 100 feet. On top of the trench set a large 500 H. P. electric fan. Turn the switch. Ohi! Gazuca! The Germany army sneezes itself to death—the "Reserves"—Oh! they’re kept busy bringing up handkerchief reinforcements! Inventor, Paul F. Henning, Harrison, Pa.

Prize Winner. GARFIELD DURING THE STREET LAMPS. Why wait for official orders from old "Doc" Garfield to shut off the street lights? Use my unpatented automatic, pedestrian-operated electric head-light. Its operation is simplicity itself. Every step counts, as it is geared up to spin the dynamo 50 Revs. per sec. The dynamo charges the storage battery; battery lights head-light as well as tail-light. You can’t go wrong with this simple device. And it "burns no fuel"—neither does it use energy derived from fuel. We hear the "Doc" calling "James, the ice water," Inventor, Herbert N. F. Wilcox, S. C. S., West Hoboken, N. J.
QUESTION BOX

This department is for the sole benefit of all electrical experimenters. Questions will be answered here for the benefit of all, but only matters of sufficient interest will be published. Rules under which questions will be answered:
1. Only three questions can be submitted to be answered in each number.
2. Only one side of sheet to be written on; matter must be typewritten or else written in ink, no penciled matter considered.
3. Queries, diagrams, etc., must be on separate sheets.
4. If a query is rendered by mail, a nominal charge of 25 cents is made for each question. If the questions entail considerable research work or intricate calculations a special rate will be charged. Correspondents will be informed as to the fee before such questions are answered.

LEARNING ARMATURE WINDING

(900) H. M. Rodriguez, Calif., writes:
Q. 1. Can I learn the trade of "Armature Winding" successfully from a correspondence school?
A. 1. Armature Winding is practically a trade by itself, and it is usually the best policy to acquire this trade in an electrical repair shop or manufacturing plant where such work is performed. It is rather difficult to learn all the practical details of this job just from books.

However, there is a large amount of technical material connected with the understanding of armature winding which can be procured from a good correspondence school course, and we would strongly recommend that you get in touch with the correspondence school advertising in ELECTRICAL EXPERIMENTER.

ELECTROLYTIC RECTIFIER

(910) W. A. Osborn, Cleveland, Ohio, wants to know:
Q. 1. How to make an electrolytic rectifier?
A. 1. The best home-made rectifier is constructed as follows: Procure four jars having a diameter of four inches and about eight inches high, and make proper covers for these jars of wood dipt in hot paraffine. Paste to these four pieces of wood an aluminum plate and a lead plate, the aluminum plate to be 4 x 6 inches while the lead plate should be 3 x 6 inches.

You should then proceed to fill the jars with electrolyte made up by dissolving as much sodium phosphate as the solution will dissolve without a precipitate, when filled to one inch from the top with water. It will then be necessary to add a few drops of sulfuric acid to reduce the resistance of the electrolyte, depending upon the amount of current you wish to draw. Diagram of connections is given herewith for four-cell rectifier, which rectifies both halves of the A. C. cycle.

MAGNETIC TEST FOR BRASS

(911) C. Robinson, Victoria, Australia, asks:
Q. 1. For a good test to determine things that are made of brass.
A. 1. One of the simplest methods of determining whether an article is made of brass or not is by means of a steel magnet.

Of course, an article might look as if it were brass and be made of another alloy, but if the magnet does not exert any effect on it, it is always possible to determine in this way whether an alloy containing a reasonable percentage of one of these metals.

THE USE OF "DUMMY ANTENNAE"

(912) Harry E. Longmire, Missouri, inquires:
Q. 1. I want to know if the United States Government demands of us ama-

ODD PHOTOS WANTED AT $1.00 EACH!!!

Now is the time to make your Kodak pay for itself in a real practical way. To secure interesting photographs of out-of-the-ordinary electrical, radio and scientific subjects and are willing to pay $1.00 cash for every one we can use. Please bear in mind that for half-tone reproduction in a magazine, a photograph should be particularly sharp and clear. Of course, if a subject happens to interest us particularly well, we can pay the photo retouched. For the general run of subjects, however, it does not pay to go to such expense. Therefore, please take pains to properly focus and expose your pictures. It often happens that a really mediocre subject well photographed will be given over an excellent subject poorly photographed. And don't send us plate or film "negative"; send unmounted, or mounted "positive," preferably a light "positive" one.

As to what to photograph: Well, that's a long story. We like to have something unusual that's up to you, and every reader now has the opportunity to become a reporter of the latest things in the realm of Electricity, Radio and Science. But, please remember—it's the "odd, novel or practical stunt" that we are interested in. Every photo submitted should be accompanied by a brief description of 100 to 150 words. Give the "facts"—don't worry about the style. We'll attend to that. Envelope stamps if photos are to be returned and place a piece of cardboard in the envelope with them to prevent mutilation. Look around your town and see what you can find that's interesting.

Address photos to—Editor "Odd Photos," ELECTRICAL EXPERIMENTER, 225 Fulton Street, New York City.

WHAT IS SPONGY PLATINUM?

(913) Charles Honeywell, Glensville, N. Y., asks:
Q. 1. What is spongy platinum and where can it be obtained, as well as its present cost?
A. 1. Spongy platinum is a form of platinum which is very sensitive to gases; i.e., when this metal is exposed to a gas it absorbs the gas considerably, causing a compression in the metal which manifests itself as heat or incandescence. Automatic cigar lighters, gas detectors, etc., make use of this unique property of spongy platinum.

The price of this platinum changes so often that we cannot give you its present cost, but we would refer you to any chemical supply house.

ELECTRIC MOTOR IN VACUUM

(914) W. R. Oliphant, Healdton, Okla., writes the "Question Box".
Q. 1. Can I run a motor in a vacuum or would it burn out?
A. 2. In answer to your second question, wherein you ask whether the motor might run more efficiently in a vacuum, we are certain it would not do so, that such a system of running motors in a vacuum is impracticable, for under these conditions it would be necessary to maintain a constant vacuum by means of pumps which would have to work constantly.

From a purely academic point of view, there perhaps would be gained a little, due to the fact that the armature would run without air-resistance, but the gain is very slight.

ELECTROSTATIC INTERRUPTER QUERY.

(915) P. Barahino, Chicago, Ill., writes:
Q. 1. I am having trouble in operating a spark coil with an electrostatic interrupter. What would you advise?
A. 1. We believe the trouble to be with your electrostatic interrupter. A sure test for ascertaining this to be so is to connect (Continued on page 856)
Amateurs! Experimenters!! Opportunity Extra-Ordinaire!

Size of machine 19¼ x 9½ x 8¼. Net weight 18 lbs.

Three tapes show how machine works.

"I have carefully read all the statements contained in this advertisement. Every word is true; nothing has been exaggerated. I believe this to be the greatest bargain—the greatest value—that has ever been offered by my company to amateurs and experimenters, in its 14 years of existence."

HISTORY

The telegraph and perforating machine herewith illustrated and described is regularly manufactured by one of the largest electrical companies in the U. S. Some time ago a western telegraph company owned a small quantity of these machines for their regular requirements. As we understand it, they paid over $70.00 apiece for these recording machines. The machines were duly shipped West by Express, but the telegraph company having financial troubles could not pay the heavy express charges. Therefore the machines were returned to New York with added charges, and were finally sold at auction by the express company to recover the transportation charges, as is customary. We bought the entire lot of machines.

DESCRIPTION

This is a standard commercial, large size, perforating, telegraph recorder. It is exactly as manufactured by the Western Union and Commercial Telegraph Companies in their main offices. This machine requires a double contact (back stop) telegraph key and a few batteries. Pressing the key operates in turn the two sets of powerful electro-magnets, which on their part operate the two ratchet wheels. These then operate two plunger plates which punch the holes in the tape. (see illustration of tape). By sending Morse code, the holes are punched in a certain manner. Thru feeding the tape back thru the machine and by arranging two brass contact fingers, the tape will spell out dots and dashes by means of a buzzer.

This machine has a truly wonderful spring motor. It is absolutely silent and has a centrifugal regulator speed-adjuster and stop arrangement. At the highest speed the motor runs 18 minutes, at the slowest speed 65 minutes continuously. Over all dimensions of machine are 19½ x 9½ x 8¼. Diameter of holes punched 1/16 in. The width of paper tape is 6½ in. The magnets measure 2½ in, and are 1½ in. high. The net weight of the machine is 18 lbs. Our Illus. shows machine with cover removed to show motor. The small inset shows the beautiful tauten electro-magnet arrangement. The ratchet wheels and perforating equipment. All wood work is solid mahogany.

USES

What you can do with this beautiful machine:

1ST—USE AS A PERFORATING MACHINE as already described. By means of a block of wood and a few bits of brass (or you can mount them on the base of the machine) you have a regular Morse sender and receiver. You can then ask a good operator to send you a long message and you can listen to the dots and dashes as often as you wish. The tape record thus prepared will last a very long time.

2ND—AS A REGULAR MORSE REGISTER. With instructions which we supply and by using only two magnets (instead of 4) and by making a few slight changes, which any experimenter can do, the machine will write regulation dots and dashes on the tape. A pencil lead is used to do this. You can then have an enigmata on the recorder, and you are now enabled to send the messages by sight. Or you can send the message yourself with an ordinary key, etc., etc.

3RD—AS A SPECIAL REGISTER. By utilizing all four magnets a special type of dot and dash can be sent (as used in cable telegraphy). See sample of writing on the tape just leaving machine, above. This record can be read just as easily as regulation dot and dash (the dot is represented by the y sign). To send such signals a slight change is necessary which can be made by any experimenter handy with tools.

4TH—AS A TELEGRAPHONE. Every experimenter has long wished for a real telegraphone, whereby the voice is recorded on a film steel wire, and then reproduced over a cheap style 15 cent penny telephone receiver. By means of this machine a very efficient telegraphone can be built by any experimenter handy with tools. No extra expense are needed; a few bits of brass and steel will do the trick.

We furnish blue Prints and full directions to make all the above apparatus using the recorder. We also furnish 3 paper reel tapes, standard size.

Price as described complete

$15.00

This machine does not permit pulling all of the many good points of the recorder. Suffice it that the machine is the most economical commercial type, with everything of the very best.

A similar machine is listed at $100.00 in the catalog of the Western Electric Co. We bought these machines cheap thru expedite, hence the ridiculously low price. All machines in stock, will be shipped immediately on receipt of remittance.

ELECTRO IMPORTING CO. (Signed: H. Gernsback, President.

231 FULTON ST., N. Y. C.

"Everything for the Experimenter"

See also our full page ad on page 800.

You benefit by mentioning the "Electrical Experimenter" when writing to advertisers.
2 Promotions -- Pay Doubled

Mr. Victor C. Harrell, one of Uncle Sam's brave flying men, wrote us the other day as follows:

Aviation Field, Minola, N. Y.

To: Aviation Field, Minola, N. Y.

Gentlemen: I have received two promotions due directly to your valuable lessons in connection with your famous book -- the United States Government recently made me an Honor Flight Instructor and said I HAD ALMOST DOUBLED.

VICTOR C. HARRELL
Chief Arm. Inspect. Aviation Branch, United States Army.

Wanted--Men!

Yes, men who know the Science of Aviation. The United States Government plans to send 30,000 flying men to Europe and has appropriated $166,000,000 for new airplanes. The airplane constructor needs half a million men now. You can learn this science at home during your spare time. Your training will be under aviation experts—men like Walter Brook, the famous aviator who won the London to Paris Race.

FRE BOOK!

Just put your name and address on the coupon and we will send you our free book about the Science of Aviation and our special limited offer on our complete Mail Course. You can learn all about the new General Aviation Course ask for the price of a new billion dollar industry. Read out this coupon and mail at once. Do it NOW!

National Aero Institute,
Dept. 7444, Morton Building, Chicago, Illinois

Gentlemen: I have received two promotions due directly to your valuable lessons in connection with your famous book -- the United States Government recently made me an Honor Flight Instructor and said I HAD ALMOST DOUBLED.

VICTOR C. HARRELL
Chief Arm. Inspect. Aviation Branch, United States Army.

MAKE YOUR OWN GENERATOR!

We have a complete line of sturdy efficient generators and alternators from 100 to 1000 watts. We furnish these complete, or parts furnished ready to assemble with wire and instructions to wind. Send for catalogue.

ALL AT FACTORY PRICES.

BERGMANN MOTOR WORKS, 1223 M�示A. St., BUFFALO, N. Y.

(GOOD hand generators, 110 volt, clock work, $5 each, be replaced 20% at factory price. Clock could be replaced with any type of clock. Chief of engine generators. CHEAP!

W. A. WATTS, 267 Gas Bldg., Chicago

ELECTRICAL EXPERIMENTER
April, 1918

QUESTION BOX. (Continued from page 854)

the coil across some batteries, and if it then works all right, naturally the trouble is in the interrupter.

The best way to remedy the trouble with the interrupter is to try different strengths of solution, and if this does not work, try an interrupter porcelain tube with a smaller hole. If it appears that your secondary is broken down, which you will find out by the dry battery test, then the primary voltage is too great; that is, the voltage when used in connection with the electrolytic interrupter breaks down the insulation of your spark coil.

SIMPSON MERCURY VALVE RADIO TRANSMITTER.

(916.) Walter R. Rathbun, Alaska, writes:

Q. 1. Where can I find information re-

paid, and in which there is considerable theory given of the Simpson Valve and its operation. We give official wiring dia-

gram of the Simpson transmitter herewith.

DATA ON WATER FALL. (917.) Edward Lecchis, New York, N. Y., asks for:

Q. 1. Data on water wheels, water falls, etc.

A. 1. We would advise that the formula to use in the computation of the horse-

power given by a water fall, water wheels, etc., is contained in an extensive article dealing with such problems in the July and August, 1916, issues of the ELECTRICAL EXPERIMENTER, copy of which we can supply you at 20c each. This article also deals with the design and constructional details of logical water wheels of different sizes, suitable for driving dynamos, machinery, etc.

SAYVILLE RADIO PLANT HAS NEW BUILDING.

Work was recently started on the erecti-

on of a building, 50 by 80 by 56 feet, of tile and stucco, at the big Government radio station at Sayville, L. I.

This will be used as a transmission build-

ing and connected with that will also be a similar building to be used as a machine shop and storage rooms.

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MEANING OF "WIRE" AND "CONDUCTOR."

In the United States Bureau of Standards Publication No. 37 the following definitions for "wire," "conductor," "duplex" cable, and "twin" cable are given:

"A wire is a cylindrical rod or filament of indefinite length but of uniform section and homogeneous material, or a multiple of such rods or filaments, usually sheathed in a non-conducting material."

"A conductor is a wire or a combination of wires, not insulated from one another, suitable for carrying a single electric current."

"A duplex cable consists of two insulated single-conductor cables laid parallel, having a common covering."

"A twin cable comprises two insulated single-conductor cables twisted together. They may or may not have a common insulating covering."

And at that, we think they are still wrong for Dr. Steinmetz says he believes that wires do not carry "electric" currents at all—they merely act as guides; the currents travel thru the ether surrounding the conductor—leg ponder—wire.

ELECTRICAL RESISTANCE OF THE HUMAN BODY.

Results obtained from measuring the resistance of the human body to electric currents vary from 500 ohms to 8,000 ohms and even more. According to a note by Dr. A. O. Boas appearing originally in _Elektrotechnik_ of that city, these enormous differences are due to the employment of defective methods. When an excessive continuous current is used, muscular contractions and nervous excitation ensue which falsify conclusions. Experiments made by Dr. Nix and Prof. Brandenburg have brought consistent results. They used both direct and alternating current—in the first case at 1 millivolt, corresponding to the action of the heart; in the second case replacing the slide-wire of a Wheatstone bridge by a trough filled with a solution of sulphate of zinc, says _Revue Générale de l'Electricité_. The subject plunged his arms or his legs into salt water at the temperature of the human body and resistance was measured between the arms or between one arm and one leg, the experiments being repeated after two weeks' time. The results are tabulated as follows:

- Resistance to Alternating Current, Ohms
- Resistance to Current, Ohms
- Arm to Leg to Arm to Leg
- Healthy country-man (59 years) 1100 1400 233 350
- Woman with nervous malady 1000 1290 255 455
- Diabetic patient 1450 1750 384 434
- Man 65 years 2000 2100 322 414
- Man with softening of brain 1800 2600 399 414
- Dtte. 1400 1400 576 480

When the subject was apprehensive the resistance to direct current, it was found to be greater than when he was tranquil, 1,700 ohms from arm to arm and 1,500 ohms from leg to leg being recorded in the first case, and 1,600 ohms from arm to arm and 1,200 ohms from leg to leg in the second state.

THREE YEARS AGO I was earning 830 per week. With a wife and two children to support I was in constant struggle to make both ends meet. We saved very little, and that only by sacrificing things we really needed. Today my earnings average a thousand dollars weekly, I own two automobiles, and I do not work more than a few hours a week.

What I have done, any one can do—for I am only an average man. I have never gone to college for education is limited, and I am not a "brilliant" by any means. I personally know at least a hundred men who are better educated who are better informed on hundreds of subjects, and who have much better ideas than I ever had. Yet not one of them approaches my earnings. I mention this merely to show that earning capacity is not governed by the extent of a man's education and to convince my readers there is only one route for my success—a reason I will give hereafter.

One day, a few years ago, I began to "take stock" of myself. I found that, like most other men, I had doubled my income, determination, and energy. Yet in spite of these assets for some reason or other I drifted along without getting anywhere. My lack of education bothered me, and I had thought seriously of making further sacrifices in order to better equip myself to earn more. Then I realized that for but few millionaires ever collected the entire amount. Rearper, Hill, Schwab, Carnegie—not one of them had any more schooling than I had. One day some statement unfolding that woke me up to what was wrong with me. It was necessary for me to make a decision on a matter of importance and I knew what was the right thing to do, but something held me back. I said one thing, then another. I couldn't for the life of me make the decision I knew was right.

I lay awake most of that night thinking about the matter—not because it was of any great importance in itself, but because I was beginning to discover myself. Along towards dawn I resolved to try an experiment. I decided to cultivate my will power, believing that if I did this I would not hesitate about making decisions that when I had the idea I would have sufficient confidence in myself to put it "over"—that I would not be "afraid" of myself or of things or of others.

With this new purpose in mind I applied myself to the problem. But the will, I was sure that other men must have studied the subject, and the results of their experience would doubtless be of great value to me in understanding and developing my own will power. So, with a directness of purpose that I had scarcely known before, I began my search.

The results at first were discouraging. While a good deal had been written about the memory and other faculties of the brain, I could find nothing that offered hope of acquiring the new power that I hoped might be possible.

But a little later in my investigation I encountered the works of Prof. Frank Channing Haddock. To my amazement and delight I discovered that this eminent scientist, whose name ranks with James, Bergson and Royce, had just completed the most thorough and constructive study of will power ever made. I was astonished to read his statement that in the years he had devoted twenty years to this study—how he had so completely mastered it that he was actually able to show how the very experienced could anyone develop the will, making it a bigger, stronger force each day, simply through an easy, progressive course of training.

It was not long, therefore, that I at once began to practice the simple exercises formulated by Dr. Haddock. And I need not recount the extraordinary results I experience almost from the first day. I have already indicated the success that my developed power of will has made for me.

I understand that Professor Haddock's lessons, rules and exercises in will training have recently been compiled and published in book form by the Pelton Publishing Co., of Meriden, Conn., and that any reader who cares to examine the book may do so without sending any money in advance. In other words, if after a week's reading you do not feel that this book is worth $3, the sum asked, return it and you will owe nothing. When you receive your copy for examination I suggest that you first read a few of the articles on: the law of great thinking; how to develop analytical power; how to perfectly concentrate and so forth. You will find that the few articles will be sufficient to convince you that your efforts in this line have not been wasted or that your will is not strong. You will get a clear idea of what Power of Will is, and will be able to estimate your own strength as you read this book. I have found this book a most invaluable aid in developing my will power.
a night it must have been for him, but OH! what a night it WAS for me; well do I remember in trying to retreat from the razor strap with the phones still clamped tightly on my head. In my excitement I sat on the key with my right hand holding tightly on the spark gap reaching for the door with the left, at the same time busily engaged in studying the least path of resistance. Oh! yes, it was nice to have been a pioneer; in fact it's the only way. It was only thru the Modern Electrics then, and the Electrical Experimenter NOW that got my start and which allowed me the above pleasures. Well, Bugs, I'll not keep you from your work any more, connect them in series or in parallel, I don't care, you know what you want. 

E. T. J.

**UTILIZING BURNT-OUT LAMP BULBS.**

(Continued from page 833)

tain pure hydrogen; the other, pure oxygen gas. The former is connected to the negative, the latter to the positive pole of the battery.

Nearly every experimenter wishes to possess a good electroscope. One can be readily made from a burnt-out lamp bulb as is shown in Fig. 7. Take an ordinary bulb and cut off the top as explained in the preceding articles. Leave one lead wire which must be the one going thru the central connection as shown in illustration. By means of a long pair of tweezers bend this wire around to form a small hook. Now take a strip of gold leaf 2 inches long, 1/4 of an inch wide, and fold once. This gold leaf is simply a little of the leaf tied up with a thread, and which will not fall from the thread.

The writer, who has had quite a good deal of experience, was quite pleased, has talc, paraffin, or even vaseline, some material to handle, adheres to the fingers and is a general nuisance all around. For some years past he has used a gold leaf substitute, which can be easily handled, and which works just as well if not better than gold leaf.* The substitute gold leaf can be readily fastened to the central lead wire, as, for instance, with a bit of thick shellac; or it may be simply hung loosely; but we believe shellac to be the better method. Ordinary fish glue may also be used, and it proves quite satisfactory. In that case, simply place a little of the glue by means of a wooden splinter to the hooked lead wire. The gold leaf can then be hung on the little hook of the lead wire, and will adhere there readily. After all is finished, the bulb is secured to two wooden blocks as shown in the illustration, the lower block carrying a piece of felt to support the bulb, while the upper ring-like clamp simply holds the bulb in its upright position. Four pieces of felt may be placed between bulb and ring, so as not to crush the glass. Rubber feet at the bottom of the base complete the apparatus, which is quite necessary. Now, for instance, an ordinary rubber fountain pen can be rubbed on the sleeve, thus electrifying it, and after it is brought near the metallic tip of the lamp, the two gold leaves will diverge. The stronger the charge, the further the leaves will diverge. They can be made to diverge quite violently if an ordinary piece of blotting paper is taken and strongly rubbed over your knee. This strongly electifies it, and the leaves will diverge more or less; they are lost enough they will touch the wall of the bulb.

In the next idea is shown how the experimenter can make an efficient Leyden jar (condenser) by means of a discarded lamp bulb. Take a bulb and break off its tip under a solution of ether strong salt water

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or acylated water, one part acid, four parts water. The solution will rush into the bulb as mentioned in the "barometer" experiment. It is, however, not necessary to quite fill the bulb. In other words, three-quarters full will be sufficient. As will be noted from the illustration, the two lead wires can remain after the filament has been broken off. Nothing further remains to be done except coating the outside of the bulb by means of tin foil which may be shellacked to the bulb. In order to make a good connection, our detail illustration shows how this can be accomplished. A piece of copper foil about 1 inch long and 1/2 inch wide will be sufficient. This copper foil is shellacked against the glass of the bulb, and the tin foil is then wound around the bulb over the copper foil. No shellack should be used between the copper foil and the tin foil. Otherwise a bad connection results. The tin foil should reach up as high as the solution goes, and should be on the level with the latter. It does not matter how far the tin foil reaches down, and this is up to the constructor. In our illustration we have only shown it three-quarters way down, but the tin foil could go still further down. Of course, in that case, the copper foil would be moved further down also.

In order to keep the wire from tearing out the tin foil, a stout rubber band may be slipped over the bulb (not shown in illustration). This rubber band will hold the wire in a satisfactory manner.

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(Continued from page 836)

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A very practical work, and fills a conspicuous want of the text dealing with foreign types of apparatus and applications, the various ideas and theories with the found and valued to American electricians and engineers.

HOW TO MAKE HIGH PRESSURE TRANSFORMERS, by Prof. F. E. Aunt, 46 pages; 11x9 inches, illustrated; size, 4½ x 7½ inches; stiff covers. Published by the author at Hannah, N. H., 1917. Price, 65 cents.

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ranged upon opposite sides of the hull under the mirrors, the searchlights being mounted to project light diagonally upward and toward the respective mirrors on opposite sides of the vessel. The searchlights may be slightly offset from each other, so that the rays of light projected from the two searchlights will not intersect and interfere with each other, and the mirrors serve to throw the rays of light downwardly through the respective transparent platelets at the bottom of the hull.

A submerged submarine would ordinarily be easily located by these downwardly projected rays of light, and a torpedo discharge vertically downwardly in the water when the vessel was directly over the submarine, would result in a speedy destruction of the submarine.

The operator is shown just below a transparent plate, and suitable levers are provided for manipulating the mirrors to position them in a proper manner for reflecting the light in the desired direction. (It should be noted that the operator manipulating the underwater search-light could not himself “spot” the submarines. It is a well-known fact that the observers on a battleship are stationed quite a distance away from the search-light. This could be arranged here by flashing alternate beams, observing thru the dark windows.)

A SYNCHRONOUS MOTOR MADE FROM AN IRON PULLEY.

(Continued from page 843)
platinum wire are allowed to protrude thru holes in the bottom of the vessel and sealed in with paraffin or beeswax. The sides and bottom of the pan are coated with melted paraffin. The pan is filled with acridated water (electrolyte) and while under the water the tubes are inverted and placed over the platinum wires. The tubes should be previously graduated by weighing twice as much pure water in one as in the other. The level of the water is then matched on each tube with a little oil paint or scratched with a file.

It is possible to rectify both waves of the alternating current by equipping the shaft with two slip rings besides the commutator, as shown in the diagram, Fig. 3. This, of course, complicates matters considerably. In this case the brushes have to be dispensed with, but there would be two brushes bearing on the commutator and a brush for each of the two slip rings. Any of the shaft sections are directly connected to the inner ring in diagram, and the brush segments to the larger ring shown.

The commutator must revolve at such a speed that during each half cycle a section passes under each brush; and the brush must be so set that both of them change connections at about the time the brushes could be dispensed with, but there would be two brushes bearing on the commutator and a brush for each of the two slip rings. Any of the shaft sections are directly connected to the inner ring in diagram, and the brush segments to the larger ring shown.

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ELECTRICAL EXPERIMENTER

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lishers not to write until this time has elapsed, thereby saving them a vast amount of clerical labor.

THE CHEMISTRY OF SELENIUM.

(Continued from page 845)

action which now contains Selenic acid (H₂SeO₄), is obtained by and when cold, diluted with water, filtered, and then heated with a quarter of its volume of fuming hydrochloric acid, until three-quarters of the liquid has been distilled off. By this process, chlorin is evolved, and is reduced to Selene-

out acid (H₂SeO₃). The cold solution is then poured into the sediment and saturated with sulfur dioxide, when selenium separates out as a red powder.

(1) H₂SeO₄ + 3H₂O + 2H₂ = 2H₂SeO₃ + 2H₂O

Selenium may also be prepared by digest-

ing the lead-chamber deposit on a water-

bath with a concentrated solution of potas-

sium cyanide until it assumes a pure gray color.

(2) KCN + Se = KCN

From this solution the selenium is deposited in red-flakes, on the addition of hydrochloric acid. This deposit contains both lead and copper, and these impurities are removed by distillation or by being fused with a mix-

ture of Nitre (Potassium Nitrate) and Sodium Carbonate, and this is again treated with hydrochloric acid and sulfur dioxide. These impurities may be removed by evap-

orating the solution to three parts with nitric acid, and reducing the aqueous solution of selenious acid by means of sulfur dioxide.

Properties:

Selenium, like sulfur with which it is isomorphous, exists in three different al-

tropic forms, three well defined forms being known.

1. Amorphous, Vitreous, and Colloidal

Selenium, being slightly soluble in carbon disulfide. These three differ in appearance but may all be considered as belonging to the same alteration, and are sometimes known as "liquid" selenium.

(a) Amorphous: This modification is formed as a finely divided brick-red powder, when a solution of selenious acid is precipitated by sulfur dioxide gas, when the acid is reduced by Zinc, Stannous (tin) Chlorid, or other reducing agents, and is also formed by the electrolysis of the acid.

This form is slightly soluble in carbon disulfide, which produces a change to dark gray metallic selenium, containing about 97 degrees. This form has a specific gravity of 4.26.

Amorphous selenium is often obtained in a colloidal form, which is very unstable, and will not keep, and which is soluble in water. This colloidal modification is formed when a solution of selenious acid is added to a solution of selenics, and when a diluted solution of selenious acid, and when a diluted solution of selenious acid is a

(Continued on page 870)
ELECTRIC PARACHUTE.

(209) Loyd Nord, International Falls, Minn., has sent in an idea wherein a parachute is to be installed on an aeroplane in such a manner that when the pilot becomes endangered, all he has to do is to press a button on the steering wheel which will immediately explode a parachute by means of certain electrical firing apparatus, which in turn will shoot up a parachute which is attached to the seat back while the pilot remains. This is supposed to disengage from the aeroplane and land the operator in safety.

This is an idea that looks very well on paper, but is not practical for the reason that the exploding caridge would certainly tear the parachute to pieces. Parachutes have been tried on aeroplanes before, but have not met with much success. We do not think that an invention of this kind would be practical.

"BELL SOFTENER." (210) W. B. Hanlon, Pittsburgh, Pa., has submitted a bell softener which comprises a number of brass tubes which are to be struck by a certain re-arranged piece of chapper on a bell. This is supposed to do away with the harsh sound. Our advice is asked.

A device of this kind does not fall within our idea of a bell softener. Quite the contrary, we are certain that it will make the sound just as harsh as in ordinary gongs were used. We are afraid this does not solve the problem of softening the noises of an ordinary telephone bell.

COLLAPSIBLE TYPEWRITER. (211) Harry Drake, Seattle, Wash., writes as follows: "Could you give me information concerning the possibilities of inventing a collapsible typewriter, weighing only a few pounds and suitable for school use?"

A. The possibilities of this device are, of course, very good, and there should be a vast field for such a machine, if it can be built cheap enough, and if the machine is mechanically right. There are several collapsible machines on the market now, as for instance the "Corona" machine, but this is rather expensive.

CARDBOARD MOUSE TRAP. (212) A. R. Dunham, New York City, has sent in a clever design and description of a cardboard mouse trap which can be made and sold for less than 10c if necessary. The idea being that once a mouse is in the cardboard box, it can be disposed of with its contents, and the box has even provided the box with a string, and the box is arranged in such a manner that it will not come to the owner's knowledge. These features should prove especially attractive to the "weaker sex." A. This idea is a very good one. It seems to have commercial possibilities, if worked out right. We would advise our
H. GERNBACk.

is of interest to inventors and particularly to Phases. Regular inquiries address to "Patent charge. Such inquiries are published here for the bene方面的, we make it a rule not to do so. A charge of $1.00 is made for each question, plaintiff. Only one side of sheet should be writ-

correspondent to try out a few of these traps in actual practise to see if the mice are not afraid of the contraption, as these rodents are, as a rule, very wily and ear traps of this kind. We believe a patent can be obtained on this device.

SPECIAL FLASHLIGHT. (214) Thomas A. Pilling, Camp Greene, Charlotte, N. C., submits a design of a flashlight having a special spiral filament bulb and conical concentrator for the rays. The flashlight is supposed to be used by physicians and dentists for exploration of small cavities.

A. A device of this kind is not new. Similar instruments of this sort are being marketed right now. We do not think a patent could be obtained on a device of this kind.

COMPREST AIR SHELL. (214) F. M. Keelsing, New Albany, Ind., submitted an explosive shell for war purposes but air, compressed to a very high degree, is used instead of an explosive. The shell is afterwards exploded in a certain manner.

A. We fail to see anything practical in a device of this kind for the reason that the entire arrangement would be too complicated, too costly, as well as too cumbersome to handle. We also believe it is somewhat dangerous, as our correspondent proposes to charge the shell with so much air up to almost the bursting resistance of the shell itself. We think that the present explosive shell containing ordinary explosives is very much more satisfactory in all respects, being vastly cheaper to manufacture, and having quite a number of other advantages over the compressed air shell.

AUTO FASTENER. (215) Chas. Ruerger, Cheboygan, Mich., has asked our advice on a certain fastener for automobile work which contains certain threads, and which for this reason will not loosen up, he claims, due to the vibration of the car.

A. We think that the ordinary snap fastener for automobile work which contains certain threads, and which for this reason will not loosen up, he claims, due to the vibration of the car.

OIL ATTACHMENT. (216) Fred Van Dyke, Detroit, Mich., wishes to know if a device whereby a certain oiling device is attached to stock and dies is new, and whether it can be patented. The idea is that every stock and die needs a good deal of oil, which at the present time is supplied by hand, by means of an oillcan. Our correspondent does away with this feature, using an automatic oiling apparatus incorporated in the tool itself.

A. This is a very clear idea, and quite novel as far as we can see. We have never seen the like of it, and would advise him to get in touch with a patent attorney.

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ELECTRICAL EXPERIMENTER

April, 1918

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April, 1918

THE CHEMISTRY OF SELENIUM.

(Continued from page 567)

—hydrazine hydrate. It can also be prepared by pouring a solution of selenium in carbon disulphide into a large volume of ether, according to Maljishoff. It is a dark red powder which is comparatively insoluble in water, forming a red fluorescent solution, which gradually becomes insoluble on preservation. The solution may be boiled without undergoing any change, but the selenium is deposited on the addition of acids or salts. The solution on spontaneous evaporation consists the selenium as a red transparent film.

(b) Vitreous. Vitreous selenium is always produced when liquid selenium has been heated to 217 degrees and then kept in a water-cooled. It then solidifies to a dark brownish-black, glassy, amorphous, brittle mass, which is also slightly soluble in carbon disulfide. This form has a specific gravity of 4.28. These varieties have no definite melting point, softening gradually on heating. Like the amorphous amorphous selenium does not conduct electricity.

(c) Insoluble or Metallic Selenium: This modification is obtained by cooling melted selenium quickly to 210 degrees, and then keeping the melted mass at this temperature for some time. The selenium at length solidifies to a granular crystalline modification, its temperature rising suddenly in the act of solidification to 217 degrees. This change from the amorphous to the metallic condition also takes place only more slowly as the lower temperatures; thus if a mass of amorphous or vitreous selenium be gradually heated it softens and melts as soon as the temperature approaches 100 degrees, begins to pass rapidly into the metallic form, the temperature rising to 217 degrees. A similar change occurs at the ordinary temperature when amorphous selenium is placed in contact with quinolin, anilin and certain other liquids in which it is soluble, or by fusing the vitreous form between carbon plates and then allowing to cool slowly. If a concentrated solution of potassium or sodium selenide be exposed to the air, metallic selenium separates out in microscopic crystals, and it is also formed as a crystalline powder when sulfur dioxide is passed thru a hot solution of selenious acid, the amorphous form, which is the first product, being rapidly converted to the metallic form.

Metallic selenium conducts electricity and exposure to light increases its conducting power. The peculiar effect to light is best exhibited on selenium which has been exposed for a considerable time to a temperature of 210 degrees, until it has attained a granular crystalline condition. When selenium in this condition is heated, its electrical resistance is increased, whilst on exposing it to the action of diffused daylight, the electrical resistance instantly diminishes; this however, is only a temporary change, for on cutting off the light, the electrical resistance of the selenium slowly increases, and after a short time reaches the amount exhibited before the exposure.

Metallic selenium possesses all the physical characteristics of a metal. In the making of selenium cells, it is used either in a metallic condition. Vitreous selenium which has not been annealed, when used in cell-making, is used in the same way, difference being a perfect non-conductor. The peculiar sensitiveness of selenium to the electric current, when exposed to light, is attributed to its metallic modification, caused by annealing.

Methods of making Selenium Cells:

Various methods of making selenium cells have been described in previous issues of this journal (ELECTRICAL EXPERIMENTER,
Use of Selenium:

So much has been said in previous issues of this journal regarding the uses of selenium as well as the application, that the writer will not go over the same ground as covered in these papers.

In 1873 Willoughby Smith noted that the electrical conductivity of selenium varied with light, the metal being about 600 times as good a conductor under the influence of light as in the dark. This opened a very extensive field for research work among the investigators, and many interesting experiments with this substance, and the numerous applications developed by scientists have been covered in previous papers. The application of the electrical properties of selenium are still in the experimental stage and the future will undoubtedly reveal new apparatus which will depend principally upon these remarkable electrical properties.

Selenium has been used in the glass industry. In 1891 Wetz patented the use of selenium for producing red or orange stain in glass and in 1894 Spitzer employed seleniums and selenates, in conjunction with a reducing agent, to color glass. Since then selenium has been used to produce red-colored glass, particularly ruby glass, where the red must be clear, without a trace of green, as in railroad signal lights, and photographic dark-room lamps.

Various shades of glass may be obtained by combining selenium with gold and silver, and with opacifying metals, oxides and minerals, such as cryolith, fluor spar, etc. Selenium is also used as a decolorizer in white glass for discharging the green color due to iron.

Wasserman has patented a process for making dyestuff, by using salts of selenium in conjunction with organic salts.

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[Note: The text is a mix of advertisements and content, likely from a magazine or journal, discussing various scientific and technical topics, including the use of selenium, electrical engineering, and practical education.]
next instant I saw Ingals rising from his seat without the formality of a request to the Council Chamber. I cautioned him.

"I move this body accept in its entirety the report of Mr. Elvan," he shot out in sharp, decisive fashion. We were adopt- ing unqualifiedly Professor Firman's suggestion, abiding decidedly in that scientist's ability to direct our nation almost of itself.

The positive ring of his tone imposed itself upon the overwrought nerves of us all. There was no time to reflect and de- liberate. The members of the meet- ing seemed to have exploded with the light- ning decision of Ingals' action. In sheer relief, it seemed the moving voice somewhere in that august body rumbled out. "I second the motion!" and the next instant the council had accepted the die and cast it like a challenge in the face of the demonic forces.

By Monday morning a startled universe heard aghast, and with mingled feelings of fear and hope, that the Martian insolence was to be defied, and that secret prepara- tions were being perfected with all haste under the direction of a leading scientist.

Thursday noon was the time when the Martian ultimatum was to expire. Since o'clock in the morning, the laboratory in the university on Morningside Heights, now converted into a puls- ing workshop, had been the scene of tremendous activities. Two thousand planes had stopt at Firman's win- dows, around which a screened landing platform had been erected, and above the platform, in the remaining cases aboard, had climbed into one of the machines.

Ava was with me. She had insisted on coming and I had no desire to refuse her. Either we were to be successful, and my joy in the triumph would be heightened by sharing it with her, or we would fail, and then we could perish together in the midst of the cataclysm.

It was an hour pregnant with fatal possi- bilities, and our faces showed the strain. Even Firman, with his nerves of steel, re- flected the general feeling. His eyes were sunk deep in their sockets and his promi- nent nose was still further accentuated by the hollows in his cheeks.

The scheme that was accepted was gigantic in its simplicity. The planes were stationed in pairs at equal distances above New York. On each plane was a sending and receiving station (tuned to the same wave-length as that of its mate) for a powerful helum ray. The two rays, crossing in the electrical field generated between the planes, reflected the images in their paths on sensitive se- lenoid plates within the planes. Thus, by covering the entire territory, we would dis- cover the Martians when they landed to plant their contact points, if Firman's plan did not miscarry.

Eleven o'clock was the hour when Firman expected us to report. We had begun their work in order to fulfill the threat of their ultimatum. Precisely on the second he flashed the order to the satellite planes to open their batteries.

Our machine was stationed with its mate over Battery Park. As the order was given, and the powerful electric current thrumming through the crack- ling batteries, we bent over the selenoid plate with passionate eagerness. Ava's hand was in mine, our fingers intermingling in a grasp so tight every artery and vein in their hunting paths, we had prepared the selenoid plate, the sensitive surface.

The area of our electric field included all of Battery Park and the greater part of the harbor. The helum rays were shot forth and ghostly outlines of ships passing thru the harbor and people walking in the parks could be seen. At the same time we kept our silent vigil, then suddenly our hearts leaped and a rush of blood to the head made it almost of the necessity.

We even saw the skeletal men of the Martian ships as they covered their flees and it seemed as if one hideous creature from the nether world had come to wreak unholy devast- ation upon us.

Firman smiled, a haggard smile of triumph on his sharpened features. An in- stant longer he watched those phantom fig- ures moving about boldly, confident in their ship of invisibility, and then out of the fearful gaze vanished.

With an audible sigh of satisfaction Fir- man uttered the word: "Fire!"

An electric shot crashed over our plane. From somewhere below came the sound of splintering glass and metal, coupled with shrieks of agony. The crawling image on my plate broke rose into a thousand fragments and fell in deadly silence. As in a nightmare I heard the next command: "Now the other."

Again the slow, cool gun whipt out its tongue of shooting flame, and from the around the din of destruction rose in clamoring echo. The invisible fleet lay, a futile ruin, on the soil of the city it had come to destroy.

As those rising from the tortured dreams of a black night, we stared at each other, unable to speak in the first few moments of indescribable relief. Then Ava burst into an exultant laugh.

"The Universe is saved!" I cried in an ecstasy of joy.

"Yes," agreed Firman; then added thoughtfully: "And the Martians take their place in the long line of them who would conquer the world by force!"

(COSMIC FORCE.

(Continued from page 828)

FIELD, liberate, and with combustion in the form of heat. These crystallized specks of energy may be made up of complex vibrations that have either a positive or negative charge and cling together not only from their own electrical tendencies but also by the action transmitted from the sun. One form of energy made up in a certain complex form would have its own character- istics, as copper might have ions like Fig. 1, and iron with ions as in Fig. 2, etc. This probably explains why different materials react to different inducements, one of the principles on which metallurgy is based.

These specks of energy make molecules which are in a form but also by means of chemistry and metallurgy we are able to disassociate the different classes of molecules by means of characteristics. These sciences have been developed so that we can now understand a great many of
ELECTRICITY TO PREVENT FUTURE FUEL CRISIS.

(Continued from page 825)

were supplied from one big generator. At first sight it would appear that a 40,000 H.P. machine would be needed to carry the load, but such is not the case. To my mind, it is a matter of fact a generator of 50,000 H. P., or even smaller, would be ample, for the simple reason that all the industries would never need their full quota of power at the same time. The principle is the same as that which permits a bank to serve its depositors with a reserve that is very much less than its total deposits. When producing its own power each plant might occasionally need the full power of its generator, but for the most part the generator would be running below its rated capacity and therefore the understanding and enlightenment and high coal consumption per horse-power. By combining all these small loads on to one machine, a much more uniform large load and a much higher operating efficiency are obtained. As a result, the large unit would consume even less than from 1/2 to 1/4 of the coal consumed by the individual plants of the 80 industries.

The same principle applies to cities as well as to plants, and if, therefore, several cities were supplied with power from a single system (obtaining its electrical energy from several large steam and water-power generating plants), and compared with present conditions would be truly remarkable.

Small generators must necessarily be near their loads and the coal they need hauled to them. This, however, is not the case with large machines generating enormous masses of power and capable of supplying the demands of entire cities. It is thoroughly feasible to place the generator at the consumer’s door and transmit the electrical energy over wires, thus eliminating railroad transportation altogether. The bee-line distance between New York City and the anthracite region is but 100 miles. Electricity is at this time being transmitted over 200 miles in several American systems, and in one case the distance is over 400 miles. How gratifying it would be at this time if New York’s power were independent of railroad and tug-boats!

But while it is true that generating stations had to be located away from the mines, as in many cases it will still be necessary for some time to come, it would obviously be a very much simpler matter to supply coal to a few large plants equipped with every modern time- and labor-saving device than to distribute coal to a large number of small plants situated in all sorts of inconvenient locations and without proper facilities for rapid handling of the fuel. Much of our present trouble is due to the difficulties incident to handling the coal-waiting cars, frozen coal, an insufficient number of rail cars, men, etc. Such difficulties would be entirely eliminated were the bulk of the coal to go to a few central points.

Passing now to the fifth point, the electrification of a large portion of our railroad system (no one expects that all of our traffic will be operated electrically during the present century) would be the greatest single step that can be taken in the direction of fuel economy. American railroads consume nearly 150,000,000 tons of coal annually, nearly one-quarter of our country’s total output. Much of this coal consumption could be eliminated by the use of water-power, and almost as much could be saved by generating power in sufficient, small, well-placed central generation plants, instead of in the naturally wasteful steam locomotives. Some idea of the possibilities can be had from the fact that the Chicago, Milwaukee and St. Paul Railroad saves annually a half a million tons of coal and several hundred thousand barrels of fuel oil by operating 440 miles of its line by means of hydro-electric power.

Equally important, from the stand-point of preventing the occurrence of the present fuel crisis, would be the great increase in traffic capacity that electrification would secure on railroads. The steam locomotive has about reached the limit of its power and therefore freight trains have also about reached the limits of their speed of travel. With the electrification of the railroads there is practically no limit to the amount of power that can be transmitted to a large electric locomotive. Several times more powerful than the largest steam locomotives are already in operation, and still larger ones can be built when occasion demands. With more power available longer trains could be operated at higher speeds, which means that more freight could be hauled in a given time over existing rails.

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THE TELAUTOGRAPH—WHAT IT IS.

(Continued from page 823)

Gray's Telautograph.

The object of the invention by Prof. Elisha Gray, in 1893, was to overcome the difficulty heretofore experienced and provide a writing telegraph or telautograph in which the transmitting pen would operate simultaneously with the transmitting pen and produce a facsimile of whatever matter was written to the operator, thereby rendering possible telegraphic transmission of any kind of characters and sketches. Subsequent improvements were granted to Gray and others for minor improvements and for different forms of telautographs. The first telautograph was patented in the fundamental principles employed until about 1899.

The Modern Telautograph Principle.

About that time the Gray National Telautograph Company, from experience previously obtained and at the earnest solicitation of Mr. George Steere-Tiffany, chief experimental engineer of the Company at that time, decided to abandon entirely the old step-by-step method, which until then had been considered the only form of obtaining facsimile reproduction. All of the immense amount of work and mental effort and development of patents and improvements in fifteen years, representing as it also did an expenditure of hundreds of thousands of dollars in development, is thrown into the scrap heap and Mr. Tiffany undertook to devise an entirely new form of telautograph to operate on the theory of reproducing the message at one time, very much like a recording voltmeter.

In this "Variable Current" instrument the messages vary, the telegraph wire has variations in strength of a continuous current, which, traversing the line wires, affects at the receiving instrument changes in strength of electro-magnets by which the pen is moved in unison with the transmitting pencil.

Some years after the establishment of the first telautograph built on this principle was completed, and while crude and cumbersome in its construction, yet its work with a certain degree of reliability and satisfaction. One by one electrical and mechanical difficulties encountered in the invention of engineering were successfully overcome by Mr. Tiffany and others associated with him, and the present telautograph is the perfected form of many improvements devised. In this process of improving three distinct mechanical types of instruments were developed. A type was in use in 1901 and was later succeeded by an improved model in 1904, which in turn was succeeded by the model in use today in all general features is the same instrument that is in successful operation today.

Construction Problems Solved.

The greatest problem encountered in the improving and refining process of the telautograph has been to devise an instrument which would be sensitive enough to respond to the smallest movement of the transmitting stylus. The transmitting stylus must be delicate or fragile but substantially built; an instrument that would not be damaged, but would preserve the original message in the most severe conditions of operation. Also, in order to make it a commercial instrument in every sense of the word, it must be made thoroughly dependable and care less handling on the part of the operators and against inquisitive meddling of irresponsible people.

That this problem has been solved in the present telautograph may well be indicated by the many stringent services to which it has been put. For example, it has been mounted on the gun carriage of the heavy type of Coast Defense gun not more than twenty inches away from the barrel and its adjustments have not been disturbed by the blast and concussion from the firing of the gun. It is also used in the manufacture of steel plants, where it is subjected to heavy and continuous vibration without experiencing any defects in service.

Telautograph Uses.

The telautograph in no way replaces, nor is it a competitor of the telephone, because it is not used for communications where ordinary conversation will suffice for the transmission of the message. It is only used when the message or order requires accurate or secret transmission or being written on the face of some document. It is used to overcome the deficiencies of the human element. It is more a competitor of the messenger boy with his written messages, or steam or pneumatic tubes with their written messages on slips of paper.

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In banks and trusts companies it is generally used between the paying teller, note teller and other offices for obtaining individual depositor's balances and other information from the bookkeeper in connection with the paying or certifying of checks and with the handling of discounts, loans and pass books.

In hotels, telegraph lines from the telephone switchboard forward guests' orders and complaints to the various house departments, which execute and attend to them. It is used between the telephone switchboard and front office to get information as to room numbers of guests when they are absent, between telephone switchboard and bell captain for sending paging messages to locate guests when called on the telephone or called upon and the guests notify their roommates; between telephone switchboard and service pantry, kitchen and bar for ordering meals and drinks to be served in the rooms; and for various other services far too many to be enumerated.

In department stores the telegraph is a valuable means of communication between the sales, buying and stock department in sending orders for replenishing stock in retail departments; for obtaining credit information between the sales people or tube centers and the credit department when customers desire to charge goods purchased; and between the complaint and delivery desks for tracing out packages lost in delivery or sent to the wrong address.

The railroads make use of telegraph service at passenger terminals for announcing the arrivals and departures of trains, giving the time of arrival or departure and the tracks on which they will arrive or depart. These messages go simultaneously to every department that has to do with the handling of the incoming mail, express, baggage, and passengers, and serve also as information to the public. For engine dispatchers there are telegraph lines between the engine dispatcher's office and the roundhouse or engine tower for ordering and assigning engines for outgoing trains and informing them to what orders to depart. They are further used for instructing yardmasters, station platforms, switchmen, etc., in regard to the makeup of trains.

In steel plants reports of chemical analysis of every 'heat' of steel tested in the laboratory by the steelmaker or simultaneously to the rolling mills, shears, mixers, blooming mills, billet mills and shipping department, so that the quality of each 'heat' of steel is constantly known at every point where it is handled and the steel may be assigned to an order or orders for which its contents qualify it; also for recording the movements of steel billets from place to place with their distinguishing serial 'heat' numbers, likewise for the purpose of identifying each lot.

In commercial, wholesale and retail houses telegraphs are used for ordering articles to be brought to sales floors from stock rooms; for issuing shipping orders from order department to stock room or shipping room; or for orders from stock rooms on incomplete orders between packing department or shipping department and stock rooms; for obtaining credit information between sales department and accounting department and credit office; and for many other uses too numerous to detail.

The foregoing are a few typical services that the telegraph renders to its users, but it by no means represents all that this wonderful instrument accomplishes in the saving of time and money and in increasing efficiency in operation of business and industrial enterprises.
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THE PHENOMENA OF ELECTRICAL CONDUCTION IN GASES.

(Continued from page 830)

metal box thru insulators and upon one a metal plate P is placed, while upon the other a very fine strip of gold leaf, hardly larger than a thread, is placed so that it hangs at an angle with the vertical. If we now practise the terminal A connected to the body whose charge is to be measured, and the plate P by a constant source of about 200 volts, the attraction between plate P, and the gold leaf L, holds the leaf at a certain angle which decreases, and the leaf starts to fall as soon as the charge leaks away from the body to be measured, and hence lowers the potential of the gold leaf. By using a telescope attachment to observe the leaf, an exceedingly minute loss of charge may be measured and a change in potential of even .0001 (one thousandth) of a volt.

By such simple apparatus much has already been done. The most important qualities of the electron, namely its mass and charge, have been measured, and a careful study of different positive ions has been made in an effort to isolate the positive unit, having nothing to do with the electricity which produces the negative electron. So far no ion smaller than a molecule of hydrogen has been discovered having a charge equal to that of an electron, and this is of course a hundred thousand times larger than the electron.

Besides these qualities of ions, four very important facts about their behavior have been studied. The velocities of different kinds of ions has been measured, and their rates of recombination and diffusion. By recombination is meant attraction and recombination of positive and negative ions to form a neutral molecule. By diffusion is meant the spreading out of the ions by the forces that is their being attracted to the walls of the conducting vessel. Last, but not least, the phenomena of ionization of gases has been investigated and it has been found that when ions collide with neutral molecules, fresh ions are formed. These various things represent the main phenomena which have been studied in this great field, the importance of which is just beginning to be recognized.

The first question perhaps that anyone would ask is—how are the ions formed in the first place? The answer is that, according to P. J. Thomson's theory, the same things that form the ions. The method of ionization varies, liquids; in other words, when a molecule falls under the influence of X-ray, heat or another ionizing agent, the molecule is torn apart in such a way that one or more electrons burst themselves to one part, making it negatively charged, and leaving the other part positive. These parts then are the ions, and when they travel towards any particular point, constitute a current. This current, the body of electricity, or the electric current, loses its charge thru having it carried away, little by little, by them. Such a slow loss of charge is the leak which an electroscope is often used to detect.

Besides its practical importance the study of the ionization of gases should go far towards simplifying the laws of gases, and matter really are, especially as a gas is the simplest form in which matter exists.

EXPERIMENTAL PHYSICS.

(Continued from page 834)

found to no longer hang horizontally (except at equator), but the dip (the $x$ pole in northern latitudes and the $y$ pole in southern latitudes), the amount of metallic fluid in the earth is only equal to the latitude. Thus the dip needle can be used to determine latitude (approximately). The miner uses it to determine the presence of magnetic ores. At most places on the earth the magnetic needle does not point true north, but instead a

little to the east or west of north. Hence, if we wish to know direction accurately, we must add the correction (called declination) to allow for this, i.e., the declination is the difference in direction between true north and the direction in which the magnetic compass points. Since the declination varies for different places from year to year, it is necessary, when surveys are made to determine the true northsouth direction can be determined and the land map accurately.

To test the magnet, place a tack against a magnet and now bring this tack near another tack. The first tack will act as a magnet. Thus, we see that when a piece of iron is put in contact with a magnet, it becomes a magnet itself and will attract iron. The reason is that when a magnet, when dipped into iron filings or nails, lifts a number of them attached to another one that is each becomes a distinct magnet. This influence of a magnet over iron or steel by which it is made a magnet extends...
Molecular Theory of Magnetism.

These last few experiments are of very important consequence and must be borne in mind by the teacher in his instruction. They add much to our theory of the molecular structure of elementary magnets, as shown in Fig. 68-B, and in an ordinary Bunsen burner, where the material is in small elementary magnets, and as arranged in Fig. 68-A, etc., when iron is magnetized its molecules are arranged in a similar manner. This is the general position of the magnetic centers (magnets), which is shown in Fig. 68-A, etc., when iron is magnetized its molecules are arranged in a similar manner. In the latter case, they are all lined up with their respective ends in the same direction, so that they act as one large magnet, and are thus polarized as in Fig. 68-B. In experiment 73, striking the iron bar, the tiny molecular magnets were jarred, and hence lined up, due to the earth’s induction when placed in a north-south line, when in the east-west position they were jarred out of the north-south line. As a final conclusive proof of the exactness of the molecular theory, stroke a needle once with a magnet; letting the needle up to a compass and note the deflection; stroke once more and note the increased deflection. After several times it will be found that the point is reached where further stroking has no longer any effect; increased the deflection, i.e., the needle has reached its point of magnetic saturation. Since this point will be reached when all the little elementary magnets are lined up, no further stroking will cause any change, hence no increase in strength.

The molecular theory of magnetism is a beautiful example of how well the modern physics theories hold, how they express plain phenomena, and how they are themselves strengthened by these phenomena. It is this fact that makes it adhere to the fact with so much faith and sway by them. Most of them are so well established that we vouch for them as solid facts for facts. (To be continued.)

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