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The Electrical Experimenter

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The Electrical Experimenter

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Secret Intelligence

"UN *homme averti en vaut deux*"—a man forewarned is worth two;—so runs the well known French proverb.

To our country, surrounded by a web of spies and intrigue, this is of vital importance today. Even when we were at peace with Germany, our officials soon learned that the country where the "art" of spying is developed to a higher degree than anywhere else on this globe, stopt at nothing to secure important military information. When in 1915 we ventured the opinion that the Sayville Radio station could be and probably was used to send un-neutral messages to Berlin, we were laughed at. That same month our Government took over Sayville, after a New Jersey Radio amateur actually succeeded in "canning" on phonograph cylinders incriminating radio messages, sent out from Sayville.

Today, being at war with Germany, we are facing a tremendously more difficult problem of dealing with the spies. And evidence is not lacking that the latter are doing their work quite satisfactorily to their government just now.

When Admiral Sims took his fleet to England, Berlin knew the fact four days ahead of the arrival of our ships. Again, when our first transports were sent to France, Berlin knew that too, days before our ships reached France; hence, the flotilla of submarines lying in ambush.

The question is, how did the enemy get the intelligence? Our officials frankly admit that they don't know. In some quarters the opinion prevails that the information was sent by mail or by wire to Mexico—in clever code of course—and thence sent across the Atlantic over the powerful Mexico City radio plant. This may be possible, but we much doubt it.

We can be certain that a nation that attained as high a scientific development as Germany, will use subtler and surer means to convey priceless intelligence. Besides, the round-about route thru Mexico is certainly far too slow and too dangerous, all messages being closely watched by our alert officials.

No, we must look elsewhere. An enemy usually attacks at the most vulnerable or exposed spot. Unfortunately we have thousands of such spots, namely, our endless coastlines. On the coast of Long Island and Maine, for instance, there are countless thousands of spots where a human being is hardly ever seen. There are hundreds of secluded little inlets and sheltered spots from which intelligence could be sent out in a ridiculously simple manner, and perfectly safe too for the sender.

No, we don't think he would be so foolish as to operate even a mediocre radio outfit, for our Navy has too many ears. What, for instance, is to prevent a spy from sending messages daily to a submarine lying still some ten or more miles off the coast? This could be accomplisht by various methods. One is by means of the Fessenden underwater oscillator; twenty to thirty miles can be covered very easily. And if we don't know that this sort of thing is going on, we'll never discover the spy. And we insist once more that no man in his right senses will use a Radio Outfit—it is too dangerous.

Then again what is to prevent any enemy submarine from bringing over an electric cable ten or twenty miles long, unreeling it on a shallow sand bank (using a motor boat to accomplish this) and establishing a secure terminal in one of the secluded spots on the coast. The other end, twenty miles out in the ocean could end in a submerged buoy. The submarine then has nothing to do but to hover about that buoy, while the land operator presses his key at certain pre-arranged hours of the day. By means of an electro-magnet inside of the buoy, the metal shell of the latter is struck, spelling out the Morse or other code signals. The sound can be muffled of course to such an extent that only a submarine with underwater microphones can hear the sounds over a radius of a few hundred feet.

Then by using its own powerful radio, the submarine can send the message across the Atlantic either direct or by relaying it. By radiating certain long undamped waves, detection becomes almost impossible. For as soon as the message is sent the U-boat submerges and lays motionless for the next twenty-four hours if necessary.

Now, this may or may not be the exact means how the trick is done, at any rate we feel that the intelligence leaves by way of our coastline—it is too vulnerable and too inviting.

The remedy? Intensified and intelligent coast patrols—thousands of them. Then let us sink super-sensitive microphones two or three miles apart along our entire coastline. This will do two things: First, every underwater signal could be heard, no matter where; second, hostile U-boats could be heard readily and accurately located.

We owe it to our soldiers to take every precaution humanely possible. We do not wish to wait till a score of our transports have been sunk. H. GERNSBACK.

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THE ELECTRICAL EXPERIMENTER

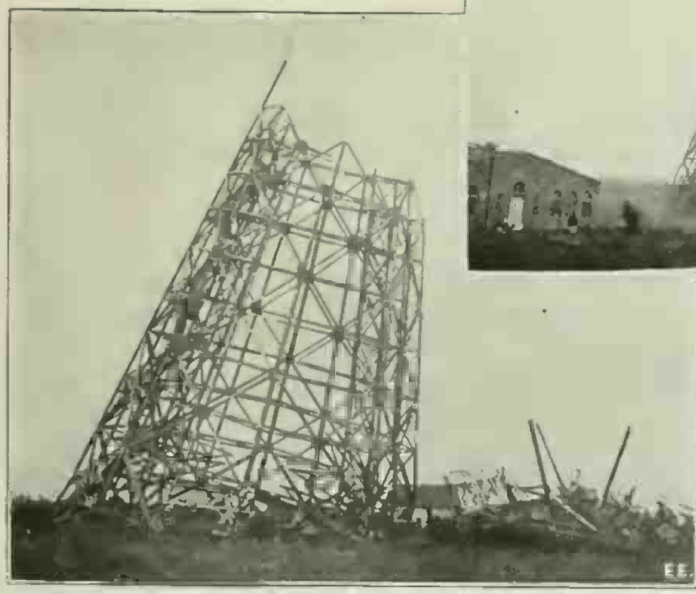
H. GERNSBACK EDITOR
H. W. SECOR ASSOCIATE EDITOR

Vol. V. Whole No. 53 September, 1917 Number 5

U. S. Blows Up Tesla Radio Tower

SUSPECTING that German spies were using the big wireless tower erected at Shoreham, L. I., about twenty years ago by Nikola Tesla, the Federal Government ordered the tower destroyed and it was recently demolished with dynamite. During the past month several strangers had been seen lurking about the place.

Tesla erected the tower, which was about 185 feet high, with a well about 100 feet deep, for use in experimenting with the transmission of electrical energy for power and lighting purposes by wireless. The equipment cost nearly $200,000.



Two Views of the Last Minutes of Tesla's Gigantic Radio Tower at Shoreham, L. I., New York, As It Was Being Demolished by the Federal Government. It Was Suspected That German Spies Were Using the Tower for Radio-Communication Purposes. It Stood 185 Feet Above the Ground and Cost About $200,000. Tesla Had Not Used It For Several Years.
Photos by American Press Association

The late J. P. Morgan backed Nikola Tesla with the money to build this remarkable steel tower, that he might experiment in wireless even before people knew of Marconi. A complete description, revised by Dr. Tesla himself, of this unique and ultra-powerful radio plant was given in the March, 1916, issue of THE ELECTRICAL EXPERIMENTER. Everyone interested in the study of high frequency currents should not fail to study that discourse as it contains the theory of how this master electrician proposed to charge this lofty antenna with thousands of kilowatts of high frequency electrical energy, then to radiate it thru the earth and run ships, factories and street cars with "wireless power."

Most of our readers have, no doubt, read about the famous Tesla wireless tower, which structure involved the expenditure of a vast sum of money and engineering talent. From this lofty structure, which was designed some 20 years ago by Dr. Tesla and his associates, there was to be propagated an electric wave of such intensity that it could charge the earth to such a potential that the effect of the wave or charge could be felt in the utmost confines of the globe.

Further, it may be said that Tesla, all in all, does not believe in the modern Hertzian wave theory of wireless transmission at all. Several other engineers of note have also gone on record as stating their belief to be in accordance with Dr. Tesla's. More wonderful still is the fact that this scientist promulgated his basic theory of *earth current* transmission a great many years ago in some of his patents and other publications. Briefly explained, the Tesla theory is that a wireless tower, such as that here illustrated and specially constructed to have a high capacity, acts as a huge electric condenser. This is charged by a suitable high frequency, high voltage apparatus and a current is discharged into the earth periodically and in the form of a high frequency alternating wave. The electric wave is then supposed to travel thru the earth along its surface shell and in turn to manifest its presence at any point where there might be erected a similar high capacity tower to that above described.

A simple analogy to this action is the following: Take a hollow spherical chamber filled with a liquid, such as water; and then, at two diametrically opposite points, let us place, respectively, a small piston pump, such as a bicycle pump, and an indicator, such as a pressure gage. Now, if we suck some of the water into the pump and force it back into the ball by pushing on the piston handle, this change in pressure will be indicated on the gage secured to the opposite side of the sphere. In this way the Tesla earth currents are supposed to act.

The patents of Dr. Tesla are basically quite different from those of Marconi and others in the wireless telegraphic field. In the nature of things this would be expected to be the case, as Tesla believes and has designed apparatus intended for the *transmission of large amounts of electrical energy*, while the energy received in the transmission of intelligence wirelessly amounts to but a few millionths of an ampere in most cases by the time the current so transmitted has been picked up a thousand miles away. In the Hertzian wave system, as it has been explained and believed in, the energy is transmitted with a very large loss to the receptor by electro-magnetic waves which pass out laterally from the transmitting wire into space. In Tesla's system the energy radiated is not used, but the current is led to earth and to an elevated terminal, while the energy is transmitted by a process of *conduction*. That is, the earth receives a large number of powerful high frequency electric shocks every second, and these act the same as the pump piston in the analogy.

Quoting from one of Tesla's early patents on this point: "It is to be noted that the phenomenon here involved in the transmission of electrical energy is one of *true conduction* and is not to be confounded with the phenomena of *electrical radiation*, which have heretofore been observed, and which, from the very nature and mode of propagation, would render practically impossible the transmission of any appreciable amount of energy to such distances as are of practical importance."

"Our Navy" On The Stage

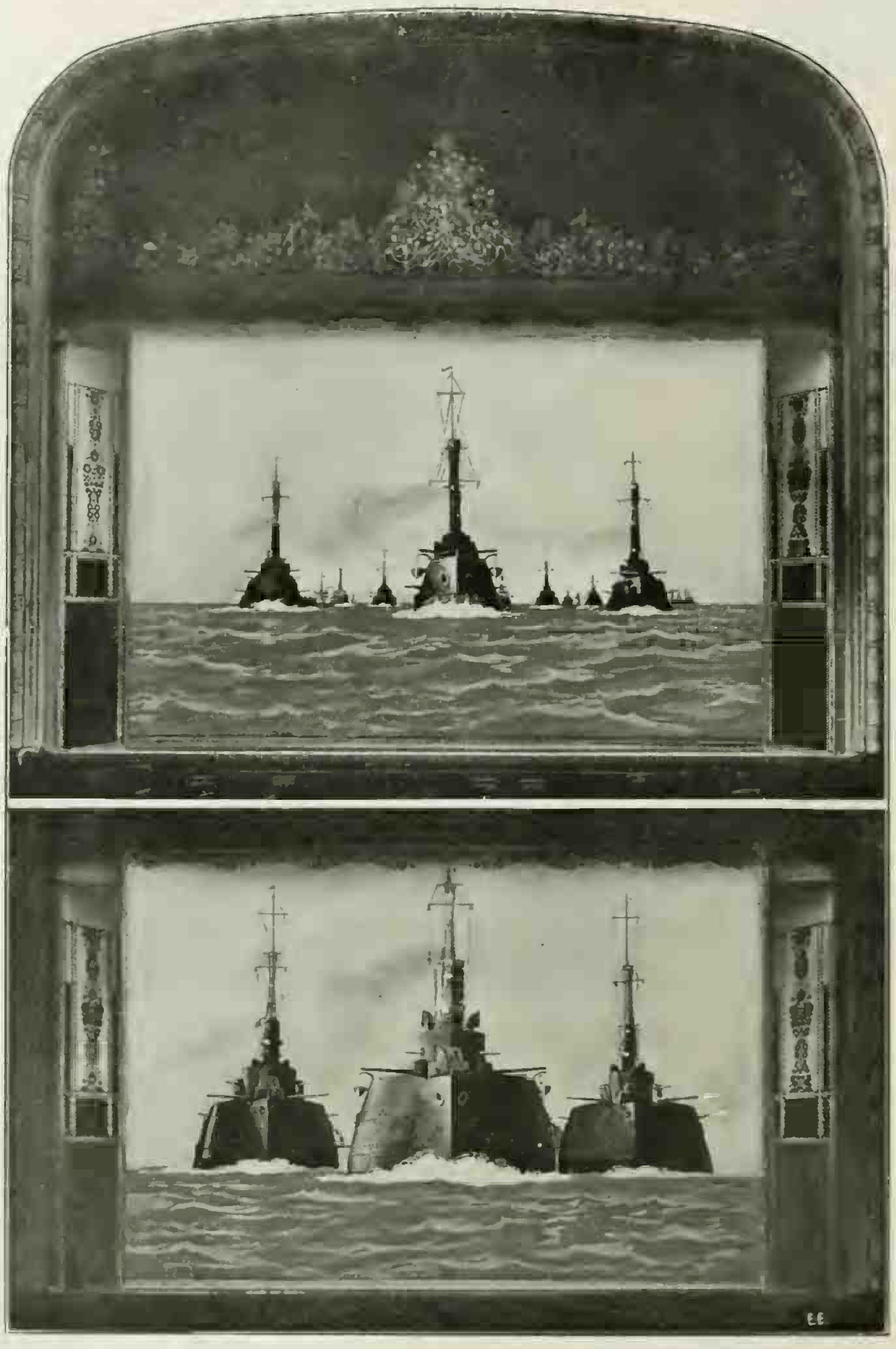
By GEORGE HOLMES

THE electrical engineer who was artist and dreamer as well, has again outdone the common-place. A spectacular theatrical effect is now playing in New York, which besides giving further publicity to "Our Navy," bids fair to rival Uncle Sam's big fleet in awe-inspiring and realistic thrill. Electricity plays the master rôle in this wonderful spectacle, which has become the talk of Broadway.

At the rise of the curtain we see a golden sunset with the sun slowly sinking in the west and night gradually approaching. With a hush we watch a fleet of war ships in battle formation steaming toward us on the distant horizon. They gradually draw nearer, increasing to three times their original (or life) size, and as they get immediately before us, we get a sensation as if the ships are going to bear down upon us. This realistic illusion is based upon the scientific principle of perspective; *viz.*, the further away an observer is from an object the smaller it appears to the eye; and that every particle of the object's contour increases in exact proportion as it enlarges in approach.

Each ship is electrically operated and controlled by a single operator, who manipulates the numerous and various devices by means of switches, push buttons and rheostats, all of which are located on a massive switchboard on the rear of each ship.

The motive power under the control of each operator is supplied by two large electric motors which are connected to the various parts of the apparatus by gears, belts and chains, thus enabling the ships to appear to travel slow or faster in their approach as desired. Each ship has its own set of motors, belts, chains and gears. An electrically heated boiler furnishes steam for the smoke stacks. The cannon are fired by electricity, the signal lights blink, searchlights play across the horizon and on "Old Glory," making a truly inspiring and lasting impression upon the audience.



New York Stage Producers Have Outdone Themselves In Evolving the Great Marine Spectacle "Our Navy." By the Aid of Electricity These Warships Are Made to Grow Larger and Larger; the Guns Boom, Searchlights Flash and Even the Smoke Is Not Forgotten.

The inventor of this magnificent spectacle is Langdon McCormick, and the whole apparatus was built in his New York studios, where other similar theatrical sensations like "The Honeymoon Express" and "The Forest Fire" were conceived and produced —proving that this genius accepts the stage as having no limitations. All in all it is probably the most complex and true to nature theatrical effect ever produced on any continent.

A few more electrically operated spectacles like this one would seem a big national stimulus toward recruiting. Who can sit and witness such a stirring scene without feeling the red-blooded desire to be up and doing something patriotic, even to buying *Liberty Bonds*.

LIGHT FROM THE FISHES?

Long strides are being taken by the biological department of Princeton University to obtain light without heat. If the discovery fully realizes its expectations it will doubtless revolutionize modern lighting. Professors Edwin Conklin, Ulric Dahlgren and Edmund N. Harvey are working on luminous animals in an attempt to fathom the cause of their luminosity, which is 99 per cent light. Modern electric light produces only from 2% to 3% light, the rest being wasted in heat.

Professor Harvey obtained a considerable quantity of the luminous material from small fish found in Japan. He has partly analyzed the substance, finding that like the proteids of the living bodies it can be kept for years by drying it and sealing it in vacuum tubes. When released, moistened and exposed to oxygen it will light into a clear, bluish phosphorescent flame.

The substance is very powerful, as it is still visible when one part of it is diluted in 1,700,000 parts of water.

SQUIRTED TUNGSTEN FILAMENTS.

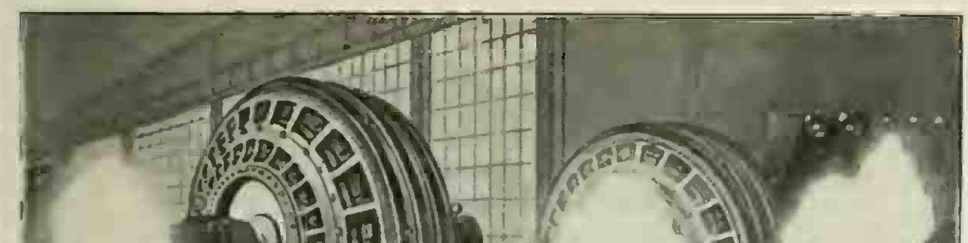
Some interesting particulars of a peculiar method of preparing tungsten filaments, which are ductile in spite of being squirted, are cited in *Engineering*, London.

The process, which was described by Dr. W. Böttyer before the December meeting of the Bunsen Gesellschaft, is employed by Julius Pintsch, and is due to Messrs. O. Schaller and Orbig. Members of the society were able to watch the process in the works after the meeting. The metallic powder is mixed with 2 per cent. of thoria and kneaded into a paste with addition of some binding agent; a thread is then squirted. The thread is first pre-heated and then rapidly heated up to 2,400° C. or 2,600° C., the object being to make the crystallization of the metal more rapid than the passage of the wire thru the hot zone. The first apparatus used for this delicate operation had the dimensions of several meters; the actual apparatus is only a few centimeters in height. The resulting wire is said to consist of crystals several meters in length, tho only a few hundredths of a millimeter in thickness, the cross-section of the wire comes out octagonel rather than circular. There are very few joints in a wire. A re-crystallization of the filament after long-continued use of the lamp is said not to occur.

ELECTRICITY OPERATES PANORAMA CAMERA AND FLASHLIGHTS AUTOMATICALLY.

The accompanying illustration shows a novel idea recently evolved by a New York inventor, Mr. George Wall, by which it becomes possible, thanks to the flexibility of electrical control, to take large photographs, particularly those of a panoramic nature inside buildings, such as power houses, etc. A small battery box which can be carried by the photographer supplies the small quantity of electrical energy necessary in igniting the flashlight powder, which is placed in proper containers on a series of telescopic flashlight stands. The electric panoramic camera is specially designed, so that once the photographer has it focust causes a movable contact drum to close the individual circuits to the various electric flashlight stands progressively, as the camera turns to take in the complete view.

This arrangement should prove extremely practical and of great service to commercial photographers who are confronted with the problem of photographing large interiors, machinery, etc., which are often extremely difficult to handle with ordinary cameras. With Mr. Wall's invention properly applied, the panorama camera swings around the circle for the number of degrees desired, and lights up each part of the scene

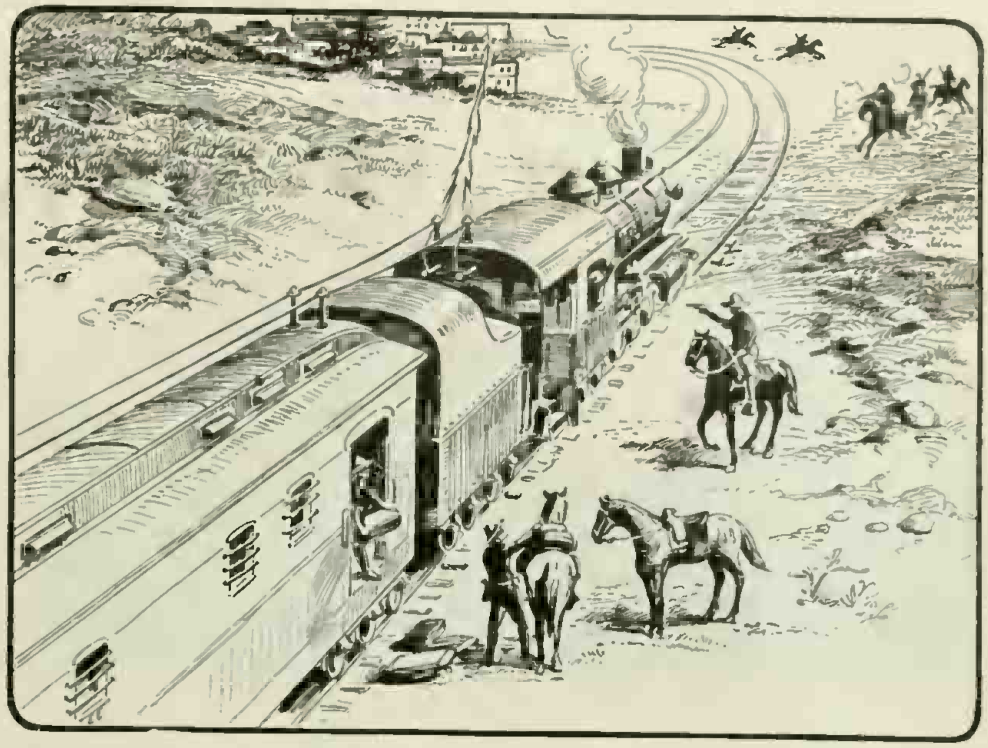


A New Photographic Scheme Involving the Application of Electricity to Rotate a Panorama Camera and to Ignite a Series of Flash-Lights Successively and At the Proper Instant. In This Way an Even Illumination of the Scene Is Assured.

to take in the proper view as it swings about on its tripod, propelled by means of special gears and a miniature electric motor (operated from the battery before mentioned), it progressively as it turns; thus giving a very uniformly illuminated picture, which is very difficult to obtain with the usual style of concentrated flash where the magnesium powder is ignited all in one spot or in two or three spots.

FOILING THE TRAIN ROBBER WITH RADIO.

A number of American railroads have experimented with wireless installations on moving trains and exceptional results have been obtained in many instances, the messages having been transmitted over distances of 75 to 100 miles from the train while in motion. These considerations have led a New York genius, Mr. George Wall, to suggest that all trains traversing barren parts of the country such as the prairies of the West and Southwest be provided with wireless apparatus particularly for use in summoning police aid in the event of being held up by train robbers.



Now That Wireless From Moving Trains Has Been Demonstrated As Practical, We May Expect to Read In Future Train Robbery Accounts That the Brave and Heroic Radio Operator Stuck to His Post Until His Frantic Distress Signals Brought the Police.

Albeit, this is not such a far-fetched idea at that, as we read quite often of a train being held up, even in this latter age of enlightenment and civilization. As the unsettled regions of the country are becoming rapidly populated, at least to a fair extent, and as mounted police are to be found at relatively short distances in practically every part of the United States, the suggestion seems very logical, and undoubtedly when the present war situation has past away, the leading railroads will foresee the distinct advantages and facilities provided by installing radio-telegraphic sets on all trains passing thru unsettled parts of the country.

Not only will the radio prove exceptionally valuable in many such instances as that here illustrated, but it has already proven of extreme efficacy in the handling of trains. It may in this way often be the means of averting a serious train wreck, especially when severe storms have caused bad washouts along the line and dismantled the telegraphic and telephone wires. One eastern railroad, the Delaware, Lackawanna and Western, has tried out a wireless train installation with excellent satisfaction, and found it of great practical use in the dispatching of trains during the winter months, when severe storms had demolished part of the communication lines.

All Aboard for "Luna's" Electric Top

ONE of the largest and most interesting rides ever constructed at Coney Island, New York's famous pleasure park, is "The Top," which is one of Luna's latest amusement devices. It is an immense structure, seventy-five feet in diameter and eighty feet high, and follows closely the design of an ordinary spinning top. There are two sets of tracks, one on the outer and the other on the inner rim, with the cars operated by a third-rail system. The entire ride covers nearly one mile. Forty-five tons of steel were used in the construction, and the ride in its finished condition, with equipment, carries fifty tons, all of which rests upon a solid concrete foundation.

Coney Island, New York's Supreme Play-Ground for Grown-Ups and Youngsters Alike, Now Boasts Something Real New In Amusement Devices. You Board a Small Car and Before You Know It You Are Whirling Around the Spiral Track of "The Top," As Luna Calls It. This Gigantic Electric "Top," 80 Feet High By 75 Feet In Diameter Rotates at a Speed of 25 Miles Per Hour.

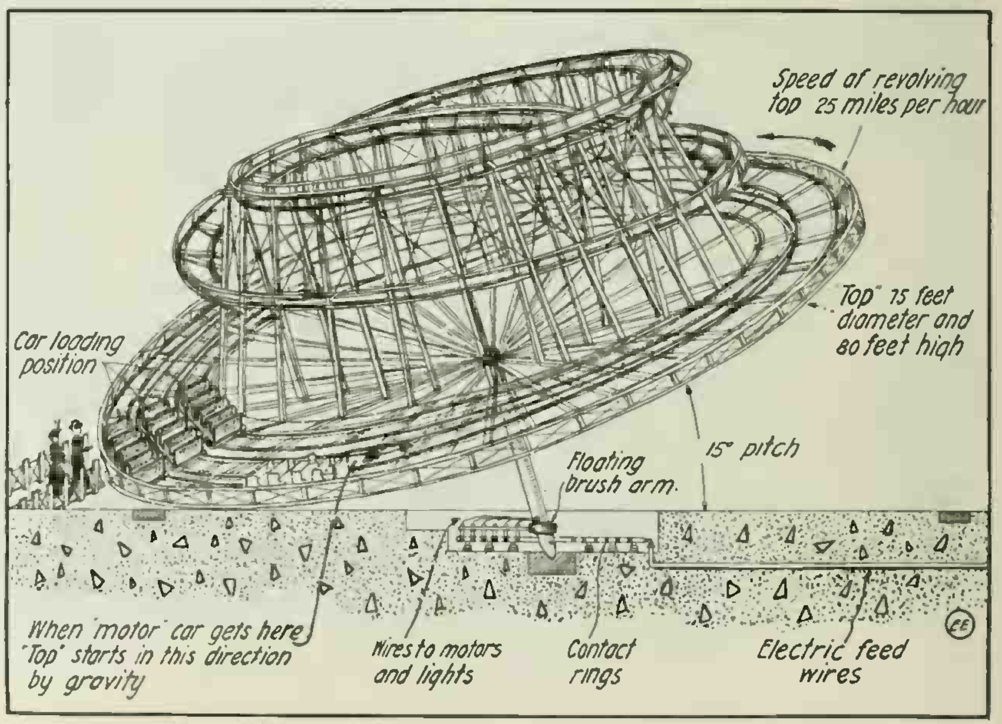
It is an electrical achievement which has been accomplisht after several years of study and experimenting. One of the greatest problems that has been solved is the transmission of current to the wheel which is revolving on a shaft resting in a pivot socket, as shown in the drawing, while the shaft is at all times resting at an angle of about 15 degrees from the horizontal. The lighting and operating current is transmitted from the socket pit by means of stationary contact rings and a floating brush arm carried on the shaft. The necessary electric current for the motor car and lamps (night illumination) is thus conveyed thru the revolving brush arm and brushes.

No great electrical driving force is required, as the shifting weight of the motor cars on the outside rim drives forward, by gravity, the cars (without motors) on the inner rim up an incline to a height of thirty feet.

Four motors, each of seven and one-half horse power, are used in the operating. These are fitted to the motor car running on the outer rim. In loading position the "top" is so designed that all three passenger cars are on the lowest level of each of the three independent tracks, and all in line before the gate. Passengers may thus pass thru the first car to the second and third cars. The two inner cars are always slightly behind the (outer) motor car when the "top" is running.

The passengers in the inner cars enjoy the most sensations, rising and falling as the "top" whirls around. The outer motor car keeps at an average elevation of 15 feet above the ground; but owing to the track (and "top") continually rolling, the motor and other cars eventually swing around a complete circle. The "top" has to make fifteen complete revolutions for a "ride", so as to bring all the cars back to the lowest track levels and in line before the gate.

Luna Park has augmented its brilliancy by the addition of thirty-two posts, each with five three hundred watt lamps. Placed at equal distances apart and in the center of the main concourse, they have brightened the entire park. The concourse is now known as Luna's White Way.



Illustrating In Detail How Luna's Wonderful Electric "Top" Is Operated. Its Central Shaft Rests On a Cone Bearing and the Climbing Movement of the Outer Motor-Car Causes the Whole Structure to "Roll" Around, Propelling the Inner Cars By Gravity Alone.

EXTENSION TO C., M. & ST. PAUL RAILWAY ELECTRIFICATION PROGRESSING.

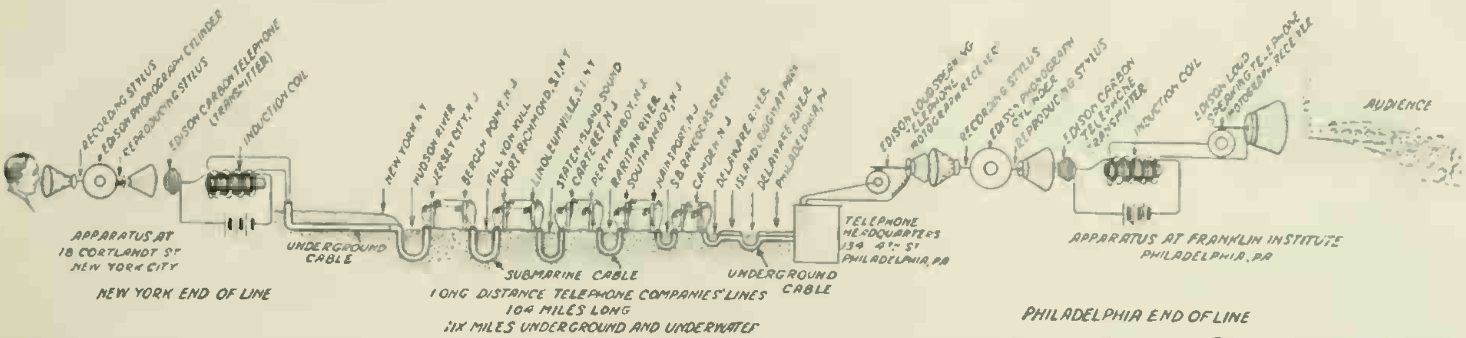
That part of the Chicago, Milwaukee & St. Paul Railroad between Harlowton, Mont., and Avery, Idaho, a distance of 437 miles, is now being operated as an electric line. Electric power is supplied by various plants of the Montana Power Company, the largest two of these being at Great Falls, Mont., and Thompson Falls, Idaho. The first electric train was moved in December, 1915, and the last steam-operated train was taken off the Missoula division in February, 1917. On that division is the St. Paul Pass tunnel, which cuts thru the summit of the Bitter Root mountain range near the Montana-Idaho line, and has a length of 8,000 ft.

The work of electrifying another division, of 217 miles, began about May 16, 1917. The starting point is at Othello, 100 miles east of Cle Elum, and electrification will proceed westerly to Seattle and Tacoma. Power will be furnished by the Intermountain Power Company. It is figured that the work will be completed between Cle Elum and Seattle and Tacoma before the close of 1918.

JACK BINNS ENLISTS IN BRITISH ARMY.

Prominent among the applicants answering the call for British recruits in America, was Jack Binns, the wireless operator, whose messages from the liner Republic on Jan. 23, 1909, brought rescue ships after she had been rammed by a freighter. Jack gave up the sea soon after the sinking of the Republic and took up newspaper work. Binns is thirty-two, married and has two children. He was injured in a train wreck and could claim exemption, but would not.

Transmitting Sound by Phonograph and Telephone 104 Miles, Thru 48 Physical Changes



One of the Most Remarkable Telephonic Demonstrations Ever Attempted Is That Here Illustrated. By Means of Phonographs and Loud-speaking Telephones the Human Voice Was Transmitted Thru a Series of 48 Physical Changes, 15 Different Mediums and Thru the Air 5 Times, Between New York and Philadelphia. Mr. Hammer, Who Engineered This Stunt, Was Awarded the "Franklin Medal" in Honor of the Occasion.

SOME years ago when telephony was still quite a youngster, one of the most interesting and remarkable scientific demonstrations involving several of Thomas A. Edison's great inventions, including the phonograph, were demonstrated by a New York Electrical Engineer, Mr. William J. Hammer.

Mr. Edison was very highly pleased with this really beautiful piece of engineering and scientific technique, which not only seemed impossible of accomplishment by the leading telephone engineers of the day, but which also retained and involved the demonstration of several Edison inventions.

This remarkable experiment in the phonographic and telephonic transmission of sound took place between New York and Philadelphia, over 104 miles of telephone cables, six miles of which were under ground and under water, as the illustration here shown clearly indicates. This novel experiment was shown by Mr. Hammer in his lecture on "Edison and His Inventions," delivered before the Franklin Institute at Philadelphia. It employed two Edison phonographs, two Edison carbon transmitting telephones, two Edison motograph receivers or loud-speaking telephones, two sets of induction coils and batteries and 104 miles of long-distance telephone circuit as before mentioned; 98 miles of this circuit consisting of wire strung on poles.

In this experiment in which three of Mr. Edison's wonderful inventions were shown working in juxtaposition, it will be observed that the sounds, which consisted of talking, singing and cornet playing, were transmitted thru the air *five times* and were transmitted thru no less than *fifteen distinct mediums*, from the speaker and musician in New York to the audience in the Franklin Institute in Philadelphia.

These mediums included vocal chords, cornet, air, glass, iron and mica diaframs, carbon buttons, styli of steel, palladium-faced pens or springs, hydrogen gas, distilled water, wax and chalk cylinders, copper wire and the mechanism of the ear.

The physical characteristics of the sound waves were changed during transmission no less than 48 *times*, as follows: (1) Air waves produced by vibration of the vocal chords in the speaker's throat or by the cornet. (2) Vibration of the glass diafram of the phonograph recorder, producing variations in curvature of the diafram. (3) Variation in longitudinal stress of the steel stylus attached to glass recording diafram. (4) Undulations in the wax cylinder of the phonograph. (5) Variation in the longitudinal stress of the steel stylus attached to diafram of phonograph reproducer. (6) Vibration of the glass diafram of the phonograph reproducer producing variations in curvature of diafram. (7) Sound waves thru the air. (8) Vibrations of the iron diafram of the carbon transmitter producing variations in curvature of the diafram. (9) Varying pressures on the carbon button, varying the resistance of the carbon exactly in accordance with the number and amplitude of the vibrations of the diafram. (10) Pulsatory current produced in the primary winding of the induction coil. (11) Undulating magnetic force produced in the iron core of the coil. (12) Alternating electric currents in secondary winding of the coil. (13) Minute Eddy currents appearing in copper wires of the primary and secondary windings of coil and in the iron core of the coil. (14) Heat produced by Eddy currents. (15) Magnetic hysteresis in iron core formed in overcoming molecular friction in the iron caused by reversals of polarity. (16) Heat produced by hysteresis in iron. (17) Infinitesimal variation in length of iron core due to magnetizing currents. (18) Moving electro-static flux on the line accompanied by or producing electromagnetic flux around the wire. (19) Heat produced by passage of electric current thru the wire. (20) Variation of the coefficient of friction between the surface of chalk cylinder and palladium-faced pen or spring of the motograph receiver. (21) Electrolytic action, causing evolution of hydrogen and oxygen between the chalk cylinder and palladium-faced spring of the motograph receiver. (22) Electro-capillary action, forcing moisture to the surface of the chalk cylinder of motograph receiver. (23) Variation in longitudinal stress of bar or spring attached to mica diafram of the motograph receiver. (24) Vibration of the diafram of motograph receiver producing variations in curvature of the diafram. (25) Sound waves thru the air. (26) Vibrations of glass diafram of phonograph transmitter producing variations in curvature of diafram. (27) Variation in longitudinal stress of steel stylus attached to glass transmitting diafram. (28) Undulations in wax cylinder of the phonograph. (29) Variations in longitudinal stress of steel stylus attached to glass reproducing diafram. (30) Sound waves thru the air. (31) Vibrations of iron diafram of carbon transmitter, producing variation of curvature of iron diafram. (32) Varying pressure on carbon button, varying the resistance of the carbon exactly in accordance with the number and amplitude of the vibrations of the diafram. (33) Pulsatory current produced in the primary winding of the induction coil. (34) Undulating magnetic force in the iron core of the coil. (35) Alternating electric current in secondary winding of the coil. (36) Minute Eddy currents, appearing in copper wires of the primary and secondary windings of coil and in the iron core of the coil. (37) Heat produced by Eddy currents. (38) Magnetic hysteresis in iron core formed in overcoming molecular friction in the iron by reversal of polarity. (39) Heat produced by hysteresis. (40) Infinitesimal variation in length of iron core due to magnetizing currents. (41) Moving electrostatic flux on the line accompanied by or producing electromagnetic flux around the wire. (42) Variation of the coefficient of friction between the surfaces of chalk cylinder and palladium-faced pen or spring of the motograph receiver. (43) Electrolytic action causing evolution of hydrogen and oxygen between the chalk cylinder and palladium-faced spring of the motograph receiver. (44) Electro-capillary action forcing moisture to the surface of the chalk cylinder of the motograph receiver. (45) Variation in longitudinal stress of bar or spring attached to mica diafram of the motograph receiver. (46) Vibration of the diafram of the motograph receiver producing variations in curvature of the diafram. (47) Sound waves thru the air. (48) Translation of sound waves into words by the auditory nerves and other mechanism of the ears of the audience at Philadelphia. By means of transmitters placed upon the stage, the lecture was listened to by audiences in fourteen different cities.

THE FRANKLIN MEDAL AWARDS.

The Franklin Medal, which is awarded annually by the Franklin Institute, Philadelphia, Pa., to "those workers in physical science or technology, without regard to country, whose efforts, in the opinion of the Institute, have done most to advance a knowledge of physical science or its applications," were awarded May 16 to Hendrik Antoon Lorentz, president of Royal Academy of Science, Amsterdam, and professor of mathematical physics, University of Leyden, in recognition of his "researches which have so largely contributed to laying on a new foundation our knowledge of the nature of light and in developing our ideas concerning the ultimate constitution of matter"; also to David Watson Taylor, chief constructor and chief of Bureau of Construction and Repair, United States Navy, in recognition of his "fundamental contributions to the theory of ship resistance and screw propulsion, and of his signal success in the application of current theory to the practical design of varied types of war vessels in the United States Navy."

Electric "Bloodhounds" to Find and Destroy U-Boats

By H. GERNSBACK and H. W. SECOR

NO one will deny the fact that the modern U-boat owes its deadliness to its invisibility. The submarine operates upon the time-old principle of waylaying its quarry, hidden in the dark from the view of its victim. The victim, unsuspecting of the waylayer is stabbed in the back, at the opportune moment when the bandit feels himself safe from counter attack.

Were the U-boat to operate in a perfectly transparent medium—such as the air for instance—we would not have much trouble in hunting it down soon. It is plain that we could then go after it with our own submarines, or on the other hand, merchant steamers would see the U-boat long before it could fire a torpedo, and in such a case the ship could be maneuvered quickly, making a torpedo hit unlikely.

Unfortunately water is far from transparent. To all practical purposes it is as opaque as a brick wall. Therefore, inventors who are apt to fight submarines — on paper—by means of powerful submerged searchlights should do well to remember that even the strongest light rays do not penetrate the ocean more than 300 feet at a depth of 25 feet below sea level.

Coming back to our analogy of the bandit, everyone knows that while our own senses are more or less imperfect, this is not the case of the senses of certain animals. Thus if you fear an attack on a lonely road, you probably would take along a good dog if you owned one, reasoning that the dog would smell and hear the bandit in time and thus warn you. Also the dog would probably show you the direction in which the waylayer is located, and if you were armed, you could "go for the bandit." All this irrespective if it was in bright sunlight or on a dark night.

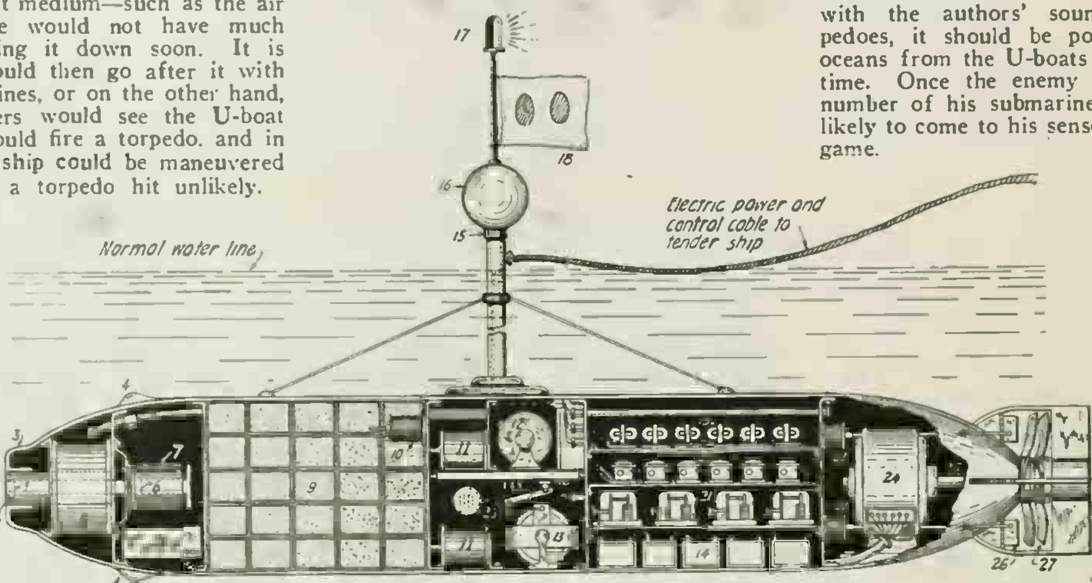
Applying this reasoning to the present submarine war, we find that if we can design the mechanical counterpart of a real bloodhound, the invulnerability of the U-boat, *i.e.*, its invisibility, will be wiped out.

With this in mind the authors have devised an electro-mechanical "bloodhound" which functions upon the same principle as his live brother on land. While the live bloodhound is mainly guided by his hearing and by his smell, the authors' machine operates only by "hearing."

Briefly, the idea consists of equipping a standard torpedo with a number of supersensitive microphones, which are provided with certain *tone-filters*, well known to electrical engineers. Now, a submarine must run its electric motors when running under water, and these motors of necessity make quite a good deal of noise. In fact, the sound of submarines has been detected with *microphone-audion* units for over 20 miles. This is a well established fact.

While on the other hand we have it on good authority that of late German U-boats mount their motors on felt and other sound deadening substances, the fact remains that the sound of a 600 horsepower electrical motor of a submarine cannot be deadened entirely. Then too—and this will be a surprise to the layman—sound travels much better and farther in water than in the air. (If you don't think so, next time you are in your bath tub, submerge both ears in the water and slightly rub two fingers together, under the water, of course. You will be surprised how well you can hear the slightest noises.) Therefore, even if the enemy submarine muffles its motors, we will still be able to hear the U-boat machinery over a distance of several miles. And that is all we require.

Our electro-mechanical "bloodhound" then, thanks to his electric brain and his electric motors, will start at once in the direction of the U-boat, as soon as he picks up its noise. Just as his live brother, he will then guide us to the invisible enemy as certain as fate.



1-Brass rod. 2-Iron. 3-Bronze or gun-metal shell tip. 4-Microphone. 5-Powerful holding magnet. 6-Iron core. 7-Telegraphing magnet. 8-Induction balance apparatus. 9-Explosive chamber. 10-Electric detonator. 11-Diving plane control solenoids. 12-Cable drum. 13-Electric Gyroscope. 14-Batteries. 15-Auto. release. 16-Ball float. 17-Pilot lamp. 18-Position flag. 19-Solenoid control relays etc. 20-H. Res sensitive relays. 21-Amplifiers. 22-Rudder control solenoid. 23-Microphone. 24-Motor. 25-Shaft. 26-Rudders. 27-Propellers.

Fig. 1

Hunting the submarine in its own lair by an electro-mechanical "bloodhound" is proposed in this interesting article. The idea is to steer a torpedo by the sound of the submarine propellers. Certain sensitive microphones on the torpedo cause the latter to "go for" the U-boat and blow it up.

And like the flesh and blood dog, the electric "bloodhound" guides us by a rope. In this case the rope is an electrical cable thru which the current passes to drive its propelling motors. The cable contains other wires, too, as will become apparent later. The cable itself runs to the fast motor boat chaser, which we own already, but which are rather ineffective today, due to their blindness; i. e., they can neither see nor smell submerged U-boats. Given a hundred submarine motor boat chasers equipt with the authors' sound-controlled torpedoes, it should be possible to rid the oceans from the U-boats in a few months' time. Once the enemy sees that a large number of his submarines are sunk, he is likely to come to his senses and give up the game.

Now, the authors, who have carefully gone into all of the details, find that the idea is entirely practical and feasible. For obvious reasons, not all of the details and refinements are made public at this time, and this article is published with a view of setting other able workers to think along similar lines.

It is thought that even if the enemy should become aware of the plan, no harm would be done, because there does not seem to be a defense against the proposed scheme. Also by publishing the idea thousands of people will become interested in it with the very great possibility that the device will be greatly improved upon in a short time.

It should be remembered that the electric "bloodhound" contains no startling new apparatus or machines, nor is it based upon mere theories or untried ideas. It makes use of certain well-known apparatus and devices, the only new thing being in their application and disposition. Any factory turning out torpedoes now will be able to construct the new "U-Boat Killer" in short order.

It should also be borne in mind that this idea does not depend entirely upon the principle of the microphones "hearing" the hum of the motors alone. The Germans might in time make their motors entirely noiseless — altho the authors very much doubt that it can be done. There remains the very loud sound of the propellers churning the water. And this cannot be supprest by any possible means, unless the U-boat lies perfectly still, and a U-boat can't always lie perfectly still; it must move some time. Then, too, during the night it is forced to come up to the surface, running its Diesel oil engines in order to charge the storage batteries. And it is

(*Continued on page 347*)

The Sob of the Sub.

By Ed. Schultz.

Ten ambitious submarines
Splashing through the brine;
One, alas, went out of gas,
Which left together nine.

Nine aspiring submarines
Thrust themselves to fate;
One dove steep, in fact too deep;
Their number then was eight.

Eight aggressive submarines
Seeking for a haven;
One, take note, refused to float,
Which made their total seven.

Seven alert submarines
The enemy went to "fix";
They all went fine, till a floating mine
Reduced the fleet to six.

Six defying submarines
Ready for the strife;
They then took count, but quickly found
That really they were five.

Five evading submarines
Skilled in ocean lore;
All went well, till an en'my shell
Diminished them to four.

Four determined submarines
Terrorized the sea:
Their reign was brief, for a hidden reef
Curtailed the group to three.

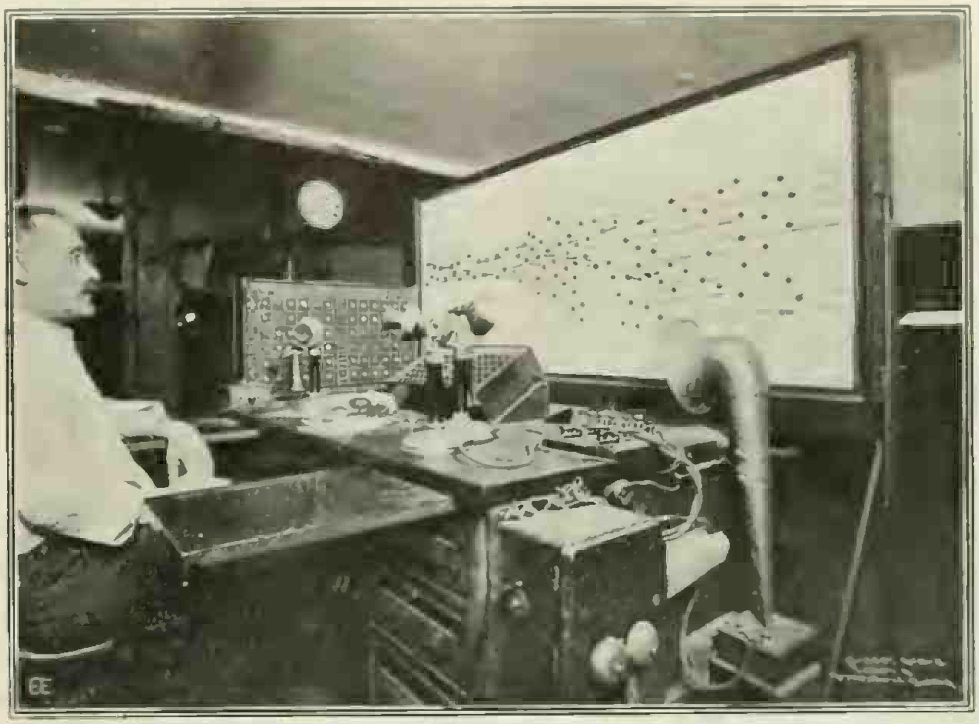
Three desperate submarines
Beneath the ocean blue;
While there, a net made them regret,
Because it left but two.

Two dejected submarines
Their voyage nearly done;
One 'tis plain was rammed in twain,
For now remained but one.

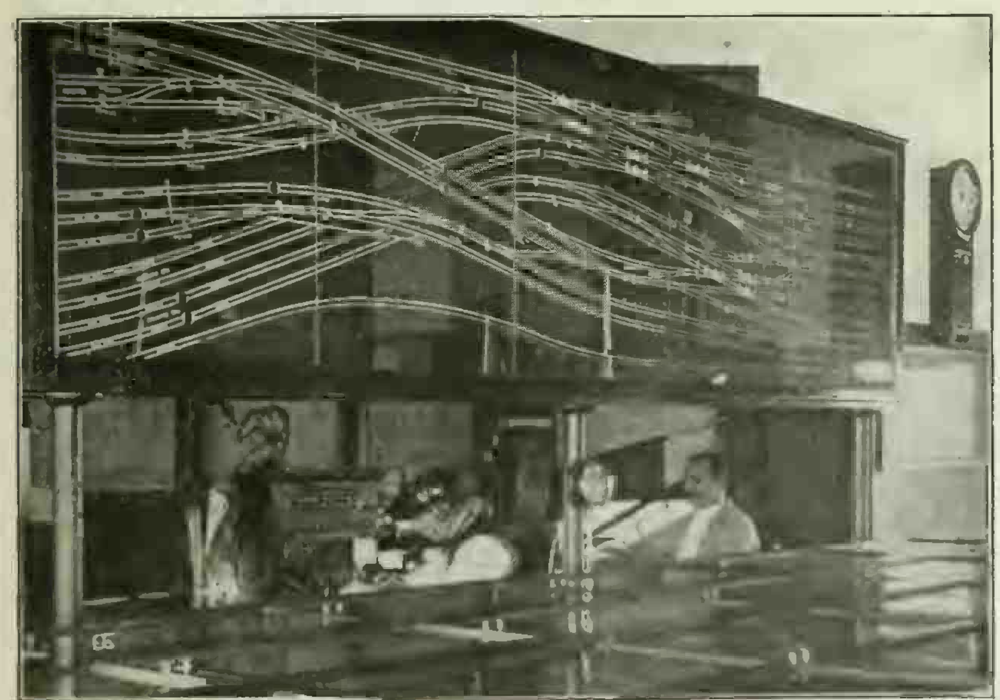
One remorseful submarine
To a neutral port came near;
It there sojourned till 'twas interned,
Which left the high seas clear.

Electric Tally-Board Shows Positions of Trains Constantly

Do you ever stop to think, as you go speeding over the clicking rails, of the large forces of men and the numerous devices and appliances that watch your trip day and night that you may reach your destination safely? Perhaps few of us give much thought to this all-important matter.



A Tower Director at the "Grand Central" Terminal, New York City, with His Elaborate Electrical Aide-de-Camp. The Various Lamps Show the Progress of Trains, Confirmed by Telegraph, Telephone and Telautograph.



© Photo by American Press Association

The Twentieth Century Railroad Tower Director Is a Very Important Personage Indeed. To Facilitate the Accurate Handling of Trains in Complicated Terminal Yards, Electrical Tally-boards Are Provided Which Show the Exact Position of Every Train by Means of Lamps.

We are either engrost in business, or watching the scenery, and seldom give a second's consideration to the large corps of men located in many isolated towers along our journey watching the speeding trains with a guiding hand, always with the watchword "safety first" in mind.

Practically all of the large roads have within the last few years greatly increased the number of appliances which tend to safeguard the public and at the same time eliminate the human factor as a figure in accidents, making every mile of the road always visible to the dispatchers. In the accompanying photographs may be seen views of the large electric tally-boards in the dispatchers' offices on a great eastern road. These boards show the position of all trains over the section covered by that particular office, by means of little lights which automatically flash, and go out as the train advances from one *block* section to another. In addition to this new device, the dispatcher has also the telegraph and telephone to aid him. In this way it is indeed rare that collisions occur, as the man in the tower or dispatcher's office knows just where every train is located constantly.

STEEL FOR ELECTRICAL TRANSMISSION.

In a recent paper, read at a joint meeting of the American Institute of Electrical Engineers and the Association of Iron and Steel Engineers, Mr. H. B. Dwight emphasises the utility of steel cables for transmission purposes on branch lines, especially in cases where the size of copper strictly required to meet the load would be too small for use in practise. For alternating currents the resistance of a steel cable is considerably greater than for direct current, owing to the skin effect. In copper or aluminum conductors the latter is negligible, increasing the resistance by at most 1 to 2 per cent., but at high frequencies the apparent resistance of steel conductors may be increased by 100 per cent. or more. The losses may be kept within moderate limits by using fine strands to act as laminations, and by winding the spirals of alternate layers of wire in reverse directions.

Spy Aerials

"SPY wireless" is one of the all-absorbing topics of interest thruout the country at the present time, and quite naturally it would be, for some of the reasons which are illustrated and described herewith.

The average law-abiding citizen will probably consider that some of the devices mentioned would not serve at all for the reception or transmission of wireless messages, even over short distances of five to ten miles, but such is the case as experts well know from many experiments and tests which have been conducted in the past few years.

A simple and extremely innocent-looking flag-pole aerial might be constructed by a clever spy as shown in Fig. 1. This is nothing else but the well-known concentrated aerial of which much has been publisht in the past three years. In France the concentrated antenna consisting of a small rod or tube, a few meters in length and wound with a layer of insulated wire, has proved capable of picking up wireless messages at quite considerable distances from the Eiffel Tower Radio Station at Paris. In this country several very satisfactory experiments have been carried out with similar aerials consisting of a large number of turns of wire concentrated in a small space, notably at Union College, Schenectady, N. Y., and Atlantic City, N. J.

It is a matter of actual fact that these small concentrated aerials, which however possess considerable inductance, tho of very small dimensions, have picked up messages five hundred to one thousand miles away. In fact, it is believed that the Union College aerial, which did not measure over ten feet square, actually picked up messages from Nauen, Germany, a distance of nearly four thousand miles. Several modifications of the flag-pole antenna are possible; the layer of wire might be covered with a fiber or other sheath painted to imitate wood, etc.

Metal roofs may often be used to advantage in receiving wireless messages, and also for transmitting them over short distances as indicated by Fig. 2. If the roof is grounded by a continuous leader pipe running down into a cistern or sewer, then this pipe would have to be cut or patched up in some way, so that the metal roof would be insulated by the framework of the building, and a lead wire run from the roof or leader into the house.

Electric light wiring is one of the simplest indoor aerials which could be used by a Spy. It would usually be necessary to open the service switch so as to isolate the house wiring system, and as every electrician knows, these wires are very highly insulated and form really a very good radio aerial, in view of this excellent insulation.

Fig. 3 also shows another form of secret aerial which might be employed for carrying on nefarious radio intercourse by the Kaiser's able spies. Many houses are fitted with *metal* instead of wood lath, and the perforated steel lath plates usually overlap, presenting quite an appreciable capacity, especially when large rooms or corridors are considered.

Another interesting and possible aerial which might be imprest for service in emergency is the ordinary *gas pipe* system as illustrated in Fig. 4. It would be an easy matter for an enemy radio expert to disconnect the gas pipe at the meter in the cellar of the building, so as to isolate it, and in this way the building gas pipe system would be fairly well insulated by the wooden framework, and would serve as an antenna for the reception of messages or even for transmitting them.

Little does the washerwoman hanging up clothes on an *iron-wire clothes-line* stop to think that that very clothes-line might be serving as a medium for secret radio-communication. Such may be the case very easily (see Fig. 5), and there have been several instances already where wires very much resembling clothes-lines have been discovered on roofs of buildings which have proven to be disguised wireless antennae. One of these aerials in a large eastern city extended for several blocks, and was easily capable of picking up messages from such powerful stations as that at Nauen, Germany. If you live in the city (or even in the country) and have occasion to use a metal clothes-line of any appreciable size, it might pay you to closely scrutinize the supporting framework to see whether or not some alien enemy has been at work in an effort to use it for wireless communication purposes.

In preparing this article we have endeavored to show the unsuspecting public how an enemy agent may either send or receive radio messages by means of the most innocent appearing objects.

The Editors thought it best to give the article wide publicity, in order that patriotic citizens may the better apprehend possible spies, who might be using secret aerials of the types illustrated.

The article is intended for public enlightenment, as well as for the country's safety.

Fig. 6 illustrates two devices which the enemy might employ to carry on wireless service for quite a considerable distance. The first of these involves the use of a hidden aerial supported inside of a brick *smoke-stack*. Such an aerial might easily be quite a pretentious affair, comprising a large number of wire strands. Consider for the moment also that there are thousands of brick chimneys in various parts of the country in the neighborhood of factories and other plants, such as have been closed down, and who would want to gamble for one moment that such a stack—which might have a height of two hundred feet, as many of them have—is not harboring a secret radio aerial. City houses too can easily harbor good aerials in their chimneys and these will work irrespective of the fact that much heat goes up the flue.

Another substitute antenna which is often available on factory chimneys, as well as on private houses, is the *lightning rod*, which you and I would most probably pass by unthinkingly a thousand times, and yet that very lightning rod might be serving as a valuable link in the Teuton's espionage system. Of course the lightning rod would have to be cut at the earth so as to insulate it and the trick is done; and come to think of it, we have seen lightning rod installations which rambled over considerable areas, especially on large factories, not to mention 200 foot and 250 foot brick chimneys. Even a one-hundred-foot aerial for instance is a mighty good one, as any radio experimenter will tell you.

The *open well* could easily be used especially in the country to contain a radio aerial in a similar manner to that described in connection with chimneys. A clever Spy might even bury his lead-in wire from the apparatus in the house, and simply connect it at the well to a small wire cable, which could be substituted for the usual innocent-looking well rope, fastening a bucket to the lower end of the cable in the regular manner. When in use of course the bucket would have to be out of the water so as not to "ground" the steel cable. When this is cleverly done, we would like to know indeed of a more innocent-looking radio antenna.

Have you examined your *shade trees* closely this summer? Don't be surprised if you find a wire cleverly painted to match the bark on the tree and leading up to the various branches. It is readily possible for a persistent member of the enemy espionage squad to thus rig up a tree aerial, and it is not necessary to travel very far to find a sufficiently large tree, which would serve as a framework for several hundred feet of insulated wire.

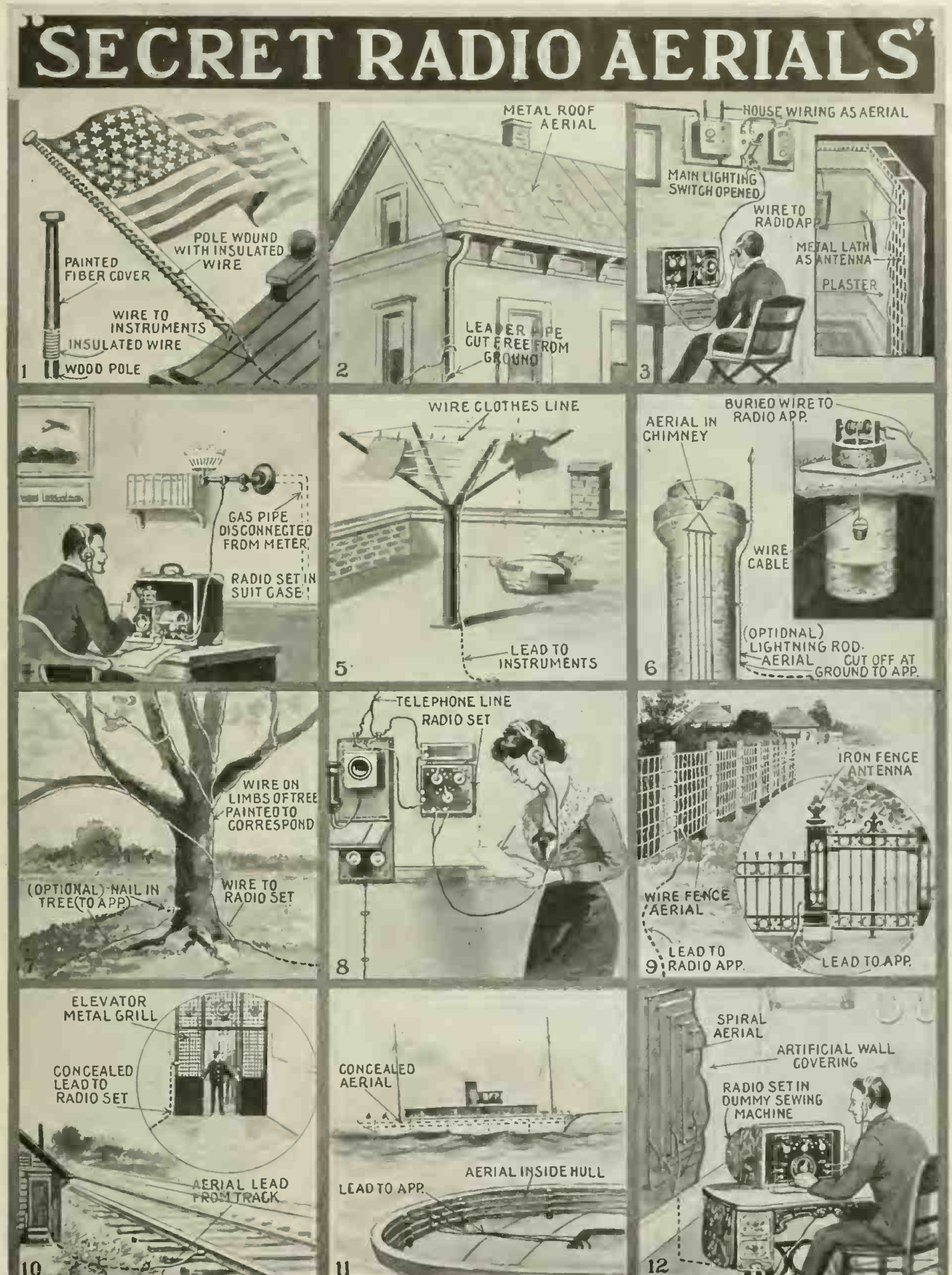
Fig. 7 illustrates this very ingenious antenna. In many instances success could be attained using the same tree as an aerial for wireless communications, but placing no wire in the tree whatever. General G. O. Squier, Chief Signal Officer, U. S. A., found in some tests made several years ago that it is readily possible to receive wireless messages over fair distances by simply driving a nail in the trunk of a tree, and thus utilizing the tree itself and its foliage as the antenna. This works surprisingly well.

Not to be outdone by all of the foregoing more or less efficient emergency aerials, wireless experts have for some time known that radio messages could be picked up over remarkable distances by properly connecting a radio receiver to existing *telegraph or telephone lines* as illustrated at Fig. 8. A Spy could readily use a pocket wireless set in this case, and chances are, he would thrive many months and even years before being detected, as naturally he would not endeavor to carry out this important experiment in the front parlor with the shades up and the lights turned on. Quite the contrary.

In Fig. 9, we see two other forms of aerials, which may be used to cover quite respectable distances, either transmitting or receiving. One of these is the ordinary *wire fence*, which may be found most anywhere and some of which are very well insulated, due to the particular construction employed, and the other possible aerial here shown is the ordinary *iron fence*, which very often is mounted on stone basepillars, so that it would be quite well insulated. These suggestions may sound a little out of place to a great many persons, but it is well to remember that several years ago, a number of tests carried out in New York City, proved that wireless messages, even from out of town stations could be picked up very easily by connecting a wireless receiving set to an ordinary *iron fire-escape* located not higher than the

(*Continued on page 342*)

"SECRET RADIO AERIALS"



(See descriptive text on opposite page.)

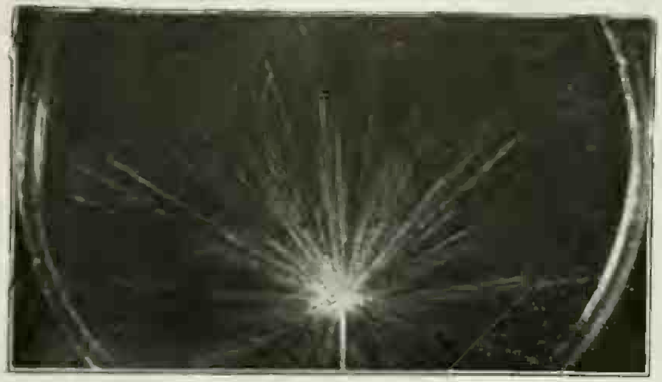
The Marvels of Radio-Activity

By JEROME S. MARCUS, B.Sc. (Ch. E.)

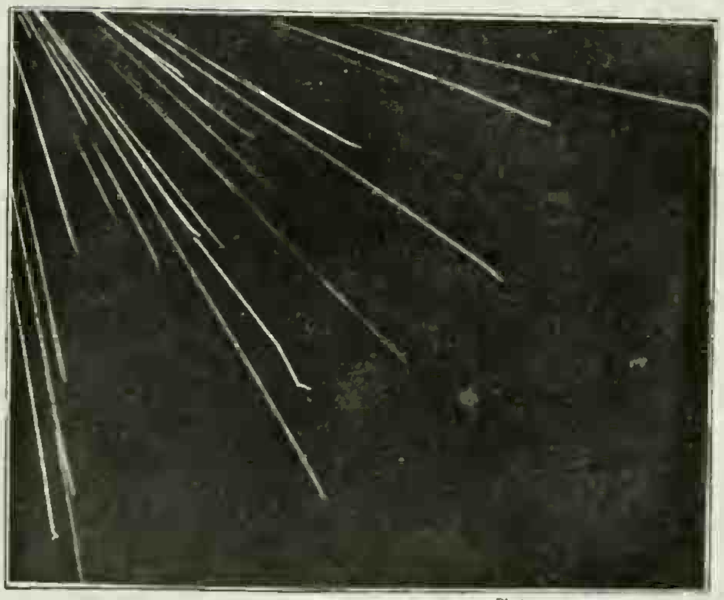
PART II.

Properties of Radium Rays

THE radiations emitted from Radium are of three distinct types known as the *alpha, beta* and *gamma* rays. Rutherford showed, in 1899, that the radiation from *uranium* was complex and consisted of (1) an easily absorbed radiation stopt by a sheet of paper or a few centimeters of air, the alpha rays, and (2) a far-more penetrating radiation capable of passing thru several centimeters of aluminum, the beta rays. Later Villard found that radium emitted a very penetrating type, the gamma ray, capable of passing thru twenty centimeters of iron and several of lead.



Formation of the Electrons of the "Alpha" Rays from a Particle of Radium. Photographic Picture by C. T. R. Wilson. Magnified 1:2, 18.



Photos courtesy Radium Limited

"Alpha" Rays of a Radium Particle as Above. Highly Magnified. The Fracture of the Rays Is Remarkable. It Is Produced by Collision of the A-corpuscles with Another Atom. The Ingenious Method of Wilson Is Based Upon the Electronic Property of the Radium Rays. In Water Vapor the Electrons Generate Condensation Droplets of Aqueous Vapor.

The Alpha Rays

The alpha rays are the most characteristic and important of the three forms of radiation. They are slightly deflected by an intense magnetic field. Some idea of the intensity may be gathered from the fact that a field which will deflect cathode rays (from a vacuum tube) in a circle of 0.1 cm. radius will turn alpha rays only in a circle of 39 cm. radius.

Before going on with our discussion of the types of rays, it would be well to interpolate an experiment on their ability to affect a photographic plate, that this phenomenon may be used later. (Experiment—A plate is well wrapt in black paper in a dark-room, and a small amount of the salt secured—as explained in the last article—placed on top. A key or other bit of metal may be placed between the salt and the paper. After about forty-eight hours the plate is developed. In all these experiments the salt used may be kept in a glass tube if care is taken to secure lead-free glass, as the Jena variety. The lead in ordinary glass will absorb a considerable number of the rays. The author took the radiograph shown in thirty hours, using two grams of *uranyl chlorid* in the bottom of a Jena beaker.)

Becquerel demonstrated the magnetic properties of the alpha rays by placing a plate with radioactive salt a short distance away in a magnetic field. The plate showed a distinct band where the rays had moved. The deflection is greatly magnified in a partial vacuum.

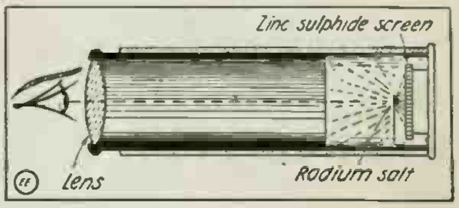
By means of the magnetic field it has been determined that the alpha ray consists of a stream of *positively* electrified particles. Hence, they will be deflected also by an *electrostatic* field.

Observations of the mass and velocity of these particles have been made by Rutherford, from the data secured by deflection. The velocity of an alpha particle is 2.5×10^9 cms. per second, or approximately 15,000 miles per second. The mass is calculated from physical chemistry as twice that of the hydrogen atom.

The alpha radiation is intense, but the power of penetration by the rays is independent of the intensity. A thickness of medium sufficient to stop any one particle will stop the whole discharge—regardless of its strength. That the penetration is small is due to the fact that the mass of an alpha particle is large.

Due to the large mass, the alpha particle possesses a considerable kinetic energy (6×10^{-6} ergs). Owing to this fact the particle has a great power of ionizing gases. The range of ionization depends on the element emitting the ray, the nature and pressure of the gas. The maximum is about seven centimeters of air at atmospheric pressure.

The alpha rays do not possess much power of affecting a photographic plate, the greater part of the effect being produced by the beta and gamma rays. They do, however, exhibit a remarkable power of causing *fluorescence* in many substances. A little instrument devised by Sir William Crookes, known as the *spinthariscope*, shows this phenomenon in a very pretty and visual manner. A short brass tube has a screen coated with crystalline zinc sulfid at one end, and a lens that can be focused at the other. A small pointed brass needle, having an extremely small amount of radium salt mounted on the end, is fixt a few millimeters from the screen. The screen will be seen to scintillate at points where the alpha rays strike, the beautiful effects having been likened to "moonlight on rippling water." (These instruments can be purchased very cheaply.) Each flash corresponds to the impact of an alpha particle against the screen. This is possibly the only direct evidence of the action of one individual atom known to science.



The Marvels of Radio-activity Are Happily Available to Everyone Interested, in the Instrument Known as the "Spinthariscope." The Eye Perceives the Radium Particles Bombarding the Zinc Sulfid Screen, the Action Being Magnified by a Strong Lens.

It is known that a given mass of radium maintains itself at a temperature higher than that of the surrounding air. This is due to the changing of the kinetic energy of the alpha particles into heat. Professor Curie reached the conclusion that one gram of pure radium would emit a quantity of heat equal to 100 gram-calories per hour.

Photo Radium Limited

Radium-therapy Is the Newest Agent for Treating Various Ills. This Is a Practical Apparatus for the Generation of Radium Emanation Water. The Inner Porcelain Cell Contains An Insoluble Radium Salt, Which Activates the Whole Volume of Water Daily.

The Beta Rays

The beta rays are composed of *negatively* charged particles. They are considered by many as electrons with an exceptionally high velocity, 1.6×10^{10} cms. per second. Beta particles are deflected by magnetic and electrostatic fields with much greater ease than the alpha particles. The deviation reduces the ionizing power.

The ionizing caused by the beta radiation is considerable, but not as marked as that caused by the alpha type. However, the range is very much longer.

Owing to the exceptionally high velocity of the beta particles, they have a considerable power of penetration. The absorption effected by matter is approximately proportional to the density of the medium. Thus lead is a far better absorbent than aluminum. (Experiment—A charged electroscope is placed on one side of a thin sheet of lead and the salt on the other. The rate of collapse of the leaves is noted. A sheet of aluminum of the same thickness is then substituted for the lead and the rate of collapse again noted, and a comparison made.)

The photographic action of the beta rays is intense, as proved by deviating them away from the other types, and allowing them to act on a plate. A brilliant fluorescence is caused in many substances, but not the scintillation of the alpha rays.

The mechanical disintegration caused in many substances, appears largely due to beta rays. Paper and rubber, after having been wrapt around relatively large quantities of highly active compounds, become quite rotten. Chemical changes are also produced, or induced, in many stable compounds. The harmful physiological effects, as the Becquerel burns, are attributable to these electronic rays.

The Gamma Rays

The third type of radiation has an almost incredible power to penetrate matter. The gamma rays appear to be similar to X-rays, being *ether pulses*, but are endowed with very considerably greater power of penetration than even the most penetrating variety of X-rays.

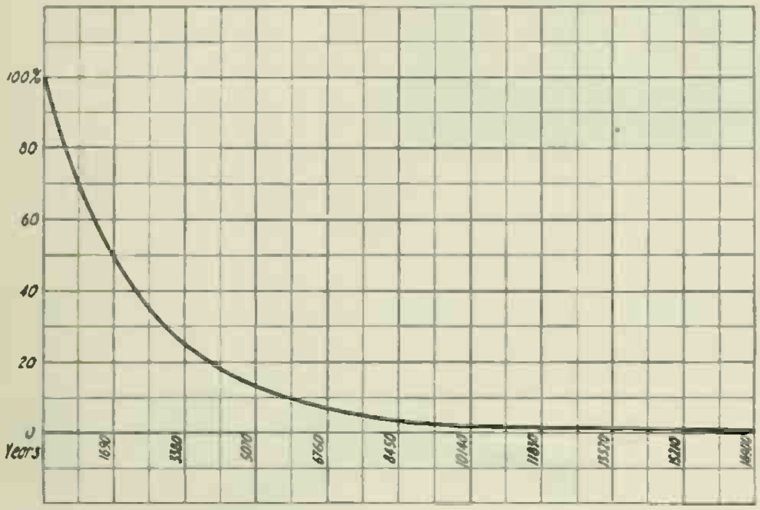
The gamma rays can be investigated by the electrical method as they ionize gases they pass thru. Rutherford states that the gamma radiation from 30 milligrams of radium bromid could be detected by the electroscope after passing thru *30 centimeters* of solid iron!

Photo Courtesy Cold Light Mfg. Co

Here the Radium Is Measured by Means of An Electroscope; Employees from Other Parts of the Laboratory Are Excluded at All Times, as the Electroscope Is So Sensitive That Even the Radium Infection In Their Clothing Impairs Its Accuracy. (Electroscope in the Middle Foreground.)

The photographic action of the rays is also very intense, and most of the action produced by any radioactive substance seems to be due to the gamma radiation emitted. Fluorescent effects are produced by the gamma rays to a marked extent in a wide variety of materials, altho there are cases where the action differs from that of X-rays.

Experiment shows that the absorption of gamma rays depends on the density of the medium, as in the case of the beta radiation. But assuming the gamma rays to be a variety of *ether disturbance*, it seems impossible to assign a limit to their theoretical penetration. Yet a certain thickness of a medium will serve to absorb them.



Prepared specially for the "E. E." by Radium Chemical Ltd.

Curve Showing the Decay of Radium. Each Radio-active Element Transmutes at a Constant Rate That Is Characteristic for That Element. Radium Is Disintegrating at Such a Rate That Half of Any Quantity Will Have Transformed in 1,690 Years. After a Second Interval of 1,690 Years Half of the Remaining Radium Will Be Gone, and So On Until After Ten Times the Half-decay Time Has Elapsed, 16,900 Years, There Will Be Remaining Only 0.1% of the Original Amount of Radium. The Curve Shows This Graphically. By Substituting the Half-decay Time of Any Other Radio-Element, the Curve Can Serve to Show Its Rate of Decay. Thus for Radium Emanation 3.85 Days Is the Half-decay Period, and So In 38.5 Days, Any Quantity of This Substance Falls to 0.1% of the Initial Amount.

Gamma rays are not affected by a magnetic field and so cannot be charged particles, as are the other two types.

Occurrence

The alpha rays are found in the radiation of all radio-active bodies. Beta rays are emitted by radium, uranium, thorium and actinium, but not by polonium. Gamma rays being, according to some theories, a consequence of beta rays, are given out by actinium, thorium, uranium and radium. In all cases, the radiation from radium is stronger than the others.

Secondary Rays

The three types of ray all set up secondary radiation on passing thru matter. A pencil of beta rays falling on matter is widely scattered in all directions, the scattered radiation being known as the secondary beta rays. The gamma rays give rise to secondary rays which consist in part of scattered gamma rays, and in part of electrons moving with a high velocity. These secondary rays produce *tertiary* rays, and so on.

The impact of the alpha rays on matter sets free a number of slow-moving electrons which are very easily affected by a magnetic or electro-static field. This type of radiation was first observed by Thomson, and has been called by him the δ rays.

The angle of incidence of the primary rays affects the intensity of the secondary radiation. The most effective angle appears to be about 45°.

(*Continued on page* 355)

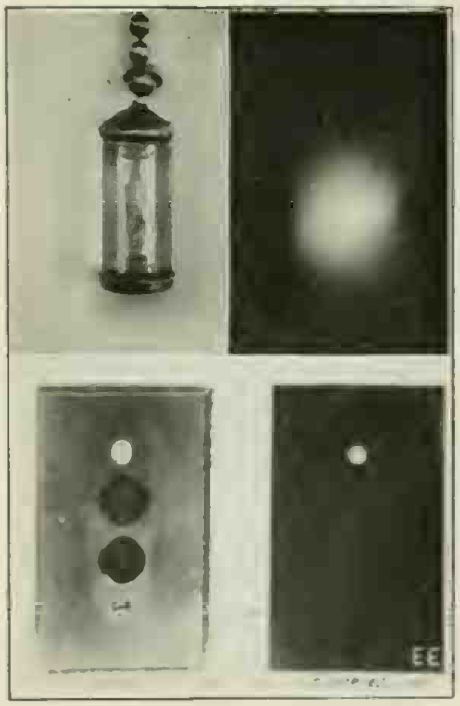
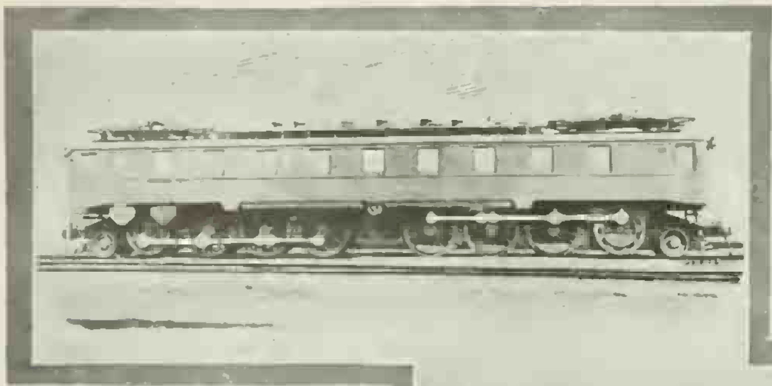


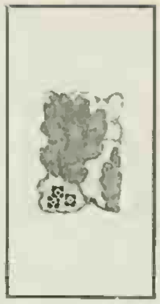
Photo Courtesy Cold Light Mfg. Co.

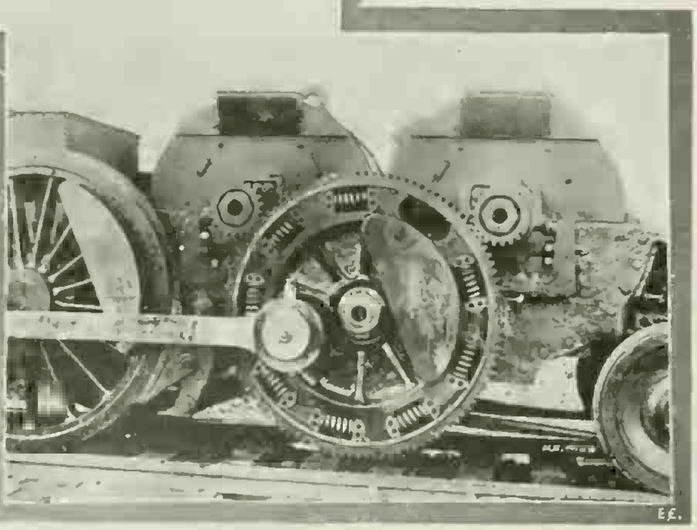
Luminous Radium Paint Is Being Widely Applied Now to Switch Buttons, Lamp Pendants, Dials, Etc. At Right, Appearance In Dark of Radium Coated Pendant and Switch; Left, Daytime Appearance. The First Radium Luminous Mixtures Were Made In 1902 by Wm. J. Hammer, the Eminent American Electrical Engineer, Which Fact Is Proved In His Letters Patent.

LARGEST ELECTRIC LOCOMOTIVE DEVELOPS 7,000 H. P.

A new era in railroad practise is dawning. The problem now confronting the







This Electric Locomotive Is "King of the Rail," Measures 76 Feet In Length and Develops 7000 Horsepower. Equal to Two Giant Steam "Locos" It Will Haul Freight Trains Over the Allegheny Mountains At Twice the Speed of Its Predecessors.

railroads is that of increasing their efficiency, of getting more out of their existing equipment of trackage. Their product, namely transportation, is restricted by congestion and made more expensive by increased costs of fuel, materials and labor.

Accordingly they have turned to electrification as a solution of the problem thru the application of higher powered engines to their trains. Greater saving is also secured thru the more efficient use of coal in the great steam turbine plants, and also from the huge water power plants.

Pursuing a far-seeing policy, which was clearly exemplified some years ago when it built the first steel passenger car, the Pennsylvania Railroad has recently had built the electric freight locomotive shown, which is the first of what will be a standard type of high-powered units to be used by the railroad for moving its freight traffic. This locomotive, which is the most powerful ever built, weighs 260 tons, is 76 feet long, and is capable of developing a maximum of 7,000 *horsepower!*

This monster of the rails, capable of exerting as much power as a string of trolley cars over a half-mile long, draws its current from a wire no bigger than a lead pencil. This is made possible by the use of the high voltage, single phase, alternating-current distribution system. Current is supplied from a single trolley wire at 11,000 volts and the track is used for the return circuit just as in the case of the ordinary city trolley car. This current is changed by means of suitable auxiliary devices on the locomotive to a form suitable for application to the four three-phase induction motors, two of which are mounted on each of the locomotive trucks. These motors possess characteristics which particularly adapt them to this work, namely, ruggedness, constant speed and powerful starting effort.

The locomotive is built in one unit consisting of a cab, and trucks each having six driving wheels, six feet in diameter. On each truck there are mounted two powerful motors, geared to a *spring gear* jackshaft, which in turn is connected to the driving wheels by side rods in a manner very similar in construction and appearance to a regulation steam locomotive.

The engine may be operated from either end, and the control system has been designed so that the application of power is so gradual that a long train may be started without a jerk.

A maximum speed of slightly over 20 miles an hour can be obtained by this locomotive with a heavy train on grade, a speed that is deemed sufficient in view of the heavy traffic, sharp curves and steep grades to be encountered. A speed of 10 miles an hour can also be obtained when desired for slow movements, such as switching and running about the yards.

This engine is primarily intended for use in hauling the tremendously heavy traffic on the Pennsylvania Railroad over the Allegheny Mountains between Altoona and Johnstown, Pa., including the famous Horseshoe Curve, a distance of about forty miles. The freight traffic over this section is unusually heavy, amounting to as much as 300,000 tons a day. The grades are unusually steep, and electrification will greatly facilitate the movement over this grade section. Trains of maximum tonnage will be handled by two of these engines, one pulling and one pushing, at a speed of over twenty miles an hour, that now require *three and sometimes four steam locomotives of the largest size, and at only about one-half the speed* that will be attained by the electrics.

Notwithstanding the power of these giants of the rail, they are operated by one engineer with perfect ease, owing to the design of the control apparatus.

HONK! HONK! HERE COMES THE MOTOR CHAIR.

One of the chief attractions at the recent San Francisco Exposition and at other similar fetes thruout the country, as well as at the seaside resorts, is the electric motor chair, one of which is here illustrated.

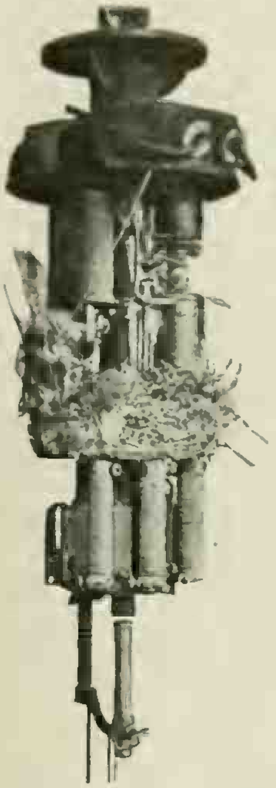
An electric-motor chair furnished with either 150 amp.-hr. or 200 amp.-hr. batteries is the latest luxury. The 150-amp.-hr. battery when fully charged will give five hours of continuous running service, it is said, and the 200-ampere-hour battery will give seven hours. The batteries are of the 12-volt type and the motor is designed to develop 0.5 hp. to 2 hp., according to load. The motor is geared directly to the axle of the front wheel with a triple worm which permits the motor to propel the car up a 15 per cent grade when loaded with two adults. Extending in front of the car is a guard which breaks the circuit between the batteries and motor and applies the brake when it comes in contact with any obstacle.

Honk! Honk! Watch Your Step. Here Comes the Motor Chair. It Is Particularly Adapted to Ladies' Use and Will Not Bite, Balk or Rear. Can Be Stopt Instantly and Is Both Clean and Noiseless.

Electrically illuminated signs to be carried on the roofs to show whether taxicabs are vacant or occupied have been patented in England. Why not invent an electric sign giving the rates to various points? We never could savvy taximeter jargon.

BIRD'S NEST IN ARC LAMP.

Recently an employee of the Cincinnati, Ohio, Electric Company, found that English sparrows had built a nest in an arc lamp. The top of the lamp had been broken so that the birds found a warm place for a home. Evidently the nest which they built was occupied thru most of the winter. The birds picked the wires and this interfered with, but did not stop the illumination. Attention was thus called to the lamp, and investigation showed the presence of the nest, which had been built so as to fill part of the interior. The birds had not been harmed by their experience. Photo courtesy C. G. Stander.



The Birds In Cincinnati Are Strictly Up-to-date. This Nest In An Arc Lamp Proves It.

AUTO CUTS OFF TELEPHONE POLE.

At Logan, W. Va., recently an automobile crashed into a telephone pole carrying a heavy load. The car struck the pole with such force that a 20-foot section was broken out of the pole just above the ground line. This part of the pole fell

A Peculiar Accident In Which a Telephone Pole Was Severed By An Auto Crashing Into It. The Pole Remained Suspended by Its Own Wires.

across the top of the car and remained securely balanced there, as the illustration shows. The upper 10-foot section of the pole, relieved of its former support, dropt down and alighted squarely upon a steel messenger wire which was strung above the street at a less height. There the piece of pole remained in an upright position. Photograph courtesy C. W. de Forest.

FREES JUNGLES OF TERRORS FOR EXPLORER.

Radio-telegraphy has shattered the silence and terror of the jungle for explorers, and it is possible to penetrate vast wildernesses now without once losing touch with civilization. This is the message that Dr. Alexander Hamilton Rice, the explorer, brought with him from his perilous journey 2,100 miles up the Amazon River. He was accompanied on his journey by his courageous wife and a party of scientists.

In speaking of his explorations, Doctor Rice said:

"We took the Alberto, a yacht drawing seventeen feet, up the Amazon to Iquitos, a distance of 2,100 miles. Commodore Benedict last year took the Oneida up to Manaos, but we went 1,000 miles further, and I think the Alberta is the first yacht that ever went as far as Iquitos.

"It was while we were off Iquitos that we realized the possibilities of the wireless. At that remote point we had no difficulty in picking up the signals sent out from the Arlington Station at Washington. They came to us sharp and crisp, and it made us feel sort of homelike to think that we were in touch with the outside world in spite of the fact that we had penetrated thousands of miles of this vast country.

"We, of course, were not the first explorers of the Rio Negro, which we reached. Others, notably Dr. Russell Wallace, in 1851, went up the river, but Doctor Wallace did not succeed in making the latitude and longitude observations on the north bank, which we accomplisht.

"Another purpose was the further testing of the portable wireless which had been especially made for this journey, and a third object was the study of the diseases of the Rio Negro Valley.

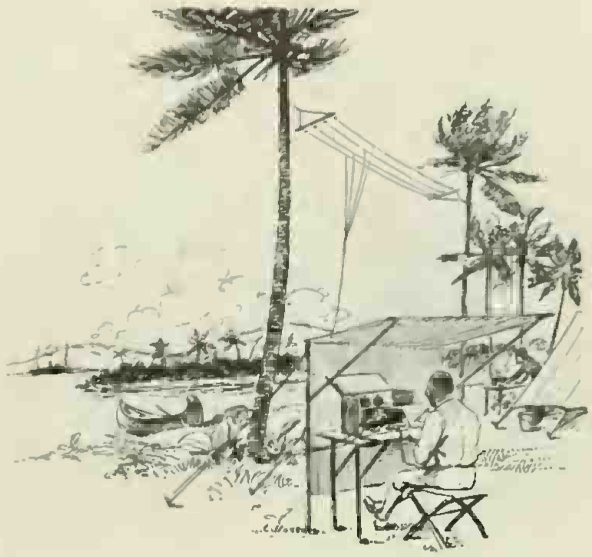
"As its name indicates, the Rio Negro is a black water river, and it is unusually free from the logs, driftwood and debris. White water rivers like the Amazon, in this region, are just the reverse, being full of floating matter. Then again the white water rivers have the usual vegetation extending back from their banks into the forest, but with the Rio Negro the vegetation varies and has no set law of consistency.

"After you leave Santa Isabel you come to the Caoxeiras rapids and cataracts, which are formed by ledges and rocks."

A CHANGEABLE DECORATIVE LIGHT SHADE.

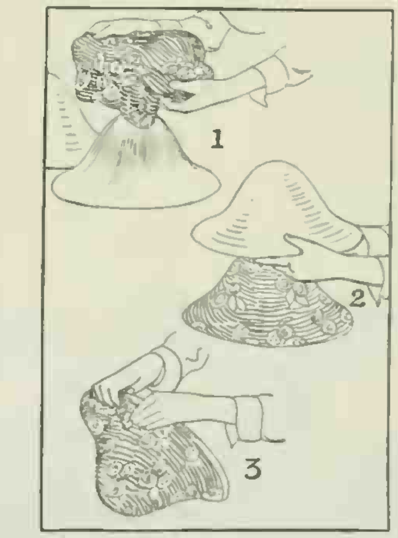
The increasing desire of the modern housewife for artistic decorative effects in her home is bringing about the development of home furnishings of all kinds that readily adapt themselves to varied tastes and designs of home decorations. The most striking feature about these fixtures is that their design can readily be changed from time to time to suit an entirely new type of interior decoration, any special party or other social function, or even to satisfy a passing mood of the housewife. This has never been possible heretofore in metal and glassware fixtures than have been installed permanently.

The secret of the changeability of these new fixtures consists in their unique construction, which embodies two separate glass bowls held together by means of a metal ring and so arranged that between



On a Recent 2,100-Mile Journey Up the Amazon River In South America, a Noted Explorer Found His Radio Apparatus of Wonderful Value. The Arlington "Time Signals" Were Received Daily As Well As Other News.

them can be inserted a piece of colored silk or cretonne. By changing this insert it is thus readily possible to change the entire decorative effect of the fixture. These fixtures are made in some half dozen different sizes and shapes, some having shallow, others deep bowls and some urn-shaped bowls. A pattern is furnished with each size and type of fixture. This permits cutting the fabric to exactly the right shape and size. The fixture is very easily assembled and any housewife can readily take it apart and change it as she wishes.

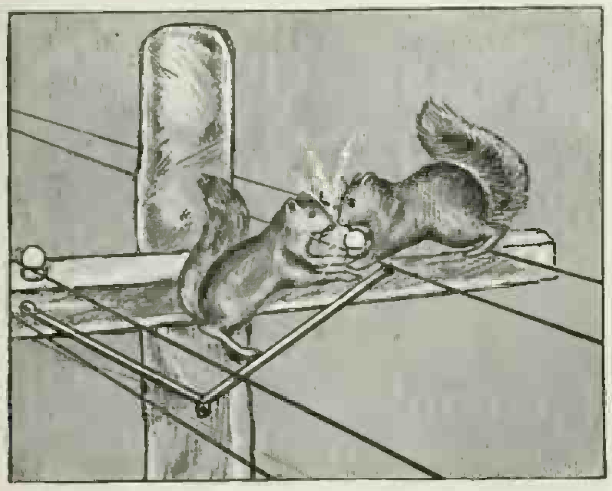


When Madame Tires of the Same Lighting Fixture She May Insert a New Piece of Flowered Silk or Other Material In This New Shade and Realize Her Heart's Desire.

The fabric is first placed over the inner bowl, after the latter is inverted on a table. This bowl has prismatic ribs upon it which serve to reflect most of the light upward toward the ceiling, thus making the fixture a purely semi-indirect type.

THE KISS OF DEATH.

Contrary to expectation, this is not the title of a new film thriller, but the story of a short-circuit on a 13,800-volt line. On a recent Sunday, trouble showed on the Fayville line between Hopkinton and the Sudbury dam in England. On patrolling the line thru the woods Charlie Marshall, Hopkinton trouble man, found one of the lines on the ground with a squirrel lying dead beside the wire. Another squirrel was wedged in the cross-arm brace on the pole, and was also dead. On examination it was found that the bodies and noses of both animals were burned. The nature of the burns disclosed the fact that one squirrel was on the line and the other was on the brace, which is grounded. When the little animals touched noses a flash-over from line to arm was caused, which burned off the wire and resulted fatally for the unfortunate lovers. Which goes to show that the top of a pole carrying 13,800 volts is a bad place for spooning.



When These Squirrels Touched Noses There Was a Flash of Sparks and Two Red-skins Bit the Dust.

MAKING "MALLO TOPPING" BY MOTOR.

Mallo topping—that delicacy which we all enjoy so much at soda fountains—is now made by motor.

Place one-half gallon of Mallo Topping in the whipper, and add four ounces of hot water, says the recipe. Start the machine and whip two or three minutes. Then add four ounces more of hot water. Whip this until nice and light. The Mallo Topping when finished will be about the consistency of whipt cream. By whipping the Mallo Topping with this amount of water, it will double in volume. If you wish to re-flavor or re-color it, place the flavor or color desired in the mallo when it is being whipt up.

Mallo Topping for Soda Water Fountains Can Be Made in a Jiffy with this Motor-driven Whipper.

The Destruction of Steel and Concrete by Electrolysis.

By K. M. COGGESHALL

QUITE often, while walking down a city street, we will notice a little squad of workmen digging in the roadway to unearth a burst water main. Perhaps we will see a piece of the old pipe after it has been removed and will be surprised to note how it is pitted and eaten away. If a pocket knife is used to dig into the sides of the pipe, it will be found to be soft and easily cut. A chemist would tell us that this destruction of the steel or cast iron pipe was caused by electrolysis—a decomposition by an electric current.

A further explanation might make this action more lucid if we consider the electro-chemistry of the plating bath. Here we have the current entering the bath thru the copper, silver, or nickel metal, passing thru the bath, and leaving by the metal article being plated. A chemical reaction then takes place; the copper, silver, or nickel, as the case may be, is decomposed and a deposit of this same metal is formed on the object being plated. The voltage necessary to create this action may be quite small altho the decomposition will increase materially with a larger difference of potential.

Dry soil does not easily lend itself to the passage of an electric current altho, especially in large cities, it contains a great deal of mineral matter and salts. When the earth is wet, however, these salts dissolve, thus changing the soil into an electrolytic conductor. It can easily be seen, then, that if there is a difference of potential between two points on the earth's surface, a current of electricity will flow from one to the other.

Most cities operate a street railway system which uses the rails as a return circuit. As it is impossible to insulate the rails from the ground, the current will stray from them and flow back to the power house thru the soil. If a water main is in the near vicinity of these currents it will serve as a conductor for part of the distance until a path of less resistance presents itself. Here, then, is where a problem must be solved by the municipal and railway engineers. At every point along the water main, where the electric current leaves the pipe, decomposition by electrolysis will occur.

Eventually this decomposition will destroy the walls of the pipe and bursting may take place at a critical moment when an excess pressure is put upon it during a fire.

The sketch shows the condition contributing to electrolysis. The current flows along the trolley, thru the car motors, to the rails, and back to the power house. Suppose that a water main runs parallel to the track. Some of the current will stray from the track, as indicated by the arrows, and use the water main as a conductor. At the point of exit near the power house electrolysis will occur.

Quite often there will be a high resistance joint in the water pipe caused by a coating of asphalt or other compound. In such instances the electric current will shunt around this joint thru the soil. Here, again, we find electrolytic action where the current leaves the pipe. This disintegration, as a rule, causes pittings close to the lead filler, which softens, resulting in a leak.

It is interesting to note the effect electrolysis has on different metals. The cast iron pipe does not show the destructive action on its surface while in the ground. If a section of the pipe is removed, however, and exposed to the sun's rays until thoroly dry, the graphite and other impurities with which the pittings are filled, become hard and drop out or may be easily removed with a pen knife. In wrought iron and steel pipes the iron oxid resulting from the chemical action is diffused thru the soil. As a rule in wrought iron pipes the action will concentrate at one point, thus causing rapid deterioration. White and yellow salts are formed when electrolysis takes place in lead pipes. This is especially noticeable where lead-sheathed cables are used in underground wiring.

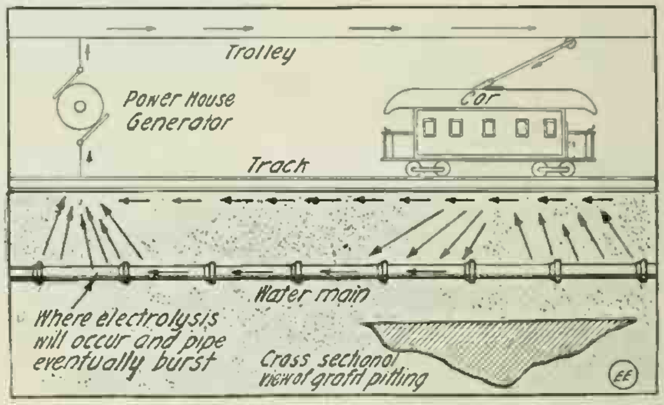


Diagram Showing How the Street Railway Current Often Strays from the Rails to a Water Pipe, Eventually Causing a Ruptured Main Where the Current Leaves the Pipe Line.

Many experiments have shown that concrete when damp is a good conductor of electricity. The majority of the concrete structures of to-day are reinforced with steel bars. It has been found that when currents of electricity pass from these bars into the concrete, the latter will crack. The oxids of iron formed occupy a space greater than the original bar and a terrific outward pressure is produced. It has also been found that when currents pass from the concrete into the iron, the former will soften and eventually the rigid bond between the two will be broken. Electrolysis in concrete is often found in bridges and where steel foundations are imbedded in concrete.

All of the foregoing discussion refers only to the action of direct currents such as used for street railway power. The damage caused by alternating current is so slight as to be negligible. The only difference is that while with direct current electrolytic decomposition occurs only at the positive electrode, with alternating current this corrosion is present at both electrodes.

NEW LIFE BELT HAS ELECTRIC LIGHT.

The illustration herewith shows a new wrinkle in life belts, and one which should be conducive to the saving of many lives annually. It often happens that persons washed overboard, even tho provided with a life belt, are lost nevertheless, particularly when this occurs in the night time.

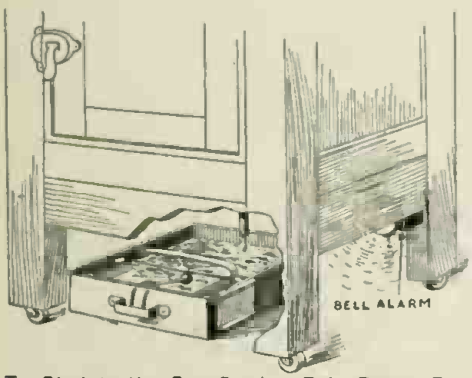
A Yankee Genius Has Come Forward With An Electric Light Attachment for Life Belts, Which If Adopted, Should Help to Save Many Lives Annually.

To increase the chances of being rescued of the person so situated, a New York inventor, Mr. A. M. McGiff, has patented a *luminous life belt.*

As soon as the person dons this life belt a switch is closed which illuminates the electric light or lights, and thus the shipwrecked soul has every chance of being seen by another vessel in the dark. The lamps may be supplied with current from a dry or storage battery placed within one of the belt compartments.

ELECTRIC DRIP PAN.

How many times have you heard mother say, "Johnny, empty that drip pan," and when you undertook to carry out the assigned task found that the pan was filled to overflowing, and possibly had flooded several square yards of carpet about the ice box. To obviate this household catastrophe which has occurred and will most probably occur many thousand times, a New York inventor, Mr. M. Jacobson, has recently obtained a patent on an electric drip pan alarm here featured. When the water reaches a certain predetermined level in the pan, the float arm rises, causing the electric



To Obviate the Overflowing Drip Pan a Recent Patent Provides for a Simple Electric Alarm Bell and Float Switch, Which Act When the Pan Is Nearly Full.

bell circuit to be closed. This should prove a God-send to the busy housewife, not to mention the perpetually busy servant girl or cook who, when she is not busy frying potatoes or baking cakes, or perusing one of Laura Lean Jibby's famous works, is highly preoccupied with the fatuous and propitious duty of entertaining the iceman.

MOVING MAGNET OPERATES MYSTIC WINDOW DISPLAY.

Possibly you have found yourself among a hundred others standing before an attractive show window, and patiently stretching your neck in an effort to see what held the interest of the crowd. Mysticism is the key to nearly all of the best window attractions that have been evolved in the past several years. The one shown herewith is no exception, and undoubtedly you have come face to face with it more than once without being able to figure out just what caused the ever shuffling advertisement to move about in such an uncanny manner.

The display in question is generally designed with a heavy plate glass top supported on four well-spaced columns. When you see this device in operation, it is really very puzzling, for it is hard for one to conceive that a magnet could be made powerful enough to move the advertisement card and its attached base about on the glass plate, which latter stalls most of the "electrical experts" in the crowd, as glass is known to be a good electrical insulator. A magnet is really in back of or rather under

Magic and Black Art Still Exercise Their Charm Upon the Public. If You Don't Believe It Watch the Crowd This Magnetic Window Novelty Attracts.

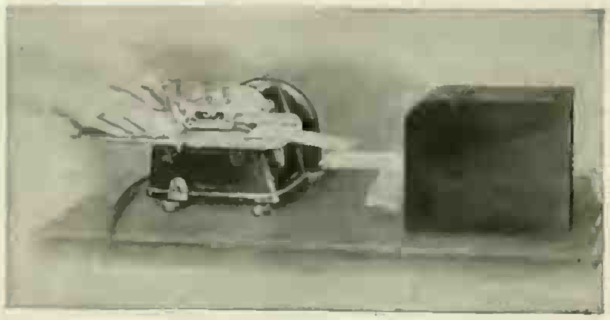
the whole device, and it is repeatedly changed in position by means of proper gearing, and an electric motor hidden in the base.

The pedestal supporting the advertisement card is of iron so that the magnet can act upon it.

OPENING 50 LETTERS AT ONCE BY MOTOR.

Anyone who has ever had to open a thousand letters by hand or by hand-operated letter openers, knows the enormity of the task involved and the amount of time necessary to complete the operation. In addition, the greatest care has to be exercised in the opening process in order that enclosures be not mutilated. This can all be eliminated, and the time required reduced to a minimum by the use of the motor-operated opener shown. This device opens the letters in a continuous stream, cutting only a thread from the edge of the envelopes, and in a seemingly uncanny way missing the enclosures. One of these letter openers in actual operation has opened 73,000 letters in a working day of 8 hours!

In operation, the unopened letters are placed on a feed-table back of a guard, which has a capacity of 50 letters at a time. They are fed thru one at a time by means of two rubber rollers, which pass them along past two cutting wheels. The guard eliminates all possibility of the operator's fingers coming into contact with the cutters. The depth of the cut may be varied and set at will. After the letters



73,000 Letters Opened in 8 Hours, Is the Record of This New Electric Letter Opener.

are opened they are automatically thrown out and stacked up in the case of the machine, as shown in the illustration. A 1/20 h.p. electric motor operates it.

NEW TRAVELING ELECTRIC TALKING SIGN.

Recent improvements in the talking electric sign have made it possible to either flash the message in consecutive distinct flashes or continuously traveling, the story moving across the lamp field from right to left. The sign can be supplied in any size, either for outdoor display or for store or show window use. One of its greatest features is that it can flash an advertisment of any desired length. The system consists of only three essential parts, the lamp letter field, the flash controller for the operating stencil, and the connecting cable which joins the two.

How does it do it? The words are spelled out on a bank of very closely spaced electric lamps. The lamp bank may be of a size to flash a six-foot or six-inch letter.

The word-flashes are operated by means of a motor-driven stencil ribbon, per-

The Latest Electric Talking Sign Enables the Advertiser to Flash a Continuously Changing Message to the Public. The Letters Move From Right to Left.

forated with the message. This ribbon may be practically any length. It may be continuous so as to repeat the message. Sections of message-ribbon may be added at any time or removed—all in a few minutes. The story may thus be kept up to the minute.

Vocation of the Engineer

By PROF. A. E. WATSON
Instructor in Electrical Engineering, Brown University

WHAT is an engineer, and what does he do? The trade definition is obvious and simple, but the professional application is meant, and to that the answer is not so easy; at least it cannot be short. New extensions and applications of the name are constantly being found, suggesting wide differences in the definition.

The name was early used in a military sense, for to the "engineer corps" of an army was assigned the detail of designing and constructing fortifications, roads, bridges, etc. For the arts of peace the building of canals and railroads demanded similarly skilled men, but in civil life. It was in the decade of 1865-1875 when the first great transcontinental railroads were building that these "civil" engineers, as distinguished from the military engineers, were recognized as forming a separate professional body. To equip railroads and ships with their motive power, great factories with their machinery and tools, required men trained along quite other lines, and the mechanical engineers became a second professional class. Hand-in-hand with these latter, at first perhaps a step behind, but now with the slogan "Do it electrically," quite in line with his elder brother, the electrical engineer has found his functions both a demonstration and a challenge.

Like that of other professions, the work of engineers is constantly becoming more diverse and specialized. With the multiplication of proofs that their work is ordinarily done in an economical and reliable manner, more and more matters, not at first regarded as properly within the scope of engineering, have been entrusted to their advice, judgment, and execution. Thus in addition to the older designation of "city engineer" we find "public service engineer," "efficiency engineer," "illuminating engineer," "heating engineer," etc. It is from these actual instances rather than from a dictionary that the present usage of the word is to be derived.

It is fortunate that all of us are not vitally interested in the same things, for a certain sort of life-work that is a source of the highest inspiration to some would be of most depressing drudgery to others. While a normal man is sufficiently resourceful and energetic to adapt himself to circumstances, and to derive a sufficient and tolerable subsistence from any one of a variety of employments, he should be given free choice in the matter of selection of that work which above all others appeals to his whole heart and mind. Once entered upon this course he will bode no stint or limitation. Some have heard that call in engineering, have followed, and not been deceived. As judged by their own admissions and by the testimony of word and deed, they have done the work for which they have seemed specially fitted.

What shall we reply then to the young man who says, "Engineering is just what I want. How can I get into it?" If possible, even from the first, the value of the personal element should be recognized. Tell him that if he knows of an engineer with whom he can get acquainted, let him do it. Try to visit him at his work, or even at his play. If engineers or engineering societies in the neighborhood have meetings for discussion, let him attend such as appear to furnish subjects of interest. Ordinarily the public is cordially invited to such gatherings. Altho many of the topics may be over the young visitor's head, he will be sure to become interested in certain of the attendants, and some of the members will become interested in him.

Prof. A. E. Watson, Instructor in Electrical Engineering, Brown University, Is to Our Mind An Ideal Educator and Scholar. He Holds Degrees of B. Sc., and Ph. D., and Is a Member of the A. I. E. E. Besides His Tutorial Duties He Finds Time to Write Technical Books and Papers, and We Are Pleased to Present His Message to Embryo Engineers Herewith.

IN THE OCTOBER "E.E."

"Research in High Frequency, High Potential Currents," by Dr. Nikola Tesla.

An automatic electric "zig-zagger," to prevent torpedoing of ships.

The marvels of Radio-activity—Part III—by Jerome S. Marcus, B.Sc.

Electricity in the manufacture of Ammunition and Guns.

"A new electrical war scheme"—by H. Gernsback.

The American inventor of Radio who antedated Marconi.

The earliest electrical apparatus—an article of historic and technical interest, by H. Winfield Secor.

Chemical action of storage batteries—of interest to all electrical and radio students, by Albert W. Wilsdon.

New and startling experiments with High Frequency Currents—Lighting a bank of 110 volt lamps thru the body, and a host of other extremely interesting and mystical experiments.

Radio-dynamics—the control of torpedoes, boats, et cetera, by wireless waves. Some recent developments in this field.

The How and Why of Radio Apparatus—Part 5. Helices and Oscillation Transformers.

The "October issue" will be of particular interest to all classes of readers. It will mark the official opening of the "working" season. We will all be back from vacations then and ready to study up on the latest advances in electricity, radio and science—which "THE ELECTRICAL EXPERIMENTER" *knows just how to serve. Don't miss it, Friends!*

This association should quicken his intellect and unfold to him some of the problems of the engineers and their tentative or final solutions. Let him subscribe for an engineering magazine, and read such others as may be available. Without interfering with regular school or other work, such an enquiry extending over a couple of years will demonstrate if the interest in engineering matters is merely transient or is likely to be permanent. Once in the life-work the competition between one's fellows is altogether too real to permit trifling with the original selection.

To have any reasonable chance of getting into the first rank of engineers or even of good standing in the profession, the aspirant should have a college or technical school degree. Of course numerous instances can be quoted of successful engineers who have not received such formal education, but they will be found to consist mostly of the older generation whose schooling came before the present numerous and comparatively easy opportunities for education were afforded. Immediately after graduation, two-year training courses are ordinarily available in some consulting, designing, erecting, operating or manufacturing concern. During such a coarse the "student-engineer" receives a living wage, say $60.00 to $75.00 per month, and is frequently transferred from one department to another, whereby he acquires a working familiarity with a great variety of subjects or apparatus. During such a course or at its completion, the embryo-engineer is supposed to have made a sufficient impression upon his employers as to merit an appointment to their permanent staff, or to secure a recommendation to some allied interest, or to warrant his getting into business more of his own making. He can now properly call himself an engineer, but to secure that recognition from his fellows he should make application for membership in one of the national engineering societies. Its publications and associations should prove of lifelong interest.

Thus scheduled it would appear that the engineer has to a considerable degree been the product of artificial methods, that he has been machine-made, without the recognition of the inventive and creative attributes usually ascribed to one of his profession. Perhaps this criticism may occasionally be heightened by hearing a seasoned veteran maintain that engineering consists simply of good common sense. In reality, however, such a statement hardly puts the case strongly enough, for successful engineering will be found to consist of uncommonly good sense. In this last expression is to be summed the whole school education of the man, then tempered and supplemented with years of experience. The weight of increasing responsibilities in connection with important and even stupendous enterprises may dim the recollection of college and apprentice days, but that early training is indispensable.

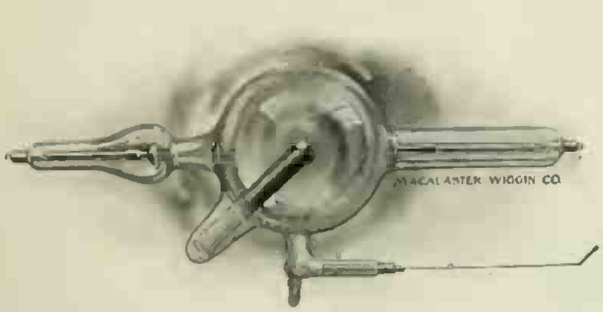
The expectant engineer may well consider that his life-work will bring him in touch with city councils, with legislative committees and assemblies, with courts of law, with financial interests, and undertakings. He may be called upon to give public addresses and to prepare papers for publication. His word and action will be critically watched, for the engineer must make no mistakes. Life and property are too valuable to serve as subjects for snap-judgments and ill-considered experiments.

X-Ray Tubes for High Frequency Coils

By Dr. FREDERICK FINCH STRONG
Lecturer on Electro-therapeutics, Tufts Medical School, Boston

IN all the history of scientific achievement there has been perhaps no discovery of such a startling and revolutionary character as that of the X-Ray.

The *Electron theory*, which forms the basis of the chemistry and physics of our New Age has been formulated almost en-



Standard Form of Single-Focus High Frequency X-Ray Tube. The First Powerful X-Ray Tubes Were Excited By a High Frequency Oscillator.

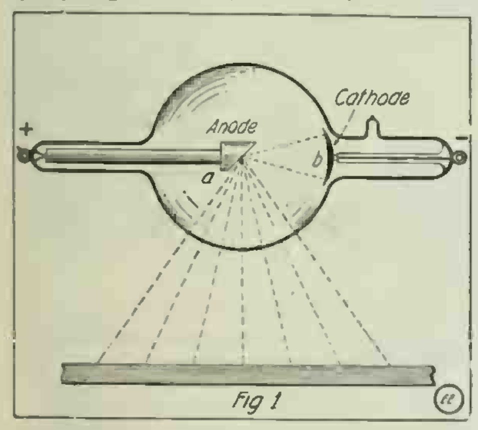
tirely from deduction made possible by the work of Roentgen and the Curies.

If we review the history of these discoveries we find that they have resulted from long series of researches dealing with the phenomena of electrical discharges in partial vacua.

The air pump was invented in 1650 by Otto von Guericke; by its use Sir W. Snow Harris, in 1834 was able to show that the spark-length of a given electrical machine increases in inverse ratio to the pressure of the gas thru which it passes. His tubes were exhausted to about one five-hundredth of an atmosphere, and the dischage took the form of a pencil of violet-pink light.

Geissler, in 1838, experimented with discharges in low vacua, and invented the beautiful tubes which bear his name. By improving the air-pump, he was able to withdraw all but one ten-thousandth of the original air from the glass tube, and change the color of the glow, in the electrified space from violet-pink to a pure white.

The invention of the mercury air-pump by Sprengel in 1865, made it possible for

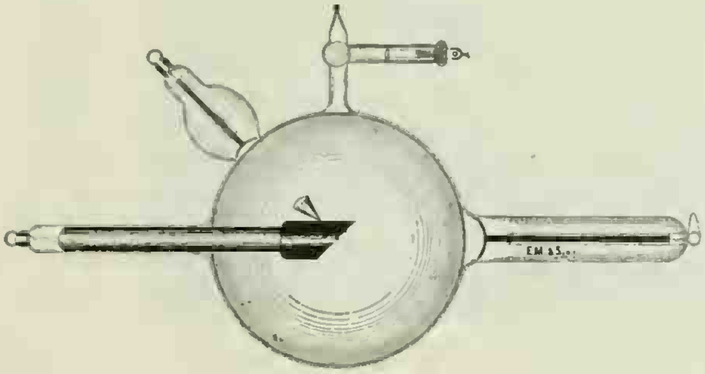


The Simple X-Ray Tube Contains an Anode or Target "a" and an Aluminum Cathode "b." The Cathodic Electron Bombardment of Target "a" Causes X-Rays to be Produced At Right Angles or Downward As Shown.

Sir William Crookes in 1878, to study electrical discharges in rarefied gases with pressures as low as *one one-millionth* of an atmosphere. He gave to the world the "Crookes tube," with which Lenard in 1894, proved the existence of the "Cathode rays," and from which in 1895, Roentgen accidentally discovered a new form of emitted energy which he tentatively called the "X-Ray."

We all recall the circumstances of this discovery. Roentgen was experimenting with a Crookes tube enveloped in an opaque cover, when he noticed a bright glow on a nearby card, coated with Platinum-Barium-Cyanid. The glow continued even when the uncoated surface of the card was presented to the tube, and further experiment showed that the interposition of the experimenter's hand between the covered tube and the fluorescent screen would cause a shadow-picture of the bones to appear upon the glowing surface.

The publication of Roentgen's discovery led investigators in all parts of the world to study the new phenomena. Static machines and Ruhmkorff induction coils were at first employed to excite the Crookes tubes; but the intensity of the re-



Commercial Form of a Second Type of Single-Focus High Frequency X-Ray Tube Shown Sectionally in Fig. 4. These Tubes Are Adapted to High Power Tesla or Oudin Coils.

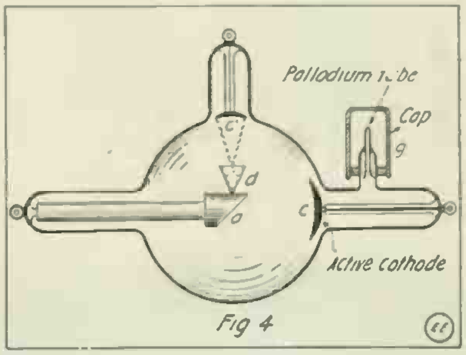
sulting X-rays was not very great. In those days an induction coil giving a four-inch spark was regarded as exceedingly powerful. We know now that such an apparatus is entirely inadequate to the production of X-rays for any practical purpose.

Tesla and Elihu Thompson advocated high-frequency currents for X-ray generation, and in 1896 the Knott Apparatus Company of Boston designed the first practical commercial X-ray machine. It consisted of an open-core transformer, glass-plate condenser and Tesla coil, immersed in oil, and a rotary spark-gap not unlike those now used in Radio-telegraphy.

A few months later, the writer made the first practical high-frequency apparatus having solid insulation instead of oil, and suitable for therapeutic as well as X-ray work. The many types of high-frequency machines that are now made for physicians' use are but variations and improvements of this original apparatus.

At the present time the professional Roentgenologist uses almost exclusively powerful apparatus of the high-tension transformer type; the high-voltage, low-frequency, alternating current being rectified by a high-tension commutator operated by a synchronous motor. With such an apparatus and suitable X-ray tubes, a skiagram of the adult thorax or abdomen may be made in the *fraction of a second*.

For the general practitioner, the dentist and the amateur experimenter, however, the high-frequency apparatus is still the most convenient and inexpensive device for ex-

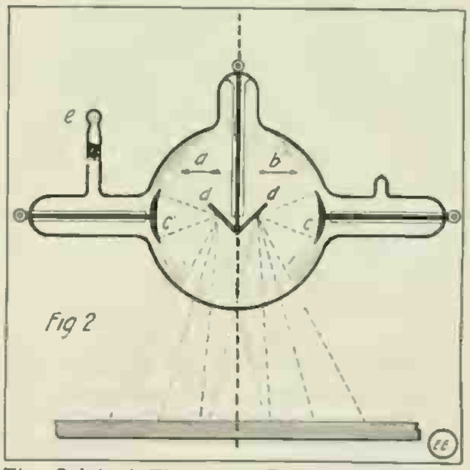


Special Form of X-Ray Tube of the Single-Focus Type, Fitted With Palladium Vacuum Regulator and Focussing Mirror "C", Also Copper Cone "d," for Dissipating Auxiliary Cathode Stream.

citing X-ray tubes, and produces results quite adequate to their respective needs.

The construction of an X-ray tube is familiar to all:—in its simplest form it consists of a Crookes tube (as shown in Fig. 1), containing an anode or target (a), faced with platinum or tungsten, and a concave aluminum cathode (b). A high-voltage, unidirectional current flowing thru the tube causes streams of electrons to pass from the cathode to the target, which is set at an angle of forty-five degrees to the axis of the tube. The electronic stream ("Cathode rays"), is reflected at right angles and part of the energy is transformed into X-rays, which emerge from the glass in a divergent cone, as shown. Such a tube is not suited for use with alternating or oscillating currents, as a double set of rays would be produced; this would tend to melt the aluminum cathode and cause the absorption of the residual gas in the tube so that it would soon be too "hard" to use.

This led Elihu Thompson, in 1896, to invent his "double-focus tube"; the con-



The Original Thompson Double-Focus High Frequency X-Ray Tube Which Really Comprised Two Distinct Bulb Elements.

struction and operation of the Thompson double-focus tube is shown in Fig. 2.

(*Continued on page 328*)

The Franklin Experimental Club

By WILLIAM J. HAMMER
Consulting Electrical Engineer

DUE to the exigencies of the World's War, our Government has deemed it advisable to dismantle the many Wireless Plants about the country which might be used to convey messages to the enemy, and strict regulations are at present in force. Doubtless there are thousands of enterprising and ambitious boys all over the country who have constructed and operated wireless plants at their homes whose ardor for scientific knowledge and experimentation has been somewhat cooled by their inability to operate their stations.

The writer has noted with great interest the illustrations of wireless installations, many of them elaborately equipt for both sending and receiving wireless messages; which have been designed and built by amateurs all over the country who have sent in photographs and data regarding their installations for reproduction in the columns of THE ELECTRICAL EXPERIMENTER, and he has a fellow feeling for these young men, as he has dabbled somewhat in this field himself and believes that he was the first person in the world to use wireless for domestic purposes in 1894. (See *Elec. Review*, Feb. 25, 1905). Therefore, he would like to make a suggestion to the host of "Electrical" and "Radio Bugs" about the country which might further stimulate their interest in scientific matters, for which their work in wireless has already given them a keen taste.

The writer's suggestion is that in various communities boys interested in wireless and other branches of electrical science, physics, chemistry, etc., get together and form a scientific club where they can study, experiment, build apparatus and models, where they can gradually collect tools, instruments and supplies such as batteries, wire, chemicals, etc., as well as a library of technical books and papers, and where each boy will be enabled to avail himself at small expense of the club's facilities and secure the benefit of the criticism and help of the other members and perhaps the valuable advice and co-operation of older men in the community who have had experience in scientific matters. Such men, for instance, as the teachers of science in the local public schools, whom he feels confident would be glad to assist the boys in organizing and conducting the club, for they realize the great benefits which come from doing things with one's hands and believe that boys should be encouraged to do useful work of this character and they also realize that there are few things out of which boys can derive as much pleasure.

The Electrical Side of the "Franklin Experimental Club's" Laboratory and Work-Shop. Every Member Had His Own Tool Drawer and Prizes Were Given Monthly for the Best Original Piece of Work Or Experiment.

Perhaps the "Electrical" and "Radio Bugs" to whom this article is addrest and who may consider forming such a scientific club may secure some useful suggestions if the writer tells them of such a club which he took the initiative in forming and in which he was greatly interested for several years until a serious fire, which started in an adjoining alleyway, destroyed the club's headquarters, causing him a personal loss of several thousand dollars in apparatus, books, tools, etc., which he had loaned the organization, and unfortunately putting a quietus upon the club's activities.

The *Franklin Experimental Club* of Newark, N. J., was organized January 31st, 1890. The object of the club as stated in its constitution was *"the advancement of its members in scientific knowledge by study and experimental research thru the helpful influence of united effort."*

This modest little club was really the result of the writer's previous unsuccessful efforts made years before to interest certain prominent men in the formation of an Institution in New York City where Popular Scientific Lectures would be given, where there would be a scientific museum of models of historical value, and also containing many working models and instruments, each demonstrating some scientific principle, and each accompanied by an appropriate explanatory card. Keys, push-buttons and switches for operating the apparatus would be supplied and instead of the usual notice everywhere, *"Please do not handle,"* the visitor would be requested to *"handle everything"* and more than this, the proposed lyceum was to have experimental laboratories and workshops where young men without means who showed an aptitude for scientific investigation and were properly fitted and desirous of availing themselves of such opportunities, would be supplied without cost to them with instruments, tools and appurtenances for such work, and could prosecute their studies and experiments under qualified instructors. However, such a plan did not

Another View of the Well-equipt Laboratory, Showing Part of the Chemical Apparatus At Extreme Left. Such a Club Is a Real Asset to Any City Or Town. There Ought to Be 50,000 of Them Right Now.

receive the necessary encouragement. Some years later (1889) while visiting Berlin, Germany, with Mr. and Mrs. Edison, we were shown thru the New "Urania" Museum by the chief director and originator, Dr. Werner Siemens, and the writer saw that here was a small model of the very institution which he had tried previously to establish in New York and he decided upon his return to America to start a scientific club in a small way hoping that its earnest work and actual accomplishments would cause public spirited men to extend it into the original plan he had conceived.

The accompanying illustrations, Fig. 1, 2, and 3, give a fair idea of the exterior and interior of the club headquarters, which the members facetiously dubbed the "Chinese Laboratory" by reason of its occupancy of the premises over Mr. Sing Lee's laundry. The club and Mr. Sing Lee were soon on speaking terms, due among other things to the "high periodicity" of the upset battery jars and chemicals in the club rooms.

The bare beams and walls were covered with heavy paper and hung with many photographs, pictures, diagrams, etc., and later draped with a fine collection of flags of all nations which the writer had collected in his various trips to Europe. A case containing a collection of butterflies, bugs and insects, which he had caught and mounted while an assistant at Mr. Edison's laboratory at Menlo Park, N. J., 1880-1, may be noted in one of the accompanying photos.

One side of the Club room was devoted to electrical and physical apparatus and the other side to chemical apparatus, while work tables and benches ran around the walls and down the center of the room.

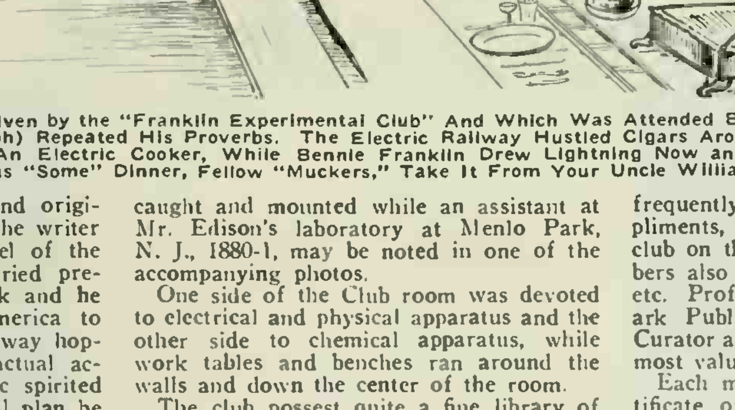
The club possest quite a fine library of technical books and some twelve scientific monthlies, several quarterlies, and a number of weeklies were on file, and it is well to note that publishing and supply houses not only gave the club special rates, but frequently sent us things with their compliments, and certain publications put the club on their free list. The various members also loaned books, instruments, tools, etc. Professor George C. Sonn of the Newark Public High School and the Club's Curator and Historian, was one of the club's most valued supporters.

Each member received a handsome certificate of membership bearing Franklin's portrait.

The initiation fee was $5, and the dues $1 per month. The dues were expended for rent and the purchase of apparatus and supplies. Each member was supplied with keys to the club and access could be had at all times, night and day, and each had a special drawer for his tools, apparatus, etc., and a section of the work bench. All apparatus, tools, books, etc., whether the property of the club or of individual members, were at the disposal of all members and were under the guardianship of the Club Curator.

Lectures and informal talks and demonstrations were frequently given.

The Wonderful Electrical Dinner Given by the "Franklin Experimental Club" And Which Was Attended By Many Notable Guests. Franklin (Thanks to a Concealed Phonograph) Repeated His Proverbs. The Electric Railway Hustled Cigars Around the Table, the Skulls Flashed and Howled, Oysters Sizzled In An Electric Cooker, While Bennie Franklin Drew Lightning Now and Then From the Kite String. It Was "Some" Dinner, Fellow "Muckers," Take It From Your Uncle William.



Obverse and Reverse of Souvenir Medallion of Benjamin Franklin Which Each Guest At the "Franklin Experimental Club" Electrical Dinner Received. A Pleasing Memento.

Experimental Physics

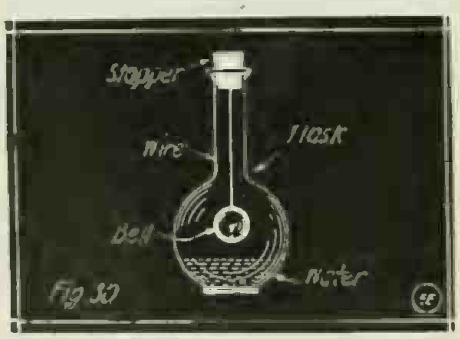
By JOHN J. FURIA, A. B., M. A.
Instructor in Physics and Science Master, Riverdale Country School

LESSON 7.
Sound.

WE all pity the unfortunate person who is born deaf and has to go thru life without hearing a sound. He never has the opportunity of hearing the exquisite music of people eating soup, of the baby next door yowling twenty-four hours a day, of the rollicking ragtime rattle of the square piano downstairs, of the straining of the vocal cords of Miss Nightingale upstairs while she sings the "ahs" and "ohs" and "ees" preliminary to allowing the impresarios fight each other as to who shall have her services at $5,000 per, for the next season's opera. Never does our poor unfortunate hear the strains of Heine's little German Band playing in the back-yard, nor does he hear the harmony of the cat quintet.

The question arises, "if we were all deaf, would there be no sound?" Believing that the world could not possibly get along without the above enumerated soothing sounds, we are gratified that in so far as "Physics" is concerned, the sound really does exist, whether anyone hears it or not. When *we* hear the sound it simply means that the Physical sound is causing a Physiological sensation in us. In everyday life sounds are usually disturbances. Therefore the grouch will be gratified to learn that Physics teaches us that *all sounds are* always *disturbances* (of the air).

EXPERIMENT 40—Place about half a cup-ful of water in a large Florence flask (or thin bottle which can be heated without breaking). Stick a heavy wire thru a rubber stopper which fits the flask tightly, and attach a small bell (such as hangs on pussy's neck to warn the mice that she is approaching) to the end of the wire as in Fig. 30. If now with the stopper tightly in place the flask is shaken, the bell is heard distinctly. Remove the stopper with bell attached and place the flask on a Bunsen flame or stove and allow the water to boil several minutes. Then replace the stopper tightly; allow the flask to cool and when sufficiently cool run cold water over it. If now the flask is shaken the bell will not be heard and if the stopper is not airtight it will be heard only indistinctly. This leads us to the first important consideration that sound will not travel in a vacuum. The clapper hit the sides of the bell in both cases; and if now the stopper is removed and the air allowed to pass into the flask, on shaking, the bell will again ring.



To Demonstrate That Sound Is Conducted Thru the Air and Not Thru the Ether, Try to Make a Bell Ring in a Vacuum.

The question naturally arises, "What caused the vacuum?" When the water was heated the steam from the water displaced the air in the flask and caused the air to leave. As the flask was cooled the steam condensed to water again and if the stopper was airtight since no air could enter to replace the steam, a vacuum was left above the water in the flask. The fact that sound will not travel thru a vacuum and that when a sound is made the surrounding air moves violently, as for example when the automobilist has a blowout, or when an explosion occurs, etc., leads us to the next important consideration, namely, that sound is a disturbance of some medium—usually the air.

As far as Physics is concerned the sound occurs if the air is disturbed, whether there is anyone present to hear the sound or not. On careful consideration one will grant that this is the logical way to look at it, just as one grants that the Sun shines at night even tho *we* do not happen to see it. Light exists while we are in a dark cellar, but we do not happen to be getting the *physiological sensation*. In other words, the question of whether or not a sound exists if no one is around to hear it is identical with the question of whether light exists if we shall all become blind suddenly. The actual *physical* phenomena exist in both cases, and it is the *Physical* phenomena of sound that the Physicist deals with. The Physiologist and Psychologist deal with the sensations which the human being interprets as light or sound.

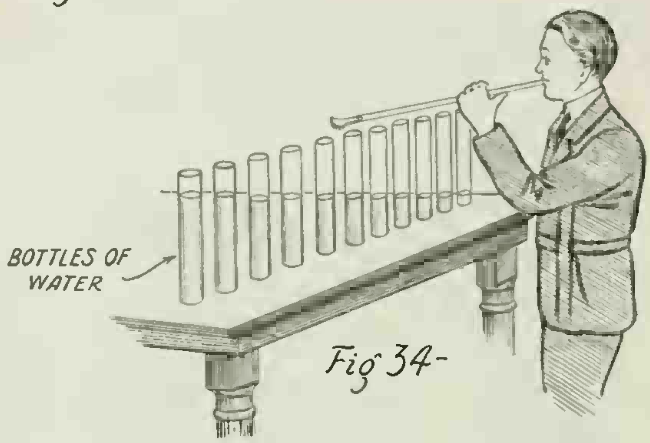
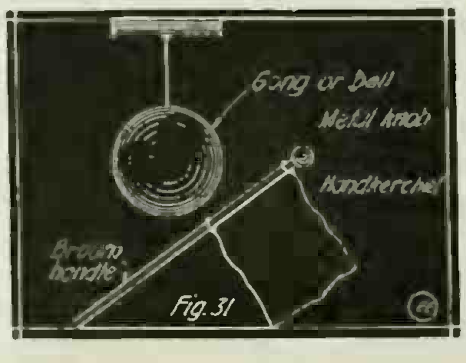
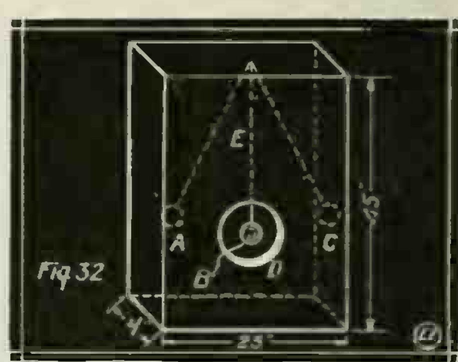


Fig. 33 Illustrates the Well-Known Tin-can Telephone, Which Shows the Principle of Sound Conduction by Means of a Vibrating String. Fig. 34 Shows the Principle of the Organ Pipe. The Air Columns Are Set in Vibration by Blowing Over Them.

EXPERIMENT 41—Everyone has noticed that the lightning flash is seen before the thunderclap is heard. Anyone who has been present when a cannon is fired at a distance from him has noticed that the sound of the cannon is not heard until after the flash is seen. On the other hand if one is close to the cannon the flash and sound appear to occur at the same time. It is evident that sound travels more slowly than light (for all practical purposes light can be taken to travel instantaneously) and it is interesting to measure just how fast sound does travel. Two persons are necessary to perform this experiment, but it is by no means complicated and does not require any elaborate apparatus except a stop-watch, which may be borrowed for the occasion. A piece of metal is attached to the end of a broom handle or other stick and a handkerchief is tied as in Fig. 31. A gong or old bell or a large cow bell such as is used on New Year's Eve, is suspended so as to hang freely. Thirty-three hundred feet is measured out from the gong by use of a tape, or string of known length, or by taking 1,100 paces if your pace is three feet. Your partner stands there with a stop-watch and watches the gong. Standing below the gong you wave the improvised flag from the horizontal position slowly to and past the gong. At the given signal you wave slowly past the gong three times at an even rate of speed; at



A Simple Experiment in Measuring the Velocity of Sound by Means of a Flag, a Gong, and a Stop-watch.



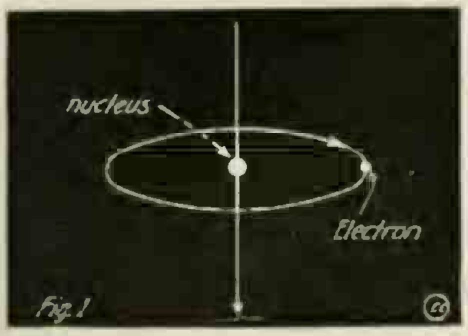
Another Scheme for Checking Up the Velocity of Sound by Means of the "Seconds Pendulum." Sound Travels at 1,100 Feet Per Second.

(*Continued on page* 345)

Manufacturing Magnetism

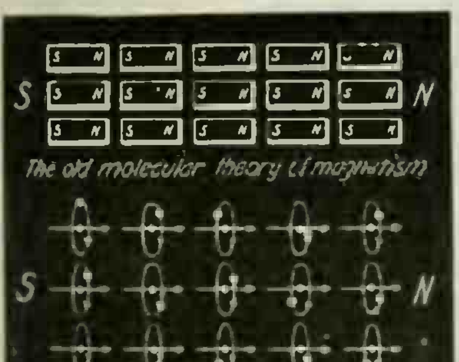
By ROGERS D. RUSK, B. Sc.

MAGNETISM is such a common force today that we hardly ever stop to think how it is made or why we do not make more of it, why we do not use it to sweep the submarines from the sea, or why we



The Old Theory of Magnetism Has Undergone a Revolutionary Change in the Science of To-day. Each Atom Is Now Believed to Comprise a Positive Nucleus or Center, About Which the Negative Particles (Electrons) Rotate At High Velocity.

do not use it to put out of commission the delicate machinery of some distant enemy. In the first place it has never been possible to direct a magnetic field or concentrate it at a distant point. Then iron, our most magnetic element, can only be magnetized to a certain intensity known as the *saturation* value. Further than that man has been producing magnetism in the same old way ever since its discovery by stroking a piece of steel with the pole of another magnet or by placing an iron core in a coil of wire thru which a current is flowing. This latter is the same process by which the magnetism of the motor, the dynamo, the transformer, or the electro-magnet, is produced. A current flows in a solenoid about a core of iron when lo and behold, the iron becomes a magnet. Until lately there has never been another method by which magnetism could be produced except by placing the body to be magnetized in such a magnetic field, either that due

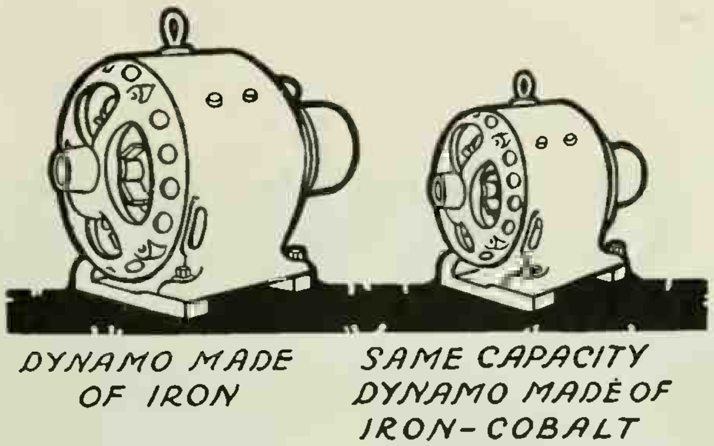


Representation of the Old and New Molecular Theories of Magnetism.

to a solenoid or to a permanent magnet. Recently, however, strange things have been found out about magnetism. Several magnetic alloys have been found which are composed of metals *not* magnetic in themselves. Iron, which was long supposed to be the most permeable substance known, has now been surpast by one of its alloys, and Dr. S. J. Barnett, of Ohio State University, has discovered a totally new method of producing magnetization not dependent on the ordinary electro-magnetic processes, but one the theory of which reaches back to the fundamental constitution of matter itself, and is based upon simple laws of mechanics.

Mother Nature herself has always been the greatest manufacturer of magnetism, for in some strange and mysterious way she keeps a supply permeating the earth all of the time. If the earth's magnetism, weak as it is, could be concentrated at a single point it would be over a trillion times stronger than the strongest field ever produced, and it would pull the largest dreadnaught afloat right out of the water and over the land!

If we could manufacture magnetism in the same way that the earth's magnetism is being continually generated, or if we could find some element or compound vastly more magnetic than iron, industry would be revolutionized, fortunes would be won, science would advance years at a



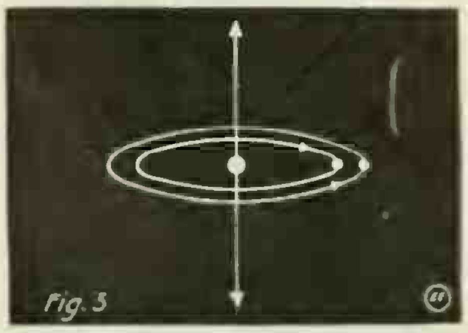
Comparative Size of Two Dynamos, Each of Equal Output, One Made of the Usual Iron and the Smaller One of the New Iron-Cobalt Alloy, Whose Permeability Is 25 Per Cent Higher Than That of Pure Iron.

single bound, inventions would multiply, and warring nations might be at once subdued.

Many attempts have been made to solve the problem of the earth's magnetism and for the most part these have failed because they presented nothing new. In fact, only the most vague and unsatisfactory guesses have been possible concerning its origin, such as that it is due to static charges carried about by the rotation of the earth, and thereby acting as a magnetizing current; or that it was induced by some heavenly body.

The earliest method of producing magnetism was, of course, by rubbing with the lodestone or natural magnet. This was a slow way at best, and magnets of great strength were not made until after Oersted had discovered the magnetic effects of an electric current. Up to this time it has scarcely been suggested that there was any close relation between electricity and magnetism, but shortly after Oersted's discovery electro-magnets of huge size were constructed, and we read of one constructed by Henry in America which was capable of lifting a ton weight. Nowadays commercial lifting-magnets are made much more powerful still.

The intimate relation between electricity and magnetism is now well known, and it

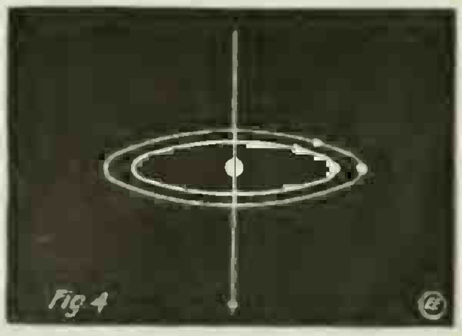


Showing How the Electrons Revolve About the Nucleus In Opposite Directions In the "Non-Magnetic" Atom.

was upon a further study of this intimate relation that Dr. Barnett was led to conclude that a bar of iron could be magnetized by simply rotating it. His results show his assumptions to be true and these give us many new ideas concerning the nature of magnetism and even suggests a totally new theory concerning the magnetism of the earth itself.

The theory of magnetization by rotation, tho of deep scientific interest and one which reaches back to the very structure of matter itself, is not at all hard to understand.

Everyone knows that a spinning top stands upright without visible support, due to its motion. In the same way a gyroscope, which is nothing more than a wheel revolving about an axle, will retain its horizontal position and if displaced will return to it. Now if a bushel basket full of gyroscopes all of them running, was suddenly started revolving, all the gyroscopes would line up with their axes parallel to the axis of rotation of the basket, and all would point in the same direction. That is the secret of Magnetization by rotation, only in the case



Structure of the "Magnetic" Atom, Wherein the Electrons Act Together.

of a rotating piece of iron, the gyroscopes are the atoms themselves, and because each atom acts as a little elemental magnet; when they line up the bar is magnetized. The only

(*Continued on page 355*)

A Remarkable Amateur Radio Station with a Record

By A. F. PENDLETON

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 equipt 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 thruout the country, who will be benefited by up-to-date wireless articles treating on both the transmitting as well as receiving equipment. Remember! that you must not connect up radio apparatus to any form of antenna.—The Editors.*

THE accompanying photographs show radio station 2PM, owned and operated by Messrs. Faraon and Grinan of New York City.

This station has (prior to the war) repeatedly establisht new records for long-distance work. In February they succeeded in communicating directly with station 9ZF, in Denver, Colo., and a few weeks later they were reported being heard in Los Angeles, Calif., by Mr. J. B. Farrington of that city. To our mind this is wonderful work, since at no time did they use more than 450 *watts input*. Their wave length was 200 meters and decrement .09, as tuned by the radio inspector.

During March they handled 400 messages, most of which averaged over 1,000 miles. This also included a message sent from Seattle, Wash., to them *via* but one relay station, 9GC in Grand Forks, N. D.

The author recently made a trip as operator on the S. S. *Manchuria* and heard 2PM's signals six days out. We were then 2,100 miles East of Nantucket. The author was using a single vacuum valve detector.

Mr. Lebowitz, senior operator on the S. S. *Ancon*, has reported that he heard 2PM's signals while lying at anchor in Colon, Panama, on a galena detector.

Operator Grace of the S. S. *El Sol* and Frank Attwater of the S. S. *Pastores* have both heard 2PM while in Havana harbor.

The author visited their station a number of times and noticed that the way in which they handled traffic, even thru the worst kind of interference, was remarkable. The efficiency of their installation should be a goal for all other amateurs.

Mr. Grinan operated old "N. Y.", 42 Broadway, and was also at the Sayville trans-Atlantic station during 1914. Mr. Faraon on a recent trip to France operated the Eiffel Tower station in Paris for seven months.

On February 6th last, they were the starting point of the epoch-making trans-continental message. It took exactly one hour and twenty minutes for them to receive an answer to their message addrest to 6EA of Los Angeles, Calif.

Speaking of Real Amateur Radio Stations, Here's One That Was Operated With Extreme Success by Messrs. Faraon and Grinan, in New York City. Records, Did You Say? Well, They Were Heard 2,100 Miles Away by a Commercial Ship Operator on One Occasion. That's "Class" on 200 Meters and 450 Watts Input.

We know of many commercial stations that are envious of the records made by these men during the past year.

Herewith is a list of stations with which 2PM has worked before the war:

Stations Worked by 2PM.

8AAK	9AAB	9WG
8AEZ	9AAR	9GC
8AFO	9ABD	9WO
8AHN	9ALM	9XM
8ALE	9AU	9ZL
8AMG	9BJ	9ZN
8AOF	9CF	9ZF
8ARH	9DB	
8ASG	9DC	1ASE
8CO	9DK	1ASR
8CS	9EG	1DK
8ED	9GJ	1IZ
8EG	9GY	1SJ
8JA	9HQ	1VN
8JX	9IC	
8IZ	9JI	3AEP
8LE	9KR	3AFA
8NH	9AFG	3AK
8PA	9LR	3ATR
8OB	9NN	3NB
8OK	9NW	3NG
8VP	9ON	3PC
8VX	9PC	3UF
8XE	9PF	3XJ
8YI	9PI	3ZS
8YO	9QR	3WM
8ZP	9RW	
	9VY	2AGJ

U. S. SEIZES POWERFUL RADIO.

A powerful wireless outfit, valued at $10,000, was confiscated recently and a man, said to be Edward Clay, was arrested by United States secret service agents about four miles west of Greenfield, O.

The secret service agents found the apparatus strung from two big oak trees.

SOUTH AMERICAN INDIANS HAD RADIO IN 1898.

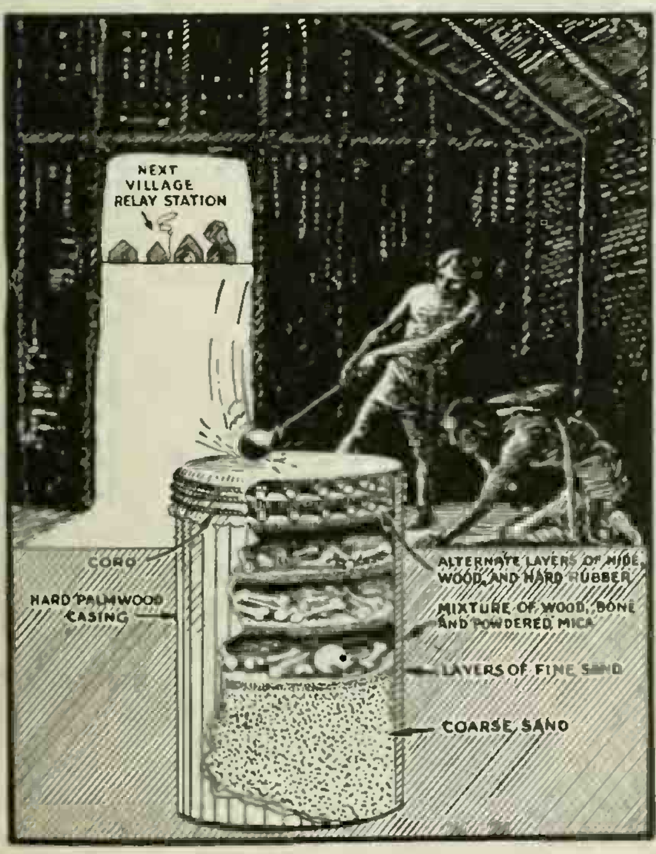
In these days of wireless telegraphy it may be interesting to learn that as long ago as July, 1898, there was recorded the discovery of a wireless telegraphic apparatus in use among the Catuquinaru, an Indian tribe of the Amazon valley in South America, says a writer in the *Geographical Journal*.

The apparatus, called *cambarysu*, consists of a hole in the ground about half filled with coarse sand; above this layers of fine sand, fragments of wood and bone, and powdered mica fill it almost to the surface of the ground. These materials are surrounded by a case of hard palm wood, which extends above the surface. The upper part of the apparatus consists of layers of hide, wood and hard rubber, arranged in the manner shown in the accompanying illustration below.

Between the upper layers and the lower layers there is a hollow space. With a club, much like the stick used to play the bass drum, the native strikes the layer of rubber that forms the top of the instrument.

One of these instruments is concealed in each hamlet of the tribe. The villages are not more than a mile apart, and are placed in a direct North-and-South line. Altho a person standing outside the building in which the apparatus is kept cannot hear a blow of the stick on the rubber top, it is quite distinct in a similar building a mile distant. When one of these instruments is struck, the neighboring ones to the North and South echo the blow. The Indian stationed at each one of the posts answers the signal, and by means of code messages a long conversation may be carried on.

An electrical process is being tried in Russia for the manufacture of gold leaf, heretofore made only by hand.



As Far Back As 1898, the South American Natives Had a System of "Wireless Communication" Working. It Employed Sound Waves Propagated Thru the Earth.

PUEBLO, COLO., NAVY STAFF STARTS RADIO SCHOOL.

Spurred by the need of the navy for several thousand radio operators, members of the Pueblo naval recruiting staff have, of their own initiative, arranged to start a school in wireless telegraphy. Classes will be held at the naval recruiting headquarters starting very soon. Charles T. Randall, head of the station, and H. T. Rainey, one of his assistants—both men graduates of the U. S. naval radio service course at Mare Island near San Francisco—will be the instructors.

The course will be free of charge. It will be open to young men between the ages of 18 and 25 years, tho in special cases men up to 30 years of age and approaching 18 will be accepted.

The navy is now in urgent need of wireless operators. Every ship which crosses the Atlantic now must be provided with them. The great merchant fleet of 1,000 ships being built by the United States Government to beat the German submarine blockade must be supplied with naval radio operators and gunners. In addition there are some 300 submarine chasers which will have to be supplied with operators by fall. Many ships of various other kinds are now in the service or will be placed in the service in the near future.

All of these must have naval radio operators.

The men who may be enrolled as landsmen for electrician (radio operators) must be able to receive at least ten words a minute in the continental code legibly, spell correctly at the rate of 25 words per minute and have a grammar school knowledge of arithmetic.

Randall and Rainey will give the instruction an applicant needs to qualify for enlistment as an operator. They estimate that the average man should master this end of it inside of three weeks. Then, if he qualifies for enlistment in other regards, he will be sent on to one of the three training schools for wireless operators—Harvard, Mare Island, or the New York school in the Brooklyn navy yard.

Three of four months' training should make a man able to handle an instrument in the naval service. Thus, inside of three or four months, a man should be able to get into actual service on some craft of the United States navy. He might be detailed to a submarine chaser and go thru with the tense excitement of hunting out the German sea sharks off the British Isles or the coast of France. Or he might be put on one of the great merchant fleet ships which will run the submarine gauntlet. Or again be assigned to one of the U. S. battleships.

In addition to affording a chance for all kinds of wild adventure in the radio service inside of a short time, it is one of the most desirable branches of the naval service, all of the grubby and disagreeable work which falls to the lot of an ordinary seaman being eliminated.

The radio operators, third class, will receive $32.60 per month and all expenses; second class, $52, and first $61.

SENATOR MARCONI ENCOURAGES WOMEN'S WIRELESS CLASS.

The accompanying photograph shows the women's wireless class of Hunter College, New York City, and Senator Marconi of the Italian Commission in a special pose at the Hotel Ritz-Carlton, where the Senator received the girls.

The women are studying to become radio operators for the Government. The class was organized before the war was declared and now has one hundred and twenty-five women enrolled. The students are now taking the more intensive course at the Marconi School. Senator Marconi talked to the women on their work as an aid to the Government in war time.

Photo © by Underwood & Underwood

Senator Guglielmo Marconi on His Recent Visit to New York and the Young Women Radio Students of Hunter College to Whom He Gave Important Advice as to the Future, as Well as the Military Advantages of Radio-Telegraphy.

U. S. SIGNAL CORPS WANTS ELECTRICAL AND RADIO MEN.

Still the cry comes for more men! You young fellows hanging on the outside of things in these stirring days don't seem to grasp the opportunities that are being offered you in the U. S. Signal Corps.

How the New York Division of the "Signal Corps" Exhibits Radio Apparatus to Drum Up Recruits.

At the Right We See a New York Street Exhibit Where the Omnigraph Clicks Off the Dots and Dashes to Future Soldiers.

The Signal Corps needs men and needs them badly, so if you are qualified in any branch of the work just step up and be one of the boys to "do your bit."

A large school has been opened at Pratt Institute, Brooklyn, to give training to young men in Radio work, and all men enlisting are immediately transferred there to receive a complete course in Radio Telegraphy.

The Corps is using many interesting and novel ways of street advertising and two illustrations are here reproduced showing some of these stunts. The field radio pack set is on exhibition at Times Square, New York City, and is drawing quite a number of worthy lads to the service. Recruiting offices have been opened all over the country for this branch of the service, including New York, Philadelphia, Rochester, Baltimore, Richmond, Ithaca (where aeronautics is taken up with this work) and Pittsburgh.

One of our illustrations depicts an omnigraph attached to a small electric lamp bulb. The telegraphic flashing off and on always draws a big crowd of men and boys, who gasp in astonishment at the unfamiliar signaling apparatus.

As soon as a bystander manifests the slightest interest and starts asking questions, one of Uncle Sam's smart khaki clad soldiers gets busy and explains the many advantages of the service to him.

The main offices for the Eastern Division are at 39 Whitehall street, New York, and all communications and inquiries should be addrest to Major Henry G. Opdycke, who is in charge of recruiting in New York City and vicinity.

It's up to you, so show your colors!

DeFOREST LOSES "AMPLIFIER" AND POSSIBLY "OSCILLION" PATENTS.

Judge Julius M. Mayer found the following on July 11, for the Marconi Company, plaintiff, against the de Forest Radio Telephone and Telegraph Company, defendant:

"This is the return of an order to show cause why the decree and injunction heretofore made and issued does not cover and include certain devices which defendant makes and sells and why the reports already filed *should not be extended to include such devices.*

"The devices in question are called 'amplifiers' and 'oscillions.'

"In the first place, this procedure is correct. It has frequently been followed in this court and, as I understand, approved by the Circuit Court of Appeals.

"The opinions of the Circuit Court of Appeals and of this court on the main controversy so fully discust the essential features of the patent and the infringing device that it must be assumed that the litigants are, by this time, fully informed of the views of the two courts. As in the original case, there is again the use of 'Audion' language, which is more or less meaningless from the standpoint of the patent law and certainly does not add to a clear understanding of what has now become reasonably simple, even in an abstruse art.

"1. An *amplifier* consists really of two or more detectors in tandem with a telephone transformer interposed between each element of the series. The primary element of such an amplifier may be either an Audion or any other form of detector. In some of the amplifier sets sold by defendant, the primary element is a part of the outfit. In other instances, the primary element is not part of the outfit.

"I fully agree with Waterman on his facts and explanation as to the 'amplifier'. In other words, an 'amplifier' is part of a detector. In any event, the case falls under the familiar rule of Roberts v. Ryer, 91 U. S. 150, 157, many times since reiterated and followed. I have no doubt whatever that the motion in this regard must be granted.

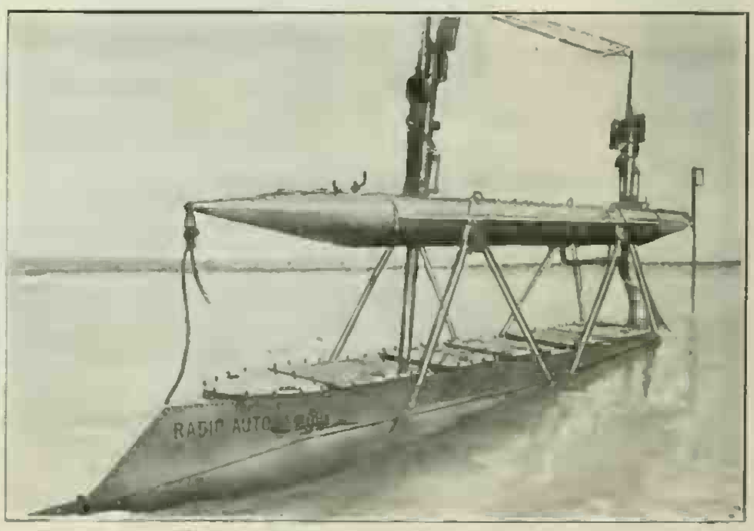
"2. I am not clearly convinced that the Fleming valve can perform the functions of an 'oscillion' so as to oscillate and generate radio waves. On this branch it will be necessary to give demonstrations or oral testimony or both and witnesses should be subject to cross-examination. This is really equivalent to a trial. My view is that where the court on an application of this kind is not clearly convinced that the motion should be granted, then the proceeding should be by bill and answer, because the inquiry necessarily develops into a trial, and, therefore, the issues should be clearly joined. There is usually little saving of time or labor in short cuts.

"The motion, therefore, as to 'oscillions' is denied."

A FRENCH RADIO CONTROLLED TORPEDO.

By Frank C. Perkins.

The accompanying illustration shows a remarkable French automatic wirelessly controlled torpedo on the River Seine. The control of this torpedo from a distance is accomplisht by a wireless operated valve supplying compress air to the motor. To turn the torpedo one way or the other the rudder is moved by two solenoids controlling the air valve by means of different wave lengths. To steer the torpedo to the right one set of wave lengths are used, the coherer acting on the proper solenoid and operating the air valve turning the rudder in that direction. To turn the rudder so as to swing the torpedo to the left, another similar mechanism is used which works on another wave length. At the wireless controlling station there is checking and tally apparatus.



A French Radio-Controlled Torpedo. Such Devices as These, If Made to Resist Enemy Radio Interference, May Prove One of the Deciding Factors in the World War.

PORTABLE WIRELESS REPORTS CALIFORNIA "WASH-OUTS."

By Charles W. Geiger.

During the annual rainy season in Southern California, a wireless outfit is sent out in all directions to report the condition of the roads and various bridges that may have been washed out.

The wireless outfit is mounted on a 1½-ton motor truck. The equipment consists of field telephones, switchboards, relay coils, guys, metal pins, aerial and demountable poles, head sets, telegraph keys and other equipment. The truck made 30 miles an hour on good roads. It carried a company of 15 men. The following is a copy of a wireless report from the expedition: "*Roads open Bakersfield Castaic Wash quick sand dangerous cars sinking to frame passable towed county team Ridge route passable from end State highway to Castaic rough dangerous Bakersfield reached Bouquet canyon Elizabeth lake rough thruout deep ruts bogs Mint closed (Signed).*"

In California They Have Developed a New Use for the Radio. During the Rainy Season a Portable Radio Outfit Is Sent Out to Report the Road Conditions.

MISS SYDNEY SHIELDS, WIRELESS OPERATOR.

Miss Sydney Shields, the little leading woman who was recently seen in "The Case of Lady Camber," is the very first woman of the stage to have completed a wireless telegraphic course. She is now ready to enlist in the Signal Corps of the United States Navy. Wanting to be especially efficient in the field she has chosen to serve her country, Miss Shields has taken a post-graduate course in the various other ways of marine signaling —by means of flags and semaphores, Ardois lights and "blinkers." Just now she is intensely interested in the new means of communicating on the high seas with "smoke signals," which are electrically operated, according to the Morse code.

"Although it may seem wicked to say so," said Miss Shields, "I have never had such a good time as since war was declared. When I was a youngster my greatest regret was because I was a girl instead of a boy. I wanted to be a sailor."

A high barbed wire fence now surrounds the United States radio station at North Head, Wash., and the strands of wire are heavily charged with high-tension electricity.

The Present Status of the Audion

By Dr. LEE de FOREST

NOW that the U. S. Circuit Court of Appeals has refused to reverse the lower Court's finding that the Audion is an infringement of two claims of the Fleming Valve patent, a brief review of the facts brought out in the trial will be of interest to all radio men.

First of all it was shown that both Fleming and de Forest utilized the *Edison effect*, or the incandescent lamp with a cold electrode—Fleming as a rectifier simply and solely, connecting the cold electrode, always and invariably, to the negative of the filament battery; that this rectifier was inferior to any ordinary crystal rectifier, and has never been used in commercial wireless signaling; incidentally that Fleming claimed in his patent that he *had discovered* this rectification phenomenon, quite forgetful of Edison, Howell, Wehnelt, etc. Further, that de Forest was the first to disclose the use as a wireless detector of the heated electrode in gas—at atmospheric or rarefield pressure; that by the addition of the *B-battery* in the telephone circuit a genuine relay (as distinguished from the rectifier) effect was obtained, of much greater sensitiveness; that two years after de Forest's disclosure of the Edison lamp relay detector with *B-battery*, Fleming recognized the *new way* as he styled it, in which this incandescent lamp detector can be used, and patented a form of *B-battery* "valve" of which some 200 were used; that long prior to this "discovery" de Forest had introduced the third, or *grid* electrode, which at once placed the Audion in a class by itself; that this grid principle and numerous improvements which de Forest and other inventors had brought out from time to time had made possible the reliable trans-oceanic telegraphy, trans-continental telephony (wire and wireless), the Audion Amplifier of low and high-frequency currents, the Ultraudion, or self-heterodyning detector, the Oscillion or generator of undamped waves of any length; that tens of thousands of grid Audions have been, and are in use by every Government in the world; that the present state of our U. S. Navy Radio Service, and of the Radio Art itself, could not exist without the Audion; that the Fleming valve (as disclosed in his U. S. and Foreign patents), had contributed nothing whatever of utility to the art, and has evolved not at all; that the rectification effect on which the valve must absolutely depend (ceases) when both electrodes are heated; that the Audion effect on the other hand is unaffected whether *one, two or three electrodes are incandescent;* that any rectification effect, if existent at all, is wholly *parasitic* and of no effect in the genuine relay and extraordinarily sensitive actions which make the Audion so immensely practical.

However, and largely due to the clever and fact-defying feats of the Marconi expert, all the above considerations availed nothing to convince the Court that a very great injustice would be inflicted by granting to the inutile Fleming patent, domination over what all unbiased scientific minds the world over have come to regard as one of the most radical and practically valuable devices yet discovered in the art of signaling, by wire or wireless. Truly—"the Shadow dominates the Substance."

This Audion patent case is on all fours with that of the famous Selden automobile patent, but with this immense difference: the Court there, while finally sustaining the visionary and impractical Selden patent as *basic*, so limited its applications that its owners were no longer able to extort tribute from those who had actually developed the gasoline-engine-propelled vehicle of commerce.

Early in the Audion trial the Marconi Wireless Telegraph Company confest the validity and their infringement of the de Forest grid and amplifier Audion patents, and are now perpetually enjoined from these patents. They are at present endeavoring to avoid this hardship by developing an Audion with the grid member on the *outside* of the glass, in defiance of the de Forest Patent No. 841,386; but due to the present inferiority in sensitiveness of this to the *interior* grid Audion, they have not yet used the device in practise. They were also forced to file a disclaimer in the Patent Office, limiting their claims to *high-frequency* currents—as otherwise all their claims were invalid on their face, in view of Edison. For ten years those claims have thus stood obviously invalid and un-menacing to a rapidly developing Audion art.

To those familiar with U. S. Courts of Appeals in patent causes, the recent sustaining of the Lower Court's finding in so highly technical a case detracts nothing from the true merits of the Audion as against the "valve." It is the consensus of unbiased opinion of those acquainted with the facts that an opportunity to correct a grievous injustice has been regrettably lost by this court.

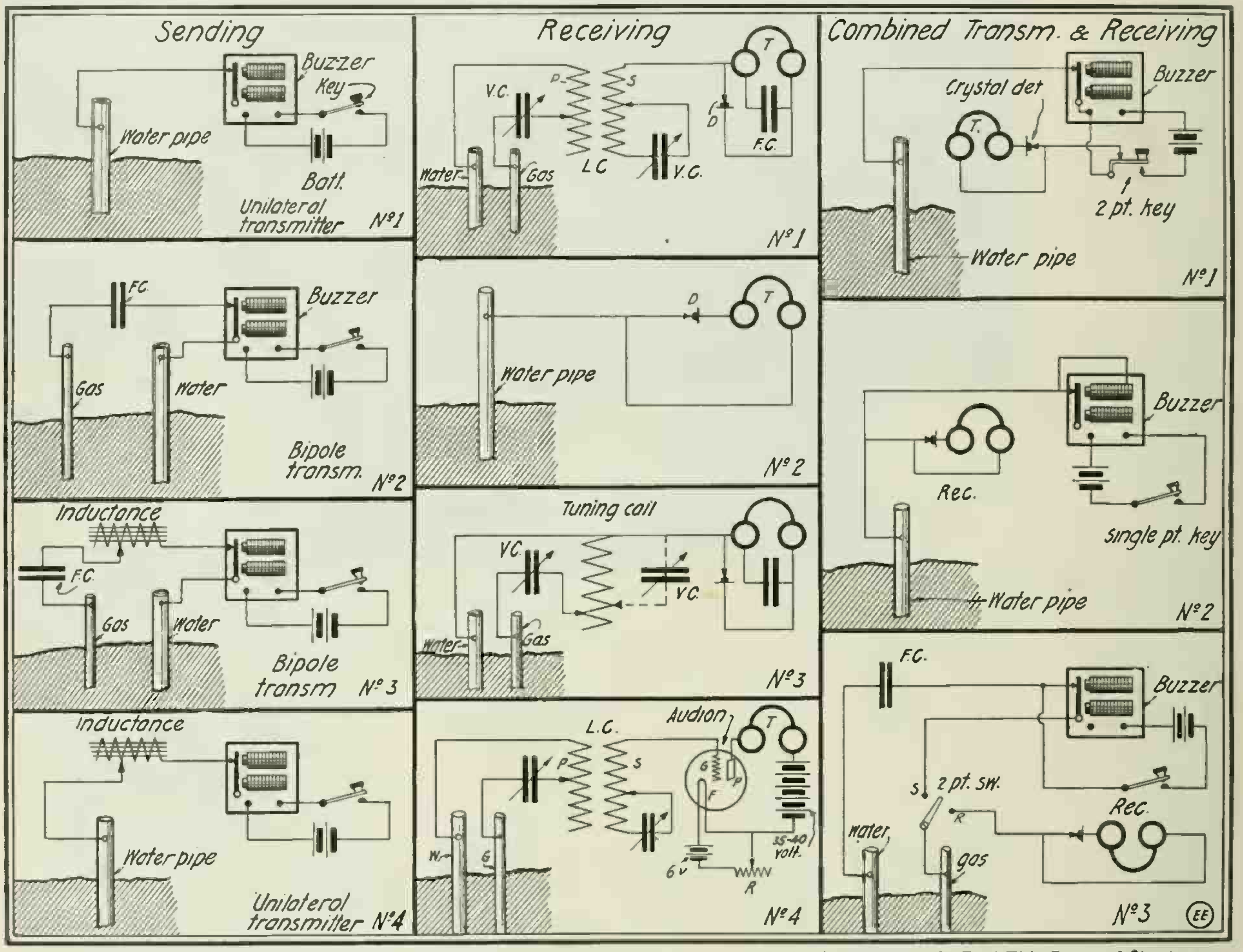
"Radio"-Communication Over Gas and Water Pipes—"Wired Wireless"

We have been careful in studying the various phases embodied in this article, and it is our opinion that amateurs may now find a good as well as practical use for their outfits. Let it be understood that the ideas set forth in this article, do in no way violate the President's order, as no radio waves are either radiated in free space (ether), nor can outside radio messages be received with such outfits. From this it follows that "Wired Wireless" is nothing but a modified telegraph wire line. The "wire" in this instance being the gas or water mains.

By means of this system, amateurs should be enabled to cover modest distances by relaying messages from house to house or from block to block. This should keep them in trim until such time when we will be allowed to send and receive real radio messages.

THE radio amateur has undoubtedly in many instances felt that all was lost after amateur and experimental radio stations thruout the country had been closed by order of the President. In the following paragraphs there general is to utilize the ordinary buzzer, such as commonly used for signaling purposes in place of bells, etc., as the reader will perceive from the diagrams here given.

Referring first to the sending circuits, an ordinary buzzer is utilized thruout in ture terminals of the buzzer, interposing a small fixt condenser in series with one of these leads to prevent short-circuiting the buzzer coils. This is a more efficient type of transmitter than that shown in Fig. 1.



"Radio-bugs" Who Are Grieving Their Hearts Away Because They Cannot Use Their Radio Apparatus, Will Find This Group of Short-range "Wired Wireless" Hook-ups of Interest. A Buzzer Transmitter Is Employed and a "Unilateral" Receptor.

are given a number of new ideas which it is believed the radio amateur will find of considerable interest under the present stringent conditions governing all such work.

The general scheme here outlined is to carry on *short-range communication* by means of radio apparatus of *extremely low power*, and with which it is not possible to transmit or receive messages over a distance exceeding a few city blocks or possibly one-quarter of a mile.

The circuits shown are presented in three different groups under "Transmitting," "Receiving," and "Combined Transmitting and Receiving Hook-ups." The idea in Figs. 1 to 4. In Fig. 1, there is shown a low-power buzzer transmitter, a connection being establisht between the water pipe (or a piece of pipe or other metal driven into the damp earth) as indicated. This connection being known as *unilateral* excitation. It should be used wherever a short distance of a few hundred feet is to be covered, so as to not create any undue disturbance or interference with other stations which may be using a similar transmitter.

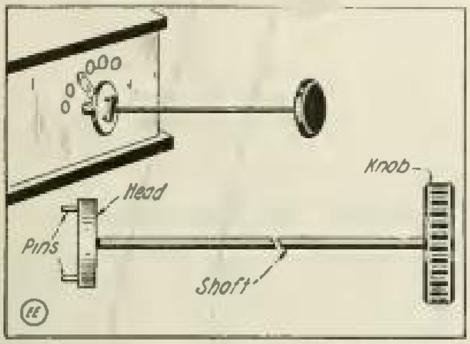
The buzzer transmitter shown in Fig. 2 represents a *bipolar* transmitter, connections being establisht between the gas and water pipes to the contact screw and arma-

Diagram Fig. 3 shows a *bipolar* buzzer transmitter, connected to the gas and water pipes with a fixt condenser in series with one of the leads, and also utilizing an extra *kicking* inductance in one of the exciting leads. This inductance may consist of a soft iron wire core, about ¾ inch in diameter by 6 inches long, wound with several layers of No. 16 insulated magnet wire. The inductance coil tends to intensify the radiated current by the self-inductance action of the coil and iron core. Fig. 4 shows a *unilateral* connection of buzzer with inductance coil.

(*Continued on page 332*)

A CONTROL HANDLE FOR UNDAMPED WAVE TUNERS.

In the handling of super-sensitive undamped wave apparatus, the operator is put to a great deal of inconvenience by the fact that the proximity of his hand to the apparatus has a marked effect upon the operation.



To Prevent "Body" Capacity Interfering With Undamped Wave Audion Tuning Use May be Made of This Extension Handle.

To overcome this annoying and time consuming condition, there is a scheme whereby the knobs of the control are extended as far from the set as is necessary to keep the operation of the set stable. This plan, while effective, disfigures a neat appearing set, and takes up valuable room.

To secure the advantages of the above plan, at the same time doing away with the disadvantages, the author devised the controller shown in the sketch, which is self-explanatory. The entire device should be made of Bakelite, hard rubber or fiber, with the exception of the pins, which may be of brass. The knobs of the set have two small holes drilled in them to receive the pins. These holes need not be very deep, and will not mar the appearance of the apparatus in the least.

In operation the device is used for fine or close adjustments. The set is roughly tuned to the incoming wave in the usual manner. Upon removing the hand, the signals often die completely out. Then by using the controller, the signals are brought back to their original loudness.

The hard rubber rod should be not less than twelve inches long. With some sets two feet may be necessary.

Contributed by C. S. ROBINSON.

TRY THIS ON YOUR "VICTROLA."

Most of "us amateurs" who are still without Audions can make use of their pet phonograph to receive undamped waves. Where no motor is available to drive the *tikker*, cut out a metal disc about 10½ inches in diameter, having picks evenly spaced about the circumference, ⅛ inch apart. When the phonograph is not otherwise engaged, put on this new *record* and use it as a circuit-breaker in place of the ordinary crystal detector in the receiving circuit. Try it—it works!!

Contributed by F. C. HAMILTON.

A Toothed Metal Disc Driven By a Phonograph Motor So As to Interrupt the Condenser Circuit Rapidly Provides a Serviceable "Tikker."

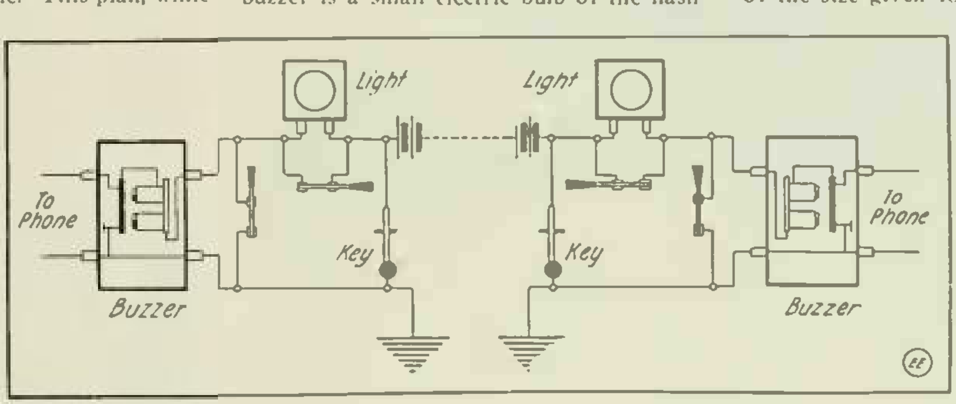
AN EFFICIENT SCHEME FOR LEARNING THE CODE.

To learn the code well, altho not difficult, requires considerable and attentive practise. Very often the beginner claims he knows the code well, giving as proof his ability to send. The proof, however, should be his ability to receive well and the impatient learner usually fails in this attempt. Confusion, the cause of this, is the result of the incoming signals not being impress sufficiently upon his memory to respond quickly. His efforts should therefore be directed to methods more suitable than the ordinary sound signals.

Referring to the accompanying sketch, the lead wires lettered "to phone" are taken from the stationary contact and armature of the ordinary buzzer. In series with the buzzer is a small electric bulb of the flashlight type. By enclosing the light in a small box which supports in front of it a small transparent screen of a gray color, the persistence of vision on the retina of the eye will not be effective to such a degree as to interfere with the proper reception of signals. The buzzer should be adjusted to a high pitch and packed in a box with cotton. Four dry cells, two at each end of the line, will provide current enough for several hundred feet. The operation of the line is as follows:

When receiving, the beginner should look attentively at the gray screen in front of the electric bulb. The receiver should be held on his ear by the customary head-band and may be of the seventy-five ohm type. When the key is deprest at the other end, he will not be confused, as the light and buzzer will act simultaneously in their action on his mind in the same manner that persons speaking naturally convey their meaning by facial expression and words, the two always acting in harmony. By means of the cut-out switches shown, any one of the instruments at either end of the line may be used.

Contributed by JOSEPH BRAFF.

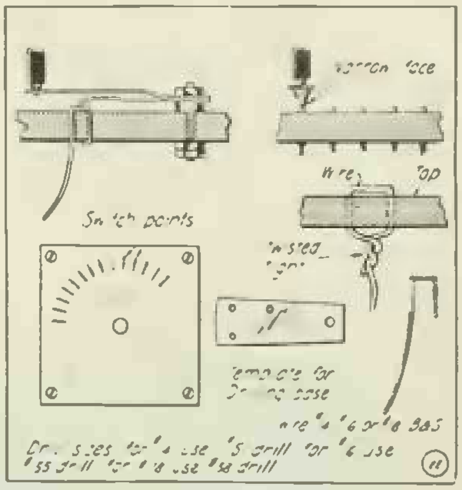


With the Arrangement of Lamps and Buzzers Shown, the Telegraphic Signals Are Imprest on the Student's Mind Both Visually and Aurally.

PLACING LARGE NUMBER OF SWITCH POINTS IN SMALL SPACE.

For use where a large number of switch points are necessary in a small space, or where the regular switch points are geographically or financially out of reach, this switch is recommended. Forty-eight of these points can be put in a two-inch circle with as much or even greater separation between points than is usually allowed.

The template is another thick piece of metal. The stud for the center hole of the switch is soldered fast to it, and three holes, of the size given for the different sizes of wire, drilled in the outer end. In making a switch, the stud is inserted in the central hole of the base and the first hole drilled. Put a pin (a phonograph needle) through the template into the base in this hole and drill the next pair. Then move the template so that the pin will enter the outer hole of the pair just drilled, and drill the next pair; continuing in this manner until the required number have been finished.



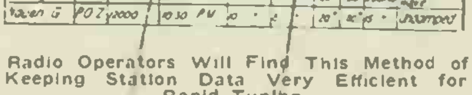
This Scheme Proves That There Is a Way to Get an Unusually Large Number of Switch Contacts in a Small Space.

This method insures a true, evenly spaced switch, without use of dividers, or laying out the switch base, marking it off, etc., and when carefully made the switch is a neat and very efficient article. Enameled wire may be used for the points, and cleaned off on top with sand or emery paper, after the switch is finished. The wire is best twisted several times on the back of the base or panel, so as to ensure its remaining in place permanently. Tap leads from coils may be soldered to the twisted wire stubs. The idea is very useful in building miniature loose couplers.

Contributed by C. E. P.

RADIO STATION CHART FOR TUNING DATA.

The chart here shown will prove useful in any wireless station for keeping a record of the setting of the instruments. It saves time and patience as one can tune any station on the minute providing it is recorded on the chart. Such a chart will also show how far you can receive.



Radio Operators Will Find This Method of Keeping Station Data Very Efficient for Rapid Tuning.

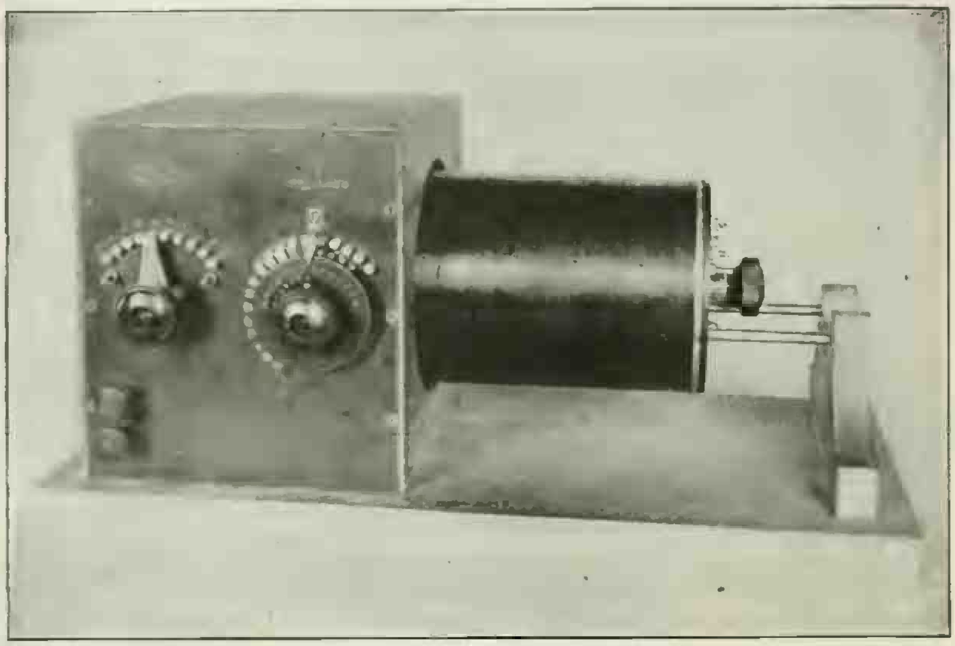
Contributed by MAURICE L. MUHLEMAN.

Calculation and Measurement of Inductance

By H. WINFIELD SECOR AND SAMUEL COHEN

PART 3 (*Conclusion*)*

HAVING thoroly discust the methods of both calculating and measuring the inductance of coils, we are now in a position to continue with the design of the most important type of inductance coils used in radio work. We will confine ourselves to the types of coil which are mostly used, namely—loading inductances, loose couplers, variometers and transmitting oscillation transformers.



A Modern Long Wave Loose Coupler Provided With Dead-end Switches. To Ensure Accurate Inductance Adjustments in Any Case, All Switch Connections Should be Mounted on Hard Rubber or Bakelite. A Large Loose Coupler Is Usually Superior To a Small One and a Loading Coil.

Before we delve into the actual design of these coils, let us first consider the first fundamental facts necessary for the design. Since the inductance is employed in building up the proper oscillating condition of the circuit and consequently the wave length, we can express this relation by the following formulæ:

We have first the formula expressing the wave length, *W.L.*, of the open (antenna) oscillatory circuit, thru the primary, L_o, of a loose coupler, loading or tuning coil.

$$W.L. = A\sqrt{L \times C}\,; \qquad (1)$$

where:—

A = a variable, ranging from 38.15 to 59.6 for short wave lengths. (See curves for various values of "*A*" in article above cited, in February, 1917, issue.)

L = total inductance in centimeters of aerial, including lead-in and loose coupler, tuning coil or loading coil.

C = capacity in micro-farads of aerial, including lead-in.

Those interested in this subject should refer to the excellent article on "The Design of Large Radio Receiving Transformers," by C. S. Ballantine, in the February, 1917, issue of this journal, page 732. The variable factor, 59.6, appearing in the usual wave length formulæ was there discust at length, with a graph giving the different values of this function for various wave lengths and aerial inductance to localized inductance ratios.

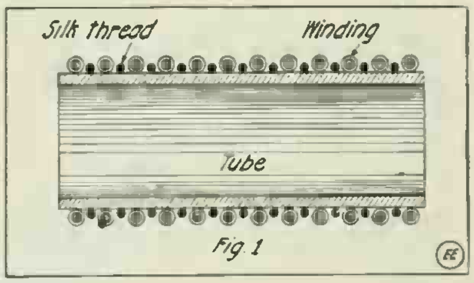
Considering long wave lengths (10,000 meters and higher) and the design of large loose couplers, we are safe in using the expression:

$$W.L. = 59.6\sqrt{L \times C}\,;$$

where:—

L = inductance of loose coupler primary and loading coil (if used); the inductance of the antenna being neglected, owing to its small value compared to the inductance of the loose coupler (or loading coil).

C = capacity of antenna, including lead-in.



One Method of Winding Radio Inductances Involves the Use of a Thread Spun on Between the Turns.

For designing short wave apparatus we shall call L_o the value of the loose coupler (or tuning coil) primary inductance. Then we have:

$$L_o = \frac{\lambda^2}{3552 \times C} - L\,; \qquad (2)$$

here:—

L_o = inductance of load (loose coupler, tuner, etc.), in centimeters.

λ = maximum wave length to be tuned to.

L = inductance of antenna and lead-in in centimeters.

C = capacity of antenna and lead-in in micro-farads. (See tables herewith for these values.)

For long wave apparatus, let L_o represent the loading coil inductance, plus the inductance of the loose coupler primary (or tuner, if used). Then we have the formula:

$$L_o = \frac{\lambda^2}{3552 \times C}\,; \qquad (3)$$

with all values the same as in formula No. 2.

The following tables will be found useful in applying the above equations to the design of loose couplers, etc.

TABLE "A"

Cap. in M.F., Including Lead-in, of 4 Wire Inverted "L" Aerials. Wires Spaced 3 Ft. Apart

Height in Feet	Length of Flat-top in Feet 60	80	100	120
40....	.00033	.00042	.00051	.00060
50....	.00035	.00043	.00050	.00058
60....	.00036	.00044	.00051	.00059
70....	.00037	.00045	.00052	.00059
80....	.00039	.00046	.00053	.00060
90....	.00040	.00048	.00055	.00061
100....	.00042	.00049	.00056	.00062

TABLE "B"

Inductance in Cms., Including Lead-in, of 4 Wire Inverted "L" Aerials

Height in Feet	Length of Flat-top in Feet 60	80	100	120
40....	35,000	41,100	47,200	53,310
60....	48,800	55,460	62,090	68,700
80....	62,400	69,320	76,300	83,300
100....	76,260	83,500	90,750	98,020

It is possible to determine approximately the inductance required to produce a desired wave length when the capacity of the total oscillating system is known. When using any of the above formulas, it should be remembered that they include the total value of the unit. Thus, the capacity factor includes the antenna, and condenser capacity, each of which must be determined separately and the capacity of the antenna must be obtained by actual calculation, formula for deriving this quantity having been given on page 732 of the February, 1917, issue of this journal, as well as a table of the capacities of a four wire antennæ of different lengths and heights.

The first step in the design of an inductive tuner (having determined the wave length) is the actual size of the instrument, and from this to find the approximate dimensions of the winding tubes to be used. Having these on hand, and knowing the maximum inductance of the primary by equations (2 or 3), we can immediately determine the number of turns that the primary coil will require to obtain the wave length sought, by solving equation (3) of (Part 1, March, 1917, issue) for N;

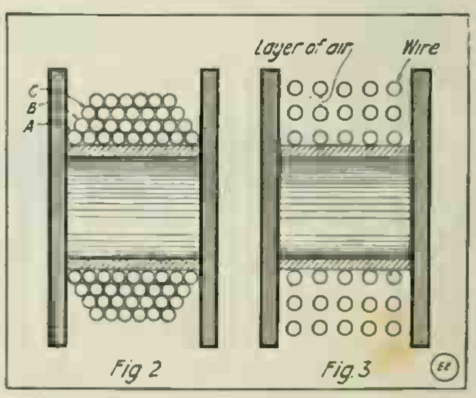


Fig. 2 Shows a "Staggered" Radio Inductance and Fig. 3 a Sectional View of the New "Morecroft" Multilayer Radio Winding, Designed to Have Minimum Distributed Capacity.

*Parts I and II of this series appeared in the March and April, 1917, issues of THE ELECTRICAL EXPERIMENTER.

in terms of units we obtain the following relation:

$$N = \frac{1}{5d}\sqrt{\frac{L\,(3\,S + d)}{3}} \qquad (4)$$

Where:—
N = total required number of turns.
d = diameter of coil in inches.
S = length of coil in inches.
L = inductance required in centimeters.

The inductance of the secondary winding should be such that its wave length should correspond very nearly to the antenna circuit, and that of the primary. If this condition is to be obtained, then we have an ideal condition of maximum efficiency and great care must be exercised in bringing about this ideal condition. The value of the secondary inductance must therefore be in the neighborhood of the primary (unless it is to be shunted by a variable capacity), but in practise it is made somewhat larger than that of the primary. It is customary in coupler design to allow one-half inch difference in size of diameters between the primary and secondary tubes and therefore the diameter of the secondary can readily be determined. The number of turns required is deduced from equation (4).

The size of wire to be used on the secondary coil is a very important factor in efficient couplers, and the only factor controlling the diameter of the wire to be used is whether a crystal or Audion detector will be connected in the secondary circuit. Since the latter type is a potential operating device it is essential that the winding should consist of a smaller wire than if the same coil is to be connected to a crystal detector. The reason for this is that the energy received by the secondary winding is so infinitesimally small that any superfluous resistance in the secondary circuit due to small wire winding destroys the intensity of the rectified current in the telephone receiver; but this condition does not hold true for a potential operating detector where the superfluous resistance is overcome by applying a greater potential in the circuit by the variation of the "B" battery of the Audion circuit. It was found from actual experiments carried out by the authors that with an Audion detector, the secondary winding should be made with a gage wire ranging

Details of a "Morecroft" Radio Inductance. In Winding the Coil a Layer of Card-board is Placed Between the Layers to Give a Spacing Between All Turns as Shown Clearly in Fig. 3.

from No. 28 to 32 B&S, while with a crystal detector numbers 22 and 24 were found to give best results.

After the primary and secondary coil quantities have been obtained, the specified design is completed and the next step is to consider the general mechanical features of the tuning devices and the manner in which the coils are held in place; the latter will be left to the builder, since each one has his own idea of finishing up an instrument.

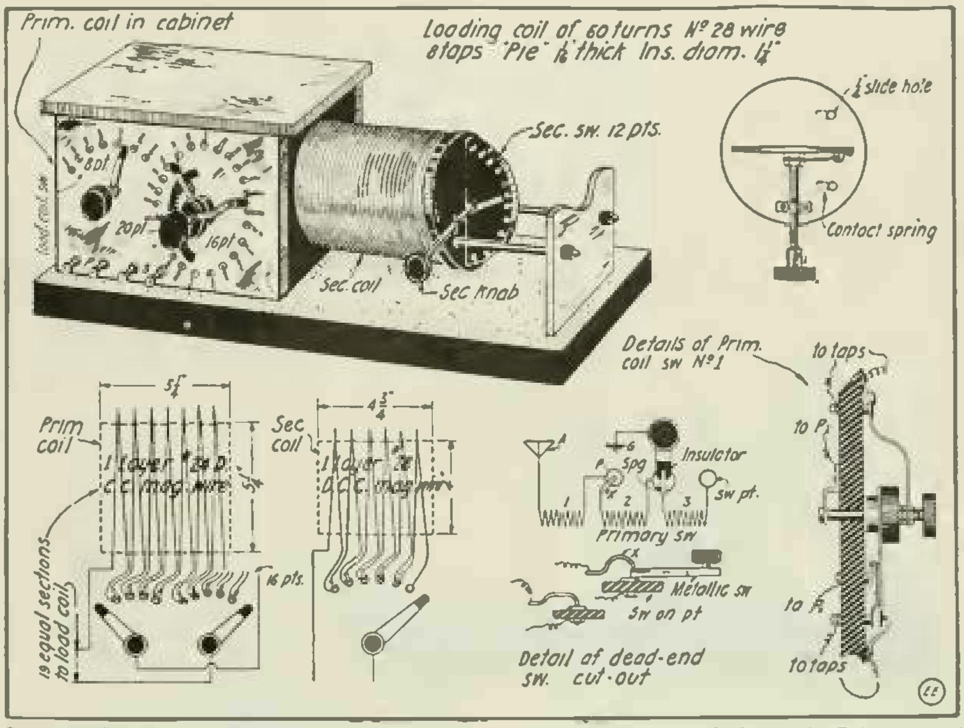
It is advisable at first in winding the coils, that no shellac or any kind of varnish be applied to the wire to keep it in place, as the capacity dielectric losses between adjacent turns are considerably increased, which naturally decreases the efficiency of the instrument. An ideal method of winding the wire is to cut a very fine thread on the surface of the tube in a lathe, and winding the wire in this thread. If a coil of this kind was going to be made, hard rubber or Bakelite should be used; the latter is preferable since it does not warp during changes of weather conditions. The method of winding a wire on a threaded tube is also advantageous in reducing the distributed capacity of the winding.

Still another method of winding the wire on a coil upon which a thread can not be machined, is to wind a fine silk thread between adjacent turns. Fig. 1 shows how it is done. This method of winding has been used considerably in building high grade inductance coils and has proved of sufficient merit to warrant its use with inductive coupler windings.

The question of tap connections and switches is a very important one in designing inductive transformers, and the following points should be kept in mind by the designer: *i. e.*, that all connections from winding leads should be as short as possible; all connections are to be invariably soldered and if possible they should consist of *stranded cable* in order to reduce lead resistance. These terminal leads should be soldered to copper lugs which are connected to the switch point. The latter must be free from any lacquered plate coating as this increases the high frequency resistance due to an increase of metal surface. It has been found, however, that if the metal is silver-plated and its surface kept white (not lacquered), that the increase of surface resistance to high frequency currents is negligible. Care should be taken to keep the buttons and switch blade contact as clean as possible, in order to minimize the contact resistance. This also applies to the elimination of the use of lacquer or any other form of polish on switch contact surfaces.

It is advisable in building a coupler to always employ a *dead-end switch* in order to reduce losses due to the distributed capacity inherent in the coil. Both primary and secondary windings should be equipt with one of these switches, and a very excellent and easily constructed type was illustrated and described on page 33 of the May, 1917, issue of THE ELECTRICAL EXPERIMENTER.

A great deal of deficiency and loss of energy accrues to the use of wood, hard rubber and fiber for switch panels, as the former usually contains water, acid or



Construction Details of 4,000 Meter Loose Coupler Having Dead-end Switches in Primary and Secondary Circuits. The Secondary Terminals Are Attached to the Slider Rods, Against Which Two Brushes Bear, These Brushes Being Placed Inside the Secondary Form.

other mineral substances, which cause a partially short-circuit on the taps; consequently not permitting the total energy to traverse the winding, which naturally does not permit the total flux induction to take place between the windings.

The fiber and hard rubber panels are not satisfactory for the simple reason that their surface deteriorates in time, and with the latter material, a film of sulfur is formed which collects dust, into which metallic particles lodge. These produce a short-circuit between contacts. Fiber, too, is rather hygroscopic. The best material for the construction of switch panels is Bakelite, which makes an ideal insulator for radio work. It is used on all receiving sets now built by the large commercial companies.

For the benefit of those who desire to build an excellent 4,000 meter loose coupler, we give herewith a complete working drawing of one.

There is still another type of inductance coil which has recently proven very satisfactory for tuning long waves, and this is the *multilayer coil*. During the last few years considerable criticism was made against the use of these coils, due to the untoward distributed capacity effect produced by adjacent layers. However, these criticisms lost themselves among certain radio engineers who have been working on this problem and notably the Telefunken experts, who have evolved the so-called *staggered winding* multilayer coils, which consists of tapering layers of wire on top of each other in the manner shown in Fig. 2. The first layer A was wound in the usual way; the second layer B was

(*Continued on page 322*)

"RELAY KEY" MADE FROM TELEGRAPH SOUNDER.

I give below description of an easily made relay key.

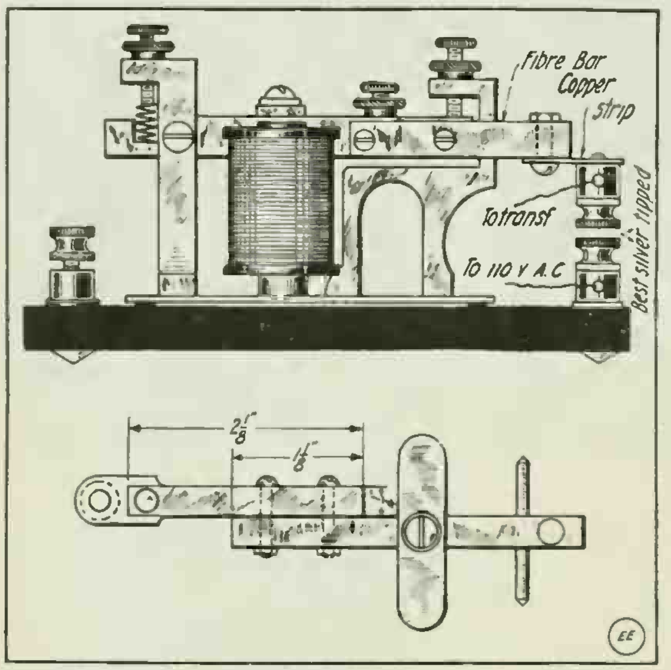
A good many amateurs are using the small (legless) type of telegraph key and are bothered with the points burning away—at least that was my trouble until I thought of this way of preventing it.

I don't think that this *key* has ever appeared in your magazine as I have been a reader of THE ELECTRICAL EXPERIMENTER for the past two years and have never run across it among the pages of your very useful magazine.

The relay key, which is nothing more than an old telegraph sounder, is easily made and I think that most amateurs have the necessary material lying in their junk heaps.

Cut a piece of fiber 2⅝"x⅜"x¼". Drill two ⅛" holes thru this and the bar of the sounder and fasten these together with bolts. Then drill a hole thru the outer end of the fibre bar and fasten on a piece of copper, to which an old binding post has been riveted. Another binding post serves as the bottom contact, it having been fastened to the base of the sounder, as shown in the drawing, when the key is ready to hook-up. Two dry cells will be sufficient to operate this key as it works similar to the telegraph sounder and the battery will not burn the points off the small key as will the A.C.

Contributed by DON I. BAILEY.



Substantial Design of Heavy Current Relay Key Which Can Be Made from a Discarded Telegraph Sounder.

CALCULATION AND MEASUREMENT OF INDUCTANCE.

(*Continued from page* 321)

started from the center of the first two turns as shown; the third between the first two of the second layer and so on until the last winding which consisted of a single turn.

Great precaution must be exercised in making the turn for the approaching next layer. This is done by making a sharp bend in the wire. This type of coil has been used with success for a number of years by the Telefunken concern, and they are still being used. They are excellent for building inductances for long wave lengths in a small space.

Something new in multilayer inductances is shown in Figs. 3 and 4. This design is due to Prof. J. H. Morecroft of Columbia University, who has done considerable research work in radio.

It was pointed out in an article on "Distributed Capacity and Its Effect" in the May, 1917, issue, that on the long single-layer coil the distributed capacity increased with an increase of coil length, and that the potential effect is greatest at the end of the coil. It naturally follows that with extremely long coils the voltage is extremely high at their ends, as compared with any of the apparatus used in the tuning circuit. It has usually been considered that multilayer coils had considerably greater distributed capacity than those of the single layer type, due to the proximity of the layers making up the coil, but it has recently been found that by properly constructing such coils, the inherent capacity is minimized. This fact was proved by constructing two multilayer coils where the layers of each winding were separated by a layer of air as indicated in Fig. 3. One of these coils has twenty layers, the other ten layers, yet the distributed capacity was found to be very low, or of the order of 25 centimeters and an inductance value of about 70 milli-henries.

The winding is made over a cagelike insulating reel, by eight wood pins past thru two end pieces. After one layer is wound a strip of cardboard is placed across the winding right over each wooden peg. The next layer is then wound on and the cardboard strips give an air space between the two layers. Each successive layer is wound in a similar manner, giving an air space between layers.

The inductance of multilayer coils of the Morecroft type is obtained from equation No. 10, Part 1 of this series. The notation of symbols is the same. The cross-sectional diagram, Fig. 2, of the first series shows a multilayer coil without an air space between layers, but the relation of the units holds true for the air space coils, since the dimension of the air space must be considered in the actual calculation.

In determining the capacity of multilayer coils the following equation has been found quite accurate:

$$C = \frac{a}{420}\left[\frac{b\,e}{c\,x} + 0.8\right] \qquad (5)$$

Where:—

C = capacity in milli-microfarads.
a = means radius of coil (inches).
b = axial length of coil (inches).
e = 2.718.
c = winding depth of coil (inches).
x = insulation thickness between layers in mils.

The first part of the equation represents the capacity due to the dielectric flux between layers, and this varies with the different parts of the coil as the variation of voltage is different at the various lengths of the winding. It also takes care of the dielectric losses due to the wire, and for air, which is used in the Morecroft coils, it is unity. Various other losses are encountered in these types of coil such as eddy current, hysteresis and skin effect, all of which losses are still under investigation.

The general construction and dimensions of the Morecroft multilayer coil is shown in Fig. 4. The ends are made from well-seasoned wood and the ¼" dowel pegs are glued into the holes made in the side pieces as indicated. The winding consists of ten layers of No. 30 silk covered wire. Each layer consists of 75 turns.

The great advantages of these coils are that long wave lengths can be tuned with a small size coil, and the capacity effect of the operator's body upon the coils is minimized, which eliminates the detuning effect on the oscillating Audion circuit when the operator stands near his apparatus. This effect is very noticeable when the long inductance coils are employed.

This completes this series, and it is the aim of the authors to have the information given herein accurate and concise so that it may prove of value to both the electrical and radio experimenter who reads these columns. The student who is endeavoring to master the various problems of the calculation, measurement and application of inductance coils in radio circuits will do well to procure copies of the March and April, 1917, numbers, the three articles forming a complete series. This is a subject which no prospective radio expert, whether operator or engineer, can afford to neglect.

AUDION EXPERT IS AWARDED RADIO ENGINEER'S HONOR MEDAL.

The first award of the medal of honor of the Institute of Radio Engineers which was described and illustrated in our July issue of THE ELECTRICAL EXPERIMENTER has been presented to Mr. Edwin H. Armstrong, E. E., of the Radio Research Department, Columbia University, New York City, in recognition of the valuable contribution to the art represented in his work in connection with receiving apparatus, and particularly to the efficiency of the well-known *Armstrong Circuit.*

It will come as a surprise to many of our wireless readers no doubt to learn that Mr. Armstrong's regenerative Audion circuit was developed and perfected in his amateur experimental days. This simply goes to prove that much is to be gained by experiment in the radio field, and this should prove a decided incentive to every radio amateur worth his salt. Certain it is, that little may be gained that is really worth while by simply owning a radio station, if one intends to simply sit at the apparatus and punch the key. In this, as in every other field of scientific endeavor, and wireless certainly is scientific if anything, it has always developed in practically every case on record that wherever a revolutionizing, original idea or invention has been evolved, that back of it all there was invariably a vast amount of hard work which required much study and experimental research. The present situation, when all experimental wireless stations have been closed by the Government, due to the war, should prove nothing less than a spur to urge the real radio amateur on to a higher goal. "After the War" days are surely coming, and with them will come a wonderful opportunity for radio experts, not to mention the present great opportunities in the Army and Navy signal divisions, besides many lucrative positions available with industrial concerns at the present time for first-class radio experts.

Due to the advent of the war, we are particularly desirous of obtaining manuscripts describing original and practical "Electrical Experiments." We shall continue to publish Radio articles, but what we need is snappy "Electrical" articles. Be on guard for the enemy—Repetition!

THE CONSTRUCTOR

How I Built A 2½ H.P. Flivverette

By CLEAGE FEILD

"NOTHING succeeds like success," would seem to be the beacon-light of one Master Cleage Feild, age fifteen years, who has patiently designed and built the racy looking motor car in miniature here shown. Like many other motor car makers of the day, Master Feild has assembled his parts around an engine that runs, preferring not to take chances on casting and machining the engine parts. The inventor deserves considerable credit for his ingenuity in building a little pleasure automobile that really gets there. It covers the ground at a speed of 20 miles per hour easily and 35 miles on a gallon of gas is regular work with Cleage. Fellow-bugs—electrical, mechanical and radio—Master Feild. Master Feild, etc. The introduction having been effected, let us read what this young mechanic and inventor has to say regarding the details of his 2½ H.P. flivver-ette.—Editor.

Construction Details

Frame—The frame is of red oak, one and three-fourth inches square. It is seventy-four inches long, fourteen inches wide and thirteen inches above the ground. It is bolted at the corners and braced by pine and oak strips.

Hood—The hood is of oak with poplar slats on it, 4 inch slope, 27 inches long, 14 inches wide, 15 inches high in front and 19 inches back. A screened hole in the front admits air. It has two hooks on each side to secure it to the frame.

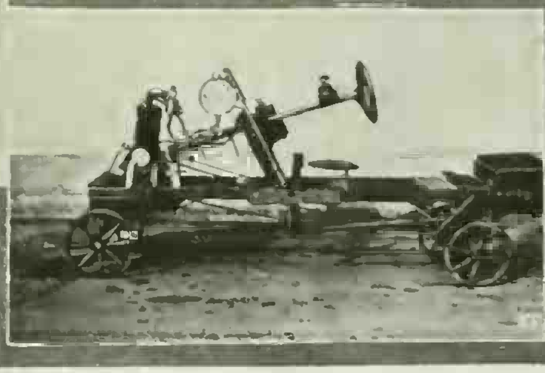
Dash Board—The dash is separate from the hood and is nailed to the bed. It is made of oak and has the same dimensions as the back of the hood.

Steering Gear—This runs thru the dash in an iron box; the rod is a piece of broom handle and the wheel came from a book press. The horn (hand Klaxon) is clamped to this rod. Ropes wrapt around the part of the rod under the hood, in opposite directions, run thru pulleys on the left of frame to the swivelled front axle block, as shown in drawing.

Wheels—These are No. 3, Auto wheel, coaster, size 10 inches high and use ½-inch axle. They are roller bearing and are held on by cotter pins. The wheel base is 58 inches. The front axle is riveted to the block, while the rear one revolves in four iron boxes.

Brake—I have only a foot brake. This pushes on the rear left wheel and the pedal for it is on the same side of frame.

Seat—I have three seats which may be changed to suit the occasion, a wooden one, which is my country and county seat, another one which came off of a girls' tricycle, which is my town seat. And a small leather auto seat which is my "Sunday best"!



Boys, Wouldn't You Like to Ride Around Town In Your Own Little Car? Read the Story of How a 15-Year-Old Genius Built His Own "Racer" From Odd Parts.

Engine—The engine is a 2½ horse power, Shaw bicycle attachment, air-cooled type. It is fastened to the frame by iron strips and bolts. I use a Cico spark plug and a contact timer equipt with a spring to keep it shut off. In the cylinder head is a priming cup which can be used as a compression release when starting.

Carburetor—The carburetor is a small one-half Acme Essex, of the float valve type.

Tank—The gas tank is made of a copper tank cut in two; it has a copper tube running from it to the carburetor. The tank is on the back of the dash board and has a capacity of one-half gallon. It has a screw cap on top of it.

Piston—This has three rings and is connected directly to the two fly wheels, which are enclosed in the crank case.

Oil System—The oil is poured into the oil case thru a plug.

Ignition—The ignition consists of the spark plug, four dry batteries (which are located in the box behind the seat), a vibrator coil (which will give about ¼-inch spark), a switch, the ground connector, the timer and wires connecting them all together properly.

Controls—The spark is the main controller of the speed of the engine. A wire runs from the timer to a small lever which works into a notched slot. This lever may be seen on left of frame. The gas feed is regulated by a string which opens and shuts the vaporizing chamber door. Since my drive was changed I have no need for an idler.

Drive—This is the last, but very important subject. The engine runs in opposite direction to the wheels, but the gears, as you can see in the drawing, being only two, reverse the direction of pull, causing the wheels to go forward. My gears and the boxes connected with them and the rear axle I got off of an old "Irish Mail Flyer." The small countershaft was once the axle of a wheel-barrow and two of the boxes on the rear axle came from the same outfit. The left rear wheel is equipt with bearings like the front two, but the right and *drive* wheel is different. I found the end of the axle cut almost square, or I would have done it myself. A piece of a flat iron strip with a square hole in it was fitted over the axle and bent thru the spokes. This clamps axle and wheel firmly together. The automatic idler I spoke of is very good. The pull of the belt, which is at the bottom of the rear pulley wheel, tends to raise the small gear, boxes, shaft and itself upward. This movement lengthens the distance between pulleys and tightens the belt. The smaller gear, as you can see, would naturally climb up the larger one and do the same as above.

A few facts—My car will make about 20 miles per hour. The wheels altho a little too small, possibly, are very good

Seven Years of Wireless

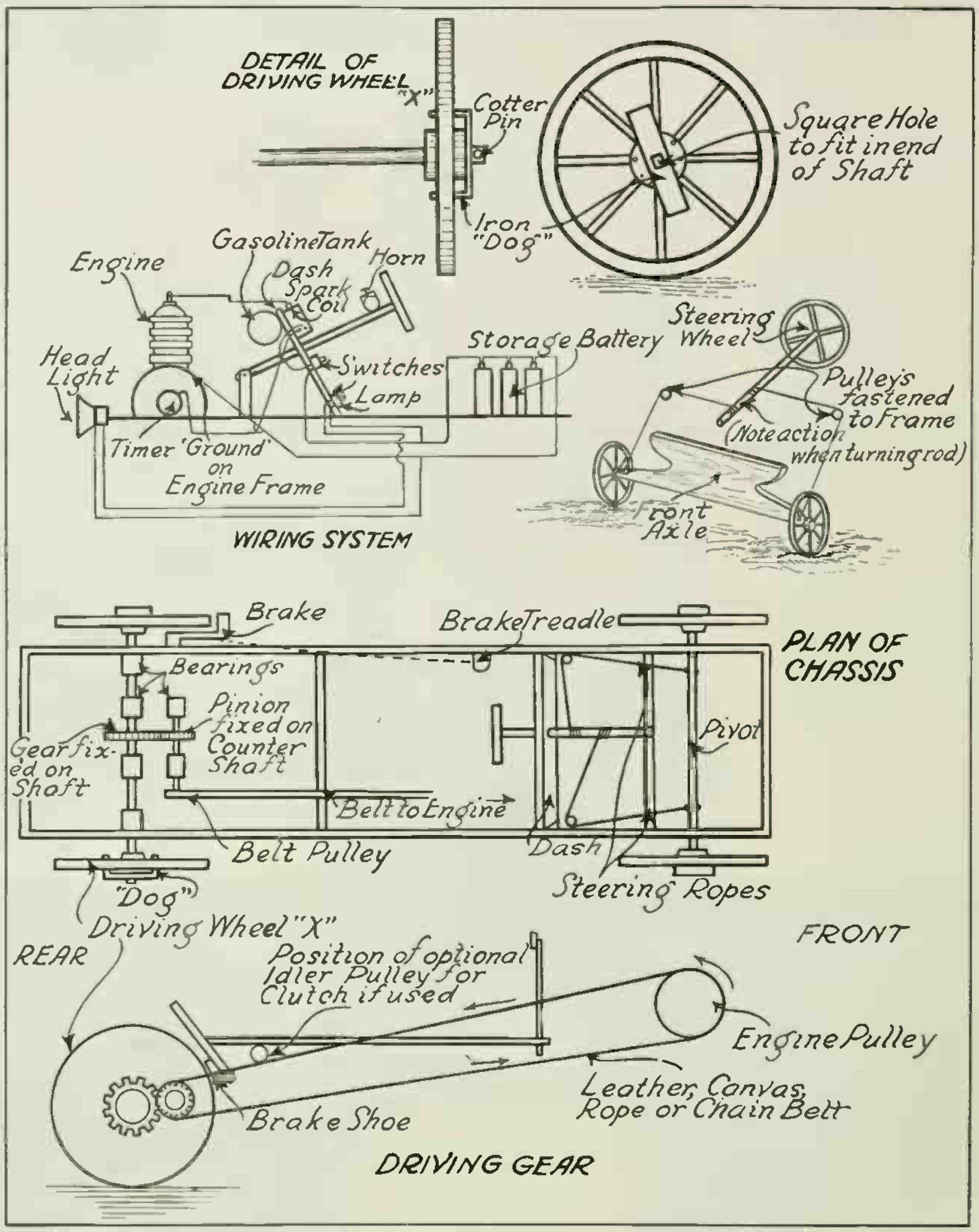
By HOWARD S. PYLE

WELL I remember my first days in the mysteries of wireless, seven years ago. It all started with the problem of ringing a bell from a 220-volt source of supply. The results exceeded my greatest expectations. But in them was kindled the fire of experimentation. The usual collection of junk accumulated in different parts of the house until finally I was forced to seek larger quarters in the attic. There began the construction of an indoor aerial of bell wire; four strands, thirty feet long and about the same height, tacked to the rafters; a "coal" detector and a receiver borrowed from the family 'phone. Three months were spent in vain endeavor to pick up the Navy Yard station, 15 miles away. I recollect trying all manner of mineral matter in the detector—from gold nuggets to tinfoil wads, finally abandoning the detector to look for other trouble.

I finally purchased a 75 ohm watch case receiver for 40 cents and began anew. Still no results, so the aerial came down post haste and was replaced by a single wire 100 feet long and 40 feet high, running parallel to a 220-volt A. C. circuit, but four feet below, for its full length. A trip to New York (my station being in Paterson, N. J.), resulted in the purchase of a highly nickeled but extremely small tuning coil of the double slide variety, a piece of silicon crystal and a potentiometer. After struggling along with meagre instructions from the first wireless catalog published. I finally jimmied the collection of apparatus (?) into a workable hook-up, according to a printed diagram and with a thrill of expectation, glued the receiver to my ear. The only response was a humming so loud that my ear sang for some minutes afterward. After three days of this I asked information of a more advanced radio friend and with his help and advice, placed my one wire aerial at right angles to the A. C. power circuit. Upon trying the set we found the hum almost entirely eliminated but "no sigs." Where then was the trouble? After a thoro investigation and testing of each individual piece, we found the wire on the tuner to be a continuous short-circuit under the sliders. An expert friend constructed and presented me with a small but well-built loose-coupler at this time, which probably was the only thing that prevented me from turning to a more gratifying art. At last after seven months of experimentation and disappointment, the coupler was hooked in and we received good signals from two stations, one about twelve, the other fifteen miles away, both *five kilowatt* installations.

This fired me to greater efforts and the remaining three years of my residence on the east coast were spent in constant experimentation and endeavor to improve on the original installation, which finally consisted of two loose-coupled receivers and a ½ K. W. transmitter, a complete description of the whole installation appearing around about the latter part of 1911 in the *Modern Electrics* magazine. A combination of circumstances resulted in my being compelled to drop Radio work for about six months, but at the first opportunity I erected a two-wire aerial 90 feet long and 40 feet high, and started in again on the Pacific Coast. I found conditions here much better, being remarkably free from the troublesome static of the Atlantic seaboard. However, the stations out here were few and even less Amateurs, as this was about the time that the Radio law went into effect. I made immediate application and received one of the first second-grade amateur licenses issued. After about a year's work, during which time nothing particularly noteworthy occurred, we again changed our residence, still remaining in Seattle, however. Right after these things began to happen, the Marconi people installed a 5 K. W. station in the tallest building west of Chicago, which brought them just three miles from me—a high-power station was establisht at Astoria, Ore., 300 miles S.W. by the same company. The Y. M. C. A. undertook the instruction of operators for commercial service and a local concern began the manufacture and installation of radio equipment on vessels of this coast. I secured employment with this concern and worked on the installation of the Alaska S. S. Co., involving about 15 complete 1 K. W. equipments. I also took up a course at the Y. M. C. A. school and settled down to real earnest work, averaging five evenings a week at my instruments. I was not equipt for sending for about two years, but spent a great deal of time in perfecting my receiving equipment. My "log book," which I have always kept up-to-date, shows many trials and disappointments which have been conquered, and makes interesting reading for me now, I can tell you.

A little later, I met thru our "ads" in a radio publication an old *United Wireless* operator who had a 1 K. W. *United* transmitting installation for sale, and this I purchased and brought up-to-date. I had hardly installed it when we again moved to our present location, and where I have practically completed a first-class 1 K. W. station, which awaits the end of war.



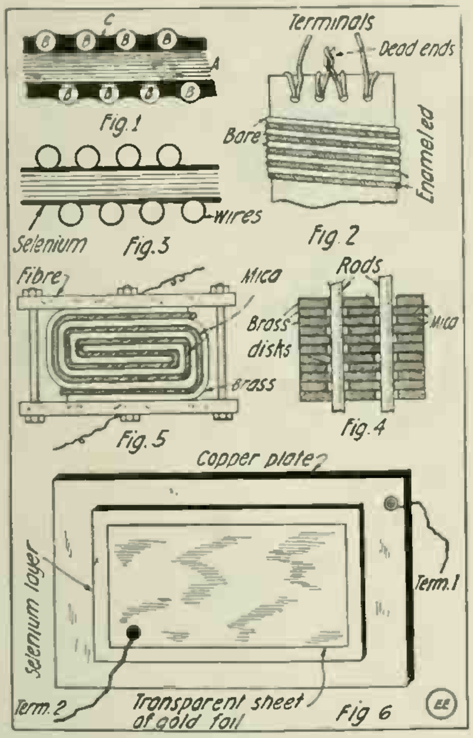
Why Wish for a Flivver-ette, "Bugs"? Here's How to Make One From the Simplest Materials Possible. Four Wheels, a Few Sticks of Wood, a Broom-stick, a Battery and Spark Coil, and Lastly—a Discarded Motorcycle Engine That Still Peeps, and You're In for the Tim^ of Your Life, Even to Stealing Your Rival's Best Girl.

It will climb any ordinary hill. I've been working to get this perfected for nearly a year and my new drive system so far has been a great success. If any one desires any more details I shall be pleased to write them. Address me in care of the Editor, inclosing stamped envelope.

Selenium Cell Design and Construction

By THOS. W. BENSON

THAT selenium or one of its closely related elements possessing similar properties will find many uses in the near future is a logical and foregone conclusion. In the past its sporadic applications have been many, but its present status remains more or less in an experimental stage. Among other applications, we find that Minchin used it in his astronomical work, Prof. Barnard of Lick Observatory employed selenium cells in a device to automatically detect comets, Siemens for photometric measurements, Ruhmer, Bell and Taintor and others for wireless telephony and experimenters without number have employed selenium in one way or another in an effort to transmit pictures over a wire. Among these might be mentioned Senlecq, Larroque, Korn, Dussaud, Liesengang and DePaloa.



Various Types of Selenium Cells: Fig. 1, Cross-Section of a Bidwell Cell; 2, Modified Bidwell Type; 3, Second Type of Modified Bidwell Cell; 4, Bell and Taintor Cell; 5, the Mercadier Cell and Finally the Fritts Form of Selenium Cell, Fig. 6, Which Is the Most Sensitive Ever Discovered, the Light Shining Thru the Thin Gold Foil.

Many experts have bent their efforts to the perfection of the selenium cell proper, rather than the application of the same, and it is their work with which we will deal. Among these workers, the names of Giltay, Draper, Hittorf, Adams and Day, Ayrton and Perry, Mercadier, Bidwell, Ruhmer, Hammer, Fritts and Gripenberg are the more prominent. Despite their efforts the selenium cell of today is far from being a reliable piece of apparatus. This may be due to a certain extent to the fact that the material is but little understood.

The physical changes that take place when the substance is heated are too well known to require extensive mention, but the *action of the light on the metal* is still the subject of much conjecture. And herein lies the stumbling block.

We can, however, draw certain conclusions that will assist us greatly in designing selenium cells that are nearly alike in their various characteristics. For one thing the light can only affect the *surface* of the cell, but it is reasonable to suppose, however, that the ultra-violet rays can penetrate the material to a certain extent, since it is more effective in altering the resistance of the cell. The longer light waves of the visible spectrum act on the *surface* only, since the metallic form of selenium is opaque.

Then again, just what is the action of the light when it strikes the cell? Several theories of the physical action occurring have been put forward, one being that since light is a form of electro-magnetic ether vibration it may act to cohere the particles of the metal in a manner resembling the action of the well-known coherer and thus serve to reduce the resistance of the material.

This theory was rendered highly improbable by the research work of Adams and Day, who in 1877 publisht the results of a series of experiments. They claim that the conduction thru a selenium cell differs from metallic conduction, partaking of that occurring in an electrolyte when the current passing decomposes the solution. This would seem to support the theory that the light falling on the selenium causes the same to throw off electrons and in this manner form a low resistant conductor. The latter phenomena is well known and has been the subject of much research work, particularly by Fleming.

Even so, we are now in a position to design cells with a maximum sensitiveness. As in the case of other conductors the resistance of selenium increases directly with the length and decreases as the area is increased. Therefore a cell made in the usual form, that is with wires wound on a support as in the Bidwell type, will have a low resistance due to the comparatively large area of selenium lying between the wires.

Referring to Fig. 1, a cross-section is shown of this type of cell with the selenium applied. The insulating support of slate, mica or porcelain is shown at A, the spirally wound parallel conductors at B, B, etc., while the selenium is shown at C. A cell so constructed is not sensitive, for the following reason: The light only affecting the surface of the selenium may reduce the resistance of the surface to a great extent, but the total resistance of the selenium present is only slightly affected, as will be clear by applying the law covering resistances connected in parallel.

The above condition is that usually met with in home-made cells; the writer recently constructed a cell along these lines with a resistance of but 200 ohms, its change of resistance was approximately 20 ohms from darkness to sunlight. Naturally this is not a good cell, its use being impractical since the variation is too slight to make it respond to small changes of light intensity.

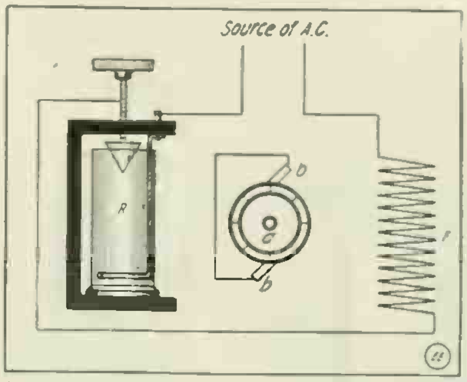
To overcome this state of affairs a Bidwell cell was made as shown in Fig. 2. In this case four wires were wound on the porcelain support. Two of these were bare and formed the terminals for the cell, the other two were enameled and were dead-ended. The selenium being applied over the wires could not get between them and in this way the area of the light-affected part formed a fairly large part of the total conducting area. This type of construction is satisfactory for general work, its ratio rarely exceeding 5 to 1, however, and the resistance is fairly high. This can be reduced to a certain extent by using fine wires, say No. 32 B. & S.

(*Continued on page 332*)

RUNNING SMALL D.C. MOTORS ON A.C.

Below is given a method which I find useful in running D.C. motors on A.C. circuits.

Disconnect the field winding from the armature and connect the brushes (b) of the



A Plan Whereby a Small D.C. Motor Can Be Operated As a "Repulsion" Type Motor On A.C. Circuits. Shift the Shorted Brushes Until Best Results Are Obtained.

armature (a) together. Then connect the field (F) in series with a variable resistance (R) and the source of current. The resistance should be low for starting, but may be increased when the motor is under full speed.

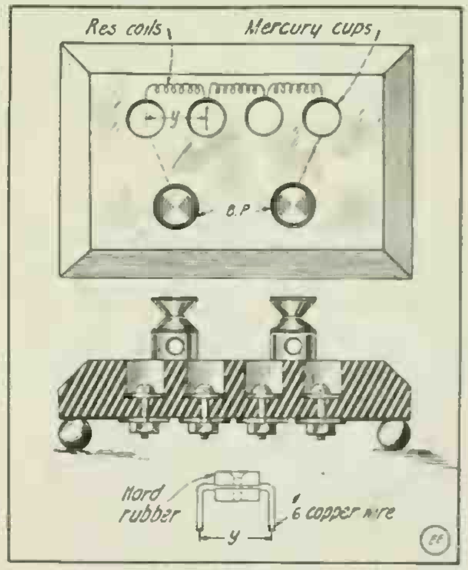
Contributed by RAE GALUSHA.

A VARIABLE RESISTANCE GALVANOMETER SHUNT.

This galvanometer shunt consists of a baseboard 4" x 6" x 1" mounted on feet made of two strips of half-inch dowel pin, each 4" long. Bore holes for the binding-posts and mercury cups, as shown in the accompanying sketch. Put all screws, washers, etc., in place and then solder in the resistances and connections.

The resistances are best made of No. 22 double-cotton insulated German silver wire, which runs nearly one ohm per foot. Relative values 1:2:4 for the resistance coils are convenient. These used singly, or two or three in series, will give a wide range of combinations.

The actual resistance of these coils will, of course, depend upon the resistance and sensitiveness of the galvanometer.



Simple and Efficient Variable Shunt for Use With Galvanometers, Employing Mercury Switch.

Short pieces of heavy copper wire bent to connect two adjacent mercury cups are used for short-circuiting the coils when not in use.

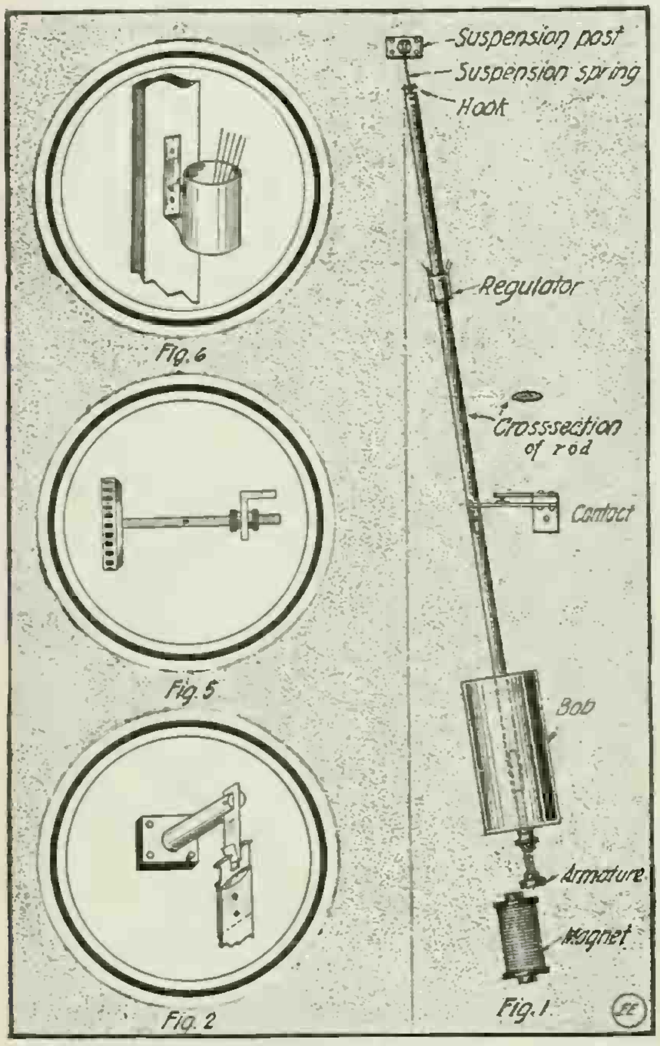
Contributed by PETER J. M. CLUTE.

Making an Electric Clock

By THOMAS REED

Part 1—The Pendulum

COME on now, "Bugs," roll up your sleeves, sit down on anything you aren't supposed to sit on, like the bench or the top of the tool-cupboard, and I'll tell you how to make your clock. ("High time he did," they say.)



Several Important Details of the Electric Clock Are Here Illustrated, Showing Among Other Things the Particular Manner of Suspending the 39-Inch Pendulum and Bob, Also the Electrical Contact Actuated by the Swinging Pendulum Rod.

In a mechanical clock, the pendulum is driven by the wheelwork; but in an electric clock (of the Hipp type at least; see page 114, June, 1917 issue) the pendulum drives the wheels. This is an advantage (for "Bug" purposes at any rate) because, there being no heavy power on the wheel-train, it can be made very light, and you aren't ruined by a rough bearing or wobbling gears as long as they're true enough to keep in mesh.

In my clock (which has an unnecessarily heavy wheelwork) the pendulum receives an impulse once every 6 or 8 seconds, when the dry-cell is fresh. The interval diminishes as the battery runs down, till just before it's played out it receives the feeble impulse every 2 seconds. One dry-cell will run the clock for 7 or 8 months; I usually put on two cells in parallel, which run it practically just twice as long, or from 14 to 16 months.

Almost all the energy is used up in driving the wheelwork. With the pendulum swinging alone, it's really surprising how little power is required; a single impulse of the magnet will drive it from 5 to 10 minutes—*minutes*, not seconds. You know the pendulum is theoretically a perpetual-motion machine, and but for friction and air-resistance would swing forever if once started. On this basis, one cell would keep the pendulum going for about 38 years, if it could stand up that length of time. Wish it would, and that were all there was to it! You could hitch on a cell when the baby was born, and leave it to him to pay for the next one when he reached middle-age—provided he'd laid by enough of the old healthy "mazuma" in the meantime; some of us don't. But of course a pendulum alone doesn't make a clock, any more than one swallow makes a—drink; it's useless to measure the time unless you record the measurement.

All the same, if any of you "Bugs" start a clock, I'd recommend you to make the pendulum and its apparatus first, and get it going nicely before you begin the wheelwork. It's easier on battery-finances, for one thing. Battery upkeep used to be quite a factor in my young days, and in my efforts to keep the upkeep down I experimented quite largely, and invented a new form of battery which I explained at some length in the August issue.

So now about the pendulum. Fig. 1 shows it at the end of the *right* oscillation, just as the contact is made. The departure from the perpendicular is exaggerated. The amplitude should be kept as small as possible, and depends upon the size of the teeth in the escape-wheel. Of course you can place your contact-post and magnet in accordance with the degree you require.

Begin at the top of Fig. 1, with the suspension-post. This is a plain brass rod, say ½" diam., attached to the back-board by a machine-screw thru the back, or better attached to a base-plate and screwed on from the front. It ought to be very strong and solid, as the slightest wiggle will throw your time all out of gee. It has a perpendicular slit in front, into which you poke the suspension-spring and pin it.

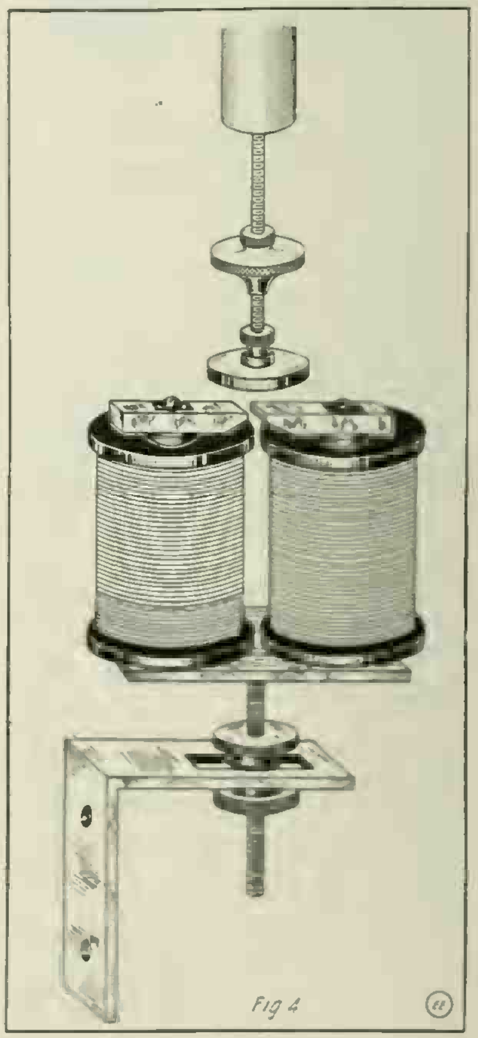
The suspension-spring you can make easily enough, if you want to. It's simply a piece of flat steel spring like a watch-mainspring, with a hole in each end for a pin. But it hardly pays to make it, for you can buy one for a nickel or so at any clock-store, much thinner than watch-mainspring (of course the thinner it is the better) and with neat brass ends. You can get big ones, but the little ones made for mantel clocks are all right. Don't be afraid if it looks small; I had a 20-lb. pendulum once hanging on one of those. Only be sure that your hanging-pins go thru the steel itself, as on these light springs sometimes the brass ends are only pinched on. Another reason for buying your spring is that a home-made one, especially if thinned by filing, is apt to have inequalities, which make your pendulum wobble.

Now then, your pendulum rod. Thank heaven in this case the best is the cheapest, for it's recommended to be made of ordinary white pine, on account of its lightness. That's on the theory of concentrating all the weight possible in the bob, but it isn't much more'n a theory; if you'd rather have a nice pretty mahogany or rosewood rod, go to it. If you have a pine rod, paint it black and shellac it to keep the moisture out.

A good size for the rod is 3/4" wide by 1/4" thick, and it's planed down rounding to an edge till it has a cross-section like a lens. This is only theoretical too, in order to cleave the air better; a square-cornered one will do about as well.

At the top of the rod you saw down a slit and set in a piece of thick sheet brass, bent into hooks as shown in Fig. 2, to hang on the pin of your suspension-spring. This enables you to take the pendulum off more easily than drawing out a pin. You'll have occasion to take it off quite a few times, you know, before it starts on its 50-*year non-stop run*.

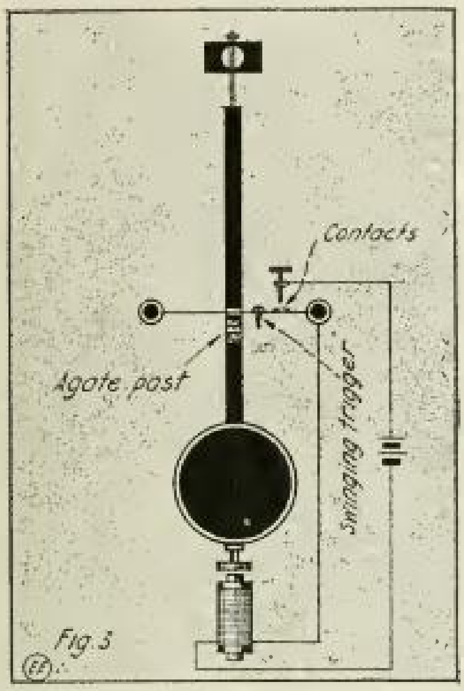
At the bottom of the rod, drill a hole lengthwise (and for the love of Mike, drill it straight!) and screw in a length of 8-32



Showing How the Pendulum Actuating Magnet Is Mounted So as to Be Readily Adjusted. It Pays to Make All of These Parts Right, Especially the Pole-pieces or Faces of the Magnet Poles. The Magnet Coils Are Periodically Excited from a Battery.

screw wire for the regulating nut and armature.

The length of a seconds-pendulum (for mean solar time) is 39.1 inches from the middle of the suspension-spring to the middle of the bob; so you won't know how long to have it unless you make your bob first.



The Electric Clock Problem Was Finally Solved by Resurrecting Hipp's Pendulum. This Design Seemed to Work the Best.

The bob can be any size, shape or weight, but practically should be a symmetrical figure, and the heavier it is the better. It takes no more power to drive a heavy one than a light one, and the heavy one eats up some slight temporary disturbances.

The cylindrical bob is easiest to make. Use a brass tube about 6" long and 2" in diameter. Make an extra foot of wooden rod the same shape as your pendulum-rod but a little larger. Stick this rod up perpendicularly in a pailful of sand, having the surface of the sand packed hard and smooth. Set your brass tube down over the rod till it rests on the sand, being sure that your rod comes exactly in the middle of the tube (top and bottom) and projects out an inch or so at the top. Now pack more sand around the tube, to hold it during the pouring process and stop the lead from running out the bottom.

Melt up some scrap lead, but don't get it too hot—not redhot, just hot enough to run freely and show up shiny. Pour it in till the tube is full, and stand by to pour a little more as it shrinks on cooling. Your wooden core will smoke, but let it smoke; a charcoal core is just as good as a wooden one, and comes out easier. When cold, drive it out, and your bob is done, except for polishing and lacquering.

The bob-regulating nut should have a good large diameter as the heavy bob takes some power, and besides it's easier to see how much you've turned the nut.

The armature is at the very bottom of the rod, and is simply an iron disc of good thickness and about 3/4" diameter. It's screwed up on your bob-screw and held fast by a check-nut on top (here's where that ever-faithful dry-battery nut comes in). If you look in the box at the hardware-store where they keep the thumping big washers, you'll probably find some punchings from the inner holes, which are just the thing for armatures. I imagine the wicked washer-makers adulterate their goods with as many of these useless punchings as they dare, to the woe of the hardware-man; but it's an ill wind that blows nobody good, and we should worry about tainted punchings.

The magnet needs pole-pieces as shown in Fig. 4, and the illustration gives what I've found to be a very good adjustable mounting. I use a magnet with coils about 1" diam. by 1½" long, wound with No. 24 wire; I imagine the entire magnet measures about 20 ohms.

The Hipp-pattern contact was described in a previous article, but if the Editor please, we'll have the illustration again here (Fig. 3) in order to get everything together. The contact is mounted on a screw-post (Fig. 5) with nuts front and back, in order to adjust the trigger to the notch very finely, and also the distance from the backboard, as the contact and magnet have to be in the same plane as the pendulum.

I past up for the moment the rinktum shown near the top of the pendulum, that looks like a flower-pot with a dead begonia in it. (Figs. 1 and 6.) That's the *precision-regulator*. You could never train a clock down to *seconds-a-day* if every time you regulated it, you had to stop the pendulum and screw the bob up and down; besides a 32 screw isn't fine enough. You must have some means of changing the rate of the pendulum without stopping it, and that with extreme delicacy, as any change you make accumulates till after the 86,400 seconds in a single day it shows up big. So you first attach a little brass cup to the pendulum (Fig. 6) about a third of the way down from the top, and put in it a dozen or so pieces of about No. 24 wire, long enough to project well out of your cup, so you can get hold of them easily with your fingers. Now you regulate your pendulum by the bob-screw till you get it fairly good, say to half a minute a day; after that, you regulate by taking wires out of the cup, or putting more in, as the case may be. Your hand can follow the motion of the pendulum easily enough, especially as the oscillation is short up near the top, so you don't have to stop it. The more you load the cup, the faster the pendulum will beat, which is opposite to what you might suppose; but the weight above tends to make a shorter and quicker pendulum there, which shortens the net *oscillating length* of the whole. As you get nearer to *seconds-a-day* you can use pieces of finer and finer wire, till finally you reach the point where the erratic changes exceed your regulation.

[*Watch for the next paper describing the wheel-work in the October issue.*]

HOW TO POLISH HARD FIBER.

Hard fiber is used to a larger extent by amateurs in making wireless and electrical apparatus, but it has the disadvantage of absorbing moisture and soon becoming a poor insulator. To overcome this difficulty I used the following method: After the fiber has been cut to size, sand-papered smooth and all holes drilled, soak a piece of waste in thin white shellac and place on the center of a piece of cloth which has been soaked in boiled linseed oil. Then bring the edges of the cloth up around the waste and twist up tight until the shellac begins coming thru the cloth. Then rub the fiber firmly but rapidly with a circular motion, and continue rubbing until the shellac begins to get sticky. Do not stop with the cloth resting on the fiber as it is apt to leave a spot. Before the polish is put on the fiber should be left in a warm dry place for a day or so to expel all moisture. After one layer has dried, the fiber may be rubbed with fine steel wool and another coat of polish put on. About three or four coats should give a fine mirror-like polish. This is the way the finish is put on pianos, etc., and if the experimenter is careful, he should be able to attain good results after a few trials. To keep the moisture out the fiber should of course be covered completely with the polish.

Contributed by E. C. SCHURCH

A HOME-MADE "MAGNETIC" WINDOW ATTRACTION.

This window attraction is suitable for a tobacconist's or other shop and never fails to attract the passers-by, who try to solve the riddle. The effect produced is as follows: A glass dish "A" is resting on three glass knobs "C," which in turn are supported by a small wooden box "D."

About half a dozen cigarettes are lying in the glass dish. Suddenly the cigarettes rise on end and are standing nearly vertically for a few moments, then they fall back again. This is repeated for any length of time.

The cigarettes cannot be operated by threads, as they roll about when they drop back again, and as the dish is supported by three glass knobs, the average spectator does not think it likely that the cigarettes are operated from below.

But they are!

The box contains a powerful electro-magnet which consists of an iron core "F" and the winding "E." This electro-magnet is connected in series with a Thermo-blink flasher and three carbon filament lamps. The latter are connected in parallel. When the current is thrown on, the iron core "F" will be magnetized by the coil and attract the cigarettes.

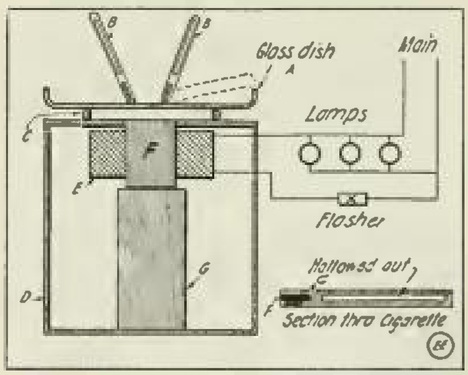
These cigarettes are of special construction and consist of a wooden part "G," and a steel part "F." The latter is made from a wire nail about ⅛ inch diameter by ⅝ inch long.

The wooden part is hollow so as to make the cigarette *dummy* rise easily when the current magnetizes the core "F."

After the current has been passing thru the circuit described above for a short time the Thermo-blink flasher breaks the circuit only to close it again in a few seconds.

Three lamps are placed in parallel so as to get the greatest amperage possible, and for the same reason carbon filament lamps were chosen.

The iron core was made of a short piece of mild steel shafting, 3 inch diameter. It was thoroly annealed before being used, so as to keep the residual magnetism as small as possible.



Details for Making the "Magic Cigarettes" Electrical Window Attraction. It Also Provides Plenty of Mystery for Parlor Entertainments.

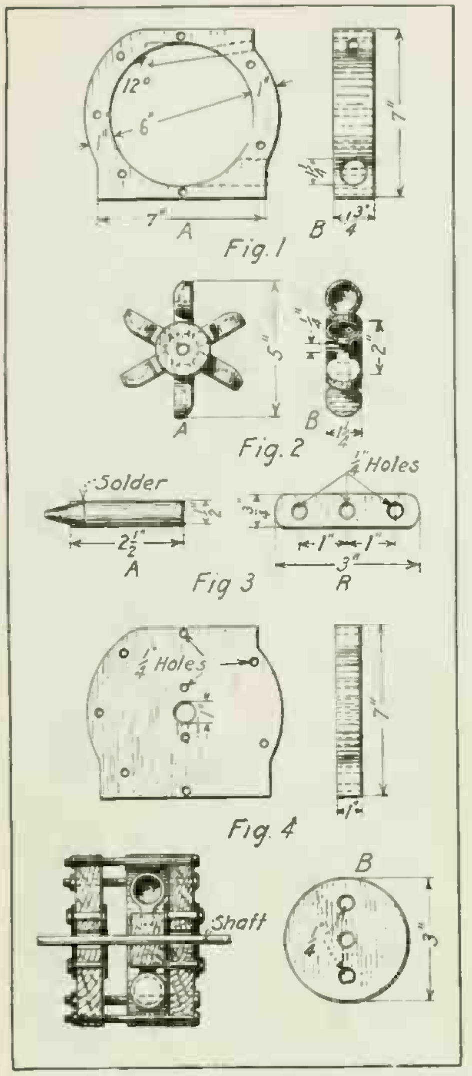
The magnetizing coil "E" consisted of about 200 turns of No. 14 gage, double cotton covered copper wire. "G" is a wooden block to hold "F" in position. The connecting wires should be led thru the bottom of the box to render them as inconspicuous as possible

Contributed by C. A. OLDROYD.

A SMALL WATER MOTOR FOR DRIVING DYNAMOS.

By W. E. Leach.

A water motor, owing to the variety of uses it may be put to, will find ready call among experimenters. It is not at all difficult to construct and below I describe one



Construction Details for a Small Water Motor Which Will Prove Useful In Driving Dynamos or Other Light Machinery.

that I made and used successfully to drive a dynamo, sharpen tools, as a drill, and also as a small lathe.

The first thing to obtain is the materials. These consist briefly of the following:—1 piece 2" x 8" x 10" plank (hard wood), 2 pieces 1" x 8" x 10" board (pine), some ¼" x ½" board (soft or hard wood)—7 5" x 3/16" bolts, 4 1½" x 3/16" bolts, 1 piece brass tubing ½" in diameter, 2½" long (for nozzle).

To begin with, cut a case from the piece of plank as shown in Fig. 1 A and B. Bore seven ¼" holes thru this as shown. At the bottom bore a 1¼" hole for an outlet. Then at the top, bore a ½" hole about 12° to the horizontal: this is the inlet. The rotating section is made up as shown in Fig. 2 A and B. The vanes or paddles are cut from ½" boards and of dimensions shown. They are hollowed out at the ends and are set into an axle cut from a piece of hard wood 1¼" x 2" with a ¼" hole thru the center.

To make the nozzle take the piece of brass tubing above mentioned and solder to it a cone shaped piece of tin as in Fig. 3—A. Now drive this into hole at top of case until its tip first comes to the inner edge.

Now for the sides, cut two pieces out of 1" pine as shown in Fig. 4. Bore 7 ¼" holes thru these to correspond to those in the case (Fig. 1). At the center bore a 1" hole, and about 1" away from the center in a perpendicular line, drill one ¼" hole on each side of this as shown. Now make two plates 3" in diameter and ¼" thick as shown in B (Fig. 4). Bore a ¼" hole in the center and about 1" to either side bore another ¼" hole. Make two plates of iron as in Fig. 3—B. Drill holes to correspond to those in the plates, Fig. 4—B.

Give all parts two coats of good water-resisting paint and when dry assemble as follows:—Place a plate (Fig. 4—B) on the outside of the sides, put a wad of packing soaked in oil in the 1" hole. Then place an iron strip (Fig. 3—B) on the inside of each side and bolt firmly together with two 1½" x 3/16" bolts. Drive a shaft thru the rotating part. Insert one end of shaft thru one side and then place inside of case. Put the 7 5" x 3/16" bolts thru and fasten the other side together. (In setting up, if some pitch is placed between the sides and case it will prevent any leakage.) Connect the motor to any faucet by a rubber hose and it is ready for work. If all parts were smooth and bored and cut accurately, little trouble will present itself and the motor will go buzzing around at first connection.

X-RAY TUBES FOR HIGH-FREQUENCY COILS.

(*Continued from page* 309)

It is really a combination of two distinct tubes, as indicated by the heavy vertical dotted line. When the current passes in the direction of the arrow (b) X-rays are produced from the cathode and target (c and d) in the righ-hand half of the tube; alternations in the opposite direction, indicated by the arrow (a), produce a stream of rays from the left half of the tube. This is the most efficient form of high-frequency X-ray tube, as it uses both sets of alternations. It is now practically obsolete, however, as it was found that the two sets of X-rays overlapt and produced double outlines in the skiagram.

At the present time there are two types of X-ray tubes made for use with high-frequency currents. The one shown in Fig. 3 has a target of heavy copper faced with tungsten, and is mounted opposite the active cathode (c); when the current flows in the opposite direction the electronic stream from the small cathode (c^1) becomes choked out and dispersed by the constricted glass neck (d), which acts, in a measure, as a valve, eliminating the inverse discharge.

Another type of modern high-frequency X-ray tube is shown in Fig. 4. in which the cathode rays from the small aluminum mirror (c^1) focus inside a small copper cone (d), in which they are converted into heat and take no part in the production of the X-rays.

Tubes of these types may be operated by the current from a Tesla coil or from an Oudin resonator. In a previous article in the May issue of the ELECTRICAL EXPERIMENTER the writer has given details for the construction of apparatus of both these types.

When the Tesla coil is used its terminals are connected to the two aluminum cathodes (c and c^1); the Oudin coil has but one active terminal which should be connected to the active cathode (c); the small cathode (c^1) may be grounded, but this is not absolutely necessary.

X-ray tubes are spoken of as "hard" and "soft"—a "hard" tube is one which has been exhausted to a very high degree—(say, one-ten-millionth of an atmosphere) —a "soft" tube has a lower degree of exhaustion (between *one-five-hundred-thousandth* and *one-one-millionth* of an atmosphere). More current is needed to operate a hard tube, but it gives deep penetration and works more quickly. The soft tube, on the other hand, produces strong contrasts in the skiagram or fluoroscope.

Tubes have a tendency to become hard by use, the trace of residual air or gas being gradually driven out thru the intermolecular spaces of the glass by the electronic bombardment. So it is necessary to provide the tube with some means for replacing these lost ions at intervals.

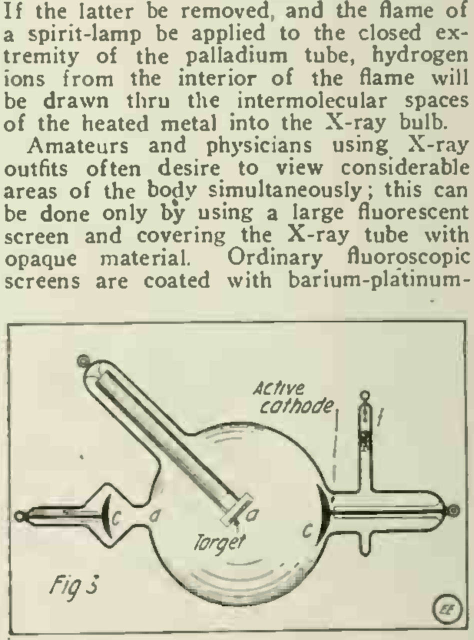
The first is of the thermic type and is now seldom used (see e, Fig. 2); it consists of a small bulb containing potassium chlorat sealed into the side of the X-ray tube. By heating this bulb with a match or spirit-lamp, a trace of oxygen is given off, which reduces the pressure in the tube to the required degree. The modern high-frequency tubes use the forms known as the "spark regulator" and the "osmotic regulator."

The first is the more common type and is shown in (f, Fig. 3). A platinum wire is sealed in the regulator tube which contains a gas-producing chemical, such as manganese dioxid, or sodium formate, f.

In practise a piece of E-shaped stiff brass wire set in a rubber handle is used to divert a portion of the current from the active terminal to the wire in the regulator; the heat from the current liberating the gas and softening the tube.

A regulator of the osmotic type is shown at (g, Fig. 4). It consists of an extremely small tube of metallic palladium sealed into the side of the X-ray bulb, the inner end of the metal tube being open while the outer end is closed. Ordinarily the tube is protected by a cylindrical glass cap. If the latter be removed, and the flame of a spirit-lamp be applied to the closed extremity of the palladium tube, hydrogen ions from the interior of the flame will be drawn thru the intermolecular spaces of the heated metal into the X-ray bulb.

Amateurs and physicians using X-ray outfits often desire to view considerable areas of the body simultaneously; this can be done only by using a large fluorescent screen and covering the X-ray tube with opaque material. Ordinary fluoroscopic screens are coated with barium-platinum-



One Form of Commercial High-Frequency X-Ray Bulb of the Single-focus Type, Utilizing An Active Cathode "C", Also a Small Cut-off Cathode "C¹". The Inverse Cathodic Stream from "C¹" Is Choked Off and Dispersed by the Constricted Glass Neck "D", Which Acts As a Valve.

cyanid and cost about $0.25 per sq. inch. A very good screen may, however, be easily made by evenly coating a sheet of white cardboard with a solution of sodium silicat and immediately sifting on it finely powdered calcium tungstat. Gently raise the screen on its edge and tap it to shake off the excess of tungstat; then allow to dry. A still simpler experimental screen may be made by painting a card several times with a strong solution of quinine bi-sulfate.

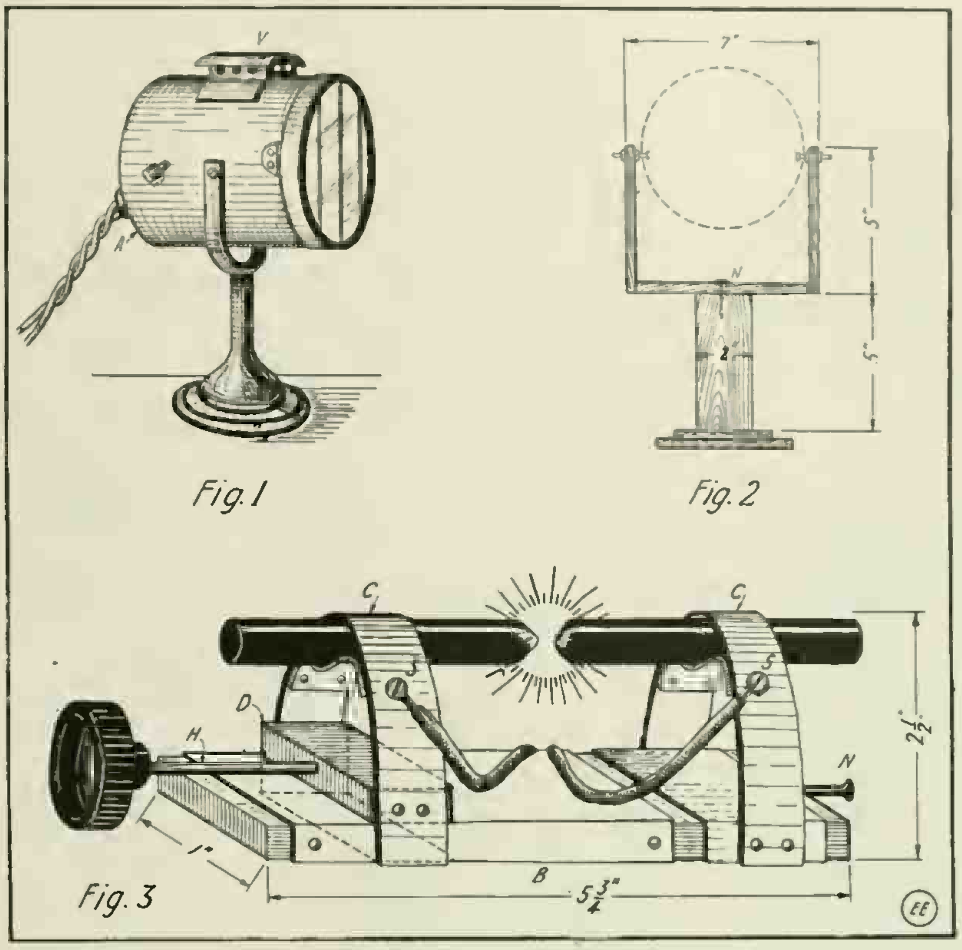
A Home-Made Arc Search-Light for the Amateur

By FRANK M. JACKSON

THE arc search-light here shown and described when properly constructed and focused, is capable of projecting a powerful beam that can be seen for several miles around. The amateur will find it very interesting to pick out distant objects as well as passing pedestrians and vehicles. The materials required are few, most of which are found around the amateur's home. The search-light is not difficult to construct and is quite worth the effort.

The body of the searchlight, A (Fig. 1) is a large syrup can, 7 inches long and 6½ inches in diameter. No other size can will do unless the carbon clamps and base are made to correspond with it. The ventilation top, V, is made from tin, cut and bent into the shape shown. The holes are punched to allow the heat and smoke to escape. Before fastening it to the can a large oblong hole is cut directly under it. The top is then fastened on with small stove bolts. A broom stick fastened to the back of a tin strip, bent into a sort of U shape, bolted to the back of the can, forms a handle.

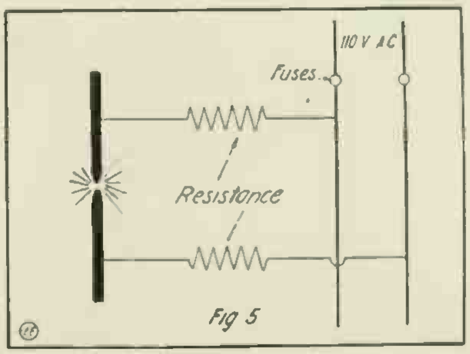
The next thing to make is the base. A stand taken from an old electric fan is just the thing, but a wooden or iron one with the same swivel adjustment can be easily made and will well serve the purpose. In Fig. 2 the wooden one is shown with the dimensions. The dotted circle represents the front of the can and shows method of fastening it to the base. These bolts must be loose enough to permit movement up and down. Movement from side to side is allowed by the single nail shown at N, Fig. 2. Next procure from an automobile supply house or garage a parabolic reflector such as that from an old gas lamp. This should be about 6 inches in diameter. It is next fastened to the rear end of the search-light. This mirror reflects the light from the arc and sends out a beam greatly intensified.



Appearance and Detail of Arc Carbon Holder for Experimental Search-Light. Many Scientific as Well as Practical Uses Can be Found for Such a Device, Including the Stunt of "Talking Over a Beam of Light."

Showing the Arc Search-Light Made by the Author, Complete with Rheostat.

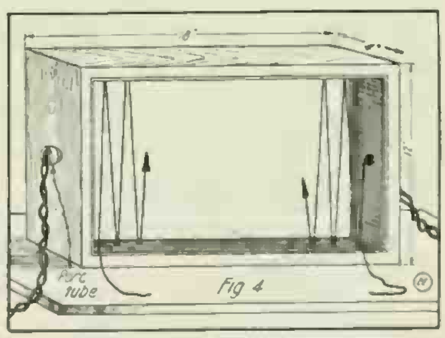
Great care must be taken in the construction of the clamps, which are to hold the carbons, to follow the dimensions correctly. The wooden base, B, Fig. 3, is 5¾x1x½ inches. First cover it all over with a thin piece of asbestos. Next a strip of tin is fastened around the left hand end of the base and runs ⅗ of the way to the other end. Then a small space ¼ inch is left so that the tin strip on this end will not short-circuit with the strip on the other end. A small piece of tin is put on the right hand end, the same as the left, but much shorter. The clamp at the left hand end is adjustable. It should slide easily over the tin strip on the base. It is made from tin cut and bent around the carbon and base and then fastened onto each side of the block, D, which is 1x1x½ inches and is covered with asbestos and tin. To this block is also fastened the handle, H, with the hard rubber knob on the end. The clamp at the right is stationary and is fastened to the base. The clamps should each be 2½ inches high. A stick of carbon ½ inch in diameter and 12 inches long may be procured from a store dealing in electrical goods for only five cents. It is broken into four equal pieces to put into the clamps and held into position by the screws, S and S. Put a nail, N into the right hand end of the base.



Connections for Miniature Arc Search-Light on 110 Volt Circuit.

The next thing to do is to put the clamps into the search-light can. The best way to find the position for the proper focus is by holding a candle at different distances from the reflector. When the smallest spot is projected this is the best focus. Mark this position and put the clamps in as shown in Fig. 3, with the nail at the right hand end and the handle at the left going thru small holes, one in each side of the can. If desired striped glass, as shown in Fig. 1, may be mounted on a hinged door at the front of the searchlight, but is not necessary. The searchlight is now complete.

A suitable resistance to operate with the searchlight must be constructed. This resistance is shown in Fig. 4. The two ends are each 4x12 inches and the top and bottom are each 4x18 inches. After screwing these boards together as shown, they are lined inside with heavy asbestos. Procure from a hardware store 50 feet of No. 18 soft iron wire, which will cost about five cents. Cut the wire in two 20 foot lengths and run it in zig-zag fashion thru staples in two rows 3 inches apart, the length of the boards. Fig. 4 shows how the wire is pulled thru the staples in two



How Rheostat Frame Is Made. It Should be Constructed of Fire-Proof Materials Thruout.

(Continued on page 332)

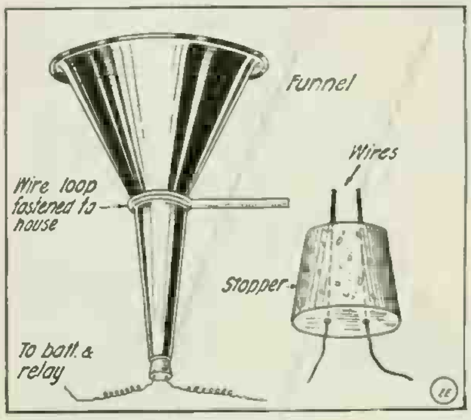
This department will award the following monthly prizes: First Prize, $3.00; Second Prize, $2.00; Third Prize, $1.00.

The purpose of this department is to stimulate experimenters towards accomplishing new things with old apparatus or old material, and for the most useful, practical and original idea submitted to the Editors of this department, a monthly series of prizes will be awarded. For the best idea submitted a prize of $3.00 is awarded; for the second best idea a $2.00 prize, and for the third best prize of $1.00. The article need not be very elaborate, and rough sketches are sufficient. We will make the mechanical drawings. Use only one side of sheet. Make sketches on separate sheets.

SECOND PRIZE, $2.00

AN ELECTRIC RAIN ALARM.

Take an ordinary funnel, either glass or tin, and fasten it into place where the rain can get into it easily and quickly. Take a cork, or preferably a rubber stopper, with two wires thru it, as shown in the diagram, and insert in the smaller end of the funnel. The wires should be only a small space apart, and you should drop a little salt into the funnel to make the water a better conductor.



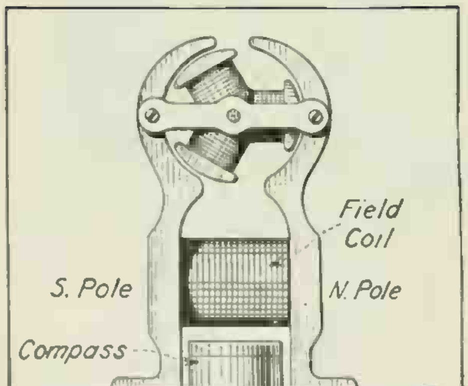
An Electric Rain Alarm Is of Undoubted Value In Every Home. The Rain Water, Mixing With a Few Grains of Salt, Closes the Alarm Circuit.

When a few drops of rain fall into the funnel it will close the circuit thru a relay and battery, thus ringing a bell.

Contributed by G. C. ZANKL.

UNIQUE EXPERIMENT WITH MOTOR AND COMPASS.

While working at my electrical apparatus, I picked up my compass and placed it near a screw-driver not thinking that it would injure the compass. After remaining there for two days, it drew all the magnetism from the needle of the compass. It would remain in any position that I placed it, making it, of course, useless. I resolved to fix it, and after experimenting with it for fully an hour, succeeded as follows: I placed the North pole of my toy motor facing North, then I placed the compass under the field coil of my motor, which I put in operation for about one minute, after which it served as a new compass. The armature should be left out of circuit.



Demagnetized Compass Needles May Be Made As Good As New by Simply Placing the Compass Under the Field Legs of a Toy Motor.

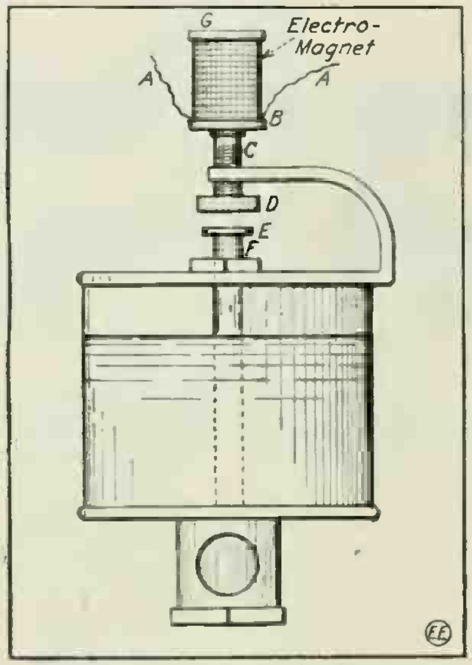
Contributed by JOHN UEBLER.

FIRST PRIZE, $3.00

A MAGNETICALLY CONTROLLED OIL CUP.

An electro magnet is used in this scheme. A are the electric wires. D is a round soft iron plate, C is the screw rod, E is an iron cap on top of the oil feed pipe F.

To open the oil cup turn on the electric current and iron disc D becomes magnetized and pulls up cap E on top of oil feed pipe F, and the oil will start to drip. When the current is shut off D loses its magnetic power. E and F drop down and close up the oil hole again. To regulate the flow of oil, B is turned and the screw rod C raises or lowers plate D. By using a small solenoid and a rheostat the control of the oil cup can be made quite precise.



A Practical Application of the Electro-magnet, Enabling the Engineer to Control Oil Cups At a Distance, Also In Groups.

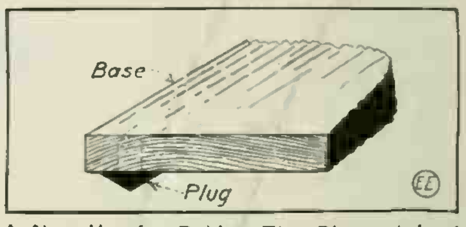
Contributed by OTTO C. HALSTRUM.

Due to the advent of the war, we are particularly desirous of obtaining manuscripts describing original and practical "Electrical Experiments." We shall continue to publish Radio articles, but what we need is snappy "Electrical" articles. Be on guard for the enemy—Repetition!

THIRD PRIZE, $1.00

TIRE PLUGS AS INSTRUMENT FEET.

After trying out various anti-shock feet, insulators, etc., I hit upon the idea of taking a rubber bicycle tire repair plug and drilling a hole in each corner of the base the size of the stem and gluing the plug fast. This makes an excellent insulator as well as silent and shock-proof foot. (Ye Gods! Next!! Editor.)



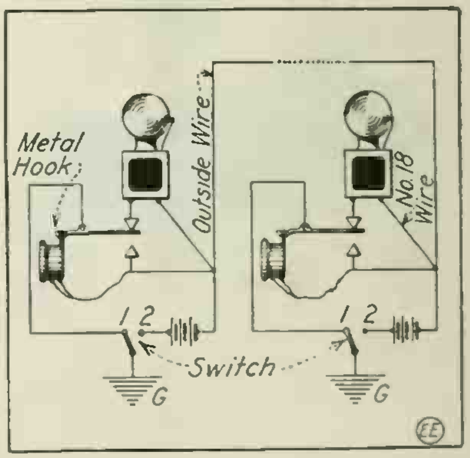
A New Use for Rubber Tire Plugs at Last. Why Not Use Them for Instrument Feet? Too Bad Some Genius Can't Find an Electrical Use for Old Shoe Nails.

Contributed by WILMER J. SLIFER.

A SIMPLE TELEPHONE.

The accompanying diagram shows a good way in which to rig up a telephone system by means of an E. I. Co., Pony receiver which may be used as a telephone (both for transmitting and receiving) up to a distance of 150 feet or more. For longer distances batteries should be connected between the receiver and line wire.

After the stations are connected as indicated, one station may ring the other by removing his receiver, the weight of which has kept the ground wire in connection with the bell, and turning the switch handle to point 2 in the diagram. To put both receivers in the circuit it is necessary to throw the switch back on point 1. The weight of the metal hook will cause it to drop to the lower contact.



To Make This Simple Telephone System All You Require, Are Two 75 Ohm 'Phones, 2 Call Bells, 2 Push Buttons, Batteries, 2 Switches and a Pair of Home-made Hook Switches.

Contributed by CLAUDE IRELAND.

THE FRANKLIN EXPERIMENTAL CLUB.

(Continued from page 311)

vited guests and members, and every encouragement was given to original experiments and the construction of original apparatus and for some time it was a rule that each member must perform an original experiment, however crude, at least once a month, and many well-known principles in electricity, magnetism, sound, light, chemistry, etc., were thus demonstrated and originality and initiative stimulated.

With a view to bringing before the community the earnest aims and accomplishments of the club, an elaborate electrical dinner was given on January 31st, 1891, which was attended by Mayor Haynes of the City of Newark; Senator M. T. Barrett; Supt. of Public Schools, W. N. Barringer, Sec. of the Board of Education, Lyndon Brice, and other prominent men, including William Wallace, Edward Weston, Francis R. Upton, Frank J. Sprague, James M. Beck and Richard F. Outcault. The guests were entertained by electrical experiments, and many novel effects, and regaled with food and coffee cooked by electricity. Cigars were lighted by electricity, for there were no matches to be had, and a tiny electric railway running about the table carried food, cigars, cigarettes, etc., to the guests, while in the meantime they were entertained with instrumental and vocal music rendered by a young lady seated at a piano a block away, which music was transmitted by a loud-speaking telephone thru a trumpet suspended over the table; from this trumpet hung a circular bomb, which was exploded by electricity during the feast, bombarding the guests with bonbons.

A number of electro-magnets hung suspended at various points from the ceiling and were connected in series with the lighting circuit; these magnets held up roses and carnations to each of which a tiny nail or screw had been attached, so that when the magnet circuit was broken the guests were treated to a shower of beautiful flowers, which fell all over the table. There were bears, alligators and storks about the table, equipt with blinking eyes and holding electric lamps or other ornaments, while real gold fish, which had tiny incandescent electric lamps inside their stomachs, connected by thread-like insulated wires to a storage battery were beautifully illuminated from time to time in the darkened room as they swam about in a huge glass globe. Near the center of the table were three skulls with electric lamps blinking in their eyeless sockets; they rested on a black velvet pedestal containing a concealed phonograph and frequently during the meal the guests were startled by a sepulchral voice emanating from the skulls which said:

"As ye are now, so once were we.
As we are now, so ye shall be."

Perhaps the most interesting feature of the dinner was presented in a life-sized wax figure of Benjamin Franklin loaned by the "Eden Musee," who with a benignant smile on his countenance, sat at the head of the long table and presided over the feast; periodically Franklin who held in one hand a kite string attached to a replica of Franklin's kite placed in the far corner of the ceiling of the room, would draw a long flash of lightning to a key held in the other hand and by means of a phonograph inside of his anatomy, he made an address to the guests as follows:

"My dear Friends:—

"Through the genius of Mr. Thomas A. Edison, I come back to you from the past of over a century ago. I am glad to find I am so well remembered and I am pleased to preside at this, the first annual banquet of the Franklin Experimental Club of Newark, New Jersey.

"Good things will bear repeating. Let me quote some expressions of mine, which I see have now become household words of yours.

"'Early to bed, and early to rise, makes a man healthy, wealthy and wise.'

"'If you would know the value of money, try and borrow some.'

"'When the well is dry, they know the worth of water.'

"'Experience keeps a dear school, but fools will learn at no other.'

"'Now I have a sheep and a cow, every one bids me good morning.'

"'For want of a nail, the shoe was lost; for want of a shoe, the horse was lost.'

"'Three removes are as bad as a fire, and a rolling stone gathers no moss.'

"'A small leak will sink a great ship.'

"'What maintains one vice would bring up two children.'

"'Industry pays debts, and despair increaseth them.'

"'Always taking out of the meal tub, and never putting in, soon comes to the bottom."

"'If you would have a faithful servant and one that you like, serve yourself.'

"'Sloth, like rust, consumes faster than labor wears, while the used key is always bright.'"

During the dinner some appropriate remarks bearing upon Franklin, and his work, made by Mr. Edison, and which he had *personally* recorded upon a phonograph cylinder especially for the occasion, were listened to with great interest.

At the center of the table stood a five-foot reproduction of the Eiffel Tower, lighted by many tiny electric lamps with a miniature searchlight on top. During a sudden darkening of the room the model was beautifully illuminated by colored fire set off by electricity on the various platforms of the tower; this was followed by the Marseillaise sung by Mme. Adini and M. Melchizdec of the Grand Opera, Paris, rendered by a phonograph cylinder made by the society's president in M. Eiffel's private room on top of the Eiffel Tower the day the Paris Exposition of 1889 closed.

The guests also listened with rapt attention to the voices of M. Eiffel, M. Gounod and others shouting "Vive la France," "Vive la Republique" as the booming of the official gun stationed on top of the Eiffel Tower could be plainly heard, announcing the close of the Paris Exposition; simultaneously a tiny cannon on top of the replica of the tower, which decorated the table, was fired off by electricity and the dinner and its festivities came to a close. Each guest carried away as a souvenir a medallion of Benjamin Franklin, on the reverse of which was inscribed data regarding Franklin, and the Franklin Experimental Club.

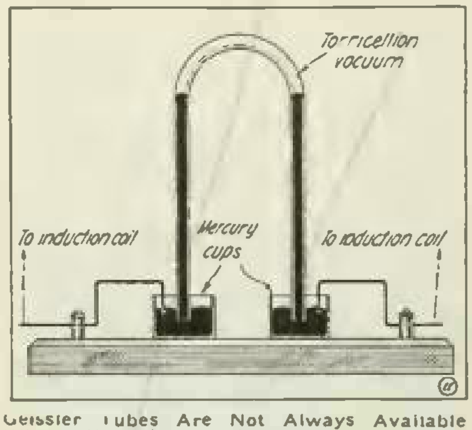
AN EXPERIMENTAL GEISSLER TUBE.

The best results and effects are obtained with discharges from the secondary of an induction coil in glass tubes when the exhaustion is carried to a pressure of about 2 mm. of mercury, and the tubes are permanently sealed.

However for experimental purposes a Geissler tube made as described below gives most satisfactory results.

Procure a glass U-tube about 34 inches high. Fill it with clean mercury, close the ends with the fingers and invert it into two vessels of mercury. Upon removing the fingers, the mercury in the two arms will fall a few inches, as shown in the accompanying sketch. This will create a vacuum in the upper part of the tube, known to physicists as a Torricellian vacuum, from Torricelli, a pupil of Galileo.

Wires are led from the mercury cups to two binding-posts, as shown. If the electrodes of an induction coil are connected to these terminals, a luminous phenomenon



Geissler Tubes Are Not Always Available When Wanted. Here's the Way to Make One In Your Laboratory.

is produced in the upper section of the tube.

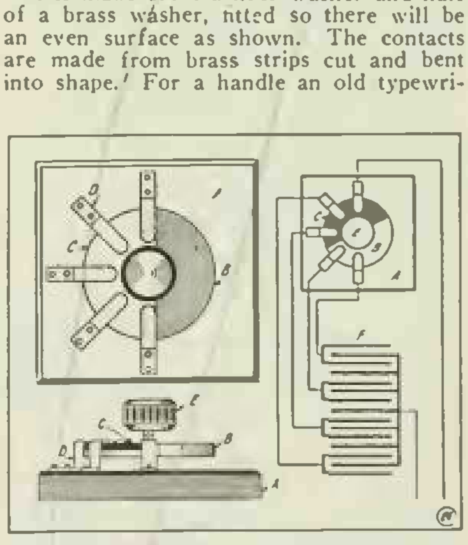
This experiment may be varied by carefully admitting different gases or vapors into the evacuated space. The luminous effects obtained thereby are very beautiful. The colors are determined by the nature of the residual gas. Hydrogen glows with a brilliant crimson; the vapor of water gives the same color, indicating that the vapor is dissociated by the discharge. An examination of this glow by the spectroscope gives the characteristic lines of the gas in the tube.

Contributed by PETER J. M. CLUTE,
(Union College, Physics Laboratory.)

A CONDENSER SWITCH OF PROVEN EFFICIENCY.

Here is a small (or any size the reader may desire to make it) switch for use on an adjustable condenser. It is simply built and will work easily without getting out of order readily.

It is made from a fiber washer and half of a brass washer, fitted so there will be an even surface as shown. The contacts are made from brass strips cut and bent into shape. For a handle an old typewri-



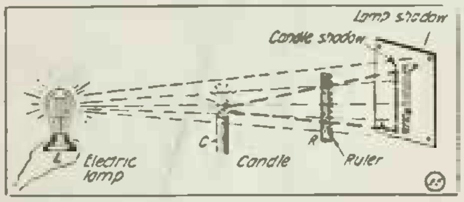
If Properly Made This Form of Condenser Switch Will Give the Best of Satisfaction. Bend the Contact Springs So They Do Not Catch on the Disc Edge.

ter knob will do. A few brass, round-head screws and a wooden base make up the rest.

Contributed by A. C. HANSEN, JR.

HOW TO CALCULATE THE CANDLEPOWER OF A LIGHT.

To compare the (illuminating) power of two lights, *e. g.*, lamp (L) and candle (C) is quite a simple matter by the following (Rumford or shadow) method: Pin to the wall a piece of white paper. About a foot away from and in front of this paper fix a rod, R (say an office ruler), vertically, says a writer in *The Amateur Photographer's Weekly*. Place the lamp L, in line

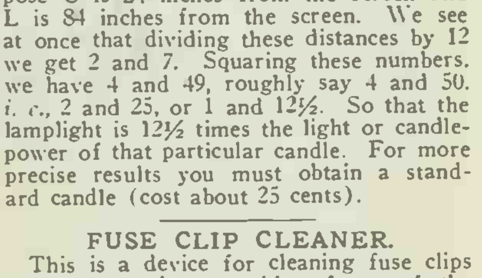


A Simple Method of Determining Candle-Power of a Light.

with the rod so that it casts a shadow of the rod, R, vertically somewhere about the middle of the paper screen. Now place the candle, C somewhere between L and R, so that the two shadows of R cast by C and L are just touching (side by side). Move C and L about until these two shadows seem to be equally dark—or light, as you may be disposed to regard matters. Now the shadow cast by L is illuminated by C, and that cast by C is illuminated by L. The illumination values are inversely as the squares of their distances from the screen. For example, suppose C is 24 inches from the screen and L is 84 inches from the screen. We see at once that dividing these distances by 12 we get 2 and 7. Squaring these numbers, we have 4 and 49, roughly say 4 and 50. *i. e.*, 2 and 25, or 1 and 12½. So that the lamplight is 12½ times the light or candlepower of that particular candle. For more precise results you must obtain a standard candle (cost about 25 cents).

FUSE CLIP CLEANER.

This is a device for cleaning fuse clips on blocks using cartridge fuses of the ferrule type, and as dirty clips do not make good contact it will prove a very useful and handy article to have. It is made from a blown fuse of the proper size to fit the block to be cleaned. Take two pieces of fine emery cloth, cut to the width of the brass ferrules of the fuse, marked A-A, and just long enough to go around once. Put a little glue on the cloth side and squeeze tightly around ferrule and tie with a string to hold them securely until the glue has had time to dry. Then drill a hole thru the fiber body B, and insert an eight-penny nail to be used as a lever. To use, insert in the fuse clips as you would an ordinary fuse and by using the nail as a lever and rocking it back and forth, you will find that the clips have been evenly



Pull This Home-made Cleaner Back and Forth a Few Times in the Fuse Clips and They Will Be Thoroly Cleaned.

cleaned, and will make a first-class contact. A large percentage of fuses are blown, or in other words melted, by the heat generated from a poor contact of the fuse, and the fuse terminals or clips.

Contributed by FRED R. KLINK.

"RADIO" COMMUNICATION OVER GAS AND WATER PIPES.

(*Continued from page* 318)

Considering the receiving apparatus necessary to pick up the buzzer signals as transmitted thru the earth, we have at Fig. 1 the simplest type of receiver, *viz.*, one employing a radio detector such as silicon, or other mineral, and a pair of radio receivers connected unilaterally to the water pipe. We call particular attention to this first circuit, as it shows a very important consideration; *i. e.*, that the radio detector circuit of whatever type used should be connected only in a *unilateral* manner so as to be excited by *one wire* or unipolar current. The detector circuit should not under any condition be connected in a *bipolar* manner, or the operator thereof is liable to get into serious trouble with the Government authorities. The receiving circuit Fig. 2, shows a unilateral detector with small fixt condenser shunted across the 'phones; this local circuit being tunable by means of a loose coupler, and variable condensers shown. The primary of the loose coupler is connected thru a variable capacity to the water and gas pipes.

The receiving circuit shown in Fig. 3 is similar to diagram No. 2, except that an ordinary tuning coil or adjustable aircore inductance is employed instead of a loose coupled two-coil transformer. In this circuit a variable condenser may be used as indicated by the dotted lines to properly attune the secondary circuit. Receiving diagram No. 4 is for loose coupler and an Audion detector which is connected unilaterally.

Several hook-ups are given for combined transmitting and receiving circuits utilizing a buzzer transmitter and unilateral radio receptor. These circuits are simple and no trouble will be experienced in understanding them.

Diagram No. 1 utilizes a double-contact telegraph key; diagram No. 2 calls for a single contact key, and circuit No. 3 also utilizes a single contact key, but requires a two-point switch to change the apparatus from transmitting to receiving.

A HOME-MADE ARC SEARCHLIGHT FOR THE AMATEUR.

(*Continued from page* 329)

rows, from one end to the other. A porcelain tube is put in each end.

The apparatus is connected as shown in Fig. 5. Two lamp cord wires are run from the plug and socket attachment into the resistance box and connected to the two resistance wires, one to each row. Lamp cord connections are made to the wires at the other end and led out to the searchlight. Here they run thru a porcelain tube into the searchlight, where they are connected to the screws that hold the carbons in place. Before trying the searchlight change the fuses in its circuit to at least 15 amperes. This is important, for if the searchlight is left burning continuously very long, fuses of lower ampereage are apt to blow. To use the searchlight, push in the handle with the rubber knob on it until the carbons touch. The light will not be very bright until the ends of the carbons have points burnt on them. It is a good plan to file a point on the carbons before putting them in. Different focuses can be obtained by merely turning the knob to the right or to the left. A large spot is best for short distances, while a small spot is best for long distances.

I have shown many boys in my home town how to construct searchlights similar to this one. A searchlight seems to interest every boy.

SELENIUM CELL DESIGN AND CONSTRUCTION.

(*Continued from page* 325)

for winding, but it is rather difficult to wind such wires evenly.

Another modified form of this cell construction is shown in Fig. 3. In this case the selenium is placed on the insulating support before the wires are wound on. This form was not found to be very satisfactory. It is difficult to properly anneal as the selenium is practically hidden by the wire and in use the selenium is shaded too much by the wires unless the light is traveling perpendicularly to the axis of the cell and the source at a fairly great distance.

The disadvantages of the Bidwell cell are to a large extent done away with in the forms of construction employed by Bell and Taintor, Mercadier and Fritts. A cross-section of the cell employed by Bell and Taintor in experiments with their *photophone* is given in Fig. 4. Round disks of brass or copper about one inch in diameter are mounted on two metallic rods, the plates being separated by mica washers and alternate disks connected to the rods. The result is a cylinder with alternate plates connected to the same terminal. The selenium is flowed over the surface of the cylinder in a thin layer and thoroly and slowly annealed. This construction is good where it is feasible to use a parabolic reflector, so all sides of cell may be acted upon. The thinner the film on the cell the greater the ratio of the lighted to the darkened resistance.

Where a flat cell is preferred the Mercadier type will be found useful. In this cell the conductors are wound in a flat spiral as shown in Fig. 5. Mica strips serve to insulate the plates. With a little care excellent cells of this type may be constructed. They have the same characteristics as the Bell type of cell, but are of simpler construction. Due to the fact that the strips are curved, it will be found rather difficult to make a number of these cells having the same resistance, because slight variations of the curvature between the metallic strips will result in cells of widely differing resistance.

To Ruhmer is due the credit for enclosing selenium cells in a vacuum to protect them from moisture and dust. In all types of cells in which the selenium comes in contact with the air it is advisable to make some provision to keep out moisture. This can be done by enclosing in a glass bulb or test tube. Flat cells may be enclosed in small wooden pill boxes which have a small glass window on one side. A simple construction employed by the writer is to utilize the end of a tubular flashlight. The tube was cut off just back of the threaded end supporting lens and a fiber bottom put in. The container was warmed and after inserting the cell was sealed with wax. A small threaded screw was fastened in the fiber bottom to clamp the cell in any desired position. Another method of protecting the cells is to paint them with a transparent varnish. By mixing dyes with this varnish it is possible to make a cell that will only be acted upon by one color. The transparent collors sold for painting postcards will be found suitable for the purpose.

The last mentioned cell, the Fritts, is possibly the most sensitive type ever developed. Its construction is fairly easy, but gold foil is used in the construction. It is not affected to an appreciable extent by moisture and can be made in extremely small sizes without difficulty. (See Fig. 6.)

It consists essentially of a thin film of selenium on one side of which is a copper

(*Continued on page* 356)

Experimental Chemistry

By ALBERT W. WILSDON

Sixteenth Lesson

Sulfuric Acid (History)

SULFURIC acid, is without doubt, the most important and useful acid known, and has been called, next to human food, the most valuable of products. By its means nearly all the other acids are prepared, whilst its manufacture constitutes one of the most important branches of modern industry owing to the great variety of purposes for which it is needed, as there is scarcely an art or trade in which in some form or other it is not employed. In enormous quantities

Fig. 81. Introducing Burning Sulfur in Bottle for the Minute Preparation of Sulfuric Acid—H_2SO_4.

it is used in the preparation of material for bringing food plants to maturity, in the manufacture from common salt of a great variety of compounds of Sodium and Chlorin, which enters into the making of such commercial substances as glass, soap, bleaching powder, and even bread. Scarcely any of the products of civilized life have been brought to perfection without its use, directly or indirectly. It is manufactured on an enormous scale in many countries; nearly one million tons are annually made in the United States, while Germany had, previous to the European conflict, produced a similar amount. Great Britain produced close to one and a half million tons.

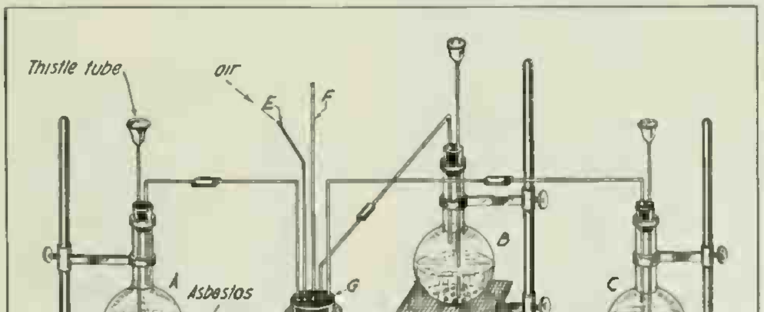
Geber probably made and used this acid, which he called "Vitriolic Acid," but Basil Valentine was the first to fully describe the preparation of this acid from Ferrous Sulfate [Fe SO_4] or Green Vitriol, and to explain that when Sulfur is burnt with Saltpeter a peculiar acid is formed.

Sulfuric acid was originally obtained exclusively by heating Green Vitriol; the acid thus prepared consisted of Sulfur tri-oxid dissolved in Sulfuric acid, and from its property of fuming in the air is known as "Fuming Sulfuric acid."

The method by which the greater part of the acid is at present produced is said

Fig. 82. Method of Introducing HNO_3 on Paper in Bottle in Which Sulfur Was Burned. For Preparation of Sulfuric Acid.

to have been introduced into England from the Continent by Cornelius Drebbel; but the first positive information which we possess on the subject is that a patent for the manufacture of Sulfuric acid was granted to a quack doctor by the name of Ward. For this manufacture he employed glass globes of about 40 to 50 gallons capacity; a small quantity of water having been poured into the globe, a stoneware pot then introduced, and on to this a red-hot iron ladle was placed. A mixture of Sulfur and Saltpeter was then thrown into this ladle, and the vessel closed in order to prevent the escape of the vapors which were evolved. These vapors were absorbed by the water, and thus Sulfuric acid was formed. This product, from the mode of its manufacture, was termed *Oil of Vitriol.*



Set-up of Apparatus Used in the Laboratory Preparation of Sulfuric Acid. The Apparatus Follows: A, Flask Holding Water; B, Flask Containing Copper and Sulfuric Acid; C, Flask Containing Copper and Nitric Acid; D, Central Flask, the Sulfuric Acid Generator; E, Tube for Blowing in Air; F, Ventilator Tube (Side Neck Tube in Experiment Described); G, 5-hole Rubber Stopper.

Preparation

It is not practical to make the acid from its salts. Sulfur dioxid [SO_2] in presence of water [H_2O] and some oxidizer becomes Sulfuric acid [H_2SO_4]. Sulfur Dioxid

Fig. 83. Recording on Chemical Thermometer the Temperature Caused by Adding Sulfuric Acid to Water.

[SO_2] and Water [H_2O] have affinity for each other and form Sulfurous Acid [H_2SO_3], which only requires one more Oxygen atom per molecule to make it Sulfuric acid [H_2SO_4]. If Oxygen [O] were forced thru the Sulfurous acid [H_2SO_3], or if the latter were exposed to air, a weak acid would very slowly form, but in practise a stronger oxidizer is needed. Nitric acid [HNO_3], Nitrogen Trioxid [N_2O_3] and Nitrogen Peroxid [NO_2] are most effectual for this purpose. Sulfur Dioxid is made by the reducing action of Copper [Cu] on Sulfuric Acid [H_2SO_4].

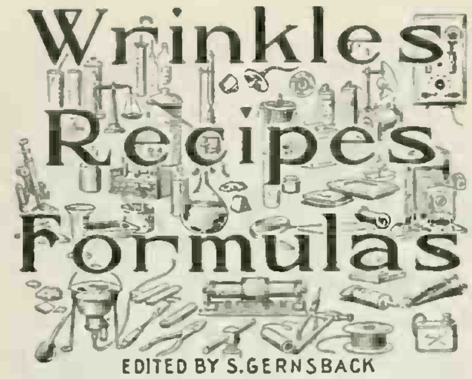
$$\underset{\text{Copper}}{Cu} + \underset{\text{Sulfuric Acid}}{2H_2SO_4} = \underset{\text{Copper Sulfate}}{CuSO_4} + \underset{\text{Water}}{2H_2O} + \underset{\text{Sulfur Dioxid}}{SO_2}$$

By the action of Copper [Cu] on Nitric Acid [HNO_3], Nitric Oxid [NO] is formed, and in the presence of air oxidizes to Nitrogen Peroxid [NO_2].

$$\underset{\text{Copper}}{3Cu} + \underset{\text{Nitric Acid}}{8HNO_3} = \underset{\text{Copper Nitrat}}{3Cu[NO_3]_2} + \underset{\text{Water}}{4H_2O} + \underset{\text{Nitric Oxid}}{2NO}$$

$$\underset{\text{Nitric Acid}}{NO} + \underset{\text{Oxygen}}{O} = \underset{\text{Nitrogen Peroxid}}{NO_2}$$

(*Continued on page* 351)



Under this heading we publish every month useful information in Mechanics, Electricity and Chemistry. We shall be pleased, 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.

COMPOSITION OF ALLOYS.

The number of alloy compositions such as bronze, brass and babbitts which are now placed on the market by various companies are almost innumerable, each containing various proportions, and some having special ingredients but nearly all contain practically the same combination as a basis. In almost every case the composition is varied slightly according to the uses to which the part cast from the alloy is to be put.

In general the composition of the most common alloys is as given in the accompanying table:

TABLE OF COMPOSITION OF COMMON ALLOYS

Alloys	Tin	Copper	Zinc	Antimony	Lead	Bismuth
Babbitt's metal...	10	1	..	1	..	..
Bell-Metal	5	16	..	..	..	..
Brass, engine bearing	13	112	¼	..	..	..
Brass, locomotive bearings	7	64	1	..	..	..
Brass, for straps and glands.....	16	130	1	..	..	..
Flanges to stand brazing	..	32	1	..	1	..
Muntz's sheathing	..	6	4	..	..	..
Metal to expand in cooling......	..	..	..	2	9	1
Pewter	100	..	..	17	..	..
Spelter	..	1	1	..	..	..
Statuary Bronze..	2	90	5	..	2	..
Tough brass, engine work......	15	100	15	..	..	..
Tough brass, for heavy bearings..	25	160	5	..	..	..
Yellow Brass, for turning	..	2	1	..	..	..
Solders						
For brazing (hardest)	..	3	1	..	..	..
For brazing (hard)	..	1	1	..	..	..
For brazing (soft)	1	4	3	..	..	..
For brazing (soft) or	2	..	..	1	..	..
For lead	1	..	..	..	1½	..
For pewter	2	..	..	..	1	..
For tin	1	..	..	..	2	..

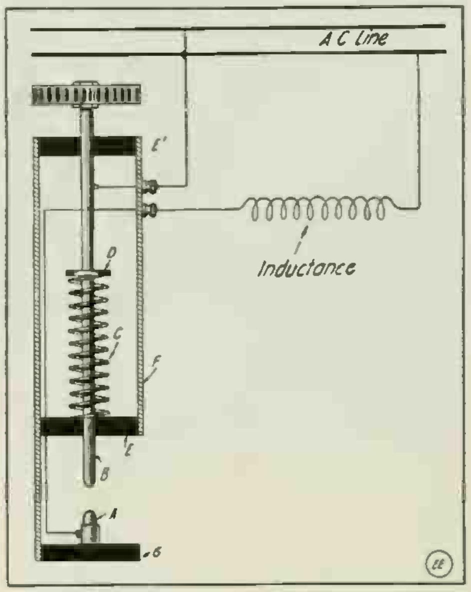
EXPERIMENT HOW TO MAKE GAS.

Take some hard coal and grind it up fine. Put it in the bowl of a clay pipe and put some plaster of Paris over the top to seal it. Then put the bowl of the pipe over or in the flame of the gas stove. In a few moments the gas will be coming out of the stem of the pipe and the same can be lighted.

Contributed by SHERMAN B. LAW.

AN ELECTRIC GAS LIGHTER FOR THE "LAB."

An electric gas lighter is not only a necessity but a convenience, especially in laboratories and such places, where gas is turned on and off at frequent intervals. The sketch shows how the writer constructed one with a few tools and in a very short length of time. The casing (F) is of hard rubber or fiber sawed as shown in sketch; the bushings (E) and (E') are also hard rubber or fiber, but can be made of impregnated hard wood. Spring (C) is to keep the movable electrode separated from the stationary electrode (A); (D) is a clamp around the movable electrode to hold the spring in its proper place.



This Electric Gas Lighter Will Be Found a Distinct Convenience in Every Shop and Laboratory. Use an Iron Core Inductance On A.C. Circuits and a Resistance Coil On D.C. Circuits.

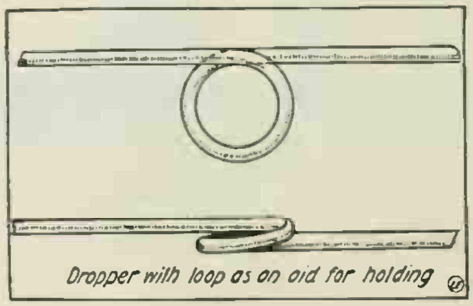
The wires leading to the line and inductance are flexible cords and may be brought out to small terminals on the side of the casing.

The inductance can be varied by the number or turns required for different cycles; the inductance used by the writer was obtained from an old A. C. arc light but one may be easily constructed by winding a number of turns of wire around a soft iron core.

Contributed by HARRY E. BEANE.

AN IMPROVED PIPETTE.

In chemical laboratories the most commonly used dropper consists of a straight glass tube. However, if the tube or one's hands are wet, the dropper is hard to hold.



Place Your Finger In the Loop of This Improved Pipette and It Simply Can't Slip from Your Grasp.

I overcame this difficulty by bending the tube so as to form a complete loop in it, of about three-fourths of an inch. One can slip a finger thru this loop and all danger of its slipping is eliminated. The sketch represents the improved dropper more clearly.

Contributed by
ALFRED H. HANSRATH, JR.

HOW TO SOLDER ALUMINUM.

There are various compounds on the market for soldering aluminum, but this operation depends more on the workman than on the solder and unless considerable experience has been had it is probably better to purchase solder than to attempt making it. Zinc can be used but does not form a very strong joint. Tin can also be used, is more nearly the color of aluminum, is stronger than zinc, but is very difficult to work. A small proportion of phosphor tin added to pure tin makes it work more readily and is the basis of most aluminum solder.

The chief difficulty in soldering aluminum is that the heat is dissipated so rapidly that it cools the soldering iron and furthermore aluminum oxidizes instantly upon exposure to the air. This extremely thin film effectually prevents a perfect union being made. If the parts are well heated and melted solder kept hot while the iron is allowed to stand on it, the surface can be scraped beneath the melted solder by the point of the soldering iron, thus preventing to a certain extent the oxidization. In this way the metal can be tinned. When both parts to be brought together are well tinned, the parts can be united with some chance of success, nitrat of silver, resin, or zinc chlorid being used as a flux. A soldering tool of nickel gives more satisfactory results than a copper one as the latter alloys with the tin and soon becomes rough.

Cleaning the Metal: If the surface is of such a shape that it cannot be readily cleaned by scraping, it can be cleaned by dipping it into a solution of nitric acid in three times its bulk of hot water containing about 5 per cent. of commercial hydrofluoric acid. This causes a slight action on the surface of the metal as shown by bubbles. Rinse the metal after removing from the acid bath and dry in hot sawdust.

Aluminum Solder: The following formula, in the hands of a competent man, can be used to unite aluminum or aluminoid parts:

Tin—10 parts.
Cadmium—10 parts.
Zinc—10 parts.
Lead—1 part.

The parts to be united must be thoroly cleansed and allowed to stand two to three hours in a strong solution of Hypo-Sulfate of soda before being operated upon, or cleaned in the acid bath described above.

Contributed by AN EXPERIMENTER.

THE WHEEL GLASS-CUTTER.

Many experimenters have at some time or other occasion to cut glass, and no doubt most of them use the wheel-cutters, which are soon thrown away as of no use. Perhaps the following tip will be of service to them. I had occasion to cut some glass a few days ago, and had only an old, and, as I thought, worn-out wheel to do it with. I tried dipping it in a drop of paraffin, and was astonished to find that it cut as well as when new. I experimented with two others which I had discarded, and found that they cut equally well. Turpentine seems to answer the same purpose.

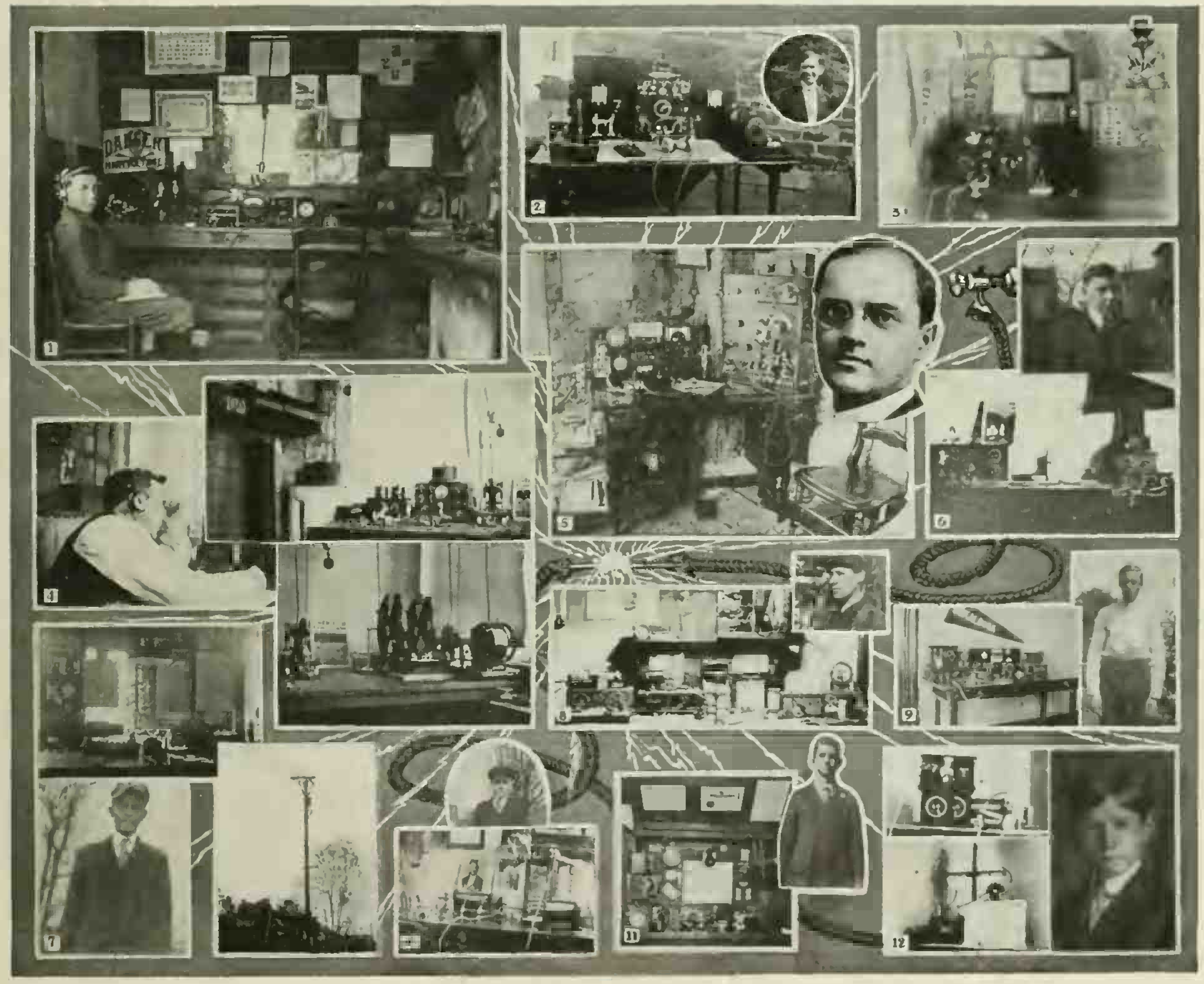
This may be a welcome tip to some of your readers; it was certainly a new experience for me.

WITH THE AMATEURS

Our Amateur Laboratory Contest is open to all readers, whether subscribers or not. The photos are judged for best arrangement and efficiency of the apparatus. To increase the interest of this department we make it a rule not to publish photos of apparatus unaccompanied by that of the owner. Dark photos preferred to light toned ones. We pay each month **$3.00** prize for the best photo. Make your description brief and use only one side of the sheet. Address the Editor, "With the Amateurs" Dept.

IN THE LANGUAGE OF "BILLY SUNDAY"—"WAKE UP! YOU ELECTRICAL 'LAB' SLACKERS!!!"

"Slackers!" 'at's what we said. Why in the name of Howling Pete is it, that you "Electrical" and converted (?) "Radio-bugs" can't get some real American spirit in your craniums and start something? The way you slack around, bemoaning the free-for-all radio experimental days, one would think "Uncle Sam" had injected a sleep-walking toxin in every mother's son of you. Suffering kilowatts, shake yourselves—"Bugs!" What's the world coming to when not one "Bug" out of 800,000 of you ohm, volt and oscillation chasers, will condescend to accept $3 in prize money?!! The devil'll get you sure as guns; said devil being We, Us & Co. Open your eyes, read Mr. Hammer's eloquent sermon on this all-important topic in this issue; likewise the Editor's. Read 'em! Preach em! Then dare to sit tight and howl "There ain't no young 'Hammers' or 'Edisons' no more." Rot! We don't and won't believe you. Now get busy and to help awaken the future Faradays, Hammers and Edisons we will give, besides the $3 prize for the best "Electrical Lab." photo, 5 (FIVE!!!) additional prizes of a year's subscription to this journal and a copy of the "Experimental Electricity Course." Come on, you sore-headed "Radio-bugs"; hit the trail; "Experimental Electricity" is King now. Redeem yourselves to-day, before it is too late. Address the Editor "With the Amateurs" Prize Contest.



A GROUP OF ALL-AMERICAN AMATEUR RADIO STATIONS.

Radio Stations of, 5—K. F. Gray, Easton, Pa. (Prize Winner); 1—William F. Warden, Jr., Mt. Dora, Fla.; 2—A. E. Facks, Brooklyn, N. Y.; 3—Harold Bennett, Clarinda, Iowa; 4—J. H. Hamilton, Philadelphia, Pa.; 6—John F. Isenberg, Altoona, Pa.; 7—Edward G. Raser, Trenton, N. J.; 8—Floyd M. Rush, Salem, Ore.; 9—Guy L. Tullis, Oskaloosa, Iowa; 10—Russell C. Cravens, Angola, Ind.; 11—S. Webster Piper, Hagerstown, Md.; 12—Lot and Hodge Alexander, Grove City, Pa.

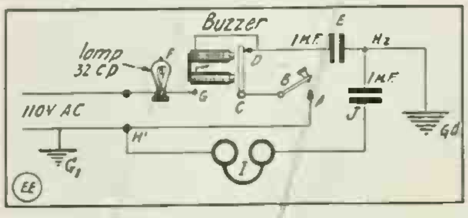
Prize Winners in "Radio Problem" Contest

We are pleased to publish herewith several of the suggestions we have received as well as the prize winning ideas telling what to do with your radio apparatus during the war. Several thousand suggestions were received from all parts of the country, but the majority of them covered similar topics to those discust below.

FIRST PRIZE $10.00.

A Non-Radio Communication Scheme That Works

I am quite sure that the following little experiment should fulfil the desired wants of my fellow



Radio friends whose apparatus is now on the shelf.

In the following explanation I will show how "idle" condensers, keys, receivers, and buzzers can play an important part in re-establishing communication between them. While the distance is limited, there should be no trouble in communicating thruout the city. I have successfully used this system for a distance of nine (9) city blocks. The circuits thus far used do not permit the reception of "Radio" signals and thereby evade the now strict law regarding Radio stations being kept closed. This is by no means a "Radio" station and cannot be clast as such. I cannot emphasize too strongly on this point regarding the fact that Radio signals cannot be heard at all; this, of course, gives us the desired results: "Idle" apparatus put back into use and communication re-established.

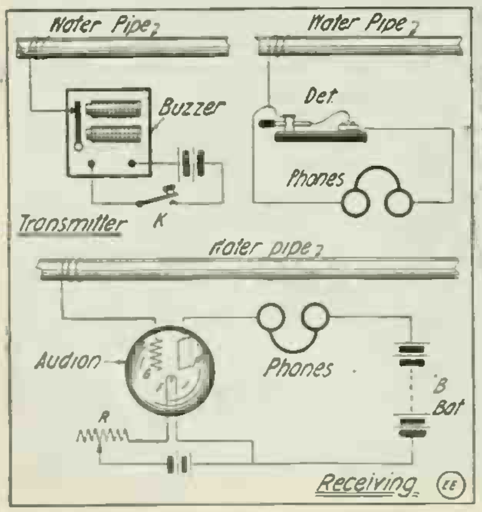
I hope that you will not fail to consider the importance of such a system when it will bring thousands and thousands of my friends back into the game and help pass these dreary days when almost any amateur would offer $5.00 to hear CQ again. The best feature of this system is that it is naturally a "break-in" system. If my friend who lives nine blocks away is sending to me and if I have QRM, I just make some dots and he stops. It certainly is interesting and we are communicating every day. As yet we have not heard a single Radio signal on it. Just previous to the declaration of war we were free from interference as we were the only ones using this circuit in town and it therefore was easy working—and it is now, until we get some other one wised up to this circuit and he starts to butt in. As we have not had any experience with interference it will be hard to state what action a third party will have on the interference question; should he interfere schedules will have to be arranged.

Again—by inserting *inductance* or *detectors* in the receiving circuit *no change* is detected; therefore none are required.—EDW. T. JONES.

SECOND PRIZE $5.00.

Buzzer Communiciation via the Water Pipe

There is about only one way left by which we can communicate without wires and use our radio sets (that is part of them) and not be clast as "wireless" and that is to employ some sort of ground system, such as a water or gas pipe or two ground plates.



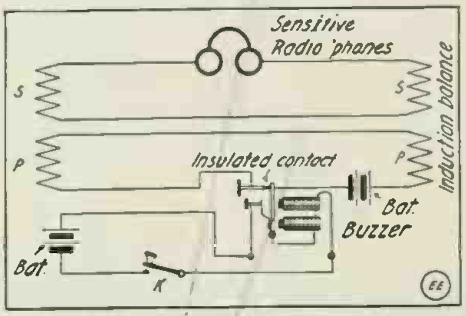
Another "Radio-bug" of this city has a friend in Toronto, Can., who reports that the experimenters there are using a water pipe for the conductor, a buzzer for transmitting, and an Audion in the receiving circuit. They are covering about ten miles with this system. We have no more "dope" as to the exact hook-up at present. The accompanying hook-ups might be worth trying.

In cities where the amateurs are close together there could be relays; if the range is short this would be quite a bit of fun and keep us from getting too rusty.

A spark coil or a transformer could possibly be used to take the place of the buzzer for greater distances.—OLIN M. WARREN.

How to Use Your Radio Apparatus for Scientific Tests

As I have actually used my wireless apparatus with success as follows, other experimenters will find these uses practicable and interesting. As the



directions for constructing the apparatus can be found in back numbers of THE ELECTRICAL EXPERIMENTER, I have refrained from giving construction data here.

If you have a high-priced pair of head 'phones they need not remain idle, for they can be used in connection with a Hughes "Induction Balance." With such a "balance" you can test the sensitiveness of various receivers, determine the degree of magnetism in all metals, test the hearing ability of your friends and the relative frequency of currents. In connection with this instrument your receiving condensers, both fixt and variable, will come in handy. Your buzzer set can be used in frequency tests.

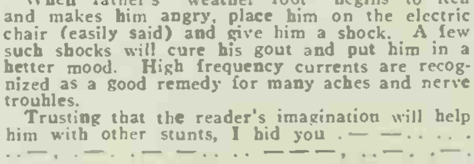
The helix or oscillation transformer can be used to advantage in the operation of a musical arc or speaking arc. Such an arc light is a source of much amusement and the mystification of your friends.

If you have a coherer set with a good relay, you can easily construct a selenium cell to use with the relay. With such a cell you can start a motor by waving your hand, or make an "electric dog," and numerous other experiments. An Audion can be used to advantage in connection with the selenium cell.

Finally boys be patriotic and run a nice big American flag up your wireless mast. Show your patriotism!—ROBERT CHANDLER.

Oudin or Tesla Coil from Tuning Coil and Helix

Take a single slide tuning coil and remove the rod and slider. Then set the coil inside a helix



(see Fig. 1) and by connecting up as shown in Fig. 2 an Oudin coil will be the result.

Burned out Audion and electric bulbs make good giessler tubes. By nailing copper plates to the kitchen chair a valuable "Sing Sing Death Chair," to mystify the spectators will be added to your apparatus.

When father's "weather foot" begins to itch and makes him angry, place him on the electric chair (easily said) and give him a shock. A few such shocks will cure his gout and put him in a better mood. High frequency currents are recognized as a good remedy for many aches and nerve troubles.

Trusting that the reader's imagination will help him with other stunts, I bid you . — — . . . . . . — , . — . — — . . . . — — — , . . — . . — . . . . — . — . . . .

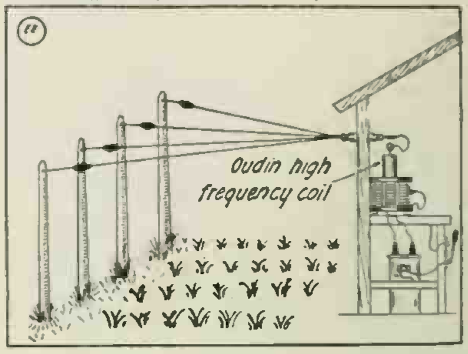
—LEWIS MOSKOWITZ.

Exhibit Amateur Radio Apparatus

It seems to me that about the best use to which the amateur wireless operator might put his apparatus during the war would be to install it in the nearest Signal Corps recruiting station. Its more or less intricate appearance as a whole undoubtedly would attract attention and enlistments. Furthermore, it would arouse enthusiasm for wireless on the part of the fellows too young to fight; and, at the conclusion of hostilities, they might go in for wireless. As such an experiment would undoubtedly act directly for the good of the nation, and, ultimately, for the good of wireless itself, it seems to me that this is about the best use to which the amateur might put his apparatus during the war.—JAMES R. ALLEN (9EU).

Electric Vegetable Cultivator

Thinking it my duty to send you an idea, to



answer the question *"What can I do with my wireless apparatus,"* every amateur ought to help solve the food question and he can if he adds a Tesla coil to his outfit and uses his apparatus as an "Electric Vegetable Cultivator" or else an X-ray outfit.

If he makes an Electric Vegetable Cultivator, he will not only derive pleasure out of it, but profit also.—BRUNO BONKOFSKY.

Convert Radio to Electrical "Lab."

Why not enlarge your wireless station and change it into an electrical laboratory? Almost every amateur has on hand odd electrical apparatus, such as bells, magnets, motors, dynamos and the like. Such apparatus as this with the wireless set will make up a large part of the laboratory equipment and, aside from making it look "electrical," will find a practical use. Such parts of the wireless set as the spark coil or the step-up transformer will be of special value in performing Tesla experiments or in X-ray work. Likewise other parts will find uses equally as practical. From time to time articles in THE ELECTRICAL EXPERIMENTER will be of great value to the amateur in his work and I am sure many of them will explain the uses of wireless instruments in the laboratory.

Money spent in laboratory apparatus and for electric books is always well invested.

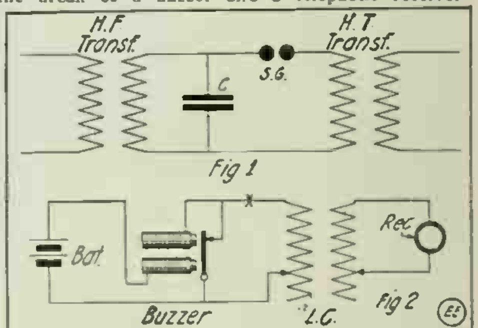
May the wireless enthusiasts get together on electrical laboratory work, thru THE ELECTRICAL EXPERIMENTER and clubs thruout the country, as they have been in wireless telegraphy.—FRANK M. JACKSON.

More High Frequency Stunts

Herewith are given a few ideas for the use of radio instruments during the war.

The average amateur sending set is an almost complete high frequency generator. All that is necessary is to insert within the old helix or oscillation transformer primary a secondary of fine wire on a cardboard tube of suitable length. The result is a high frequency coil of either the Tesla or Oudin type. See Fig. 1 for connections.

By connecting a loose coupler primary across the break of a buzzer and a telephone receiver



to the secondary, we have an instrument for demonstrating electromagnetic induction, for tuning and coupling to some extent and for code practice as well as for measuring purposes. See Fig. II.—JACOB HALLER, JR.

Several other good ideas will appear in the October issue.

Laboratory "Contest"(?)

TOO bad. Too bad. Here we have gone and advertised for three solid months that we wanted photos from "bugs", experimenters, *et al*, showing their laboratories. Uncle Sam says: "Boys, Wireless is taboo, just now. Nix on the ether waves." The EXPERIMENTER being a patriotic sort of a chap, promptly seconds the motion. The radio amateurs not to be outdone, not only second the motion, but triple and quadruple it, i. e., they fire radio-station photos at us till the postman staggers under the load.

Question: Why when wireless is forbidden do we get twenty radio-station photos a day, where before the war we received but two or three? Verily, verily, the ways of human nature are strange.

At any rate this month we proudly exhibit one specimen. Yes this one is the real stuff, no fake about it, honest. And what's more—hang the modesty stuff—it shows your editor in person. You always wanted to know what kind of a mug he has, didn't you? Well you've had your wish. True, the picture is not a very recent one, having been taken some odd 19 years ago, but it's the best to be had, of those memorable days. If we were to tell you that the proud young person in the picture was 13 years old when it was taken, you could of course figure out quickly how old the "ancient crab" is at present. But as modesty forbids such statements we will not indulge in them.

At any rate your young hopeful was as big a "bug" as grow nowadays. Yep, he *was* some "bug." There was nothing that was not represented in that "lab" of his. Of course, wireless was not as yet invented in those days, but telephones, batteries, magnetos, spark coils, meters, Tesla coils, motors, dynamos, etc., all were here in a great array. And believe us, fellow bugs and buglets, we had *some* fun. There was a telephone line and a telegraph line to our friend's house and we even had a Bell Photophone, made with a crude selenium cell, and a telephone receiver of antique vintage. This, as you probably know works by talking over a ray of light, using the back of a vibrating mirror as the sender, while the selenium cell, telephone and battery form the receiving station.

With this apparatus we covered about 200 feet at first. The transmission of speech was very good and the articulation fine—if we yelled loud enough. We might add that we could hear just as well without the apparatus! But, as real dyed-in-the-wool experimenters, we did not give up. Rather finally we "obtained" (censor deleted the mode of "obtaining" it) a commercial selenium cell, and with this we actually transmitted articulate speech over a light ray about ¼ of a mile. It worked real well, too, and it is a matter of constant surprise to us that present day "bugs" don't go in for this sort of work. It certainly is a whole lot of fun to talk over a mere ray of light.

Next came another sort of "wireless" phone. This was an earth conductive system* by burying a set of metallic plates, 100 feet apart at different levels in the earth. A microphone and batteries connected with the plates. The receiving end consisted of a set of similar plates, spaced equally apart, and buried at different levels, too. A simple telephone receiver connected with the plates. Speech was thus actually transmitted over a distance of one mile, and this outfit worked for a long time. By using large zinc and copper plates, this system was improved in 1903 and over 3 miles were then covered.

"La-dies an' Gen-tell-menn! This Way, Please—and Don't Crowd Too Much. Here You Behold the Ge-nnu-ine and Only Photo in Captivity Portraying Your Editor's Phiz! Yes, La-dies, the "Ancient Crab" Was Some "Bug" Once!

But your young hopeful's main and staple vice in those days was batteries. Without fear of contradiction we make the sweeping assertion that he spent more time and money on batteries than any other boy, alive, dead, or as yet to be born, Thomas Reed inclusive!! Batteries, ah! You elusive, ever perplexing devils! And we made every one ourselves, no "boughten" ones for us.

Ah, yes, those brave Bunsen's! Some batteries! Strong as an ox, both in current *and* smell! But we fixt the fumes alright, you bet. How? Simplicity itself! On top of the vile-smelling nitric acid, contained in the porous cups, we poured about one inch of petroleum! That stopt the fumes *almost* entirely and the batteries kept on working longer. Ten such batteries each about 12 inches high, could light a dozen or more 16 volt 8 C.P. old time carbon lamps, and what's more, the Bunsen's kept doing it for 2-3 weeks on one filling, feeding the lights each night. And the lamps burned remarkably steady, too. Of course, the cleaning and filling was a nasty, messy job, and many a pair of shoes and pants were ruined by the strong acids, but in the pursuit of science, we stop at no such commonplace items as these!

Our photo shows the young battery "bug" surrounded by his Bunsen's. As may be noted, they gave quite a spark on short-circuit. Soon, however, we gave up the vile-smelling Bunsen's and we then ran the whole gamut of the battery will-o'the-wisp. Chromic-acid, one and two fluid; Daniel copper sulfate; Edison-Lalande copper-oxid; gravity copper sulfate cells; peroxid of lead-zinc (a good battery by the way) down to Upman's chlorin-gas battery. Yes, we believe there is no battery that was ever invented that we did not actually try out. Some day we'll describe a few new ones, so as not to be humiliated by Tom Reed!

At any rate we finally settled down and compromised on an 8 cell glass jar storage battery, giving 16 volts and 40 ampere-hours. Each of these 8 cells were connected to a "Pachytrop" exactly described by Mr. C. A. Oldroyd in the March, 1917, issue of this journal. Turning the handle 90 degrees connected all the cells in parallel. Another turn connected the cells in series. While connected in parallel the eight storage cells gave, of course, about 2 volts, and in this position they were charged by eight very large copper-oxid-caustic soda-zinc batteries. These cells are ideal for storage battery charging, and will be described fully in a later issue, if we can find the time. Suffice it to say that each cell was made of black sheet iron in the form of a tray, about 18 inches long by 12 inches wide. The height was but 3 inches. These trays were copper-plated inside and a stout copper wire was soldered in a corner. This formed the positive pole. The bottom of the tray was covered with a ½" layer of Cupron nuggets,* while in each corner of the tray there was a small porcelain insulator. On top of these a heavy zinc plate, well amalgamated was placed. The tray was then filled with a solution of caustic potash, so that it stood ½" over the zinc plate. On top of the caustic potash we poured a layer of mineral oil. The battery was then ready to operate at once, and it gave about 0.9 volt and 12 amperes. This voltage dropt to 0.7 when charging the storage cells. The eight tray-batteries, therefore, gave over 6 volts, enough to charge the storage batteries.

These Cupron cells were "all to the good" and gave no trouble worth mentioning. They did not mind in the least being short-circuited for hours at a time, and the steadiness of the current is amazing. These batteries are perfectly odorless, require no attendance and need not be filled for months at a time. Nor are materials consumed when they stand idle.

Now "bugs," for the love of Pete, get busy and shoot along those "lab" photos. *We* aren't paid to write up this sort of "dope." Soon we'll strike! Lookatatime! I A. M.!! Have you no pity on the overworked "old man"?!

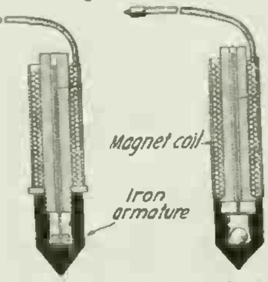
* See "The Wireless Telephone," by H. Gernsback, Page 26.

* Cupron is a higher form of the ordinary commercial copper-oxid, i. e., suboxid.

LATEST PATENTS

Magnetic Battery Gage
(No. 1,231,708; issued to Emerson L. Clark.)

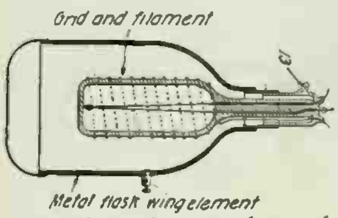
A simple form of battery gage especially for use with dry cells. The cost of the device is very low, and it is extremely simple and rugged in design. It indicates



whether a cell is up to standard by means of an audible signal or by the sense of touch. A low resistance magnet coil is wound on the non-magnetic frame, and when the point of the instrument is placed on one battery terminal, and the flexible lead touched to the other terminal, the coil will produce a magnetic field, thus pulling up the iron armature. This can be heard when attracted by the magnet core, and if the finger is placed over the top of the hollow core, the rising armature pin will strike the finger, giving a second form of indication. The inventor gives details for elaborating the moving armature design so as to use scales; thus permitting of calibrating the instrument for any strength of current.

Metallic Audion
(No. 1,230,874; issued to Lee de Forest.)

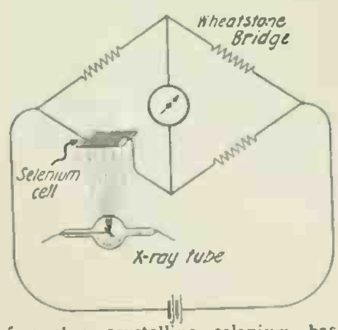
Dr. de Forest, the well-known radio inventor, has here developed



an especially desirable form of Audion blub, which is made of metal so as to stand transportation better than glass. Moreover, the metal flask containing the grid and filament elements serves as the wing or plate. The grid support is preferably all glass, and the patent contains details of assembling the flask and other parts. Finally a metal bottom is welded to the open end of the flask, and the completely inclosed receptacle thus formed is connected to a vacuum pump, and thereby exhausted of air thru the usual tip.

Measuring Gage for X-Rays
(No. 1,229,740; issued to Robert Fürstenau.)

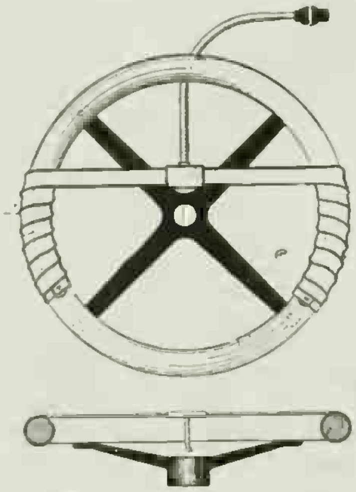
This invention is based on the



fact that crystalline selenium has the property of varying its electrical resistance when subject to the action of X-rays. This resistance variation is very slight for X-rays, but the patentee overcomes this objection by placing the selenium cell in one branch of a Wheatstone bridge as shown in the diagram. The arrangement and the strength of the resistances are so calculated that when the selenium cell is not exposed to any rays, a current flows thru the galvanometer of the bridge in a direction which is opposite to that of the current flowing thru the instrument when the cell is exposed to the rays.

Electric Steering Wheel Heater
(No. 1,230,788; issued to Even J. Rohne.)

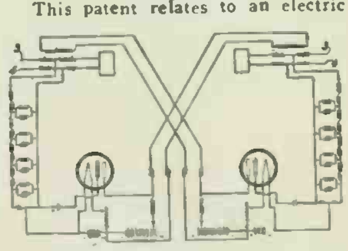
If you have had occasion to drive a motor car in the winter time, you will most probably agree with



the inventor of this device that some simple form of heater for the steering wheel will prove a very welcome addition to the automobile world. The invention here shown comprises a long flexible ribbon made of leather, cloth, etc., folded upon itself to form a flat casing which serves to support and insulate the electric heating elements or wires, and which elements may be connected either in series or in multiple. The electric heater may be connected to the storage battery or dynamo of the automobile, and takes but little current.

Electric Wave-Filter
(No. 1,227,113; issued to G. A. Campbell.)

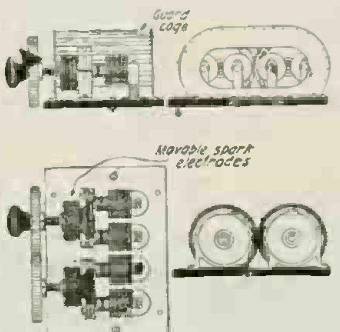
This patent relates to an electric



wave filter utilizing a multiplicity of interconnected and specially tuned circuits comprising inductance and capacity especially adapted to transmit with negligible attenuation, sinusoidal currents of all frequencies lying within a range of preassigned limiting frequencies, while attenuating and extinguishing sinusoidal currents of frequencies lying outside the limits of the pre-assigned range. This wave filter is applicable to wireless telegraphy and telephony, multiplex high frequency wire telephony, etc., and particularly for use on telephone repeater circuits. The diagram shows two Audion type relays connected with the wave-filter circuits, and in series with a telephone line, each side of the line being connected to the terminals 3 and 4.

Spark Gap Improvement
(No. 1,231,489; issued to C. E. Campbell.)

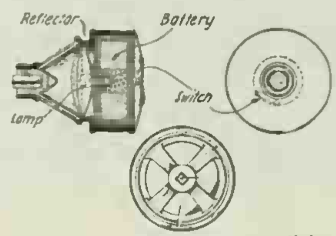
A unique design of spark gap intended particularly for high power



X-ray equipment. The spark gap shown comprises one or more pair of stationary spark electrodes, each electrode being fitted with a large number of cooling vanes in the manner shown. Opposite each pair of stationary electrodes there is provided a disc electrode threaded on the outer perifery and arranged by gears or otherwise with a suitable adjusting knob, so that the one or more discs can be advanced or receded from the stationary electrodes; thus varying the gap length.

Door-Knob Flashlight
(No. 1,230,942; issued to August Sundh.)

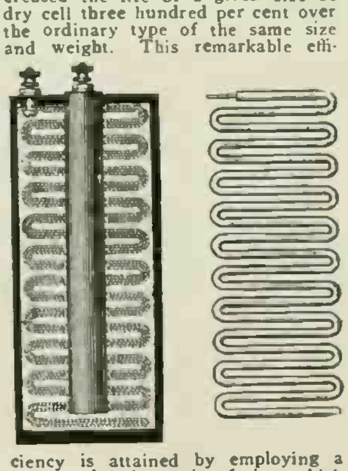
The outermost face of the knob comprises a diafram with a switch attachment, and when depressed this



closes the lamp circuit. The light is reflected by means of a lens and two distinct reflectors placed at right angles to the axis of the knob, thru a glass container and between the supporting spider of the knob itself. A new battery may readily be replaced by unscrewing the outer diafram switch cap.

Unique Dry Cell Battery
(No. 1,231,057; issued to Herbert R. Palmer.)

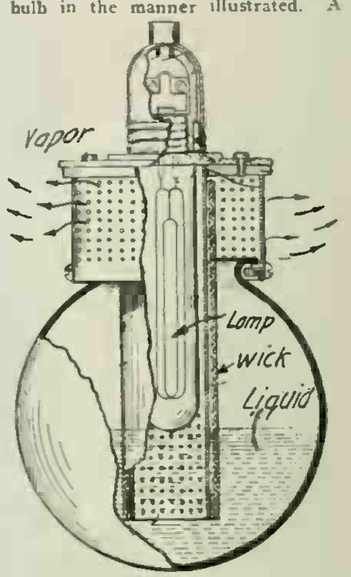
Apparently this idea presents a marked advance in battery design. The patentee claims to have increased the life of a given size of dry cell three hundred per cent over the ordinary type of the same size and weight. This remarkable effi-



ciency is attained by employing a long, undulating strip of zinc, which is thoroly encased in a porous material such as bibulous paper, and then bent or corrugated as shown in a sinuous form. The zinc is first perforated so that the carbon cathode can pass thru the various undulations of the encased zinc element without touching the zinc itself.

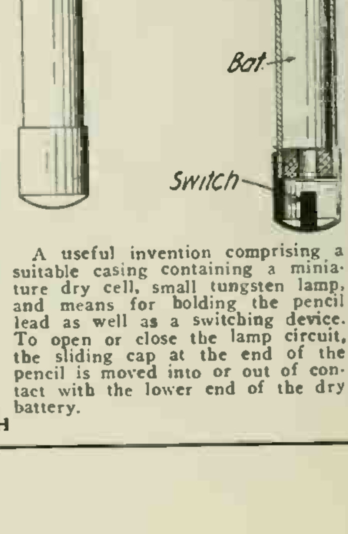
Electric Disinfector and Deodorizer
(No. 1,230,342; issued to R. Thornberg.)

An ordinary tubular incandescent lamp is employed as the source of heat for vaporizing the disinfecting or medicating liquid, which is placed within the glass bulb in the manner illustrated. A



perforated tube surrounds the lamp, the tube itself being covered with an absorbing wick. In this way the liquid is spread out so as to realize the full vaporizing benefit from the heat of the lamp, and the vapor escapes thru the perforated ring at the top of the device as shown by the arrows.

Illuminated Pencil
(No. 1,230,721; issued to E. V. Kelly.)



A useful invention comprising a suitable casing containing a miniature dry cell, small tungsten lamp, and means for holding the pencil lead as well as a switching device. To open or close the lamp circuit, the sliding cap at the end of the pencil is moved into or out of contact with the lower end of the dry battery.

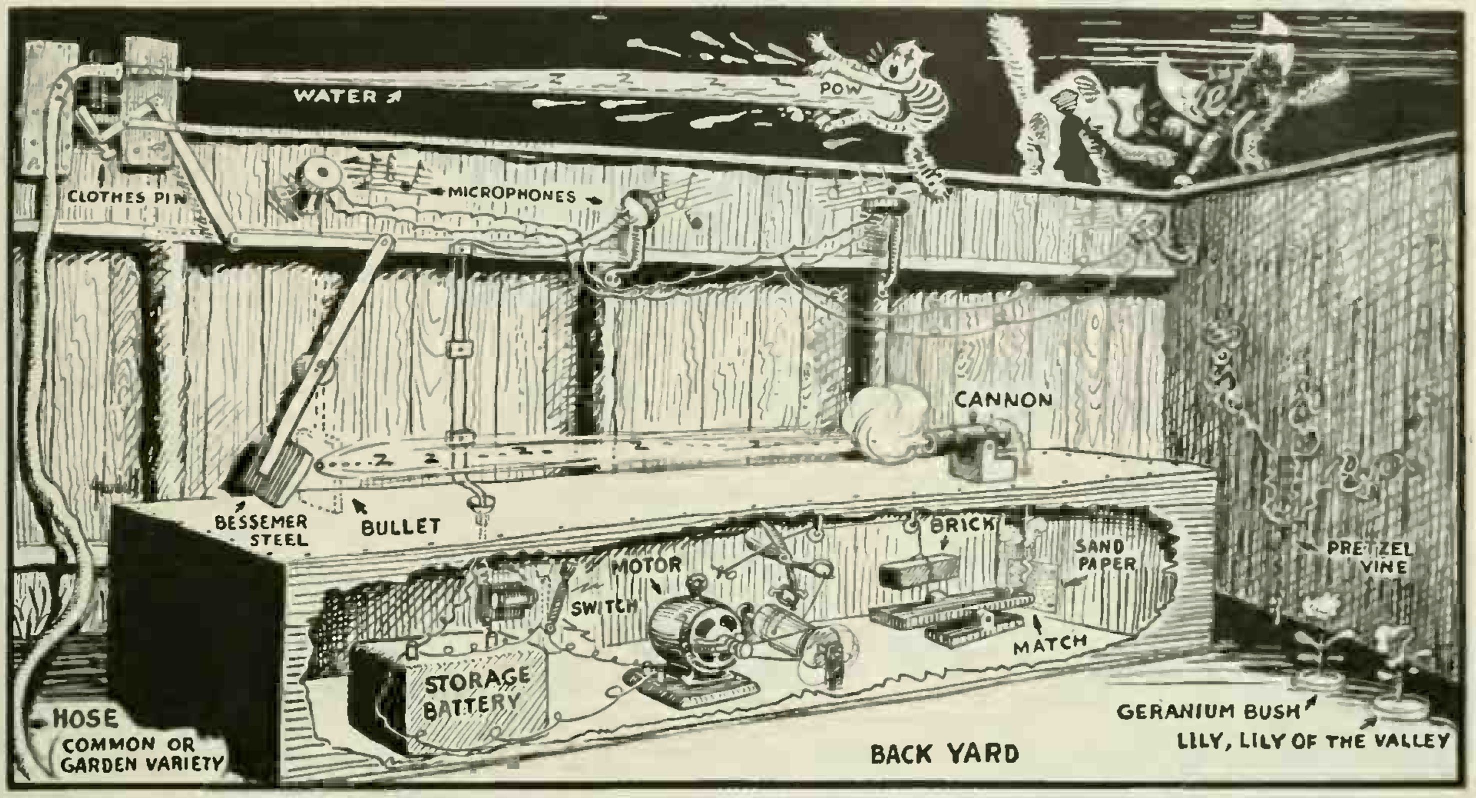
COPIES OF ANY OF THE ABOVE PATENTS SUPPLIED AT 10 CENTS EACH

Phoney Patents

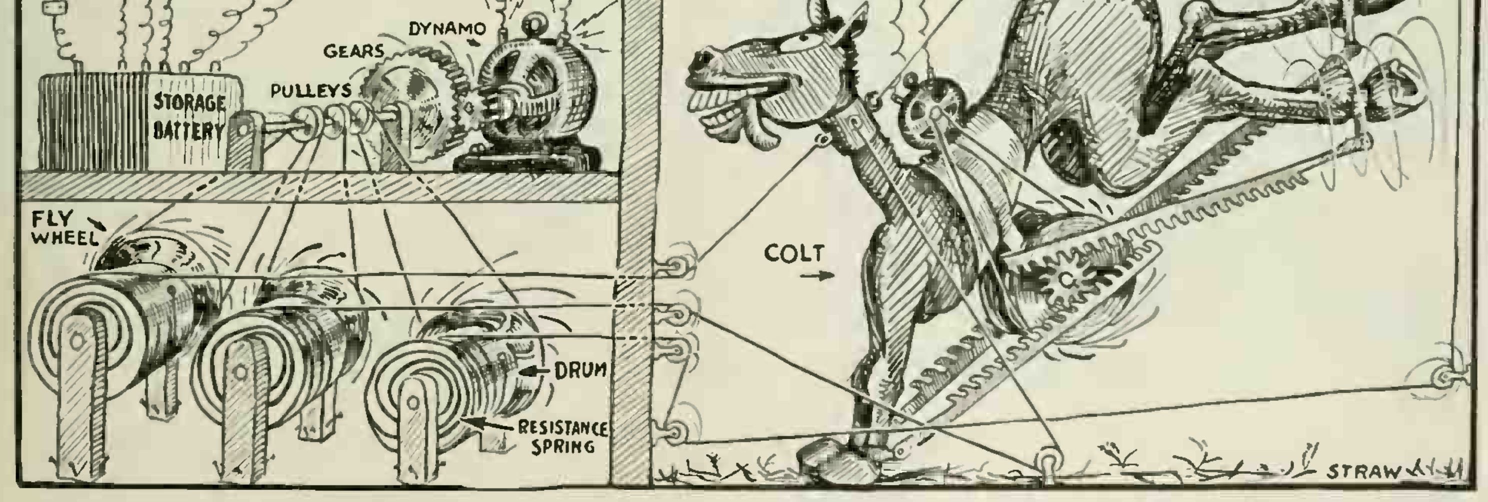
Under this heading are publisht electrical or mechanical ideas which our clever inventors, for reasons best known to themselves, have as yet not patented. We furthermore call attention to our celebrated Phoney Patent Offizz for the relief of all suffering daffy inventors in this country as well as for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

PHONEY PATENT OFFIZZ



FIRST PRIZE: Catextinguisher. Music of Feline Cats Impinges Upon Sensitive Microphones Near Top of Fence. These Operate Relay Thru Storage Battery. The Latter Operates Motor Attached to Winding Drum. String on This Winds Up, Closing Scissors. Scissors Cut String. Brick Drops on See-Saw Board. This Rubs Match At End of Board on Sand Paper. Match Lights Fuse of Cannon, Which Goes Off. Bullet Hits Bessemer Steel Target Which Pulls Lever, Thus Opening Water Supply. Water Stream Extinguishes Cats and Music.
Inventor: H. Gehrig, Cincinnati, Ohio.



COLTPOWER: The Prodigous Power Let Loose by Frisky Colts Has Never Been Harnessed. This Pattent Solves the Trick. By Attaching Gears and Racks to the Colt. Every Time He Gets Frisky and Kicks, He Generates Electricity Thru the Dynamo Attached to His Back. Likewise If He Feels Like Jumping and Running About, Steel Cables Attached to His Collar Will Operate Certain Spring Drums, Which Latter Thru Pulleys and Gears Work the Dynamo. Thus Lots and Oodles of Juice Is Generated.
Inventor: Paul Cromwell, Elkins, W. Va.

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 matter of sufficient interest will be publisht. Rules under which questions will be answered:

1. Only three questions can be submitted to be answered.
2. Only one side of sheet to be written on; matter must be typewritten or else written in ink, no penciled matter considered.
3. Sketches, diagrams, etc., must be on separate sheets. Questions addrest to this department cannot be answered by mail free of charge.
4. If a quick answer is desired 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.

KITE ANTENNA.

(825.) Everett Converse, Ft. Collins, Colo., writes us:

Q. 1. Please tell me if No. 24 bare copper wire suspended from a kite would make a satisfactory aerial and what would be its wave length, if 400 feet of such wire was used?

A. 1. 450 meters.

Q. 2. Would this No. 24 bare copper wire be all right to wind a tuning coil with and what would be good for insulation between turns?

A. 2. Yes. The insulation between turns should consist of a silk thread impregnated with shellac. A still better method of winding this wire is to make a thread on the surface of the tube by placing it on a lathe and winding the wire in the threads so formed. This is an ideal method and all commercial coils of this type are made in this manner.

INDUCTION MOTOR.

(826.) Paul E. Nelson, Fort Smith, Ark., wishes to know:

Q. 1. Can a two-phase, 220-volt, 60-cycle ½ H.P. induction motor be changed to run on 110-volt, 60-cycle A. C.?

A. 1. Yes, by rewinding the stator or field coils so as to be operated on 110 volts.

Q. 2. About how much power would be developed?

A. 2. The power developed will be the same, or ½ H.P., since the motor will now consume twice the current it would when operated on 220 volts.

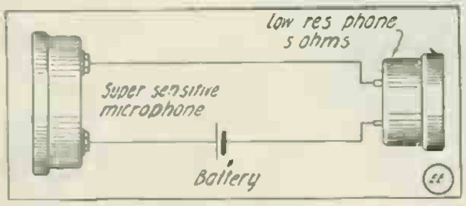
SUBMARINE COMPASS.

(827.) Cyril Thorn, St. Louis, Mo., inquires:

Q. 1. I would like to know how a submarine can use a compass. I should think that the steel shell of the submarine would act as a magnetic screen to the earth's lines of force. Of course, I mean when they are submerged.

A. 1. Submarines do not employ a magnetic compass but they use a gyroscopic compass which is not affected by magnetic bodies but by the earth's rotating forces. It would be impossible to use a magnetic compass on a submersible due to the massive iron hull surrounding the compass, which would act as a magnetic screen as you mention.

DETECTOGRAPH.



Hook-Up for Sensitive Telephone Set or "Detectograph."

(828.) Owen Walker, Lewiston, Me., writes us:

Q. 1. What instruments are necessary for me to build a *detectograph?*

A. 1. A sensitive microphone, a low resistance telephone receiver and a flashlight battery.

Q. 2. Where can I buy them?

A. 2. You can purchase these parts from the Microphone-Detector Co., 26 Cortlandt St., New York City, N. Y.

Q. 3. Please give me a diagram of connections.

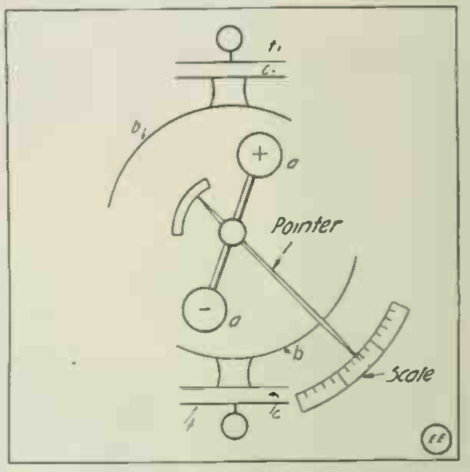
A. 3. The wiring diagram of the instruments is given herewith.

ELECTROSTATIC VOLTMETER.

(829.) Henry Manville, Los Angeles, Cal., writes:

Q. 1. Kindly describe and explain the action of an electrostatic voltmeter as used in the measurement of high tension electromotive forces.

A. 1. The Kelvin voltmeter, developed by Lord Kelvin, its inventor, is suitable for direct or alternating currents from 40 to 100,000 volts. A certain well-known



Connection and Principal Parts of Electrostatic Voltmeter Such As Used in Measuring High Potentials.

company has developed a line of electrostatic voltmeters for pressures from 2,500 to 120,000 volts using condensers in series. In the diagram a and a_1 are movable condenser elements consisting of hollow spherical members supported on a steel ball bearing mounted on polished jewels; b and b_1 are covered metallic sheets forming the opposite plates of condensers which a and a_1 approach as they rotate; c and c_1 are pairs of plates of condensers in series, being connected on one side of the instrument t and t_1 and on their other side to the inner condenser plates b and b_1. The rotation of a and a_1 is opposed by controlling springs, the position of equilibrium where the attraction between the fixt plates b and b_1, and the moving cylinders a is balanced by the springs; the indication is given by a pointer moving along the scale shown. The containing case is filled with oil which buoys up the moving element, acts as a damper to the moving system besides maintaining high insulation and increasing the capacity.

D'ARSONVAL GALVANOMETER.

(830.) George Whiting, San Francisco, Calif., asks:

Q. 1. What is the size of wire used on the winding and what is the coil suspended by, a flat strip or a wire, on a D'Arsonval galvanometer of the reflecting mirror type?

A. 1. The size of wire used in these type of galvanometers depends upon the degree sensitiveness of the instrument, but in general the wire used on the coil is a No. 38 double silk covered magnet wire. The coil is suspended by a thin strip of phosphor bronze.

Q. 2. What is the resistance of 80 feet of No. 30 soft iron wire?

A. 2. 34.8 ohms resistance.

Q. 3. What is the ratio of movement on

a galvanometer mirror to the foot; *i.e.*, suppose the mirror moved .0001 of an inch, how much would the spot of light from the mirror move at 1 foot distance and at 8 feet distance?

A. 3. It would be impossible for us to give you this data as it is necessary to know the angular momentum of the moving element, which means that the weight of the element is required which is necessary to determine the time constant of the coil. Furthermore, it will be necessary for us to know the curvature of the mirror, in order to give you the intensity of illumination which the mirror will throw at the distance specified.

STORAGE BATTERY FOR SIX-INCH COIL.

(831.) Sidney Tholan, Washington, D. C., would like to know:

Q. 1. How many storage batteries would a six-inch spark coil require, or how many volts and amperes would it require to give best results, with an aerial 50 feet high and 75 feet long, consisting of four wires? How far would this coil transmit in a tuned sending outfit?

A. 1. Three 6-volt, 80 ampere-hour storage batteries will be required to operate the six-inch spark coil.

18 volts and 4 amperes is the power consumed by the coil. About 30 miles can be covered with this outfit.

Q. 2. Does a helix step up the voltage, or amperage or does it step up both?

A. 2. A helix does not necessarily step up the voltage or amperage, but it is used to attain resonance of the closed oscillatory circuit, and to regulate the length of the emitted oscillatory wave.

RADIO DISTANCE FORMULA.

(832.) Joaquin Agusty, San Juan, Porto Rico, asks:

Q. 1. How many pounds of No. 14 D. C. C. wire will be necessary for the primary of 1½" spark coil, core 8½" long by ¾" diameter?

A. 1. Two and a half pounds.

Q. 2. How may I magnetize a piece of iron in order to make a permanent magnet in any desired form?

A. 2. The best manner by which you can magnetize a piece of steel (not iron) of any desired shape is to wind four to six layers of No. 20 B. & S. magnet wire around the iron, which is to be magnetized and passing a current of electricity thru it. Care should be taken to see that the current is a uni-directional one or direct current and this source is best obtained from a storage battery or direct current dynamo.

Q. 3. Which is the formula used to compute the range in miles of a radio receptor? For example, a complete receiving set with coupler and suitable antenna and 'phones, tunable to 3,000 meters, what is the maximum distance for receiving signals in good weather conditions?

A. 3. There is no formula which gives the receiving range of a receptor. The only formula of such nature is adaptable to transmitting apparatus.

HYSTERESIS VS. SELF-INDUCTION.

(833). W. C. Phillips, Julian, N. C., wishes to know:

Q. 1. Is hysteresis the same in a magnetic circuit as self-induction in an electric circuit?

A. 1. Yes.

TESLA TRANSFORMER QUERY.

(834.) Wm. Oshback, Philadelphia, says:

Q. 1. I have a Thordarson one K. W. 60 cycles transformer, the voltage across the secondary terminals is 20,000. Is the secondary voltage of the above transformer too high to construct the 24-inch high frequency apparatus for medical and lecture use, as given by Dr. Frederick Finch Strong, in the May and June issues? If the above case is possible and the ratio of the Tesla coil is 1 to 80, what will be the secondary voltage of the Tesla coil? Why is a rotary spark gap used between the condenser and Tesla transformer?

A. 1. The voltage of the transformer is sufficient to operate the Tesla high frequency transformer, but regret to say that it is impossible to estimate the voltage obtained from such an instrument as the conditions are entirely different from those of magnetic type of high tension transformers. The voltage of a Tesla transformer runs in the neighborhood of millions of volts at the secondary terminals.

A rotary spark gap is used between the primary of the Tesla coil and the secondary of the Thordarson transformer to increase the spark frequency of the closed oscillatory circuit which causes an increase of secondary voltage and frequency in the Tesla transformer secondary. It also acts more efficiently than a fixt gap, which tends to arc and heat up.

BRAKE HORSE-POWER CALCULATION.

(835.) Earl Lea, Memphis, Tenn., asks:

Q. How would you calculate the brake horse-power of a motor when the following data is on hand? The lever arm of the brake is 3 feet long and the reading of the scales is 30 lbs., when the motor is running 1,000 R. P. M.

A. 1. The following formula gives the relation of the factors named with that of the brake horse-power:

$$\text{B.H.P.} = \frac{2\pi \text{ L N W}}{33{,}000}$$

Where 2π = constant
L = length of lever arm in feet.
N = revolutions per minute of shaft.
W = force in pounds at end of lever arm as measured by scales.

Substituting your values in the above formula we get:

$$\text{B.H.P.} = \frac{2\pi \times 3 \times 1{,}000 \times 30}{33{,}000} = 17.1$$

Q. 2. Knowing the brake horse-power of a motor, how would you determine the efficiency of the motor?

A. 2. It will be necessary to determine the electrical power taken by the motor under test and dividing the B.H.P. by the electrical horse-power, multiplied by 100, which will give the percentage efficiency of the motor.

Q. 3. What is the nature and object of the commutating field produced by the interpoles of a dynamo?

A. 3. Its object is to assist commutation, that is, to help reverse the current in each coil, while short-circuited by the brush, and thus reducing sparking. The excitation of the interpoles being produced by series turns, the field will vary with the load, and will if once adjusted give good commutation at any one load, keep the same proportion for any other load, provided the iron parts be not too highly saturated.

TELEPHONE AND TELEGRAPH INTERFERENCE.

(836.) ———, asks:

Q. 1. What are the characteristics of the "D'Arsonval" currents mentioned in the article "Electricity and Life" in the May issue of THE ELECTRICAL EXPERIMENTER? How can apparatus be constructed for their production?

(*Continued on page* 343)

SPY AERIALS.

(*Continued from page* 300)

third story of a brick dwelling. This is not fiction, but an actual fact, and consider for the moment that such an iron fire-escape is very much smaller compared to the metal fence, which may run for several hundred feet or more.

Fig. 10 shows two other novel schemes, which a desperate enemy might employ to signal his confederates. The first of these is the ordinary railroad track which invariably rests on wooden ties, and it would not be very difficult at all to thoroly disguise the connecting wire from the railroad track to the apparatus, even by digging a small ditch and covering it over. The operator might even have the temerity and good sense to use a nearby house or shanty, which no one would ordinarily suspect, and moreover he might only visit the scene of these operations at night, which would naturally make his detection and apprehension extremely difficult.

Many of our office buildings are fitted with extensive *metallic grill work* enclosing elevator shafts and the like, which are very often insulated from the ground, and thus provide another chance for an enemy to receive wireless messages.

The ordinary *motor-boat* may appear peace-like enough when speeding along the coast, but it is not improbable that such a vessel might contain an enemy wireless outfit. It is easy to see that if such a boat could be at large along the coast, that it would cause considerable trouble, as on the one hand it could readily intercept radio messages from shore by means of a concentrated antenna as shown in Fig. 11, and the wires of which might even be placed between an inner or outer hull to defy detection, and on the other hand, such a floating information base could readily communicate with a submarine or "raider."

Finally, we come to the use of the *concentrated radio antenna*, of the type described some months ago in THE ELECTRICAL EXPERIMENTER, and which was tested with extreme satisfaction at the radio laboratory of Union College. It is not at all difficult to see that a radio Spy who knew his business could readily deceive most anyone for an indefinite length of time by simply constructing one of these concentrated aerials which could be erected between the *real wall* of a room and a *false partition* or wall covering. If a room happened to be small, it would be readily possible of course to use more than one of these concentrated aerials, placing them on various walls of the room, and covering them over with a board partition, or in some other way cleverly disguising the presence of the aerial.

Of course the every-ready radio inspector will tell you that the wireless Spy cannot exist for any length of time, and in fact for only a short time, for the reason that the Government experts are equipt with the latest radio-locating and detecting instruments, which enable the inspectors to rapidly close in on any suspicious wireless wave, and to thus locate the apparatus.

But this is not all of the story by any means, as there has been perfected in the last year or two a particularly clever wireless system of which but little is known, but which utilizes for one thing an inaudible note, or in other words an undamped wave, and messages when transmitted by this system are not sent out in a continuous series of signals, but in an intermittent series of signals, all of which characters are eventually recorded on a special receiving instrument, which co-relates individual characters, so that eventually the Spy at the receiving end has before him the original message, in a secret code to be sure.

A. 1. The characteristics of D'Arsonval currents are of such nature that they produce continuous uni-directional impulses. They are usually of lower potential than Tesla currents.

Q. 2. Can a telegraph set be used (without interference with telephone service) employing one wire of the city telephone system and using the ground as a return, if the telegraph message was to go thru the central station switchboard? If this is possible, please give hook up.

A. 2. Yes, we would suggest that you refer to the article on page 197 of the July issue of this journal.

Q. 3. How far can messages be exchanged by means of the inductive wireless telephone described in the May issue of the "E. E."?

A. 3. 30 to 100 feet.

PRODUCTION OF ELECTRIC OSCILLATIONS

(837.) Otto Patersen, Camden, N. J., desires information as to:

Q. 1. What is the best way to generate electric oscillations of any desired frequency?

A. 1. There are several ways by which electric oscillations can be generated, viz., by means of the electric arc, alternator, metallic arc, and vacuum tube or Oscillion. The last contrivance is the most convenient for such work.

Q. 2. Is the Chaffee gap adaptable for radiophonic work?

A. 2. Yes.

Q. 3. What are the main features of the Chaffee gap?

A. 3. The use of aluminum and copper spark electrodes are the fundamental features of this particular gap.

ELECTROMAGNET TO FRY EGGS.

(838.) P—— A——, Chicago, Ill., wishes information on the large A.C. electro-magnet described in the March, 1917, issue of this journal by Raymond Francis Yates.

A. 1. We believe that the large electro-magnet as described in the article by Mr. Yates will perform its work satisfactorily; the strength of the same is due to the product of the current in amperes, multiplied by the number of turns of wire in the coils. You will thus see that if the current is kept constant and the number of turns increased, you will gain considerably thereby.

On the other hand, with a constant source of potential or voltage an increased number of turns will simultaneously increase the resistance of the coil which will reduce the current passing thru it. Therefore, it is quite possible that in some cases the total result will be less than expected, or even attained, with a less number of turns, owing to the reduced current.

However, with the electro-magnet in question it will be possible to increase its strength by increasing the turns as you suggest for the reason that this magnet is not designed for the full line potential, and, therefore, you can adjust the current so as to keep it constant with the increased turns by means of a resistance or reactance coil.

For most experiments, and particularly those cited by Mr. Yates, the electro-magnet *must be excited by alternating current;* not direct current. It will require considerable resistance in series if used on direct current as much more current will then flow.

THE BACHELET LEVITATION RAILWAY.

(839.) Edward A. Brand, Springfield, Ill., writes us:

Q. 1. Where can I obtain information on the Bachelet electrical levitation system?

A. 1. Relative to some literature or books describing the electrical levitation system of Emile Bachelet, would suggest that you take up this matter with our Book Department.

You might also obtain some very valuable information in this direction by communicating with the Bachelet Medical Apparatus Co., 320 Schermerhorn St., Brooklyn, N. Y., who represent Mr. Bachelet in this country.

4 K.W. TRANSFORMER QUERY.

(840.) Ralph H. Seipel, Elwood City, Pa., sends us design of 4 K.W. transformer on which he wants advice.

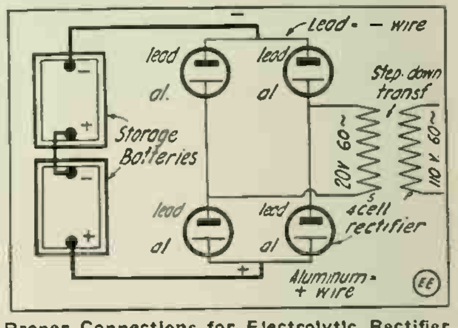
A. 1. It would seem that the transformer you describe will be all right to operate at a load of 4 K.W. at intermittent periods as you mention. The size of the primary wire is correct and agrees with the designs usually followed in this work.

With respect to the number of primary turns to be connected in circuit for the different kilowatt in-puts, this would work out as follows:

The secondary voltage will vary inversely as the number of primary turns, *i.e.*, as the number of primary turns in the circuit are reduced the secondary potential will increase and *vice versa*. We have not investigated the entire design of your transformer, but presume that with all of the primary turns in circuit, that you have so proportioned the windings and the iron core, that it will take 1 K.W. from the primary mains or develop 1 K.W. in the secondary winding. If such is the case, then with 50 primary turns in circuit, the secondary potential will be twice that with 100 turns, and the output of the transformer will be doubled or 2 K.W. The secondary current remains approximately the same. With 25 primary turns in circuit, the inverse ratio would then be as 4 to 1, and the secondary potential would be four times that with 100 primary turns and the output of the transformer 4 K.W.

ELECTROLYTIC RECTIFIER TROUBLES.

(841.) Mr. H. C. B——, Ft. Towson, Okla., writes:



Proper Connections for Electrolytic Rectifier and Step-down Transformer.

Q. 1. I have tried to get my electrolytic rectifier working, but can not get it to rectify.

A. 1. We have noted what you have to say concerning the electrolytic rectifier. In the first place, there is no question at all as to whether the aluminum-lead or aluminum-iron rectifier will rectify, for it certainly will.

There are several particular reasons why these rectifiers do not apparently work to their proper efficiency at first. One of the most important of these is that the aluminum plates must become properly *formed* by electrolytic action, and it can only do so in many cases, or at least in a majority of cases, where it is possible to pass direct current thru the rectifier for a short time.

Otherwise this *forming current* may be supplied from a 110 volt A.C. line with some lamps in series, allowing considerable current to pass thru it for a short period, or until the lamps become dim, denoting that the gas film has formed.

Another reason why these rectifiers do not always work perfectly at first, is due to the fact that the solution may not be fresh, and this is a point well worth looking into. The Editor remembers one particularly obstinate case of this nature in which he suggested that the user take a fine pen-knife and scratch criss-cross on the face of the aluminum plate. This will sometimes hasten the formation of the fine gas film which gathers on the surface of the aluminum, and which of course is the principal desideratum in the operation of the electrolytic rectifier.

You might also try a warm solution at first, as these rectifiers work most efficiently with a hot solution or when a solution has heated up some. We have data on a rectifier of the aluminum-lead type employing a saturated solution of ammonium fosfate and which has been tested at the Electrical Testing Laboratories of New York City.

If you are sufficiently interested in the theory and operation of this electrolytic rectifier, we shall be pleased to furnish you with a duplicate copy of the engineering report given by the above laboratory at a charge of $1.

EXPERIMENTAL PHYSICS.

(*Continued from page 312*)

the fourth time you continue as before, except that instead of going past the gong you strike it. Your partner sets the stop-watch as he sees the flag reach the vertical position on the *fourth* swing and touch the gong, and then stops the watch when he hears the sound. On looking at the watch it will be noticed that the sound was heard *three* seconds after the flag reached the vertical position and struck the gong. Since the distance between you and your partner was 3,300 feet and it required three seconds for the sound to travel that distance, we see that the speed of sound is about 1,100 feet per second, or about 1,000 miles per hour.

EXPERIMENT 42—The method of Experiment 41 can be carried out very carefully and the results obtained will be quite accurate. For those not having access to a stop-watch, the following method is given: Figure 32 represents a light wooden box 4" by 25" by 45", approximately. A hole is cut at D and the inside of the box which can be seen thru this hole is painted white. B is a small block of wood painted black and attached to the top of the box by a string E. The length of this string and block together should be thirty-nine inches, and when drawn to position A or C and let go, it will oscillate back and forth as a pendulum and the black block will pass the white opening *once in each second.* If on trial it does not pass exactly each second it can be slowed down or speeded up by lengthening or shortening the string. When it is adjusted it is what is known as a *Seconds Pendulum.* Let your partner pound loudly on the side of the box just when the block (bob) B passes the white hole and keep doing so each time while you in the meantime move back away from the pendulum. As you move away, the pounding will be heard after the bob passes the white hole, and keeps losing and losing until it is lapt by the bob and the sound again coincides with the bob's passing the white hole. Obviously since the sound has been lapt by the bob and the pendulum is a seconds pendulum, *it takes the sound just one second to travel from the box to you.* On measuring the distance, it is found to be about 1,100 feet. Thus far we have noticed that sound will not pass thru a vacuum, but that it will pass thru ordinary matter, and usually the heavier the matter the faster the sound travels thru it.

The Indians put their ears to the ground to hear the noise of approaching horses, since the ground is heavier than air, and the sound travels faster and appears louder. If two stones are clapt together under water the sound is louder to the person with his ears in the water than to the person with his ears out of the water. (If you don't think so, try it!) In air sound travels always at the same speed, 1,100 feet per second, and *all different kinds of sound, whether of different pitch or of different loudness, travel at the same speed.* Thus the gentle squeak of the high string of the violin, and the low thump of the bass drum, and the ear splitting wail of the cornet of the symphony orchestra of the Movie show reach our ear at the same time.

EXPERIMENT 43—Loosen a low string from some stringed instrument, such as a banjo, guitar, mandolin, violin, etc. If now it is plucked and gradually tightened until it just gives off a low musical note, it will be seen to vibrate rather slowly. On tightening it a little more we notice that the *note* given off is of *higher pitch* and that the *vibrations are faster.* This leads us to the next important principle, namely that the *pitch of a note* depends on the *frequency of vibration* of the source, *i. e.,* the faster the source vibrates the higher the note. If one looks inside the piano, it will be noticed that the bass notes are given by long, heavy, loose strings, and that the high notes are given by short, thin tight strings. The laws of vibrating strings can be stated as follows:—the *tighter* the string the *faster* it vibrates and consequently the *higher the pitch* of the note given off; the *shorter* the string the *faster* it vibrates and consequently the *higher the pitch* of the note. Pitch should not be confused with loudness. Loudness depends upon the distance of the sound source from the listener. Also loudness of a sound depends upon the amount of the disturbance. A small fire-cracker disturbs a small amount of air, and the sound is weak, while a large salute disturbs a large amount of air and a loud bang results.

EXPERIMENT 44—Obtain two medium-size cans of peaches, or pears, or whatever canned fruit you like best. Now remove the tops and the contents of the cans. With a thin nail and hammer, punch a whole in each of the bottoms of the cans. "Borrow" about 100 feet of Pa's fishing line. Pass the ends thru the holes in the cans and tie them inside to match sticks.

If now the string is stretched as in Fig. 33 and your partner talks into his can, you will hear him distinctly. When he is thru talking you can talk into the can and he will hear you distinctly. When you talk into your end of this telephone you cause the air in the can to vibrate, which in turn causes the bottom of the can to vibrate. The end of the can causes the tightly stretched string to vibrate, and the string causes the bottom of your partner's can to vibrate. The bottom of his can causes the air in his can to vibrate and it in turn cause the membrane in his ear to vibrate so that he hears your voice.

In other words, the disturbance which you cause in the air near your mouth has been transmitted to the air immediately near your partner's ear, which gives the same effect as if you were standing beside your partner and talking to him. The modern commercial telephone works on a similar principle. The diafram which corresponds to the bottom of the can in our case, is made to vibrate by the motion of the air caused by speaking. This vibration is transmitted *electrically* to the receiver at the other end; the receiver at the other end causes the air at the listener's ear to vibrate and the listener hears the speaker. The electric auto horn consists essentially of a thin metal disk or diafram which is made to vibrate rapidly by the electric current and the vibration of the diafram causes a disturbance in the air which may herald the approach of a Ford, a brass band, or a cat-call. The phonograph also depends upon the vibration of a disk or diafram. The needle is attached to the diafram by a small lever. As the needle passes around the record it vibrates according to the indentations in the record. This vibration is communicated to the diafram by the lever. The vibration of the diafram causes the air in the horn or sound box to be disturbed. On placing the thumb gently on the diafram (reproducer) one can *feel* the vibrations.

It may be well to note just how the sound is transmitted thru the air. If a half-dozen billiard balls are placed in a straight line touching each other, and then the cue ball is made to strike the end ball, the ball at the other end will move out and the others will remain in their places. In the transmission of sound, instead of billiard balls we have the molecules of air. The molecules do not touch, but are very close together and hence we get only a slight displacement. The sound is thus transmitted from molecule to molecule in all directions. Obviously if a molecule at the source of the sound vibrates in a certain way the molecule near the listener will vibrate in that very same way, since each individual motion has been transmitted as it was made.

EXPERIMENT 45—If ten or a dozen olive bottles or other bottles are placed in a row, and partially filled with water as in Fig. 34, on blowing over the tops a thin flat jet of air, musical notes will be heard. The jet of air may be secured by blowing thru a rubber tube at the end of which is attached a flattened Bunsen burner *wing tip* which can be purchased for a few cents. On adding to or subtracting from the water in the various bottles the various notes of the musical scale can be gotten and then one can by a little practise learn to play simple melodies. This interesting experiment illustrates the working of the organ pipe. A thin flat jet of air passing over a column of air causes the column to vibrate; the longer the column the lower the note.

Just as a billiard ball on hitting the cushions of the billiard table is reflected, so when a sound wave caused by the vibration of a molecule hits an object, it is reflected back. If the reflecting surface is near, because of the tremendous speed at which the sound travels, the reflected sound and the original one are heard at practically the same time, simply re-enforcing each other. If, however, the distance is sufficiently great, the reflected sound reaches the air later, and we call this the *echo*. If a sound is caused by a source vibrating in an irregular manner, the vibrations interfere with each other and the result is a *noise*. If, however, the source is vibrating in a regular manner, the sound is pleasing and is called a *musical sound*. Both are disturbances of the air, but the former is a disturbance to those hearing it.

(To be continued)

ELECTRIC "BLOODHOUNDS" TO FIND AND DESTROY U-BOATS.

(*Continued from page* 298)

inconceivable how the noise of these powerful engines could be deadened entirely so that the super-sensitive microphone-Audions would not detect it, when they once came into a reasonable range.

The authors confidently look forward to an early trial of the idea, feeling convinced in its feasibility and successful application to the U-boat peril.

The electric torpedo bloodhound depends upon several well-known physical and electrical laws for its mode of attacking and destroying a submerged U-boat. Principal among these are the utilization of sound waves, such as given off by the engines and propellers of a submarine, and also the principle of the *induction balance*. The presence of a metallic mass as for instance a submarine hull, will upset the electrical balance of two coils, which fact is here made use of and which will prove efficacious over a considerable distance; at least several hundred feet, when a sensitive galvonometer relay, such as the Weston type, is employed for indicating the state of balance in the coils. As for the practical range of sound wave control thru water, this scheme has been successfully applied by the Allies, particularly along the French coast, for detecting and locating submarines up to twenty miles distant.*

Instead of simply listening for the sound of an enemy submersible, as in the scheme just cited, the authors propose to cause these sound waves coming thru the water to spell the end of the tricky sub-sea craft. Furthermore, it is evident both theoretically and practically, that if we can pick up the sound of a submarine five miles away and amplify it so as to make it plainly audible in a telephone receiver, that it is certainly possible to cause this same subaqueous wave to actuate a properly tuned and sensitive microphone, which in turn actuates an Audion amplifier (or Brown telephone relay). This device then closes or opens certain local control circuits connected to the propeller, rudder and diving plane mechanism of a special torpedo of the general type illustrated.

Of course someone will immediately ask: "Why not make the device full automatic and turn it loose in a submarine infested area?" This sounds like good logic and possibly is under certain limited conditions, but we must not forget that our electric submarine "bloodhound" would have no scruples about attacking friend as well as foe; steamer as well as submarine. Therefore, it seems the best logic to attach one of these torpedoes to a submarine chaser by means of a flexible electric cable, which is attached to an automatic-release drum. The commander of the mother-ship thus retains control over the ever-vicious U-boat "bloodhound," which, once it hears a submersible purring away in the briny depths, immediately proceeds to dive straight for it, prepared to sink the suspected craft, whether friend or foe and which, if made full automatic, would blow the under-sea fighter to bits, without any parleying whatsoever. For these and other obvious reasons it is best to retain control of the electric torpedo.

As seen in the illustration, Fig. 1, the electric "bloodhound" has quite an interesting internal make-up. In general, there are two *induction balance* coils arranged on port and starboard of the nose as shown clearly in the front cover illustration. The forward compartment contains also a powerful electromagnet for holding the torpedo against the submarine hull; a special signaling electromagnet is provided as shown, which, when intermittently excited by means of a telegraph key on the bridge of the submarine chaser, causes the sliding brass rod inside the holding magnet core to work up and down. Thus it becomes possible to telegraph the Herr Commander of the U-boat, that unless he will arise at once and surrender he will be blown to bits by the 200 pounds of gun cotton in contact with his craft. Moreover, the U-boat officer can reply by telegraphic signals sent out thru his regular electric under-water sound telegraph, the signals being picked up either by one of the microphones on the electric torpedo or by a regular sound wave telegraph receiver of the Fessenden type, as used by practically all ships today.

The forward compartment also contains the interrupter, battery, etc., for exciting the coils of the *induction balance*, details of this apparatus being given in Fig. 2. Note that the secondary coils of the balance are connected to a super-sensitive galvanometer relay, which acts to close certain control circuits going to the rudder, plane and propeller solenoid mechanism. This apparatus comes into control of the "bloodhound" when the microphone control has brought it to within a few hundred feet of the submersible, where sound reverberations would tend to throw the microphone control somewhat off. Several sets of tuned microphones are placed along the top and bottom, as well as the sides of the torpedo as indicated.

The next compartment would contain the explosive, usually gun cotton, to be detonated when desired by throwing a switch on the submarine chaser. The center space is occupied by an electric gyroscope, used for stabilizing the torpedo, also solenoid magnets for controlling the diving and raising planes on the exterior of the hull.

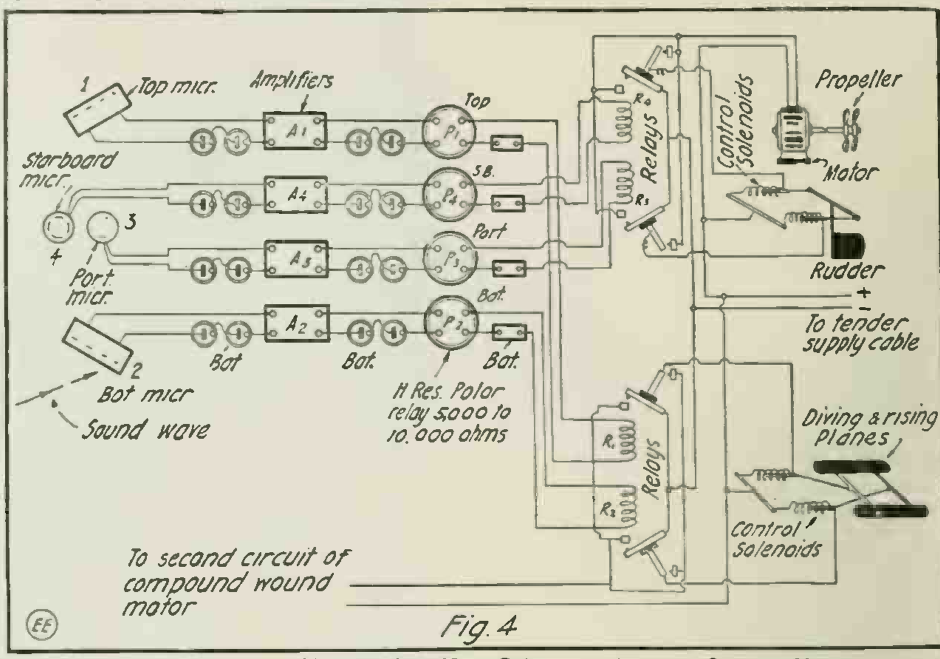
Next we come to the mast. This is hollow to permit of the electric control cable and pilot lamp cable passing down thru it to the interior of the torpedo. The pilot lamp (fitted with semi-circular reflector to throw light toward tender vessel) and flag are carried on a short pole mounted on a weighted ball-float as illustrated. If the "bloodhound" takes the "scent" and dives, the ball-float automatically releases and floats on the surface of the water for the guidance of the officers. The pilot lamp (for night work) is supplied with electric current thru a flexible cable which reels out from an automatic drum in the manner apparent. The movements of the torpedo can thus be gaged quite accurately.

Passing to the next "aft" compartment, this is devoted to the batteries, relays, amplifiers and other auxiliary electric control instruments. Behind this there come the propeller motor and rudder control solenoid magnets. See Fig. 1.

*See article describing the method of applying the sound wave detector for submarine detection and location in the January, 1916, issue of THE ELECTRICAL EXPERIMENTER.

The diagram, Fig. 3, shows the circuits for the retaining and signaling electro-magnets in the nose of the torpedo. The smailer or signaling magnet is controlled by a telegraph key on the submarine chaser as aforementioned. The holding magnet coil would be excited as soon as the torpedo started in motion, or it could be arranged to be excited only when the torpedo had approached to within a few feet of its prey.

Many readers will no doubt be sufficiently interested in this almost human submarine annihilator to study some of the peculiar control circuits necessary to bring about the results already described, and particularly the method used to prevent the torpedo from striking the propellers of the enemy sub-sea fighter. The principal electric control functions are outlined in the diagram, Fig. 4, which will help to make clear how the device actually steers its own course toward the invisible enemy.



Microphone Connections to Various Amplifier, Relay and Solenoid Control Circuits in the Electric U-boat "Bloodhound."

First, we have the four distinct sets of tuned microphones, disposed on the top, bottom and two sides of the torpedo. These microphones are designed especially to respond to the peculiar note given off by the engines and propellers of a submarine and thus do not respond to the sound of the torpedo's propellers or that of the tender ship. It is also possible to shield the microphones so that they will not he affected by the sound of the torpedo's propellers.

Keeping in mind the location of the four sets of microphones or sound detectors, it is easy to understand that if these are properly connected to the control mechanisms, that a sound wave emanating (generally speaking) from any one of four directions will cause the "bloodhound" at once to start in that particular direction, i. e., it may dive either up or down, right or left, or in some angular direction between these by the co-action of two sets of control apparatus.

As will be observed the propeller motor is compound wound so as to be controlled by both sets of relays, i. e., those controlling the rudder solenoids or those working the diving plane solenoids. The supply cable from the tender furnishes current for the propeller motor as the diagram shows.

The mode of action will best be seen by considering that for instance a sound wave strikes microphone No. 2, on the bottom of the torpedo. The resistance of the microphone is changed, causing the amplifier A. 2, to act simultaneously. The latter device boosts the microphone signal several hundred times in strength, enabling the high resistance, polarized relay P2 to close its local circuit to special relay R. 2.

This relay, R. 2 (and its brothers, R. 1, R3 and R4) are provided with special armatures, having insulated contact arms on them as shown. Hence, when the sound wave has finally caused relay R. 2 to close,

(*Continued on page* 351)

PATENT ADVICE

Edited by H. GERNSBACK

In this Department we publish such matter as is of interest to inventors and particularly to those who are in doubt as to certain Patent Phases. Regular inquiries addrest to "Patent Advice" cannot be answered by mail free of charge. Such inquiries are publisht here for the benefit of all readers. If the idea is thought to be of importance, we make it a rule not to divulge details, in order to protect the inventor as far as it is possible to do so.

Should advice be desired by mail a nominal charge of $1.00 is made for each question. Sketches and descriptions must be clear and explicit. Only one side of sheet should be written on.

COMBINATION SWITCH SPARK GAP.

(170.) Claude E. Johnson of Leoti, Kansas, has sent in a very clever design of a combined antenna switch spark gap and lightning protector, and wishes to have our advice on this design. Mr. Johnson wishes to know if the idea is practical and whether a patent may be obtained, etc.

A. The idea looks feasible to us, and has several points in its merit. While a patent might be obtained on this invention, we have little hope that this will be remunerative financially, for the simple reason that there is no market for radio devices at the present time. However, after the close of the war, this might be worked up into a profitable patent. The idea is as good as it is novel.

NOVELTY FAN.

(171.) Sidney Brown of Lake Charles, La., has submitted to us an illustration and description of novelty lights to be installed in a ceiling fan. Our correspondent would like to have our opinion as to whether this is a practical invention, and whether it would be worth while to have it patented.

A. While the idea is novel, we think the device would cause too much flickering. In other words, the light would be quite unsteady, and would hurt the eyes of whoever is in the vicinity of this fan. It might be all right, however, for advertising purposes, and we would advise our correspondent to get in touch with a patent attorney.

PATENT QUESTIONS.

(172) Alif Byran of Nephi, Utah, wants to know:

Q. 1. How does a person obtain a patent?

A. 1. There are two ways of obtaining a patent. You can prepare your own patent drawings, and describe the application of the patent yourself by writing up specifications in a certain manner, and sending them to the patent office, paying the government fee of $20.00.

It is safe to say, however, that not one in ten thousand inventors ever take out their own patents, as they have no technical experience in preparing the drawings and presenting the claims in a legal manner.

The right way is to employ a capable patent attorney, such as you will find listed in our advertising columns, and this is not only the cheapest in the long run, but the best method.

Q. 2. What does a patent usually cost?

A. 2. It is impossible to state this in figures as it depends entirely upon the article to be patented. Some patents are so simple that they only need a small drawing and very little explanatory text, and the claims are perhaps few and simple. Other patents need a great many illustrations which necessitates several sheets of drawing, and we have seen patents that have from twenty to twenty-five printed pages of text, and anywhere up to 100 claims. Naturally such patents cost a great deal more. It all depends how much work the patent attorney has to put into the application. Usually the patent attorney will tell you how much he is likely to charge for his work. The government fee is of course always the same, no matter whether the patent is a long or short one. The fee is $20.00 with the application, and then there is a final fee when the patent is allowed of $20.00 also.

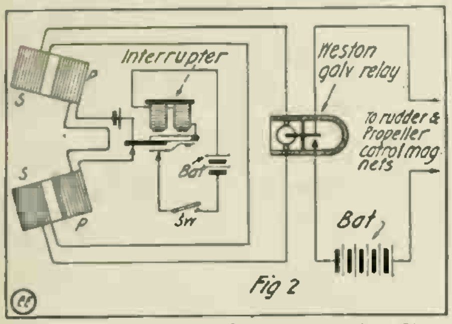
Q. 3. Can you always get a manufacturing company to manufacture a patented idea if it is a good one?

A. 3. If the idea is of merit, there certainly should not be much trouble in disposing of the patent to some reputable concern; that is, if the idea is really a good one. As a rule, there is a market for everything good and practical, and while it may take time and trouble to find the right concern, if the patent is really a meritorious one, it can as a rule be disposed of.

ELECTRIC "BLOODHOUNDS" TO FIND AND DESTROY U-BOATS.

(*Continued from page 348*)

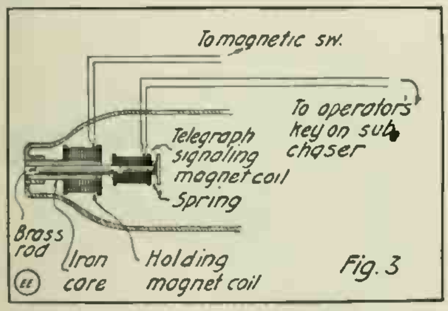
it completes a circuit thru one winding on the propeller motor, causing the torpedo to get under way. It is made to dive at the same time by the inert action of the *opposite* relay, R. 1, thru whose armature the diving plane solenoid is excited; the planes are thus placed at the proper angle



"Induction Balance" Connections in Electric "Bloodhound." A Sensitive Galvanometer Relay Is Necessary.

to carry the torpedo downward. The same action occurs for steering the torpedo to right or left, the *opposite* "R" relay serving to actuate the proper solenoid to swing the rudder to port or starboard, as the case may be. Of course, there are a number of refinements which could be introduced such as interlocking cut-outs, semi-manual control from the tender, etc., but the basic principles of such control are here outlined.

To prevent the "bloodhound" from running its nose dead into the submersible's propeller blades, it is possible to provide several means for overcoming this contingency. Suppose for example that we connect a special relay in shunt to the amplifier secondary circuits, which relay would only operate when the torpedo had approached within, say, 50 feet of the enemy, the received sound wave being then sufficiently strong to close this relay. Again, consider that this sluggish relay was caused to operate a time limit circuit-breaker or relay, which could be set to open its secondary control circuit after a time period of sufficient duration to carry the torpedo one-third the length of the submersible past the propellers. Thus it is seen that it is possible to so set the control apparatus that when the torpedo has reached a distance of, say, 50 feet from its prey, that the special relays just described could be caused to control the planes and rudders so as to steer the "bloodhound" parallel with the sub-sea boat for a distance one-third its length; then the time limit relay



Details of "Holding" and "Telegraphing" Electro-Magnets of Electric U-boat "Bloodhound."

would open, the *induction balance* apparatus would be acted upon by the metallic hull; its galvanometer relay would take control of the rudder, planes and propeller and steer the missile straight for the enemy. As soon as the torpedo hit the hull, its holding magnet would retain it securely in place and the propeller motor would stop.

The commander of the submarine chaser boat can then either blow up the submarine without further ado or he can pursue the more humane mode of signaling the U-boat commander to come up at once and surrender with the whole crew.

OFFICIALS ARREST JOHANN ZENNECK.

Acting under special orders from the Department of Justice at Washington, United States Deputy Marshal Linford Denny recently arrested Prof. Johann Zenneck, German radio expert, and took him to Ellis Island, where he will be interned for the duration of the war.

EXPERIMENTAL CHEMISTRY.

(*Continued from page 333*)

Steam is furnished by boiling water.

$$\underset{\text{Water}}{H_2O} = \underset{\text{Steam}}{\widetilde{H_2O}}$$

The gases thus formed, H_2O [Steam], Sulfur Dioxid [SO_2] and Nitrogen Peroxid [NO_2], mingle in the large central flask, and combine as follows:

$$\underset{\text{Steam}}{\widetilde{H_2O}} + \underset{\text{Sulfur Dioxid}}{SO_2} + \underset{\text{Nitrogen Peroxid}}{NO_2} = \underset{\text{Sulfuric Acid}}{H_2SO_4} + \underset{\text{Nitric Oxid}}{NO}$$

Nitric Oxid [NO] takes oxygen again from the air, forming Nitrogen Peroxid [NO_2], and once more passes on half of it. The action is very peculiar and continues so long as there is a supply of oxygen. Nitric Oxid is therefore called a *carrier of oxygen*. It is thus seen that the nitric oxid [NO] is a reducer, Nitrogen peroxid [NO_2] an oxidiser.

The Chamber acid, has a specific gravity of 1.5 and is about 65% acid and 35% water. This is strong enough for the manufacture of sodium sulfate [Na_2SO_4], one of its two main uses. If stronger, it absorbs much nitrous anhydrid [N_2O_3]. It is then removed from the chambers and reservoirs, and evaporated in open lead pans till it has a specific gravity of 1.75. Stronger than this it dissolves considerable lead, and it is then evaporated in platinum crucibles till the specific gravity is 1.83. This is about the commercial strength; pure acid being 1.854.

The *contact method* of making the acid which is now coming into considerable use in this and other countries, involves the very simple principle of making SO_2 into SO and leading the latter into water.

Properties—*Physical*

1. Sulfuric acid is a thick, oily, and corrosive liquid without color or odor when pure. It usually has a brown color due to the presence of charred organic matter, such as straw and dust.

2. Specific gravity if pure 1.854; commercial about 1.83.

3. It possesses a sour taste and acid reaction.

4. It boils at 338 degrees C. (about 642 deg. Fah.) and freezes at about zero.

5. It is miscible in water, with which it reacts and condenses.

Chemical

1. It reacts with most metals to form sulfates; if dilute, liberates hydrogen; if strong sulfur dioxid. Its action takes place at a low temperature, hydrogen is evolved, providing sufficient water is present to dissolve the metallic sulfate formed.

$$Zn + H_2SO_4 = ZnSO_4 + H_2$$
$$Fe + H_2SO_4 = FeSO_4 + H_2$$

Mercury [Hg], silver [Ag] and Copper [Cu] are not affected by the action of cold [H_2SO_4], but if concentrated acid is used and the temperature raised sufficiently, they react, reducing part of the sulfuric acid, forming sulfur dioxid and water, and metallic sulfates:

$$Cu + H_2SO_4 = CuSO_4 + 2H$$
$$H_2SO_4 + 2H = 2H_2O + SO_2$$

Thus at ordinary temperature, sulfuric acid acts like hydrochloric acid, exchanging its hydrogen for metals, but when hot and concentrated, it acts also as an oxidizing agent.

2. Sulfuric acid does not affect Gold, or Platinum, and only hot, concentrated, affects Lead.

3. At red heat it dissociates into H_2O and Sulfur trioxid [SO_3], and thence Sulfur dioxid [SO_2] and oxygen [O].

4. It possesses great affinity for water.

The fact has been repeatedly illustrated in experiments already performed that sulfuric acid has a very strong tendency to absorb water and form compounds with it, thereby causing great heat to be formed in this action, and attention is called to the necessity for caution in mixing this acid. *Always pour sulfuric acid in small quantities into the water, while stirring the same vigorously.* If care is not exercised in mixing this acid with water, the heat may crack the container and spatter the hot acid.

The tendency of sulfuric acid to absorb water may be illustrated by the following examples:

(a) When concentrated, it absorbs moisture from the air, and from gases passing thru it.

(b) It is frequently employed in the laboratory to dry gases, since it is not volatile at the ordinary temperature.

(c) Wood, paper, sugar, starch, etc., and many organic substances are blackened by the acid, due to the acid removing both the hydrogen and oxygen, forming water, and leaving carbon.

From oxalic acid [$H_2C_2O_4$] or alcohol [C_2H_6O] it removes hydrogen and oxygen, causes them to combine to form water, and absorbs the latter.

$$H_2C_2O_4 = H_2O + CO_2 + CO$$
$$C_2H_6O = H_2O + C_2H_4$$

Its action on the skin, producing painful sores, and on organic matter generally, is due to its affinity for water.

5. It neutralizes and dissolves bases and metallic oxids to form sulfates:

$$2KOH + H_2SO_4 = K_2SO_4 + 2H_2O$$
$$Ca(OH)_2 + H_2SO_4 = CaSO_4 + 2H_2O$$
$$ZnO + H_2SO_4 = ZnSO_4 + H_2O$$
$$Fe_2O_3 + 3H_2SO_4 = Fe_2(SO_4)_3 + 3H_2O$$

USES

As stated under the history of this acid, it is used in almost every art or trade, either directly or indirectly. Its manufacture is the king of industries.

Probably the uses which would be of most interest to readers of this journal would be when used in conjunction with electricity.

1. In lead storage batteries, in the charged state, a positive plate of lead peroxid [PbO_2] and a negative plate of finely divided lead, are introduced into sulfuric acid. When discharged, the surface of both plates has been changed to lead sulfate [$PbSO_4$]. The plates may be brought back to their original condition by sending a current thru the battery in the reverse direction. Storage battery plates are usually made by two general methods, which are only modifications of the original Planté or Faure process.

The Planté process includes all methods in which the active material is made from the plate itself, which should be pure soft lead. There are numerous methods of accelerating the formation. Usually the surface is worked up mechanically by cutting grooves, provided it has not been cut in this form. The next operation is to produce the necessary amount of active material. The plates are frequently permitted to stand in some corroding solution of acids that produce a thick layer of lead sulfate [$PbSO_4$], for a certain time. The lead sulfate may then be reduced electrolytically to lead, or oxidized to lead peroxid [PbO_2]. When acids other than sulfuric are used, these must be thoroly washed out before the battery is ready for use. For instance, a mixture of Nitric and Sulfuric acids would have the effect of producing a layer of sulfate.

The theory of the lead storage battery which is generally accepted is known as the "Sulfate theory," and is due to Gladstone and Tribe. Sulfuric acid combines with the plates on discharge, and is set free on charge, according to this theory. On discharge, hydrogen is deposited on the lead peroxid which reduces it to lead oxid [PbO], which is changed to lead sulfate [$PbSO_4$], as represented by the equation:

$$\underset{\text{Lead Peroxid}}{PbO_2} + \underset{\text{Hydrogen}}{H_2} + \underset{\text{Sulfuric Acid}}{H_2SO_4} = \underset{\text{Lead Sulfate}}{PbSO_4} + \underset{\text{Water}}{2H_2O}$$

At the same time the sulfate radical [SO] is deposited on the lead plate and changes to lead sulfate:

$$\underset{\text{Lead}}{Pb} + \underset{\text{Sulfate Radical}}{SO_4} = \underset{\text{Lead Sulfate}}{PbSO_4}$$

The sum of these two equations is the total change in the storage battery on *discharge:*

$$\underset{\text{Lead Peroxid}}{PbO_2} + \underset{\text{Lead}}{Pb} + \underset{\text{Sulfuric Acid}}{2H_2SO_4} = \underset{\text{Lead Sulfate}}{2PbSO_4} + \underset{\text{Water}}{2H_2O}$$

When in the *discharged* state both plates are covered with sulfate. Upon *charging*, the reaction on the positive plate is:

$$\underset{\text{Lead Sulfate}}{PbSO_4} + \underset{\text{Sulfate Radical}}{SO_4} + \underset{\text{Water}}{2H_2O} = \underset{\text{Lead Peroxid}}{PbO_2} + \underset{\text{Sulfuric Acid}}{2H_2SO_4}$$

While in the negative plate:

$$\underset{\text{Lead Sulfate}}{PbSO_4} + \underset{\text{Hydrogen}}{H_2} = \underset{\text{Lead}}{Pb} + \underset{\text{Sulfuric Acid}}{H_2SO_4}$$

The sum of the last two equations represents what takes place in the whole battery on *charging:*

$$\underset{\text{Lead Sulfate}}{2PbSO_4} + \underset{\text{Water}}{2H_2O} = \underset{\text{Lead Peroxid}}{PbO_2} + \underset{\text{Lead}}{Pb} + \underset{\text{Sulfuric Acid}}{2H_2SO_4}$$

This equation is just the reverse of the one given as the sum of the first two equations (No. 3), and the changes taking place both on *charge* and *discharge* may be represented by the reversible equation:

$$\underset{\text{Lead Peroxid}}{PbO_2} + \underset{\text{Lead}}{Pb} + \underset{\text{Sulfuric Acid}}{2H_2SO_4} \rightleftarrows \underset{\text{Lead Sulfate}}{2PbSO_4} + \underset{\text{Water}}{2H_2O}$$

From right to left this represents the charge, and from left to right the discharge.

(This use as regards storage batteries is taken from the manuscript which the author has in preparation on "CHEMICAL ACTION OF STORAGE BATTERIES.")

2. This acid is the basis of the manufacture of most other acids, and so of most salts. The manufacture of alkalies too, including sodium carbonat, depends mainly upon this acid.

3. Its action on bones to make fertilizers. This action transforms an insoluble calcium phosfate [$Ca_3(PO_4)_2$] into a soluble one [$H_4Ca(PO_4)_2$], thus enabling plants to absorb the phosfate from soils on which fer-

(Continued on page 354)

EXPERIMENTAL CHEMISTRY.

(*Continued from page* 352)

tilizers is used. Rain dissolves the soluble superphosfate, as $H_4Ca(PO_4)_2$ is called, and it is carried to the roots of plants and thence circulated by the sap and deposited in the fruiting parts of the plant. Food plants, like the cereals, will not come to maturity or fruitage without phosphorous in this form. In this way our daily bread is in part supplied by sulfuric acid.

4. Another important use is in the preparation of sodium sulfate [Na_2SO_4], from sodium chlorid as a step in the sodium carbonat [Na_2CO_3] manufacture. Sodium carbonat forms the basis of such industries as the manufacture of glass, soap, saleratus, baking powders and most alkalies.

5. Besides these uses, sulfates are formed by action of the acid on metals or their salts.

6. Directly or indirectly H_2SO_4 is employed in the preparation of compounds for bleaching, dyeing, printing, electroplating, telegraphy, galvanizing iron plates and wire, cleaning metals, making shoe blacking, glucose, mineral waters, soda waters, ether, nitroglycerine, gun-cotton, vegetable parchment, celluloid, etc.

EXPERIMENT NO. 89

Preparation from H_2SO_4, Cu, HNO_3, and H_2O.

CAUTION.—This experiment should be performed in a well ventilated room, or under a hood.

The author has found this experiment, when carefully made, an excellent and very interesting one.

As this experiment requires several of each piece of apparatus, many readers will not want to go to the expense of purchasing the additional pieces required. If this be the case, it might be well to try and borrow these from a friendly druggist, if he has them, or, if you have some friends who are interested in chemistry, who have the pieces, you might be able to work this experiment with them. Again, if several get together and each pay for the additional apparatus, it may be performed, by this method, at the same time, it will undoubtedly create sufficient interest, for the others to start experiments of their own, and in this way, each experiment could be performed by the several people at the same time.

Have four Erlenmeyer or Florence flasks, three of which are plain, thin glass, and of 125 to 250 cc. capacity; the other of 250 cc.; *thick glass* and side neck (not given in the illustration) with a rubber stopper to accommodate the numerous delivery tubes. The three small flasks have 2-hole rubber stoppers, each carrying a thistle and a right angle delivery tube, and each is set on an iron tripod, or ring stand with an asbestos pad. The delivery tubes lead into the large flask, and should extend at least two-thirds of the distance to the bottom. The fourth hole in the stopper of the receiving flask contains a short tube with a rubber connector to another tube used as a mouthpiece, for blowing in air.

Pour into one of the small flasks, 25 cc. of water, into each of the other two not over 10 grams of copper scraps. Adjust the apparatus and then pour into one of the flasks containing copper 25 cc. of sulfuric acid. Heat the flask containing water, and also the one containing copper and Sulfuric acid. As soon as the water boils and action begins in the other heated flask, pour into the third flask containing copper alone, 22 cc. of nitric acid diluted with half water. Apply gentle heat to this last one, if necessary. Remove the heat for a minute from the other two flasks. In all cases heat must be carefully regulated. The fumes in the large flask should become white, then red, then white again. When they become white, blow into the receiver thru the mouthpiece, and if necessary to change them to red, heat the flask containing nitric acid, or even put in more acid. Bear in mind that sulfuric acid can only be made when red NO_2 fumes are present. Hence keep alternating the heat for the three flasks and blowing into the receiver. The breath furnishes oxygen, which combines with the nitrogen dioxid [NO] from the nitric acid to form nitrogen tetroxid [NO_2], which latter gives up half of its oxygen to the sulfurous acid [H_2SO_3] to form sulfuric acid [H_2SO_4].

After continuing the process twenty minutes, clean the entire apparatus, save the acid made, and wash and save any remaining copper.

EXPERIMENT NO. 90

Made from Sulfur, Nitric acid, Water and Air.

The reactions in making sulfuric acid, and its preparation on a minute scale, may be shown by the following experiment.

Burn in a wide mouth bottle of 250 cc. capacity a piece of sulfur the size of a split pea, placed in a combustion cup and set on fire in the usual way, as shown by Fig. 81. Keep the receiver nearly covered with a glass plate. When combustion stops, take out the sulfur, keeping the bottle still covered. Fasten a small tuft of cotton to a splint and dip it into a little Nitric acid in a dish. Or fold a piece of old book or newspaper about 5 x 8 inches, with folds about ½ inch in width, and immerse about an inch of this folded paper in 5 cc. of Nitric acid so as to saturate it, but avoid dripping. Take the cover momentarily from the wide mouth bottle and bring the acidified cotton or paper in contact with the fumes, alternately raising and lowering it; then hang it on the inside of the bottle and cover it at once, letting it stand for five minutes or more, as shown by Fig. 82. Now boil 10 cc. of water in a tube, and, having taken out the acidified cotton or paper, pour it while hot into the bottle. Cover the latter with a stopper or the hand and shake it vigorously a minute or two,

(*Continued on page* 358)

MANUFACTURING MAGNETISM.

(*Continued from page* 313)

thing left to see is why the atoms, or elemental magnets, act like gyroscopes and line up when the bar is rotated. Let us remember that one of the assumptions of the modern electron theory of matter is that every atom is believed to be composed of a positive nucleus or center, about which the negative particles or electrons rotate at high velocity, as in Fig. I. It is not hard to see that each atom therefore acts as a gyroscope (called in this case a gyrostat). Also the revolving electron constitutes a minute electric current flowing in a circle about the nucleus, and like all electric currents flowing in such a manner, it has a magnetic field directed thru its orbit in the direction of the vertical arrow. Ordinarily, when a piece of steel is strongly magnetized by stroking it with another magnet, it seems that all or a majority of these little electro-magnetic systems are forced about until they point in the same direction, and the magnetism of all of these added together constitutes the magnetism of the whole body.

This gives us a theory of magnetism which is quite an advance over the old so-called molecular theory of magnetism which asserted that no matter how much a magnet he subdivided the parts would always be little magnets just like the first. The advance which has been made in the theory is shown in Fig. II.

By rotating a bar of iron or steel about a longitudinal axis these atomic gyrostats line up like so many spinning tops and the bar is magnetized. So far it has not been possible to overcome the internal force of the iron sufficiently to magnetize the bar except very weakly, but this has been done, and repeated experiments all agree, showing that a new method of producing magnetization has really been obtained, and showing that the assumptions concerning the atom were true.

This method of magnetization suggests a new explanation of the earth's magnetism, as being due, in part at least, to the rotation of the earth. Such a calculation, however, only accounts for a very small part of the earth's magnetism, and we are led to conclude that either the magnetism of the earth is due in very small part to rotation, or else our knowledge of the physical state of the molten interior of the earth may be too little upon which to justify in any way a calculation based upon the observation of a solid bar of iron.

About a year ago a somewhat incautious newspaper reporter sent word to his paper that a new metal had been discovered with about a hundred times the magnetic permeability of iron, and that soon a small electric power plant could be carried in the pocket. Although the latter statement may not be so far from the truth, the former, like the alchemists of old, is a long, long way from being realized. In fact, it was a mere rumor suggested by some research work of Trygve Yensen (at the University of Illinois), who was studying an iron-cobalt alloy (Fe_2Co). This work, tho not at all startling, is nevertheless of no little interest to both scientists and engineers alike, because it deals with a metal alloy having a higher permeability than iron itself. This alloy was really discovered by Weiss of Zurich in 1912, who found it had a saturation value of magnetization ten per cent. higher than that of pure iron. Up to this time it had been supposed that such a metal was a practical impossibility. Thruout the usual range of field strength the permeability is twenty-five per cent. higher. If the alloy proves itself commercially practical this would mean a twenty-five per cent. reduction in size and amount of wire on dynamos, motors, transformers and other such pieces of apparatus.

Heusler probably paved the way for the discovery of this alloy when he found the famous alloys which bear his own name in 1903. These alloys composed of manganese, aluminum and copper; and of manganese, aluminum and zinc, are themselves strongly magnetic tho the elements composing them are non-magnetic.

The two facts, that a magnetic alloy can be made from non-magnetic metals, and that an alloy of higher permeability than any known can be made of iron and cobalt, tho they seem at first in contradiction to ordinary law, are in reality quite in harmony with recent theory. If the atom consists of a nucleus about which a number of electrons revolve, and if all the electrons do not revolve in the same plane or same direction the magnetic effect of the atom may be anything from maximum to zero, depending on how much the revolving electrons tend to neutralize each other. Figs. III and IV represent simple conditions showing atoms with two electrons having maximum and minimum magnetic strength.

When a number of neutral atoms of non-magnetic elements enter into a new relation, as in the case of the Heusler alloys, then it seems probable that a change takes place so that the electronic orbits shift, and if the electrons no longer oppose each other the neutral atom then becomes magnetic.

Such a theory suggests that alloys with a still greater permeability than the iron-cobalt alloy just mentioned, will be found at some future time.

THE MARVELS OF RADIO-ACTIVITY.

(*Continued from page* 303)

Sir William Ramsay, in his last article, penned just before his death, said:

"Radium has been prepared in the state of a metal; it is white, hard, and is soon attacked by the air and the moistness of the atmosphere, and turns into a white powder—the oxid. (Radium metal was first produced in 1910 by Madame Curie and Dr. Debierne, by the electrolysis of the chlorid into a mercury cathode, the mercury being subsequently volatilized. See the *Comptes Rendus de L'Academie des Sciences*, vol. 151, page 523, 1910.)

Radiograph of Several Objects Made With 2 Grams of Uranyl Chlorid in Thirty Hours By the Author.

"The gas from radium changes quickly into a solid metal which Soddy and Rutherford called 'radium-A'; it in turn changes still more quickly into a second, termed 'radium-B'; from it a third, fourth and fifth successively develop, which they named 'radium-C,' 'D' and 'E,' respectively; 'E' changes into 'F,' and that turned out to be the same as the Curies' 'polonium.'

"During each of these changes, a relatively enormous amount of heat is given off; now, heat is a form of energy; and Rutherford and Soddy ascribed the successive changes to what they called the 'degradation' of the radium and its products, that is to radium changing into another element, namely the gas termed by Rutherford 'emanation' but now known as 'niton.'

"The change of radium into niton is accompanied by the emission of 'alpha rays,' one of the kinds observed by Becquerel to be emitted from uranium. When radium-A is formed by the degradation of niton, alpha rays are also expelled; radium-A changes into radium-B, however, with the loss of no alpha-rays, but only the beta-rays; and beta-rays were shown, later on, to be identical with electrons. What are alpha rays?

"The present writer (Sir William Ramsay), along with Mr. Soddy, separated the niton from a comparatively large quantity of radium. It had all the properties of a gas; it expanded by heat, and altered its volume under pressure, exactly like other gases, such as oxygen and hydrogen. But one of its properties was almost miraculous; on standing, the niton disappeared slowly, and its place was taken by another gas called 'helium,' discovered by the writer in 1895.

"Such a phenomenon was at that time new to chemists; it implied the 'transmutation' of one element into another. It is true that, unlike the attempts of the old alchemists to transmute the 'baser metals' (lead, silver, etc.) into gold, this change took place spontaneously; it could not be controlled; still it was no less revolutionary and striking. *One element may change into another*, for there is no denying that both radium and its product helium are in the ordinary sense of the word elements. Some years later, the present writer, working with Gray, made a balance so sensitive that by its aid the weight of a quantity of niton so small that it would just fill a glass tube no larger or thicker than a very fine needle was determined; and also a much smaller weight, that of the helium, produced by the disintegration of the niton.

"By an extremely clever set of experiments, Rutherford actually counted the number of atoms of helium shot off from radium-C in a given time; and he proved that alpha rays are nothing but a stream of helium atoms in enormously rapid motion, poured out from radium and some of its products of disintegration. This stream goes on as long as there is any of the emitting substance left: each atom of radium, for example, loses an atom of helium, and forms a new element niton.

"But the change of one element into another is not always accompanied by the emission of an atom of helium; sometimes, as when radium-A changes into radium-B, an electron is lost instead, and an electron is nothing but an atom of negative electricity; nevertheless, radium-A is just as different from radium-B as radium is from niton; all four are different kinds of matter, as unlike as iron is to silver.

"Are elements compounds? Yes, in a sense; but they are very stable compounds, much more stable than ordinary compounds such as water, or oxid of iron; when they decompose, one of their products appears to be always helium; and their decomposition is in all the cases which have been followed accompanied by the escape of a prodigious amount of heat; far more, regard being paid to the amount of substance changing, than any ordinary heat change.

"For example, an Atlantic liner gains the power necessary for crossing the ocean from the burning of coal, and the heat produced by its combustion. It is not difficult to calculate that if the energy of a few ounces of radium could be utilized (for it comes off far too slowly to be made use of—it takes thousands of years) it would give all the power and more, than the coal carried in her bunkers. We can control the combustion of coal; we cannot alter the rate of change of radium.

"Radium is a very rare substance; the ore from which it is extracted, pitchblende, is not common; good ore contains one-tenth of its weight of real oxid of uranium; and of such ore, less than one-ten-millionth is radium; moreover, the cost of extraction is considerable. Up to now, its chief use has been in medicine."

(To be continued)

SELENIUM CELL DESIGN AND CONSTRUCTION.

(Continued from page 332)

or brass plate and a transparent sheet of gold foil on the other side. To construct the cell a sheet of copper or brass of the desired size is covered with a thin film of selenium and while the same is in a molten state, a plate of glass is placed on it and a slight pressure applied. When the selenium has cooled and crystallized the glass is removed and a sheet of transparent gold foil is placed over the selenium. The cell is now ready for annealing. In annealing, a similar piece of copper, coated with selenium, may be placed alongside of the cell to indicate if the temperature is too great and as a check on the condition of the cell. These cells have been made with a ratio as high as 330 to 1; the resistance depends upon the thickness of the film, and the thinner this is the lower the resistance.

It should be clearly understood that a selenium cell requires some care to keep it in good condition. It should be kept in the dark when not in use and will retain its sensitiveness longer if exposed to light every day or so. After some time the dark resistance of the cell will decrease, and when abnormally low may be returned to its original value by subjecting the cell to alternating current till the resistance is regained. If exposed to a bright light for long lengths of time the cell will become fatigued and lose much of its sensitiveness.

A FEW DONT'S.

Don't leave the cell in the dark for weeks at a time.

Don't be afraid of allowing the cell to anneal for several hours, the longer the better.

Don't use a Bunsen burner for annealing; use an alcohol lamp that is large enough so that one filling lasts for five hours.

Don't use commercial selenium. Get the chemically pure grade from a reliable chemical supply house.

Don't keep the cell in the light too long.

And above all, don't get impatient or disgusted if the first four or five cells you make fail to work. It takes patience, patience and more patience, but perseverance overcomes all obstacles.

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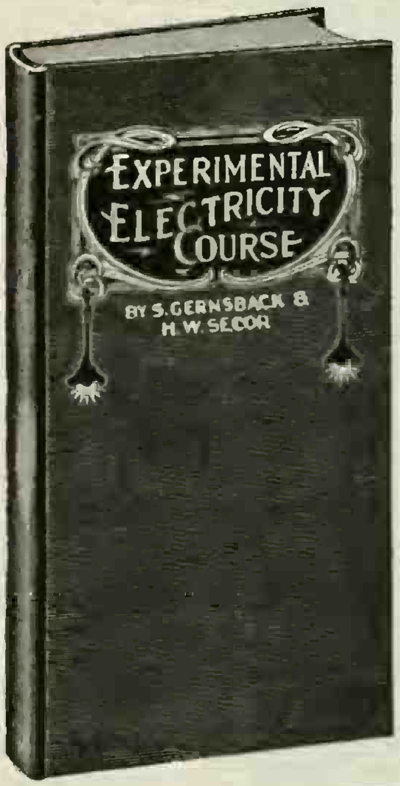

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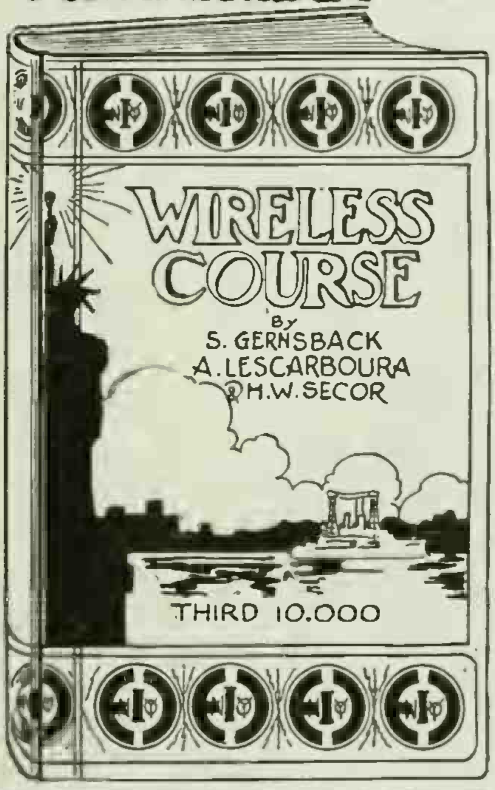

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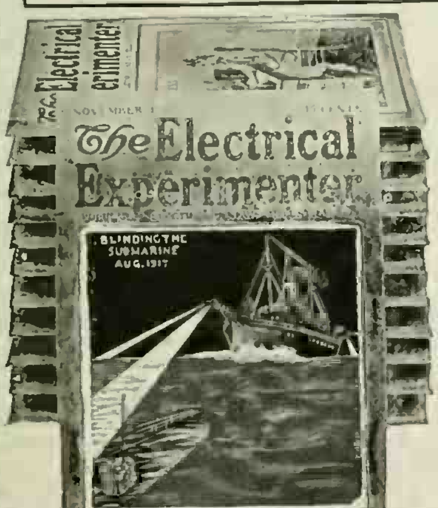

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EXPERIMENTAL CHEMISTRY.

(*Continued from page 354*)

being very careful not to get any acid on the clothing, as it quickly oxidizes and removes the color.

The acid prepared by this method will be very weak, but should at least give the barium chlorid and litmus tests.

EXPERIMENT NO. 91

To ascertain whether we actually have sulfuric acid, it will be necessary to make tests for the *positive* and *negative* parts, in other words, to test for *hydrogen* and then for the *sulfate radical* [SO_4]. Take some of the acid made by either process above and test it with blue litmus paper.

To show that sulfate is present, take about 10 cc. of a solution of barium chlorid [$BaCl_2$] or barium nitrat [$Ba(NO_3)_2$] and pour a few drops of the liquid you prepared or which you wish to test, into it. Observe the color of the precipitat formed, and note results.

Keep the precipitat and add to it 10 cc. of dilute hydrochloric acid, made by mixing one volume of the ordinary acid with three or four parts of water. Shake the mixture well and see whether the precipitat dissolves. If it *does* it shows that you *do not have* sulfate ions or radicals present, and the acid is *not* sulfuric. But if the precipitat *does not* dissolve, *it is* a sulfate, for any salt of barium would have dissolved in dilute hydrochloric acid.

This statement may be verified by making other salts of barium that are insoluble in water, and trying to dissolve them in dilute hydrochloric acid, as barium carbonate [$BaCO_3$] and barium chromat [$BaCrO_4$]. These being insoluble in water, are made by the usual method of preparing insoluble salts. (See June 1917 issue of the ELECTRICAL EXPERIMENTER, p. 155.)

It will thus be seen that the barium chlorid test is a test for the sulfate ion or radical, *and not for the acid alone.* To verify this make a solution of any soluble sulfate, as sodium sulfate [$Na_2 SO_4$] or ammonium sulfate [$NH_4]_2$ [SO_4], and apply the test.

The carbonization test is one for the acid as a whole. To apply it in four cases, take four small tubes in a test tube rack—into one put a gram or so of sugar, into another a like amount of powdered starch, into a third a wad of paper, and into the last a clean splint. Pour on each of these 5 cc. of commercial sulfuric acid, and let them stand a few minutes. Eventually all will be affected the same way if it is sulfuric acid.

EXPERIMENT NO. 92

Action of sulfuric acid on water.

Measure out in a graduate 10 cc. of cool water from the faucet and pour it into a medium-sized test tube. Immerse a chemical *Centigrade* thermometer in the water, carefully resting the bulb end on the bottom of the tube, as the glass of the latter is thin and mercury is heavy (Fig. 83.) Let it stand a minute, and take the reading and record it. Now take out the thermometer and rest it in another tube in the rack, then measure out 10 cc. of the concentrated commercial sulfuric acid and slowly pour it into the water of the first tube. At once immerse the thermometer in the mixture of acid and water, stirring it gently with the thermometer tube; when the mercury reaches its highest point, take the reading and record it. Remove the thermometer, wash it thoroly by holding it under a jet of water to wash out all the acid, then wipe it dry and replace it in the case.

Compare the difference in the thermometer reading both after placing in the water, and after the acid was added.

(*To be continued.*)

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