ELECTRIC "BLOODHOUNDS"
FIND AND DESTROY SUBMARINES
SEE PAGE 298
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SOONER or later you will be standing in front of the mahogany desk. The big man reclining in his office chair will glance earnestly at you while his keen gray eyes "take you in."

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Will you withstand such a bombardment? No, Sir. Not if you have no actual experience in back of you? WHAT'S BACK OF YOU? Just a little personal dabbling in your attic at home, a few books and some magazines? Or have you actually done these things yourself with your own hands, in a place where such things are done every day? The keen eyed man behind the desk will know in less than a minute. You cannot bluff him. HE knows. He wants an expert, not a dabbler. It's experience that counts today. It's experience that brings the big coin.

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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 as it is by a web of spies and intrigue, this is of vital importance today. Even when we were at peace with Germany, our government soon learned that the country where the art of spying is developed to a higher degree than anywhere else on this globe, sought 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, were laughed at. Sixteen years later our Government took over Sayville, after a New Jersey Radio amateur actually succeeded in "canning" on phonograph cylinders incorporating radio messages, sent them out off 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 his 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 is given out that the information was sent by mail or by wire to Mexico—in liberal code of course—and thence sent across the Atlantic over the powerful Mexico City radio plant. This may be possible, but we must doubt it.

We can be certain that a nation which attained as high a scientific development as Germany, will use subtler means to convey secret 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.

So, 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 coastline, the coast of Long Island and Maine, for instance, there are 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 accomplished 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 directly or by relaying it over other damped 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 humanly possible. We do not wish to wait till a score of our transports have been sunk. H. GERNBACH.

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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 have 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.

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 Experi- menter. 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 the lofty antennas with thousands of kilowatts of high frequency electrical energy, then to radiate them 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 vast 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

militated 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 of 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, and the liquid secured to the opposite side of the sphere. In this way the wireless currents are supposed to act.

The tower of Dr. Tesla are basically quite different from those of Marconi and others in the wireless telegraphic field. In the first place no things 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 current received in the transmission of intelligence wirelessly amounts to but a few milliamps 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 receiver 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 as the pump piston in the analog.

Quoting from one of Tesla's 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 it is not to be confounded with the phenomenon 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

THERE is a certain thrill in watching and dreaming of battleships. A surprising 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 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

paratus 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 adapts 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 be successfully realized its effects will doubtless revolutionize modern lighting. Professors Edwin Conklin, Ulric Dahlgren and Edmund N. Harvey are working on luminescent 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 7,000,000 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. Bottyer before the December meeting of the Bunsen Gesellschaft, is employed by Julius Finisch, 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 more, and a few inches 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 octagonal 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 FLASH-LIGHTS 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 focus 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 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.

Although 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.

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.

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.

September, 1917

THE ELECTRICAL EXPERIMENTER

295
All Aboard for “Luna’s” Electric Top

O

NE of the largest and most interest-
ing 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, seven-
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 be-
fore the gate.
Luna Park has augmented its brilliance
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 bright-
ened the entire park. The concourse is now
known as Luna’s White Way.

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
457 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-oper-
ated train was taken off the Missoula divi-
sion in February, 1917. On that division
is the St. Paul pass tunnel, which cuts
thru the summit of the Bitter Root moun-
tain range near the Montana-Idaho line,
and has a length of 8,000 ft.
The work of electrifying another divi-
sion of 217 miles began about May 16,
1917. The starting point is at Othello,
100 miles east of Cle Elum, and electrici-
fication will proceed westerly to Seattle and
Tacoma. Power will be furnished by the
Intermountain Power Company. It is fig-
tured that the work will be completed be-
fore Cle Elum and Seattle and Tacoma
before the close of 1918.

JACK BINNS ENLISTS IN BRITISH
ARMY.
Prominent among the applicants answ-
ering the call for British recruits in Amer-
ica, was Jack Binns, the wireless operator,
whose messages from the Inner Republic
Jan. 23, 1909. Brought rescue ship 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.

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.
September, 1917

THE ELECTRICAL EXPERIMENTER

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

SOME years ago when telephony was still quite a youngster, one of the most interesting and remarkable scientific demonstrations involving several of Thomas 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 photographic and telephonic transmission of sound took place in Philadelphia, 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 phonograph receivers, 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 unison, it is asserted 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.

The mediums included vocal chords, cornet, air, glass, iron and mica diaphragms, 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 diaphragm of the phonograph recorder, producing variations in curvature of the diaphragm. (3) Variation in longitudinal stress of the steel stylus attached to glass recording diaphragm. (4) Undulations in the wax cylinder of the phonograph. (5) Variation in the longitudinal stress of the steel stylus attached to diaphragm. (6) Vibration of the glass diaphragm of the phonograph reproducer producing variations in curvature of the diaphragm. (7) Sound waves thru the air. (8) Vibration of the carbon diaphragm of the carbon transmitter producing variations in curvature of the diaphragm. (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 diaphragm. (10) Pulsatory current produced in the primary winding thru the wire. (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 phonograph receiver. (21) Electrolytic action, causing evolution of hydrogen and oxygen between the chalk cylinder and palladium-faced spring of the phonograph receiver. (22) Electro-capillary action, forcing moisture to the surface of the chalk cylinder of the phonograph. (23) Variation in longitudinal stress of bar or spring attached to mica diaphragm of the phonograph receiver. (24) Vibration of the diaphragm of phonograph receiver producing variations in curvature of the diaphragm. (25) Sound waves thru the air. (26) Vibrations of glass diaphragm of phonograph transmitter producing variations in curvature of the diaphragm. (27) Variation in longitudinal stress of steel stylus attached to glass transmitting diaphragm. (28) Undulations in wax cylinder of the phonograph. (29) Variations in longitudinal stress of steel stylus attached to glass reproducing diaphragm. (30) Sound waves thru the air. (31) Vibration of iron diaphragm of carbon transmitter, producing variation of curvature of iron diaphragm. (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 diaphragm. (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 electromagnetic 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 phonograph receiver. (43) Electrolytic action causing evolution of hydrogen and oxygen between the chalk cylinder and palladium-faced spring of the phonograph receiver. (44) Electro-capillary action, forcing moisture to the surface of the chalk cylinder of the phonograph. (45) Variation in longitudinal stress of bar or spring attached to mica diaphragm of the phonograph receiver. (46) Vibration of the diaphragm of the phonograph receiver producing variations in curvature of the diaphragm. (47) Transmission of sound waves into words by the auditory nerves and other mechanism of the ear. (48) 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, David Watson, 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 various types of war vessels in the United States Navy.

www.americanradiohistory.com
Electric "Bloodhounds" to Find and Destroy U-Boats

By H. GERNBASCH 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 snared in the back, at the opportune moment when the bandit feels himself safe from counter attack. The U-boat, however, not only can 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 plausible that it could then go after us 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—one paper by m a e a m powersubmerged 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 counter part 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 its 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 super-sensitive microphones, which are provided with certain low-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 on good authority that of late German U-boats mount their motors on felt and other sound deadening substances, the fact remains that they do make quite a bit of noise.

And like the flesh and blood dog, the electric "bloodhound" can be fended off 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 cannot see the not so small submerged U-boats. Given a hundred submarine motor boat chasers equipped 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 device details, find that the idea is entirely practical and feasible. For obvious reasons not all of the details and refinements are published in 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 machinery, 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. And 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 through water. And this cannot be suppressed by any possible means, unless the U-boat lies perfectly still, and a U-boat can 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 propellers, to charge the storage batteries. And it is

(Continued on page 317)
The Sob of the Sub.
By Ed. Schultz.

September, 1917

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 enemies went to "Pe"; 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 his plain was rammed in twain, For now remained but one.

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 de-

...vices and appliances that watch your trip day and night that you may reach your destination safely? Perhaps you give much thought to this all-important matter.

...Within the last few years greatly increased the number of appliances which tend to safeguard the public and all the 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 black section to another. In addition to this new device, the dispatcher has also the telephone and telegraph 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.

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.

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

We are either engross 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
Spy Aerials

"SPY wireless" is one of the all-absorbing topics of interest throughout the country at the present time, and quite naturally it would seem the closest of which are illustrated and described herewith. The average law-abiding citizen will probably consider that some of the devices mentioned will be employed 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. The system described is based upon tests which have been conducted in the past few years.

As already mentioned, the exceedingly flagpole 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 published in the past three years. In France the concentrating arrangement 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 from quite considerable distances from the Eiffel Tower Radio Station at Paris. In this country several very satisfactory experiments have been carried out with carrying 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 unusual fact that these small concentrated aerials, which however possess considerable inductance, 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 arrangement of a layer of insulated wire covered with a fiber or other sheath painted to imitate wood, etc.

Aerial "spring" 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 and in the case of many electricians, these wires are highly insulated and form really a very good 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, his responses being recorded with metal instead of wood lath, and the perforated steel lath plates usually overlap, presenting quite an appreciable capacity. Especially with large rooms on corridors are considered.

Another interesting and possible aerial which might be impressed for service in emergency is the ordinary gas pipe system as illustrated in Fig. 4. It would be an easy matter for an enemy expert to disconnect the gas pipe at the meter in the cellar of the building, so as to isolate it, and when used in this way, the 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 very clothes-lines might be used for radio-communication. Such may be the case very easily (see Fig. 5), and there have been wire very much resembling clothes-lines have been discovered on roofs of buildings which have proven to be disguised wireless antennas. One of these aerials in a large eastern city extended for several blocks, and was easily capable of picking up messages from such points as stations throughout the country. 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 transmission. Fig. 6 illustrates two devices which the enemy might employ to carry on wireless service with quite 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 easily concealed in a large number of wire stands. 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, and as easily employed as the above, is 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 taken down, but the trick is done; and come to think of it, we have seen lightning rod installations which rambled over considerable area, not to mention 200 foot and 250 foot 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 work in the cellar of the house, fancying a bucket to the lower end of the cable in the regular manner. When in use of course the bucket would be filled and 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 aerial for the first time, right under our noses.

Have you examined your shade trees closely this summer? Don't be surprised if you find a back in the bark of 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 only not difficult 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 aerial, wireless experts have for some time known that radio messages could be picked up over remarkable distances by obtaining a radio receiver to existing telephone lines as illustrated at Fig. 8.

Not to be outdone by any 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 employing a radio receiver to existing telephone lines as illustrated at Fig. 8. This would readily fit the case this in 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 iron fence, which may be found 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 basepals, so that it would be quite well insulated. These suggestions may sound a little outlandish, but they may be found most anywhere, 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 fence located not higher than the

(Continued on page 342)

THE ELECTRICAL EXPERIMENTER

September, 1917

300
SECRET RADIO AERIALS

1. Painted Fiber Cover
2. Wire to Instruments Insulated Wire
3. Leader Pipe Cut Free from Ground
4. Main Lighting Switch Opened
6. Wire Cable
8. Wire on Limbs of Tree Painted to Correspond
9. Wire to Radio Set
10. Elevator Metal Grill
11. Concealed Lead to Radio Set
12. Spiral Aerial Artificial Wall Covering

(See descriptive text on opposite page.)
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 stop by a sheet of paper or a few centimeters of air, the alpha rays, and (2) a far more penetrating radiation capable of passing through several centimeters of aluminum, the beta rays. Later Villard found that radium emitted a very penetrating type, the gamma ray, capable of passing through twenty centimeters of iron and several of lead.

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 wrapped 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 chloride in the bottom of a brass tube.)

Bequerel 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 2.5x10^6 cm. 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 lead sufficient to stop any one particle will stop the whole discharge—regardless of its strength.

Due to the large mass, the alpha particle possesses a considerable kinetic energy (60x10^4 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 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 vivid manner. A short brass tube has a screen coated with crystalline zinc sulfide 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.

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.
The Beta Rays

The beta rays are composed of negatively charged particles. They are considered by many as electrons with an exceptionally high velocity, 1,600 cm per second. Beta particles are detected by magnetic and electrostatic fields with much greater ease than the alpha particles. The deviation reduces the ionizing power.

The ionizing power of 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. Typical lead and 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 easily proved by deviating them away from the other types, and allowing them to act on a plate. A brilliant fluorescent image is caused in many substances, but not the scintillation of the alpha rays.

The mechanical disintegration caused in metal by the primary beta rays, despite the fact that it is largely due to beta rays. Paper and rubber, after having been wrapped 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, known as the beta 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 other 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 milli-

Here the Radium Is Measured by Means of An Electroscope: Employees from Other Parts of the Laboratory Are Excluded at All Times, as the Arcscope Is So Sensitive That Even the Radium Infection In Their Clothing Impairs Its Accuracy. The photo-graphic 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, although there are cases where the action differs from that of X-rays.

The half-life of radium is 1,600 years. The radioactive element, the curve can serve to show its rate of decay. Thus for Radium Emanation 3.8 Days is the Half-life Period, and So In 38.2 Days, Any Quantity of This Substance Falls to 0.1% of the Initial Amount.

The occurrence of the gamma rays depends on the density of the medium. Radiation is best observed by Thomson and has been called by him the radiations. The angle of incidence of the primary rays affects the intensity of the secondary radiation. The most effective angle appears to be about 45°.

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 second-

The Alpha Rays

The alpha rays are found in the radiation of all radio-active bodies. Beta rays are emitted by radium, 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.

LARGEST ELECTRIC LOCOMOTIVE DEVELOPS 7,000 H. P.

A new era in railroad practice is dawning. The problem now confronting the 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 70 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 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 fete, 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

This Electric Locomotive is "King of the Rail," Measures 76 Feet in Length and Develops 7000 Horse-power. Equal to Two Giant Steam "Locomotives" It Will Haul Freight Trains Over the Allegheny Mountains At Twice the Speed of Its Predecessors.

のヒント：このページは8日間で本の「電気実験者」によって作成されたもので、1917年9月発行です。

全ページを読むと、以下のようなトピックが挙げられています。

1. 新しい鉄道時代の到来
2. 鉄道の効率向上
3. 電気機関車の導入
4. 貨物列車の運行
5. 速度の向上

このページは、電気機関車の導入とその効果についての説明文です。
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.

AUTO CUTS OFF TELEPHONE POLE.

At Logan, W. Va., recently an automobile crashed into a telephone pole. The Birds In Cincinnati. This Nest In An Arc Lamp Proves It.

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 the fixtures is that their design can readily be changed from time to time to suit an entirely new type of interior decoration, any social 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 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 unshaped 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.

A CHANGEABLE DECORATIVE LIGHT SHADE.

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.

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 ELECTRICAL EXPERIMENTER

September, 1917

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THE ELECTRICAL EXPERIMETER
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 13,200-volt line. On a recent Sunday, trouble showed its head when workmen were digging in the roadway to unearth a burst water main. Perhaps we will see a piece of sidewalk fly against the face of the driver. As it is, he was merely surprised to note that the water was Premont.

Quite often, while walking down a city street, one 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 street fly against the face of the driver. As it is, he was merely surprised to note that the water was Premont.

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

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 fatal for the unfortunate lovers. Which goes to show that the top of a pole carrying 13,200 volts is a bad place for spooling.

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 shaker, 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 whipped 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 whipped up.

The Destruction of Steel and Concrete by Electrolysis.

By K. M. COGGESHALL

Quite often, while walking down a city street, one 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 street fly against the face of the driver. As it is, he was merely surprised to note that the water was Premont.

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

The Destruction of Steel and Concrete by Electrolysis.

Some of the old pieces of pipe that have been removed and will be surprised to note how it is pitted and eaten away. A pocket knife is used to dig into the sides of the pipe, if will be found to be cut and cut into the pipe. Another chemist would tell us that this destruction of the steel or cast iron pipe was caused by the chemical 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 the metal deposit 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. If the voltage on the object is increased to seven or eight, the necessary to create this action may be quite small; although 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 although, 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. This is easily been seen, there is a difference of potential between two points on the earth's surface, a lead being placed. The 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 through 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 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 barrier 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 each 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, we find electrolytic action when the current leaves the pipe. This disintegration, as a rule, causes pitting 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 thoroughly dry, the graphite and other impurities with which the pittings are filled, become hard and drop out or may be easily removed with a pocketknife. In wrought iron and steel pipes the iron oxide 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 Runs 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 oxides 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 one difference seems to be that while direct current electrolytic decomposition occurs only at the negative electrode, with alternating current this corrosion is present at all 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.

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 ascribed 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 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 perspiring one of Laura Lean Jibby's famous works, is happily preoccupied with the fatuous and prodigious duty of entertaining the icedman.

**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 row. Mysticism is the key to nearly all of the best window attractions that have been evolved in the past several years. The one shown here-with 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 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 A MACHINERY.**

Anyone who has ever had to open a thousand letters by hand or by hand-operated letter openers, knows the enmity of this task and the amount of time necessary to complete the operation. In addition, the greatest care was 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 making 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 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 advertisement 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 this? The letters 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-
Vocation of the Engineer

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

This association should quicken his intellect and unfold to him some of the problems of the engineers and their tentative or successful solutions. Let us suppose that he is an editor of an engineering magazine, and read such others as may be available. Without interfering with regular school or other work, such periodical 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 laboratory the competition between one's fellows is altogether too real to permit trifling with the original selection.

As to any real 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 these were persons who consistently worked at their profession.

Upon graduation, two-year training courses are ordinarily available in some consulting, designing, erecting, and manufacturing concern. During such a course the "student-engineer" receives a living wage, and is frequently transferred from one department to another, whereby he acquires a working familiarity with a great variety of subject and apparatus. Such a course or at its completion, the "student-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 it appears that the engineer has to a certain degree been deprived of the use of artificial methods, that he has been made as a consultant without the recognition of the important 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 work will bring him the recollection of college and apprentice days, but that early training is indispensible.

The expectant engineer may well consider that his life-work will bring him in touch with city councils, with legislative committees and associates, with financial interests, and undertakings. He may be called upon to give public addresses and to prepare papers for publication. His work 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.

IN THE OCTOBER "EE"

"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. Germsbach.

The American inventor of Radio who Antonio genius.

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

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

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

Radio-dynamics—the control of torpedoes, boats, etc., ether, by wireless waves.

Some recent developments in this field.


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!
X-Ray Tubes for High Frequency Coils

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

N 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 entirely 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 discharge 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 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 image formed by 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 created investigations 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 resulting X-rays, and producing 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 fill 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 Thomson, in 1896, to invent his "double-focus tube"; the construction and operation of the Thompson double-focus X-ray tube is shown in Fig. 2. (Continued on page 328)
UE 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.

The Franklin Experimental Club

By WILLIAM J. HAMMER
Consulting Electrical Engineer

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 equipped 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 dallied 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 Elect. Revie., 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, 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 also realize that there are few things out of which boys can derive as much pleasure.

Perhaps the “Electrical” and “Radio Bugs” to whom this article is addressed 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 through 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, pushbuttons 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
receive the necessary encouragement. Some years later (1889) while visiting Berlin, Germany, with Mr. and Mrs. Edison, we were shown thru the New “Urania” 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 possess quite a fine library of technical books and some twelve scientific volumes, several quarterlys, 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

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 Husted Cigars Around the Table, the Skulls Flashed and Heaved, 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 Willam.

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 col-

The first Annual Meeting of the Franklin Experimental Club was held at the Hotel McAlpin, New York, Jan. 31, 1911. The Hon. William McGee, Chairman, presided. The Club was organized on Jan. 1, 1910. It is a scientific club, devoted to experimental and research work in science and engineering.

Obverse and Reverse of Souvenir Medallion of Benjamin Franklin Which Each Guest at the “Franklin Experimental Club” Electrical Dinner Received. A Pleading Memento.

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 ELECTRICAL EXPERIMENTER

Experimental Physics

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

September, 1917

LESSON 7.

Sound.

We all know that the fortunate person who is born deaf and has
never heard 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 taut wires of Mr.
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
for $5.00 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 Physi- cal
sensation in us. In everybody's
life sounds are usually disturbances.
Therefore the grouch will be gratified to learn that Phys-
sics teaches us that all sounds are always disturbances (of the air).

EXPERIMENT 40—Place about half a
cupful 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
puddy'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 indis-
tinctly. This leads us to the first im-
portant 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.

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 blow-
out or when an explosion occurs, etc.,
leads us to the next important consider-
amation, 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 phe-
nomena exist in both cases, and it is
the Physical phe-
nomena of sound
that the Physicist
deals with. The
Physiologist and
Psychologist deal
with the sensations which the hu-
man being interprets as light or
sound.

EXPERIMENT 41—Everyone has noticed that the lightning flash is
seen before the thunderslap is heard. Anyone who has been
close to a cannon 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 much slower 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 and
hung 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. Stand-
ing below the gong you wave a flag
provided by 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

(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 have not yet been able to use the Earth's mass to lift a ton weight.

New and improved electromagnets are now available, and they can lift ton weights. At the present writing, the greatest manufacturer of magnetism is a certain manufacturer of iron, who has manufactured a magnet of such strength that it can lift a ton weight.

This magnet is made by the same method as the old magnets, but with a new iron core. It is made by the method of magnetization, and it is now known that iron can be magnetized in a single bound.

The old method of magnetization was by the use of a solenoid. The new method is by the use of an electro-magnet. The old method was unsatisfactory, and the new method is superior.

The old solenoid was a device for producing a magnetic field in a coiled wire. The new electro-magnet is a device for producing a magnetic field in a coil of wire.

The old solenoid was made by winding a coil of wire around an iron core. The new electro-magnet is made by winding a coil of wire around an iron core and then passing an electric current through the coil.

The old solenoid was used to produce a magnetic field in a coiled wire. The new electro-magnet is used to produce a magnetic field in a coil of wire.

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THE ELECTRICAL EXPERIMENTER

RADIO DEPARTMENT

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 years, and secondly, there will be hundreds and even thousands of new radio pupils in the various naval and civilian schools throughout the country, who will be benefited by up-to-date wireless articles treating on both the transmitting as well as receiving 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. Faragon and Grinan of New York City.

This station has (prior to the war) repeatedly established 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


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. Faragon 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 address to 6EA of Los Angeles, Calif.

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:
- BAAK 9AAK 9GW
- BAEZ 9AAK 9GC
- BAGF 9NAR 9FD
- BAGH 9ALM 9XM
- BALE 9AU 9ZL
- BANQ 9B1 9ZM
- BARR 9CF 7ZB
- BASH 9DB
- BASG 9DE 1ABE
- BCK 9DK 1ARK
- BCS 9EG 1DK
- BGD 9G1 1Z
- BEG 9GC 1SI
- BHA 9HN 1VN
- BHN 9IC
- BII 9JIC 1AEF
- BLE 9KBS 1FPA
- BND 9AB 1AS
- BPA 9LR 1ATR
- BPH 9NB 1NB
- BOK 9NW 3NG
- BOP 9OC 3PO
- BPS 9PC 3UP
- BSE 9PI 2J
- BSV 9RI 2M
- BVO 9OR 3WM
- BZP 9UW 2AGJ

U. S. SEIZES POW-ERFUL 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.

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.

A. F. PENDLETON

September, 1917

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

A. F. PENDLETON
SOUTHERN 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 Catuqinaru, an Indian tribe of the Amazon valley in South America, says a writer in the Geographical Journal.

The apparatus, called cauharyaru, 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. 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. Altogether 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.

PUEBLO, COLO. NAVY STAFF STARTS RADIO SCHOOL.

Sppeared 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 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—Havard, 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 cruddy 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-Carleton, 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.

...
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.

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 omni-graph 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 30 Whitehall street, New York, and all communications and inquiries should be addressed 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 "OSCILLATION"

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 herefore 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."

"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."

"I am not clearly convinced that the Fleming valve can perform the functions of an 'oscillation' 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, 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 'oscillations' 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 accomplished by a wireless operated valve supplying compressed 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 solenoids is used, the coherer is used which works on one wave length. At the wireless controlling station there is checking and tally apparatus.
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, metallic 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 frames passable county team Ridge route passable from end State high-ways to Castaic route dangerous Bakersfield reached Bouquet canyon Elizabeth lake rough throughput deep rut bogs Mint closed.”

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 postgraduate course in the various other ways of marine signaling—by means of flags and semaphore, Arduoi lights and “hissing.”

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 a youngster my greatest regret was because I was a girl instead of a boy and 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, Howett, 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 reduced pressure. It is true 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 sensitivity, that 18 months after their disclosure de Forest’s disclosure of the Edison lamp relay detector with B-battery, Fleming recognized the device 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 de Forest, who “discovered” the Audion, 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 Ultraloud, or so-called heterodyning detector, the commercial 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 exploit, all the above considerations availed nothing to convince the Court that a very great injustice would be inflicted by granting to the inutil 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 communication, 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 not obtusely pointless and impractical Selden patent as basic, so limited its applications that its owners were no longer all that they actually had developed the gasoline-engine-propelled vehicle of commerce.

Early in the Audion trial the Marconi Wireless Telegraph Company contested the validity and their infringement of the de Forest grid and amplifier Audion patent, 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 practice. 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; they are obviously absurd and 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 such highly technical a case detracts nothing from the true merit 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 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 general scheme here outlined 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 throughout the terminals of the buzzer, interposing a small fixed 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.

Diagram Fig. 3 shows a bipolar buzzer transmitter, connected to the gas and water pipes with a fixed 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 3/4 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)
THE ELECTRICAL EXPERIMENTER

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 weight of the extended hand to the apparatus has a marked effect upon the operation. On goniographs to receive undamped waves. Where no motor is available to drive the tinker, cut out a metal disc about 1/2 inches in diameter, having pickets evenly spaced about the circumference, 1/8 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.

AN EFFICIENT SCHEME FOR LEARNING THE CODE.

To learn the code well, attim does not difficult, requires considerable and attentive practice. Very often the beginner chimes, the code will, give 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 impressed 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 sheet of glass, 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 depressed 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 this out-door scheme, any one of the instruments at either end of the line may be used.

Contributed by JOSEPH BRAFF.

TRY THIS ON YOUR "VICTROLA.

Most of “us amateurs” who are still without Audions can make use of their pet phono-grams with as much or even greater separation between points . . . is usually allowed. The template is made of thin piece of metal. The stud for the outer 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 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. Enamelled 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 couples!

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 one can receive.

Contributed by MAURICE L. MUHLEMANN.

A Toothed Metal Disc Driven By a Phonograph Motor So As to Interrupt the Condenser Circuit Rapidly Provides a Serviceable "Tinker."
Calculation and Measurement of Inductance

By H. Winfield Secor and Samuel Cohen

HAVING thoroly discus 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 coppers, meters, variometers and transmitting oscillation transformers.

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 formula:

\[ H' \cdot L. = A \times L \times C \]  

where:

- \( A \) = a variable, ranging from 38.15 to 596.0 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, 596.0, appearing in the usual wave length formula was there discussed 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:

\[ H' \cdot L. = 59.6 \times L \times C \]

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.

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

\[ L_s = \frac{\lambda^2}{3552 \times C} \]  

with all values the same as in formula 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" Aerial. Wires Spaced 3 Ft. Apart

<table>
<thead>
<tr>
<th>Height in Feet</th>
<th>60</th>
<th>80</th>
<th>100</th>
<th>120</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>.00033</td>
<td>.00042</td>
<td>.00051</td>
<td>.00060</td>
</tr>
<tr>
<td>50</td>
<td>.00035</td>
<td>.00043</td>
<td>.00050</td>
<td>.00058</td>
</tr>
<tr>
<td>60</td>
<td>.00036</td>
<td>.00044</td>
<td>.00051</td>
<td>.00059</td>
</tr>
<tr>
<td>70</td>
<td>.00037</td>
<td>.00045</td>
<td>.00052</td>
<td>.00060</td>
</tr>
<tr>
<td>80</td>
<td>.00019</td>
<td>.00046</td>
<td>.00053</td>
<td>.00060</td>
</tr>
<tr>
<td>90</td>
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<tr>
<td>100</td>
<td>.00042</td>
<td>.00049</td>
<td>.00056</td>
<td>.00062</td>
</tr>
</tbody>
</table>

**TABLE "B"**

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

<table>
<thead>
<tr>
<th>Height in Feet</th>
<th>60</th>
<th>80</th>
<th>100</th>
<th>120</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>35,000</td>
<td>41,100</td>
<td>47,200</td>
<td>53,310</td>
</tr>
<tr>
<td>50</td>
<td>48,500</td>
<td>54,600</td>
<td>60,700</td>
<td>66,800</td>
</tr>
<tr>
<td>60</td>
<td>62,400</td>
<td>68,200</td>
<td>76,300</td>
<td>83,100</td>
</tr>
<tr>
<td>70</td>
<td>66,260</td>
<td>72,100</td>
<td>80,200</td>
<td>87,300</td>
</tr>
<tr>
<td>80</td>
<td>76,260</td>
<td>82,100</td>
<td>90,200</td>
<td>97,300</td>
</tr>
</tbody>
</table>

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 various wires and antennas 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 tube to be used. Having the tube 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 I, March, 1917, issue) for \( N \);
in terms of units we obtain the following relation:

\[ N = \frac{1}{5} \sqrt{\frac{L (S + d)}{3}} \]  

(4)

Where:

- \( N \) = total required number of turns.
- \( d \) = diameter of core jacket.
- \( S \) = 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 practice 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 coupling 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 when an Audion detector is used, the secondary winding should be made with a gage wire ranging 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 cannot 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 resistance due to high frequency currents is negligible. Care should be taken to keep the buttons and switch blanks clean 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 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. Fibre, 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 or 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 coil, 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 2 ½"x3½"x3½". Drill two ½" 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, 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 J. BAILEY.

CALCULATION AND MEASUREMENT OF INDUCTANCE.

(Continued from page 321)

started from the center of the first two turns as shown; the third begins at the center of 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 this connection. 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 is increased with an increase of coil length, and that the potential effect is greatest at the end of the coil. It was pointed out that with all extremely long coils the voltage is extremely high at their ends, as compared with any of the apparatus used in the tuning circuits. It has been considered that multilayer coils had considerably greater distributed capacity than those of the single layer type, due to the proximity of each layer to the inside of 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 5 milli-farads per layer, and an inductance value of about 70 milli-henries.

The winding is made over a cylindrical insulating reel, by eight wood pins past thru two end pieces. After the first 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 following 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 configuration 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:

\[ C = \frac{a}{420} \left( b + 0.5e \right) \]  

Where:
- \( C \) = capacity in milli-microfarads.
- \( a \) = radius of coil (inches).
- \( b \) = axial length of coil (milles).
- \( e \) = 2.718.
- \( c \) = winding depth of coil (inches).
- \( s \) = 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 dielectric constant of coil. The distribution of voltage is different at the various lengths of the winding. It also takes care of the dielectric loss in the air, 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 windings, losses due to 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-sealed wood and layers 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 eight windings.

The great advantages of these coils are that long wave lengths can be tuned with a small size coil, due to the location of the operator's body upon the coil. It eliminates the detuning effect on the oscillating Audion circuit when the operator moves away from his apparatus. This effect is very noticeable when the long inductance coils are employed.

The complete series of these coils is presented to the authors who have the information, and is the aim of the authors to have the information given herein accurate and concise so that 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, 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 may be gained by experiment in the radio field, and this should prove a decided incentive to every radio amateur worth his salt. Ceradial, in recognition of the great work which required much study and experimental research. The present situation, when all experimental wireless stations have been closed by the military, and in the event that the war is over, should prove nothing less than a spur to urge the real radio amateur on to a higher goal. After the "War" days are finally coming, and the amateurs will come a wonderful opportunity for radio experts, not to mention the present great opportunities in the Army and Navy sectional 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 articles, and do our best to secure what we need is snappy "Electrical" articles. Be on guard for the enemy—Repetition!
How I Built A 2½ H.P. Flivverette

By CLEAGE FEILD

"N"OTHING succeeds like success," would seem to be the beacon-light of one Master Cleage Field, 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 Field 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, Fellowships—electrical, mechanical and radio—Master Field, Master Field, 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.

Construction Details

Frame—The frame is of red oak, one and three-fourths 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 wrap 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.

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 equippt 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.

Pitman—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,

Wheels—These are No. 3, Auto wheel, coaster, size 10 inches high and use ½ inch axle. They are roller bearing and are held by cotter pins. The wheel base is 38 inches. The front axle is riveted to the block, while the rear one revolves in four iron boxes. The 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. You will 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!"

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 ½-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 eqipt 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 my one wire aerial at right angles to the A. C. power circuit. Upon trying the set we found the burn almost entirely eliminated but "no sags." Where then was the 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 entirely 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 note-worthy were experienced, 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 established 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 earn earnest work, averaging a week at my instruments. I was not equipt for sending for about two years, but spent a great deal of time 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 older 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 a large ocean-going steamer made its way into our present location, and this I have practically completed a first-class 1 K. W. station, which awaits the end of war.
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 unanimous conclusion. In the past its sporadic applications have been many, but its present status remains more or less in experimental stage. Among other applications, we find that Miechun 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, Giltay, Mercadier, Bidwell, Taintor, Perry, Mercadier, Adams and Ilittorf, who in 1877 published 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 of a Bidwell Cell: 1. Modified Bidwell Type: 2. Second Type of Modified Bidwell Cell: 3. Taintor Cell: 4. Pilsen Type; 5. The Mercadier Cell and Finally the Fritts Form of a selenium cell. Fig. 7, which is the Non-Sensitive Ever Discovered, the Light Shining Thru the Thin Gold Foil.

Korn, Dussaud, Liesengang and DePalma.

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, Hittord, Adams and Day, Ayerton and Percy, Mercadier, Bidwell, Ruhmer, Hammer, Fritts and Gribenberg 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 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 parities of the material 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 published 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.

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

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 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 are 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 breakfast table or the top of the book-cupboard, and I'll tell you how to make your clock. ("High time he did," they say.)

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 impetus once every 6 or 8 seconds, when the dry-cell is recharged, 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 that 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. Yours truly hitched on a fine 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 be led 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 batteries; 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 \( \frac{1}{2} \) 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 gear. 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-rack, 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 these. Only be sure that your hands don't have to hold 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 more much 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 \( \frac{3}{4} \)" wide by \( \frac{1}{4} \)" 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

Several Important Details of the Electric Clock Are Here Illustrated, Showing Among Other Things the Particular Man-ner of Suspending the 38-inch Pendulum and Bob. Also the Electrical Contact Actuated by the Swinging Pendulum Rod.
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'll have to make it unless you make your bob first.

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 pail 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 red hot, 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-out 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 washers 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 can. The armature-man is a busy fellow, and 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 attached. A magnet of this size and weight will move a 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 show 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 notches 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 bug 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 stroke and screw the bob up and down; besides a 32 screw isn't fine enough. You must have some means of controlling the rate of the pendulum without stopping it, and that with extreme delicacy, as any change you make accumulates till after the 80,400 seconds in a day it shows up big. So first you 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 No. 24 wire long enough to project well out of your cup, so you can get hold of them easily with your fingernail. Fix the bob-screw 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 in it, as the case may be. Your hand can follow the motion of the pendulum easily enough, especially as the oscillation is short and near the top, so you don't have to stop it. The minute you load the cup, the faster the pendulum will beat, which is opposite to what you might suppose; there is a decrease to 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 showing your apparatus a conductor, and 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 in a circular motion, and continue rubbing until the shellac begins to get sticky. Do not stop with the cloth resting on the fiber, but leave it. 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 tolaconist'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 screwed on three glass knobs "C," which in turn are supported by a small wooden box "D." The latter are conned in parallel. After 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 1/2 inch diameter by 1 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-blank 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, 1 inch diameter. It was thoroly annealed before use, so as to keep the residual magnetism as small 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

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 1 1/2" x 1/2" board (soft or hard wood)—7 5" x 3/16" bolts, 4 1 1/2" x 3/16" bolts, 1 piece brass tubing 1/4" in diameter, 2 1/2" long (for nozzle).

To begin with, cut a case from the piece of plank as shown in Fig. A and B. Bore seven 1/4" holes thru this as shown. At the bottom bore a 1/4" hole for an outlet. Then at the top bore a 1/2" 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 1/4" 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 1 1/2" x 2" with a 1/4" hole thru the center.

To make the nozzle take the piece of brass tubing above mentioned and solder to it a piece of sheet tin of size 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 3/4" 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, bore in another place a drill one 1/4" hole on each side of this as shown. Now make two plates 3" in diameter and 3/4" thick as shown in B (Fig. 4). Bore a 1/4" hole in the center, and on either side bore another 1/4" hole. Make two pieces 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-resistant paint and when dry assemble as follows:—Place a piece (Fig. 4) 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 1 1/2" x 3/16" bolts. Drive a shaft thru the rotating part. Insert one end of shaft 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 bolted 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 297)

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 (c) 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 overlapped and produced double outlines in the skiatogram. For 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 cathode (c') becomes choked off and dispersed by the constricted glass neck (d), which acts, as 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') focus inside a small copper cone (d), in which they are converted into heat and take 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 the Author, in the Messrs. 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'); the Oudin coil has been one end of the tube should be connected to the active cathode (c); the small cathode (c') may be grounded, but this is not necessarily the case. 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-tenth-million of an atmosphere—a "soft" tube has a lower degree of exhaustion (between one-fifty-hundred-thousand and one-millionths of an atmosphere). More current is needed to operate a hard tube, but it gives deep penetration and would work fairly well as a -ray tube, on the other hand, produces strong contrasts in the skiatogram or fluoroscope. Tubes have a tendency to become hard by the use of carbon slowly 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 thermal type and is now seldom used (see Fig. 2); it consists of a small bulb containing potassium chlorate sealed in 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 former is the more common type and is shown in (1), Fig. 3. A platinum wire is sealed in the regulator tube which contains a gas-producing chemical, such as manganese dioxide, charcoal, etc.

In practise a piece of E-shaped slice brass wire set in a rubber handle is used to divert a portion of the current from the active terminal tube to 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 fluorescent screens are coated with barium-platinumcyanid and cost about $0.25 per sq. inch. A very good screen may, however, be easily made by evenly coating a sheet of cardboard with a solution of sodium silicat and immediately sifting on it finely powdered calcium tungstate gently raise the screen on its edge and tap it to shake off the excess powder; then allow it to dry. A still simpler experimental screen may be made by painting a card several times with a strong solution of quinine li-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 4½ 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 position of the clamps, which are to hold the carbons, to follow the dimensions correctly. The wooden base, B, Fig. 3, is 5½ x 13½ 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 ¾ of the way to the other end. Then a small space ½ 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 6 x 1½ inches and 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 T. Put a nail, N into the right hand end of the base. 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 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, strip glass, as shown in Fig. 1, may be mounted on a hinged door at the front of the search-light, but is not necessary. The search-light is now complete.

A suitable resistance to operate with the search-light must be constructed. This resistance is shown in Fig. 4. The two ends are each 4 x 12 inches and the top and bottom are each 4 x 18 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 3-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 rows (Continued on page 332).
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.

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.
Contributed by JOHN UEBLER.

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

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.) 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.
The electrical experimenter

(continued from page 311)

visited guests and members, and every encouragement was given to original experimentation with original apparatus and for some time it was a rule that each member must perform an original experiment, however crude, 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 Hayes of the City of Brooklyn, Senator William H. Barrett; Sup't of Public Schools, W. N. Barrett; Sec. of the Board of Education, Lyndon Bierce, and other prominent men, including the local dentist, Edward Weston, Francis R. Upton, Frank J. Sprague, James M. Beck and Richard F. Outcault. The guests were entertained by electrical experiments on novel effects, and regaled with food and coffee cooked by electricity. Cigars were lighted by electricity, four small matches to be had from a tiny electric railway running about the table carried food, cigars, cigarettes, etc., to the guests, while in the meantime they were subjected to the instrumented 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 extending 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 were attached, so that when the magnets were turned on, the flowers were thus thrown into a beautiful shower, which fell all over the table. There were bears, alligators and storks about the table, making eyes to their passengers, including electric lamps or other ornaments, while real gold fish, which had tiny incandescent filaments in their gills, were connected by thread-like insulated wires to a storage battery were beautifully illuminated from time to time in the darkened room by a hint of electricity, in a hushed room, on the table, and into the globe. Near the center of the table were three skulls with electric lamps blinking in their eye sockets; they rested on a black velvet pedestal containing a concealed photophone 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 ye."

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

Perhaps the most interesting feature of the dinner was a life-sized wax figure of Benjamin Franklin loaned by the "Eden Musee," who with a benign smile on his countenance, sat at the head of the 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 room, would be drawn a long flash of lightning to a key held in the other hand and by means of a phonograph of his anatomy was made an address to the guests as follows:

"My dear Friends:-

Knowing of the genius of Mr. Thomas A. Edison, I came back to you from the past of over a century ago. I am glad to find that I am still remembered and that I am pleased to be able to attend this first annual banquet of the Franklin Experimental Club of N.York, New Jersey.

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

"For speed to heal, 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.

"'Here 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 remotes are as bad as a fire, and a rolling stone gathers no moss."

"'For small is a great ship.'

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

"Industry pays debts, and despair inures."

"Always taking out of the meat 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, while the seed key is always bright."

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

At the center of the table stood a five-foot reproduction of the Eiffel Tower, lighted by many tiny electric lamps in a miniature searchlight on top; 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 Marseilles sung by Mme. Adini and M. Melczidce of the Grand Opera, Paris, rendered in subdued tones 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 loosing 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 charged.

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

Procure a glass 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 vessels 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 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 with an adjustable condenser. It is simply built and will works easily without getting out of order readily.

It is made from a fiber washer and half of a brass washer, niced 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 typewriter key knob will do. A few brass, round-head screws and a wooden base make up the rest.

Contributed by A. C. HANSEN, JR.
THE ELECTRICAL EXPERIMENTER

September, 1917

RADIO" COMMUNICATION OVER GAS AND WATER PIPES.

(Continued from page 318)

Consider a certain 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 carbon microphone, or other mineral, and a pair of radio receivers connected unilaterally to the water pipe. We have 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 fashion, so as to be excited by one wire or unipolar current. The detector circuit should not under any condition be connected in a bilateral fashion.

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, C and L are in contact (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 the distances from the screen. For example, suppose C is 24 inches from the screen and L is 94 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 125. So that if 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 copper wire, cut 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 the fuse clips as you would an ordinary fuse and by using the nail as a rigger, you can remove fused fuses without ever touching them.

A HOME-MADE ARC SEARCH-
LIGHT FOR THE AMATEUR.

(Continued from page 329)

The apparatus is connected as shown in Fig. 5. The leads one end to the plug and socket attachment into the resistance box and connected to the two resistance wires, one to each rod. 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. There it is connected with the screws that hold the carbons in place. Before trying, the searchlight change the fuses in its circuit to at least one ampere. The reason for this is that if the searchlight is left burning continuously very long, fuses of lower amperage are apt to blow. To avoid this it is best to change the fuses 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 burned down. It is advisable to place a good paper to file a point on the carbons before putting them in. Different focuses can be obtained by 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.

This lets the student of medicine in my home town how to construct searchlights similar to this one. A searchlight seems to interest every boy.

A "NOIL" A.

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

THE ELECTRICAL EXPERIMENTER

SELENIUM CELL DESIGN AND CONSTRUCTION.

(Continued from page 225)

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

Another modified form of this cell construction is shown in Fig. 3. The need of insulating support before the wires are wound on. This form was not found to be very satisfactory. The selenium used in this case 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 perpendicular to 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 is given in Fig. 4. Round disks of brass or copper about one inch in diameter are wound, the plates being separated by mica washers and alternate disks connected to the rods. The result is a cylinder with alternate disks of brass and copper. The selenium is flowed over the surface of the cylinder in a thin layer and thoroughly mixed in. It is then polished and found to be good where it is possible to use a parabolic reflector, so all sides of the cell may be acted upon. The thinner the film on the surface of the selenium, the better is the lighted to the darkened resistance.

Where a flat cell is the preferred the Mercadier type will be found useful. In this type of construction a broken 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. The characteristics as the Bell type cell, but are of simpler construction. Due to the fact that the strips are curved, it will be found that the number of these cells having the same resistance, because slight variations of the curvature between the metallic strip support in cells of widely differing resistance.

To Ruhmer is due the credit for enclosing selenium cells in a vacuum to protect them from moisture. Many 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 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. The fiber 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. Coloring dyes with this varnish is it is possible to make a cell that will only be acted upon by the current of one color. Copper sold for printing postcards will be found suitable for the purpose.

The last mentioned cell, the Fritts, is probably the most extensively 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 350)
Experimental Chemistry

By ALBERT W. WILSDON

Sixteenth Lesson

SULFURIC Acid (History)

Sulfuric acid, without doubt, the most important and useful acid known, 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 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 other acid products of civilized life have been brought to perfection without its use, directly or indirectly. It is manufactured on one small scale in many countries; nearly one million tons are annually made in the United States, while Germany, with its vast manufactures and agriculture, produces 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 SO₄) or Green Vitriol, and to explain that when Sulfur is burned with Sulpeter 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 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 his 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 this a red-hot iron ladle was placed. A mixture of Sulfur and Sulpeter 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.

PREPARATION

It is not practical to make the acid from its salts. Sulfur dioxide (SO₂) in presence of water (H₂O) and some oxidizer becomes Sulfuric acid (H₂SO₄). Sulfur Dioxid

[SO₂] and Water [H₂O] have affinity for each other and form Sulfurous Acid [H₂SO₃], which only requires one more Oxygen atom per molecule to make it Sulfuric acid [H₂SO₄]. If Oxygen (O₂) were forced thru the Sulfurous acid [H₂SO₃], 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 (HNO₃), Nitrogen Trioxid (N₂O₃) and Nitrogen Peroxid [NO₂] are most effectual for this purpose. Sulfur Dioxid is made by the reducing action of Copper (Cu) on Sulfuric Acid (H₂SO₄).

Cu + 2H₂SO₄ = Copper Sulfuric Acid
CuSO₄ + 2H₂O + SO₂
Copper Water Sulfur Dioxid

By the action of Copper (Cu) on Nitric Acid (HNO₃), Nitrogen Oxid [NO₂] is formed, and in the presence of air oxidizes to Nitrogen Peroxid [NO₂].

Cu + 2H₂SO₄ = Copper Sulfuric Acid
3Cu(NO₃)₂ + 4H₂O + 2NO
Copper Water Nitric Acid Peroxid
Nitric Acid + O₂ = NO₂

NITRIC Acid + Oxygen = Nitrogen Peroxid

(Continued on page 351)
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.

Wrinkle Recipes
Formulas

Edited by S.Gernsback

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

<table>
<thead>
<tr>
<th>Alloys</th>
<th>Tin</th>
<th>Copper</th>
<th>Antimony</th>
<th>Lead</th>
<th>Brass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Babbit's metal</td>
<td>10</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Bell-Metal</td>
<td>10</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Brass, engine</td>
<td>13</td>
<td>112</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Brass, locomotive bearings</td>
<td>7</td>
<td>64</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Brass, for straps and girdles</td>
<td>16</td>
<td>130</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Flangety and brazing</td>
<td>32</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Munz's sheathing</td>
<td>6</td>
<td>4</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metal to expand in copper</td>
<td>2</td>
<td>90</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pewter</td>
<td>100</td>
<td>1</td>
<td>17</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spelter</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stanley Bronze</td>
<td>2</td>
<td>90</td>
<td>5</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Tough brass, engine work</td>
<td>15</td>
<td>150</td>
<td>15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tough brass, for heavy bearings</td>
<td>25</td>
<td>150</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yellow Brass, for turning</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Solders

| For brazing (hard) | 3   | 1      | 1        |      |       |
| For brazing (hard) | 1   | 1      | 1        |      |       |
| For brazing (soft) | 1   | 4      | 3        |      |       |
| For brazing (soft) | 2   | 1      | 1        |      |       |
| For lead          | 1   | 1      | 1/2      |      |       |
| For pewter        | 2   | 1      | 1        |      |       |
| For tin           | 1   | 2      | 1        |      |       |

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 in the flame of the gas stove. In a few moments the gas will come out of the stem of the pipe and the same can be lighted.

Contributed by SHERMAN B. LAW.

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.

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 solders.

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 the surface can be scraped beneath the melted solder by the point of the soldering iron, thus preventing to a certain extent the oxidation. 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 aluminumic 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 while being operated upon, or cleaned in the acid bath by boiling.

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 wheel and as I thought I'd cut it on my wheel I experimented with two others which I had discarded, and found that they cut equally well. Turpentine seems to answer the purpose.

This may be a welcome tip to some of your readers; it was certainly a new experience for me.
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 the 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!"—"That'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 today, before it is too late. Address the Editor "With the Amateurs" Prize Contest.

A GROUP OF ALL-AMERICAN AMATEUR RADIO STATIONS.

Prize Winners in "Radio Problem" Contest

We are pleased to publish hereewith several of the suggestions we have received as well as the prize winners of our contest, to show what can be done with your radio apparatus during the war. Several thousand suggestions were received from all parts of the country, and the majority of them covered similar topics to those discussed below.

**FIRST PRIZE $10.00.**

A No-Radio Communication Scheme That Works

I am quite sure that the following little experiment should fulfill the desired wants of my fellow Radio friends whose apparatus is now on the skid.

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 communica-
tion. I have successfully arranged a system for a distance of nine miles, if Q9 city blocks. The circuits thus far used do not permit the reception of "Radio" signals and thereby evade the troublesome interference caused by long waves being kept closed. This is by no means a "Radio" station and cannot be classed as such. I cannot emphasize too strongly the importance of this point. I believe from the fact that Radio signals cannot be heard at all; 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 weeks when almost any amateur would offer $5.00 to hear Q9 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 Q9, I just make some dots and be silent. 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 wired 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 should be taken in such a question; should be interfere schedules will have to be arranged.

Again—by inserting inductance or detectors in the circuit about the receiving apparatus, therefore none are required.—EDW. T. JONES.

**SECOND PRIZE $5.00.**

Buzzer Communication via the Water Pipe

There is about only one way left by which we can communicate without wires and use our radio apparatus during the war. I will not attempt to classify the various types of apparatus I have no use for a "Radio" system.—LEWIS MOSKOWITZ.

Exhibit Amateur Radio Apparatus

It seems to me that 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 increase apparatus would produce an unlooked-for result; it 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 same time, enlist the aid of the fellows too old to fight. Such an apparatus 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 for your radio apparatus during the war.—JAMES R. ALLEN (9ED).

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 himself to a crack. A spark coil for a transformer could possibly be used to take the place of the buzzer for greater distances.—OLIVE M. WARRIL.

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 sensitivity of various receivers, determine the degree of make and break of relays, test the hearing ability of your friends and the relative frequency of currents. In connection with this instrument your receiving condensers, both fixed 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. Such an arc light is a source of much amusement and the mystification of your friends.

If you have an older 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 "elec-
tric dog," and numerous other experimental. 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. You know you will need it to help your country's cause.

Oudin or Tesla coil from Tuning Coil and Helix

Take a single slide tuning coil and remove the red and slider. Then set the coil inside a helix (that is part of them) and not be classed 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 you report that the experimenters there are using a water pipe as a conductor, for transmission and reception 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 a try.

In cities where the amateurs are close together they could work out the" establishment of the radio bug" from this system so that every bug would have quite a bit of fun and keep us from getting too rusty.

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

Convert Radio to Electrical "Lab.

With the option of making a noise and changing it into an electrical laboratory? Almost every amateur has on hand old 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 add 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 apparatus in the laboratory.

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

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

**Third Prize $2.00.**

More High Frequency Stunts

Here are given some ideas about the use of radio instruments during the war.

The average amateur sending set is an almost complete high frequency set. All that is necessary is to insert within the old helix or oscillation transformer primary a secondary 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 loud speaker quickly and connecting the break of a buzzer and a telephone receiver to the secondary, we have an instrument for demagnetizing electromagnetic induction, for tuning and coupling to some experiment and for electrical practice as well as for measuring purposes. See Fig. 2 for connections.

Several other good ideas will appear in the Octo-

ber issue.

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www.americanradiohistory.com
too bad. Too bad. Here we have gone and advertised for "bugs", the most improved drug. What a host of colleagues that was! As we wanted photos from "bugs", experimenters, et al, showing their laboratories, Uncle Sam says: "Boys, wires--you know, Nix on the ether waves." The Experimenting being a patriotic sort of a chap, promptly seconds the motion. "Good heavens, not only second the motion, but triple and quadruple it, i.e., they fire radio-station photos at us till the postman staggered under the weight.

Question: Why when wireless is forbidden do we get twenty radio-station photos a day, while 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. This, as you see, is the real stuff, no fake about it, honest. And what's more--hang the meddling easy 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 years ago, but it's the best to be had, of those memorable days. If we were to try to say 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" grab" is at present. But as modesty forbids such statements we will not indulge them.

At any rate your young hopefuls was as big a "bug" as grow nowadays. Yes, he was a "bug." "Bug" was nothing that was represented in that "lab" of his. Of course, wireless was not as yet invented in those days, but telephones, batteries, magneto, 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 receiving cell and battery form the receiving station.

With this apparatus we covered about 200 feet at first. The transmission of speech was nothing but 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" (sensor deleted the mode of "obtaining" it) a commercial selenium cell, and with this we actually transmitted an article over a light ray about 1/2 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.

Our photo shows the young battery "bug" surrounded by the usual apparatus! But, 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 old time battery. Chronic-acid, one and two fluid; Daniel copper sulfate; Edison-Lalande copper oxide; gravity copper sulfate cells; peroxide of lead-zinc (a good spark) down to Upman's chlorin-gas battery. Yes, we believe there is no battery that was ever invented that we did not actually try. 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 amper-hours. Each of these 8 cells was connected to a "Pachytop" exactly described by Mr. C. A. Ohlson, in the Sept., 1917, issue of this journal. Turning the handle 90 degrees connected all the cells in parallel. Another turn connected the cells in series. With this outfit in parallel the eight storage cells gave, of course, about 2 volts, and when this position they were charged by eight very large copper-oxide, secondary sodalime 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 cells 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 layer of porous nuggets, while in each corner of the tray there was a small porcelain insulator. On top of these a heavy zinc plate, wetly amalgamated was placed. The tray was then filled with a solution of caustic potash, so that it stood 1/2" 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 13 amperes. This voltage drop to 0.7 when charging the storage cells. The eight tray-batteries, therefore, gave over 6 volts, enough to charge the storage batteries. These Copper oxide batteries were considered 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 was remarkable. These batteries are perfectly odorless, require no attendance and need not be filled for months at a time. Not are materials consumed when these are charged.

Now "lines," for the love of Pete, get busy and shoot along those "fab" photos. If it aren't paid attention to now, we'll say "dope." Soon we'll strike! Lookouttimin! I A. M.!! Have you no pity on the over-worked "old man"?

The cost especially of radio and telephone equipment has been greatly reduced by the use of selenium cells, which contain selenium as an active element. The use of selenium cells for the power supply of radio receivers has been found to be very satisfactory, as they are easily adjustable and require little maintenance. The selenium cell is a simple device consisting of a plate of selenium with a grid and a cathode. The selenium cell has a very high resistance to current, which makes it suitable for use in radio and telephone equipment. It is also very durable and can last for many years without requiring repair.

The selenium cell is connected to the receiver in such a way that the selenium cell is placed in series with the receiving circuit. The selenium cell acts as a rectifier, converting the alternating current from the power supply into direct current that can be used to operate the receiver.

Selenium cells are particularly useful in radio receivers because they can provide a steady source of power for the receiver, even when the power is fluctuating. This makes them ideal for use in areas where the power supply is unreliable, such as in remote locations.

Another advantage of selenium cells is that they are very compact, making them easy to transport and install. This makes them ideal for use in mobile radio equipment, such as in military vehicles and emergency response units.

In summary, selenium cells are an excellent choice for use in radio and telephone equipment because of their simplicity, durability, and ability to provide a steady source of power. They are a reliable and affordable alternative to other types of power supplies, and are likely to continue playing a significant role in the development of new radio and telephone technologies.

P. M.

A. R.

R. M.
Phoney Patents

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

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PHONEY PATENT OFFIZZ


Inventor: H. Gehrig, Cincinnati, Ohio.


Inventor: H. Gehrig, Cincinnati, Ohio.

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

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. 1. 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 1/2 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 1/2 H.P., since the motor will now consume twice the current it would be operated on 220 volts.

SUBMARINE COMPASS.

(827.) Cyril Thorn, St. Louis, Mo., inquire:
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 shield 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." 

(883.) 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.

(839.) 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 electro motive 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 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, are movable condenser elements consisting of hollow spherical members supported on a steel ball bearing mounted on polished jewels; b and b are covered metallic sheets forming the opposite plates of condensers which a and a, approach as they rotate; c and c, are pairs of plates of condensers in series, being connected on one side of the instrument t and t, and on their other side to the inner condenser plates b and b. The rotation of a and a, is opposed by controlling springs, the position of equilibrium where the attraction between the first plates b and b, and the moving cylinders q 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 coils used in the windings of galvanometers depends upon the degree of sensitiveness of the instrument, but in general the wire used on the coil is a No. 28 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 .001 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 and any 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?

Rico, by whom the coil is tuned sending in a tuned sending outfit?

A. 1. Three 6-volt, 80 amper-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 Agustry, San Juan, Porto Rico, asks:
Q. 1. How many pounds of No. 14 D. C. cable will be necessary for the primary of a 1/2 inch spark coil, pole 8/5" long by 4/3" 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 expose several layers of No. 20 B. & S. magnet wire around the iron, which is to be magnetized, and passing a current of electricity through it. Care should be taken to see that the current is a uni-directional one and that the source is best obtained from a storage battery or direct current dynamo.

Q. 3. Which is the formula used to compute the radius in miles of a radio receiver? For example, a complete receiving set with a 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 range of a receiver. The only formula of such nature is to be given to the apparatus itself.

HYSTERESIS VS. SELF- INDUCTION.

(833.) W. C. Phillips, Julian, N. C., wishes to know:
Q. 1. Is hysteresis the same as a magnetic circuit as self-induction in an electric circuit?

A. 1. Yes.

TESLA TRANSFORMER QUERY.

(834.) Wm. Oshbuck, Philadelphia, says: I have a Thordarson 1 K. W. 60 cycles transformer, the voltage across the secondary terminals is 20,000. Is the

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secondary voltage of the above transformer too high to construct the 24-inch high frequency apparatus and lessen the weight of the device, 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 transformer?

A. 1. The voltage of the transformer is sufficient to operate the Tesla high frequency transmitter, and it is 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 the magnetic system of transmission transformers. The voltage of a Tesla transformer runs in the neighborhood of millions of volts at the secondary.

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 at the high gap, which tends to arc and heat up.

BRake-POwER CaLcULATION.

(835.) Earl Lea, Memphis, Tenn., asks: 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 12 inches long and the reading of the scales is 30 lbs., when the motor is running 1,000 R. P. M.

A. The following formula gives the relation of the factors named with that of the brake-horse-power:

\[ B.H.P. = \frac{2\pi \times L \times W}{63,000} \]

Where \( \pi \approx \) constant
\( L \) = lever arm in feet
\( W \) = force in pounds at end of lever arm as measured by scale.

Substituting your values in the above formula we get

\[ B.H.P. = \frac{2\pi \times 12 \times 30}{63,000} = 17.1 \]

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 horse-power by the following method, 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. Its object is to assist commutation, that is, to help reverse the current in each coil, while the commutator is being brushed, thus reducing sparking. The excitation of the interpoles being produced by series turns, the field will vary with the load, and will if given 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.) F. C. White, Tonawanda, N. Y., asks: What are the characteristics of the D'Arsonval telegraph transmitter as described 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)
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THE BACHELET LEVITATION RAILWAY.

(ED.) Edward A. Brand, Springfield, Ill., writes us:

September, 1917

THE ELECTRICAL EXPERIMENTER

A. 1. The characteristics of D'Arsou currents are of such nature that they produce continuous unidirectional impulses. They are usually of lower potential than Tesla currents.

Q. 2. Can a telephone be used (without interference with telegraph service) employing one wire of the city telephone system and using the ground as a return, if the telegraph message way is 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

(387.) Otto Petersen, 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 by means of the electric arc, alternator, metallic arc, and vacuum tube or Oscillation. The last concomitance is the most convenient for such work.

Q. 2. Is the Chaffee gap adaptable for radiophone 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.

(388.) A. Chicago, III., 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 electromagnet as described in the article by Mr. Yates will perform its work satisfactorily if 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 coil. 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 electromagnet 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.

(830.) Edward A. Brand, Springfield, Ill., writes us:
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Otherwise this forming current may be supplied from a 12:volt D.C. line with some time allowing considerable current to pass thru it for a short period, or until the lamps become dim, denoting that the solution has been heated up.

Another reason why these rectifiers do not always work perfectly at first, is due to the fact that the user takes a fine pen-knife and scratch cross-rows on the face of the aluminum plate. This will sometimes hasten the formation of the electrolytic rectifier, 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 when the temperature is about the solution had reached an equilibrium.

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. The fourth swing is the one that clears 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 it took 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 approximately 345 miles per hour.

EXPERIMENT 42-The method of Experiment 41 can be carried out very carefully and the results obtained will be of great assistance in having access to a stop-watch. The following method is given: Figure 32 represents a light wooden box cut approximately 1/2 inch in depth. 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 sound 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 the string 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 Second Pendulum. Let your partner pound loudly on the side of the box just when the block (B) passes the white opening 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 white hole, and after the black hole, keeping losing and losing until it is lapt by the bob and the sound again coincides with the bob's passing the white hole. Observed sound has been lost 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 travels thru the vacuum, but that it will pass thru ordinary matter, and usually the heavier the matter the faster the sound travels thru. This puts together certain true to the ground to hear the noise of approaching horses, since the ground is heavier than air, and the sound volume is louder and louder. If two stones are clapt together under water the stone 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 at the same speed, 1,100 feet per second, and all different types of sounds are 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 string of a deep bass drum, will be heard with the same loudness and pitch since the distance of the sound source from the listener. Thus far the pitch of a note depends on the frequency of vibration of the source, that is the faster the sound 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, that the treble notes are given by short, tight strings. The laws of vibrating strings can be stated as follows:—the shorter 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. Thus far the pitch of a note depends on the amount of the disturbance. A small pebble 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 put 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 talking thru the can and you will hear him distinctly. When he is talking thru the can and you will hear him distinctly. When you talk into your end of this telephone you cause the air in the can to vibrate. The air is then reflected back thru 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
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same effect as if you were standing beside your partner and talking to him. The modern commercial telephone works on a similar principle. The diaphragm which corresponds to the bottom of the can in our example 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 diaphragm which is made to vibrate rapidly by the electric current and the vibration of the diaphragm causes a disturbance in the air which may be heard the approach of a Ford, a brass band, or a cat-call. The phonograph also depends upon the vibration of a disk or diaphragm. The needle is attached to the diaphragm 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 diaphragm by the lever. The vibration of the diaphragm causes the air in the horn or sound box to be disturbed. On placing the thumb gently on the diaphragm (reproducer) one can feel the vibrations.

It may be well to note just how the sound is transmitted thru the air. 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 that 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 ring on 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. If a flat 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 these disturbances of the former is a disturbance to those hearing it.

(To be continued)
ELECTRIC "BLOODHOUNDS" TO FIND AND DESTROY U-BOATS.

(Continued from page 296)

inconceivable how the noise of these powerful engines could be deadened entirely so that the spectacled monkish microphone-Auditor 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 practicability 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 the U-boat. Properly 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 considerably intercepted 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 telephone graph 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 interrupter 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 submarine, 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 "bloodhound" and propeller 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" revolved, he would dive, and 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 these cables which results 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.

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The diagram, Fig. 3, shows the circuits for the retaining and signaling electromagnets in the nose of the torpedo. The smaller or triggering magnet is controlled by a telegraphic key on the submarine chase.

The diagram, Fig. 4, which will help to make clear how the device actually steers its own course toward the invisible enemy. The four different 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 tone given off by the engines and propellers of a submarine and thus 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 be 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 whole device will best be understood 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 potentiometer relay R 2, to close its local circuit to special relay R 2.

This relay, R 2 (and its brothers, R 1, R 3, and R 4) 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, the principal 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
COMBINATION SWITCH SPARK GAP

(170.) Claude E. Johnson of Loei, Kansas, has sent in a very clever design of a combination antenna wire 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 might be obtained.

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 this 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 a novelty fan 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, it would result in more sparking and steady, and would hurt the eyes of whoever is in the vicinity of the fan. It might be all right, however, for advertising purposes, and we would advise correspondence to get in touch with a patent attorney.

PATENT QUESTIONS.

(172.) Hyman 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 $2.00.

It is safe to say, however, that one in ten thousand inventors ever take up 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 application to be patented. Some patents are so simple that they only need a small drawing and a very little explanatory claim, and the claims are perfect for a one dollar. Other patents need a great many illustrations which necessitates several sheets of drawings, and we have seen patents that have from twenty to twenty-five preliminary pages of drawings, 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 $200 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 interested in the idea as 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.

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FROM A RADIO EXPERT

The "RADIOTONE" Buzzers, made by E. L. C. I. Co. sent me some time ago have been thoroughly tested out in my Laboratory, and I am very pleased to say that they fully live up to the performance advertised.

The tone and frequency of the instrument is TRULY A Most WONDERFUL and perfect reproduction of a MUSICAL WIRE. NOISE, and when used in connection with a wireless receiver it is a perfect test of a real wireless station with FIVE HUNDRED CYCLES in the primary circuit. One of the most commendable features of the buzzer is that of being capable of standing up under continuous service without the annoying "sticking" effect that has been so characteristic of other buzzers that I have had occasion to use. In conclusion, I can say that both in performance and appearance the "RADIOTONE" is truly a WONDERFUL little instrument which I cordially recommend.

R. F. H. WILKINS
815 Niagara Ave., Niagara Falls, N. Y.

I have thoroughly tested your "RADIOTONE" Buzzers which I received a few days ago, and am very impressed with their high quality. I am sure that your company realizes its performance.

GEORGE G. \n
I wish to say that your "RADIOTONE" Buzzers are superior to any that I have had, and I don't think there is a BETTER BUZZER to be had. In every respect, they are a great improvement over any other buzzer that costs twice the price.

PERRY CRAWFORD

I have given your "RADIOTONE" Buzzers a thorough test, and found them to be very good and satisfactory. Also, that I am very much pleased with them and will use them in my Laboratory. I would recommend it to all learners as a very good instrument. In fact, in any case where I have any one under my care I shall extend it to them.

W. R. CRUGNILLI

I received your "RADIOTONE" Buzzers a few days ago and have not been without them ever since. I wish to say that you are a great improvement over any buzzer that I have ever seen. Thank you again for your wonderful buzzers. I am, Yours very truly,

H. A. PAGE

Your "RADIOTONE" Buzzers certainly came up to all my expectations. I have tried them at the lowest and highest notes and they are not affected by high altitude nor damp weather. It is a beautiful instrument as one would wish to see. IT IS BLUnt. That is the more improved Buzzers which I have tried and I cannot see how it can be matched. It is far better in the test than any buzzer I have ever seen and it seems to have a lovely ringing quality and has one of the ELECTRO TONES which I have get a Buzzer that I have never seen. Thank you again for your wonderful buzzers. I am, Yours very truly.

H. A. PAGE

I have given the "RADIOTONE" Buzzers a most careful test and I must say that they are better in every respect than any other Buzzers. The Buzzers are well made and I recommend them to all learners as a very good instrument.

L. B. RILEY

I wish to say that your "RADIOTONE" Buzzers are the best Buzzers that I have ever seen in my Laboratory, the Buzzers have been tried and tested and I cannot see how it can be matched. I have tried the Buzzers and tried them at the lowest and highest notes and they are not affected by high altitude nor damp weather. I wish to say that you are a great improvement over any buzzer that I have ever seen and it seems to have a lovely ringing quality and has one of the ELECTRO TONES which I have get a Buzzer that I have never seen. Thank you again for your wonderful buzzers. I am, Yours very truly.

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H. A. PAGE
consider that this sluggish relay the received sound wave being then propeller

it 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.
and the temperature raised sufficiently, 
and the reactor, reducing part of the sulfiuric
acid, forming sulfur dioxide and water, and
metallic sulfates:

$$\text{CO}_2 + \text{H}_2\text{SO}_4 \rightarrow \text{CaSO}_4 + \text{H}_2\text{O}$$

Thus at ordinary temperature, sulfuric acid acts as an oxidizing agent, exchanging
its hydrogen for metals, but when hot and concentrated, it acts also as an oxidizing agent.

3. Sulfuric acid does not affect Gold, or
Platinum, and only hot, concentrated, affects Lead.

5. At red heat it dissociates into \(\text{H}_2\text{O}\) and Sulfur trioxide \([\text{SO}_3]\), and thence Sulfur
dioxide \([\text{SO}_2]\) and oxygen \([\text{O}]\).

4. It possesses great affinity for water.

The fact has been repeatedly illustrated in experiments already performed that sulfiuric 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 prepare sulfuric acid with care and from gases passing through the air, and from the best sources of supply, and from gases passing through the air, and from the best sources of supply, and from the best sources of supply.

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 through it.

(b) It is in great demand in the laboratory to dry gases, since it is not volatile at the ordinary temperature.

(c) Waxes, resins, 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 \([\text{H}_2\text{C}_2\text{O}_4]\), or alcohol \([\text{C}_2\text{H}_5\text{OH}]\) it removes hydrogen and oxygen, causes them to combine to form water, and absorbs the carbon from the organic substances:

$$\text{H}_2\text{C}_2\text{O}_4 \rightarrow \text{H}_2 + \text{C}_2\text{H}_4$$

It's action on the skin, producing painful sores, and on organic matter generally, is due to its affinity for water.

5. It neutralizes bases and metallic oxides to form sulfates:

$$2\text{KOH} + \text{H}_2\text{SO}_4 = \text{K}_2\text{SO}_4 + 2\text{H}_2\text{O}$$

$$\text{Ca(OH)}_2 + \text{H}_2\text{SO}_4 = \text{CaSO}_4 + 2\text{H}_2\text{O}$$

$$\text{Fe}_2\text{O}_3 + 3\text{H}_2\text{SO}_4 = \text{Fe}_2\text{SO}_4 + 3\text{H}_2\text{O}$$

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 use which would be of most interest to readers of this journal would be in conjunction with electricity.

1. In lead storage batteries, in the charged state, a positive plate of lead peroxide \([\text{PbO}_2]\) and a negative plate of finely divided lead, are introduced into sulfiuric acid. When discharged, the surface of both plates has been changed to lead sulfate \([\text{PbSO}_4]\). This is a situation closely analogous to the discharge of a dry battery in which the terminals are removed and the plates of the battery are reversed. The discharge is normally a reversible reaction, and the process of charging is the reverse of discharge.

2. Sulfuric acid has a number of specific applications, as a drying agent, in the production of sulfur dioxide, and in the manufacture of sulfur trioxide.

3. Sulfuric acid is used in the production of sulfuric anhydride, which is a crucial ingredient in the production of sulfur trioxide.

This equation is just the reverse of the one given as the sum of the first two equations \((\text{No. 3})\), and the changes taking place both on charge and discharge may be represented by the reversible equation:

$$2\text{PbSO}_4 + 2\text{H}_2\text{O} = \text{Pb}_2\text{SO}_4 + \text{H}_2\text{SO}_4$$

This equation is the same as the equation for the addition of hydrogen and oxygen to form water. It is used in the production of sulfuric acid and in the production of sulfur trioxide.

From right to left this represents the charge, and from left to right the discharge.

This equation is used to represent the charging of a lead storage battery. The cell is represented as being composed of a lead plate and a lead sulfate plate, which are connected by a salt bridge.
The "Electro" Codophone  
(Patents Pending)

Now that we are for the time being, deprived of using our radio outfits, it behooves us as good Americans in become proficient in learning the Wireless as well as Telegraph Codes. Operators who know the Code are, and will be, in ever rising demand. The Army and Navy need thousands of operators right now.

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Can you qualify XIX? Are you proficient? Can you send and receive when your country calls you?

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which we present herewith is the outcome of several months of intensive study and experimentation of our Mr. H. Gornshke. It superseded our former Radiophone Codophone, which comprised a Radiophone silent buzzer, a loud talking receiver and a key. As in all of his work Mr. Gornshke strives for simplicity. So he combined the three above mentioned instruments into one stroke likeness ONE single instrument. He combined the Radiophone buzzer and the loud talking receiver into a single unit, but only mechanically, but electrically as well. This involves an entirely new principle, never before attempted, and requires a different method of using.

What this remarkable instrument is and does.

The "Electro" Codophone is positively the only instrument made that will stimulate a 500 cycle note exactly as heard in a Wireless receiver, so close and so wonderfully clear, that Radio operators grasp in astonishment when they first hear it. And you need not receivers over the ears to hear the imitation sailing ships, which, when all the necessary work is done, are produced; the perfect high-fidelity distant powerful Radio Station. No, the high-talking receiver combined with these twos makes it possible that you can hear the same ship's talk in the room, even if there is a lot of other noise.

FURTHERMORE, this jack-of-all-trades marvel can be changed instantly into our famous silent Radiophone test buzzer, simply by replacing the metal diaphragm with a soft base rubber bell diaphragm sliding lid instrument.

FOR INTERCOMMUNICATION. Using two dry cells for each instrument, two Codophones when connected with one wire and return ground, can be used for intercommunication of our Wireless stations. Either Codophone can act as a talk station.

An Army type buzzer. Last, but not least, two Codophones with two 75 ohm resistors can be used to operate every miles of line (33, 36 & 8 Wire), so fine that no one can hear the wire. Or you can use long metallic fence and the ground, or you can communicate over your 110 volt line up to several miles, using no wires, only the ground.

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The "Electro" Codophone is a astonishing, well made instrument, fool proof, and built for life. The parts are of hard steel .1 inch in diameter, that will not need instrument. Base and housing is of metal through and through, being on the other side nickel plated and finished. Three new style metal kinds are furnished.

There is also a neat code chart and full directions enabling any intelligent young man or girl to learn the codes within 20 days, practising only.

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This is only 25 cents more than the cost of the instrument. If you cannot afford to purchase the instrument, you can have the lesson cards without cost. Please write for particulars.

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EXPERIMENTAL CHEMISTRY. (Continued from page 352)

Sodium carbonate is used. Rain dissolves the soluble superphosphate, \(\text{Ca}_3(\text{PO}_4)_2\), and carries it to the roots of plants to be used as food when it is carried to the roots of plants, or when mature, it is carried to the roots of plants and thence circulated by the sap and deposited in the fruiting parts of the plants. The plant food, hence, is formed in the roots of plants and then is transported to the top of the plant where it is deformed in the fruiting parts of the plants. Thus, the plant food, hence, comes from the soil and the plant itself.

4. Another important use in the preparation of sodium carbonate is the formation of sodium bicarbonate, which is a base in the soil and the plant itself.

5. Besides these uses, sulfates are formed by the action of the acid on metals or the plant itself.

6. Directly or indirectly, sodium carbonate is employed in the preparation of compounds for bleaching, dyeing, printing, electroplating, telegraphy, galvanizing iron plates, and wire, cleaning metals, making shoe whitening, glucose, mineral waters, soda waters, ether, nitroglycerine, gun-cotton, vegetable parchment, celluloid, etc.

EXPERIMENT NO. 89

Preparation of \(\text{H}_2\text{SO}_4\), Cu, HNO\(_3\), and H\(_2\)O

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 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 friend or 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. capacity, of a dark and light green glass (as used in the illustration) with a rubber stopper to accommodate the numerous delivery tubes. Remove the small flasks have two-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 tube should extend to the bottom of the 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 constrictor 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 flask, pour into the third flask containing copper alone, 22 cc. of nitric acid diluted with half a dram of water. Apply gentle heat to this flask if necessary. Remove the heat for a minute from the other two flasks. In all cases heat must be carefully regulated. The fumes from 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 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 nitric acid to form nitrogen tetroxid [NO\(_4\)], which latter gives up half of its oxygen to the sulfuric acid [H\(_2\)SO\(_4\)] to form sulfuric acid [H\(_2\)SO\(_4\)].

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 1 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 heated for five minutes or more, as shown by Fig. 82. Now boil 10 cc. of water in a tube, and, having drawn out the air with a 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)

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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 oxide. (Radium metal was first produced in 1910 by Madame Curie and Dr. Dohierno, by the electrolysis of the chloride into a mercury cathode, the mercury being subsequently volatilized.


“The gas from radium changes quickly into a solid metal which Soddy and Rutherford called ‘radium-A;’ it in turn changes again into B, from C and D; from A, and F. With the passage of time (55 years) the substance which is at first radium-C, turns into E; then F; and finally into G.”

“During each of these changes, a rela-

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The present writer (Sir William Ramsay), along with Mr. Soddy, separated the radium 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 also 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, 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 quanti- ty 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 the 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, 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-C 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. In the first place, they are simple substances, and in the second place, they cannot be doomed when they decompose, one of their products appears to be always helium; and their decomposition is in all the cases which have been followed by the escape of a prodigious amount of heat; far more, regard being paid to the amount of substance changing, than any ordinary chemical 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 is not far to reach a possible use--it takes thousands of years) it would give all the power and more, than the coal carriers each year. 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 oxide of uranium; and of such ore, less than one-thousandth is radium; moreover, the most of extraction is conceivable. Up to now, its chief use has been in medicine."

(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 still hot a sheet of molten germanium is placed on top of it. 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 30 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 increased to its original strength by sub-jecting the cell to alternating current until the resistance is regained. If exposed to a bright light for long enough 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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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 chloride and limbus 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 hydrocyanic and then
for the sulfate radical \( \text{SO}_4^- \). 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 chloride
\( \text{BaCl}_2 \) or barium nitrate \( \text{Ba(NO}_3^- \) and
pour a few drops of the liquid you prepared
or which you wish to test, into an ounce
of barium chloride. You will notice
the color of the precipitate formed, and note
results.

Keep the precipitate 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 precipitate dis-
solves. If it does show that you do not
have sulfate ions or radicals present, and
the acid is not sulfuric. But if the precipi-
tate 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 acids, as barium car-
bonate \( \text{BaCO}_3 \) and barium chromate
\( \text{BaCrO}_4 \). These being insoluble in water,
are made by the usual method of preparing
insoluble salts. (See June 1917 issue of
the Electrical Experimenter, p. 134.)

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 \( \text{Na}_2 \text{SO}_4 \) or
ammonium sulfate \( \text{NH}_4 \text{SO}_4 \), and apply
the test.

The carbonization test is one for the acid
as a whole. To apply it make in four cases,
take four small tubes in a test tube rack—
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 3 cc.
of commercial sulfuric acid, and let them stand
a few minutes. Eventually all will be af-
fected 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 chemi-
cal Centigrade thermometer in the water,
carefully resting the bulb end on the bot-
tom 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 thermom-
er 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; then, as 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 ther-
rometer reading both after placing in the
water, and after the acid was added.

(To be continued.)
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WIRELESS

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