BLINDING THE SUBMARINE
SEE PAGE 234

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The Submarine War

Gunfire from the U-boat is a secondary consideration, for with ships becoming armed more and more, the submarine is forced to rely upon its torpedoes.

At the present time our inventors are working valiantly to train submarine "detectors." Of what earthly use are these? Suppose we do know that a submarine is near our ships? Suppose that we even know its exact position? What will it help us? Our knowledge will certainly not prevent a torpedo from reaching our ship. You can't destroy a submerged U-boat as yet. Even running in a zig-zag does not make them always help, for the crafty U-boat commander, if he can but take a few observations, running in a straight line behind the fleeing ship. He changes the zig-zag course and if he wants to use two torpedoes, one of these almost certainly will find its mark.

While in some high quarters the opinion prevails that there will never be found a real cure against the submarine evil, we refuse to share such a view. There has never been a weapon in all history which in time did not find its equal or its replacement. The submarine and its torpedo will prove no exception to this rule. Science in the end will conquer as it always does.

It is more than probable that it will not be a starting new invention that will solve the problem. Rather, we venture the opinion that a combination of well known and tried out methods will do the trick. All indications point that way. Also, we believe that either means 2 or 3 as above enumerated will prove the simpler of the three.

If we would only make up our minds which course to pursue, the solution of the problem would be reached much sooner.

It is foolish and humiliating trying to build ships faster than the U-boats can sink them. If we pursue this course the U-boat will win in the end. If the sun melts your ice too fast you should try to and put out more ice in the sun. You devise means to keep the sun away from the ice, by protecting the latter.

The submarine war is no different. And we will need a lot of ships. Let our inventors devise means to protect them adequately.

H. Gernsback.
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Tesla's Views on Electricity and the War
By H. Winfield Secor
Exclusive Interview to THE ELECTRICAL EXPERIMENTER

NIKOLA TESLA, one of the greatest of living electrical engineers and recipient of the seventh "Edison" medal, has evolved several unique and far-reaching ideas which if developed and practically applied should help to partially, if not totally, solve the much disputed submarine menace and to provide a means whereby the enemy's powder and shell magazines may be exploded at a distance of several miles.

There have been numerous stories bandied about by more or less irresponsible self-styled experts that certain American inventors, including Dr. Tesla, had invented among other things an electric ray to destroy or detect a submarine under water at a considerable distance. Mr. Tesla very courteously granted the writer an interview and some of his ideas on electricity's possible role in helping to end the great world-war are herein given:

The all-absorbing topic of daily conversation at the present time is of course the "U-boat." Therefore, I made that subject my opening shot.

"Well," said Dr. Tesla, "I have several distinct ideas regarding the subjugation of the submarine. But lest we forget, let us not underestimate the efficiency of the means available for carrying on submarine warfare. We may use microphones to detect the submarine, but on the other hand the submarine commander may employ microphones to locate a ship and even torpedo it by the range thus found, without ever showing his periscope above water. "Many years ago while serving in the capacity of chief electrician for an electric plant situated on the river Seine, in France, I had occasion to require for certain testing purposes an extremely sensitive galvanometer. In those days the quartz fiber was an unknown quantity—and I, by becoming specially adept, managed to produce an extremely fine cocoon fiber for the galvanometer suspension. Further, the galvanometer proved very sensitive for the location in which it was to be used; so a special cement base was sunk in the ground and by using a lead sub-base suspended on springs all mechanical shock and vibration effects were finally gotten rid of. "As a matter of actual personal experience," said Dr. Tesla, "it became a fact that the small iron-hull steam mail-packet ships (ships) plying up and down the river Seine..."
BRITISH WOUNDED HEAR LONDON'S FAVORITES VIA TELEPHONE

The free Telephone Service, contributed by public-spirited people of London to the hospitals in that city, includes an installation by which a hundred patients can listen, whilst lying in bed, to the performances transmitted from the leading musical comedy theaters and music halls in London. The accompanying illustration shows some patients, with their feet upon a hot-water bottle, enjoying a performance. It is probable that some similar arrangement will be made in this country when the regular and auxiliary hospitals become filled with wounded soldiers and sailors. The telephone has made unprecedented strides in America where there are more telephones per capita than in any other country in the world. There are more telephones in New York City than in all Europe.

Hence, with such extension telephone facilities available, the American convalescents will surely fare as well as their allies. Connection with band and orchestra concerts would seem very suitable.

at a distance of 3 miles would distinctly affect the galvanometer.

"How could this be applied to the submarine problem? I asked.

"I believe," the scientist replied, "I believe this magnetic method of locating or indicating the presence of an iron or steel mass might prove very practical in a submarine. And it is of course of paramount importance that we do find a means of accurately locating the ships and other things when they are submerged, so that we can, with this information, be ready to close in on them when they attempt to come to the surface. Especially is this important when several vessels are traveling in fleet formation; the location and presence of the enemy submarine can be radiographed to the other vessels by the one doing the magnetic surveying and, by means of nets in some cases, or gun-fire and the use of hydro-aeroplanes sent ahead, the enemy under water stands a mighty good chance of being "bombed," shelled or netted.

"However, I should think thesubscriber would soon be found of nullifying this magnetic detector of the submerged undersas war-craft. They might make the 'U-boat' hulls of some non-magnetic material, such as copper, brass, or aluminum. It is a good rule to always keep in mind that for practically every good invention there is a good equal and something worse can have been invented an opposite, and equally efficient counteracting invention."

"How about this new electric ray of Mr. Tesla?" I ventured to ask.

"Yes, yes, I am coming to that," the master electrician parried. "Now suppose that a large electric arc took place on a vessel, a large rectangular helice or inductance coil of insulated wire. Actual experiments in my laboratory at Houston Street (New York City), have proven the presence of a local iron mass, such as the ship's hull, would not interfere with the action of this device. To this coil of wire, measuring perhaps 400 feet in length by 20 feet in width (the length and breadth of the ship) we connect a source of extremely high frequency and very powerful oscillating current. By this method there are radiated powerful oscillating electro-static currents, which as I have found by actual experiment in my Colorado tests some years ago, will first affect a metallic body (such as a submarine hull, even tho made of brass or any other metal), and in turn cause that mass to react inductively on the exciting coil on the ship. To locate an iron mass it is not necessary to excite the coil with a high frequency current; the critical balance of the coil will be affected simply by the presence of the magnetic body. To be able to accurately determine the direction and range of the enemy submarine, four exciting inductances should be used. With a single induction, however, it would be possible to determine the location of a submarine by running the ship first in one direction and then in another, and noting whether the reactive effect caused by the physical presence of the submarine hull increased or decreased. The radiating induction must be very sharply attuned to the measuring apparatus installed on the ship, when no trouble will be found in detecting the presence of such a large metallic mass as a submarine, even at a distance of 5 to 6 miles; of this I feel confident from my past experiments in the realm of ultra-high frequency currents and potentials.

"What particular experiments do you have in mind, Dr. Tesla?" I asked.

"The Colorado tests of 1898-1900. Wonderful were the results there obtained, both as anticipated as well as those unexpected. As an example of what has been done with several hundred kilowatts of high frequency energy liberated, it was found that the dynamos in a power house six miles away were repeatedly burned out. Due to the powerful high frequency currents set up in the surrounding atmosphere heavy sparks to jump thru the windings and destroy the insulation! The lightning arresters in the power house allowed a stream of blue-white sparks jumping between the metal plates to the earth connection. I could walk on the sand (ordinarily considered a very good insulator) several hundred feet from my large high frequency oscillator, and sparks jumped from my shoes! At such distances all incandescent lamps glowed by wireless power, and banks of lamp, connected to a few turns of wire arranged in a coil on the ground, were lighted with a loud crackle of sound. The effect on metallic objects at considerable distances was really remarkable."

I asked him about the "Ulivi ray," which was accorded considerable newspaper publicity some time ago.

"The "Ulivi ray" really was translated from this country to Italy," asserted Dr. Tesla. "It was simply an adaptation of my ultra-powerful high-frequency phenomena as carried out in the United States, and published previously. With a powerful oscillator developing thousands of horsepower it would become readily possible to destroy paper and munition magazines by means of the high frequency currents induced in every bit of metal, even when located five to six miles away and moving at a speed of 100 miles an hour."

(Continued on page 270)
Electric Submarine Forts to Destroy Submarines

A NOVEL method of destroying the stealthy submarine is here illustrated and described. It is the invention of Mr. H. Hartman, a consulting engineer of New York City, whose Submarine Camera, Electric Speaking Clock, Automatic Electric Light Buoy, Automobile Direction Signal, etc., have been described and illustrated in previous numbers of THE ELECTRICAL EXPERIMENTER.

The present invention relates to a Submarine Exploration Device which originally has been intended only for the purpose of conducting submarine exploration and salvage operations at such depths of her, and a number of instruments like water-pressure gage, volt and ammeters, switches, telephone, etc.

Attached below the main cylinder is an auxiliary casing, closed electric seal containing a second storage battery for the purpose of overcoming the buoyancy of the main body. This auxiliary casing can be dropped at will by the operator in case of emergency; for instance, if the wire rope from which the whole device is lowered into the water should break, in which case the main body would rise by buoyancy to the surface of the water.

Furthermore, there is provided at the rear of the main cylinder an electrically operated screw propeller which will rotate the whole suspended (or anchored) unit round its vertical axis if desired by the operator. The main cylinder is divided into three separate compartments as is shown in the picture. The lowermost compartment contains a storage battery of high capacity and sufficient evacuated space to take up any gas which the battery may develop during its discharge action.

Hermetically sealed from this compartment follows the operator's chamber in which a man may comfortably ride on an elastic saddle and observe the surrounding waters thru a system of heavy lenses which are set carefully and watertight into the steel cylinder. To illuminate the water a very powerful electric searchlight is arranged within the next or top compartment, which in its turn is also divided from the operator's chamber by a watertight partition, so that no water can enter the same in case that the large lens thru which the light is projected into the water should break under the high pressure prevalent at great depths. The watertight cover of the main cylinder contains a special cooling arrangement which is required, as otherwise the heat emanating from the light projector would rise to a dangerous degree, which could cause the bursting of the large lens; nevertheless the same is protected by an inner circle of transparent tins with small openings thru which the heated nitrogen gas, filling this compartment, may only gradually and slowly circulate before striking the large lens which is cooled from outside by the icy waters of the depth.

The operator can not only swing the light projector under different angles by means of electro-magnets but also rotate the whole device slowly round its vertical axis and incline the same to a certain degree and observe the surrounding water in every direction. A telephone connection, whose insulated conductors are embedded into the core of the wire rope from which the device is suspended into the water, permits the operator to remain in constant communication with his mother ship and to report at once everything he sees and also to direct salvage operations, when so used. The submarine fort can also be anchored as shown, the top cable running to a submerged buoy. A string of these forts could be placed across the entrance of a harbor or bay.

(Continued on page 270)
Putting the Ocean Waves to Work

By CHARLES W. GEIGER

If there is any one invention that has been well-nigh worked to death, it is that which tends in some way or other to make practical use of the boundless energy in the ocean waves. But, regard being paid to all the study and work that has been expended on this engrossing and worthy problem, all attempts up to the present time have signally failed to produce any satisfactory results in putting these ever-rolling walls of water to work. It must have exasperated many an engineer to see this tremendous power continuously going to waste. But indomitable courage and resourcefulness will overcome almost any obstacle as long as it comes within the pale of practicability.

Just to show that there is a way to harness the industrious waves and breakers, two California inventors have worked out what seems to be a start in the right direction, as the accompanying photographs bear testimony, illustrating as they do, two distinct types of wave motors installed at Long Beach, California. They are intended to develop considerable power and to show that it is possible to develop electrical energy more cheaply than by burning coal or by other means. The view, Fig. 1, shows the extensive wave power plant now being installed in commercial capacity at Long Beach, California. The wave motor here presented displays a wide divergence from the wave motors of past experimentation.

The unique feature of this new machine is a compound uni-directional or free-draw and release clutch. This clutch is an achievement in rotating a power shaft in such a manner as to free the same from all dead center action, as well as creating rolling energy with the condition of no given stroke. So perfect is the action of the clutch employed, it is said, that any vibrational action is immediately transformed into a continuous rotary impulse. The machinery employed utilizes for its driving energy the reciprocating action of the ground swell occurring in ocean water. This action being caused by volumetric displacement as the wave moves forward setting up compound actions in opposite, a feature that no other motor possesses.

Substantially the machine consists of a multiple number of large bull-wheels each actuated by an impulse paddle, well covered being installed, will, when fully completed, present an ultimate capacity of some three to four thousand horse-power.

This machine, aside from presenting the required feature of being a continuous power producer operating irrespective of surface action, also possesses the merit of being a storm resistant machine, being the only one of its kind having no resistance to start, and at no time experiencing back pressure effects. The device was thoroughly tested and proven by the operation of a demonstrating plant which experienced the action of two of the heaviest storms that has occurred on the Pacific coast for a period of twenty-five years, without the slightest damage.

With its wave power equipment the company anticipates the production of electric energy on a wholesale basis, at about 90% of the cost of production by steam, and 75% of the cost of production by present-day hydro-electric methods. According to the best of authority it will be possible even under the present street condition of the steel market to install these plants at the surprising figure of $30.00 per horsepower.

In actuating the power shaft, oscillating bull-wheels are connected by heavy ⅜-inch plow-steel cables, which engage the impulse wheels actuating the clutch units by multiple series of turns on the same. By direct connection on side and reverse connection on the opposite side, the continual rotation of the power shaft is readily maintained. The bull-wheels employed in driving the power shaft are of a six-sector bridged arc type, 24 feet in diameter, built to resist fracture stress on two one-inch steel cables. These wheels are disposed as six units to incorporate within the machine the action of two ground swells at any one time, taking care so to afford a steadied maintenance of power at all times.

Mr. Alva L. Reynolds, the inventor of the second type of wave motor being installed at Long Beach, shown at Figs. 2 and 3, possesses several promising features.

This wave-motor is of the hydraulic transmission and regulation type. The paddles are actuated with any kind of a wave, and either forward or backward movements of the paddle are transmitted into energy. The paddle is connected to a pendulum shaft with a sprocket as shown. This sprocket actuates a chain that is connected with a sprocket on the shaft that drives the pumps. On the drive shaft is a crank connected with the pumps by means of a connecting rod. These pumps were designed for this special work in this special position. The chain and cog-wheel that drives the crank-shaft is seen near the left edge of the picture. Each movement of the paddle moves this crank-shaft and by means of the connecting rod works the pumps. There are two pumps to each pendulum. There is another crank-shaft on the end of the drive-shaft that...
actuates the pump see to the left of the picture. There are four pumps altogether in this unit and two paddle wheels. As the water is compress by the pumps, it should pass thru a large pressure tank (seen to the right in the large picture). This takes the pulsating effect of the pumps out of the water and leaves a perfectly steady stream for the water wheels. This water, under 120 pounds pressure, runs a water turbine which in turn is connected to the electric generator.

The power thus generated is at present used for lighting purposes and for a large search-light. The generator is also connected to storage-batteries, which are charged when there is plenty of water power in preparation for the time when the ocean may be comparatively calm.

SELENIUM SPEEDS UP THE OCEAN CABLE.

A new invention, devised by Mr. J. B. Dixon, of New London, Conn., speeds up the telegraphic operation on certain of the Atlantic cables, and is reported to have given remarkable results, the speed of operation in the commercial handling of cable messages has been increased upwards of 125 per cent, while in tests far greater speeds have been attained.

The gain in speed is due to the use of selenium cells to amplify the signals received, and to the use of means for obtaining, from one or more sources of illumination, a very large number of light beams, concentrated coincidently upon selenium cells, and deflected by a line galvanometer across the surface of the cells, the effect being that a very intense illumination of the cells is obtained.

It is found that the practicable speed of operation increases as the intensity of illumination increases. The selenium cells operate a siphon recorder or a relay. There being no physical connection between the recorder or relay and the light galvanometer, the inertia and frictional losses present in the older magnifying and recording apparatus are largely eliminated, the more so as in the new system the amplitude of vibration of the galvanometer coil is, in general, much less than in the case of the older apparatus. It is stated that Mr. Dixon employed 45 separate light beams, all derived from one 400 candle-power tungsten lamp, and all concentrated on a thin galvanometer mirror 5 inches long and 3/4 inch wide. These light beams were reflected from the galvanometer mirror, in one case, a distance of 7 feet 6 inches, and were then reflected a further distance of 7 feet 6 inches to the selenium cells, the light beams being concentrated coincidently upon the cells.

With this apparatus, working over one of the transatlantic cables the normal rate of operation of which is less than two hundred letters per minute, a speed of 450 letters per minute and higher was speed in the regular commercial handling of business, and still higher speeds have been obtained on tests, with signals fully readable as to size and characters.

GROWTH OF ELECTRIC STEEL FURNACE INDUSTRY.

In 1908 there was one electric steel furnace in the United States with an annual production of 55 tons. January 1st of this year there were 136 furnaces reported, as compared with 73 in use in 1916. The electric furnace can no longer be said to be in the experimental stage, with 20-ton furnaces in regular operation.

ELECTRIC TRAPSHOOTERS WHO "NEVER MISS" ARE NO MORE.

For the past 10 months, from sunset to sunrise, the electrically operated trapshooters on the world's largest, most attractive, realistic and spectacular electric sign—located on the Million Dollar Pier, Atlantic City, N. J.—have fired at 10 targets a minute and recorded a "hit" every time.

Human trapshooters are not equal to the task of breaking every target thrown. Mechanisms, of course, can be made almost infallible, but mark you, from now on, the electric trapshooter is to be more realistic and more human than ever. They will miss at irregular intervals. Irregular is the proper word for the present time.

Thousands of persons seat themselves on the spacious hotel verandas and many more mass on the boardwalk every night trying to figure out when the shooter will miss. Sometimes the misses are as many as two or three in thirty seconds—while at other times the misses are not more than two in the same number of minutes. Therefore it is difficult to work out a system and play it.

Figuring out "when the shooter misses" has become quite a game in Atlantic City, and everyone is playing. You cannot help but enthuse and get into the game after watching the electrical display. It is only human to try and solve the puzzle—of ascertaining just when the shooter misses is a puzzle. Thousands check up the misses each night, keeping tabs by the hour, but on no two nights thus far has the rotation of misses been the same.

It took five months of incessant scheming and testing to perfect the scheme of having the shooters miss, and the changes had to be made so as not to affect the operation of the sign. The iron work was extended 10 feet and several hundred additional lights are now in operation.

This is the second change that has been made in the working of the great sign since it was first shown to public view—January 4, 1916. The original shooter was a man. Then the idea was suggested to have a woman afloat in a speed boat firing at the targets. This wonderful accomplishment was perfected and the fair Diana began alternating with the male shooter several months after the first operation of the sign.

There are 4,000 lights in the entire sign, which is so big by daylight that the figures of the shooters are 21 feet high. The trap puller is 18 feet 6 inches tall. The target is 15 inches in diameter. The sign cost upwards of $100,000.

There are six operations to the sign, each one taking about one second. First the green lights come on, producing a lawn effect, and then in order appears the trapshooter, who places his gun to his shoulder and aims as the trap puller rises behind him. The puller throws the lever, which releases the target. You soon learn whether the target is hit or miss. When hit, the target bursts into hundreds of small lights, looking for all the world like the fragments of a target. When the target is missed it travels the length of the sign and disappears into the fourth dimension—inkly blackness.

It is a most interesting display, and has proved the only means so far of graphically depicting the actual sport of trapshooting by mechanical effects.—Photos courtesy of R. C. Maxwell Co.
Blinding The Submarine

By H. GERNSBACK

THERE is one dead sure way of making a ship torpedo-proof and that is by making it invisible. No one will deny this. For if the submarine commander can't see his quarry he can't torpedo it. Now, this is not intended as a joke, nor do I refer to Grimm's Fairy Tales, where the young prince by the turn of his magic cap be-

**Experiment 2.** Have an assistant throw the full glare directly into your eyes. You will be blinded for several seconds.

**Experiment 3.** Try experiment 2 in broad daylight, but with the searchlight detached from the auto. Ask your assistant to move to one side of the car. Have him throw the full glare into your face. It will be impossible for you to see the car, even with the sun shining on it. You are blinded in broad daylight. This, of course, providing that the searchlight is sufficiently powerful. If you don't own a searchlight try a mirror, and have your assistant reflect the sunlight into your eyes. **Try as you may, you will never as much as glimpse an object within 500 feet of either side of him.**

**Experiment 4.** Repeat experiment 3, but protect your eyes by black glasses (smoked glasses). You will find that it won't help you at all. Instead of a ball of white fire you now get a ball of orange fire into your eyes. Less blinding, true—placing your eye close to the eye-piece, in order to shield your eye from the light. Now then imagine for a minute that you are the submarine commander, with your eye glued to the as yet submerged periscope. Slowly and cautiously you raise the periscope tube till it is a foot or more above the water. Rapidly you turn it in a circle to scan every point of the horizon. Nothing but the blue sky and the ocean. You keep on turning. Suddenly like a bolt of lightning your eyes are filled with a ball of white fire that makes your eyes water.

"Donnerwetter!" you will say—presuming that you are a German U-boat commander. Down comes the periscope, while you wipe your eyes stupidly. After a few minutes you try again. Once more you are blinded for seconds at a time. You see the light but that's all.

Now to torpedo a ship you must know several things. First you must know its position, that is how far away it is from you. Second, you must know in what direction the ship is traveling. Third, you must know its speed. Without knowing these three things it is as a rule impossible to torpedo successfully. And with a powerful searchlight trained full on your periscope you would of course

---

When a U-boat Commander wishes to torpedo your ship he must know three things:

1. He must know the speed of your vessel.
2. He must know in which direction you move.
3. He must know the distance measured in a straight line from the U-boat to your ship.

If you devise a means whereby he cannot make his observations correctly, the commander will be unable to torpedo you. The idea outlined in this article aims to blind the U-boat commander in broad daylight by means of powerful searchlights, thereby making it impossible for him to correctly take a ship's bearing.

An interesting as well as plausible article, that will set you thinking.
know where the ship was, but you could not possibly know how far away it was from you as measured in yards, nor would you know if the ship was traveling towards you or away from you. You could not know if the searchlight was on the bow or on the stern of the vessel. Neither would you know if the ship was traveling at right angles to you or whether it presented its bow or stern to you. Articulations such as sensitive microphones will not help you much. You must take the ship’s bearings accurately or you cannot possibly torpedo it. You can tell the position of the U-boat, because the ship has the searchlight, most likely will have guns too. So you curse a full round, haul down the periscope for the ninth time and drawn yourself in a stein of Hirzburger.

My idea then is this. Mount on the ship four powerful searchlights. Our illustration shows how it should be done. There should be one attendant to each searchlight. Ordinarily the searchlights are not lighted but remain dark. Each searchlight operator wears a telephone headgear, exactly as our naval gunners do nowadays. In the bow there are two observers scaring the water at all times with their glasses. One observer scans the ocean on the starboard side, the other overlooks the water on the port side of the ship. Strait to their breasts is a transmitter, the same as “Central.”

To the right of a periscope is observed, let us say on the port side, the crow’s nest immediately gives the position to the two periscope attendants. By means of a foot operated switch, the current is turned into the searchlight instantly and the latter is trained onto the periscope. The searchlight being placed on ball or roller bearings, obeys the touch of the finger. Thru a sighting tube the attendant will positively throw the glare full onto the periscope in less than five seconds after he received the position from above. Very great accuracy is not necessary for these searchlights.

Let us assume the U-boat is two miles off. At this distance the beams of the searchlight cover a fan-shaped expanse of about 50 yards. In other words, if the attendant makes a mistake of 25 yards on either side of the periscope, it does not matter. The U-boat commander will be blinded just as efficiently. Besides, the man behind the searchlight will correct his aim in less than three seconds, once his rays have hit the periscope.

Observe the simplicity of the operation. A hundred percent hit should be recorded every time. It is inconceivable how either of the two attendants could fail to make a “hit” with their rays. Note, too, that the operation is unlike firing a gun. First, considerable time is lost in sighting the projectile is almost an impossibility. It has never been done, except by pure chance. One hit in a thousand would be considered good. Consider, on the other hand, a shaft of light 50 yards wide, which can be moved instantly over an expanse of several miles, and it becomes plain why there cannot be any possible escape for the periscope.

The beauty of the scheme is the great speed at which the entire operation is performed. Five to six seconds—and with a trained crew it should be less—is ample time once the periscope is located. No submarine commander can possibly make his necessary observations in such a short time; it requires a minimum of one minute to take a ship’s bearings.

Of course it is evident that the success of the scheme lies in the ability of the lookout, who must spot the periscope at once. This, however, should not be so difficult for a trained seafaring man. I mentioned above that two searchlights could and can be used simultaneously. For practical purposes and for tactical advantages a single searchlight, however, is preferable for the following reasons:

Our front cover shows how the searchlights are mounted on a long steel extension projecting some 25 feet from the bow and stern of the ship. This is done for two reasons. First, it gives the operator a better sweep, second and most important, if the submarine commander fires a torpedo in the direction of the light, the operators have but to watch for its reappearance, when the game starts anew. In the meantime the commander of the ship can either hit the U-boat or else present the stern of the ship towards the U-boat. In either case torpedoing is extremely doubtful, and the attacked ship would make the searchlight much quicker than the ship’s observer could see the U-boat. Still the fact remains that the submarine commander would be baffled, because he could not tell if the searchlight was in the center, in the bow or in the stern of the ship. It is therefore difficult if he could make a hit, except perhaps by using two torpedoes simultaneously directed fifty yards to either side of the periscope which is done in a hit or at all certain, because the ship might present its bow or its stern to the U-boat, thereby offering a very small target. In that case the torpedoes would not course pass the ship on either side of it. The main requirements of the plan as outlined are:

1. Very powerful electric searchlights.
2. Hundreds of thousands of candlepower MUST be used, otherwise the scheme is destroyed to the extended location of the searchlights. This is not apparent at once but hear in mind that the commander does not act the ship itself, and that he does not know if the beam of light originates from the bow or from the stern of the vessel to be torpedoed. Neither does he know if it is on this side or that, and whether the U-boat is hit or not. Then, too, as soon as the enemy periscope is sighted and has been covered by the light beam, the ship can turn about at once, the searchlight’s rays however being kept on the periscope all the while during this maneuver. If the periscope is halted

To Torpedo a Ship the Submarine Commander Must Know These 3 Things:
1st. Distance from A to B in Yards; 2nd, Speed of Ship, i.e., How Long it Will Take to Travel from C to D; 3rd, Direction in Which Ship is Moving, i.e., Does It Travel from C to D or from D to C. 

Submarine Commander's Chart From the Ship's Position as Shown in Fig. 1 It Swings About—Still Keeping the Searchlights On—Until Periscope—His Narrowest Part to a Possible Torpedo. The Attacked Steamer Can Escape.
Thunder-Storms and Lightning Rods

By TERRELL CROFT

This matter of thunder-storms and lightning rods is one about which experience has given rise to many erroneous ideas. The lightning rod is the oldest useful electrical invention (it was first proposed by Benjamin Franklin in 1752) it has, however, been the writer's experience that, to-day, a majority of otherwise well-informed folks do not know whether or not lightning rods afford protection to the buildings on which they are installed. The subject is one of such universal interest that everyone should be familiar with the general facts relating to it. Therefore in this article the essential and underlying principles as they are explained by the modern theories will be discussed.

There are no experiments which the reader can readily perform to verify the facts discussed in this article because the electrical qualities involved in lightning phenomena are of such great magnitude that they cannot be accurately reproduced in the laboratory. In this instance he must, without verification, take the author's word for it that the statements which will be made are correct.

First of all, lightning rods do, when they are properly installed, afford practically perfect protection against lightning damage to structures. The United States Government Reports, Standards finds that even as they are ordinarily installed—and they are not always in practise arranged as efficiently as should be—lightning rods "reduce the fire hazard from lightning by 80 to 90 per cent in the case of houses, and by as much as 95 per cent in the case of barns." Inasmuch as something more than $8,000,000 worth of property is destroyed annually by lightning in our United States (practically all of this loss could be prevented by the suitable lightning rod installations), the importance of the subject is apparent.

Now that we understand the fundamental dollars-and-cents feature affecting this situation, let us examine the causes of thunder-storms and lightning and find out how and why lightning rods afford protection. What is it that causes lightning and thunder-storms? That is, how do the unusual electrical conditions, which we all know must precede a lightning flash between a cloud and the earth, originate? It is almost apparent that the cloud must be highly electrified. The cloud itself must contain an excess or a deficit of electrons as compared with the earth to cause the lightning to strike the earth. But how does the cloud thus become electrified?

No one can now answer this question with absolute definiteness. But we can, thanks to the researches of Dr. George C. Simpson of the India Meteorological Department, Simla, give a logical explanation which is well supported by experimental facts. It is, probably, as will be shown, that the electrification of thunder clouds is due to an excess of electrons in the cloud, which electrons have been knocked off, in the base of the cloud, from drops of water by an ascending air current.

It appears that there is always a current of moisture-laden warm air ascending from near the earth to the cloud just prior to a thunder storm. When this humid warm air current reaches the cold region at the cloud, the moisture in the air current is condensed by the low temperature there and then forms into drops of water. The data collected by Dr. Simpson tends to indicate that the ascending air current then breaks into smaller water particles or minute water globules, the drops of water which have been condensed from it.

Now it can be shown experimentally that when "drops of distilled water which are falling downward with an air blast of sufficient strength to cause some spray," the water particles and the surrounding air become electrically charged. The particles become electrified and the surrounding air becomes negatively electrified. In other words, such an air blast appears to knock off some of the electrons, which are, as has been explained, particles of negative electricity. These float about and finally penetrate to all parts of the cloud, charging the cloud negatively throughout its entire volume. The drops of water, from which the electrons were knocked, finally shoot off from the cloud and ultimately fall to the earth as rain. Thus the entire cloud becomes negatively electrified.

The ascending air current from the earth to the cloud must, in order that the electrons may be torn off from the condensed-water drops, as above described, have a certain upward speed or velocity. And there are other conditions—which it is unnecessary to discuss here—that must be satisfied. But, taken all together, observation of actual conditions leads Dr. Simpson and others, who are well qualified to judge, to believe that the above outlined theory explains in a general way, how thunder-storm clouds become so highly electrified.

Thus when a cloud has become negatively electrified, the process above outlined, the situation may then be diagrammed somewhat as shown in Fig. 1. The cloud, C, contains many or an excess of free electrons—it is highly electrified negatively. The area of the earth, E, under the thunder-cloud, is in an almost neutral state, that is, practically speaking, it contains neither an excess or a deficit of electrons. Hence, there is a tendency (which is sometimes called an electric pressure or electromotive force) tending to establish an electrical balance between the cloud and the earth. There is a tendency for the excess electrons in the cloud to pass thru the atmosphere between the cloud and the earth to restore the unbalanced electrical condition due to all of those excess electrons in the cloud.

However, the atmosphere is a non-conductor of electricity, or electrons. Hence, the excess free electrons on the cloud cannot pass thru the air to equalize the unbalanced condition. (If the air were a good electrical conductor there would be no lightning.) But the tendency of the electrons to pass to the earth does create a stress—an electrostatic field—in the air.

by the lightning-flash current. We may now understand how lightning rods protect buildings.

It will be very expensive to install a complete inclosing metallic cage like that of Fig. 2 on every building, altho such a cage would afford the ideal protection. Experience has shown that ample protection is provided if only part of the cage is installed on the ordinary building, as shown in Fig. 3. The conductor is so routed over the building as to afford maximum enclosure with minimum material. Aerial terminals or points (P, P and P) a long life under conditions where iron would run away in a short time. Iron conductors should be protected with a zinc coating to minimize corrosion. A good substantial iron conductor is, doubtless, in most cases, preferable to a flimsy, weak copper one.

The day of the lightning rod agent of ill repute is past. Once, these ramblers over the countryside, selling the unsuspecting farmers anything from a fake lightning rod to a neat parcel containing a "million volts." But the farmer of to-day is educated in electrical matters.

**Elementary Representation of the Electrostatic Stress Existing Between the Earth and a Charged Cloud.** When This Stress Reaches a Certain Limit, the Air Insulator is Broken Down, an Electric Current in the Form of a Powerful Spark (or Sparks) Passes, and We Have a "Lightning" Discharge. Thunder is the Sound Caused by Lightning.

**Joining Glass at Moderate Temperatures.**

In a paper recently read before the Royal Society, Messrs. Barker and Dalladay described some interesting experiments on the direct joining of glass at relatively low temperatures which they have carried out in the research laboratories of Messrs. Adam, G. Webster, Eng. England. The results described are not of immediate importance, are, however, of great historical interest, but afford great practical advantages in the construction of glass apparatus out of what is actually a single solid piece instead of using more or less unsatisfactory cements. The advantage of such solid construction is particularly evident in polychromic tubes and absorption cells—the latter can now be constructed with truly parallel faces and with inside faces optically worked.

The process of joining which the authors have worked out consists in a simple one—brushing the surfaces of the glass to be united in good optical contact under pressure, and then raising the temperature to a carefully determined degree. The glass surfaces are thus treated becoming perfectly smooth, so that the two pieces of glass will not separate along their former interface, and the composite piece acts as if it were a single solid mass, even a crack or a diamond-cut will pass thru the junction without hindrance or deflection. The temperature employed is chosen as high as possible in order to lessen the time required for union of the surfaces, but if distortion of the optically worked surfaces is to be avoided, the temperature must not be taken too near the limit, which the authors describe as the "annealing point." This point has been determined by observing the strains set up in a piece of glass while being heated at a definite rate in an electric-tube furnace; for each kind of glass they fix the "annealing point"—the temperature at which internal stresses—which are readily observed by means of polarized light—disappear quite in the annealing point, also, the glass becomes appreciably more transparent and its quality is indicated by a sharp tool. When similar kinds of glass are used, having similar "annealing points," the fusion of the glass in optical contact takes place well below this annealing point. Very dissimilar glasses, however, cannot well be joined, since the softer becomes distorted before the harder is hot enough to weld freely.
Women Radio Operators To Aid Uncle Sam

A modern women have never yet been found wanting when it comes to real 'died-in-the-wool' service, no matter what that service might be—even to helping in executing the duties of war. The exigencies of war have now claimed several hundreds of the fair daughters of Cleveland, Ohio, where a new radio service school has been instituted for the service the country needs. Railroad men, telegraph and wireless operators have been in great demand since the very inception of strife.

The classes are well organized and happily esconced in rooms where work is conducted in a quiet, systematic manner. The Cleveland Advertising Club has bent every effort to make the pupils comfortable, and has assumed a very live and active concern since the very inception of the measure, even sending Charles Seldon of Baltimore, chief telegrapher and head of the maintenance department of the road, to Cleveland to investigate the plan and offer the assistance and co-operation of the road. The company has supplied the classes with books on railroad rules, and has practically

Augurated by Arthur S. Newman, of that city, it has received the unqualified recommendation of Secretary of War Newton D. Baker, who says of it:

"This effort to teach a number of competent young women the art of wireless telegraphy in order that their services may be available to the Government if needed, seems to me a very practical thing to do, and it shows, too, the patriotic impulse of the service and the practical wisdom of choosing a way in which services may really be demanded."

The classes, which meet every Monday evening at 8 in the Cleveland Advertising Club's rooms, represent a real, sincere and highly practical preparedness measure conceived by Miss Newman, endorsed by Secretary of War Newton D. Baker, and entered into with a zest that assures success both to instructors and students.

The idea behind the instruction is the training of women to take places of men in telegraph and railroad service and in the wireless service on lake vessels, so that the men now holding those jobs may be relieved.

Supplies every need for efficient work, like tables and blackboards.

There have been over one thousand applicants for instruction and 238 of these have been accepted. Among these are lawyers, teachers, physicians, professional and business women. A very small per cent. has tackled the intricacies of wireless telegraphy—only about forty, in fact. Of course the wireless operation presents more complications which many girls fear to undertake and, too, there is a great deal more opportunity for real service in telegraphy than in the wireless.

"Except in case of exhaustive war," Mr. Newman stated, "there will be but little employment for women as wireless operators, while railroad work and telegraphy offer an unlimited field. In case of a long-drawn out war, women would doubtless be employed in the wireless service on freighters and passenger lake boats, but the railroads and telegraph companies can make use of efficient women right now."

Various railroads have evinced interest in the classes, but the Baltimore & Ohio guarantees to place in positions every girl who is turned out from the classes. The railroad has further announced that it is not looking for girls to take the positions in order to cut the pay roll, but will place them on the same salary schedule it uses for its men employees.

Telegraphy, wireless operating, railroad traffic and signaling will be taught during the course. The classes meet in separate rooms. A part of the two-hour period is given to talks, and the rest to practice work.

The directors of the school endeavor to bring speakers each Monday evening who will fire the patriotism of the students as well as give them practical talks on the subject matter. Scientific demonstrations are also given, and as the work progresses more complicated and technical programs will be planned.

The girls work at three tables in the telegraph room. Tables are equipped with instruments, and each table has its own instructor. Miss Agness Galagher, who has

(Continued on page 270)

DATE OF ISSUE.—As many of our readers have recently become unduly agitated as to when they could obtain THE ELECTRICAL EXPERIMENTER, all of which we wish to state that the newsstands have the journal on sale between the fifteenth and the eighteenth of the month in the eastern part of the United States and about the twentieth of the month west of the Mississippi River. Our subscribers should be in possession of their copies at these dates. Kindly bear in mind, however, that publications are not handled with the same dispatch by the Post Office as a letter. For this reason delays are frequent, therefore kindly be patient and do not send us complaints as to non-arrival of your copy before the twenty-fifth of the month.
ONE CENT'S WORTH OF ELECTRICITY.

At ten cents per kilowatt hour electricity will operate the following for one cent:
A 10-candlepower Mazda lamp for five hours.
A six-pound flatiron 15 minutes.
A radiator toaster long enough to produce ten slices of toast.
A sewing machine for two hours.
A fan 12 inches in diameter for two hours.
An electric percolator long enough to make three cups of coffee.
A heating pad from two to four hours.
A domestic buffer for one and one-quarter hours.
A chafing dish 12 minutes.
An electric broiler 6 minutes.
An electric griddle 8 minutes.
A radiant grill for 10 minutes.
An electric portable iron once a day for two weeks.
It will operate a luminous 500-watt radiator 12 minutes.
A portable vacuum cleaner 45 minutes.
A sewing machine motor two and one-half hours.
A vibrator (for massage) four hours.
A washing machine for half an hour.

"BUY A LIBERTY BOND" ELECTRIC SIGN BLAZED.

One of the leading New York electric sign producers erected this sign for the Government, free of all cost. They also maintained the sign free of cost to Uncle Sam and paid the "juice" bill. That's what we call real patriotism! Let's have more of 'em. The space is a $30,000 one. The original plan was to erect an exceptionally artistic sign, but the time was too short, so Mr. Woolley, the Director of Publicity at the Treasury Department, suggested the design as used. The phrase, "The Fate of Mankind Lies in Your Hands" is his thought.

There are 3,800 lamps in the sign, and the structure is 50 feet high and 125 feet long.—Photo courtesy O. J. Guide Co.

WIRELESS PATROL OF TRANSMISSION LINES.

The Chattanooga Wireless Club, an amateur organization having wireless stations at Chattanooga and Cleveland, Tenn., rendered excellent service to the Tennessee Power Company on three occasions by discovering breaks in the transmission line. The company has used an aluminum line, and when this part, the arc has made itself heard at the wireless stations.

ELECTRIC VIBRATORS HELP HEAL CANADIAN WOUNDED.

Surgeons in most of the hospitals caring for soldiers have found the electric vibrator extremely helpful in assisting the cure of returned soldiers, suffering from any form of muscular paralysis. The devices hasten by days the cure of bayonet, shrapnel and gun shot wounds, as well as sprains, strains and bruises. Nerves shattered by long hours under fire in the trenches, sudden shell-shock, and the resulting nervous disorders, are all benefited by electric vibratory treatment.

Under a doctor's instruction the nursing sister can use the vibrator on the patient with equally good results, and as the patient improves he himself can assist his cure. This treatment is said to energize and vitalize, besides purging the blood of toxic poisons—soothing the nerves and giving complete relaxation more restful than sleep.

The illumination shows a special vibrator, as well as a thermolite treatment lamp in actual use in one of the Canadian convalescent homes.

The thermolite, whose healing properties are produced by a combination of light and heat, is highly recommended for nervous complaints.

CITY SELLS LIGHTING POSTS FOR MUNITION USE.

The Street Department, Bronx, N. Y., has arranged for the sale of about 6,000 old lamp-posts used for gas service, and now superseded by an electric street-lighting system, to R. D. Wood & Company, Philadelphia, Pa., at a cost of $1.00 each, with removal by the purchaser. Prior to the country's entrance into the war the borough had been paying about $11 each to have the posts removed by private contractors, bringing a considerable asset where a financial burden was anticipated. It is said that the posts will be utilized in shrapnel manufacture.

These Electric Signs "Buy a Liberty Bond" and "Enlist in the Navy" Were Erected and Maintained in New York City Free of All Cost to Uncle Sam by a Patriotic Concern in That City.
An Electrical Miniature Village de Luxe

We were all kids once, to be sure, but it is doubtful if any of us ever had such a wonderful play-thing as two little Chicago boys, George and Robert, the twin sons of Mr. and Mrs. Robert Hutchison, who have an electric village that might very well typify in miniature the great electrical city of Chi-

cago in which they live. The photograph cannot, of course, show the movement of the miniature railroad train, operated by electricity; nor the speeding third-rail interurban electric car; the whirling windmill pump; the twirling of the electric stars in the little blue firmament provided; the tolling of the church bell and the music of the organ; the man cranking the automobile at the entrance to the garage, and the flashing of the sign on the opera house. These things the camera must show as tho they moved not; but when the village is in operation they all do move and, in addition, the pretty little electric fountain throws its spray nearly a foot into the air, the electric street lamps glow, the store, residence and church windows shed a pretty light, and the safety gate at the railroad crossing, just where the big engine is standing in the photograph, falls and rises with precision on the approach of the train and when it has passed.

All of these things are arranged with beautiful mechanical perfection of finish and detail. The base is fifteen feet long and six feet wide. The motive power for everything is electrical, there being nine separate small electric motors in different parts of the foundation of the electric village. There are no less than 42 miniature electric lamps, counting headlights on the trains and other small lights.

With the aid of an able assistant whose artistic work with the brush appears in the decorative part of the work, Mr. Hutchison, who made nearly every detail himself, has worked out these things and many more, with a careful regard for relative sizes; thus, the farmer standing in the barnyard, and the horse and other live stock nearby, are relatively of about correct proportions; so are the other people on the street and on the porch of the house, and so are the buildings and the implements and accessories which go to make up the completeness of social and commercial activity in this model village.

The village main street begins just to the right of the residence, and along it will be seen the house, the garage, the opera house, the stores and the church. The residence is on a grassy knoll with lawn and path neatly laid out, and the railroad line finds it necessary to pass thru a long tunnel underneath this part of the scene. The street railway, on the other hand, makes a loop over a pretty rustic bridge and around the park with the little pond and the ducks at the right-hand end in the foreground, passing back to another loop at the left hand and returning. An interesting feature of this street railroad is the automatic switches connecting the main track with the loop at each end and operated by the flange of the rear wheels of the car as it passes over them, so that the next time the car approaches the loop it will pass round in the opposite direction, varying the effect.

The electric fountain used to be supplied from the water tower, the pump feeding the latter; but this has been superseded by a direct feed from the pump to the fountain, a metal diaphragm and air chamber equalizing the pressure.

So particular has Mr. Hutchison been about the construction of his electrical features, that there are certain lamps in this installation which were made especially for him. These little incandescent bulbs have flat sides like very short bung-hole lamps of miniature type, and were made to accommodate themselves to the little electric lanterns which were originally purchased as oil lamps and have been made over by Mr. Hutchison. All motors have been rewound to accommodate themselves to the twin generator driven by a 150-watt step-down toy transformer, and the alternating current lighting circuit. The smaller illustration herewith shows the neat 400-watt electric plant, compris-

E.E.
THE ELECTRICAL EXPERIMENTER

BEAUTIFUL ILLUMINATION OF CAPITOL AT WASHINGTON.

Against the sombre shadows of night at this critical moment in our history, the inspiring white dome of our Capitol at Washington, high above the Federal City, stands resplendent in rays of shining light, a radiant monument to freedom and democracy. The plans for illuminating the Capitol dome were perfected for the recent inauguration of President Wilson, and the spectacular results were so satisfactory that the system was made permanent.

Flood lighting was the method used to illuminate the great dome, which is 135 feet in diameter at the base, 218 feet high above the roof, and is surmounted by a bronze statue of Freedom. Eighty-four flood projectors, each equipped with a 400-watt flood lighting lamp, were used. These projectors were placed in four banks, about 200 feet from the dome, on the corners of the House and Senate wings. By placing the projectors in these positions, it was found possible to throw light from different directions on the 36 columns at the base (representing the 36 states in the service. At the end of 1914 there was a total of 1,940 stations supplying electricity, 390 of these being central stations, 24 railway plant, 47 combined railway and central station plant, 1,366 isolated plants, and the remainder official installations. The water-power stations number 695, steam 788 and gas-driven stations 547. The total capacity of these stations is 608,544 kw., of which 341,009 kw. are central stations, 140,000 isolated plants. The water-power equipment totalled 366,243 kw., steam 217,967 kw., and gas stations 24,344 kw. There were 21,900 miles of aerial and 751 miles of underground transmission lines.

METAL HEATING PAD.

A western manufacturer has planned on the market, after thorough testing, a metal heating pad. This hot-pad consists of a heating element encased in a nickelated steel jacket and is made up of hinged units permitting the bending of the inner heating element. The flexibility is sufficient for the requirements demanded of a hot-pad as the illustration shows; it may even be wrapped around a limb. It operates from any lamp-socket, consumes 40 watts and its heat is easily regulated, even in the dark or under the bed cover, by a small lever. Any temperature from 100 to 200 degrees Fahrenheit is

A REAL "WAR" LAMP MADE FROM SHELLS.

An Ohio concern is now offering a special lighting unit, the "War Lamp," which is known as this remarkable and appropriate (sic pacifists) lamp is shown in the accompanying illustration and is made from genuine shrapnel shells, 3-in. Russian and British, called "18-pounders" or the French "75 mm." The total height is 23 in. and the base 5½ in., with the bullet globe 3 in. The base support uses nicked shrapnel balls. Lamps up to 75-watts can be used in the unit. This lamp is intended as a reading lamp for homes, offices or stores and is a practical unit, besides being a souvenir of historical value later. A 5 in. by 8 in. silk flag eye shade and a suitable holder for it is furnished with each lamp and adds a patriotic touch. The makers guarantee each shell to be genuine.

ELECTRIC PROGRESS IN JAPAN.

Japan is taking to electricity like a duck to water. The Lake Inawashire plant now includes six 10,000 h.p. turbines, and transmits power at a pressure of 115,000 volts over 140 miles of transmission lines in Tokyo. This is one of the big hydro-electric schemes which Japan has now put in easily attained and automatically maintained by thermostat; it cannot become overheated, as current is shut off automatically when certain temperature is reached. Under average conditions, it may be operated at least five hours for less than one cent's worth of current. It is provided with soft, washable and removable eidernow cover and enclosed in parchment envelop. It comes complete with cord and connection plug, ready for use.
THE ELECTRICAL EXPERIMENTER

August, 1917

LET THE ELECTRIC REFRIGERATOR KEEP YOUR FOOD.

The electric refrigerator illustrated comprises a motor-driven ice-machine adopted to any standard refrigerator, the ice-machine itself occupying what would ordinarily be the ice-box. Here we have the cooling coils, partly immersed in a brine tank containing receptacles in which small blocks of pure ice are formed for table use. This electric refrigerator is claimed to be entirely safe. Explosions in large refrigerating plants are due to the use of ammonia gas under pressure. To avoid possible danger from this source in the household refrigerator, ethyl chloride at low pressure has been substituted for ammonia.

This type of electric refrigerator is automatic. It is regulated to maintain a constant temperature, the machine starting and stopping automatically, by means of an ingenious thermostatic control. All valves are locked; the consumer is not called upon to make any adjustment, and the machine will run from one to three years without adjustment.

Artificial refrigeration by such a machine is said to be much cheaper than ice. About two and one-half kilowatt hours of current are required for one hundred pounds of ice-effect in the course of one day. At the eight-cent rate for current, this makes the cost of refrigeration twenty cents for the ice-effect of one hundred pounds, as contrasted with real ice at forty cents a hundred. In suburban and country districts the contrast is still more marked for the price of ice there more frequently runs up to sixty and seventy cents a hundred, and in addition the ordinary ice supply is usually irregular and inadequate.

Automatic control cuts down the amount of electricity used, for when the set temperature is reached the motor is automatically cut off. Thus the machine consumes current only when it is in actual use, and this is but a small proportion of the twenty-four hours. The entire machine can be operated from an ordinary lamp-socket, this being another indication of the small amount of power required.

With an electric ice machine, the purity of the ice it produces is absolutely guaranteed, each family using whichever distilled water it prefers for this purpose. Table ice is frozen in about two hours' time. Furthermore, with artificial cooling substituted for melting ice, the refrigerator can be kept strictly clean with little effort, thus preventing contamination of food.

The household refrigerator comes in three sizes; the smallest is rated to give the cooling effect of one hundred and fifty pounds of ice; the second size, three hundred pounds; and the largest, six hundred pounds.

The machine is regulated to preserve certain temperatures throughout the refrigerator. In the upper left-hand compartment, where table-ice is made, the temperature is twenty-four degrees Fahrenheit. The section below is kept at thirty-eight degrees, the lower right-hand compartment at forty-two degrees, and the upper right hand at forty-six degrees. These variations provide for proper circulation of air within the refrigerator, thus keeping it dry and sweet. They are also desirable, as foods require different temperatures for best results in their preservation. Thus, milk, butter and eggs would be placed in the lower left-hand compartment; cooked foods and meats in the lower right-hand cabinet; and fruits and vegetables, requiring a less degree of cold, in the upper right-hand cabinet.

The refrigerant, ethyl-chlorid, is a neutral gas which in the manner employed does not change or deteriorate with use, neither does it act on the metals of which the machine is constructed.

The process employed is known as the compression system: the gas is expanded from a liquid state at a relatively high pressure to a gaseous state at a lower pressure, corresponding to the temperature required. This gas is withdrawn from the cooling coils and discharged into the condensing chamber by means of a specially designed rotatory compressor, where, by the combined action of pressure and cooling by water passing thru the condenser coil, the latent heat of vaporization is removed, and the gas condensed to liquid again, ready once more for the refrigerating cycle. Water consumption is at the rate of about fifteen gallons per hour while the machine is running, or thirty-six if the flow being shut off when the machine is stopped.

Mine gas is detected with a portable electric outfit which miners carry.

FLASHLIGHTS AS CHEAP AS MATCHES.

It costs no more to operate an electric flashlight than to use matches for the same purpose, according to figures compiled recently. Each modern tungsten battery (for flashlight use) is guaranteed to burn for 800 hours, a second each, or for 600 flashes of 10 seconds each. Now, the average one-cent box of matches contains just 60 matches. Each of these will burn for 15 seconds, but when allowance is made for blowing out and others being used for a second or two only, it is estimated that the average match does not burn longer than 10 seconds. At this figure the cost would be the same as that of using a flashlight.

Some of the most popular styles of flashlights, however, cost a good deal less than this to operate. Take for instance, the tabular pocket flashlight, in which the battery gives 1,200 flashes of a second each for one cent. This size battery costs one-half as much to use as would safety matches.

AN ELECTRIC TABLE LAMP THAT SPEAKS.

The combination phonograph and electric lamp shown in the accompanying illustration has been developed by a New York inventor. The phonograph is concealed in the base of the lamp, which is so designed that it will accommodate any size records up to the 12-in. disk. When the phonograph is to be played the hood is raised, the disk inserted and the power turned on.

The disk is revolved by a small motor in the same circuit as the electric light, but controlled by a separate switch. This arrangement makes it possible to play the instrument when the lamp is not in use. Instead of using a horn as with some "talking" machines, the sound is diffused thru the stem of the lamp, which, it is claimed, considerably softens the tone.

Using Ethyl-Chlorid as the Refrigerant. This Electrically Operated Refrigerator Automatically Keeps the Food Compartments at Frigid Temperature. Besides, It Freezes Ice Cubes for Table and Kitchen Use.

![Image of a refrigerator with a description of how it works.](https://via.placeholder.com/150)

Behold! The Electric Table Lamp That Speaks and Sings—Thanks to a Phonograph Cleverly Concealed in the Base and Driven by a Miniature Electric Motor.

![Image of a phonograph lamp with a description of its features.](https://via.placeholder.com/150)
ELECTRICAL CITY GUIDE TELLS WHERE YOU'RE AT.

By D. Wyman.

A novel device, the Electric Directory, has been installed by several prominent New York City Hotels and will soon be seen all over the United States.

The apparatus serves the dual purpose of an accurate street guide and attractive sign board. It is of pleasing appearance, about sixteen square feet in size and has an all-glass and mirror front. In its center is a large map of New York City with a number of interchangeable advertising spaces arranged alongside of it. Below the map are two boards, each mounted with thirty numbered push buttons. In a pocket between the push button boards is an Index Book, wherein every point shown on the map is alphabetically listed, with a number placed opposite each of them. All a person has to do to operate the guide is to press the button bearing the number of the place sought, railroad station, part of street.

HOW TELEPHONE AIDS STAGE LIGHTING DESIGN.

The great motion pictures of the day are practically all directed by means of the telephone, but the telephone is used not only for directing motion picture scenes, but also as a modern aid in securing desired lighting effects in connection with the staging of scenes in a theater catering to legitimate drama.

An expert in lighting effects equips with an operator's set occupies a seat in the audience and transmits instructions to the stage electrician, who equips with an operator's set, who is stationed at the electric light switchboard, which is located on one side of the stage. By using the telephone, the most elaborate arrangements can be obtained and proper adjustments made at the instant under current direction with- out the noise of bells, buzzers or other signals, as the telephone line is in constant use throughout the performance.

The stage electrician is so located that it is impossible for him to see the lighting effect as it is seen by the audience. The telephone has again solved a problem and has accomplished the desired results with success.—T. R.

THE ELECTRICAL EXPERIMENTER

August, 1917

AT LAST A VERTICAL COMPASS.

Navigators on the Sea or in the Air can now ascertain their direction from a compass whose dial is vertical. This is especially convenient because it makes possible the reading of a compass set on a level with the eyes and does away with the necessity of bending forward and over the compass. At the same time the vertical compass on aeroplanes can be mounted a greater distance from the disturbing elements, such as control cables, etc.

This new compass was invented by Capt. F. O. Creagh-Osborne, Superintendent of Compasses for the British Admiralty. It is now manufactured for the United States Air Service by Elmer A. Sperry, member of the Naval Consulting Board, and inventor of the gyro-compass now used in American and other first-class navies throughout the world.

This new instrument is a magnetic compass, having the card mounted in a liquid in order to minimize oscillation and to help support it. The compass card really is a narrow strip of metal mounted on the float. The points of the compass are indicated on the card with a radius compound so they will be visible at night. The bowl of the compass is like a metal sphere having a circular window on its surface. This bowl is mounted so that the vibrations are not transmitted by the frame to the card. Gimbal rings are entirely dispensed with and, at the same time, a generous heeling angle is obtained. Neither rely on the need for a gimbal is necessary, the compass being read directly. Compensating magnets are provided in the small container attached separately to the frame.

ELECTRIC AUTOS IN MADRID.

It is considered probable that there will shortly be a good opportunity for pushing the sale of electric vehicles in Madrid, as the cobble pavements of the city must be replaced by asphalt or other similar surface within two years. The ordinary animal-drawn carts and heavily-laden are injurious to asphalt pavements, and it should not be difficult to get a footing for the smooth-running and reliable electrically-propelled vehicle.
UNIQUE PORTABLE ELECTRIC PLANT.

The accompanying photograph shows a portable electric generating outfit which has been manufactured especially for the use of the American Telephone and Tele-

graph Company, in building the Jacksonville-Key West toll line along the concrete causeways of the Florida East Coast Rail-

way. The set consists of a 1½ h.p. gasoline engine, belted to a 120 volt 30 amperre generator. The wiring on the power board admits of attaching three leads which are used for the electric drills and electric hammers, one of the latter being shown in the position in which it will be used. The weight of the entire outfit is not great, four men being able to handle it easily.

-Photo courtesy Western Electric Co.

MAGNET RESET FOR MAXIMUM AND MINIMUM REGISTERING THERMOMETER.

The thermometer shown in the illustration below is set by drawing the bottom of the index in each side of the tube down to the mercury column, with the magnet.

The temperature fluctuates the mercury will rise in one side or the other, leaving the index in either case to show when the needle has reached the highest degree of heat or cold since the ther-

ometer was last set.

WIRELESS FOR TRANSMISSION LINE SERVICE.

A new and important use has been developed for wireless telegraphy in connection with long-distance transmission lines of elec-

tric light and power com-

panies. For communication between stations over large systems of this character, a private telephone service usually is installed along the route, with

lines strung on the transmission poles or towers, making them liable to all the troubles to which the power lines are subject.

The wireless has now stepped in to eliminate the many inconveniences and interruptions of communication over metallic circuits with absolute and reliable service under all conditions of operation. The radio installation seems destined to be placed to this new use with increasing range of accomplishments and unquestioned possibilities, both in service and maintenance features, becoming a highly essential factor for extensive power transmission along where continuous and positive service is always necessary.

As a result of many practical experiments, the Southern Sierras Power Company of California is rapidly adopting wire-

less telegraphy transmission and reception between its important power plants and substations, readily appreciat-

ing the value and dependability of radio-communication at all times. The company's system extends from Bishop, Cal., to the Imperial Valley district, a distance of about 500 miles, consisting for the most part of a double three-phase high-voltage circuit on steel towers. The stations in the Bishop Creek section, on the north are situated on a rugged and moun-
tainous country, a territory which is fre-

quented by sudden and exceptionally severe storms and floods and extremely weather condi-

tions.

Radio transmitting and receiving sets have been installed to provide communication over this district as well as at other important projects on the main transmission system leading into San Bernardino. Plans are being perfected to provide all other primary stations with wireless equipment, effecting a complete chain for radio-com-

munication throughout the company's territory. In this, the equipment installed at the different stations will be arranged for a par-

ticular type of service, in some instances allowing for a communicating radius of 500 miles or more, and in others for connection with the next station along the route only; dependent upon the character and province of the station. The service, when entirely installed and perfected, will be used both for regular and emergency purposes.

It is interesting to note that the station operators have welcomed this change from the telephone and telegraph to wireless; and, adept in the use of the key thru the private telegraph system which the company has employed superimposed upon the telephone lines of the system, the new installation has not brought any particular departure in the general workings of the station organiza-

tions. Moreover, the company has been active in advancing the knowledge of its operators in wireless and the wireless code, furnishing equipment, data and instructions to make them fully proficient in this new phase of science.

R. K. W. ALLISON.

Even the Chinaman has found electricity a cheap and obedient servant. Thousands of electric iron and cooking utensils are used in China.

ICE CREAM BY ELECTRICITY.

Did you ever grind an ice-cream freezer on a sultry July day, and—eventually lose about 4 pounds avoiduicos, along with your appetite for the great American delicacy. That's the usual case—but our friend, the electrical engineer, has perfected an electric motor drive for turning the ice-cream freezer which is warranted not to develop a "glass" arm when the cream is about half frozen. The cost of one hour's operation for this welcome servant is only a fraction of a cent for the family size out-

fit, and the initial cost is soon paid. It is furnished in both large and small sizes.

COLLECTING TELEPHONE TOLLS BY MACHINE.

A device used as an accessory to telephone systems and which, it is claimed, simplifies the collection of telephone tolls among tenants in apartment houses, hotels or other buildings has been developed by a New York concern. The device may be placed on the switchboard ledge and con-

nected with a coin collector in every apartment. The machine enables the operator to determine whether a coin is deposited in any particular machine. Such notification will correspond with the different denominations of the coins used. The operator can also cause any number of de-

posited coins to be delivered to a customer either for the purpose of making change or for returning the equivalent of any de-

posited coin or coins. If a tenant does not have the necessary money with which to pay for a call, the operator can cause a check or checks to be issued to the tenant,
Unique Electrical Apparatus Reads the Mind

The accompanying illustrations show two extremely interesting electrical apparatus of French design, and which are of particular moment at this time, when we hear words and sentences flashed before the eyes of the person undergoing the test and also by making a series of careful observations of the various positions required for the person to more or less accurately memorize them, an accurate criterion of the subject under test is obtainable.

The illustration shows the constructional details of a unique portable pyrometer recently brought out. This device is about the size of a large tubular flashlight, being but 8½ inches long. It can be easily carried in the pocket, is staunchly accurate and not apt to get out of adjustment.

As will be observed the case contains at the lower end a flash-light battery that supplies current to the small incandescent lamp. Above the lamp is placed an opaque diagram in which is mounted a diffusing screen. The lamp is mounted on the outside of the instrument it is possible to cause a tinted film to pass before the diffusing screen. The film is tinted in the varying shades of color assumed by a heated body. The different shades are carefully calibrated with relation to the corresponding temperatures.

At the left is seen the conical eye-piece through which the operator views the hot body under examination. A small mirror is arranged to cover the eye-piece and the field of vision as shown. This mirror reflects the light that passes thru the tinted film from the lamp.

A NEW PORTABLE PYROMETER.

By Thomas W. Benson.

Possibly the first form of portable pyrometer or means for measuring radiant heat was the human eye. And stranger still to relate is the fact that some of the Old-timers can heat-treat steel more accurately by eye than some of the younger experts who use the various forms of pyrometers.

This is not difficult to understand when it is considered that pyrometers using a fast thermometer do not measure the temperature of the piece under treatment but merely the temperature of the furnace itself. That a difference exists in the temperature of the two requires no proof.

The portable form of pyrometer shown in the illustration measures directly the temperature of the body itself by measuring the brilliancy or amount of light given off. This method takes advantage of the fact that the temperature of steel varies directly as its luminosity after it begins to glow.

In use the rolls are turned until both halves of the field correspond exactly in shade, then by referring to the dial it is possible to determine accurately the temperature. It is possible to build the device in practically any range, but the more common ranges are 1000–1800 degrees Fahrenheit and 1800–2300 degrees Fahrenheit.

NEW YORK HERALD WIRELESS STATION AGAIN IN COMMISSION.

The wireless station of the New York Herald was formally returned to commission February twenty-eighth in its new quarters atop the United States harge office in New York. Mr. John Bottom, vice-president, secretary and treasurer of the Marconi Wireless Telegraph Company of America, New York, was present to assist in the opening ceremonies. This station was placed under censorship last October.
"YOU've been wantin' proof. There it is!" With a gasp of astonishment the group about the big stove in Preston's store craned, mouths and eyes wide, staring in wonder at the object old Tom Waldon had dropped from the stove beneath his big sheepskin coat.

Cylindrical in shape, it was made of heavy steel, measuring about two feet in length by four inches in diameter, and painted a bright red—save at one end where the figure "0" was stenciled in black.

"What does that prove?" Dick Preston demanded, from his perch on a cracker barrel.

"Prove?" Waldon repeated, glaring up at the boy who questioned him. "Just what I've been tellin' you—that he's a "spy" and he'll blow us all up if we don't stop him! Why, me and my boss wouldn't have been blown to pieces this mornin' if it hadn't been wet from layin' in the snow so long!"

"What is it?" Pete Bailey asked in an awed whisper.

"A bomb!" With a clatter of upsetting chairs the terror-stricken group fled precipitously to the opposite end of the store.

"Don't get scared!" Dick laughing, slipping down from his barrel and taking the tube from the old man. "Look!"

With a twist of the threaded cap he removed one end of the tube and poured out in his free hand a dirty brown wet powder. "It's gunpowder!" Waldon exulted.

"Powder, nothin'; it's sand and ashes and dirt!" Dick scoffed.

"Watch it!"

He jerked open the door of the glowing stove and threw in a generous handful of the material. On the red-hot coals it lay in an inert mass, while one by one the group tiptoed cautiously back to see and regain courage.

"Course it won't burn when it's wet," old Tom defended. "That's why it wouldn't go off this mornin'. It was layin' right in the middle o' the road at the end o' my lane and my hoss almost steped on it. So I gets out and picks it up after I'd seed it was wet."

"Suppose it was gunpowder. What does that prove anyhow?" Dick demanded, resuming his seat on the cracker barrel.

"He put it there!" the old man declared. "Did you see him?"

"Them boxes and crates and barrels and things he had me haul up, was mighty heavy," Tom Sullivan affirmed.

"Yes, and what's that thing he's been carryin' around that pretends to be a surveyin' instrument?" Pete Bailey demanded.

"All that don't prove a thing!" Dick retorted angrily. "Just because he can't choose to tell you what he's here for, and everything about his business, you think he's a spy. Why don't you be reasonable? "I am reason-able," old Tom grinned maliciously. "I hain't takin' no chances. I sent down to Squire Jefferson's this mornin' for a search warrant and when it gets here, I as constable, will go to that cabin and see just what he's doing there and find out if he can't give some reason for actin' the way he does!"

"That's the stuff. Good for you, Tom!" a half dozen endorsed.

"Yes sir. I think it was time we was a doin' somethin' besides sittin' around here talkin' and wonderin' and lettin' him have a chance to blow us into next week!" the old man continued importantly, opening his coat so that the nickel-plated star showed plainly. "This here bomb," and he tapt the tube in his lap. "sort o' set me to thinkin' and I'm goin' up the first thin' in the mornin' if that search warrant comes up on the mail this afternoon."

"You're doin' just right, Tom!" Pete Bailey declared. "I was just wonderin' if you was goin' to let him run loose around here, while you're constable."

"You bet I won't!" that official boomed.

But Dick Preston did not endorse old Tom Waldon's new decision. For a moment he sat on his cracker barrel, staring in surprise at the old constable and the group about the stove which was so loud in its support of his new plan of dealing with the mysterious and undesirable stranger.
And then without a word he slithered to the floor and past out into the house which adjoined the store and mounted the stairs to the room which he occupied under the cabinet.

A worried frown puckered his brow as he seated himself at a table covered with a blue and white checked tablecloth and started the great telegraph instrument, and his frown deepened as he adjusted the detector and inductances.

"Suspicious old fool!" he growled as he slipped in the head receivers. "I hope we can beat him!"

"H D, H D, H D, D P," the white spark in the spark gap on the clean-cut Continental as he tapped the key.

Again the call repeated before he threw over the aerial switch.

Then, "K on all H D," sounded the clear reply in his receivers.

"News to report. Coming up, the spark snarled."

"O K!" the reply buzzed.

Slipping receivers from his head Dick drew on mackinaw, mittens and cap, as he went to the door! and Dick put on his overalls, and then he turned to the back porch to adjust a capable looking pair of snowshoes.

Then off up the slope which rose abruptly to the rear of the building he swung, following a course eastward to where Pine Mountain reared its low broad bulk against the blue of the sky. Dick could see the window hole and the bits ofanking leaving behind the hamlet sprawled in the valley on the broad flat just below the narrow gorge where Pine River rushed swiftly between steep high banks. But not once did he turn to look back at the clusters of houses or to glance up at the dazzling glory of the late afternoon sun on the clean crisp white top of the steep snow which covered the whole country.

With the worried frown deepening between his brows the startled receiver in the hand, he took the last rise and came out on a broad flat summit, where, in the midst of a large clearing, stood a cabin.

It was different from the usual mountain cabin in that it was long, narrow and low and windowed at but one end. Otherwise, excepting the presence of the twelvetone wireless antenna rose in a long slant to a tree at the edge of the clearing, it was quite the usual rough log structure.

Dick set the radio at the door, and stepping inside without knocking, he found himself in a small room, evidently partitioned off from the main apartment.

Snow, burlap, a table spread with a litter of papers, and the other usual furnishings made it seem like the ordinary cabin room. The arrangement was much the same as at the bell station.

"Are there currentss about a magnet?" by F. E. Mace.

"The Franklin Electric Club, as founded by Rowland E. Thimann, and his message to the "Electrical" and "Radio-Bug" of To-day.

"Unusual Entertainments Stunts with High Pressure!" With several startling photos of actual stunts.

Announcement of Prize Winners in the "What to do with your radio set during the war" contest.

Besides these leading articles the September number will fairly bristle with dozens of live, up-to-the-minute electrical, scientific and radio articles of interest to all of our readers.

"What's the matter now?"

"Number '0' fell in front of his house last night. He's all worked up about it and now he's come in a spout. The search warrant will be here tomorrow morning if the mail's on time; then he'll ransack the whole place. If he only kept his fool notions out of his head and tried to 'bustin' around into other people's business!'"

Dick kicked savagely at a block of cordwood beside his chair.

"Of course I don't want to stir up any trouble," Hardy began thoughtfully. "You know I could resist search by him."

"But he's the only bug he worked up to believing the same as he does," Dick put in despairingly.

"Yes, that's true." Hardy replied. "But to come back to something more important, how did the tests come out?"

"I have the locations here," Dick replied, drawing a notebook from his pocket. "Number '0' fell in front of his place, and the others...

For a half hour the two bent over a detailed map of the valley while they compared figures and locations.

"That's fine! The biggest variation is about four feet and that's corrected by the adjustments I've been making to-day," Hardy breathed in satisfaction, as he adjusted his receiver. "And I think we can run a test with a real charge instead of those dummies we can be prepared to announce results.

"I know a good target for it," Dick volunteered. "It's a big pile of drift and rubbish down by the bend just below town. It doesn't belong to anyone. See — and he pointed out the spot on the map.

"Good! Just the thing!" Captain Hardy endorsed. "What do you say we try it this evening? If your friend the eminent detective is to come up here to-morrow with his search party, we can tell him everything, if the test is successful, and it suits me," Dick agreed.

"Very well," Hardy replied. "We'll set the time for nine o'clock then. Get your lunch made and coming and we'll see how this tryout works.

"All right, sir. I'll be ready," Dick replied. "And I hope that warrant doesn't get here before time," he added as he smiled at his anxious friend.

"Don't you worry about that," Hardy advised.

"Yes, but it makes me sick," Dick protested. "When a man's trying to do what you are and then for him to plot against you and it makes me sick.

"Oh, never mind," Hardy laughed. "Just you go to bed to-night and get plenty of sleep. Mountain have to run another test if this one doesn't work and I'll have to have you fresh and ready, because you're responsible for half the success of this thing."

"I couldn't have done it without your interest and the other ways you've helped. So just go along and forget that old spy-chaser."

Dick could not shake off the thought of what the old man might do to wreck Captain Hardy's plans. All the way down the long white-covered slope he wondered and pondered, as he tried to push the thought out of the complication into which his friend was drifting with the local officials. "Has the mail come in yet?" he asked his father as he tramped into the kitchen and found the family at supper.

"No," Joe Preston replied. "The trail's getting cold. That wind's melting the snow fast. Didn't you notice it?"

Then Dick remembered. While he had been in the big cabin on the top of Pine Mountain the wind had shifted to the south and with it had come balmy warm air which had rapidly softened the hard-crusted snow. It was just like the spell all. There's too much ice and snow on," Joe Preston remarked.

But Dick rejoiced secretly. It might so improve the trails as to make it impossible for old Tom's search warrant to arrive in time from the Squire down the river.

"Has the mail come in yet?" he asked his father that evening the warm south wind blew and the snow melted. It was dripping from the eaves in pattering cascades when he went out and examined the post box about thirty, after preparing his lessons for the 'morrow.

But he forgot it and even old Tom as he adjusted his wireless instruments carefully and cleaned all the contacts and tightened connections.

Then at a quarter before nine his call came on the line: "O K, H D, D P." He responded and the reply came back.

"Tell thru!"

Throwing over the aerial switch he set to work methodically. For the next fifteen minutes he sent anything and everything, stopping at intervals of several seconds to make small changes in his transmitting wave length adjustment.

Then just as the hands of the watch were about to strike him, pointed to nine, he heard faintly the muffled boom of an explosion from down the river, and with a quick shift off his receivers and crawled into bed.

Day had scarcely broken the next morning when he was awakened by an unusual sound. Sitting upright in bed he listened for several moments before he recognized what it was.

(Continued on page 279)
Dionic Water Tester Operates by Electricity

WHAT is known as a dionic water tester has been recently perfected and appears to be an extremely practical apparatus for testing water, or any dilute solution. So simple and so direct is its operation that any unskilled person can make accurate tests, and even detect and measure traces of impurity so small as entirely to escape chemical analysis.

The detection and estimation of impurities dissolved in water and the measurement of the strength of weak solutions have hitherto been carried out by chemical tests of more or less complexity. The dionic water tester involves the substitution of an extremely simple electrical measurement.

When the nature of any substance in solution is known, the conductivity of the solution is a measure of its amount; and the dionic tester is therefore able, by a simple measurement of conductivity, to determine to a high degree of accuracy the strength of the solution under test. The weaker the solution, the more sensitive becomes the method, so that the instrument is peculiarly well adapted for detecting the contamination of water. Not only is it possible by the use of the dionic instrument to measure amounts of salt in solution too small to be detected by chemical means, but it performs in a few seconds, and in the hands of totally unskilled persons, work which a skilled man would take some time to carry out by chemical methods.

It does not, of course, discriminate between one kind of substance and another, analysis alone can do that. But in most instances in which water testing is carried out for engineering and kindred purposes, the substance present in the water is well known. Such tests are not made for purposes of analysis, but to find out how much of a known substance is present in the water; and in all these cases the dionic meter gives the required answer with a rapidity and simplicity unapproached by any chemical test.

The complete apparatus is shown here, where G is a glass tube to contain the water under test, and A and B are the electrodes for passing the electric current thru the water. The electrodes are connected by wires to a direct-reading conductivity meter M, and a continuous-current hard-driven dynamo E.

The thermometer T measures the temperature of the water under test, and is capable of being lowered or raised in the reciprocal of specific resistance, and the most convenient unit for the purpose of water-testing is the reciprocal of one megohm. No one has given a name to the reciprocal and its tributaries, from which the natives wash it and obtain an ore that is 50 per cent pure platinum and 50 per cent iridium, palladium, and ruthenium.

Diagram of Dionic Water Tester Showing Tube-Provided with Automatic Compensation for Temperature, High Tension Hand Dynamo and Conductivity Meter.
“Perpetual Motion”

When your Editor was at the tender (7) age of eleven—yes, tough old birds like us were tender once—a strange as it may seem—he had, just like the rest of us, rather strange ideas about electricity and mechanics. Perpetual motion had a great and attractive fascination and appealed "most pow'fully" to his imagination. Yes, you said it—imagination is his middle name—altho, bless his dear ignorance, in those innocent days he was as yet not aware of the great axiom, to wit; "If you wish to lift yourself by your own bootstraps, do it in an elevator!"

Just like all budding electrical bugs, his first revolutionary invention consisted of the time-honored perpetual motion where you take a motor and a dynamo both of the same size, mind you, and connect them together by a belt. Then you connect the binding posts of the motor to those of the dynamo, and let 'er go! Of course you must give the belt a push, in order to start the rinktum going, that much is clear. In that case you generate a little current in the dynamo which feeds the motor. The latter in turn runs the dynamo by means of the belt. In a few seconds the system will run so fast that the dynamo—bless its soul—will have a generous amount of juice left over, which latter will feed all your various contraptions in your shop. Of course once started the system will run forever. Sounds fine.

Well, anyway, your Editor was one of those sick kids who did not believe in theory alone. Not him. He meant to try it out. He had a nice enough motor, but no dynamo. True, the patient old motor had been taken apart so often, and its field and armature had been rewound so frequently that it looked decidedly disreputable—let it ran, yes, one Lechache'!

Speak of a finely balanced armature! Well, after committing almost every imaginable crime on the bill of fare, with the possible exception of murder, enough cash was scraped together to send for that dynamo. In the catalog it said that it gave 4 volts and 4 amperes at 3,000 R.P.M. "Takes remarkably little power—can be driven nicely from a sewing machine, in order to charge storage cells, etc., etc."

Well, in those days, mail order firms were not so careful about their statements as they are today. At any rate your young hopeful for the benefit of all bugs in the Universe concerned, wishes to make public the fact that charging storage batteries with a dynamo from a sewing machine cannot be termed a howling success. He tried it. Oh yes, frequently. Once for almost ten minutes at a time. For the first 19 seconds the dynamo ran at the prescribed 3,000 R.P.M. It ran remarkably easy too. At the end of the first minute its speed had dropped to about 1100 R.P.M. At the end of the 10 minutes its speed had gone to minus 10 R.P.M. From this you will infer correctly that the storage battery now ran the dynamo as a motor, and the latter ran the sewing machine flywheel and the treadmill! This was decidedly unpleasant. So he went at it again, first taking off coat and collar. This time he lasted eight minutes. But the storage battery got some juice in its car-cass anyway, that afternoon. We should guess approximately 2½ watts net. And next day, too, your Editor-to-be had such sore legs that he could not possibly walk. But it works. The catalog was right!

But we are running ahead of the story. At any rate, the dynamo soon arrived. It was a great day. Birds sang in the trees, and the squirrels jumped hush, hush, From the tree into the bush.

From this you have correctly deduced that it was a spring day. Ah, noble spring, . . . and if we had been a trifle older we might have completed the "pome" with:

Maiden aunts grow sentimental While the landlord claims the rent!

Luckily, however, we did not know oldish maids and their sentimental scantlings, nor were we as yet much troubled with ghoulish landlords.

At least we were not while we stood in a perfect trance before that dynamo, freshly unpacked, standing there in its virgin beauty of brightly red lacquered field castings, dazzling green magnet wire covering graceful limbs, and bright nicked binding posts, the whole mounted on a heavy oak base. While we stood there gazing with love and admiration in our eyes, like a mother gazes at her first born babe, a delicious shiver ran up and down our back when we thought of the sumptuous monument that would garnish the public square which a thankful world had erected in our honor, after our death! The inscription was to read: "To the inventor of the first Perpetuum mobile."

To make an unpleasant tale abbreviated, let us disclose the fact, that little time was lost in trying out the great invention. Everything was connected carefully, the belt was tightened correctly, and the bases of both motor and dynamo screwed down tight. The supreme moment had arrived.

We connected the wire to the last binding post and gave the belt a push—nothing happened. We gave it a harder push—an ominous quietude. What could be wrong? Ah, of course, oil! Mother's can of sewing machine oil was promptly secured and soon the dynamo and motor were down-spring.

(Continued on page 280)

Among the hundreds of new devices and appliances publish monthly in The Electrical Experimenter, there are several, as a rule, which interest you. Full information on these subjects, as well as the name of the manufacturer, will be gladly furnished to you, free of charge, by addressing our Technical Information Bureau.
Experimental Physics

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

Lesson 6—Newton's Laws.

The branch of Physics known as Mechanics, of which Statics and Dynamics are subdivisions, is considered by scientists to be the foundation for all Physical Science if not of Science as a whole. Mach, in his "Science of Mechanics," says that since the time of Newton no essentially new principle has been stated but that all that has been accomplished has been a deductive formal development of Mechanics on the basis of Newton's Laws. The man who established this basis two centuries ago was a truly great man if during all these years of excellent scientific research and discovery, no essentially new principle has been stated.

Sir Isaac Newton was born in 1642, which was the year in which the great Galileo died. While a boy, Newton spent a great deal of his time in constructing many mechanical toys. He didn't like school, and since he stood at the bottom of his class in scholarship, his teachers didn't like him. His thoughts instead of being on his schoolwork, were usually on other worlds than ours. Not being very healthy and being considered a dunce, he was bullied by the other boys. He stood for this as long as he could, and suddenly one day he "got mad and beat up the bully," who was first in athletics and scholarship. In his anger he developed great strength, and he himself was more surprised than anyone else to see the licking he gave the bully. That night he decided that if he could beat up the strongest boy in the class he could also study and beat him intellectually. Henceforth Newton stood at the head of his class and was never bullied again. Therefore, my friends, if you find that you are at the bottom of the class or not up at the very top, beat up the strongest bully of the class and then study hard and get first place, and perhaps you will be second Newtons. When an undergraduate at Trinity College he studied the works of Galileo, Huygens and Kepler, became interested in mathematics and physics, and paved the way to his great future contributions to those sciences. At his death in 1727, he left those sciences established on a firm foundation. He was a great scholar, not only in his field, but also in the Classics and hence we are not surprised to find his great work the immortal "Principia" written entirely in the Latin language.

Among his many contributions, and first in importance, was his formulation of what are known as Newton's Three Laws of Motion. He stated them as follows:

LAW I. Every body perseveres in its state of rest or of uniform motion in a straight line, unless it is compelled to change that state by impress forces.

LAW II. Change of motion (i.e., momentum) is proportional to the impressing force impressed and takes place in the direction of the straight line in which such force is impressed.

LAW III. Reaction is equal and opposite to action; that is to say, the actions of two bodies upon each other are always equal and directly opposite.

Among Newton's definitions, these two are of special importance in connection with his laws of motion:

DEFINITION II. Quantity of motion is the measure of it by the velocity and quantity of matter conjointly.

DEFINITION III. The resident force (i.e., the inertia) of matter is a power of resisting, by which every body, so far as in it lies, perseveres in its state of rest or of uniform motion in a straight line.

These laws are to be regarded as axioms incapable of rigorous experimental proof. The most powerful argument for their validity rests on the fact that their application to the solution of problems in Physics and Astronomy leads to results that always agree with those of observation. For example, the time for a pendulum is calculated by assuming the truth of these laws and the remarkable agreement between the calculated time and the subsequent observed time confirms the laws.

EXPERIMENT 31—Take a ride in the subway. You will notice that the company very generously furnishes straps to hang on. Newton's Laws are responsible for making the company adorn its trains with straps. (If you live outside the city and have not had the opportunity of riding on the straphanger's route, you may take the first train for the city and enjoy this "pastime").

By Means of Thumb-Tacks, a Baseball is Suspended as Shown. Pulling Suddenly on Thread at "A", it Breaks Between "A" and Pin "B". Pulling Slowly the Thread Parts Between "C" and "D".

Bodies in the moving train tend to move toward the rear of the train when the train starts, and toward the front of the train when the train slows down, to illustrate Newton's first law, that a body in motion tends to keep in motion and that a body at rest tends to stay at rest. (This experiment is apt to prove unsuccessful if tried during the rush hour, when we are packed so tight that we cannot move.) If the train should turn a curve while in rapid motion we are thrown into the lap of a pretty young girl or (if we are sitting) sad young girl falls into our lap and we are duly thankful for Newton's first law in either case.

EXPERIMENT 32—If father should be after you for having gone to the ball game instead of to school (be having seen you by going to the game instead of to work), run into the dining room and grasp the rug firmly in both hands. As he enters the threshold, pull the rug and he will sit down on the floor in great haste, thus giving you ample time to escape. This is a case of the First Law—Pa's body tended to stay at rest while you pulled his feet from under him.

EXPERIMENT 33—Another interesting phase of this experiment which you can try on a good friend (preferably one who can't lick you), is as follows: Ask your friend to place his right foot behind and to the left of his left foot. Then let him place a long pole or broomstick on his right toe, holding the pole loosely in his left hand. Count three slowly and have him kick out rapidly at the word three to see how far he can send (Continued on page 281)

Illustrating "Action" and "Reaction." With Board "A" Removed the Fan Propels the Wagon; With "A" in Place the Wagon Stands Still.
Mr. Amateur, This Means You.

BY THE EDITORS

There are still a few amateurs scattered over the country who fail to comprehend that this nation is now engaged in the most stupendous war the world has ever known.

Being at war is a mighty serious business and it is not good patriotism for a few thousand disgruntled amateurs to pass judgment upon our government. Whether we think that the Navy Department acted wisely or not in depriving us of our stations, is of small concern to the nation at large. At any rate, the facts are that we can't use our outfits the same as before, and being placed in this position, we must try and make the best of it, as good and law-abiding Americans should do.

On the other hand, we should show a little more spunk than we have shown during the past three months. It is decidedly un-American to "chuck up" our hands and say: "Oh, well, what's the use. Wireless is as dead as the Dodo. Forget it!"

And this is just what a few chicken-hearted Amateurs have been doing. Luckily our reports show that their numbers are far from large. Things are beginning to shape themselves nicely. The situation is becoming rapidly better; there is a light gray mist where last month there was nothing but inky darkness. The Navy begins to see that the curbing of Amateur Wireless has proved a boomerang. Operators are becoming scarcer than hen's teeth, and we need countless thousands of good operators.

How to get them? In Philadelphia the Navy Department a few weeks ago took over a private wireless school in order to speed things up. As we go to press a government official calls on us asking for a list of all New York and vicinity Radio Clubs.

In order to get in touch with them and keep their interest in wireless alive, Reason: The government needs lots of operators. It will get most of them from the amateur ranks. Yes, perhaps you don't believe it, but the Government is with us now, not against us.

We think we will have some good news for you next month. Don't think that we are asleep, and if some of you have given up the ship, the Editors have NOT. So watch! The telegram and the letter reproduced here with speak volumes to any amateur who wants to see the light. Amateurs! GOOD AMA TEURS, not Ham's, are wanted more than ever. It's up to you if you prefer the trench to the dible in your receiving apparatus. This is your opportunity to get out of your shell, if efficiency or no care for your apparatus is the law, and also it keeps you in trim.

Next month we will have a lot of new stunts. "What to do with your Radio Outfit." Several thousand suggestions—some good ones—have already been received.

In the meanwhile, "don't give up the ship." As "Fips," our dear office boy, was wont to say: "It's an ill wind that has no silver lining!"

ALL RADIO AMATEURS, ATTENTION!

The Navy Department has been delegated by our President to close all amateur or experimental radio stations, in no case permission to transmit or receiving, license Mylar and therefore we shall all have to abide by this decree, whether we like it or not.

Therefore, "THE ELECTRICAL EXPERIMENTER" will endeavor to feature the Electrical Laboratories in preference to any radio stations in the awarding of the monthly prize of $3.00 in this department. Now is the time to get busy and freshen up your electrical apparatus, and incidentally improve your understanding of electrical matters, which perhaps you have unwittingly slighted to a large degree in your pursuit of radio telegraphy. Let her go, boys!
THE Signal Corps forms one of the most important divisions of any army in the world. The Signal Corps have had the good fortune to enlist in their ranks some of the best telephone, telegraph and radio engineers in the country. The extensive and ever progressive Bell Telephone System has, among numerous other worthy accomplishments, developed a particularly efficient engineering staff, comprising thousands of men, practically all college-trained and men who have proven ability in these now supremely important branches of applied electricity. This widespread organization has had not only the problem of furnishing trained officers and men to the Signal Reserve Corps, but also to face the gigantic task of maintaining its nation-wide lines of communication which it had built up.

The presidents of the various Bell Companies throughout the United States at a conference held in New York in November, 1916, approved a plan which had previously received the approval of the directors of the American Telephone and Telegraph Company, to encourage the formation from the army of the U. S. Signal Reserve Corps. The plan had and an average of about one hundred non-commissioned officers and men, with one major and an extra lieutenant (his adjutant) for each two companies, a total of about one hundred officers and 2,500 non-commissioned officers and men.

The New York Telephone Company was to provide five of these companies. A total of 2,571 volunteers. Two companies have been formed from the Manhattan-Bronx and Westchester Divisions, one from the Long Island Division, one from the New Jersey Division, and one from the Albany-Syracuse-Buffalo districts.

In addition a number of the engineers of the Western Electric Company have been commissioned in the Signal Officers Reserve to do special development and research work in connection with airplane and radio systems of communication. Maj. F. B. Jewett is the ranking officer in charge of this work and will be stationed in New York. Maj. N. H. Slaughter is in direct charge of the radio development work in Washington, where he will have a separate organization reporting to Bell, which is now engaged in organizing.

As war with Germany had not been declared when the plan was put into effect, provision was made for employees who joined the Signal Reserve Corps during times of peace, as well as in times of actual or threatened hostilities. The following regulation is in force since the country is now at war:

Leaves of absence will be granted to such employees when ordered to duty by the President of the United States in time of actual or threatened hostilities. Such leaves of absence will be subject to the following conditions:

(a) The leave will cover the period of the employee's necessary absence on such duty during the remainder of the term of the commission or enlistment, under which he is serving at the time he is ordered to duty, and during the term thereof in time of war.

(b) The employee will be allowed full pay, at the normal rate in effect when he is ordered to duty, during the period of the leave of absence; but not exceeding twelve months, he will be allowed full pay at such normal rate less the amount which he is entitled to receive from the Government. If the necessary absence on duty continues beyond such twelve months, further consideration will be given to the matter of payment.

(c) The employee will retain his eligibility to benefits under the Plan for Employees' Pensions, Disability Benefits and Death Benefits during the period of leave of absence, and such period of absence will not be deducted in computing his term of employment for purposes of said Plan.

(d) Upon return from such duty (after honorable discharge if the employee has left the United States military service), the employee will be given such employment as the needs of the service permit and as he is able and fitted to perform.

These officers and men of the Bell System, trained and experienced in "the art of construction and maintenance of wire and telegraph lines," have been accepted and commissioned by the Government, and are being instructed in military duties.
MEXICO CITY RADIO MAY REACH GERMANY.

The accompanying photograph shows the new wireless station erected close to thh stadium in Mexico somewhere near Salina Castle of Chapultepec in the City of Mex-Cruz, as well as the one installed between the latter having been transferred from the interned Ham-burg-American steamship Antonia at Tampaico.

It is known that Mexico City has been holding wireless communication with San Salvador and also with Colombia, and it is also known that the German Minister in Havana has received mysterious wireless messages having to do with Mexican affairs.

MOST ANYTHING SERVES EXPERT FOR A WIRELESS.

The police at the Second Precinct station in Cleveland, O., recently received an impromptu lesson in wireless that curled their hair and left them wondering.

A. D. Silva, equipment expert, was taken to task because police thought he had not dismantled his wireless plant in compliance with the President's order.

"But I took down my aerial," protested Mr. Silva.

"Don't do—you must take your instruments off the table—put them out of commission," explained the police.

"But I can sit right here in this room, and with materials you see on this desk I can make an outfit with which I can receive from a distance of 200 miles," said Mr. Silva.

Whereupon he took the sergeant's safety razor blades, a pencil, a telephone receiver, some wire and—(deleted by censor)—gave a demonstration that proved so interesting that it lasted for two hours.

"Or one could do the same with clock parts—if he knew how," said Mr. Silva.

KEEP UNIV. OF PENN. WIRELESS OPEN.

Permission has been granted the University of Pennsylvania by the Government to keep its wireless station open for the receiving of messages, but no messages will be sent. Eight members of the wireless class have agreed to watch the apparatus to prevent anyone with the station and to pick up any enemy messages that might be sent from hidden wireless plants nearby.

In the past two weeks thirty-two undergraduates have en-
rolled in the Signal Corps of the students' battalion and are receiving instruction in wireless work. Experienced drill sergeants are needed at once for the University bat-

Oscillatory Discharges.

Ten little coulombs looking jolly fine, One was discharged, and then there were nine.

Nine little coulombs made to oscillate, One jumped a spark gap, and then there were eight.

Eight little coulombs sent off to heaven, One became earthed, and then there were seven.

Seven little coulombs playing funny tricks, One strained the other, and then there were six.

Six little coulombs looking quite alive, One got damped, and then there were five.

Five little coulombs feeling somewhat sore, One got resisted, and then there were four.

Four little coulombs in a battery, Someone switched the current on, and then there were three.

Three little coulombs wondering what to do, One got polarized, then there were two.

Two little coulombs, after all this fun, One caught hysteresis, and then there was one.

One little coulomb, feeling rather glum, He was short-circuited, then there was none.—R. C. D., in Wireless World.

"How to use your radio instruments for short range communication without aerials (sending and receiving)" is the title of an article to appear in the September "E. E. Don't miss it, "Radiohogst!"

THIS RADIO MAST RESEMBLES EIFFEL TOWER ON WHEELS.

Hereewith is pictured one of the newest inventions for military purposes. It is a portable wireless telegraph outfit, mounted on top of a fast automobile. The transmitting and receiving apparatus is connected to a latticed steel aerial tower which looks like a miniature Eiffel tower and has a hinged top which may be raised and lowered as desired. The contrivance attracted much attention when it was recently driven about the streets of New York City.

It is possible to transmit and receive radio messages while the car is moving at any speed. It is intended to be fitted with machine guns and may serve as an elevation from which to signal by wig-wag flags or by heliograph.

August, 1917

THE ELECTRICAL EXPERIMENTER

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Photo from New York Herald.

One of the Gigantic Steel Radio Masts, Each 410 Feet High, in Mexico City. This Plant It Is Thought Can Easilly Communicate With Germany.

years, but it was practically useless, because, it was said, the towers for the aerials were not high enough. They were 85 meters high, or about 278 feet. Recently the towers have been made higher. They are now 125 meters high, or 410 feet, and one of these towers is shown in the accompanying photograph. The other tower is not in the picture, but the supporting stay wires leading to its top may be plainly seen to the right.

While this wireless station is owned and operated by the Mexican government, it is common talk in Mexico City that the recent additions and improvements have been made possible by German capital and that the station is of far greater value to the Germans than to the Mexican government. Mexico, it is indicated, has no mer-
chandising marine and practically no navy, so that the erection of an expensive wireless station at the capital would seem to be a useless and superfluous luxury.

A Mexican account says "that the wireless station installed at Chapultepec has been communicating directly with the North American city of Houston, in the State of Texas, and with some cities of South America, especially Panama. This fact signifies that our wireless service is improving daily and that its field of action is extended more and more."

The inspired "explanation" of why Mexico has suddenly added such a powerful station to its wireless service—to be prepared to report merchant ships after the war ends in Europe—has been received with some amusement by foreigners who read it in Mexico City in the government org-

cap. It was commented that the station might be of far greater value to German submarines in Gulf waters if possibly the Zimmermann note inviting Mexico to be come an ally of Germany should prove
The Amateur and Experimental Radio Research

By RAYMOND FRANCIS YATES

Part II—Suggestions for Research Work

WE may bring radio research work under two general captions. (1)—That involving the electrical and mechanical design of instruments without changing the theoretical principle. (2)—That involving the design of apparatus that operates on a new theoretical principle. During the past few years, many new instruments have been invented that would come under the first classification. We have seen scores of new detectors, tuning transformers, variable condensers—et cetera, that possess the same basic principle of operation but differ only in mechanical design. In many cases, the manufacturers permit novelty of design to interfere with the most efficient construction of the instrument, and this is indeed a mistake. There is much in the design of an instrument, but novelty plays the smallest part. Those experimenters who wish to invent new designs should first assure themselves that their new design will give greater satisfaction in either one of the following ways: i. e., efficiency, (first and foremost), economical construction without loss of efficiency, and convenient manipulation. The design of instruments forms a very lucrative field of research and experiment for the amateur and it is indeed encouraging to see that many amateurs in the United States have invented new instruments of merit and practicability.

An Experimental Poulsen Arc Will Prove Extremely Valuable for All Classes of Radio Measurements and Tests with Dummy Antennas. This Piece of Apparatus Should Be Found in Every Radio Experimenters Laboratory. It is Provided with Gas Jacket and Water Cooled Anode.

Eugene V. Turney of New York City offers a splendid example of the work experimenters, who possess a little originality, can do in the way of new designs. If an instrument can be built more cheaply, function more accurately, or made easier to manipulate, it can find a place of ready sale on the market and its inventor will be well paid for his effort, both in money and in distinction for advancing the art. The man who found that compressed air was preferable to glass as a di-electric in condensers, discovered a new principle of great importance, yet most any amateur could have made the same discovery.

We find very few new instruments on the market that operate on a new basic radio principle. There are many cases where an instrument can be designed so that it will accomplish a certain function by a different fundamental principle. The Audion is a good illustration. It is a substitute for an ordinary detector that not only operates on a new principle, but performs its part more efficiently. There are many instruments that would perform more efficiently on different principles. Thus, the quenched spark gap operates differently than the rotary and the variometer differently than the tuning transformer. In some cases, mechanical and electrical design are so closely related that we cannot alter one without considering the other.

Aside from the invention of new instruments and the discovery of new principles, the problem of hook-ups also forms an important field for wireless research workers. There is much in the method of connecting a wireless outfit and our present systems are as young and undeveloped as wireless itself, and it is only logical to conclude that as the art advances, so must the methods of connections and many important changes will take place. In many cases, patents may be procured on wireless hook-ups and if an experimenter really discovers a method of connection that increases efficiency, he may protect it and in all probability realize something from it.

Question—What Is There to Invent?

The room for improvement is so great and the multitude of suggestions so vast that it would indeed take a volume to cover them. In the following, we will outline a few of the more important and popular problems of the day.

At the present time the Audion detector is not being used by many amateurs because it is too expensive to operate, due to the cost of the flashlight batteries. Is it not possible to find a battery that will obviate the necessity of using a high potential battery? It indeed seems very reasonable that the basic construction of the Audion can be changed to accomplish this result. If this cannot be done, why not invent a "new" Audion that will possess this desirable feature? Another possibility of improvement in the "Audion" is in the fact that a glowing filament is not the only agency that will produce ionization in a vacuum. If some other agency could be utilized, "Audions" could be constructed that would last forever.

Another conspicuous problem of the day, and one that is preventing progress in radio-telephony, is the heavy-current transmitter. At first thought, this is a seemingly simple problem, but this is not so, as many great minds have worked on the problem and there is yet a great fortune in store for the inventor of a real practical arrangement.

The spark gap of today, whether rotary or quenched, is a very inefficient instrument and an extravagant user of energy. Will it ever become possible to make a circuit oscillate without a discharge in connection with a transformer? If such a discovery was made, the high-frequency alternator would probably never need to be perfected. While the high aerial today forms an indispensable part of a wireless equipment, without a doubt, it will be entirely obviated in the equipment of the future. At the present time experiments are being carried on with a "concentrated" aerial and it has been found to give remarkable results. The "concentrated" aerial is probably the fore-runner of the aerial of the future. It is only logical to conclude that the aerial of the future must be small, for at that time man will have perfected transmitting instruments to such a degree of efficiency, and brought receiving apparatus to such a point of sensitiveness, that the large and lofty aerial will no longer be necessary. The question today is, what type of concentrated aerial is the most efficient? This is, of course, left open to experimental determination. When we realize that the greatest item of expense in a powerful radio station, is the aerial-supporting towers, we can readily conceive what an important
question it really is. Many may be inclined to say that it is too early to experiment with the "concentrated" aerial, but this is not so as that degree of perfection in radio apparatus is so rapidly approaching that this type of aerial will soon be a necessity.

Every instrument in a radio equipment, no matter what it is, represents only a small degree of efficiency. The phonos, condensers, tuners, detectors, gaps or transformers are all in the embryo state. To obtain suggestions for improvement, the experimenter need only sit down at his instruments and gaze at them, at the same time analyzing each one and asking himself where and how they can be perfected.

Methods of Attacking Problems

Before entering into research on any special subject, the experimenter should first properly prepare himself in what may be called the "preliminaries." If his idea concerns tuning transformers, he should not depend wholly upon the knowledge he already has in connection with this particular instrument, but should go further and make a complete study of it. Every available bit of literature should be read. Probably the idea has been tried before, or it may be that during his investigations he will conceive of a better way to accomplish his object. Above all, he must know the theory and operation of the instrument he is concerned with. Every experiment he makes should be inspired by a definite conception of the circumstances and conditions to be involved as well as a concrete pre-determination of the result being sought. An experimenter may start a certain investigation with an isolated idea of the result he wishes to obtain, but as he gets into the practical research work, he will be surprised to find that his idea is suffering evolution. If it has no evolution, something is wrong, for when an idea is put to practical test, one invariably finds many ways of improvement, and, in many cases, these are so numerous and severe that our later conception of obtaining the desired results is entirely different from the one we originally posset.

When an amateur gets into research work and feels these circumstances developing, he will first find his interest so keen and his "inventing mood" so intense that something is sure to come of it, as his efforts are sure to be conscientious. Research work is the most interesting field of endeavor open today, and it is safe to say that with proper and rigid investigation — Research — no important invention will be made.

There are exceptions to every rule, but it is invariably true that we cannot get something for nothing. The best paid radio station or electrical engineer to-day are those engaged in research work. But they must be thorough in their knowledge.

MUSIC BY WIRELESS

Tina Lerner's Playing on Board Ship Heard on Other Vessels 500 Miles Away

Imagine sailing on a ship in mid-ocean and being able to hear your favorite pianist in a concert that she is giving on board a vessel hundreds of miles away! The possibility is not so remote as one might suppose, for on Washington's birthday last, Tina Lerner, the distinguished young Russian pianist, gave a recital on board the Ventura in her homeward journey from Honolulu, and enjoyed the unique thrill of feeling that her music was being heard by wireless operators on board passenger and freight liners as far as 500 miles away.

In the concert room where Miss Lerner was playing, a transmitter was placed, and by means of the recently perfected wireless telephone apparatus, the music was sent out over a large radius.

The experience of listening to this concert was far more novel than participating in the demonstrations which have recently been tried successfully, when singers and speakers in San Francisco were heard at meetings and banquets in New York and other cities. At these functions the guests were provided with telephones thru which they heard every tone distinctly. Even the applause that the singers received on the Pacific Coast was accurately transmitted, and all the thrills that attended the real concert were felt by this "proxy audience" on the other side of the continent.

That, however, was over telephone wires. To play the piano while isolated in mid-ocean and have the notes float thru the air and bring pleasure to those far distant, does much toward the complete annihilation of space and causes us to wonder what tomorrow may bring forth.

When we are far from home—and think of the loved ones left behind, shall we be able to commune with them thru music?

NAVY RESERVE WANTS WIRELESS OPERATORS

An opportunity for amateur wireless operators having a knowledge of wireless or land telegraphy to join the navy reserve force was announced at the Great Lakes training station at Lake Bluff recently. It was stated that radio operators soon will be needed and that facilities for giving the instruction have been provided by the navy.

Heretofore the number of radio operators who responded to the call to the colors has been so great that all positions were filled, the schools of instruction were overcrowded and all enlistments in the branch had to be stopped until further arrangements could be made.

PROF. TAYLOR DIRECTS U. S. RADIO

Professor A. H. Taylor of the physics department, University of North Dakota, was recently appointed district superintendent of communication at the Great Lakes Training Station. He is a radio expert and has been given the rank of lieutenant in the Navy.
THE "ELECTRO" CODOPHONE

(Patents Pending)

A MATEURS! ATTENTION!!

Now that we are for the time being, deprived of using our Radio outfits, it behooves us as good Americans to 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.

So far the Government has not been able to obtain any way near all the operators it requires. Not alone does the Federal Government call for thousands and thousands of operators for the army and navy, but nearly all of our many states require operators for the militia. Here is the great opportunity of a lifetime for you.

Without further ado, let us present the "ELECTRO" CODOPHONE.

THE "ELECTRO" CODOPHONE

which we present herewith is the outcome of several months of intense study and experimentation of our Mr. H. Gernsback. It surpasses our former Radiotone Codophone, which comprised a Radiotone silent Buzzer, and a loud talking telephone receiver and a key. As in all of his work, Mr. Gernsback strives for simplicity. So he combined the three above named instruments with one stroke into ONE single instrument. He combined the Radiotone Buzzer and the loud talking receiver into a single unit, not only mechanically, but electrically as well. This involves an entirely new principle, never before attempted, and on which basic patents are now pending.

What this remarkable instrument is and does:

The "Electro" Codophone is positively the only instrument made that will imitate a 500 cycle note exactly as heard in a Wireless receiver, so clearly and so wonderfully clear, that Radio operators gape in astonishment when they first hear it. And you need no receivers over the ears to hear the imitation singing spark, which sounds for all the world like a high pitched distant powerful Radio Station. The loud-talking receiver clipped to a horn, talks so loud that you can hear the sound all over the room, even if there is a lot of other noise.

THAT'S NOT ALL. By lessenimg or tightening the receiver cap, a tone from the lowest to the highest quality, up to the loudest and highest screaming sound can be had in a few seconds.

FURTHERMORE, this last-of-all trades marvel, can be changed instantly into our famous silent Radiotone test buzzer, simply by replacing the horn assembly with a felt disc, which we furnish with every 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 between two houses one-half mile apart. Any one station can talk to the other, or both can talk to each other. Sentiments can be transmitted to the other station, and both parties can be heard by the other.

We have spent considerable time and money to combine just such a practical outfit and present it herewith to our friends.

The outfit is complete as per illustration and consists of:

1. Stand, made of well quartered oak, varnished three times, so as to be acid proof and grooved on top and bottom, so that it will not warp in getting wet. Size 9 1/2 inches high by 11 1/2 inches long.
2. Glass Spirit Lamp, Size 3 1/2 inches high by 2 inches. Uses wood alcohol and is invaluable to the experimenter. Besides being used to heat test tubes contents as per illustration, it can be used to bend glass rods and tubes, to solder wires, etc.
3. Glass Filter Funnel. This funnel is made of heavy glass that will not break easily. It fits accurately in the hole on top of the Filter stand and is provided with a thick rim on the sides so that a rubber hose can be attached to it, without slipping off.
4. Glass Rod, to be used in stirring and mixing.
5. Test Tubes, made from the best imported glass. A new feature of some value and utility.
6. 1 Roll of Copper Clad Steel Wire. This wire is to be used to make a number of useful articles as shown in the illustration, such as test-tube holders, tripods to support retorts, etc. We furnish a blue print with the outfit, showing how to make all these wire articles.

Now this whole outfit as described costs you only

$1.50

the test tubes is that they have a flat bottom and therefore can be placed on any table if desired, needing no special stand.

L A B O R A T O R Y O U T F I T !

How often have you wished to possess a compact outfit in your laboratory combining a Filter-stand with a Test-tube holder and Spirit lamp?

$1.50

We have combined just such a practical outfit and present it herewith to our friends.

The outfit is complete as per illustration and consists of:

1. Stand, made of well quartered oak, varnished three times, so as to be acid proof and grooved on top and bottom, so that it will not warp in getting wet. Size 9 1/2 inches high by 11 1/2 inches long.
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4. Glass Rod, to be used in stirring and mixing.
5. Test Tubes, made from the best imported glass. A new feature of some value and utility.

In this outfit, as described costs you only

$1.50

Order one today, even if you don't need it now.

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THE ELECTRO IMPORTING CO.

Manufacturers
THE "ELECTRO" SPINTHARISCOPE

As usual we lead—others follow. Now the Spinthariscope, first to be introduced to the American public by us. The Spinthariscope was originated by the famous English Radium expert, Sir William Crookes. Everyone knows that Radium gives off a tremendous amount of energy which goes on for several thousand years, with undiminished force.

Radium gives off a number of rays of which the Alpha rays are known chiefly for their great power. These electric rays are invisible to the naked eye, the same as are X-rays. But if we take a small amount of Radium and place it in front of a zinc-sulfide screen, the latter lights up. If the radium used is arranged suitably the Alpha rays will bombard the zinc sulfide with a veritable hail of electrons and the screen begins to fluoresce and spinthariscope. This is the principle of the Spinthariscope, which we present herewith, a little instrument made of two neatly nickeled metal tubes, one telescoping into the other. The top tube has a powerful lens. The bottom contains the zinc-sulfide screen and a minute quantity of Real Radium, too small to do any harm. The instrument can only be used in the dark. After the top tube with the lens has been adjusted to the right focus, we observe a vividly illuminated green background, glowing in a soft light. As the eye becomes accustomed to it, we begin to see the ELECTRONIC BOMBARDMENT of the Alpha rays from the Radium. It looks exactly like tiny needles flashing off and on in the dark night. The more we look the better we see the miniature fireworks. We are now to the presence of the most marvelous substance man ever knew, RADIUM and its uncanny force—Radium, which some day will turn the world upside down.

The Spinthariscope up to now sold from $15.00 up words, but by greatly simplifying it the cost has been brought down by us to such a nominal figure, that no one can afford to be without this most important and marvelous instrument.

You owe it to yourself to own one. It is small enough to be put into your vest-pocket, and interesting enough to show it to all of your friends. It will continue to operate after you are dead 2000 years! We guarantee the instrument to be genuine and to contain a minute quantity of Real Radium salts. "Electro" Spinthariscope, in neat box and directions for use, as described.

Sold prepaid. IMMEDIATE SHIPMENTS.

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THE ELECTRO IMPORTING CO.

231 Fulton Street, New York City.
Details of a 20,000 Meter Undamped Radio Receiver

By WM. Burnett, Jr.

A GREAT deal has been accomplished in the last few years in the reception of undamped wave trains. In this description I will endeavor to relate some details of the experimental work that has been successfully carried on at our laboratory. A great deal of the apparatus ordinarily involved in this work is rather expensive, and unless the person has a good knowledge of electrical laws he is quite apt to get poor results.

The subject of ultra-high frequency currents has set the amateur electrical "bug" afire, and at the present time it is hard to tell from one day to the next just what will turn up in the way of a new invention.

In the accompanying diagram (Fig. 1) is shown a very good set of connections for the reception of long undamped waves. This consists of very few pieces of apparatus and works admirably well. Any one who has access to two Audion (round or tubular) bulbs will find that this is one of the most simple hook-ups.

These connections give a very sensitive circuit and by spending a little time in adjusting the Audions the experimenter will find it possible to attain excellent results. It is advisable not to connect a variable condenser across the phone terminals, as this paralyzes them to such an extent that the diaphragms refuse to move. The impedance which is connected in the diagram is one of about 9,000 ohms; a ¼ spark coil secondary, having an iron wire core running thru it, will answer the purpose.

This hook-up produces a very strong regenerative effect. This can be partly done away with if the proper attention is paid to the adjusting of the filament rheostats. In regard to the resistance of the phones, I am convinced that the 2,000 ohm type will work better than the 3,000 ohm type. The usual care should be taken in connecting the filament of the bulb to the negative binding post of the lighting battery and the rheostat to the positive post of the lighting battery. However, all who have had experience with the Audion, know that the characteristics of the bulbs differ and the experimenter will be able to adjust these minor difficulties by using good judgment.

The loose coupler used in this hook-up is one built after the so-called Cambridge Receiving Transformer design. Its over-all length is 36 inches and the secondary slides on a ¾" square brass tube. (Fig. 3.) The primary is 12" long and 8" in diameter, wound full of No. 28 single silk covered copper wire, and is divided into 19 equal parts. Being of the Navy type, the first 18 taps are brought out to switch points and the remaining section is divided into 19 equal parts and these brought out to as many switch points. The accompanying illustration (Fig. 2) will explain this.

Rather than count the turns, wait until after winding and then by direct measurement locate the position of the taps. The secondary is 12" long and 7" in diameter and is wound full of No. 33 S.S.C. wire and divided into 19 equal sections and brought out to the switch points on the front of the secondary. As the drawing below is self-explanatory, giving the principal dimensions, no further space will be given to the construction of the receiving transformer.

My best results have been obtained with the following set of connections: (See Fig. 4.) The loading coils or inductances are 4" in diameter and 32" long. These are wound with No. 30 enameled magnet wire. Taps are taken off at 10 different places, thereby giving a great variation of inductance.

USEFUL HINTS ON THE AUDION.

By Frank J. Collins.

In this paper an attempt will be made to clear up certain misunderstandings current among numerous amateurs in regard to the required amount of apparatus employed in the Armstrong Regenerative Audion receiving circuits.

Numerous articles have appeared in past issues of electrical magazines, to the effect that the Grid and Wing coils are unnecessary; that certain condensers could be eliminated; that the body could not approach the apparatus without affecting the tuning considerably (due to the capacity of the operator's body) and that the oscillations were unsteady, to say the least.

There were furnished with these articles, "newly discovered" hook-ups by the authors, claimed to do the same thing as the Armstrong arrangement, employing the minimum of apparatus and giving the same results! (Continued on opposite page.)
ductance. An advanced form of the Arm-strong coil circuit is used and is here given for Amatuer use only.

The Complete 20,000 Meter Audion Receptor for Undamped Waves, With Loading Inductances and Large Loose Coupler.

Large values of inductance and small values of capacity give the best results. N.A.A., W.L.S. and N.A.J. have been heard 40 feet from the phones. Two pairs of 3,000 ohm phones work very well in place of the one pair of 2,000 ohm. The antenna from which this set is operated is 100 feet high and 100 feet long, of the "T" type.

USEFUL HINTS ON THE AUDION.

(Continued from opposite page)

In the first place, the Grid inductance not only acts as a wave length tuning inductance, but also as a storage of energy. This stored-up energy discharges back into the Wing inductance (which also acts as a storage of energy). The Wing inductance transferring the energy back again into the Grid circuit, causing a greater amount of current to flow, than would ordinarily occur in the absence of these inductance coils, and therefore, a greater drop of current across the telephones upon the reception of signals.

It is impossible to obtain maximum signal strength, or to hold the oscillations steady, for the reception of undamped waves, unless these coils are employed and adjusted properly.

The complaint that the body cannot be brought near the apparatus during the reception of signals without interfering with the signals, can be overcome to a large degree by grounding the Grid circuit between the secondary of the loose-coupler and the negative side of the telephone battery, also by short-circuiting the unused or idle turns on the Grid and Wing inductance coils, and also by grounding the head- band thru a small condenser.

These precautions will enable the operator to work the arrangement with little or no trouble from capacity effects.

Instead of using long coils, 30 to 40 inches in length, four tubes of 6-5/6 and 4½ inches respectively in diameter, and 8 inches long may be wound full with number 32 S.S.C. magnet wire and placed within in another, using insulating rings to separate the windings, taking care the windings do not oppose one another. This arrange- ment of coils will work the same as the longer coils and take up far less room.

The use of extremely large loose-couplers for long waves is not necessary. The mutual inductance between primary and secondary of such large couplers is very great and when used in conjunction with the Armstrong circuits requires very long (or loose) coupling. An air space of 8 and 10 inches between primary and secondary is not uncommon.

Practically every large result will be obtained on a much smaller coupler, giving smaller coupling between primary and secondary: the signal strength and tuning properties remaining the same as for the larger coupler.

It has been stated that one should never use finer wire on the primary of the loose- coupler and primary loading coil than number 24. That is all right theoretically and in the reception of shorter wave lengths, but in dealing with undamped wave lengths the frequency is much lower, the current penetrating further into the wire.

Number 32 wire is found from experience to give practically the same result as number 24 wire, when used as primary loading inductances in receiving long waves, besides requiring a minimum of space.

While it is admitted the high frequency currents travel on the surface of the wire and granting the surface of a number 32 wire is not as great as a number 24: in practise, the same signal strength will be obtained and the sharpness of tuning is not affected by the finer wire.

There is no necessity of building receiving transformers for the reception of long waves containing 2,000,000 cycles, as there are few stations at the present time using wave length above that value (120,000 meters).

A variable condenser should not be shunted across the primary inductances for tuning in the long wave-lengths, but a variometer employed instead, as it is well known, a condenser so used, decreases the current strength of received signals considerably. (Dr. Cohen.)

That a short antenna is suitable for the reception of long wave undamped signals is quite true, but all things remaining the same, the higher and longer the antenna, the stronger the received signal, providing the fundamental wave length of the an- tenna remains below that of the received wave. The above assertion holds true in all cases.

Finally, every piece of apparatus as used in the Armstrong circuits is absolutely necessary and the elimination of any one piece of apparatus decreases the efficiency of the set proportionally.

There is only one fault to find in connection with the working of the apparatus, and that is the inexperienced amateur who condemns it before learning how to work it.

There is no doubt but what it requires experience to do real, serious long-dis- tance work, and the trouble lies mostly in the inability of the amateur and not in the apparatus, if connected properly.

The apparatus should consist of a pri-mary loading inductance; a loose-coupler—Grid and Wing inductance; Grid condenser; secondary tuning condenser; Wing coil condenser, and telephone condenser, in conjunction with the regular Audion de-tector apparatus.

In conclusion, the long tubular bulb with the filament entirely surrounded by the Grid and Wing, will give better results for the reception of undamped waves than the ordinary round form, as it is more stable in operation.

HOW TO EXTINGUISH ELECTRIC FIRES.

In the extinguishing of electrical fires there is large opportunity for the display of good judgment and prompt action. The element of time is exceedingly important. The operator should observe whether conditions warrant the cutting of current from affected part before the fire is attacked. His knowledge of apparatus under his charge should be such as to guide him properly. He says UI refires in a Fireman in Aug. Sc.

Sand and powder bicarbonates of soda have been found to have some merit as extinguishing agents in certain kinds of electrical fires, but their use is limited.

Where sand is provided for fire-extin- guishing purposes, it should be carefully spread upon a sieve of window screen of 14 mesh to remove the larger particles, especially scraps of metal. It should be kept in a clean and dry condition and should not be used wherever there is a liability of its getting into the bearings of moving parts.

In tests recently made in extinguishing oil fires, wet sawdust impregnated with sal ammoniac has been found to have con- siderable merit.

Bromine tetrachlorid has shown up well as an extinguishing fluid and has the advantage of being a non-conductor to a high degree, which is a very valuable attribute.

In many modern plants the liability of structural fires is vastly less than the liability of the occurrence of fire in appa-ratus, and much of this apparatus is so constructed that in case of fire occurring in the interior it is very difficult or impossi-ble to use an extinguishing agent with success.

CONTROL BY SOUND.

At Lady Drogeda's Aircraft Exhibi-tion at the Grafton Galleries, an inter-esting model airship constructed by Lieut. Roberts, in which the control is effected by sound, was recently exhibited. Elec-tric circuits are worked by a telephone diafragm, and this is tuned by an air column so as to respond to any desired note. On sounding this note the electric apparatus goes into action, the diaphragm acting as a relay, setting the circuit in motion when any particular motor can be put into operation.
THE accompanying idea is to convert a one, two or three slide tuning coil into a "Cabinet" style set. By N. H. ALLEN

Converting a Tuning Coil into a Cabinet Tuner

Now is a Good Time In Which to Re-design Your Radio Apparatus. Here's a Fine Idea for Converting Your Old Tuning Coil into a "Cabinet" Style Set. By Changing Around Tuning Arrangements May Be Had.

A DUPLEX POLARITY POTENTIOMETER.

By the diagram given it will be noticed that two batteries are employed instead of the one battery formerly employed with the potentiometer; this by no means changes the ordinary hook-up, and while serving for the same purpose as usual, eliminates the continual shifting of battery or detector leads when inserting either one, in order to find the correct connection. I have found that this connection works very good, especially when experimenting as most amateurs do, i.e., continually changing detectors and circuits. When the point is at the middle of the potentiometer the instrument is cut out of the circuit and a change either from positive to negative is made possible by moving the slider either above or below the point marked O, thereby making it unnecessary to shift detector or battery leads in order to get the correct polarity. Your

EFFECT OF WATER VAPOR ON THE PROPAGATION OF ELECTROMAGNETIC WAVES.

An interesting paper on this subject by Dr. Frederick Schwers, was recently presented before the Physical Society of London.

The author discusses the probable influence of moisture in the atmosphere on the refraction of electromagnetic waves round the earth's surface. The conclusion of Kiebitz that the presence of moisture does not affect the dielectric constant by more than 10 per cent. is shown to be erroneous, being based on the assumption that the Clausius-Mossotti formula holds when passing from the liquid to the gaseous state. Examples are quoted to show that this law fails in many cases, especially where the dielectric constant is high in the liquid state.

In the absence of more accurate data for ordinary temperatures, the author prefers to assume a value for the dielectric constant of water vapor obtained by extrapolating the results obtained by Baedeker for higher temperatures. The extrapolated value is almost certainly too low. From this result, and the average conditions of the atmosphere over the ocean with regard to temperature gradient, etc., deduced from meteorological data, it is shown that the lower layers of the atmosphere (100 to 1,500 meters or nearly in depth) refract electromagnetic waves towards the earth, so that the greater part of the space waves will reach the receiver, contrary to the conclusion of Kiebitz.

Dr. C. Chree in discussion, says:—The author, presumably unaware of their existence, does not refer to the somewhat numerous upper air data which have been published in this country (England) by the Meteorological Office. A study of this data as to the temperature gradient would, I think, have proved useful. Inversions are not confined to the lowest layers, but in these layers they are exceptional, and do not suffice to reduce the average temperature gradient to such low values as the author has taken for the first and second kilometers. For these, 5 deg. or 6 deg. per kilometer would not have been too high, especially for tropical regions. If the empirical exponential formula for vapor pressure be assumed, the pressure at any given height varies directly with that at ground level, and so in temperate latitudes in much lower in winter than in summer. It thus seems rather a fundamental point whether wireless phenomena in temperate latitudes show a marked annual variation corresponding with that of vapor pressure at ground level.
“Bats” in this case is short for extinguishers. All those who excepted a nature-fake story, or a treatise on the kind of bats which unkind people say inhabit the bell- 
ries of electrical experimenters, may now pass out quietly thru the door on the extreme left. And please don’t slam it!

The old house where I lived and moved and had my shop hadn’t been wired for electricity when it was built. You see, at that time builders were quite conservative about including electric fixtures in the specifications because the only lighting current in existence was being produced in laboratories at a cost of about a hundred dollars per kilowatt-hour. In fact, electricity was in its infancy; and if you know anything about infancy you’ll recognize that its expense-bill was running true to form.

By the time I began to take notice, electrical lighting had conquered the streets and had begun to invade the houses. It was useful mostly as one of those modest means of advertising that you were “well off,” same as the cast-iron hound on the front lawn. If you succeeded in blowing yourself like this without the grocer getting uneasy about his overdue bill, the inference was that you and Want were strangers, and that the mortgage had been left on the domicile simply in a public-spirited effort to keep money in circulation. As mere illumination the light was negligible, burning at various low degrees of candle-power, and usually going out whenever the neighbors dropt in to admire it.

I speak thus bitterly of the early light because it was an unsatisfied hankering of mine to have this current on tap for the operation of the various electrical machines which my young factory turned out with regularity. The Fates said me nix on that, and I defied them as one must; but it peeves me that now in my flat, when I can have all the “juice” I feel like paying for—I haven’t any shop! Fates are like that: if they conclude to hand you the thing you’ve wished for, they wrap up with it a neat kicko to prevent any enjoyment of it. It’s just when the fish are biting fit to take your leg off, that your bait gives out, now isn’t it?

However, you know we old fellows are great for finding reasons why any given calamity was “all for the best,” and I can console myself for the lack of the piped lighting in this way: if I’d had the handy electric socket and one of those dinky toy transformers they sell in these days (which consume me with envy just as a great big shut-eye doll with real hair consumes a girl of any age from 9 to 90) I should have mist the pleasure of experimenting with batteries.

The question of operating current was always with me, butting in like the traditional bug among the good fairies at the christening of every new rinktum, with the threat of stunting its career thru malnutrition. To provide my scientific family with their daily ration of wattage was a grim, endless duty; so, more from necessity than inclination, I was continually fussing with batteries.

The first battery I ever saw was the one used to actuate the family medical coil. It was a zinc cylinder suspended in a copper can, using a “straight” blue-vitrul solution as an electrolyte. In action, it bubbled and boiled, and produced whiskers on the zinc and mud on the bottom with surprising industry. It would run the coil for about half an hour, after which you had to clean it, and after that, clean yourself; so take it all together the coil gave you a lot of exercise as well as faradic effects.

Father used it mostly to relieve his insomnia; after the thing was all packed away, and he’d had his bath, he could usually sleep quite well. Electricity is life! That was the only one used on my first sounder, the one with the gate-hinge for an armature. It was quite strong while going at its proper stride, though not much stronger than the gate-hinge demanded. But when father’s reserve stock of blue vit solution was all used up, and I had duly received my “talking-to” for diverting it from its beneficent mission of nerve-relief, I saw distinctly that it was too rich for my blood. It was related to my own finances in about the ratio that three chorus-girls and a spendthrift son would bear to an entirely bookkeeper.

The flower of Bughood would have frozen in the bud but for good Père Leclanché. You remember Leclanché’s original wet cell—nothing could have fitted better the wants and the pocketbook of the struggling Bug. I wish all the wattage that the old wet cells ever produced could be collected and burned in a neon lamp as big as a barrel in honor of that benefactor of the race of boys!

You could make a Leclanché cell for as near nothing as figures will come without lying. Any old cut-off bottle would do for a jar. For the porous powder we used vaseline. For a nickel the junkman would part with a large piece of second-hand sheet zinc; sal-ammoniac and black oxide of manganese were the only cheap goods in the drugstore. For the carbon we made a raid on the gas works, where the rounded scales from the rotors were thrown out in heaps, there being no use for them in those days. Gee, but that carbon was hard! It was impossible to saw or work it in any way. To secure plates, we would shatter up a big hunk and select from the resulting junklets such as happened to occur somewhere near the desired size.

A battery made in this way, with the jagged end of the carbon protruding from (Continued on page 282)
An Ingenious Battery Night Lamp

I describe herewith what I call a night light. It is fastened to the wall near the bed and when I wish to know the time I just give a slight pull on the watch fob and can tell the time by the light of the miniature bulb. In the drawing the battery terminals make contact with brass or copper strips, A, and B. The reason for this is so battery is easier to change in renewing than it would be if wires were soldered direct to them.

MINIATURE ELECTRIC LIGHTS FROM 110 VOLT LAMP.

To do the following "stunt" will require quite some patience, so don't get discouraged if it does not pan out well at first. Procure a few burned-out 110-volt Morda lamps, say from 10 to 15 watts, and shake or jar a bulb until all wires are broken loose from the supports or the frame to which the fine wires are attached. Now turn the bulb so that the heavy end is pointing down and get all the broken pieces of wire on the side of the bulb where the current enters. Quickly invert the bulb and some of the wires may fall across the lead in wires—or they may not. If they do not, try it over again. When you get a wire or two to hang, connect a small current to the lamp and you will have a light, and a cheap one too. I generally connect a flashlight battery at first, in order to weld the small wires firmly in place, and then by means of a transformer and rheostat, adjust the current until the lamp burns at full brightness. I have obtained as much as 32 C. P. from nine volts on such a lamp.

HOW TO SOLDER ALUMINUM.

In soldering aluminum, it is necessary to bear in mind that upon exposure to the air a slight film of oxid forms over the surface of aluminum, and afterwards protects the metal. The oxid is the same color as the metal, so that it cannot easily be detected. The idea in soldering it is to get underneath this oxid while the surface is covered with molten solder.

First:—Clean all dirt and grease off the surface of the metal with a little benzine (bearing in mind that benzine forms an explosive mixture when in contact with air, and for that reason should not be kept near any flame whatsoever).

Second:—Apply the solder with a copper bit, and when the molten solder is covering the surface of the metal, scratch thru the solder with a small wire scratch brush. By this means you break up the oxid on the surface of the metal, underneath the soldering, and the solder, containing its own flux, takes up the oxid and enables you, so to speak, to "in" the surface of the aluminum.

Contributed by J. A. SIMONIS.

AN ELECTRICAL MUSICAL TOP.

Here is a plan for making an electric top which will play a tune. It consists of a top run by an electric motor. On the inside of the top are placed small tubes, each fitted with a reed of different tone. On the end of each tube is a circuit-breaker which is opened by an electro-magnet. One terminal from each electro-magnet is connected to the rod running thru the top, the other terminal being connected to a small brass disc, insulated from the rod. Each magnet has a separate disc and a small brass spring brush. Each spring is permanently connected with a key on a keyboard. The discs must be separated slightly from each other. In operation, the motor is started, a key is pressed on the keyboard, the current passes thru electro-magnet, causing the hole in the end of the tube to open. This permits the air to pass thru, thus causing a suction which vibrates the reed. By having enough reeds to form the musical scale a tune can thus be played. Since the electro-magnets are connected in multiple, more than one note can be produced at a time.

Contributed by EARL FINFROCK.
A high advantage of the electrolytic interrupter are: Increased number of interruptions per second, increased spark length and intensity and remarkable steadiness of the image when used for X-ray work. The electrolytic interrupter also makes a con-

Sectional View of Low Potential Electrolytic Interrupter for Use on Voltages as Low as 12

An Electrolytic Interrupter for Low Voltages

By C. A. Oldroyd

THE main advantages of the electrolytic interrupter are: Increased number of interruptions per second, increased spark length and intensity and remarkable steadiness of the image when used for X-ray work. The electrolytic interrupter also makes a con-

low voltages as mentioned above, i.e., 12 volts, the diluted acid in the interrupter must be kept at a temperature of about 50 degrees centigrade to ensure proper working. The cotton-wool C, keeps the heat in the inner vessel B, and once the diluted acid in B is warmed, it will remain warm for several hours. The gases passing through an interrupter can only escape thru the glass tube L, as the cover E fits airtight in B. As the small sketch shows, the tube L is connected by means of rubber tubing to the glass tube Y, fitting into a stopper Z, both being fixed into a glass bottle containing a solution of water and washing soda, which neutralizes the gases produced by the interrupter when working. The tube Y reaches about 2" below the level of the solution and the stopper Z, has a notch on one side to let the gases escape, after they have past thru the soda solution, and thus been neutralized. To warm the solution in the inner container B of, the interrupter, it is only necessary to withdraw the jar B by gripping the part and place it on a radiator or on a gas ring until the thermometer shows about 50 degrees centigrade. Then the container B can easily be replaced into A, in the same way. When warming the solution, care should be taken to do this gradually or the jar may crack.

To build this interrupter let us first procure two wooden jars, A and B, which should be approximately of the dimensions given. Place some cotton-wool on the bottom of the outer vessel A and compress it slightly by placing B into it. The thickness of the wad of cotton-wool should be about 1/2". Now fill the remaining space between A and B with cotton-wool, always compressing it with your fingers. Next cut a small ring D, from wood about 1/2" thick, and glue it into A. This ring serves to keep the cotton-wool in position when withdrawing or replacing the inner jar B. Next turn the cover E from hard wood 3/4" thick, making the lower part fit easily into B. Cut the glass tube and place a rubber band S into it. As mentioned above the outer diameter of S when in position, should be slightly larger than the inner diameter of the jar B. Drill a hole 5/8" diameter thru the center of the cover for the glass tube F and three other holes T, U and V, as shown in detail drawing of the cover. T is for the thermometer, U for the glass tube I, and V is a clearance hole for the screw Q, of the binding post K. This cover plate must now be soaked in molten paraffin wax for at least half an hour.

We turn now to the glass tube F. This is 3/4" long by 1/4" diameter. Take a tube about 15" long and heat the middle over a Bunsen burner until the glass becomes fairly soft. Then draw the two ends apart and you will have two glass tubes with tapering ends. Cut the taper where the bore is about 3/4" and smooth it on sand-paper. Now cut off the parallel part of the tube to a length 5/8" and fit the tube into E, by means of shellac varnish. We now come to the adjusting screw. Procure a screw M, with 3/16" thread, by about one inch long; solder to M a piece of lead rod N 35/8" long by 3/4" diameter and solder to N a piece of wood. This should be one millimeter diameter by 3/4" long. If you have a slightly smaller or larger gage in your possession, you may use it, as the diameter of the wire is of no great importance. The hard rubber plate L, is next made to the dimensions given in the detail drawing, and the center hole is tapped to suit the adjusting screw M. The plate L is then painted with shellac varnish at the side, which is to be in contact with the cover and screwed to E by means of three small screws R. The next part to be completed is the lead plate G. This is made from strip about 1/64" wide by 18 gage thick, and bent as shown. G is then fast in position by screwing Q, into the binding post K. The thermometer H and glass tube I, are now put in place, using again shellac varnish.

The interrupter is now complete and has to be filled with a solution of one part of sulfuric acid in ten parts of water, and stir the water all the time with a glass rod. (Pour acid into water—never water into acid.)

The wash bottle is next made from an eight-ounce glass bottle or any similar size. The glass tube Y is of the same diameter as L, and bent as shown. The stopper Z receives a notch as mentioned before. Place some lumps of washing soda into the bottle and pour sufficient water on it to bring the water level about 2" above the end of tube V. Finally connect I and Y by means of rubber tubing.

The interrupter is connected in series with the primary of the coil, the lead plate being the cathode. (A lead sleeve covering a copper wire may be used instead of a lead rod for the anode.)

HOW TO MAKE FIREPROOF PAPER.

Dip a sheet of paper in a strong solution of alum water and, after drying it, repeat the process three (3) times; then hold it in a flame and it will not burn.

To melt steel as easily as lead, heat a piece of steel in a fire until it is red, then take it out and touch it with a piece of brimstone (sulfur). As soon as the brimstone touches the steel the metal will melt and drop down like liquid.

Contributed by James Milten.
A Hand-Feed Arc for the Experimenter

I give herewith a sketch of an arc lamp of my own design. The right hand binding post is connected to the stationary carbon. The left hand binding post is connected to the hinge F, and is fastened along the wood to standard R. By turning the threaded rod A, this causes the slider C, which is not threaded, to lower or raise the brass arm 1. (Fig. 1.)

It is best to make all of the parts such as the base and upright R. of slate, fiber, soapstone, mica, or any other non-combustible material. They may be constructed of sheet iron with a little care as to the insulation, using mica washers and bushings on the screws. The carbons may be small or large, the standard size for commercial arcs being 1/2 inch diameter. A spiral spring, formed of phosphor bronze or steel wire, pulls the bar I downward. The glass lamp chimney is retained in place by a wood or fiber ring. This arc lamp is well adapted for use in small motion picture machines, post card projectors, model search-lights, wireless telephones, speaking arcs, etc.

Fig. 2 (left) shows a balanced, straight-line feed arc lamp which the amateur electrician will find easy to construct. Iron pipe can be used with standard flanges, etc., to make it with. The toothed rack is riveted to a piece of iron or steel rod A, the rack sliding in a slot in the front face of guide bar B. A pinion is mounted in this slot to mesh with the rack, the pinion being rigidly secured to the arc adjusting handle and shaft. The ball bearings should just about balance the moving carbon holder. Fig. 2 (right) illustrates the rack and pinion action in standard handled arc lamps.

But the Bellows

The apparatus is quite complete to be used with it, this may be either A.C. or D.C. The arc will give a powerful light on 50 to 60 volts and 5 to 8 amperes. It works best with a ballast resistance in series; this may consist of a few short coils of iron or German silver wire about No. 20 gage. The resistance should be adjustable and

for 110 volt circuits some resistance is absolutely necessary. For 110 volt D.C. service the value of resistance approximates 11 to 12 ohms. It may be in the form of a water rheostat.

Contributed by JAMES PRATT.

Fig. 2—Hand-Feed Types of Arc Lamp Which Lend Themselves Readily to the Constructive Skill of the Amateur Electrician.

TO KEEP HUMAN PESTS AWAY FROM YOUR AUTO.

How many of you fellows who own an automobile are, to put it mildly, peevish, to have some person leave their hand- marks on its glossy finish, or if it happens to be covered with a light film of dust, leave their delicately inscribed monogram traced therein. Some of this of course is thru carelessness and some thru the irresistible impulse of some people to see their name or trade-mark in every possible place. The result however is the same, leaving the car in a messy looking condition, and oftentimes actually injuring the finish.

My car, however, has of late been strangely immune from this slight source of annoyance apparently due to a short in the electrical connections. Whenever I am in the car and some "nut" starts exhibiting his skill in engraving on the metal body of the bus this short develops, and believe me, he suddenly loses all interest in his art, and this shows a tendency to do a little vaudeville turn, executing something similar to the "Highland Fling."

The secret, however, lies in the fact that I have a small spark coil connected to my storage battery and in turn connected to the metal body of the car, with a push button located in a place not readily seen, but at the same time easily got at, without attracting attention. I will not attempt to describe connections of this stunt, as anyone can easily hook it up. But take it from me if it gives Results, with a capital "R."

Contributed by H. H. L.

Fig. 1—A Swinging Carbon Type of Arc Lamp for Amateurs.

HOW TO PUMP BATTERY ELECTROLYTE FROM CARBOYS.

"Electrolyte for storage batteries is usually shipped in carboys which are heavy and unwieldy. The ordinary method of pouring the electrolyte or acid directly out of the carboy into pitchers or jars by means of which the individual battery cells are filled is a difficult task and results in considerable trouble, loss and contamination of solution, wasting of time, and frequently destruction of clothing. Where there are quite a number of stationary battery cells to be filled, as in the case of a new installation or where the electrolyte is being completely renewed," says George A. Broder, in "E. R. & W. E., "I find that a carboy pump similar to the one illustrated is a desirable adjunct.

'This device consists of a foot pump or bellows connected by a rubber tube to a rubber stopper in the neck of the carboy; from this stopper another tube leads to the jars or cells to be filled. The rubber stopper must fit very tightly, has two holes passing thru it and into one of these is placed a short piece of glass or hard-rubber tube to the top of which the tube from the pump is connected. Thus the other hole in the stopper passes a long piece of glass or hard-rubber tubing which is preferably curved slightly so as to reach the lowermost part of the carboy; this glass tube projects above the rubber stopper just enough to permit fastening the discharge tube or hose to it.

'The principle of the device is very simple. Air is forced in from the pump or bellows and creates a pressure on the surface of the electrolyte or acid in the carboy. This forces the electrolyte thru the glass tube and discharge hose which can be carried to any jar or cell to be filled. The tubing should be of one-fourth or three-eighths inch internal diameter. By this device, especially if it is used, a steady pressure can be maintained upon the electrolyte so as to secure a constant flow regardless of the amount of liquid left in the carboy; in fact the carboy can be emptied to almost the last drop. By placing a small pinchcock near the end of the filling or discharge hose, or by bending this hose sharply, it is possible to stop the flow of electrolyte without spilling a drop when changing from one cell to another.'
Hungary {J. W. F. Bowles)

DOOR-BELL music would hardly appeal to city people any more than the noise of a tambourine would, but an apparatus, consisting of Drums' Bells and ordinary electric house bells with the gongs removed, will produce music which is virtually door-bell music and which is finding favor with many musicians. The frame is used for adjusting the hammers to strike the tubes squarely.

As seen in the diagram, the working parts of ordinary vibrating bells are fastened to a frame which sets over the rows of tubes. The hammers as well as the frame itself are adjustable, making it possible to adjust the hammer of each bell to strike its corresponding tube squarely.

Hints on Weighing Chemicals.

Many of the chemicals used for making up battery and other solutions used in laboratory experiments can be weighed quite well upon a small piece of tissue paper, this being used to keep the scale pans clean. Another piece of paper of the same size is placed in the other pan to avoid errors in weighing. Some such dodge as this is particularly useful when a cheap balance is used, having the pans suspended by means of thin cords past thru holes in their edges. These cords retain small particles of the substances weighed and so give rise to impurities in solutions subsequently prepared.

A better plan than the above is to use a couple of watch or clock glasses, two being required so that one does not have to wait while the glass is washed after a previous weighing. With the tung of a file scratch a circle on the back of one glass, and a cross. Then make two counterpoises from thin sheet metal, making one round and the other like a Maltese cross, to avoid all possibility of mistaking which is which.

Contributed by H. J. GRAY.

Same on balance of (E) supports. (F) Backboard containing the bells. (G) Adjusting screws for adjusting bell to strike tubes to various pitches. (H) Leverboard or keyboard on which are mounted the keys to make circuit to bells. The keys are arranged in an order corresponding to the tubes in order. (I) Five one and a half volt dry cells. Wet batteries can be employed in the same manner and circuit. If open circuit batteries are employed and a greater quantity of current is required (which is necessary when bells are used as a continuo service) the batteries should be placed in multiple-series, which means a repetition of the present set, repeated, positive to positive and negative to negative. As well as the former, altering or direct current from power lines can be attached to the outboard as described under (L) and (M). (J) Positive binding post and bell battery wire. (K) Negative binding post and key battery wire. (J) and (K) can be reversed, as there is no set positive and negative connections to the operating apparatus. (L) Step-down transformer apparatus reducing the voltage from 110 volts to 8 volts on alternating current. The arrangement is constructed with a length of No. 16 flexible wire, with reinforced insulation, and is then attached to the primary side of the transformer. The secondary side of transformer has wires provided to connect to (J) and (K) binding posts—eliminating battery wires. (M) A direct current power line circuit with resistance to reduce the voltage from 110 volts to 8 volts. Connections can be employed in the same manner as described under (L) and (K).

(N) Attachment plugs that will fit any Edison socket or receptacle. (O) Shows how individual bell is mounted to backboard (F). The bell iron brackets are fastened to the backboard by means of screw-bolts. The bell also occurs in the hands in the same manner with a piece of felt between the two, to eliminate any foreign sound while the bells are in action. The bells in this equipment have two ohms resistance and must all be of the same make and adjustment. The wire is No. 18 for sections and No. 22 for toy or main lines which are lettered (J) and (K). The wires in the present equipment are individual, have rubber insulation and are cabled. A standard cable can be employed if the distance between parts is great.

Radio-Activity is an Absorbing Study; Here We Have a Photo Made By Exposing a Covered Plate to the Rays of Uranium-Chlorid.

The following experiment, which I worked up several years ago, has always proved of interest to men somewhat ad-
**FIRST PRIZE, $3.00**

**A NOVEL ACOUSTIC AMPLIFIER.**

An amplifier which nearly equals an Audion in its sensitiveness and which requires no battery current to operate it is described herewith.

It is however better suited for use in regenerative vacuum detector receiving sets, that use a capacity to vary the number of beats.

Referring to the illustration, R is the telephone receiver (of 1,000 or 1,500 ohms resistance), while H is a Helmholtz resonator. The resonator is mounted so that the large opening fits over the hole in the ear cap of the receiver.

The number of beats is then regulated (by turning the variable condenser) until a clear response is heard. As a resonator of this type responds only to a certain note, the beats must be regulated until the resonator is in resonance with the receiver.

The system may also be used (with somewhat less efficiency) on an ordinary wireless set, i.e., one using a crystal rectifier, by first carefully ascertaining the pitch of the incoming signal and then choosing a resonator of the proper pitch.

Contributed by F. G. THACKABERRY.

**SECOND PRIZE, $2.00**

**COMBINED PENCIL RHEOSTAT AND LAMP SOCKET.**

Here is a fairly complete description of a vest-pocket rheostat described in the October, 1916, issue of THE ELECTRICAL EXPERIMENTER.

With a Pencil, a Clip and a Lamp Socket Shell One May Construct a Vest-pocket Rheostat and Lamp Socket.

MENTER, and as now constructed, it will be found very handy for testing the strength of small lamps.

In addition to slotting the pencil and making the other details, secure a socket from a porcelain base, such as are used for miniature lamps, and force this over the end of the pencil. If necessary, an adhesive may be employed. Make the wire connections as shown, so that the current will travel via the inserted lamp after passing thru the graphite resistance, as regulated by the fountain pen clip.

Contributed by JOHN T. DWYER.

**THIRD PRIZE, $1.00**

**A SIMPLE WHEATSTONE BRIDGE.**

Select a piece of board of dimensions 8" x 15" x 1" thick. This should be well-seasoned wood, preferably some non-resinous kind. Bore holes for the binding-posts and the mercury cups, as shown in the drawing.

The contact keys are made of strips of hard sheet brass, bent as shown.

For the ratio coils No. 22 B. & S. double-cotton covered, German silver wire will be found the most convenient. It is very desirable to adjust these coils to exactly one and ten ohms each respectively, but this is not essential. Good results can be obtained by simply measuring off lengths of one and ten feet very accurately. The resistance of these wires will not vary greatly from the values marked, and their ratio will be very close to 10 : 1, which is the essential thing.

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**Method of Testing for "Grounds" on Motor and Dynamo Armatures with a Buzzer, Battery and Telephone Receiver.**

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

Nitric Acid was probably known to the ancient Egyptians and alchemists as Aqua Fortis (Strong Water). Geber is credited with having prepared it in the Ninth Century by strongly heating a mixture of Lime-water and Alum, and Copper Sulphate, the Nitric Acid distilled over, owing to the decomposition of the Sulphate by the Sulfuric Acid of the other salts. Nitric Acid was commonly prepared and used as a valuable reagent by the alchemists, especially as a means of separating Gold from Silver.

*(Synonyms—Aqua Fortis, Strong Water, Azotic Acid, Hydrogen Nitrat, Hydric Nitrat, Spirit of Niter.)*

Cavendish about 1776 prepared it by a similar method to the one which is now used, namely, by the action of Oil of Vitriol (Sulphuric Acid) on Niter (Potassium Nitrate). Lavoisier first determined the composition of this acid about 1776. He proved that one constituent was Oxygen, but was unable to prove the nature of the others.

Cavendish proved the exact composition and mode of formation of this acid from its salts by the direct combination of Oxygen gases in the presence of water or alkaline solutions.

Priestley, from his experiments, observed that a series of electric sparks was made to pass thru air included between short columns of a solution of Nitric acid, the solution acquired a red color and the air was diminished in volume.

In the place of litmus, Cavendish performed similar experiments to Priestley's, using what was known as Soap-leaf (Caustic Potash) and Lime-water. He concluded that the Soap-leaf (Caustic Potash) and the Lime-water became saturated with some acid during the operation. He proved that this was Nitric Acid, by passing the electric discharge thru a mixture of pure Deiphlogisticated Air (Oxygen) and pure Phlogisticated Air (Nitrogen) over Soap-leaf (Potash), when Niter (Potassium Nitrate) was formed.

In 1816, Gay-Lussac found the ratio of Hydrogen, Oxygen, Nitrogen, corresponded with H2O, NO.

**Occurrence:**

Like Hydrochloric Acid, Nitric Acid does not occur in the state of Nature, but is held as a valuable reagent by the chemists, especially as a means of separating Gold from Silver.

*Oxidation Number—5
Reduction Number—+3
Reactions—

\[
\text{HNO}_3 + \text{H}_2\text{O} = \text{H}_2\text{SO}_4 + \text{NO}_2
\]

Nitric Acid is commonly used for preparation of other reagents.

**Preparation:**

The acid is prepared commercially and in the laboratory by the action of Sulphuric Acid on some Nitrates.

Either Potassium or Sodium Nitrate may be employed, but owing to the greater abundance and less expensive cost of Sodium Nitrate, this is generally used.

When Sodium or Potassium Nitrate is mixed with dilute Sulphuric Acid, no obstructive sign of chemical action takes place, altho it can be proved that a reversible change has taken place, so that the Sodium is distributed between the Sulphuric and Nitric Acids. If a mixture of concentrated Sulphuric Acid and Sodium Nitrate be heated to about 130°, Nitric Acid is formed.

The two salts, Sodium Nitrate [NaNO3], and Sodium Hydrogen Sulphate [NaHSO4] are not volatile. The Nitric Acid boils at 80°, the Sulphuric Acid boils at 330°. It is thus obvious, when heated at 100°, the Nitric Acid is volatilized and the state of equilibrium of the solution disturbed, thus the Sodium Nitrat is all decomposed.

If the temperature be higher, Normal Sodium Sulfate [Na2SO4] is formed, requiring the use of less Sulphuric Acid.

In comparison of the two equations:

\[
\text{NaNO}_3 + \text{H}_2\text{SO}_4 = \text{NaHSO}_4 + \text{HNO}_3
\]

and also

\[
2\text{NaNO}_3 + \text{H}_2\text{SO}_4 = \text{Na}_2\text{SO}_4 + 2\text{HNO}_3
\]

we can see that these reactions are similar to those obtained when we prepared Hydrochloric Acid [see July, 1917, issue of the ELECTRICAL EXPERIMENTER], insofar as

An excess of acid is employed, as in the first reaction, a moderate heat is required.
THE ELECTRICAL EXPERIMENTER

AN EFFICIENT PLATE GLASS DRILL

In making a static machine, it is preferable to have the glass plates drilled in the exact center to allow passage of the cable, because the accomplishment of this task is a stumbling block to the amateur constructor and even difficult for those more skilled in workmanship. However, the simple drill apparatus shown here with will do the job splendidly well, while a little patience is necessary, the excellent results will more than compensate for the time and energy expended.

Procure a piece of plate glass about 17" x 10" x 7/4" and force out the top and bottom of the same, after which construct a shelf as shown. Then drill thru both the top piece and the shelf a hole, size of which should be of such a diameter as to allow the tube of an ordinary curtail rod to revolve freely and not too loosely. Take the brass rod that was inside of this tube, cut off a piece about 6" in length and insert one extremity into the borer of a carpenter's plumb bob. This latter should be as large as possible and weigh at least one pound. Now, saw off both ends of an ordinary thread spool and then glue together in such a manner as to form a pulley, after which fasten rigidly to the top of the drill, directly underneath the plumb bob. To give greater speed to the drill, make a larger pulley as shown and connect together by means of a leather belt. It may be, however, that it will not be found very satisfactory, as the stretching tendency of the leather will in a short time cause the belt to break and thus prevent motion entirely. A better and simpler way is to merely hold the belt at the corners of the glass drum and the work will simply turn forward as one operates the drill, and then pull forward first with one hand and then the other, which action will give a continual alternating circular motion to the drill.

When everything has been completed, insert the rod, to which the plumb bob is attached, into the drill or tube, being careful beforehand to pour in a small quantity of emery. In as much as this substance is difficult to get in a loose form, I suggest that the reader do as I did and buy a few sheets of regular emery paper. These should first be torn up in small pieces, and put in a small pot of water and finally set to boil. The paper will burn away, leaving the emery grains, which can be easily separated from the paper ash by sitting thru a fine strainer. For the purpose of raising the glass plate upward so that the full weight of the plumb bob is brought to bear, glue a piece of thread or cotton spool to its center. As the hole of the latter can be seen thru the glass, this will also act as a guide in drilling.

From time to time, in operating this drill, add a little machine oil to the emery in order to provide a lubricant and thus prevent the glass from cracking. Also, roughen the end of the drill with a file, so as to give it a sharper and therefore better cutting edge.

Contributed by JOHN T. DWYER.

R. C. SIMPSON.

PERCENTAGE SOLUTIONS.

Many persons appear to find a difficulty in working with solutions containing so much per cent of an ingredient. There is no reason why such solutions should be avoided, for percentage solutions are as easy to prepare as those whose constitution is otherwise expressed, neither is there any greater difficulty in diluting to some weaker per-
Our Amateur Laboratory Contest is open to all readers, whether subscribers or not. The photos are judged for best arrangement and efficiency of the apparatus. To increase the interest of this department we make it a rule not to publish photos of apparatus unaccompanied by that of the owner. Dark photos preferred to light toned ones. We pay each month $3.00 prize for the best photo. Make your description brief and use only one side of the sheet. Address the Editor, "With the Amateurs" Dept.

$15.00 Cash in Prizes. Get Busy, Boys!!!

Here is your chance to win a cash prize for a few minutes' brain work. The big question now confronting every radio amateur is—"What can I do with my wireless apparatus?" To help the more than 400,000 loyal radio students and enthusiasts to apply their knowledge and, most important of all, to utilize their instruments for some practical electrical or communication purpose other than wireless, we shall pay two prizes—one of $10.00 and one of $5.00 respectively, for the best suggestion as to "what to do with your radio set during the war." Be brief; 100 to 200 words should tell your story. Remember—it's the "idea" that counts. Get busy at once, boys, as we want all suggestions in by July 25th, at the latest, so that the results can be announced in the September number of The Electrical Experimenter. And don't forget we must have thoroughly "practical" ideas. Address the Editor, Radio Problem Contest.

A GROUP OF REPRESENTATIVE AMERICAN AMATEUR RADIO STATIONS.

Radio Stations of, 5—J. A. Gjelhaug, C. E. Baudette, Minn. (Prize Winner); 1—Seefred Bros., Los Angeles, Cal.; 2—Greer W. Peck, Springfield, Tenn.; 3—George N. Stoff, So. Auburn, Nebr.; 4—Leo Hirsch, Columbus, Ohio; 6—Robert A. Gerhard, Lehighton, Pa.; 7—Everett Crump, Columbus, Ind.; 8—Donald S. Bennett, Wollaston, Mass.; 9—Maurice Pollack, Chicago, Ill.; 10—Charles Cross, Oakland, Cal.; 11—L. H. Cook, Mexico, N. Y.
TESLA'S VIEWS ON ELECTRICITY AND THE WAR.  
(Continued from page 230)

"At the time of those tests I succeeded in producing the most powerful arc I ever saw. I projected a stream of light at a distance of 100 feet from the X-ray apparatus and see the bones of the hand clearly with the aid of a magnifying glass; and I could easily see them at a distance several times this by utilizing suitable power. In fact, I could not then procure X-ray glasses, so I had to use an uncorrected fraction of the power I had available. But I now have apparatus designed whereby this tremendous output of thousands of kilowatts can be successfully transformed into X-rays."

"Could these ultra-powerful and unusually penetrating X-rays be used to destroy a submarine with?" I interjected.

"Now we are coming to the method of locating such hidden metal masses as submarines by an electric ray," replied the electrical wizard. "That is the thing which seems to hold great promises. If we should shout out a concentrated ray comprising a stream of minute electric charges vibrating electrically, at tremendous frequency, say millions of vibrations second, and then intercept this ray, after it has been reflected by a submarine hull for example, and cause this intercepted ray to illuminate a special plate (similar to the X-ray method) on the same or another ship, then our problem of locating the hidden submarine will have been solved.

"This electric ray would necessarily have to have an oscillation wave length extremely short and hence there the greatest problem of all—i.e., to be able to develop a sufficiently short wave length and a large amount of power, say several hundred horse-power. I have produced oscillators having a wave length of but a few millimeters.

"Suppose, for example, that a vessel is fitted with such an electric ray projector. The average ship has available from say 10,000 to 15,000 H.P. The exploring ray could be flashed out intermittently and thus it would be possible to hurl forth a very formidable beam of pulsating electric energy which would cause a flame of hundreds of thousands of horse-power. The electric energy would be taken from the ship's plant, say by a minute insertion of energy absorbed at a tremendous rate by suitably condensers and other apparatus, from which it could be liberated at any rate desired.

"Imagine that the ray has been shot out and that in sweeping thru the water it encounters the hull of a submarine. What happens? Just this—The ray would be reflected, and by an appropriate device we would intercept and translate this reflected ray into the form of a visible beam by allowing the ray to impinge on a phosphorescent screen, acting in a similar way to the X-ray screen. The ray would be reflected to the unaided eye. The reflected ray could be firstly, intercepted by the one or more ships in the fleet, or secondly, it would be possible for the operator himself to balance the refracted portion by sending out the ray intermittently and also by taking advantage of what is known as the after-glow effect, which means that the ray would affect the registering screen an appreciable time after its original position would be determined and hence be able to follow the ship to move forward sufficiently to get within range of the reflected ray from the submarine, as the reflection would be in the same direction as the originating ray.

"To make this clearer, consider that a concentrated ray from a searchlight is thrown on a balloon at night. When the spot of light strikes the balloon, the latter at once becomes a brilliant body, shining in different angles. The same effect would be created by the electric ray if properly applied. When the ray struck the rough hull of a submarine, it would be completely obstinate, but not in a centered beam—it would spread out; which is just what we want. Suppose several vessels acting in concert, by this method: it thus becomes evident that several of them will intercept the reflected ray and accordingly be warned of the presence of the submarine. The vessels would at once lower their nets, if so equipped, order their gun crews to quarters and double the watch. The important thing to know is that submarines are present. Forewarned is forearmed!"

"The Teutons are clever, you know; very clever, they could beat them," said Dr. Tesla confidentially. "(It may be of interest to our readers to know that several submarines are already on the high seas and are likely to be before the War is over.)"

ELECTRIC SUBMARINE FORTS TO DESTROY SUBMARINES.  
(Continued from page 231)

Ordinarily the device would be lowered into the sea from on board of a suitable vessel after the storage batteries are charged, the operator tipping the cylinder with the top so that the cylinder has been closed carefully water-tight from outside. Suspended from a pipe the steel unit would slowly descend to the bottom of the sea and the operator would himself feel nothing of the ever-increasing pressure of the water, but could command all observations and controlings by turning on the light projector and rotating the device round its vertical axis through the glass ports which at all times remain in direct contact with the vessel, could at any moment stop the lowering of the device, the glass port, which when striking the sub would be absorbed by a shock absorber arranged at the bottom of the device and ending in a large electric current, so a broken vessel he could conduct and direct by means of the telephone any possible salvage operations.

For military purposes however this device can be adapted to contain at the same point in place of the camera a special arrangement of short torpedo tubes, each of which contains a special surface torpedo which can be discharged at any moment by the operator simply by pressing a corresponding electric button, and which as it detects a periscope and has his device adjusted in the right direction. For such protective and defensive purposes the inventor believes that a number of such cylinders submerged across a given water-way, across the entrance to the Harbor of New York, for instance, would doom to destruction any enemy submarine which would attempt to pass thru submerged. Each device could be connected to a large vessel on the bottom of the bay from a special heavy casing which would contain an electric battery, and a special slow-diameter electric cable would be wound to allow the operator to rise to the surface and which would be controlled by the operator thru a special switch. Thus the operator could constantly oscillate slowly up and down under the water and rise every twelve hours at a certain time to a safe place. A small vessel could at the same hour passive from one buoy to the other, open the cylinder as soon as its top would appear above the water, let the cylinder descend, and another take his place. Where it is possible the electric current necessary could be supplied by a larger electric plant of the shore to all anchors and up into the devices in place of the storage batteries and also telephone connections could be established in the same way between all cylinders submerged and a coast station (fort) so that the operators could report at once every movement of importance.

"Submarine chasers may be of great value," says Mr. Hartman, "but they have to limit their field mainly to the surface of the water. Application is necessarily which is running submerged at a certain depth; especially at night-time. It is more easily to avoid the shadow of any dangerous small craft from below the water thru special lenses than to see the submarine at a certain depth."
This department is for the sole benefit of all electrical experimenters. Questions will be answered here for the benefit of all, but only matter of sufficient interest will be published. Rules under which questions will be answered:

1. Only letters or questions can be submitted to be answered by mail.
2. Only one side of the sheet may be written on; matter must be typewritten or else written in ink, no penciled matter considered.
3. Sketches, diagrams, etc., must be on separate sheets. Questions abstracted to this department cannot be answered by mail free of charge.
4. If a quick answer is desired by mail, a nominal charge of 25 cents is made for each question. If the questions contain considerable research work or intricate calculations a special rate will be charged. Correspondents will be informed as to the fee before such questions are answered.

WIRING DIAGRAM.

(812) David Langstrom, Chicago, Ill., desires:

Q. 1. How are the wiring connections made for the Fleming combined voltmeter and ammeter method of measuring power in an alternating current circuit?

A. I. The diagram herewith gives the proper connections. The true watts will be equal to:

\[ W = A_1^2 - A_2^2 - \frac{(V_1 + V_2)^2}{2} \]

Where \( W \) = true watts
\( A_1 \) = Indication of generator current
\( A_2 \) = Indication of current consumed by load
\( V_1 + V_2 \) = Voltage across generator

If the voltmeter \( V \), takes an appreciable amount of current, it may be tested as follows: Disconnect \( R \) and \( V \) at \( Y \), and see that \( A_1 \) and \( A_2 \) are alike; then connect \( R \) and \( V \) at \( Y \) again and disconnect the load. \( A_1 \) will equal current taken by \( R \) and \( V \) (in parallel).

Q. 2. Why is the pressure in phase with the current?

A. 2. The pressure used in overcoming resistance is from Ohm's law, \( E = IR \). Hence, when the current is zero, \( E \) is zero and when the current is a maximum \( E \) is a maximum. Hence, that component of the impressed pressure necessary to overcome resistance must be in phase with the current.

FILAMENT TEMPERATURE.

(813) Paul Hancock, Boston, Mass., asks:

Q. 1. What do you consider as the temperature of an incandescent lamp?

A. 1. A carbon filament runs at 1,700 to 2,100 degrees Centigrade. If the voltage is too high the lamp consumes too much current and the temperature of the filament becomes so high that it softens and droops until it may touch the glass bulb with sparks, allowing air to enter and burn out the filament. An abnormally high temperature also causes disintegration of the filament and causes its candle-power to drop off rapidly. Tantulum and tungsten filaments run hotter.

Q. 2. What kind of current is used in electric furnaces?

A. 2. Either direct or alternating current may be used in incandescent furnaces.

REGENERATIVE AUDION.

(814) Robert Murphy, Phoenix, N. Y., writes:

ODD PHOTOS WANTED AT $1.00 EACH!!!

Now is the time to make your Kodak pay for itself in a real practical way. We are interested in photographs of out-of-the-ordinary electrical, radio and scientific subjects and are willing to pay $1.00 each for every photograph sent us. Please bear in mind that for half-tone reproduction in a magazine, a photograph should be particularly sharp and clear. If a subject happens to interest us particularly well, we can have the photo retouched. For the greater part of subjects, however, it does not pay to go to such expense. Therefore, please take pains to properly focus and expose your pictures. It often happens that a really mediocre subject well photographed wins approval over an excellent subject poorly photographed. And don't send us plate or film "negative"; send unmounted or mounted "prints," preferably a light and a dark one.

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Address photo to—Editor "Odd Photos," Electrical Experimenter, 233 Fulton Street, New York City.

Q. 1. Do all regenerative receiving circuits change the individual tone of spark signals to a hiss when maximum amplification is employed? If not, please give diagrams of the simplest and most regenerative Audion, suitable for 200-600 meter spark signal reception, where the individual spark tone is retained?

A. 1. The tone received on the regenerative Audion circuit corresponds identically to that of the impertinent frequency of the current transmitted. However, in regards to the hiss in the receiver of such a system this is due to "overflow" effect ("spilling over") of the Audion at the high potential, which is essential in a regenerative circuit and which must be controlled in order to overcome this hiss. This effect is not one which is controlled by the distant transmitter but due to local conditions inherent in the system, which can be eliminated by proper adjustment.

The wiring diagram for a receiver capable of performing the duties in question is identical with the standard regenerative Audion circuit and you will find given a complete description in the January, 1916, issue of this journal.

Q. 2. Which group of apparatus is best suited for undamped wave reception from foreign stations, the large, loose coupler using the Chamber's circuit, or the small coupler with its loading coils and condensers?

A. 2. The large, loose coupler with its accessories, such as condensers, etc., employing either the Chamber's or Armstrong circuits will be found to give best results.

Q. 3. In constructing an aerial for 200 meter transmission, what spacing of wires, what number of wires, and what length should they be, to give 160 meters natural wave length; the aerial to be of the "T" type with leads taken from the exact center?

A. 3. The antenna for 200 meters should consist of four wires, 50 feet long, 60 feet apart, and the wires should be spaced two feet apart. The 160-meter antenna should consist of four wires 50 feet long, 40 feet high and each wire spaced the same as the 200 meter one.

CAPACITY MEASUREMENT.

(816) J. Andricks, St. Louis, Mo., inquires:

Q. 1. What is the simplest and yet accurate method for measuring the capacity of a condenser?

A. 1. The bridge method is the simplest method for measuring the capacity of a condenser. This scheme employs a standard condenser and the unknown capacity (Continued on page 275)
A Novel Electric Projectile

(No. 1,225,659; issued to Clarence W. White.)

One of the most radical projectile designs that we have come across, and which involves a novel application of electricity, is the projectile made in several sections and is open thru the center except for detachable base cap c. By a clever arrangement of an air propeller connected to a dynamo, the invention causes several things to happen, viz.,—the cap c drops off as soon as the projectile is started on its way; a magnetically controlled rudder projects out at the back; electric current from dynamo is caused to act on a quantity of water in the annular chamber c' which causes a cloud of oxygen and hydrogen gas to be evolved, and which is electrically ignited to give a pre-determined time period. Moreover the projectile may be set to change its course while in flight.

Radio Receptor

(No. 1,226,628; issued to Elmer E. Bucher.)

Unique radio receptor in which 1

represents the aerial circuit, containing a tuning inductance 2, which is connected to the receiver suitable capacity at 4. The aerial 1, preferably consists of a long horizontal conductor connected to the earth. The free end of the aerial being a point of maximum potential, is connected to a vacuum detector 5. The patent mentions the use of an inductance connected to the filament circuit as shown; this inductance being adjustable.

Generator of Radio Frequency Oscillations

(No. 1,226,629; issued to Guglielmo Marconi.)

A generator of radio frequency

continuous oscillations intended for use in wireless telegraphy and telephony. Several series of insulated rotary spark gaps with compressed air blasts are used, and the oscillatory circuits are energized from a D. C. source a, controlled thru key b, and inductance i. The condenser C1 is caused to discharge into condenser C2, which discharges into condenser C3, which finally discharges thru a rotary gap d, causing the oscillation transformer secondary s, to be powerfully excited, and which communicates its energy to the aerial circuit thru a second oscillation transformer.

Electrical Toy

(No. 1,226,835; issued to Allen B. Wilder.)

An efficient and simple self-acting electrical device for continuously operating electrical bodies such as toy birds and animals, advertising devices for window displays, etc. This device is claimed to operate on a single dry cell and to consume but a very small current. The illustration shows a swinging parrot, properly counterbalanced. At the top of the upright stand is a small box containing a set of electro-magnets and a pivoted armature, provided with a contact spring which is actuated by the downward movement of the parrot. As the figure continues to swing forward, the contact is closed, and the electro-magnets at once attracts its armature, which throws the figure upward, and thus the action continues to repeat itself.

Electrical Piano Attachment

(No. 1,227,122; issued to Donald Patrick Mize.)

A clever electrical piano attachment which permits of playing several instruments such as a violin whereby it is possible for the musician to cut out any of the auxiliary musical instruments and their electrical playing attachments.

Signaling Device

(No. 1,223,590; issued to August J. Kloocke.)

Meant whereby high frequency oscillations may be produced and controlled with greater efficiency than heretofore. The invention involves the use of a special vacuum bulb provided with a metal plug, which may be heated so as to pass gas from the atmosphere, and thus the three dimensions of vacuum. The bulb also contains a heating filament, the usual grids and a small blow-out coil arranged within the chamber so as to control the thermionic currents by its magnetic field, the strength of which may be regulated by a microphone connected in the circuit. The operation of this oscillator is similar to the arc type, except that instead of the arc, a small incandescent filament serves the same purpose, and the radiation of the current is occasioned by a glowing filament in the bulb.

Electrical Magnetic for the Ear

(No. 1,227,475; issued to Albert Maurice.)

The apparatus in question consists of a telephone receiver connected with a circuit comprising a battery a rapidly moving switch or catch, such as a buzzer.

Sound-Producing Device

(No. 1,228,659; issued to Erik C. Beyer.)

A rather out of the ordinary sound-producing device which may be used as a telephone relay or as a loud-speaking telephone. The apparatus produces acoustic vibrations through the atmosphere thru the medium of a series of tightened non-magnetic wires connected in the circuit of the telephone transmitter. These wires are placed in the field of a large magnetizing coil 2. High tension is claimed with this device, and by using a microphone 8, or within the altered hood h, the device acts as a telephone repeater with amplifying characteristics.

High Tension Electric Rectifier

(No. 1,228,405; issued to William H. Chapman.)

This invention is based on the fact that if a sheet of paper is laid on the surface of a grounded metallic body and a pointed conductor having an alternating charge of several thousand volts, be brought near the paper or separated therefrom by an air space for an instant, as it is in contact with the grounded conductor, there will be no discharge from the surface of the conductor which will show a very high negative charge of many times the voltage of the alternating charge. The two metal rolls are grounded and as the paper travels around, it carries negative charges from "c" and "d" to "f" and "g." The apparatus in Fig. 1 is for producing positive electricity.

Radio Receiving Apparatus

(No. 1,228,647; issued to Elmer E. Bucher.)

The aerial connects to a metal band 2, which slides along an inductance coil 3, this coil being grounded. The free end of the inductance coil is connected to a circuit comprising a battery a rapidly moving switch or catch, such as a buzzer.
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

OTTOMATTICK DAIRY WAGON (Prize Winner, $3.00)
Why Make Butter and Cheese on the Farm? Both Alike! Pour the Milk in Funnel and say "Giddap" to the Horse. While the Wagon Moves on a Belt, Operates the Electrical Machinery Which In Turn Churns the Butter and Cheese Machine, and by the Time Hick Haysed Gets to Market the Fresh Butter and Cheese Are Ready. Simple, Afn't It? Patent: H. O. Wulffling, Bloomfield, Conn.

OTTOMATTICK RAIN ALARM
The Patent Rain Alarm Provides for a Dry Sponge, Which When the Rain Ends It, Presses a Push Button; This Latter Operates the 800 H. P. Motor Which Works a Loud-Speaking Drum Over Mr. Sleepers Head. If That Don't Wake Him, There's a Feather Duster to Tell Him So. Real Scintillating.
Inventor: Jimmie Nelson, Patterson, N. J.

MAN-O-MOBILE
The Wasted Energy of Man Has Never Been Controlled Efficiently. By Making Him Walk as follows: We Get a Lot of Compressed Air in the Storage Tank. This Air Is Then Used to Expand the Bellows Behind the Knees, Thus Propelling the Gink at High Speed. To Prevent Over-sinking Cupid's Arrow Is Provided. Inventor: Nametless. (We Forget to Send His Name).

ROAD-O-MOTOR
First We Take a Lot of Planks and Hinge Them Along the Road on One End. Now Then, When the Flivver Flies By, the Planks Will Be Dependent. Compressing Air In the Compression Pump-Here. As Soon As the Flivver Passes, a Spring Under Plank Passes It Up Again. The Compression Air Drives the Dynamo.
THE ELECTRICAL EXPERIMENTER

August, 1917

EXPERIMENTAL CHEMISTRY.

(Continued from page 207)

quired, which yields a readily soluble salt, Sodium Hydrogen Sulfate [NaHSO₄].
A higher temperature yields a Normal salt [Na₂SO₄]. For this reason moderate heat should be used when the acid is prepared in the laboratory.

Even at 86° some of the acid breaks up into Nitrogen Peroxid [NO₃], water [H₂O], and Oxygen [O].

2HNO₃ = H₂O + 2NO + O

This dissociation is made apparent by the liberation of the red fumes, Nitrogen Peroxid [NO₃], and these dissolved acid impart a yellow or red color and increase its strength. It is then called Fuming Nitric Acid [sometimes erroneously called Nitrous Acid] and is extremely powerful and corrosive. After a time the fumes will mostly evaporate, though some combine with any water and oxygen present and form Nitric Acid.

Nitric Acid is prepared commercially by heating Sodium Nitrat and Sulfuric Acid in cast-iron retorts; the vapor being condensed in earthenware condensers, cooled by water, and collected in earthenware jars. The last jar is connected with a tower filled with coke, down which a stream of water is allowed to flow. The object is to recover the Nitrogen Peroxid produced by the decomposition of the acid. The retort has an outlet pipe from which the Sodium Sulfate can be run when the action is completed. To reduce the amount of Nitrogen Peroxid formed during the decomposition of the Nitric Acid by heat, the stilts are often worked under a reduced pressure to permit the acid to come off at as low a temperature as possible.

If the solution of Sodium Nitrat and Sulfuric Acid used to prepare the acid is weak, water will dissolve first, but, if strong, Nitric Acid goes over first, an acid of quite constant composition is obtained containing about 65% Nitric Acid, which is the commercial product.

When the acid is prepared as above, it generally contains some Chlorin, and Iodin, derivatives of the Chlorids and Iodids associated with the Water. In some cases some Sodium Sulfate, Sulfuric Acid, and Iron are also carried over during the process of distillation. In order that the acid may be purified, it is distilled in glass retorts, and the first fraction which comes over is put on one side as crude acid containing Chlorin compounds. When no precipitate is observed upon the introduction of the distillat in a dilute solution of Silver Nitrat, the larger part of the Nitric Acid distilled off. The residue remaining in the retort contains the Sulfates, Iodin and Iron. The acid can be redistilled from concentrated Sulfuric Acid to remove all the water: and the Nitrogen Peroxid can be eliminated by permitting a current of carbon dioxide to flow through the warm acid until it is without color.

Professor Ostwald has patented on a process "For the Oxidation of Ammonia into Nitric Oxid" and known as the "Ostwald Process."

Nitric acid may be prepared from the air, three important stages being involved. First, the Nitrogen and Oxygen of the air are combined to Nitric Oxid:

\[ \text{N}_2 + \text{O}_2 \rightarrow 2 \text{NO} \]

Second, the Nitric Oxid is permitted to unite with more Oxygen:

\[ 2\text{NO} + \text{O}_2 \rightarrow 2\text{NO}_2 \]

Third, the Nitrogen Peroxid thus obtained is then permitted to react with water:

\[ 2\text{NO}_2 + \text{H}_2\text{O} \rightarrow 2\text{HNO}_3 \]

PROPERTIES:

Physical—1. Pure Nitric Acid is a colorless liquid with a specific gravity of 1.53 at ordinary temperatures. Strong aqueous solutions, as well as the pure acid, slowly decompose with the evolution of heat and light, forming water [H₂O] oxygen [O] and Nitrogen Peroxid [NO₃], the latter giving the acid a yellow color.

2. It is very poisonous and corrosive, possessing a sour tart, pungent odor, and acid reaction.

3. The pure acid is hygroscopic and rapidly absorbs moisture from air.

4. It is miscible in water in all proportions, and, like sulfuric acid, a rise in temperature is caused in the mixture, due to the contraction of the acid in the mixture with water.

5. It boils at 85° and freezes at 47°.

6. It completely dissolves at about 256° into Water [H₂O], Nitrogen Peroxid [NO₃], and Oxygen [O].

CHEMICAL:

1. It reacts with most metals and non-metals to form nitrates.

2. It reacts with most compounds, and turns animal matter yellow. It readily reacts with many organic substances, forming compounds of great importance. Thus, with ordinary glycine it forms the compound known as Nitroglycerine, which is the explosive constituent of Dynamite. Likewise, with cellulose, the principal constituent of wood-fiber, forms Nitro-celluloses, which are used in making smokeless powder. When Nitric Acid reacts upon Protein matter, a yellow compound known as Xanthoprotein is formed; hence when Nitric Acid comes in contact with the skin, a yellow color results.

Nitric Acid is a strong oxidizing agent due to the large percentage of oxygen which it contains, and thus readily decomposes many substances of Oxygen. Under ordinary circumstances, in the presence of a substance readily oxidized, the acid decomposes according to the equation:

\[ 2\text{HNO}_3 + \text{C} \rightarrow \text{CO}_2 + 2\text{H}_2\text{O} + 2\text{NO} \]

Nitric Acid Water Nitric Oxid Oxygen

In such cases Oxygen is not evolved, but enters into combination with the oxidizable substances present. In this way Carbon, when heated with Nitric Acid, is oxidized to Carbon Dioxid.

\[ \text{C} + 2\text{NO}_3 = \text{CO}_2 \text{Oxygen Carbon Dioxid} \]

3. Practically all Nitrates are soluble, but does not dissolve in Tin [Sn], Antimony [Sb], Gold [Au] or Platinum [Pt]. It forms white powders with Tin and Antimony.

USES:

1. The chief uses of Nitric acid are to make Nitrats, Nitroglycerine, Nitrobenzine, Gun Cotton, Celluloid, to etch Zinc and Copper, to make Nitroglycerine, and dynamite.

2. It is also used to prepare Aqua Regia, dissolve precipitates, and as an oxidizer. The most important nitrates are Potassium [K], Sodium [Na], Silver [Ag], Barium [Ba], and Bismuth [Bi]; also Nitroglycerine and Gun Cotton. The Potassium Nitrat is used as an ingot tube by lifting the entire stand and retart in making Nitric acid; the Silver Nitrat in Photography, in analysis, indelible inks; Barium Nitrat is used in fireworks; Bismuth [Bi][NO₃]OH in medicine.

So far, in this series of articles, the writer has endeavored to make use of the simplest of apparatus, knowing that most experimenters have not funds sufficient to purchase more elaborate apparatus. In this installment we make use of a glass retort. This is essential to prepare this acid, and will be used again for the preparation of other compounds. For the benefit of experimenters who desire to equip a chemical laboratory on an economical basis, the writer heartily recommends the use of the apparatus illustrated in Fig. 75, which contains nearly all the apparatus necessary, with the possible exception of 8-ounce bottles, which may be purchased, or when an experiment calls for an 8-ounce bottle, ordinary jam bottles may be employed with good results. The apparatus shown may be obtained from several of our advertisers.

EXPERIMENT NO. 82:

Fasten on an iron stand, or tripod [Figs. 75, 82] a large bottle and clamp an iron gauze or tin plate and asbestos. Above this fasten a clamp having three thumb screws, one of which grips the vertical tube, another to hold the tubule of a 250 cc. glass retort having a sharply bent neck about 25 or 30 cm. long [Figs. 75a, 76a]. The clamp should be nearly parallel to the base of the stand, but the retort neck should run at right angles to it [Fig. 76], and reach within 3 cm. of the bench. Tightly fasten the three screws. The neck of the retort is then put into a large, clean, empty test-tube, and not too tight, the bottom of the retort should be nearly parallel to the base of the stand, but the retort neck should run at right angles to it [Fig. 76], and reach within 3 cm. of the bench. Tightly fasten the three screws. The neck of the retort is then put into a large, clean, empty test-tube, and not too tight, the bottom of the retort should be nearly parallel to the base of the stand, but the retort neck should run at right angles to it [Fig. 76], and reach within 3 cm. of the bench. Tightly fasten the three screws. The neck of the retort is then put into a large, clean, empty test-tube, and not too tight, the bottom of the retort should be nearly parallel to the base of the stand, but the retort neck should run at right angles to it [Fig. 76], and reach within 3 cm. of the bench. Tightly fasten the three screws. The neck of the retort is then put into a large, clean, empty test-tube, and not too tight, the bottom of the retort should be nearly parallel to the base of the stand, but the retort neck should run at right angles to it [Fig. 76], and reach within 3 cm. of the bench.
QUESTION BOX. (Continued from page 274) is compared electrically by means of the standard.
Q. 2. Please give wiring diagram of such a simple method for measuring the capacity of a condenser.
A. 2. The diagram gives the wiring connections. The resistance arms of the bridge are represented by 2R, while 3R is the unknown condenser to be measured.

ELECTRICAL ATTRACTION. (812.) Lucius M. Turner, Royston, Ga., asks:
Q. 1. What is the current by which the laws of electrical attraction and repulsion are shown?
A. 1. There are several methods by which the laws of attraction and repulsion may be shown, and one of the simplest is by the use of the electromagnet.

POWER OF MOTOR. (310.) William Jacoby, Bronx, N. Y., asks:
Q. 1. What determines the power given out by a motor?
A. 1. The power depends upon the pressure and current supplied to the motor, which in turn is determined by the number of turns in the coil and the diameter of the wire.

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Q. 1. Would the diagram shown, by using the proper switches, be suitable for use as:

(a) Fessenden's Interference Preventer
(b) Fessenden's Heterodyne receiver
(c) Oscillating Audion for generator
(d) Amplifier for crystal detector
(e) De Forest Audion bulb as a generator and transformer.

A. 1. The circuit which you show was very ingeniously worked out and after careful examination, we find that it is satisfactory for accomplishing the results in question. It would be advisable to shunt a high capacity from condenser of 2 mfd.

Q. 1. At the E. E. show at the University of Illinois, one of the magnetic breakdowns was a quarter (25c) piece placed on a wooden base, somewhat concave, over a magnetic field consisting of three magnets, equidistantly placed, which was actuated by a three-phase current. When the current was on, the quarter given a slight start, would spin indefinitely, and the direction could be reversed at will. Please explain?

A. 1. The phenomena which explains the rotation of the coin is identical to the fundamental principle of the operation of the A. C. induction motor.
As soon as the coil was started in a field of a three-phase current, currents are induced in the quarter, which reproduce a magnetic field in phase with the generated current and this field tends to follow the synchronous with the generated current, so that rotation is evident in the coil.

Q. 2. In the design of a rotary quenched spark gap as suggested by Dr. Zemek, I believe it is necessary to revolve a wheel 30 inches in diameter at a speed of 11,400 r.p.m. This wheel may be made of either an insulator or a metal. The formula for centrifugal force is \( F = \frac{mr^2}{R} \) and is correct for a weight on the end of a weightless string. What is the formula for determining the point of application of the force or the point corresponding to the center of gravity in such calculations? If I consider the entire weight of the wheel at the circumference, the results are impossible. You may consider the wheel as being made from a plain, unwound or unspoked wheel.

Q. 2. You are entirely wrong in considering the location of a wheel for a rotary quenched spark gap at the velocity you state. It is necessary for such rotaries to be revolved at a maximum speed of 4,000 R.P.M., which is a normal speed for a wheel of 30 inches in diameter when properly balanced. There aren't any special formulae for computing centrifugal force and the equation which you give will hold true for a mass revolved at any speed, providing that the mass around the circumference is uniformly distributed.

SMALL HIGH FREQUENCY COIL.

(8233) E. F. Doherty, Dorchester, Mass., inquires:

Q. 1. What size wire should be wound on a 1-inch Tesla coil secondary, and how far apart should the turns be spaced from one another?

A. 1. The secondary coil should be wound with No. 28 D. C. magnets and each turn should be spaced from its adjoining turn by a 1/32-inch air space. It is advisable to wind between turns a thread which has been soaked with shellac or paraffin. This will prevent considerable leakage between turns.

Q. 2. Would the above coil work well on a one-inch spark coil?

A. 2. Yes. However, it is preferable that a two-inch spark coil should be employed.

Q. 3. About how many glass plates 4 x 5 inches would be needed for the condenser on a one-inch spark coil?

A. 3. Ten plates will be required.

---

How "Staggered" Windings Are Built for Radio Purposes So As to Reduce Distributed Capacity.

STAGGERED WINDING.

(8244) W. N. Smith, London, Ont., Can., inquires:

Q. 1. Please state what a staggered winding is?

A. 1. A staggered winding is a special method of winding the turns of a coil so as to minimize the distributed capacity of the coil due to its multiple layers. This method is employed considerably in winding multi-
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layer coils for use in radio work. It is sometimes called "Talbot auditors" and the manner in which the individual layers are wound is shown in a cross-sectional view given herewith. The construction of each wire is such that the diameter of each wire is equal to the corresponding turns of the coil.

U. S. Wants Radio Auditing Clerk, Also Bookkeeper and Accountant

The United States Civil Service Commission announces open competitive examinations for auditing clerk (radio) and bookkeeper and accountant (radio), in Washington, D. C., and offers the following schedule for those desiring to enter the radio branch of the service. The examinations will be held at the Civil Service Commission, Washington, D. C., for the appointment of bookkeeper and accountant at $1,300 a year; two vacancies in the position of assistant bookkeeper and accountant at $1,000 a year, all in the office of the Civil Service Commission, Washington, D. C., and future vacancies requiring similar qualifications, will be filled as soon as the examinations, unless it is found in the interest of the service to fill any vacancy by reinstatement, transfer, or promotion.

The duties of the positions of bookkeeper and accountant involve the necessary bookkeeping work in connection with both Government and commercial traffic handled by the Naval Communication Service throughout the world, including disbursements to domestic and foreign Governments for such traffic.

Applicants must state in answer to Question 1 of the application form that they have had at least six months' experience in auditing radio, telegraph, and cable accounts in connection with a communication service involving all three methods of communication. They should be familiar with laws, regulations, and rates pertaining to radio and telegraph and cable communication throughout the world. It is desirable that they be able to operate a typewriter.

Applicants for the position of bookkeeper and accountant must show that they have had at least six months' experience in bookkeeping and accounting in connection with radio, telegraph, and cable traffic, and they should be familiar with the laws, regulations, and rates pertaining thereto.

Applicants must have reached their twenty-fifth birthday on the date of the examination.

Applicants must submit to the examiner on the day of the examination their photographs, taken within two years, securely attached to the space provided on the admission card. A residence in the United States, Civil Service Commission, Washington, D. C., or to the Secretary of the United States Civil Service Board at any duly appointed place. Applications should be properly executed, excluding the medical and county officer's certificate, and filed with the Commission at Washington in time to arrange for the examination at the place selected by the applicant. The exact title of the examination desired, as given at the head of this announcement, should be stated in the application form.

Further information address U. S. Civil Service Commission, Washington, D. C.
of Preston's store stared in bewilderment at the plunging rock mass as it surged wildly down the stream with a terrible deafening din.

The three men, as one man, turned in terror to the gorge.

They had cause for terror, for there, between the high banks, the ice had jammed in a solid immovable barrier squarely across the stream's channel.

As the group stared open-mouthed in paralyzed amazement, towering higher and higher as the swirling waters from above swept down fresh masses of ice to be piled on the obstruction mounted steadily skyward. Higher and higher it reared itself and higher and higher rose the foaming yellow waters behind it, striving in vain to thrust aside the obstacle which blocked its path.

If it should triumph, if the swiftly widening lake beneath the jam should sweep down on the little clustered hamlet—The group then in front of Preston's store knew just how long their houses would survive that rush.

Dynamite! Dynamite! Pete Bailey shouted, and a half dozen men leaped to the shack where Joe Preston stored his supply of the explosive.

But even if they leaped they knew that no man could live in that churning tumult long enough to place a charge where it could blast the steady mounting obstruction from the channel.

"The hills! Run to the hills!" they shouted, and around the store and up the muddy slope they fled to the first steep knoll where children had already gathered at the first thundering break of ice.

Dick Preston did not run. For a long moment he stared, fascinated at the wall of ice which towered in the gap remaining the impounding wall of water. If the ice on top reached down before the water surged thru with its own mighty strength, he knew just how short would be the life of this little village, his home. But who could—

He whirled, dashed thru the store and sprang up the stairs to his room. At his wireless table he halled, jammed, the receivers down on his desk, and his fingers slammed in switches and connections.

Then with savage speed his key tapped out, "H, D, D, H, D, D,..." a salvo of the spark sounding dimly weak thru the deafening roar of ice and water outside. Again he repeated the call with frantic speed and yelled over his switch. "O, K, D, P, H, D," came the reply, barely audible thru the din.

"Ice has jammed in gorge! Can you—" the white hot spark faltered and then failed.

With a choking sob Dick peered over his instruments, trying wildly to locate the trouble. Then thru the window he caught sight of his aerial wires sagging limply along the ground where they had fallen when a guy wire peg had slipt.

"Dick! Dick! Hear me, Dick!" he heard his father calling in agonized tones, and snapping the receivers from his head he sprang up and dashed downstairs to meet his parent leaping in search of him.

"Hurry! Hurry! I'll go any minute!" Joe Preston implored and together father and son raced up the muddy slope to the knoll where the population huddled in a forlorn hopeless mass.

Would Dick's aerial have ruined the ground-based radar that had made his message unintelligible? Over and over Dick asked himself while he sped to safety.

At the gorge he looked and saw the ice wall still mounting higher while the water restrained behind it spread wider and wider in a huge menacing lake.
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tried out, but none of them could be classed as even a tolerable success. Of course, no one was charitably enough in those days to introduce the transformation of energy from dynamo to motor, and in turn from motor to dynamo, we lose about 20 being wasted, which is 100%. And 20 from 100 leaves 80%. And you can't lay a dollar for 80 cents—least not thru the cashier's window.

But there is bliss. So the other day while rummaging thru old papers, the Editor came across “Experiment 79, not tried out—looks positively feasible.” Experiment was one way was by the same old scheme. And if we do it in effect, the scheme evolved by an 11 year old school boy, is positivityopian, extraordinaire, as our French teacher would have said, pride oozing out of him by the handful, while he spoke.

And alas we never had the money to try it out. And what's more, we haven't got it now. And the way things look with the war, the H.C.L., and the cost of high living, there's no telling that we will ever get a crack at it.

But our Editor, who is very famed for his vast generosity (when his own pocketbook is not concerned) graciously donates his scheme to all Bugdom. Anyone may try the scheme, and there is only one string attached to the offer, to wit:—

Is the work done, well, the Editor is to get a free ride at least once a week! Now that's modest, isn't it?

Well then, "Experiment 79."

Build a scenic railroad in a complete circle, as shown in illustration. Hills and valleys—the more the better—just like the real thing, but now with only a fact that a car, launched on such a road will run the entire length of the track—almost, that is, it will almost come back to its starting point, but not quite. Now here's where the foxyness of the idea crops out.

While coasting down hill, the car expends a lot of useful energy. So let's harness it! We simply install a dynamo in the car, coupled to the axle of the latter. Use the electric current from the dynamo to a central storage battery. So we see that while the cars coast, we accumulate a lot of energy, and when we want to start the car, we simply discharge the storage battery to a central storage battery. So we see that while the cars coast, we accumulate a lot of energy, and when we want to start the car, we simply discharge the storage battery to a central storage battery.

Now then. As the car comes up the home stretch it runs slower and slower, and that's the place where the dynamo, which is "floating on the line" gives forth no more energy into the line. At this point the storage battery will pull up the car over the crest, and the play commences anew. If there's no hitch anywhere, the car will run on till the tracks are worn out!

Sounds perfectly logical, doesn't it? Now why in Sam Hill don't it work?

EXPERIMENTAL PHYSICS. (Continued from page 250)

the power, our total energy, which is down on mother earth in great haste. (It may be advisable at this stage of the experiment for you to retreat).

EXPERIMENT 31 (See Fig. 26)—Place a card on a table with part of it projecting. Place a coin on the card. If now a carrom, which is visible against the protruding end of the card, the card will fly off and the coin will tend to remain at rest and drop down underneath. With a little practise one may acquire skill and can place the card on one of the fingers of the other hand and perform the same experiment.

EXPERIMENT 35 (Fig. 27)—This represents the game of throwing the ball which can be purchased in the five and ten cent store, as well as the blocks to make this game. For instance, having obtained a card in the shape of checkers, together with a wooden head, and a wooden hammer of slightly smaller diameter than the blocks. With a slight brushing of the blocks to make it possible to knock off block F, without the rest of the pile being disturbed.

EXPERIMENT 36—So far we have considered only part of the First Law. The fact that mud flies off a bicycle wheel tangentially leads up to the consideration that bodies tend to maintain not only the direction of motion. It is inertia that keeps the water from falling out of the hull when swing ing. It makes the lasso that is sucked into the loop in the scirne; Railway and the amuse ment parks. Inertia causes rotating liquids to move out of the car in the axis of rotation; it makes flywheels hurt sometimes; it makes the diameter of the earth at the equator greater than at the poles; and generally it limits the size of the nuclear reactor. In reality it is the poisoning of just such wells that the force from the strongons of the brooms. CONSTITUTION is also largely responsible for the irritating effects which lead to the loss of PICKLE. Vital Flowers! Read what STRONGFORTIS has done for others!

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When the board A is in place the wind from the fan pushes against it, but since both the board and the fan are attached to the same wagon, no motion occurs. On a calm day, if motoring rapidly, we feel a wind. Our pushing against the air causes the air to push against us and we get the sensation of wind. The aeroplane is propelled by the reaction of the air against the propellers.

In the case of a man rowing a boat, the man pushes against the cars, the cars against the water. The reaction of the water against the cars is transmitted to the boat, and it moves. When one jumps off a boat, the boat experiences a backward thrust. When a bullet is shot from a gun or a shell from a cannon, the gun 'kicks' or the cannon is pushed back by the reaction. If the two bodies considered are of the same mass the action and reaction are easily seen to be equal in magnitude, but otherwise it may be difficult to see it at first consideration. We must remember that the quantity of motion is in each case the product of the mass by the velocity.

The importance of Newton's laws cannot be overrated, and examples of their application can be found without end. It is suggested that the reader look about him for as many examples of each as he may recognize. The writer will be glad to correspond with those further interested in this subject.

"BATS."  
(Continued from page 281)

The top of a cloth bag of dropshaped and knobby surface can be true convex for its appearance by its maker only; but it worked perfectly, and faithfully gave up its little trickle of "juice" for the operation of its 20,000 terrains. What should we ever have done without it?

Of course, like all worldly things, it had its faults; Sal-ammoniac is harmless to the human system unless you happen to get it on a cut, when it makes you execute a few capers and forget your other troubles) but its appetite for copper is unlimited, and its cunning hygroscopic habit of creeping out of the jar and spreading itself around, made it a nuisance. We have not endeared it to any member of the family, from the cat up. On returning from a summer vacation, I have more than once found myself terminated my Washington by the center of a spongy mass of a beautiful grass-green color, while everything within several feet was covered with the damp snow of sal-ammoniac crystals. I always used to go to the Washington, setting out one of these batteries in the midst of a boundless plain and seeing how far one jar-full of the stuff could spread itself if it had plenty of time and room; I believe it would cover the earth.

While the Leclanché battery was always our standby, it had its limitations. Its resistance was high, its current of small quantity, and on being short-circuited it simply polarized and died. We tried Emsen's, but they were far too expensive. But with the coming of the telegraph era, we took up gravity cells, and they soon proved to be a warmer and steadier sort. Sturdy cells worked 24 hours a day, as long as the slightest color of copper sulphate remained in them. We were never able to get of the clean-cut line of the blue solution, held in place at the bottom of the jar by its excess weight over the transparent solution above—a difference, of course, not apparent to the eye.

This battery plighted our inventive faculty because it furnished us current different from what we needed. Not only when we were using the telegraph, but all the time when we were at school, or in bed and asleep, it plodded away, and the only thing it only recognized, it! but it was impossible. If the circuit was left open, the blue solution rose by diffusion till it directly attacked the zinc, when mud and long strings of copper metal began to form, and soon the battery were ruined. Neither could you economize by lighting out this line of the blue again, for the diffusion took place, and you couldn't put it back without raising all sorts of chemical complications.

No use; we had to stand by and see all that beautiful "juice" wasted while we needed it elsewhere. It manufactured more in one day than the Leclanché cell did in its lifetime, yet it was useless because it couldn't be held back. Even the similar Daniell cell, with its porous cup, couldn't keep it over the copper plate thru a very use up the copper sulfate on its depolarizing job faster than it could spread by diffusion. All the text-book writers said there was no help for it.

But text-book writers have never been boys!

When clocks came in, the demand became still more pressing. Here was a mechanism which required but little current, to be sure. A "Leclanché" would run it for months; but that only made the gravity cell, in its obstinate generosity, more expensive. A gravity cell would run three months on one charge of sulfate, producing in that time enough current to run the clock for 40 years by mere calculation. If one could only choke it back!

Fools rush in where scientists are afraid of getting the laugh. In spite of the text-book writers, Dr. Daniell and the Lion's Den, I puzzled over ways to strangle that cell.

It first struck me to confuse the sulfate solution in a non-porous cup, and let it occum in a very small hole, instead of exposing a great area

(Continued on page 284)
In this Department we publish such matter as is of interest to inventors and particularly to those who are in doubt as to certain Patent Phases. Regular inquiries addressed to "Patent Advice" cannot be answered by mail free of charge. Such inquiries are of the benefit of all to whom they are addressed. If the idea is thought to be of importance, we make it a rule not to divulge details. In order to protect the inventor as far as it is possible to do so, no such advice is given by mail and a nominal charge of $1.00 is made for each question. Sketches and descriptions must be clear and explicit. Only one side of sheet should be written on.

DETACHABLE HEEL.

(166.) Joseph Paczy of Glassport, Pa., submits to us a very ingenious idea whereby an ordinary leather heel on a shoe can be detached when it is worn out, in a very simple manner thereby making it unnecessary to take the shoes to the shoemaker or repair shop. His idea is to get the shoe people to stock these special heels, which can then be attached by anyone without any tool whatever.

A. This is a capital idea, and no doubt a patent can be obtained. In case nothing similar has been patented before, and we doubt there is, we think a valuable patent may result. We would advise our correspondent to get in touch with a patent attorney.

Mr. Paczy also submits to us a design of a tooth brush, the idea being that it could be used for brushing teeth on the inside of the teeth as well.

A. We do not think this idea is patentable, and we believe several brushes similar to this one have been in use.

SUBMARINE MINE.

(167.) Elmer Wally, of Carnegie, Pa., encloses diagram and description of a self-explosive mine for harbor defense. The mine is supposed to be exploded when a submarine comes in proximity to it. The principle is based upon a highly magnetized needle which the submarine is supposed to deflect, and then auxiliary contacts cause the explosion of the mine, or otherwise the current for the mines may be supplied from the shore; thus doing away with the batteries of the mine itself.

A. We do not favor the first idea at all, as it is not practical, being too dangerous; i.e., the mine might explode prematurely if a fragment of metal or iron were to come into contact with the second idea is not new. The United States Navy is using similar mines controlled from shore. We cannot give any encouragement on these two ideas.

GAS SPARK GAP.

(168.) Harry McLain, Jr., Pauhska, Okla, has made some experiments with a bunsen burner and spark gap, and found that by means of the bunsen burner, the spark can be lengthened out several times its original value. He wishes to know if this is a new discovery and whether the idea is patentable. Also if it is to any advantage in any form of electrical apparatus, wireless, etc.

A. Nothing new is suggested in the design, which is old. If you take an ordinary candle and spark gap, and let the spark pass across the lighted candle flame, the spark will be lengthened considerably. The reason is that all flames contain large amounts of hydro-carbons, due to the combustion of carbon or whatever other materials are burnt up, and these carbon particles as well as the hot air form a much better conductor than the common atmosphere. This is the reason why the spark is lengthened out considerably. There is nothing new in this experiment, which has been performed by various physicists over 100 years ago.

SELLING PATENTS.

(169.) Fred Jeffries, Pascack, N.J., wants to know the best place to dispose of a patent. Mr. Jeffries is an electrician and has a patent on an electrical device which he desires to dispose of.

A. The Electrical Experimenter cannot officially give the names of persons who are likely to buy electrical or any other patent. The safest and best way is to advertise an illustration of the patent drawing in our advertising columns or otherwise in local newspapers. It might also be a good idea to send copies of the patent to advertisers in The Electrical Experimenter who make a specialty of manufacturing electrical appliances.
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Yes, the Radiotone is SILENT. In fact, it is so silent that you must place your ear on top of it to hear its beautiful sounding note.

You will be astonished at the wonderfully clear, 500 cycle note, sounding sharply in your receivers, when operated on one day cell. To learn the codes, there is absolutely nothing like it. The Radiotone is a key and one dry cell and ANY telephone, a fine learner's set is had. Two or more sets in series is always as perfect a set for pleasure for intercommunication use. Particularly now that wireless is coming to be known, the Radiotone is already in wonderful demand. All the interesting things that children ask for are being worked out for the CODPHONE (see our big ad on pages 256-7, this issue), can be performed with the Radiotone, a key, a dry cell and a phone.

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the internal resistance. The final form to which I carried the sheet is shown in Fig. 3. This is like Fig. 2, except that the capillarity is secured through several layers of burlap packing, straddling the entire edge of the inner cup. This reduced the resistance to a point where the electric output was as great as that obtained with a swinging-magnet annularator-drop very well.

Munn says the idea is patentable, but none of us is better informed. I may have the invention over to Bugdon for improvement. If such a form can be given it that the capillary mass is very much larger than the acid, it will give a big output big enough for a clock; at present it doesn't, but it is ample for any high-resistance indicating device, electrolyte, electrolytic cells, etc. As to its staying powers, I had one of these cells on open circuit in my shop for four years, testing it with the annularator-drop from time to time. At the end of the period the liquid had evaporated out by a half, owing to my cover not being perfectly tight; but the zinc plate was very little consumed, the liquid level the other jar was as clear as spring-water, the blue solution remained in the inner jar with no diminution in the sulfuric rooys, I had added to it in the beginning. The current would still work the annularator-drop, tho not as vigorously as at first, probably due to the liquid levels being a little lower. I leave the old house then, and as the battery couldn't be moved the experiment was over.

Why don't you give it a try. Bugs, just to while the time away till they give us back the air? That "hat's" a handy little thing as it is; and you could devise some low-price form that you could couple on to a clock and run the thing 5 to 10 years at a stretch—well, s'ay!

**EXPERIMENTAL CHEMISTRY.** (Continued from page 274)

also, by the finger or towel, any nitrat adhering to the tubeule, as it is liable to crack the retort on heating. The retort may now be readjusted in position. Pour into a tube about 20 cc. of strong Sulfuric Acid [H₂SO₄], and using a glass funnel, as to keep the acid out of the retort neck, pour it into the retort. Rinse the funnel, replace the stopper in the tubeule, and adjust the retort in position. Allow the acid to remain 5 minutes, or 5 cc. or more of liquid has collected in the test tube.

Upon the introduction of the Sulfuric acid into the retort, action will probably commence at once, but a gentle heat should be applied, whereupon the volatile Nitric Acid passes over and is then collected in the test tube in the bottle or tumbler, which should be kept cool. A few pieces of ice may be placed in the water.

The reactions which will probably take place are:

$$\text{NaNO}_3 + \text{H}_2\text{SO}_4 \rightarrow \text{Na}_2\text{SO}_4 + \text{HNO}_3$$

Sodium Sulfate Sodium Nitrate Nitric Acid Sulfate

or

$$2\text{NaNO}_3 + \text{H}_2\text{SO}_4 \rightarrow \text{Na}_2\text{SO}_4 + 2\text{HNO}_3$$

Sodium Sulfate Sodium Nitrate Nitric Acid Sulfate

The reason for these two equations are more fully explained under the heading PERSISTENT PARADOXICAL PHENOMENA.

Note all phenomena, fumes, color, whether or not the color changes with varying temperature, effervescence, whether anything is thrown on the retort, color of the liquid collected, etc.

As soon as the lamp is removed, pour 5 or 10 drops of Ammonium Hydroxid [NH₄OH] into a dish and dip a small piece of paper or stirring rod into it; then bring the alkaline paper or rod to the tubeule, removing the stopper with a cloth if it is hot. This will prevent the contents of the retort from being exposed to the air.

Note any action and fumes [whether gaseous or solid].

To remove the collected acid, which should lie done soon after the lamp is taken away, lift the entire ring stand with one hand and with the other grasp the test tube by its neck. If there be any foreigner and set it in the rack. [Use great care at all times not to get any of this acid on the flesh or clothing, as it is very corrosive. Let the ring stand in such a position that any acid may drip from the nozzle into the sink; then raise the retort from the sulphuric acid by changing the clamp screw. Put a funnel into the tubeule and pour water thru it into the retort bub [cautiously at first, if the acid is known to be cleaned all, the entire retort, running water several times thru the neck, bulb and tubeule.

**EXPERIMENT NO. 83:**

Note the color of the liquid obtained in the preceding experiment, and if you have some of the commercial acid at hand, compare with it in this respect.

Apply a piece of litmus paper to the liquid thus obtained in the preceding experiment, and if an acid is present it should give an acid reaction with the litmus.

Obtain a piece of colored cloth [woolen] and permit a few drops of the acid to fall upon it. Dense fumes should rise from the cloth, and the cloth should become discolored, as the rotten. From this it is obvious what would occur if this acid were to come in contact with one's suit or other cloth; thus it is obvious that great care should be exercised not to permit it to spill.

With a glass tubeule thick enough to keep the liquid on a quill, a feather or a piece of white silk; also place a drop on the finger nail, but wash it off at once. Note any change in the color of these substances. Pour into a dish a few drops of ammonium hydroxid [NH₄OH] and, using the rod, put a drop of the acid thus just touched with the acid, noticing whether the color is intensified or reduced.

Dip a splint and a narrow strip of paper into your liquid, dry them, and then set them on fire, noting how they burn.

**EXPERIMENT NO. 84:**

Put a few pieces of copper clips into a dish and pour over them some of the liquid obtained. [This is the same experiment as No. 28 in the January, 1917, issue of the ELECTRICAL EXPERIMENTER, page 666]. In Experiment No. 28, it was stated that hydrogen was not liberated by the inter-action of Copper and Nitric Acid, the equation being:

$$\text{Cu} + 8\text{HNO}_3 = 3\text{Cu(NO}_3)_2 + 4\text{H}_2\text{O} + 2\text{NO}_2$$

Copper Nitric Copper Water Nitric Acid Nitrate

[Note—In Exp. 28 this was given as Nitrogen Monoxide.]

As we did not take up the reason why Hydrogen is not liberated when Copper is reacted upon by Nitric acid, and this paper deals with the acid, it will be out of place to show why the Hydrogen is not liberated.

When moderately dilute Nitric acid [density 1.2] acts upon copper, the reaction may be expressed by the following equations:

$$2\text{HNO}_3 = \text{H}_2\text{O} + 2\text{NO} + 3\text{O}_2$$

Nitric Water Nitric Oxygen

$$3\text{O}_2 + 3\text{Cu} = 3\text{CuO}$$

Oxygen Copper Copper Oxide

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