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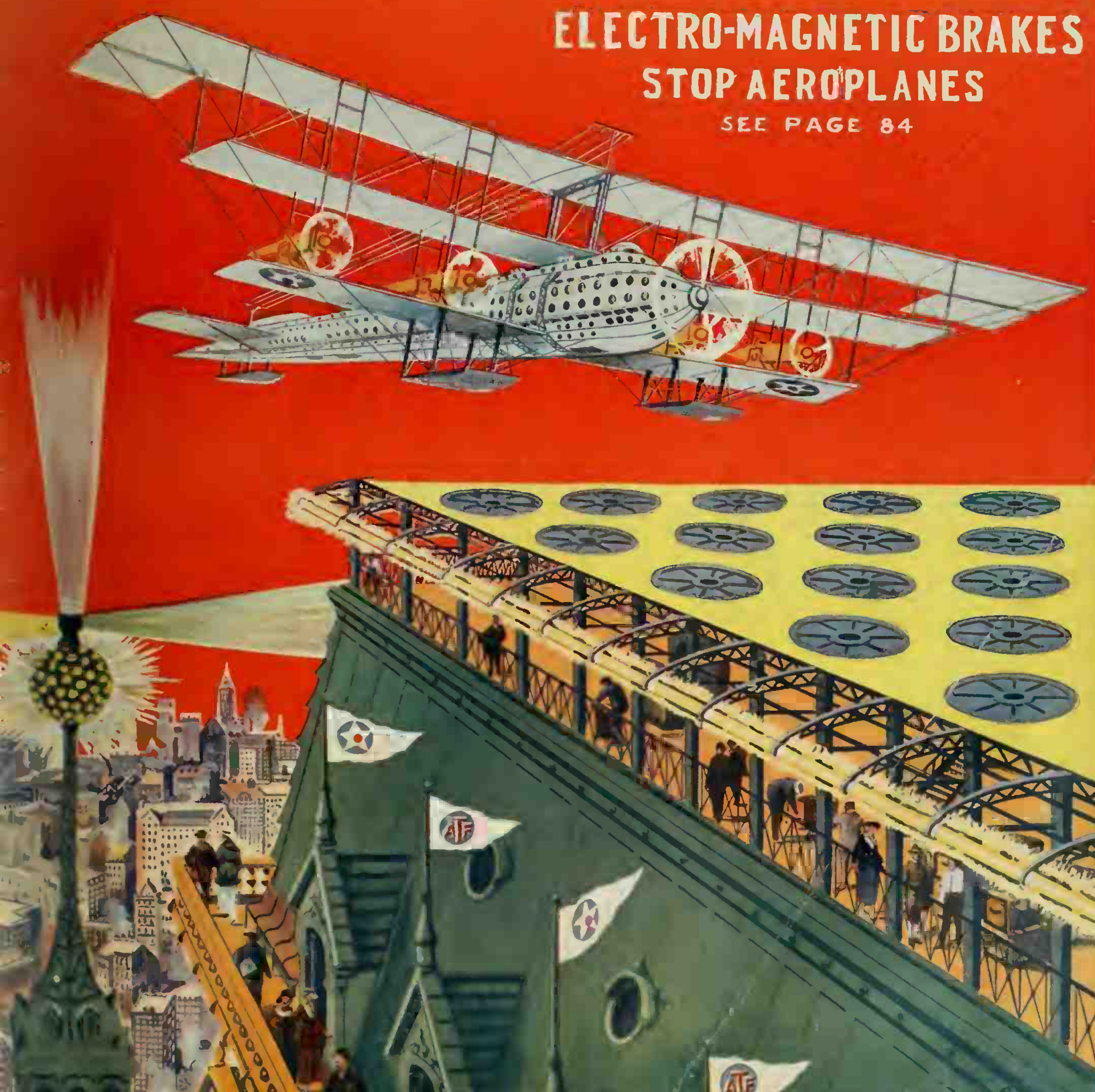

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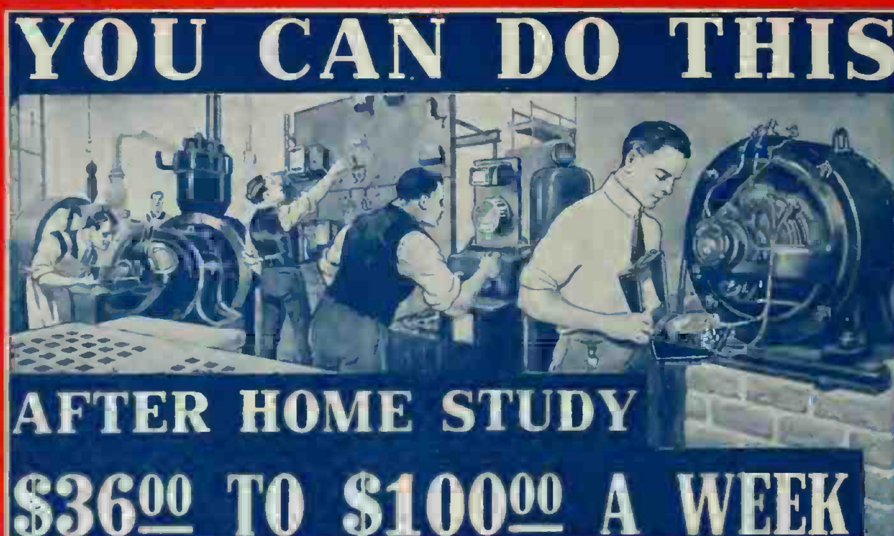

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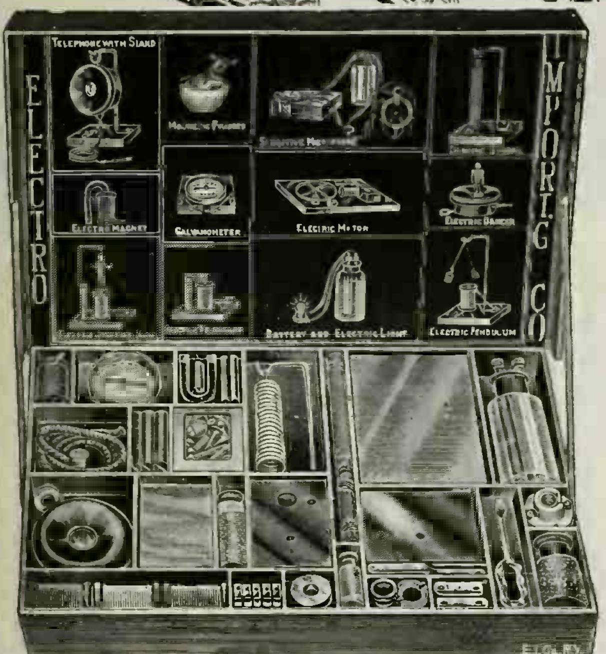

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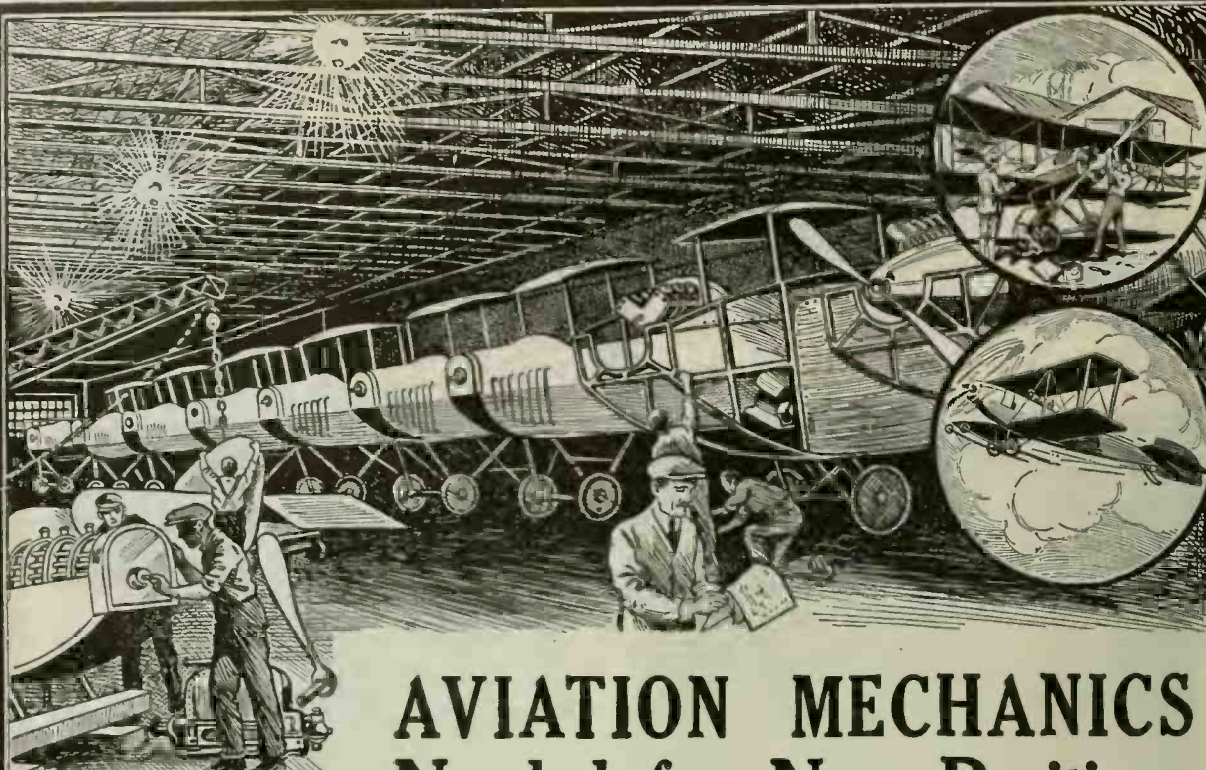

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EDITORIAL

MAGNETIC STORMS AND WINDS

ONE of the most puzzling scientific phenomena is the so-called local magnetic storm. Much has been written about this subject and many theories have been advanced, none very plausible.

Of late Professor Francis E. Nipher, of the Academy of Science of St. Louis—the distinguisht scientist who demonstrated experimentally gravitational repulsion—has shed new light upon the subject. Professor Nipher who, as is well known, is not a theorist, always supplies experimental evidence when announcing new scientific discoveries. Such being the case, and bearing in mind that the professor is an exceedingly exact and painstaking worker, it will come as somewhat of a shock, that an ordinary wind is one of the direct causes of local magnetic storms. At first blush this sounds most preposterous, for who ever imagined that the motion of the air could possibly influence a magnet? Nevertheless it is a fact supported by a wealth of experimental evidence.

Professor Nipher began by reasoning that the magnetic force of a bar magnet might be diminished by draining negative electrons from it. He actually accomplished this by means of a static machine. Then it was found that while observing a carefully screened magnetic needle during a wind storm in which sudden and violent wind-gusts occurred, the oscillations of the needle were affected in a marked way at the beginning of the wind-gust. The oscillations of the needle were suddenly and greatly changed.

Careful and exhaustive experiments were subsequently carried out at Professor Nipher's summer home at Hessel, Michigan, in a tent 50 feet from Lake Huron. The magnetic needle was a piece of knitting needle 7 cm. long suspended upon an unspun silk fiber 40 cm. long. The enclosing case was a large glass bottle, entirely air-proof, so that no atmospheric disturbances could possibly reach the magnetic needle. Attached to the latter was a small mirror by means of which the motion of the needle was observed in the usual manner with a telescope and scale. A number of elaborate precautions (by means of control magnets) were taken to make the needle as independent as feasible from the earth's magnetic field, as well as preventing mechanical shocks from reaching the suspended and magnetized needle.

It was then found—and a mass of proofs exist to substantiate the facts—that on days when the wind blows in gusts at intervals of 1 or 2 minutes, the needle is more unsteady in its motions than on quiet days. How the needle *predicts* a gust of wind is best seen in the following occurrence:

At 1:10 P. M. on July 14, the needle began to vibrate to and fro, continuing in its motion for 9 minutes. Then a sudden and violent gust of wind came in from the lake to the south, overturning a sail-boat lying 200 feet away from the observation station. About 8 minutes later the wind had practically ceased, and the oscillations of the needle had ceased as well. Many similar observations were made during the summer, all with the same results.

Professor Nipher's explanation of this strange phenomenon is that a wind disturbance, such as a tornado, among the atmospheric ions, which accumulate along the magnetic lines of force, at or near the earth's magnetic poles, is responsible for some of our widespread magnetic storms. Of course a small wind disturbance could hardly produce more than a small local magnetic disturbance, but it certainly does exist.

But the wind alone is not the sole cause of local magnetic storms. The rain as well as cloud shadows produce the same effects. Thus when small clouds are scattered over the sky and a local fall of rain occurs at the observation station, the sunlight passing thru the air thru which the rain-drops fall, a very marked magnetic storm results.

Furthermore, while the sun was hidden by clouds, the needle usually remained undisturbed. But as soon as the sun came out the needle at once began to oscillate markedly.

In an article of this kind it is impossible to present the full evidence of Professor Nipher's experiments, but it is quite apparent that local variations of the earth's magnetic field are determined wholly by local weather conditions.

Discoveries such as these tend to show how very incomplete our knowledge is as yet of magnetism and how much there remains for us to learn.

H. GERNSBACK.

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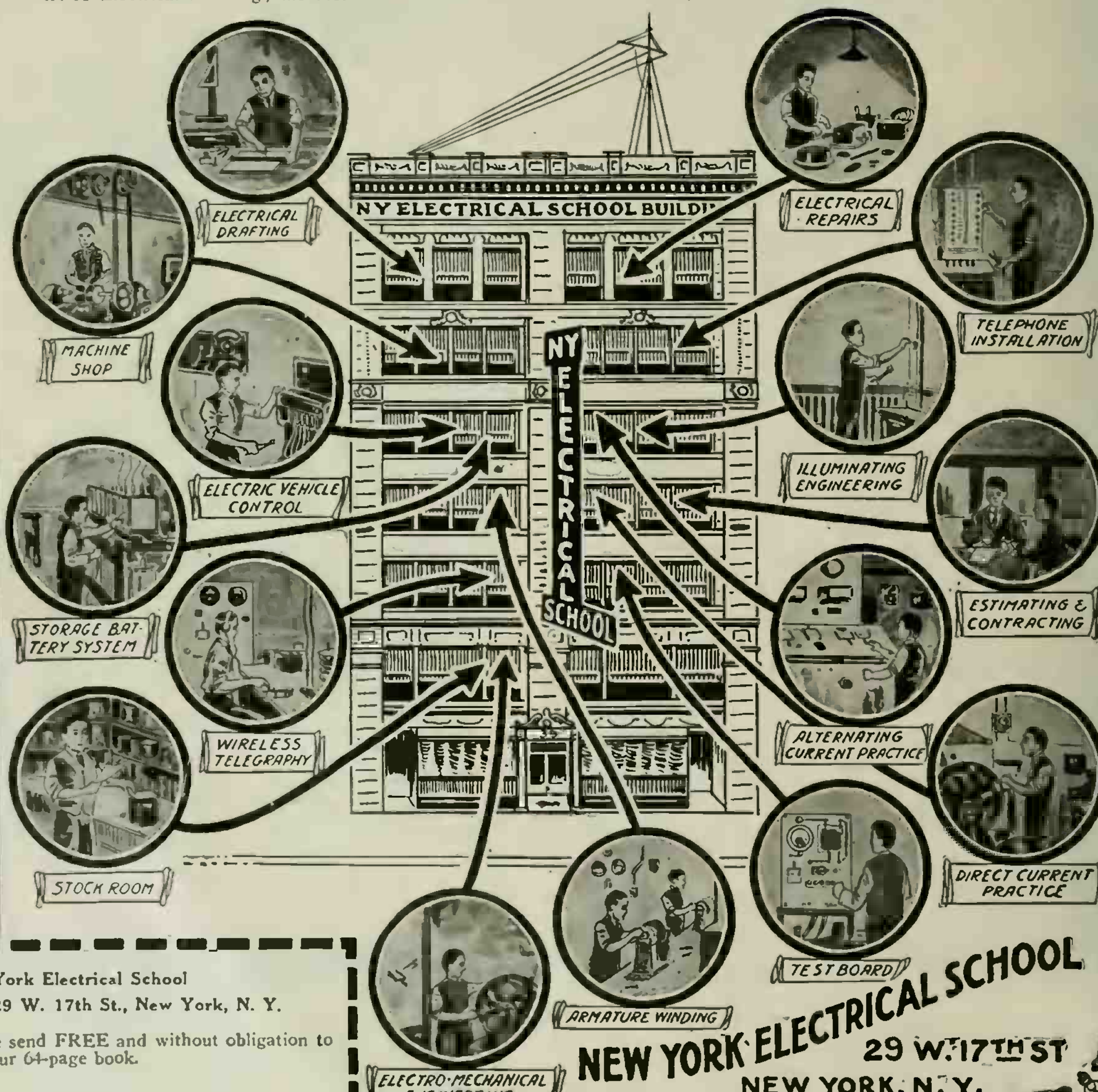

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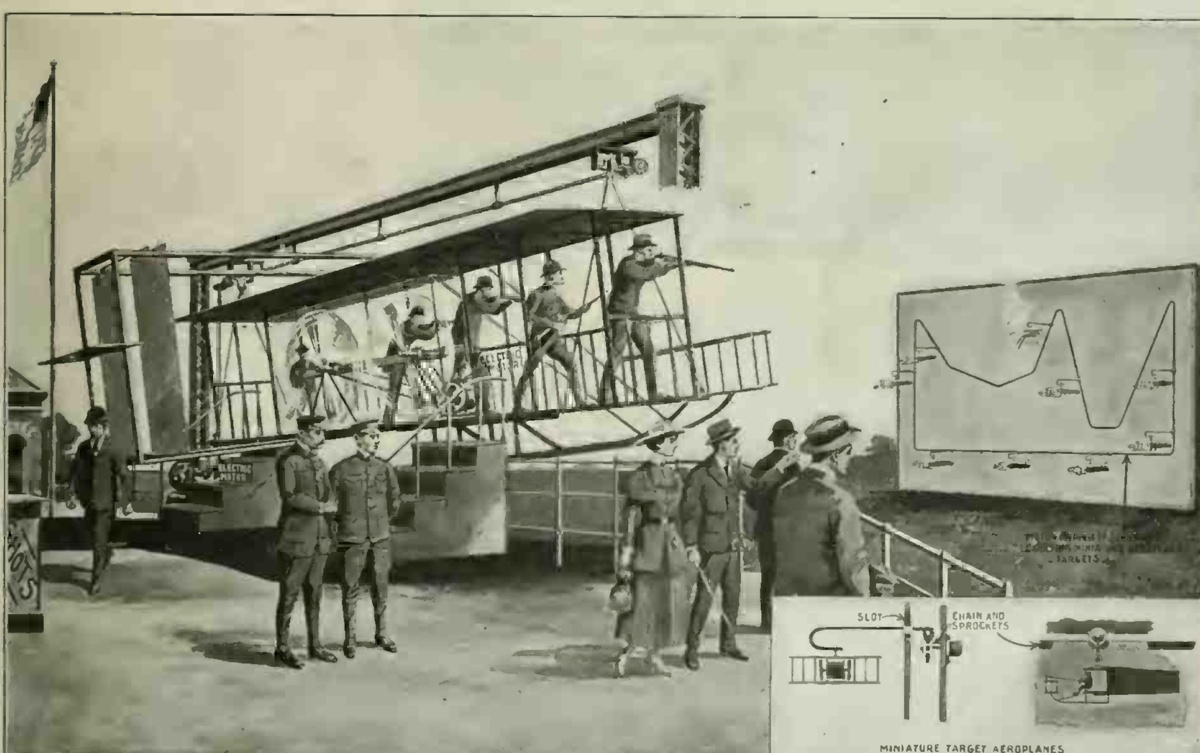
Vol. VI. Whole No. 62 JUNE, 1918 Number 2

An Electric Aeroplane Shooting Gallery

ALL aboard for the electric aeroplane shooting gallery—three shots for a dime! Right this way, Gents. Wing a "Boche" plane in flight! This may be the speech that greets you in the large amusement parks this summer. We predict it will make a sure-fire hit with the amusement-seeking public, men, women and children. This recently patented contrivance is intended to give one all the sensations of actually shooting at a moving target, in this case a miniature aeroplane, from an aeroplane in flight. As the inventor, Mr. Frederic W. Thompson, points out, considerable skill will be required of the marksman to hit the moving target for the reason that the platform on which he stands will be constantly pitching and rolling, and moreover, the captive plane can be made to roll just like a real one, in two directions, *i. e.*, up and down from side to side, and back and forth from front to tail. The whole arrangement is very cleverly designed so as to require the minimum of power to actuate it, and small electric motors do all the work of putting the flying machine thru her paces. It's quite a trick to hit a bull's eye from a moving plane, especially with a single bullet, which is quite different than the case of the regular army aviator, as there the gunner has the use of a rapid-fire machine gun which fairly sprinkles the air with bullets for a considerable area, and even then the enemy flyers do get away without being hit.

In order to accomplish the desired result, use is made of a shooter's stand in the form of an aeroplane, a distant target, and mechanical means holding the shooter's stand suspended in mid-air and imparting a rocking motion thereto. Use is also made of means for detachably suspending the target and carrying it along in an endless



Shooting Down "Boche" Aeroplanes From a Moving 'Plane, With All the Accompanying Sensations, Is the Latest Amusement Device Perfected by an American Genius. The Movement of the Shooter's 'Plane as Well as That of the Propellers and Targets Is Accomplished by Electric Motors. It Promises to Make a Wonderful Hit With the Public This Summer.

(*Continued on page 132*)

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Moving Pictures That Really Talk

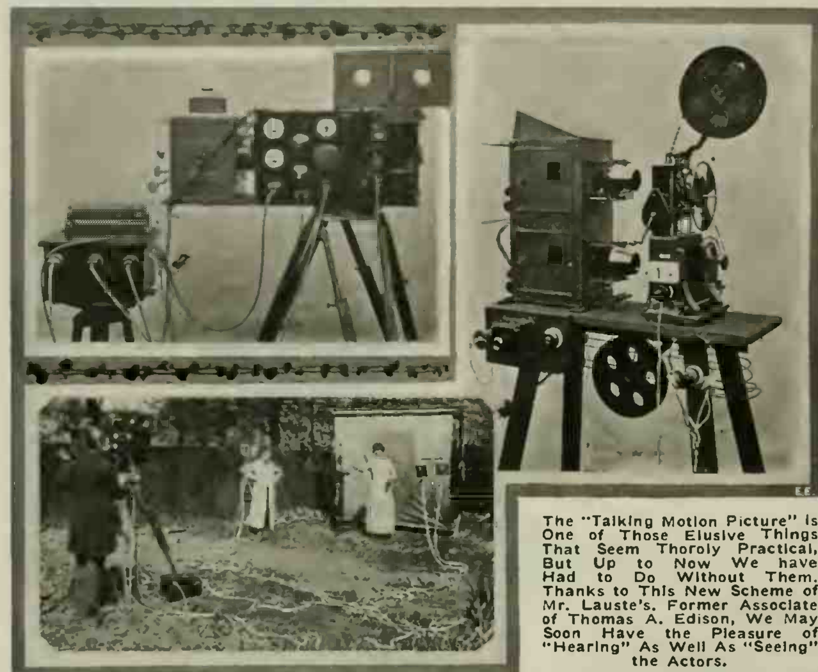
By GEORGE HOLMES

NOT so very long ago the world was startled with a new wonder, the *cinematograph* or *motion picture* as it is now known. Its rise has been phenomenal until now the "movie" business is one of the first in the land and the aggregate capital runs into the millions. In its present form it has done much to relieve humanity of its cares and worries, and for a nominal sum one may take his family to a theatre and pass a pleasant evening.

Nevertheless, inventors saw that there were more possibilities in the "films" than just a plain black and white picture; there were those who thought that in time the movie would eventually rival the spoken stage, and to this end countless men have been applying their time, money, everything to secure films that would be clear, sharp in Nature's own colors and last of all—with *speech* in perfect synchronism!

Color-photography has lately been realized by a prominent inventor, and now comes Mr. Eugene Lauste, a French inventor, who evidently can lay claim to having perfected a successful method of taking and reproducing "talking movies" that are well nigh perfect, both as to tone and synchronism.

Coming as this does from one who since childhood has dreamt of this great ideal, and made a persistent study of this great art, one may expect much. Mr. Lauste was born in Paris in 1857. At the tender age of ten when only a mere boy he conceived the idea of "motion pictures." Taking a strip of paper from the "Wheel of Life" or *Zeotrope*, he soaked it in oil to make it transparent and then pulled it thru a magic lantern in a series of jerks. Of course, this was very crude and at first no conceivable idea could be drawn from this procedure till one day, while adjusting the machine he happened to be holding his hand over the front lens in such a position as to cause a narrow slot to be formed between his fingers. By closing and opening this slot he struck upon the idea of the principle for a *shutter* which excludes the light while another picture is drawn into place. So obsesst was he with the idea that from then on it might be said that he has made it his life work.



The "Talking Motion Picture" Is One of Those Elusive Things That Seem Thoroly Practical, But Up to Now We have Had to Do Without Them. Thanks to This New Scheme of Mr. Lauste's, Former Associate of Thomas A. Edison, We May Soon Have the Pleasure of "Hearing" As Well As "Seeing" the Actors.

It might not be amiss to give a brief history of Mr. Lauste's work in that it will add weight to his claim of having invented a real "talking movie." From 1886 to 1892 he was associated with Mr. Thomas A. Edison, first at New York and later at the Menlo Park and Orange, N. J., laboratories.

While there in the year 1887, the Edison Kinetoscope first saw the light of day. It was not a projector nor did it have any form of escapement. The film ran continuously behind a peep hole and the pictures on it were viewed directly by means of a small magnifying eye-piece with a lamp arranged to shine between them. The film was of the present-day gage and with pictures of the regular size. From Edison he went to the Westinghouse Company, and from there to the Eidoloscope Company. Next he was associated with the Biograph Company, where he worked the giant cameras of the early pioneer days. In 1897 he went to England to show the Biograph Films.

During his wide and varied career Mr. Lauste has met and become acquainted with many noted persons, among them being Mr. M. J. Marey, a Frenchman, who might have received the honor for the invention of the cinematograph, had he foreseen the possibilities of his "Photographic Gun" which he built in 1876. It was not primarily intended as a motion picture camera and therefore he cannot lay claim to the title of father of the Cinematograph, which might otherwise have been his.

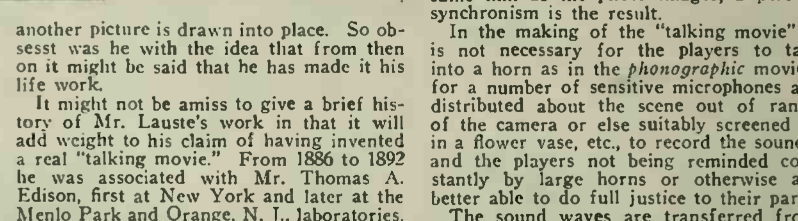
In operation the "gun" was much the same as an ordinary gun, except that instead of shooting bullets when pulling the trigger, a number of instantaneous photographs are recorded at very short intervals. The Marey gun has been resurrected during the present war and is used extensively for taking military photos from aeroplanes.

Mr. Lauste's *talking picture system* is somewhat apart from the method which was tried several years ago and which no doubt many people recollect, in that in his system no phonograph and phonographic methods are employed either in taking the picture or in the reproduction. In this new method a selenium cell and telephone system are used to reproduce the sound directly from the photographic film. The film passes continuously in front of the selenium cell and no stylus or contact of any kind is necessary. The sound waves are reproduced with utmost clarity and fidelity and since these *sound lines* are directly on the same film as the photo images, a perfect synchronism is the result.

In the making of the "talking movie" it is not necessary for the players to talk into a horn as in the *phonographic* movies, for a number of sensitive microphones are distributed about the scene out of range of the camera or else suitably screened as in a flower vase, etc., to record the sounds, and the players not being reminded constantly by large horns or otherwise are better able to do full justice to their parts.

The sound waves are transferred from the microphones thru wires and a storage battery to a highly sensitive string galvanometer or oscillograph. The string or sensitive wire is suspended in the field of powerful electro-magnets and a very slight variation of the electrical impulses transmitted from the microphones is sufficient to set the wire in motion. A beam of light

(*Continued on page* 136)



Specimen Record of Voice (Top) and Motion Picture (Bottom) Photographed Simultaneously. The Voice Record Is Made By a Strong Arc Light and Galvanometer. Reproduction of Speech Is Caused By Light Acting On a Special Selenium Cell.

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HAVE you ever thrown the hammer at athletic events? If so, then you have a correct idea of what centrifugal force is, the force, so physics teaches us, which bursts flywheels as well as speeding the athlete's weight, all due to the fact that a revolving body always tends to lengthen its radius of rotation. That is, it tends to fly outward on an ever-expanding circle.

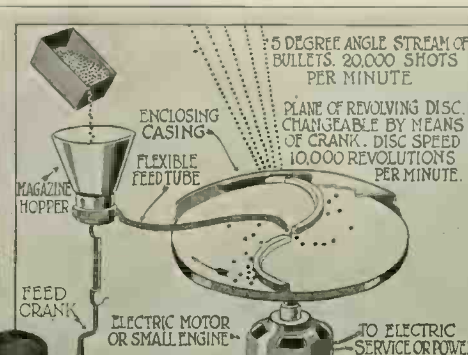
A Boston inventor, Mr. Levi W. Lombard, has brought forth a new death-dealing marvel which may prove of inestimable value to the Allies. It is nothing less than an "electric machine gun" which can hurl forth a perfect rain of bullets at the rate of 20,000 shots per minute or more.

It is therefore practically noiseless, smokeless, barrel-less and fool-proof. It has no barrel, which, is decidedly a good feature in this war, rendering it far less conspicuous than other guns provided with barrels.

Tests are said to have proved the gun's high efficiency. The new weapon has no barrel, operating on the principle of a sling. The latter operates under a disc which revolves at tremendous speed. The ammunition is fed thru a funnel-like attachment from a tube which leads into two veins beneath the disc as the drawing herewith shows, and so rapidly does the gun consume bullets that the services of an operator are necessary every moment in order to keep the ammunition hopper loaded with steel missiles.

The veins center upon an opening about two inches wide and the bullets are thrown with terrific velocity. Electricity, gasoline or steam engine is the source of energy. The weapon can be placed in first line trenches and operated hundreds of feet in the rear, simply by the connection of an ammunition feeding appliance, the steam pipes or electric wires and a simple attachment for the changing of the machine's range. The inventor states that in a recent test the gun demonstrated its force and accuracy by firing hundreds of bullets into sheets of steel plates, three-quarters of an inch thick, placed hundreds of feet away. Many of the bullets went thru the plates. As high as 33,000 shots per minute can be fired with this gun, its inventor claims.

Referring to the illustrations herewith, the Lombard electric machine gun has a two-groved disc as shown, revolved by a motor at 10,000 revolutions per minute or higher. This causes two bullets to be released thru the 5° slot in the casing at every revolution or 20,000 shots per minute. Tests have shown that bullets leave the gun at a velocity of 2,000 feet per second. The steel plate here shown is 9/16 inch thick and was penetrated by bullets fired from this gun. The bullets come out in a spray 5° wide, which can be aimed as desired.



This New Electric Machine Gun Beats Them All, According to Tests Recently Made With It. No Powder Whatever Is Used. An Electric Motor, Which Can Be Controlled From Any Distance, Whirls a Centrifugal Impeller Disc, Which Spits Bullets at the Rate of 20,000 to 33,000 Shots Per Minute. Note the 9-16ths Inch Steel Plate Punctured.

© Photo International Film Service

FRENCH WAR CAPTIVES TURN HUMORISTS.

The accompanying illustration shows one of the humoristic silhouettes made by French soldier artists interned in Switzerland. It shows the Kaiser in one telephone booth and a figure representing God in the opposite booth. Evidently the Generalissimo of the "Potsdam gang" is carrying on a long distance telephone conversation with his much vaunted *co-ally*, "Gott," while the "Boche" guard stands at attention. If the allied army keeps up its good work of annihilating the Hun troops the private telephone line between "Me und Gott" may become much overheated; in fact, so much so that the "fuse" may blow out, leaving the Kaiser and his Potsdam miners in utter darkness so far as spiritual light is concerned. In fact, we have a strong impression that the "fuse" blew out when that 76-mile shell hit a church in Paris, killing about a hundred innocent women at worship, and we'll aver, too, that it wasn't the Kaiser's talk that overloaded the line and blew the "fuse."

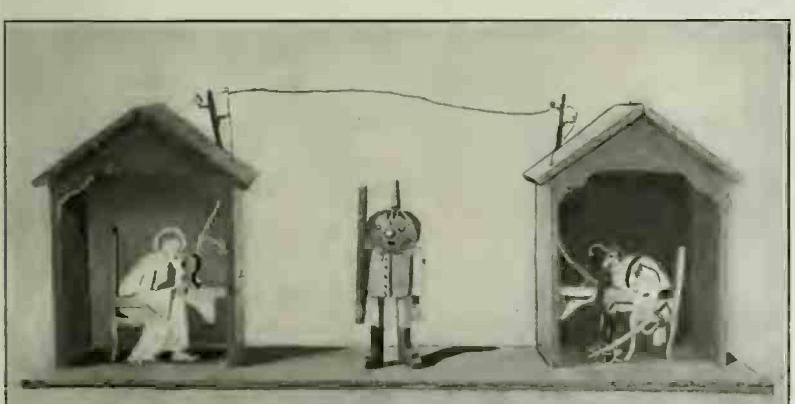


Photo from French Pictorial Service

You Guest It! The Kaiser Is "Telephoning" His Co-Ally—"Gott," of "Me und Gott" Fame. This Grotesque Silhouette Was Made by French Soldier Artists Interned In Switzerland.

The University of California is teaching farmers to use electricity. In the near future the indications are that the efficiency of electricity on the farm will be generally recognized and adapted.

BACK NUMBERS!—Many readers desire to obtain back numbers of this journal. We have a limited quantity of these back issues on hand and can supply them at the following rates:—Back numbers of The Electrical Experimenter not over three months old, 15 cents each; over three months old, 20 cents each, over one year old, 35 cents each.

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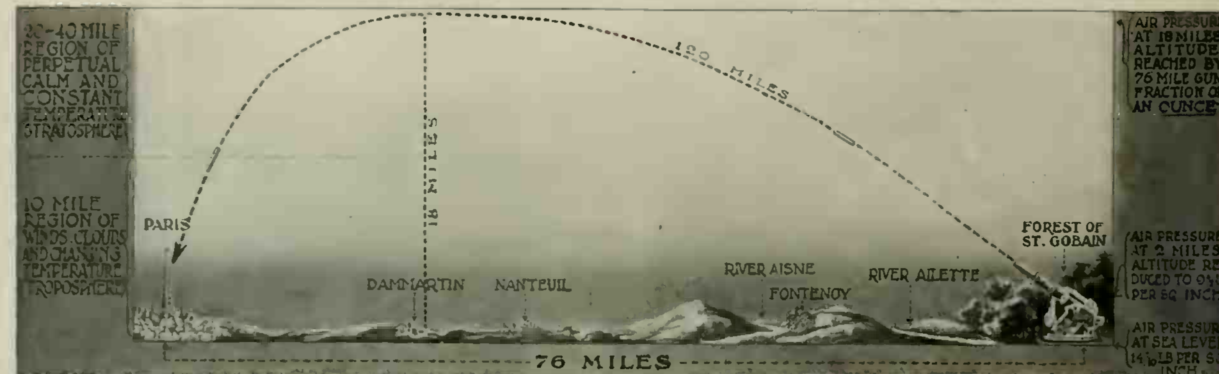
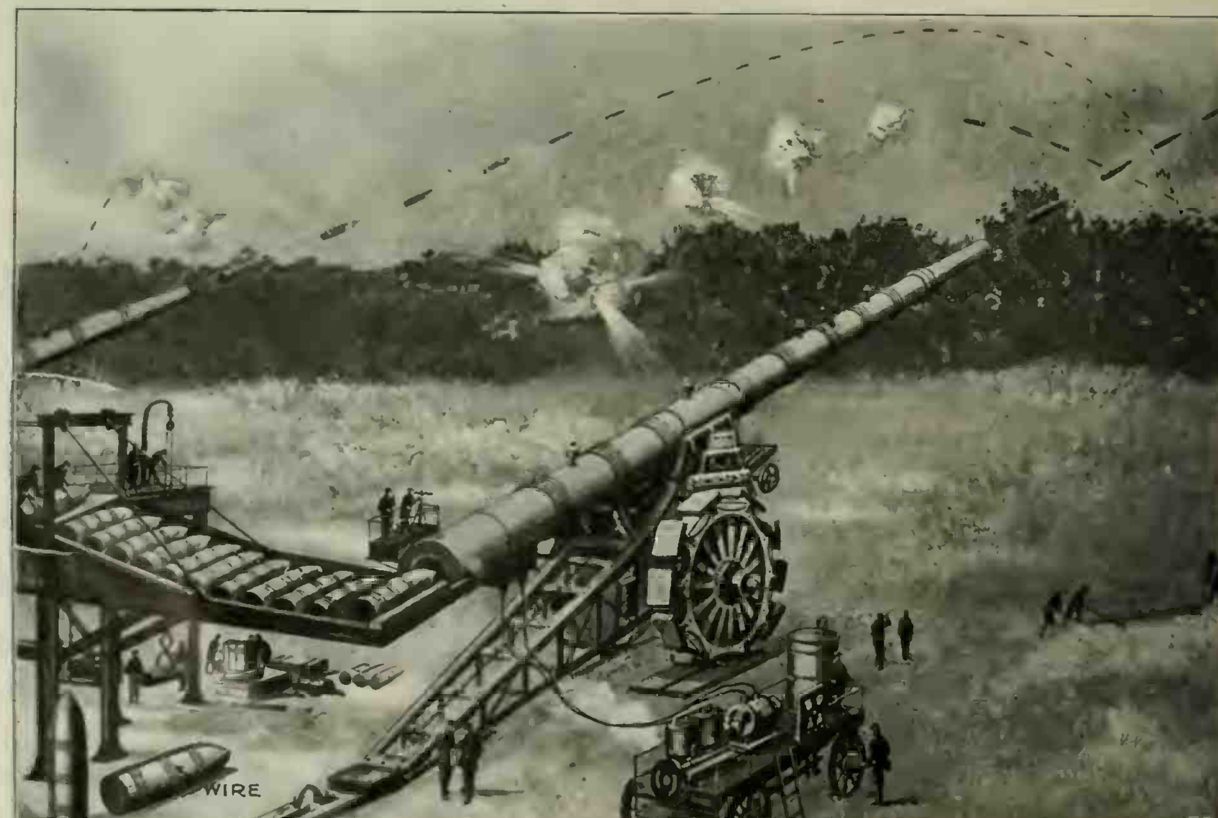
A 100 Mile Electro-Magnetic Gun

GREAT GUNS!!! That's what everyone is talking about these days, when the Teutons have succeeded in hurling nine-inch explosive shells into the heart of Paris from a monster cannon located at a distance of seventy-six miles away, safe within the German lines. The bombardment of Paris was started with two of these super-cannon, which were presently spotted by Allied aircraft observers as being situated in the Forest of St. Gobain, west of Laon. The first shells landed at intervals of about twenty minutes and did considerable damage to buildings, but caused relatively few casualties. At first it was thought that possibly enemy "bombing planes" were being utilized, flying at very high altitudes of say 25,000 to 30,000 feet, which, when properly camouflaged, would defy detection from the ground. When the Allied air scouts located the gigantic guns, however, it became evident that the wily Germans had conceived and executed another psychological grand-stand play in the form of a cannon that could actually bombard Paris from within their lines. The longest range attained hitherto with the standard 16 and 18 inch naval and coast defense guns has been in the vicinity of 25 miles. Ordnance experts have shown, however, that were it possible to build a successful 16-inch gun carriage that would support and absorb the recoil of such a standard gun at 43½ degrees elevation, then we could hurl its shells a distance of 50 *to* 60 *miles!* To fire the 76 mile gun bombarding Paris costs about $5,000 for each shot, it is calculated.



This Illustration Shows Vividly the Great Altitude Attained By a 76 Mile Shell, Viz., 18 miles. The Shell Encounters But a Small Fraction of the Air Resistance In the Rarefied Upper Strata That Short Range Shells Do in the Lower, Denser Air Strata.



The Illustration Herewith Shows a Mighty 90-Foot Electro-Magnetic Gun, Capable of Hurling a Torrent of 19-Inch Shells, Each Containing a Charge of High Explosives. It Would Be Noiseless and Smokeless, Besides Being Mobile Enough to Permit Its Transportation From Place to Place At Short Notice. There Would Be No Wear and Tear On This Gun As Is the Case Now With the Cannon Using Explosive Charges to Expel the Projectile From the Barrel. First Described In This Journal For November, 1915.

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A report from Geneva, Switzerland, contains the statement that Lieut. Gen. von Rohne, a German authority on ordnance and inspector of artillery, gives in a magazine of which he is editor additional details in regard to the long-distance German guns with which Paris is being bombarded. He says they are 20 meters (65½ feet) long. The empty shell weighs 150 kilogramme (330 pounds). The projectile attains a *height of 30 kilometers* (*18.6 miles*) and descends from the sky like a meteor on its target. Refer to the accompanying illustration showing the trajectory of the projectile and how it passes thru the highly rarefied air encountered at such altitudes, the air pressure at this height varying from a *fraction of an ounce* to several ounces *per square inch*, this greatly reducing the air resistance offered the projectile in its flight thru the air, which posseses a very much greater density at low levels, the air pressure at sea level being 14.7 lb. per square inch. Even ordinary, long-range heavy ordnance fire as used today has to waste a great part of the energy given to the projectile in overcoming air resistance, the average shell traveling at say 2 miles highest altitude, for example. Now, at 2 miles the air pressure is still quite high, being 9.8 lbs. per square inch.*

Gen. von Rohne further says it requires about three minutes for the shell to reach its destination. The greatest difficulty in the way of increasing the range was overcome by sending the projectile high enough to reach the rarefied air.

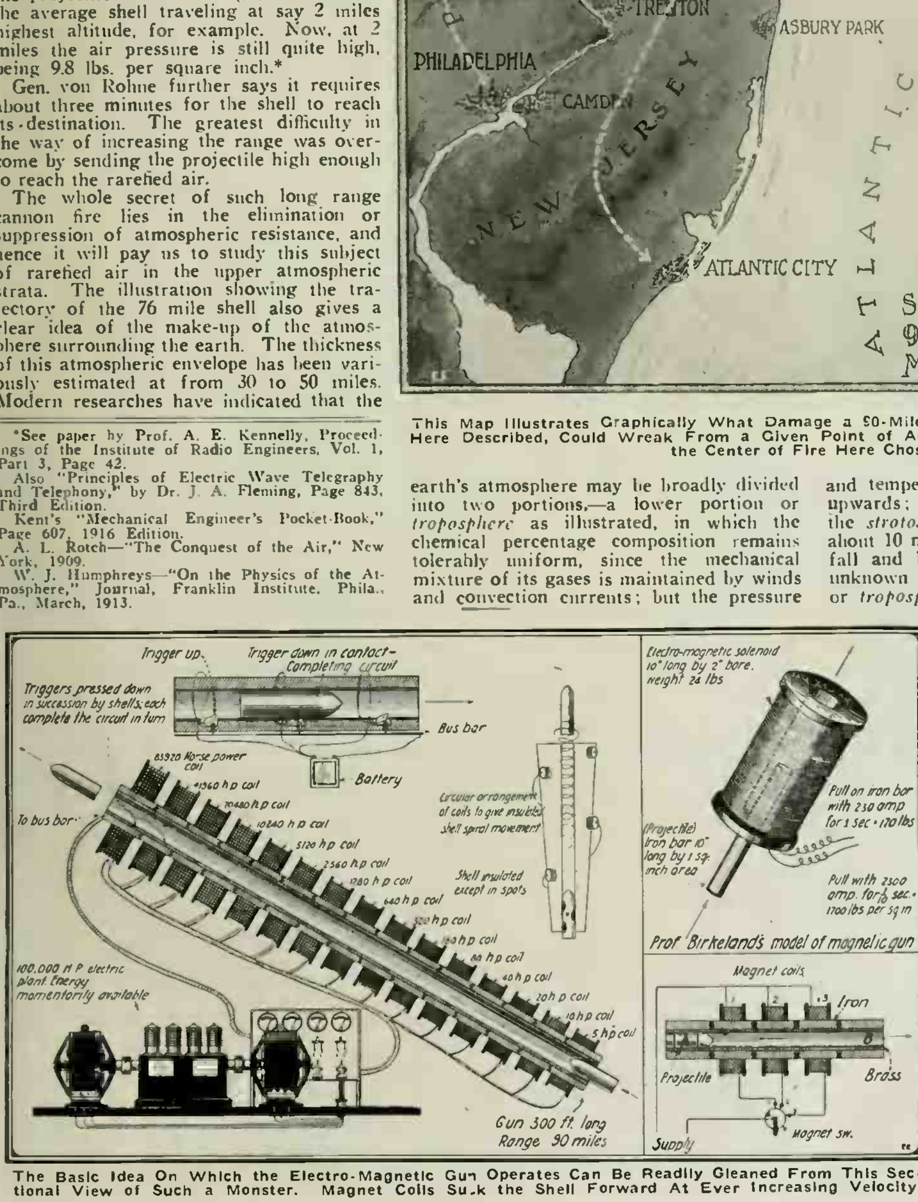
The whole secret of such long range cannon fire lies in the elimination or suppression of atmospheric resistance, and hence it will pay us to study this subject of rarefied air in the upper atmospheric strata. The illustration showing the trajectory of the 76 mile shell also gives a clear idea of the make-up of the atmosphere surrounding the earth. The thickness of this atmospheric envelope has been variously estimated at from 30 to 50 miles. Modern researches have indicated that the earth's atmosphere may be broadly divided into two portions,—a lower portion or *troposphere* as illustrated, in which the chemical percentage composition remains tolerably uniform, since the mechanical mixture of its gases is maintained by winds and convection currents; but the pressure and temperature, however, fall as we rise upwards; and a second or higher region, the *stratosphere* beginning at a height of about 10 miles, when temperature ceases to fall and becomes nearly constant for an unknown further height. The lower region or *troposphere* is the locus of clouds and water vapor. Above the 10 mile line, in the *stratosphere*, the atmosphere is in a state of perpetual calm, the gases composing it actually sorting themselves out in order of density. The highest upper regions are composed entirely of the lighter gases such as hydrogen and helium. Above 45 miles the air becomes so rarefied it has no appreciable weight. Hence the struggle of heavy ordnance designers to build a gun that could be fired at the angle giving the maximum range or 43½ degrees, and thus project the shell rapidly into the highly rarefied strata of the upper atmosphere.

There have been a number of designs for powerful *electro-magnetic guns* brought forth by various inventors in the past 15 years. One of these electro-magnetic cannon, here pictured, was described in detail in our *November*, 1915, issue. It

(*Continued on page* 132)

This Map Illustrates Graphically What Damage a 90-Mile Electro-Magnetic Gun, Such As Here Described, Could Wreak From a Given Point of Action Such As "Staten Island"—the Center of Fire Here Chosen.

*See paper by Prof. A. E. Kennelly, Proceedings of the Institute of Radio Engineers, Vol. 1, Part 3, Page 42.
Also "Principles of Electric Wave Telegraphy and Telephony," by Dr. J. A. Fleming, Page 843, Third Edition.
Kent's "Mechanical Engineer's Pocket-Book," Page 607, 1916 Edition.
A. L. Rotch—"The Conquest of the Air," New York, 1909.
W. J. Humphreys—"On the Physics of the Atmosphere," Journal, Franklin Institute, Phila., Pa., March, 1913.



The Basic Idea On Which the Electro-Magnetic Gun Operates Can Be Readily Gleaned From This Sectional View of Such a Monster. Magnet Coils Suck the Shell Forward At Ever Increasing Velocity.

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How to Avoid Electric Shocks

By H. WINFIELD SECOR

PEOPLE often receive an electric shock when they least expect it and sometimes the shock may be of sufficient magnitude to prove fatal. It is safe to assume that in many instances, the real cause of a person receiving a fatal or dangerous shock is due to either ignorance of electrical matters or to disregarding the generally known rules covering electrical apparatus and appurtenances. In the following the principal causes of receiving dangerous electric shocks which may lead to fatal results are discust for the benefit of lay readers.

One of the first things to learn about your electric lighting installation, providing you use electric lights in your home or office, is that you should never touch an electric light socket or switch and any *grounded* metal piping (*i. e.*, connected to earth), such as a water spigot or steam radiator, etc. This is so for the reason that if the electric light socket or switch happens to become defective in its insulation, thus permitting the current to charge the outer metal shell or plate, then when a person touches this "live" shell or plate, a circuit is completed thru their body to whatever *grounded* metal object they may touch such as water pipe attachment or steam and gas pipe, etc.

To the uninitiated in electrical matters, it is often a puzzle as to how such an electric circuit is formed, but the answer is simple for the reason that practically all electric light and power systems are grounded or connected to earth at various points along the feed lines for lightning protection, and also to help safeguard users of energy from transformer secondary or low-voltage circuits from receiving a dangerous high voltage shock, should the transformer insulation break down.

Figure 2 shows how a person may be severely shocked or indeed killed by touching a grounded electric lighting socket or a piece of badly mutilated electric cord while standing in a bathtub filled with water. As becomes evident a person so situated has provided a first-class connection thru the lower limbs due to the water in which the individual stands, and this water of course is connected to earth thru the waste pipe connecting the tub to sewer line, and also thru the water pipe supply to the tub which is mechanically connected thereto. An actual case of this nature occurred in Toronto, Canada, about two years ago, when a young man nineteen years of age stood in a bathtub, and so far as is known, he must have touched a frazzled electric cord connecting a portable lamp in the bathroom, with the result that he was instantly killed, due to the fact that he had unconsciously provided such an excellent and highly conducting path thru his body. Experts were immediately called in from the electric light bureau, and a test revealed the fact that the victim was killed by coming in contact with an ordinary lighting socket wire carrying 118 volts, 25 cycle A. C.; all of which goes to prove that firstly, it is possible for a person to be killed by a 100 to 118 volt shock, and secondly, that we should not tolerate any badly abrazed cord in our apartments or offices as they may spell death to us.

In this connection, it is well to point out another good maxim—when you stand on a damp or wet floor of a bathroom or in a bathtub, *don't touch any electric switch, wire or fixture*. If you must touch an electric switch lamp or wire in such a damp location, take precaution to stand on a piece of thoroly dry wood or on several thicknesses of dry paper or cloth.

In some cases one may unconsciously receive an electric shock by standing on a hot-air heating register commonly found in suburban residences and touching an electric light socket, desk, fan or wall switch under these conditions. An electric current may pass thru your body from either of these electrical devices as already explained due to the socket or switch becoming defective in its insulation and charging the outer metal shell or plate of the same. Or in the case of the ordinary desk or wall fan, one is liable to get a shock under such conditions, even tho the fan motor is in perfect condition and not grounded in itself, owing to the fact that one may touch the blade of the speed regulator switch, which is usually "alive." As long as you stand on a dry floor you can touch this live rheostat blade on a fan without feeling any shock, but if you happen to touch a grounded pipe system, such as a radiator or water pipe with your other hand when you touch the live fan switch blade, you will receive a shock more or less severe. See Fig. 3. It might be said that some people, especially electricians, who are used to receiving shocks at 110 volts potential such as electric fans and lights ordinarily operate on, do not mind such a current, but on the other hand, people who have never experienced the effect of such a shock are so surprised that they might collapse and in some instances actually succumb to a 110 volt shock as in the case of the bathtub victim above cited.

As a general thing women are much more sensitive to such an electric shock than men, while animals are very susceptible to such shocks, it having been on record that a horse has often succumbed to a shock of 100 to 200 volts.

If you happen to have a *short-circuit* start a fire in the panel switchboard in your home, office or factory, be careful how you attempt to extinguish it with a fire extinguisher or pail of water. There are certain fire extinguishers on the market which are particularly efficacious in quickly and effectively extinguishing such electric short-circuit conflagrations, and they are of course widely adopted in all power plants and engine rooms as well as in factories. However, some of the fire extinguishers project a stream of acid and water on the fire, and if the operator happens to stand on a heating register or is in contact thru his feet or hands with any grounded piping or other metallic system, he is liable to receive a shock, the electric current passing along the stream of liquid projected by the extinguisher and thence thru his body to earth. See Fig. 4.

In illustration No. 5, we wish to point out a few facts concerning fallen "live" wires. The first thing to do whether you are electrically educated or not, as past experience has often proven, is not to touch a fallen wire, no matter whether you believe it to be only a telephone wire or some other apparently harmless wire carrying a low potential. Persons have been killed in a number of instances by not exercising the proper discretion when brought face to face with this situation. It is not always the case that a fallen live wire will indicate its dangerous condition by making a sputtering noise, but in some cases it will do this, as the writer recently had occasion to note when he nearly stept on a fallen wire carrying 2,500 volts, alternating current, in which case the wire alighting on a wet ground caused a series of small sparks to jump thru the insulation which was damp owing to a heavy rainfall the previous night, and the wire sizzled similarly to a large boa-constrictor.

As aforementioned, it is not always that a live wire carrying such a dangerous potential as 2,500 volts (1,800 volts is the maximum voltage usually employed in electrocuting criminals at State penitentiaries) will manifest its presence, and its death dealing charge, and many innocent persons have met their death thru touching such a wire, which under certain dry conditions,

(*Continued on page 137*)

HATS OFF TO THE "JULY" ISSUE

The July number of the ELECTRICAL EXPERIMENTER *will be replete with a vast number of new articles, covering everything new in ELECTRICAL and RADIO science. There will be a host of short, newsy articles with special illustrations for the busy man and woman, besides the usual complete and instructive articles on physics, wireless, electricity and mechanics. We do not aim to set the world afire with a lot of half-baked editorial effusions in the* ELECTRICAL EXPERIMENTER, *but earnestly try to have it contain just the collection of technical and semi-technical articles which you would like to read every month, were you in a position to command the hundreds of diversified channels of scientific endeavor open to us. Here's hoping you like the "July" number, lots! What you don't see—ask for!*

"A New Electric Recording Compass," by Prof. Eugene Staegemann.

"Protecting New York Against Aërial Attacks by Electrical Means."

"Radium Emanation in the Treatment of Disease," by George Holmes.

"Electric or Steam Railroads—Which?" by H. Winfield Secor, Assoc. A. I. E. E.

"The Story of a Piece of Coal—What Becomes of It in the Generation of Electric Current?" An article of timely interest written by an expert.

"New X-Ray Photos."

"Electricity's Aid to War Photography."

"How Uncle Sam Tests Coal by Electricity," by Samuel Cohen.

"Harmonics—Part II—Analysis of Irregular Wave Shaped Alternating Curves," by Prof. F. E. Austin, Instructor Electrical Engineering, Dartmouth College.

"Experimental Physics—Lesson 13—Static Electricity, by John J. Furia, A. B., M. A.

"The Construction of Small Step-down Transformers," by Prof. F. E. Austin.

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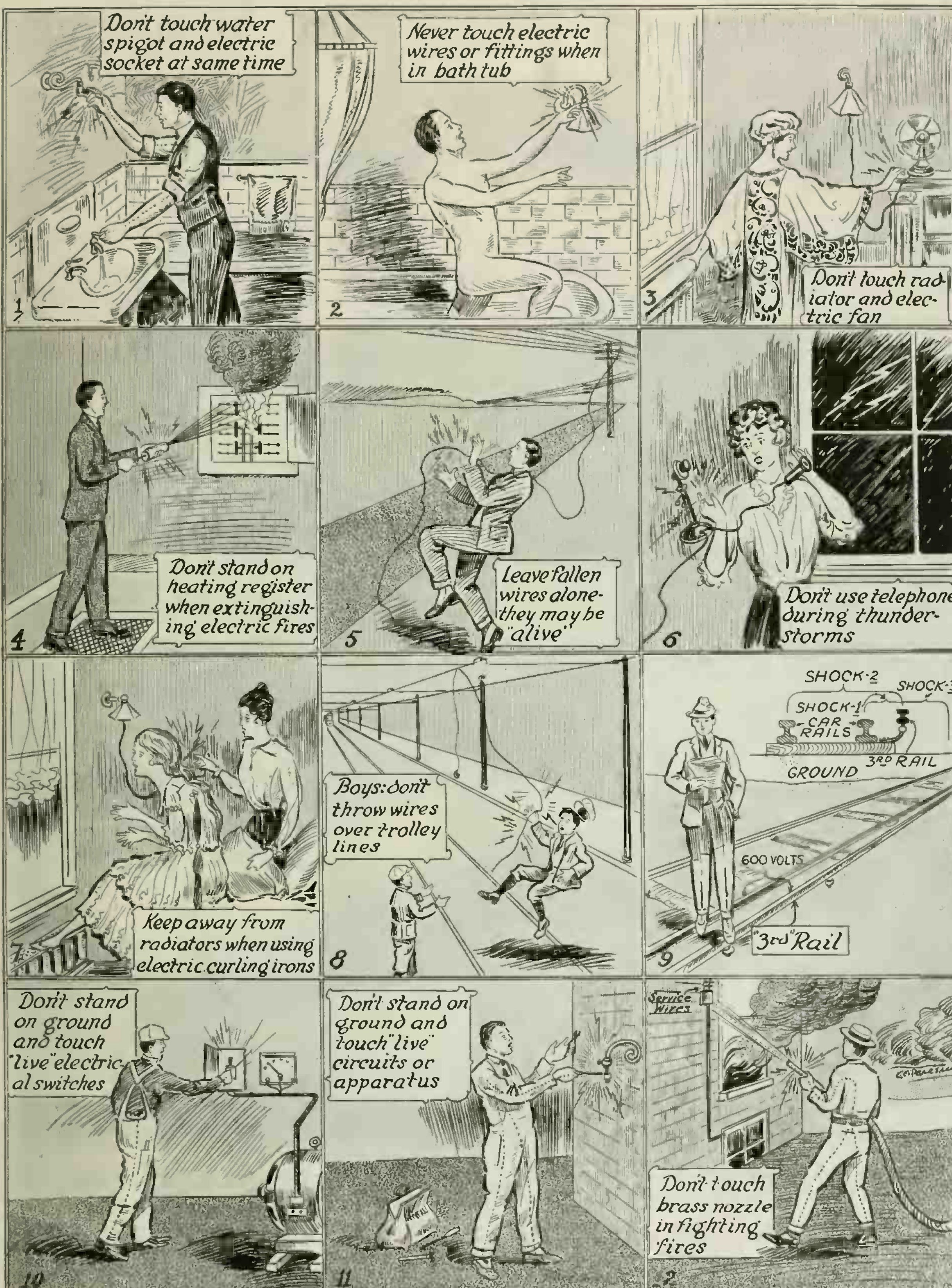
How to Avoid Electric Shocks



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(See opposite page for full description.)

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Electromagnetic Brakes for Aeroplanes

IT is a well-known fact that when the aeroplane was first brought out by the Wright Brothers of Dayton, Ohio, one of the greatest troubles they experienced was in making a safe landing. At first wooden skidding arrangements were used, while afterwards heavy rubber pneumatic tires came into vogue to take up the shock when the aeroplane alighted.

When an aeroplane lands on a plain or a large grass plot and it comes to rest, the danger is, of course, over. As aerial science is progressing, however, and as aeroplanes are forced to alight sometimes on very narrow platforms, the landing becomes more and more dangerous due to the smaller and smaller landing area which economic conditions make necessary.

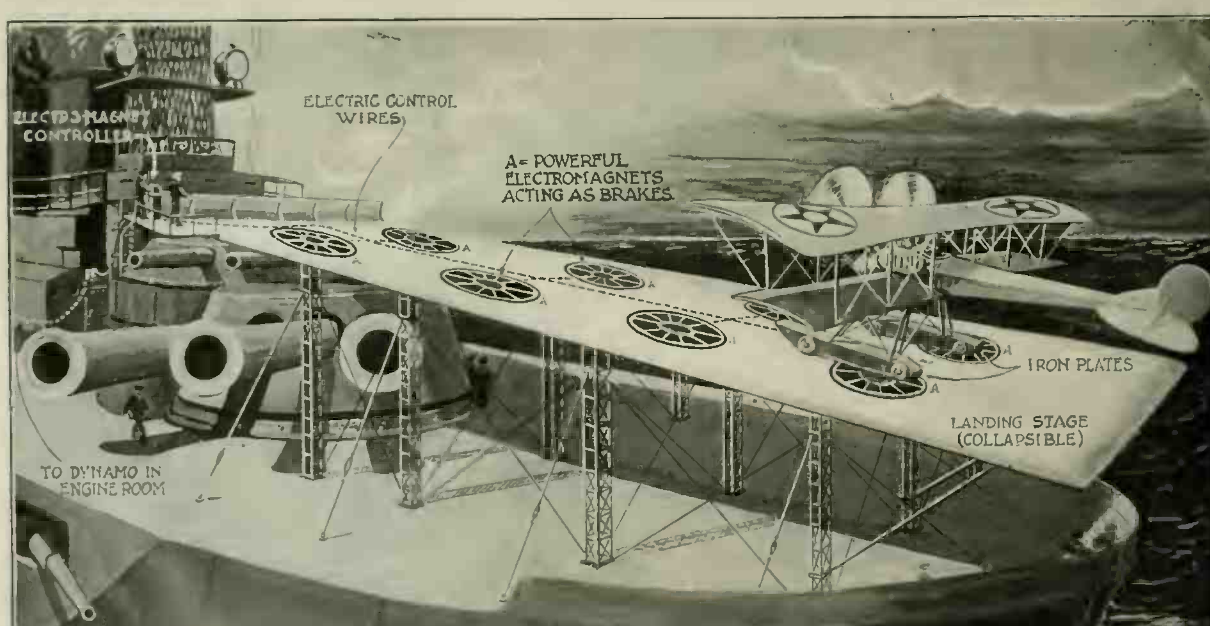
It is safe to predict that during the next twenty years our entire mode of life will have been revolutionized. Aeroplanes within ten years from now, particularly during the period of reconstruction after the present war, will become as plentiful as automobiles. The landing problem, therefore, becomes more and more important, and it goes without saying that when aeroplanes alight in a crowded city, they will not have large grass plots on which to land. Naturally the roofs of our tall buildings immediately suggest themselves. Nor is this a new idea. There exists today in Philadelphia a hotel, the "Bellevue Stratford," which has a landing platform on its roof. But this platform has never been utilized landing on a small plot for the reason that when an aeroplane comes out of the sky it cannot stop instantly. Its momentum usually carries it forward as much as 100 yards. Were the aeroplane to stop abruptly, it would naturally turn either a somersault or otherwise the machine would become wrecked. The same thing only on a smaller scale happens to an express train going at sixty miles an hour when the emergency brakes are set abruptly without the brakes gradually taking up the momentum of the train.

Recently it has been proposed to stop the momentum of aeroplanes by having them land on a wide strip of belting revolving in opposite direction to the oncoming flyer. While this idea is feasible it has never been used in practise, and it becomes obvious that it could not be used except from one direction. For instance, if the aeroplane came on at right angles to the moving belt, it would most likely be overturned. For that reason this device may be considered as impractical. Of course, when the weather is clear and the wind velocity is not great, an expert aviator will not have much trouble in alighting on a comparatively narrow run-way as has been proved right along by seaplanes making successful landings on battleships. At present our Navy has quite a few battleships equipt with narrow run-ways as explained above, but these are useless in a heavy sea, or when a gale is blowing. The reason is plane into the ocean. Quite a number of accidents have happened in the past due to these causes, and no doubt will happen in the future until some remedy is found.

Mr. H. Gernsback who has given this problem consideration seems to have found an astonishingly simple solution whereby it now becomes possible for an aeroplane to make a landing, on a very small area, no matter what its speed. The present invention on which patents are pending, is described herewith. Mr. Gernsback has also offered his invention to the Navy Department in connection with hydro-aeroplanes alighting on battleships at sea.

Our front cover illustration shows the idea clearly. This shows a future landing station "somewhere in the city of New York" on which a transatlantic aeroplane is just settling; the landing platform in this case is contructed of very heavy glass. Into this glass, which by the way is transparent, are sunk a number of large and powerful electromagnets such as are commonly used for lifting purposes. The idea of the transparent glass is that powerful searchlights can be placed underneath it and the entire glass expanse therefore will stand out sharply from its surroundings. Thus, an aeroplane from a considerable height will see the landing platform readily by night.

The electromagnets in this case would be quite large, say fifty or sixty inches across, each being capable of attracting about 200,000 pounds. These electromag-



Copyright by E. P. Co.
This Illustration Shows a Hydroaeroplane Landing on a Narrow Platform on Board of a Battleship. Huge Electro-Magnets A Are Sunk Into the Platform. Each of These Magnets Can Lift a Weight of 100.000 Lbs. When the Iron Pontoons of the Aeroplane Come Within a Few Feet of the Magnets a Powerful Braking Action Ensues, the Machine Quickly Coming to Rest. Once at Rest No Amount of Rolling of the Ship Nor Winds or Storm Will Be Able to Pitch the Aeroplane Into the Ocean.

as yet, for the good reason that it has been too dangerous, the landing area being too small.

Up to this time there has not existed a device whereby it was possible to make a that even if the aeroplane should make a successful landing, it would almost surely be tost into the sea by the combined pitching and rolling motion of the vessel, as well as by the wind trying to blow the aero- nets are by no means futuristic ideas as the accompanying photographs show. Large electromagnets are being built right now that can lift anywhere from eight to ten tons at contact.

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In further explanation of Mr. Gernsback's idea, it will be noted that the aeroplane has two iron-armored, pontoon-like projections instead of the usual wheels, or instead of the usual boats as are used on hydro-aeroplanes. It now becomes apparent that as the aeroplane comes within a few feet of these energized electromagnets, there will ensue a powerful electromagnetic attraction betwen the electromagnets and the iron pontoons of the aeroplane. The tendency will be to pull the aeroplane down into contact with the electromagnets, but inasmuch as the flying machine still has considerable momentum, it will not stop at once, but will glide over a number of electromagnets until it finally comes within a few inches of the last row of electromagnets when the maximum tractive effect will be had. The aeroplane will then be pulled down entirely so that pontoons come into actual contact with the huge electromagnets, completely arresting the flight of the airship.

Now it must be understood, and it should be realized that these electromagnets have no effect whatsoever upon the iron pontoons *until the latter come within two or three feet of the electromagnets.* Elsewhere in this issue we show how close a metallic mass must come to an electromagnet before any appreciable attractive effect is had. From this it will be gathered that this invention does not purport to pull the aeroplane "out of the sky" as some people might think. It does not do anything of the sort. The idea simply is to arrest the motion of the aeroplane while in the act of landing and then hold the machine securely. If these electromagnets were not used, then it undoubtedly would often happen that the aeroplane could not stop quickly enough, and in this case it might slide over the edge of the landing platform down into the streets. Also while making a landing in a gale, such a huge machine which necessarily must have a large wing area becomes a toy of the elements; even if it had completely stopt, the wind might carry it away before the commander would have time to get the engines running at full speed. All this the electromagnetic brakes will prevent. Once the aeroplane has settled, the electromagnets will hold it as securely as if it had been riveted to the platform. Then after the landing has been made, the aeroplane can be readily secured to the platform by guys or ropes, so that the winds or storm will not carry it away; this being only a matter of a few minutes, the power can then be turned off from the electromagnets and no current is then used.

Another important point worth remembering is, that as the iron aeroplane pontoons fly a couple of feet above the electromagnets, the tractive effect while not abrupt is sufficient to retard the motion of the aeroplane gradually, and the electromagnets in this respect will act exactly as the reversing of a ship's propellers in the water. In other words, the momentum of the aeroplane will be absorbed gradually and not suddenly. Furthermore the pontoons may be equipt with small wheels, just extending a little distance from the lower surface if this is desired. Or, otherwise, the glass landing platform may be greased by means of some form of lubricant. If either of the two precautions were not taken, there would almost certainly ensue a terrific "grinding" action when the pontoons finally settled on the platform, and when the aeroplane was still in motion. However, these are small technical details, left to our engineers; there are at present a number of simple means to effect a smooth final landing without the grinding element contained in it due to excessive friction.

One of our illustrations shows the invention as adapted to hydro-aeroplanes making a landing on battleships and the like. As mentioned before, such landings at present are very dangerous, and often disastrous. The electromagnetic brakes will do away with all this, and once a landing has been effected, it will be almost impossible for the aeroplane to leave the narrow landing stage no matter how much the ship pitches, or what the wind velocity is. If the iron pontoons of the hydro-aeroplanes only engage two electromagnets, an enormous tractive effect anywhere from *two hundred* to *four hundred thousand pounds* can be readily obtained. Our illustration shows how the invention works out in practise. As soon as the operator who is in control of the electromagnets sees the oncoming aeroplane, he has it in his power to gradually switch on current into the electromagnets. Thus for instance, the two foremost electromagnets can be energized but half or one-quarter if required, so as not to jerk the aeroplane or stop it too soon. In other words *a gradual braking action can be had* at the will of the electrician in charge. If the rolling of the boat and the wind is very strong, he will use more power, or else he can "flash" the electromagnets. By this is meant to overload the electromagnets 50 to 100 per cent. Thus, an electromagnet usually capable of attracting a weight of 100,000 lbs. can be energized by using double the quantity of the current to give a tractive effect of over 200,000 pounds. Naturally this would be only for half a minute or so, as otherwise there would be danger of burning out the windings. However, inasmuch as the aeroplane makes a landing in less than ten seconds the "flashing" of the electromagnets is of no consequence. As soon as the aeroplane has come to rest, the blue-jackets will be ready to lash it fast, and then the current can be switched off.

Huge Electro-Magnets of the Type Here Shown Are Proposed in This Article to Arrest the Motion of Aeroplanes. The Illustration at the Left Pictures a 52" Traction Magnet Capable of Lifting a Maximum Weight of 45,000 Lbs. The Casting Shown Weighs 4,800 Lbs. Illustration to the Right Shows a 62" Traction Magnet Lifting a Cast Iron Column Weighing 16,000 Lbs. This Magnet Can Lift a Maximum Dead Weight of 70,000 Lbs.

THE GERMAN WATCH TRICK.

A pet trick that the German soldiers employ is to leave a watch hanging on the wall of their abandoned trenches. Said watch connects by electric wires with a high explosive bomb, which explodes when the watch is removed from the wall.

LADIES! GET A MAGNET!

A magnet will attract a hook and eye which is liable to rust, while it rejects the non-liable ones. So a magnet is a handy tool for the sewing basket.

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FLAPPING ELECTRIC FAN RESEMBLES "PUNKAH."

If you have ever visited India or other parts of the Orient, then you will at once recall the "punkah"—the slow-moving, feather bedecked fan, wielded by a husky native at a cost of a few cents a day. Two English inventors, who evidently had sweet memories of a trip to the Orient, have taken out a U. S. patent on just such a "flapping fan," only it is operated continuously, when desired, by the ever obedient genie—electricity.

The employment of rotary fans, say the inventors, whether of the oscillating or other type, as a means of agitating the air for the purpose of ventilation, gives rise to discomfort owing to the fact that the action of the fan produces a continuous draft, usually in one direction only, while, if a rotary fan of the so-called blower type be employed, the resulting introduction of air from outside is or may be objectionable for the reason that such air may have a temperature either too high or too low relatively to that of the air within the ventilated space and may in addition be laden with impurities or micro-organisms which it is difficult to get rid of.

It has, however, been demonstrated by experiment (as recently stated in medical journals) that, contrary to the common supposition, continual renewal of the air within a closed space is not essential to the health or even the comfort of the occupants, altho, for the sake of both health and comfort, it is imperative that the air within the space should be kept in motion. It is, moreover, true that a *punkah*, as commonly used in hot climates, serves for agitating the air without either creating a continuous draft in one direction or introducing air from outside. But not only are the prime and running costs of a *punkah* excessive relatively to the benefits obtained from its use, but the fact of a *punkah* being of necessity permanently installed overhead or near the ceiling has the effect of seriously diminishing its efficiency, for the reason that movement is imparted chiefly to the upper strata of the air while the lower strata, which are breathed by the occupants of the apartment, are not directly affected by the agitation set up by the *punkah*. Who ever thought the *punkah* covered such a multitude of scientific laws and out-laws!

Hence and howsoever we have with us the gently flapping electric *punkah* here illustrated, as perfected by Messrs. Telfer and Boyd, of London. The fan actuating mechanism is very simple; in the case of the motor-driven type a cam shaft causes a sliding shaft to work back and forth inside the flexible goose-neck stem shown, thus causing the fan blade to rise and fall alternately. For battery (or 110 volt) systems they have perfected an extremely efficient electro-magnetic mechanism, which is attached to the sliding shaft aforementioned. This design would appear to solve the battery fan problem at last.

Something New At Last in Electric Fans—the "Flapper" Fan. It Brings to Mind the Oriental Breeze Producer Or "Punkah" As It is Called. It is Said to Produce the Most Healthful Circulation of Air Possible. Its Design Is Ideal for Battery Operation.

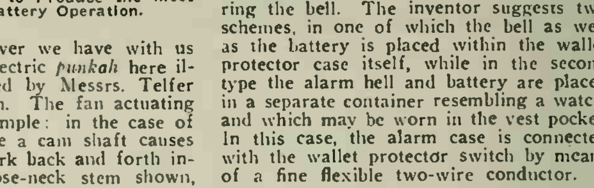
ELECTRIC POCKETBOOK ALARM FOILS PICKPOCKET.

A bright electrical genius of New York City, one John P. Williams, has recently taken out a patent on a remarkable electric attachment for pocketbooks and such, and intended to be carried on the person, so that when the ever-present pickpocket attempts to remove the pocketbook or wallet from your hindermost pocket, an electric bell kindly signals the news so that you can then presumably right-about face and nab you man—perhaps.

The electric alarm actuating device is made separate from the pocketbook or wallet and it is provided with a switch on the exterior, so that the owner can open the electric alarm circuit when he wishes to remove the wallet or other papers himself, without starting a riot.

As will be seen, the inventor has gone to considerable pains to make doubly sure that the pickpocket, no matter how well educated he may be in this crafty art, shall not be successful even if he tries to cut away part of the special pocket in which the wallet is placed. To this end he provided a double wall on the protective pocket holding the wallet or pocketbook, this wall containing two oppositely charged metallic plates, or other suitable arrangement of wires or conductors, separated by a layer of insulation and so connected with the battery and bell that should the thief try to pierce the wall of this pocket with any instrument or tool, he will short-circuit the two metallic plates and thus cause the bell to ring.

When the pocketbook or wallet is placed in the protective casings, which is firmly secured in the trouser or coat-pocket by means of a clip provided for the purpose, it is caused to open the alarm circuit by the force of gravity, or in other words by its own weight. The control switch is supposed to be opened while the wallet is being placed in the container, and it slides all the way down in the same, thus causing the alarm contacts to be held normally open by a spring arrangement; then the switch is closed. Should the thief now attempt to remove the wallet, the spring actuated contacts will come together and ring the bell. The inventor suggests two schemes, in one of which the bell as well as the battery is placed within the wallet protector case itself, while in the second type the alarm bell and battery are placed in a separate container resembling a watch, and which may be worn in the vest pocket. In this case, the alarm case is connected with the wallet protector switch by means of a fine flexible two-wire conductor.



Pickpockets Had Better Beware, for Their Intended Victim May Have His Wallet Protected By This Newly Patented Electric Alarm. When the Purse Or Wallet Is Touched the Bell Rings.

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The Making of an Electrical Man

By FRANK EFFINGER

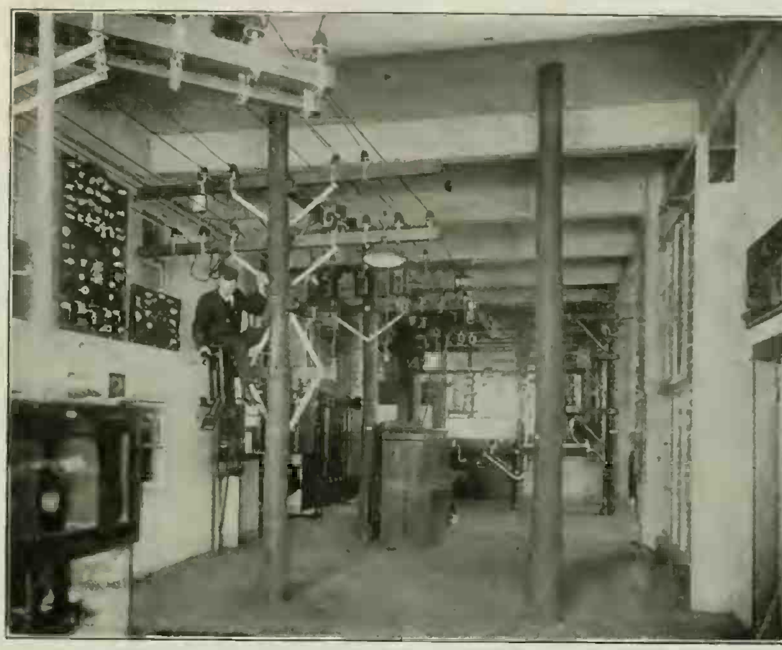
WHILE America is still preparing to win the war, in other quarters preparations are being followed to provide for after the war requirements. Sad as it is, and as much as we hope 'twill not be so, war's conflicts will mow down our numbers of brave, sacrificing soldiers and sailors. The law of war itself says that not as many that went shall return. And a great percentage of the ranks now in France, and preparing to go, are taken from America's industries, not a small number from the field of electrical activity. So, not only is the electrical field greatly vacant now due to the absence of electrical men enlisted in the war services of our government, but it will be more greatly vacant when war's results are counted, and the need for men to fill the industrial places of our soldier and sailor boys will swell the demand.

Moreover, the reconstruction and readjusting periods to follow in war's wake are going to increase the employment of electrical workers beyond even the natural immense requirements. Electricity is yet to do its biggest services to the world after the war. Tho unlimited are its boundaries now, electricity and men who know its functionary phases and operations will have even wider scope and opportunity for years after peace is declared.

To that end, a new school of engineering located at Milwaukee, Wis., is developing young men to respond to the demand for electrically trained men, developing young men to take the place of those who are not coming back, developing young men to fill the bigger duties our country will thrust upon us after the war is over.

Large quarters in two of Milwaukee's big buildings constitute this school's area, a total of 30,000 square feet. Its capacity is 1,500 students.

All branches of electricity are taught and all the space of the school is equipt for class and lecture room instruction, laboratory and work-shops fully equipt with most modern materials and appliances. This school has been considered in its idea, methods and equipment, as more of an electric industrial institution, rather than just a school of the orthodox type.



No—These Pole Tops Did Not Grow Thru the Floor. They Are Simply the Electric Poles and Cross-Arms on Which Students Are Given Practical Training at a Western Engineering School.

A View of the Dynamo and Motor Laboratory Where All the Tests Prescribed in the Text-Books Are Tried Out Practically by the Students.

Only the essential theory is taught in text-books and lectures. More stress is placed on the *practical* instruction, however. The need is for useful men; men who not alone know, but can do. The ability to do things and knowing how things should be done, what to do, etc., is of more vital importance to both the student and the actual field of electricity, than merely a mind of theory, however brilliant, whatever the *Alma Mater*.

Complete chemical laboratories are contained in the school, where students prepare actual experiments to practical results, followed by full reports made out to the instructor. Also there is an electrical laboratory, where, for example a complete telephone exchange is provided—switchboards, all the intricate parts and even a wired transmission pole, built and practised on by the students. Here is learned by direct contact and operation the technical details of telephony, installation, connecting and all, attended by each student in his practical studies. This complete system is the only feature of its kind in any school. Then there are generators, motors, dynamos, connected and disconnected by students, built, disassembled and rebuilt, and operated as in an electrical plant.

A power plant is provided, fully equipt for students to actually work at and learn by practise and really seeing, as well as reading its laws and solving its problems in class rooms.

Whoever learned *armature winding* out of books? Here armature winding is taught by a unique, original method, whereby students learn the requirements of armature winding in every detail by actually

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building armatures complete, from the bare iron core to the final form.

A model house is erected in the school, where students in their course of study completely wire a home. They thereby learn that important phase of electrical practise and become thoroly proficient in the art as well as the science.

The Telephone Switch-Board Is One of the Most Intricate Electrical Devices Known. Very Few Schools Have This Equipment With Which to Teach Telephony. First-Hand Experience Makes the Student Self-Reliant at All Times.

Thus, in every department of electricity and all its phases, the theory taught is closely supplemented with thoro practise under actual working conditions; the same occupation students will be called upon to follow or supervise when they number themselves among the electricians and electrical engineers of the world. The practical training is given not alone to develop the students to do, but by actual contact and the experience gained, to learn the cause and effect of each detail, every step, and a thoro knowledge of an entire given electrical subject or problem. A man thus educated does not hesitate in answering a query or when put to the test, but responds instantly and emphatically, for he knows the why and the wherefore.

Another feature of practical benefit at this school is the part-time employment of students.

Arrangements are held with leading local industrial and business concerns, who employ students part time. In this way students gain actual business and technical experience, in contact with the world, which aids in their development at school. Furthermore, the students receive pay for the time employed, which adds to their bank accounts or to their school fund, many students thus helping to defray their expenses. This in no way interferes with the students' studies.

This engineering school has an unusual faculty, selected from a standpoint different than customary at most schools. Each and every member of the faculty comes from the industrial life of his vocation. Every teacher has occupied high industrial positions prior to joining the faculty and thus has determined by experience, not only the results of certain electrical and industrial practises, but has discovered the essential requirements of the electrician and engineer; consequently he is prepared first-hand to teach and conduct his classes to the best advantages, consistent with the major needs of the world.

Also, the members of the faculty, being practical men of experience, bear in mind the character development of the students, and this feature, with the fatherly companionship between teachers and student, keeps the students well ordered at school.

(*Continued on page* 136)

THE JOHN FRITZ MEDAL PRESENTATION.

The presentation of the John Fritz Medal to J. Waldo Smith took place in the Engineering Societies Building, New York, April 17.

At this meeting the John Fritz Medal Board of Award presented the *John Fritz Medal* to J. Waldo Smith for "achievement as engineer in providing the city of New York with a supply of water."

Col. John J. Carty, past president A. I. E. E., presided. The medal was presented by Ambrose Swasey, past president of the American Society of Mechanical Engineers. Other speakers were Nelson P. Lewis, vice-president A. S. C. E., Hon. A. T. Clearwater and J. Waldo Smith.

U. S. HAS GREATEST RADIO IN WORLD.

At the outbreak of war, the United States Navy took over the entire radio service of the country. On account of duplication twenty-eight commercial stations were closed. All those in existence were brought together in a comprehensive system, and other stations erected. The new stations at Pearl Harbor, Hawaii, and Cavite, Philippine Islands, the most powerful stations in existence, have been completed, as well as the high-power station at San Diego, Cal. The Atlantic Coast stations are in direct communication with Pearl Harbor, and, with this one relay, a message can be flashed from Sayville, Long Island, to the Philippines. By New Year's direct communication had been establisht with Rome. The United States radio system stretches from Alaska in the north to the Panama Canal Zone in the south. In addition to this service, the Navy furnishes radio-operators for the rapidly increasing number of ships. To meet these needs thousands of wireless operators have been enlisted and trained. At present there are 5,000 at the two principal schools alone, those at Harvard and Mare Island, Cal.

Students Learning to Wind A.C. and D.C. Motor Fields and Armatures by Actually Doing the Work. This Is Done In Conjunction With the Study of Theory.

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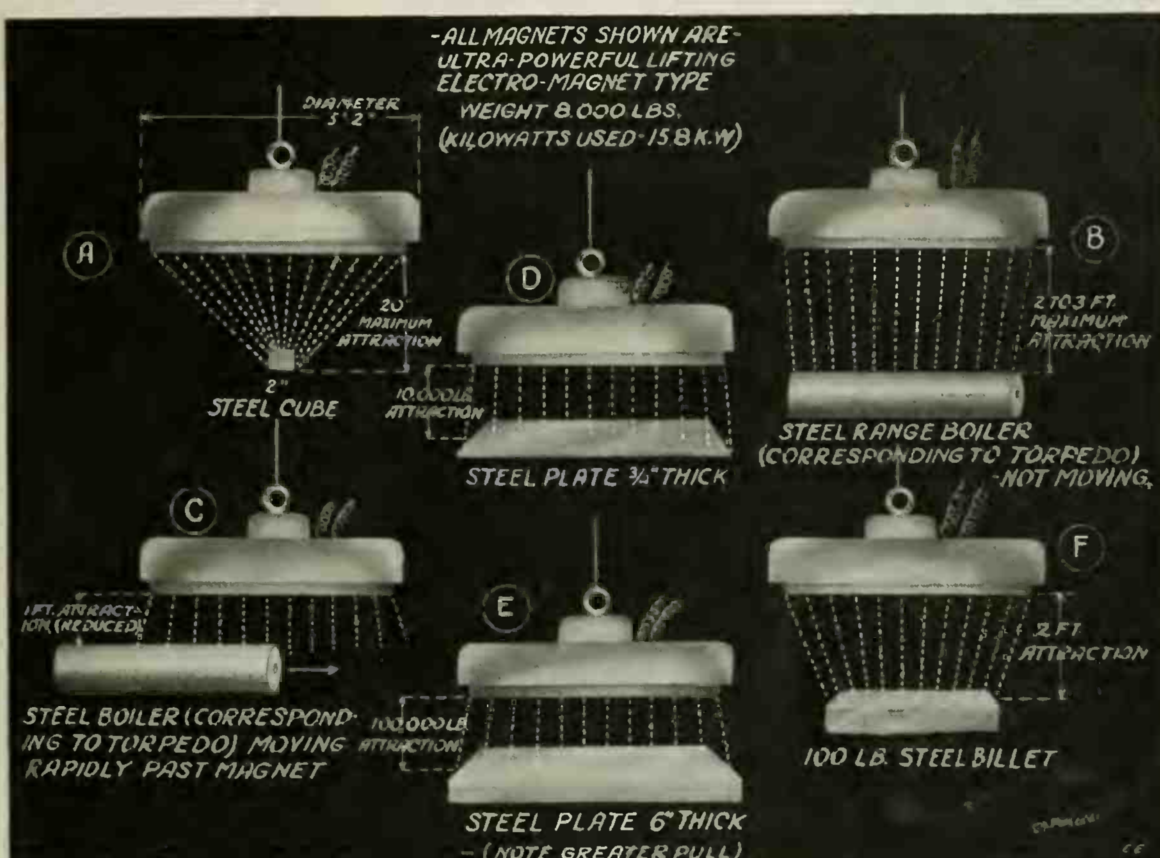
Powerful Electro-Magnets—What They Can Lift

ELECTRO-MAGNETS, poor things, have been frequently adjudged guilty of many short-comings, as well as many, far too many, prodigal but unseeming possibilities since the start of the present world war. All of the misunderstandings and wild dreams of countless patriotic inventors thruout the land seem to be traceable to a lack of definite data as to just what a large electro-magnet of modern design can lift—and what is most important of all—just how far the magnet can attract its load. Probably you remember the sad tale reported in the daily press a few years ago to the effect that a European genius had designed a gigantic electro-magnet which he could place in shoal waters and attract battleships from their channels thru a distance of several miles, and he thus hoped to pull them ashore where they could be captured or else shelled to bits by shore batteries! That's only a sample however of some of the wonderful and fearful "magnetic schemes" submitted monthly, weekly and daily to our Naval Consulting Board. Thousands of such ideas, employing "powerful electro-magnets" have been thought out over night by these enthusiastic inventors. Most of their descriptions start off with: "All you have to do is to place a 'powerful' electro-magnet here, or there, and so and so happens . . ." *ad lib. ad infinitum.*

It is the aim of this article, accompanied by the illustrations herewith, to instil in the minds of these well-meaning inventors just what such powerful electro-magnets *can* and *cannot* do. The data and figures presented are authentic, having been kindly supplied by one of the largest manufacturers of lifting magnets in the United States. Similar data has been furnished the Navy Department to enable them to judge quickly as to the merits and demerits of the thousands of "magnetic" inventions sent to them. With this data at hand you will now be enabled to judge for yourself in most cases as to whether or not a certain scheme will work, and thus save a great deal of your own time and energy as well as that of the Government's experts.

For the purpose of this article, there has been selected the largest lifting magnet built. This gigantic magnet weighs 8,000 lbs., has a diameter of 62 inches or about 5 feet, and will exert a *maximum* pull of about 100,000 lbs., when placed *in contact* with a substantial steel plate, having a thickness of 6 inches. That is, the attraction existing between the electro-magnet and the steel plate is about 50 tons when in contact. More will be said of this figure anon.

Let us look at the illustration. The largest standard magnet weighs about 8,000 lbs., contains over a ton of copper and requires 15.8 kilowatts of D. C. energy, or 72 amperes at 220 volts, D. C. This magnet would not have sufficient capacity to attract a 2-inch cube of steel thru a vertical distance greater than 18 to 20 inches. See Fig. A. Its effect on a larger object would, of course, be somewhat greater. On a steel range boiler (see Fig. B) the magnet might lift the dead weight of the steel thru a distance as great as two feet, not much further. This, of course, assumes that the boiler were stationary with respect to the magnet. If it were moving, as shown in Fig. C, the distance thru which the magnet would attract it would be considerably less. An ordinary range boiler has been selected for comparison here with a torpedo, as most persons have a clearer conception of the former body. From this it is evident that it is practically impossible to arrange booms on a ship, each of the booms being provided with one of these electro-magnets so as to attract enemy torpedoes out of their course, when traveling



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Inventors the World Over Have From Time to Time Conceived Brilliant "Magnet Schemes" By Which They Hoped to Abolish Even World Wars. They Didn't Overlook One Bet, Except That the Most Powerful Electro-Magnets Built Only Attract Their Load Thru a Distance of a Few Feet. This Chart is a Liberal Education In "Magneto-ology" and Is Based On Facts.

(*Continued on page 139*)

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A NEW ELECTRIC VACUUM WASHER.

The new electric washing machine here illustrated is said to be a great improvement in the older types. This is a "phantom" view of the new Oscillator Vacuum Washer. Note how the dasher, which is divided into four vacuum compartments, covers the *entire* surface of *all* the clothes in the machine. In operation the dasher oscillates or works up and down with a rocking motion in such a manner that, as one end of the dasher is brought down against the clothes, it forces the water thru them by air pressure, while at the same time the other end of the dasher is raised, drawing the water up thru the clothes by suction. Thus the water is forced thru *all* the clothes *twice*—once by pressure and once by suction—at every stroke of the dasher, with the result that, literally, many hundreds of gallons of hot suds are forced thru every garment in the course of a minute's time.

A New Electrically Driven Washing Machine that Operates on the Vacuum Principle. There Are no Pegs or Drums to Catch and Tear the Clothes—Even the Finest Fabrics Can Be Washed in It. It Has a Motor-Operated Wringer.

It is conceded, by those who know, that the vacuum system is the most practical, therefore the machine which most completely utilizes the vacuum principle must be the most efficient type.

In the machine shown this principle has been worked out to the greatest possible degree. With this washer it is not necessary to stop the machine and adjust the clothes. It is impossible for even the smallest piece to become lodged in any part of the tub in such a manner that the dasher does not cover it.

It produces the same satisfactory results whether the tub is filled to its maximum capacity or contains only a few small pieces. The vacuum dasher *automatically* adjusts itself to the amount of clothes in the machine without attention on the part of the operator.

The new vacuum washer is claimed to wash perfectly the heaviest and most soiled pieces, as well as delicate fabrics and laces, without the slightest wear on material and without danger of tearing. Discs will wear and pegs will tear, regardless of statements to the contrary. Anyone knows that catching a lot of wet clothing on wooden pins or pegs, slushing and jerking them thru the water, first one way and then another, must cause wear and often results in torn clothes. The present machine does not handle the clothes, but forces the hot water and suds thru them, washing them absolutely clean without wearing or tearing.

Another important feature is the entire absence of valves, springs or other inaccessible parts in the dasher, to hold grease, dirt or acid from the soap. Such accumulations cause corrosion and rust, injuring the clothes. It is unnecessary to raise one side of this machine to drain it. Simply open the drain cock, to which a hose can be attached if desired, and let the water run out. Every part may then be wiped dry with a cloth.

No mechanism whatever is placed on the cover, hence the machine is easy to open and handle. It is operated by a highly efficient electric motor, which conects with any lamp socket or floor plug.

AN ELECTRIC 3-SPEED MIXER FOR THE KITCHEN.

One of the most effective labor saving machines on the market for the modern kitchen is the new motor-driven three-speed mixer here shown. This machine is electrically operated and the operation is so simple that a child can work it. It takes a minimum amount of electricity to run these machines, it is claimed, the large heavy-duty model requiring but a one horse-power motor. The starting, stopping and changing of speeds is controlled solely by one handle in front of the machine. It is also possible to stop the mixer without stopping the motor. The bowls of the mixer are rapidly interchangeable, by means of a simple snap spring and can be changed with one hand.

Electric Kitchen Machine, With Attachments for Performing Many Operations, Such as Mixing Soups and Mayonnaise, Mashing Potatoes and Fruits, Coffee Grinding, Vegetable Slicing, Meat Chopping, Silver Polishing and Dough Mixing. Motor Driven Thru a Sliding Gear Transmission, Giving Three Speeds. A Labor-Saving Machine for Hotels, Restaurants and Institutions.

The cut shown is that of the heavy-duty model. This size mixer is for use where heavy and continuous service is required, such as large hotels, restaurants, clubs, institutions, etc. It will mix bread, cake and pastry doughs, beat eggs, whip cream, strain soup, mash vegetables, and crumb bread; and with the extra attachments will grind meat, sharpen tools, buff silver, grind coffee, and many other varied duties.

It has been found by actual test that batches mixed in these machines are greatly improved in quality, and an increase in quantity is also evident. The thoroness of the mixing makes this possible. Because of the raising and lowering of the bowl, the beater can be worked up and down in the batch, thus insuring that every part of the batch has been well mixed. These machines are also great labor savers, as one machine will do the work of from two to three men.

They have rapidly gained recognition in all fields, and are now being used by the pharmical, drug, paint and polish manufacturers, as well as by preserving and canning houses, where they are used profitably.

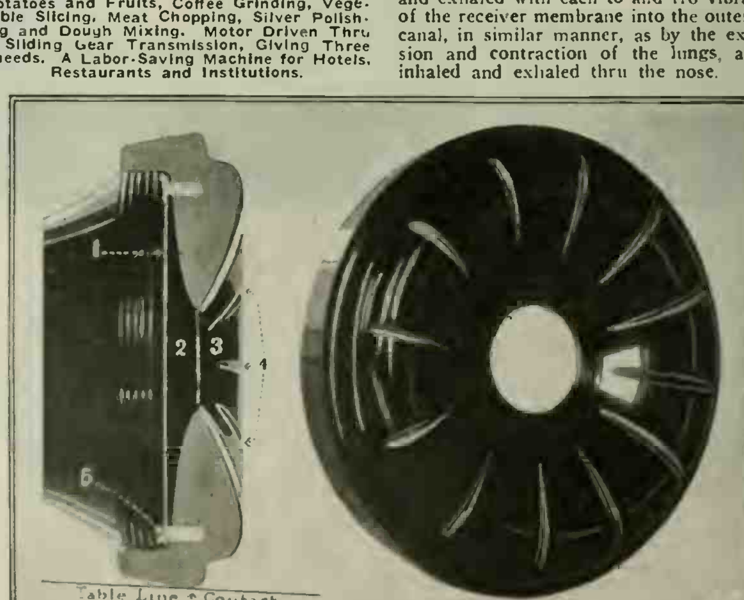
NEW TELEPHONE RECEIVER CAP IMPROVES EFFICIENCY.

Here is a new way of boosting the telephone receiver's efficiency via the ear cap, according to the sponsors of the specially designed cap shown.

A scientifically true seat for the membrane "1," prevents the minutest rattling thereof. An inverted trumpet bell, tone concentrating chamber "2," insures of whole, undistorted and most efficient guidance of the sound waves and prevents their deflection and distortion the makers claim.

A radially fluted exterior trumpet bell "3," constitutes a comfortable surface for the ear and permits the impact of each ear-shocking wave to be diverted thru the flutes, which also prevent the sounds from muffling and permits the earpiece to be held in a flat manner firmly to the ear, so as to exclude exterior noises.

Thru the flutes "4," air is freely inhaled and exhaled with each to and fro vibration of the receiver membrane into the outer ear canal, in similar manner, as by the expansion and contraction of the lungs, air is inhaled and exhaled thru the nose.



Something New in Telephone Receiver Caps—It Is Provided With a Series of Flutes in the Surface of the Cap as Shown, Which Are Said to Improve Its Efficiency Owing to the Better Circulation of Air.

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A "BULLET" FLASHLIGHT NOVELTY.

The latest in flashlights resembles a bullet. It measures 6 by $1\frac{5}{8}$ inches. It is made of heavy brass, well finished. Besides being a timely novelty, it is a real serviceable article, being equipt with a high grade dry

This Is Not a Real Bullet, But It Looks Just Like One. Inside Its Brass Shell There Are Concealed a Powerful Flashlight Battery and Lamp.

battery and Mazda lamp. It gives a strong, white, steady light of service to civilian and soldier or sailor alike.

MEASURING FOOT-CANDLES EASILY.

In the accompanying illustration a new foot-candle meter, devised by Dr. Clayton H. Sharp, is shown which makes it possible to measure illumination intensities in artificial lighting installations. The device is made in a convenient portable size and can be operated by anyone after becoming accustomed to reading the scale.

The instrument consists of a small lamp operated by dry batteries with a special volt-meter and rheostat so arranged that the lamp can be burned always at the same voltage. The lamp is placed in a small wedge-shaped box the top of which is made of translucent paper. This top is about 8 in. long and on it are made a number of small grease spots or dots in a row with a scale of foot-candles underneath. The lamp is inside the box at one end.

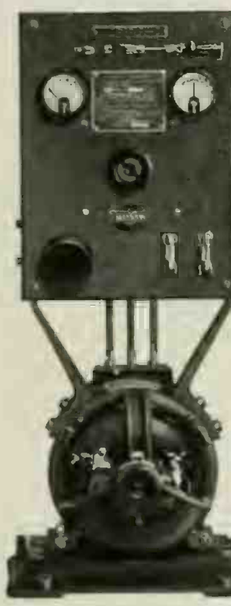
In operating this device, if there is more light outside the box, the grease spot is darker than the paper around it. The distance of the grease spot nearest the lamp is so chosen that when the lamp is burned at the correct voltage, this grease spot gets the light or illumination inside the box equal to that from 25 candles one foot away, or 25 ft. candles. The next spot gets less and so on down to the last spot. To use the device the lamp is set at the correct voltage, which is done by turning the rheostat handle until the voltmeter points at the right mark. Then the observer looks at the top of the box and picks out the point where the grease spots change from bright spots to dark spots and the marks on the scale tell just how much light or illumination, measured in foot candles, is being received on the outside of the box.

An Extremely Simple Foot-Candle Meter Recently Brought Out.

NEW 800 WATT ELECTRIC PLANT.

Electrical contractors are now in the Farm Lighting Plant business seriously and are finding it necessary to supply their customers with outfits of a better class than the cheap plants sold during the earlier days of the business.

The private lighting plant shown in the illustration has been placed on the market by a Milwaukee concern. It is of the belted type and consists of a generator and switchboard made up in one unit and a storage battery. The various elements of the plant are of well-known standard makes. The best grade instruments and rheostat are used on the switchboard, which also includes a new type of magnetic cut-out which is of an improved design. Glass enclosed fuses are furnished. These plants are made in three standard sizes provided with sixty, ninety, and one hundred and twenty ampere-hour batteries, respectively. The generator has a capacity of 800 Watts.



A New High-Class Private Electric Lighting Plant. It Connects With Any Engine and Develops Over 1 H. P. Storage Battery Equipt.

THE GERMAN WATCH TRICK.

A pet trick that the German soldiers employ is to leave a watch hanging on the wall of their abandoned trenches. Said watch connects by electric wires with a high explosive bomb. which explodes when the watch is removed from the wall.

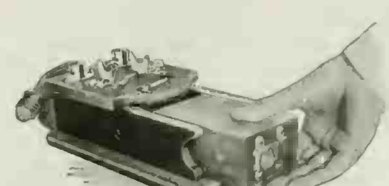
NEW AUTO SPARK COIL TESTER.

Here is a brand new device, developed to facilitate the testing and adjusting of the Ford spark coil unit and for testing automobile lamps of any candle-power or voltage, electric horns, spark plugs, for finding short-circuits, grounds, etc., recently put on the market.

One of the most important features of this tester is the fact that it tests the Ford coil under alternating current, this coil being wound for and operating in actual service under alternating current.

The new Tester, in one form, is designed for use with alternating current lighting circuit, while another type is identical in every respect, with the exception that it is designed for use where alternating current is not available and receives its energy from a six-volt storage battery or four dry cells.

The Tester is assembled in a highly polished mahogany case. All metal parts are heavily nickeled.



The Testing of Auto Spark Coils Is Greatly Facilitated by This New Device.

THIS ELECTRIC IRON HAS BUTTON CONTROL.

Women waste time, electricity (which is money), ruin clothing and ironing board

Well! Well! The Maid Can Answer the Door-bell at Last Without Burning Up a \$20.00 Lace What-you-may-call-it, for When She Releases This Electric Iron the Button Cuts Off the Current.

covers, and in many instances start disastrous fires with the old type electric iron.

Many times an ironer will be called away for a long time and forget to turn off the switch. The iron is often ruined and current wasted before she returns. This happens often when people are called away in a hurry. When the new electric iron here shown is used and there is a hurry call, the ironer will unconsciously slam the iron on the stand and hasten away. The push button is automatically released, the current stops, money is saved, perhaps property, and even lives.

The button works exceedingly easy. There is no strain on thumb muscles. The ironer hardly realizes she is holding it in.

The catch on the iron stand is put on and off in a jiffy.

The average ironing requires varying heat. Handkerchiefs, sheer waists, laces and all light material need less heat than heavy pieces. When ironing light pieces the current may be released for several minutes by simply removing thumb. When more is required, simply replace thumb over button. Many dollars are thus saved in a year's time. Danger of scorching valuable linen is reduced or entirely eliminated. The stand catch may be adjusted to keep the iron hot or not as desired.

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Burnt-Out Lamp Contest

WE have conducted a good many contests in the ELECTRICAL EXPERIMENTER in the past, but we are quite certain that our Burn-out Lamp Contest has broken every record by far. There seems to be a tremendous interest in the idea of utilizing burnt-out lamps, and up to the time of preparing this article, *over nine hundred letters* have been received, and are still coming in strong. The oddity of the contest is, that no matter how curious the idea, each has been duplicated, triplicated, and some of the ideas having been repeated as many as 208 times! Here is the record:

208 Radio Detectors.
80 Florence Flasks, Miscellaneous glass-ware, Retorts, Etc.
28 Geissler Tubes.
21 Magnifying Glasses.
15 Tesla Tubes.
13 Water Rheostats.
12 Emergency Fuses.
11 Batteries.
9 Rain Alarms.

Of this list the electrolytic detectors which rank first have been deemed impractical for actual work, and therefore have not been discust generally. You cannot make a good electrolytic detector from a standard burnt-out 110 volt lamp for the simple reason that the platinum or substitute plantinum wires are too thick and at best will only give very poor signals from a powerful station located but a few miles away. For long distance work, such a detector is entirely out of question.

Some of the chemical glass ware is being described in this article. The Geissler tube idea is not new, it having been described a great many times not alone in the ELECTRICAL EXPERIMENTER, but in other technical magazines. Remember, we wanted original ideas. The same pertains to Tesla tubes, as well as batteries. The magnifying glass idea while new, can hardly be called practical for the simple reason that no one would wish to fill a big bulb with water and use it around the desk for magnifying purposes.

As we mentioned before, all the ideas that came in have been duplicated. The ones which we mention in this article are those received first at our office, or bore post office marks showing that such an article had been mailed first. This we merely did in justice to the various contributors, as among the duplicated articles all apparently were equally well prepared.

Of course the curious and humorous element was not missing from this contest. Here are a few choice ones; all of these may be termed impractical. There have been suggested the following: wine bottles from 100 watt bulbs, chemical funnels, cigar lighters, water heaters, clothes sprinklers, and last but not least, all honors go to M. Musselman, of Velva, N. D., who proposed to fill the bulb with liquid green soap in order to use it for shampoo purposes!!

There were furthermore the following: chemical filter (using an inverted bulb with filter paper), targets for rifle practise, filling burn-out bulbs with colored liquids for window attractions. There were quite a good many X-ray tubes, but we have not seen one of these that would actually work. There were a good many variations on electrolysis apparatus, as was suggested in the original article by Mr. H. Gernsback. There were also several Helmholtz resonators, which did not seem practical to us. There were a number of flower vases, fern dishes, candle holders, cigar and match holders. There were two variable candensers which were varied by raising and lowering liquids in the condenser suggested by Mr. Gernsback. A particular clever one was suggested by Mr. Monte Cohen of New York City. This, however, lacked the elements of practicability. There were several "Chinese bombs," also detector covers by cutting off a half of the bulb to keep the dust from detectors. There were all kinds of insulating handles for static machines, and for high voltage apparatus. There were several floats for drip-pan alarms and the like, as well as many flower pots.

Mr. Allan C. Rockwood of Iowa City, Iowa, takes the cake by suggesting to magnetically release burnt-out bulbs filled with evil smelling liquids in order to have them crash on the domes of "Ham" actors. The idea is to place a push button in front of every man and women in the audience, who if mispleased, simply press a button which would release the bulb onto the unfortunate thespian member of the stage malefactors!

There was also a clever miniature volcano as well as a water fountain. Two Illinois inventors suggested—not such a bad idea,—making megaphones from burnt-out lamp bulbs to be used in connection with telephone receivers. In other words, making horns from the bulbs. There were of course half a dozen inkwells; there were several galvanometers, and even an acetylene generating machine; this utilizes the lamp bulb by dripping water on the carbide. There were a number of experimental storage batteries, and we must not forget a clever fire extinguisher suggested by Mr. H. E. Maher of Brooklyn, N. Y. He fills the bulb with the following solution: Chloride of Calcium, 20 parts; salt, 5 parts; water, 85 parts. The bulb is thrown in the center of the fire which is extinguished by the chemicals. Several would-be inventors showed us how to weigh air by weighing a lamp bulb before and after cutting off the tip, the difference in weight of course represents the actual weight of air. While a good idea, we thought that few experimenters had a sufficiently sensitive scale to detect the slight difference in weight, which of course does exist. There were many suggestions as to batteries which simply consist of utilizing half or three-quarter bulbs in which are placed the usual zinc and carbon elements.

The first prize goes to Elton Baker, 1316 N. 40th St., Omaha, Neb. This is on how to make a static machine by means of a burnt-out lamp bulb. Mr. Baker's article is reproduced in full herewith.

PRIZE WINNER ($3.00)

A BURNT-OUT LAMP BULB STATIC MACHINE.

By Elton Baker

The drawings, Fig. 1, show various views of a static machine which I have designed for the "Burnt-Out Lamp Bulb Contest." Altho the illustrations show a small 25 watt lamp bulb, much better results can be secured by the use of larger bulbs, as this machine operates on the principle of friction alone. The charges should be collected in a Leyden jar to produce a reasonably good-sized spark. The jar described by Mr. H. Gernsback in his article on "Burnt-Out Lamp Bulbs" in the April issue will do.

The "rubber" is a wood block of the shape indicated, made concave on one side to fit the curve of the bulb, covered first with a piece of felt or equally soft material and then with a strip of thin leather. To obtain best results the part in contact with the bulb should be covered with a coating of amalgam of zinc which may be scraped from the back of an old mirror. The collector is made of a similar wood block from which brass tacks protrude so that they are all equidistant from the bulb. The silk flap is attached to the rubber nearly covering the upper half of the bulb. It is for the purpose of holding the charge on the bulb until it reaches the collector.

Care should be taken that the driving belt turns the bulb *towards* the collector and also that the tacks on the collector and the leather on the rubber are in metallic connection with their respective brass balls.

The second prize winner ($2.00) is C. M. Cardeaz, 13th and Locust Sts., Philadelphia, Pa. This is on an automatic electric fire detector made from two old bulbs.

Its working principle is as follows: The hot air, see Fig. 2, rising to the ceiling, causes the air inside the bulb to expand, thereby forcing the salt or acidulated water out of the hole in the bottom and into the cup below, closing the circuit between the two battery wires. These may be connected to a red lamp or bell, as the owner may wish. The filament of the lamp has nothing to do with the operation of the device, and should be entirely broken by shaking the bulb well while full of solution.

The third prize winner (one year's subscription to the E. E.) is H. J. Huber, 24 Garfield St., Lancaster, N. Y., Fig. 3. This is on a home-made alcohol lamp. Our illustration shows clearly how it is made. All you need is a burnt-out lamp bulb, a lamp receptacle and a piece of metal or glass tubing thru which to feed the wick. The illustration shows the details. This is really a good little alcohol lamp, and will hold sufficient liquid to keep it going for quite a while. If the standard lamp bulb is too large, a small 8 C. P. one can be used.

Figure 4 shows a photographic dark room lamp, and was suggested by Mr. Lester Arnold, 381 Eastlawn Ave., Detroit, Mich. As the illustration shows, the lamp bulb is filled with a dark red solution which may be a concentrated solution of potassium bichromat. A hole is made at the top of the bulb in which is inserted a test tube, and in this a small battery bulb is placed, the latter being connected to a battery as shown. This is quite a practical idea and should come into favor with experimenters developing their own films.

Figure 5 shows a rheostat and pole tester suggested by Mr. Eugene Ruckman, 2209 E. Main St., Ottumwa, Iowa. Nothing further than the illustration is required to make this idea fully understandable. When used as a rheostat, slightly acidulated water, or otherwise water to which a few grains of salt has been added, is used. Thus, any required resistance can be readily had. When used as a pole tester, the solution

(*Continued on page 127*)

AMONG the hundreds of new devices and appliances publisht 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 furnisht to you, free of charge, by addressing our Technical Information Bureau.

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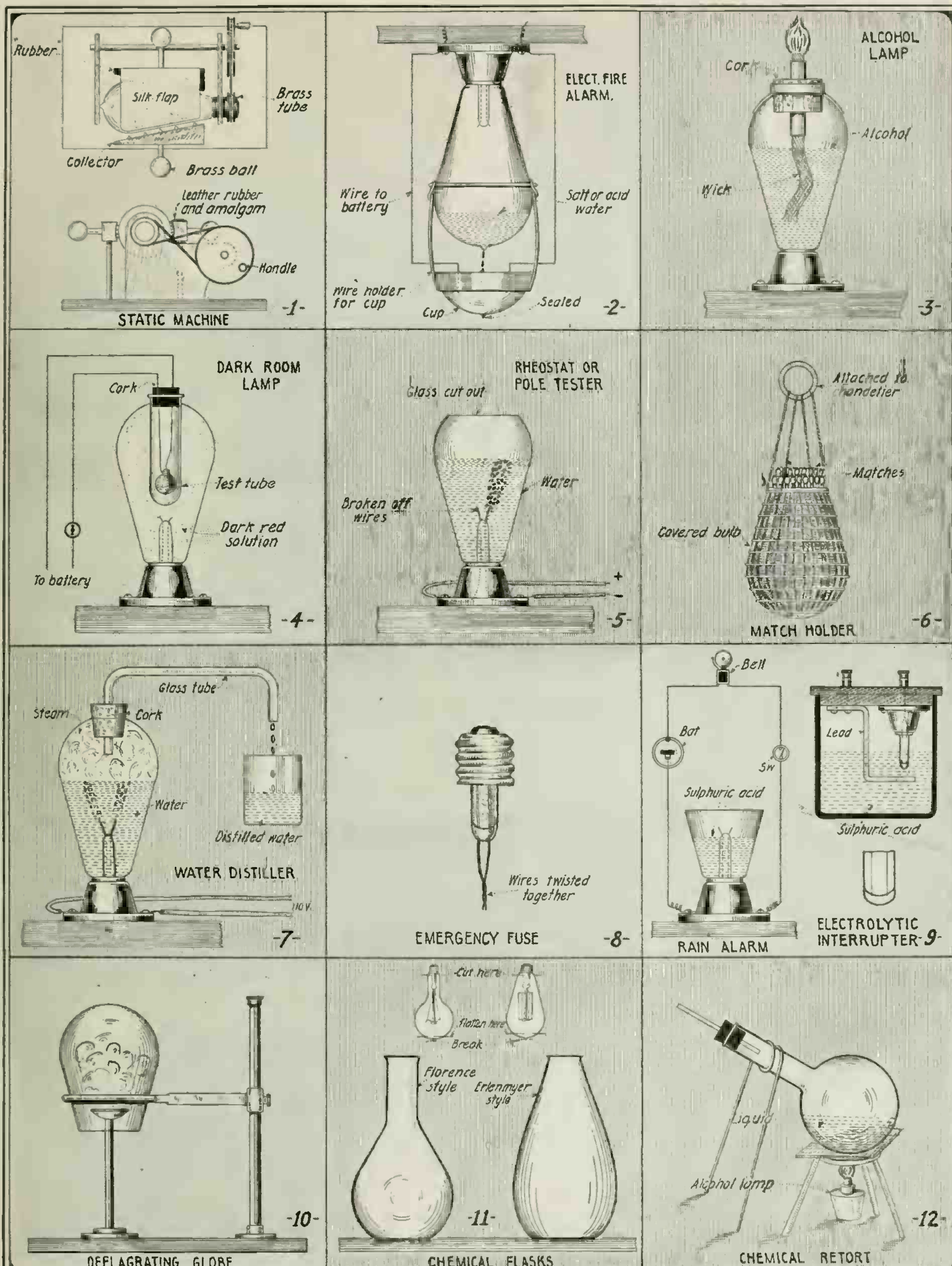
BURNT-OUT LAMP CONTEST.



(See opposite page for descriptive text.)

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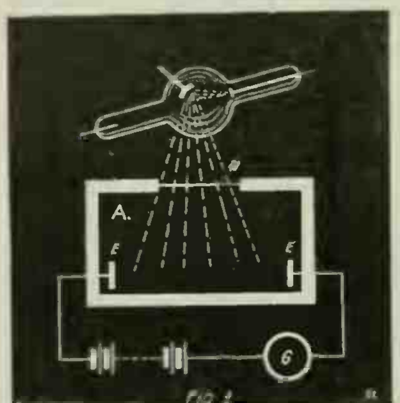
The Phenomena of Electrical Conduction in Gases

PART III—HOW IONS ARE PRODUCED

By ROGERS D. RUSK, M. A.

EVERY time a molecule of any gas gains or loses an electron so as to become electrically charged it becomes an ion or carrier of electricity. A molecule which loses an electron constitutes a positive ion, and the electron itself may be the *negative* ion unless it in turn attaches itself to a *neutral molecule*. When that occurs the neutral molecule becomes negatively charged and *it* is the negative ion. Hence the smallest negative ion known is a *free electron*, and the smallest positive ion known is a *hydrogen atom* which has lost an electron, the hydrogen atom being the lightest atom which exists.



Arrangement of X-ray Tube and Ionization Chamber for the Study of Electrical Conduction in Gases.

Electrons may be displaced from molecules by the action of X-rays, ultra-violet light, heat, electric sparks, arcs, flames, emanations from radioactive substances, and by the collision of rapidly moving ions with molecules. Any of these ionizing agents may thus change a nonconducting gas to a conductor and the effect may be proved by placing a charged electroscope in a gas which is under the influence of any one of them, and noticing how quickly it will lose its charge. Different agencies may, however, produce different types of ionization, and a study of these different phenomena leads to a fuller understanding of electricity and matter, and especially the causes of ionization.

X-RAYS.

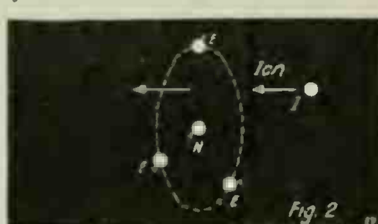
The X-Rays are one of the best ionizing agents known. In experimenting with ions produced by it, an ionization chamber is generally used which may be of the form shown in Fig. 1; A is the ionization chamber with an aluminum window W, thru which the radiation may pass and E E are electrodes by which the conductivity of the air or gas may be measured. The experiments of Prof. Millikan, of Chicago, and others have shown that for the most part the ions seem to be singly charged, which means that when one of these short ether waves strikes a molecule of gas, an electron is displaced. If two or more electrons were displaced at one time the molecule would at once become *doubly or multiply charged*.

The most noticeable feature of such ionization is that the electron which is displaced seems to be knocked out with some considerable force, which is evident from the high rate of speed at which it then travels. This is quite different from other types of ionization to be mentioned later.

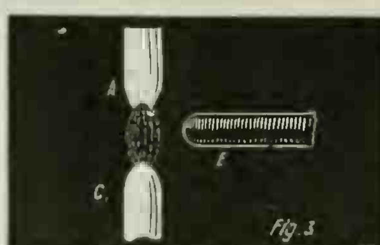
ULTRA-VIOLET LIGHT.

The fact that ultra-violet light may cause a charged body to lose its charge has been known for a long time, as, for instance, the case of a piece of zinc, which if not charged at all acquires a *positive* charge under the influence of ultra-violet light. Other metals are even more sensitive, such as sodium, potassium and rubidium *which latter is even sensitive to ordinary light*. This property of light to charge or discharge a body or cause a gas to become a conductor is called the *photo-electric effect*, and the action of ultra-violet light seems exactly the same as X-rays, for the ions become singly charged, and the electrons are displaced with considerable force.

The explanation of the ionization of gases by short ether waves seems to be that when a wave of the proper length strikes a molecule, the vibrating electron *absorbs the energy of the wave*, so that its own motion is thereby increased until it is violently shot off from the molecule. Sometimes light is absorbed without producing ionization and in that case the energy of the wave increases the kinetic energy of the molecule without causing the expulsion of an electron. The question as to whether or not a given wave will displace an electron most likely depends on the relative frequencies of the wave and the vibrating electron, and their phase relationship when they meet. A certain amount of harmonic relationship would allow absorption to take place where the lack of it no doubt would cause expulsion. Just what relation this may be is a subject for investigation.



Just How an Electron, a Beta Particle for Instance, Can Pass Completely Thru a Molecule, Is Demonstrated by the Drawing Above. There Is Considerable Space Between the Molecular Particles.



Dr. J. A. Fleming Explored the Electric Arc With an Auxiliary Pole E, and Found That While the Arc Was Burning He Could Get a Current Between E and C, But Not Between A and E, Keeping E Cold.

RADIUM EMANATION.

As is well known, the emanations from radioactive substances consist of three general classes, alpha (α) rays or positive particles, beta (β) rays or negative particles and gamma (γ) rays which are very short ether waves. If a gas be ionized by means of beta rays it has been found that single electrons are displaced with very little violence, more as if they were simply set free rather than expelled violently by collision. The same is true of ionization by alpha particles, while the gamma rays act in the opposite way to the other short *ether* waves.

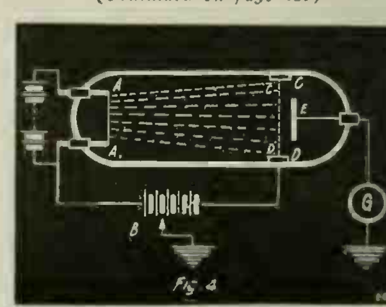
The beta particle, which is in reality an electron, is so small that it may often *pass completely thru a molecule without producing ionization*, and it frequently does this when traveling at a high velocity. The alpha particle, which is identified as a positively charged helium atom, may do the same, but on account of its much greater size produces ionization more frequently than the beta particle. Both kinds of rays produce more ions when traveling slow than fast because they then have less chance of passing thru a molecule without collision, and it is thought that the alpha particle may remove several electrons at one time thus producing multiple charges, but that point is debatable.

The way in which an electron or other small rapidly moving particle may pass completely thru a molecule can be better understood by considering Fig. 2, and remembering that the electron takes up *less than one hundred thousandth*

$$\left(\frac{1}{100{,}000}\right)$$

of the volume of any atom and the nucleus or center is probably smaller still. So that as one scientist has said the atom seems to be mostly "betweenness." By the figure it is easily seen that if the separate parts of an atom are actually this small, and if the electrons (E) are rotating at high speed about the nucleus (N), the probability is very high that another small particle traveling in the direction of the arrow (I) will pass completely thru without collision. The experiment may be tried of swinging a ball on a string and throwing marbles thru the circle described by the ball, and it will be found that rarely indeed will the ball be hit or even the string.

(*Continued on page 139*)



Design of Vacuum Tube Used by Franck and Hertz in Their Researches on the Conduction of Electricity Thru Gases.

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Television and the Telephot

Coming Inventions No. 1.

By H. GERNSBACK

(*Conclusion*)

As we mentioned in the preceding installment of this article, all the telephot schemes which have appeared so far are more or less theoretical. Many of them have not even reached an experimental stage. It seems that while most ideas look more or less practical on paper, it is quite impossible to tell if any of them would actually work in practise. At any rate the various proposed schemes here illustrated form interesting reading for the serious-minded experimenter, who is working on this more or less intricate problem. Several of the schemes outlined show a reasonable way towards accomplishing the goal.

Figure 1 shows the telephot of Mr. Sidney Rothschild, of New York, on which patents have been issued. Briefly summarized, this invention consists in causing a light controlled composite background to vary the intensity of electrical currents flowing over a wire, and causing these currents to control the intensity of light at the receiving station, this light being caused by an appropriate mechanism to produce a moving luminous spot of varying intensity in such a manner as to reproduce a facsimile image disposed adjacent to the aforesaid background at the transmitting station. The outstanding features are indicated in the illustrations, and the more technical details have not been discust. These can be readily looked up in the patent specifications by anyone sufficiently interested.

At the sending station we have a subject A, whose picture is transmitted thru lens 1, the rays of which fall on the selenium cell 4, after passing thru a belt 3, which is rotated at a high speed. This belt has a number of longitudinal slots disposed crosswise, the belt travelling in the direction indicated by the arrow. A revolving cylinder 9 is provided with a series of slots, each being adapted to register with one of the sections 8 of a further selenium cell. In this manner Mr. Rothschild expects to cut up the various points of the picture and transmit the impulses over the line as shown. At the receiving end, we find a revolving wheel 6 and another rapidly revolving belt 5 which also has longitudinal slots as shown in detailed drawing *C*. By means of a light source shown at 11, which may be an incandescent lamp, the light rays pass thru the revolving wheel 6 and slotted belt 5. The light rays in this case being cut up exactly in the same manner as those of the transmitter. These light rays fall thru lens 2 and thence are projected on to the screen *B*. Thus the picture is supposed to be reproduced. As in all other telephots, this one of necessity requires a synchronous movement as it is important that the sender and the receiver work synchronously. This is one of the difficult points of the telephot, and as yet has not been realized in practise.

A clever telephot which was patented by Messrs. A. C. & L. S. Andersen is shown in Fig. 2. The sending apparatus comprises a dark chamber shown in dotted lines, in which is placed a lens 6' which receives the rays issuing from the dark chamber. These rays after being refracted meet a small selenium cell 8, placed behind the prism 6". Screen 1 represents an object (in reality farther removed from the dark chamber than the drawing indicates). The light rays coming from the screen 1 after refraction in the lens 6 which is in front of the dark chamber form upon the endless ribbon 3, a real image reversed and reduced by the screen 1. This ribbon is flat continuous and opaque except at certain perforated points, arranged according to a diagonal line as shown in the detail sketch *S*. The distance separating the holes 5 depend upon the size of the image in the dark chamber. The holes are spaced apart in such a manner that only one point can be located at each instant within the field of the image in the dark chamber. The ribbon 3 is displaced from above downwardly by means of an electric motor; it thus forms the end of the dark chamber; the luminous rays traversing the perforations of the ribbon fall upon the lens 6'. They are received by the selenium cell 8. Only one point comes at each instant within the field of the image as the illustration shows. When the ribbon has been displaced the whole of its length, each of the points of perforation has crost the part of the image which is presented to view; thus, the entire picture is transmitted point by point.

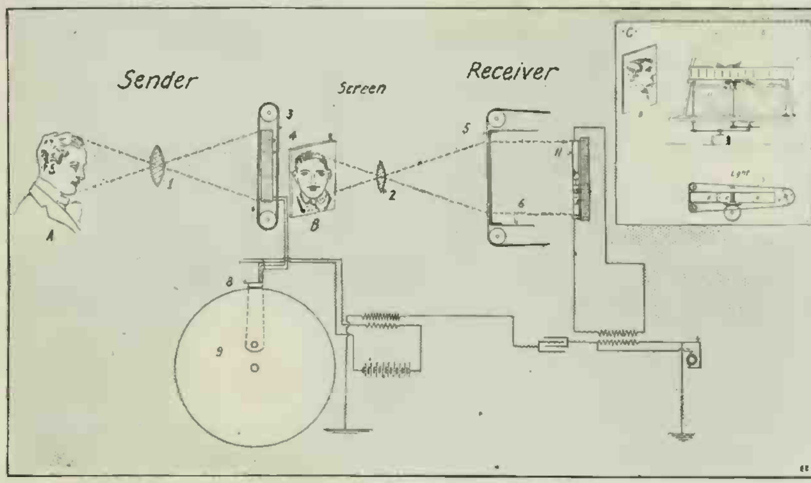

Fig. 1. This Is the Rothschild Telephot Scheme Which Cuts Up the Light Impulses by Means of a Slotted Revolving Belt 3 at the Sender. Passing Rapidly Before the Selenium Cell 4 the Impulses Are Sent Over the Line and Influence a Source of Light 11 at the Receiver Where a Similar Revolving Belt Scheme Reconstructs a Picture as Shown at B.

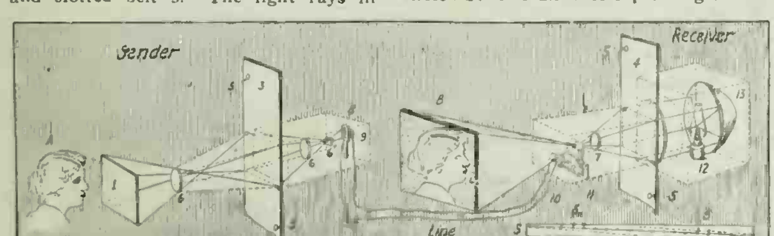

Fig. 2 Shows the A. C. & L. S. Andersen Telephot, Where Use Is Also Made of Revolving Belt 3, Having Perforations 5. This Belt at the Sender Rapidly Passes in Front of the Camera Influencing a Selenium Cell 9. At the Receiver a Sensitive Electro-Magnetic Arrangement, 10 and 11, Acting as a Shutter Cuts Off the Light Impulses: Thus Theoretically Reconstructing the Picture.

At the receiving end we find the sender practically reversed. Here we have another moving ribbon 4 with perforated holes 5. In the dark chamber 13 we have a source of illumination which may be a kerosene lamp, or an electric lamp or any other kind of a lamp 12. This lamp throws its rays thru lens 7. Here we have also the electro-magnet 10 which is connected with the selenium cell, and a battery at the sending station. By means of an ingenious shutter arrangement 11, the light rays coming from the lamp 12 are more or less influenced, due to the fact that the electro-magnet is more or less energized by the selenium cell 8 of the sender. In other words when at the sending station, the selenium cell was energized at its maximum, in this case the electro-magnet 10 at the receiving end would be energized at its maximum also, and therefore the shutter would let pass the maximum amount of light. All providing of course, that the ribbon 4 was working synchronously with the ribbon 3 at the sender. As the ribbon 4 revolves very rapidly and synchronously with the ribbon at the sender, the picture is thus reproduced point by point and is recomposed upon the screen shown at *B*. Messrs. Andersen have also incorporated into this invention an idea showing how the picture can be transmitted in its actual colors. This is a very ingenuous arrangement, but is outside of the scope of this article.

The next telephot, Fig. 3, was imagined

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by Gustav E. Hoglund, of Chicago, Ill. This invention also has been patented, and relates to that class of devices for cutting up and dividing light rays emanating from an image and causing them to act upon a selenium cell capable of changing its electrical resistance under light rays of different degrees of intensity. These vibrations are sent over a line and act upon a luminous center at the other end thereof, which may be in the form of a speaking arc and cause a fluctuation in the brilliancy of said arc which will cause light rays to emanate therefrom, said rays being of varying intensity according to the strength of the current. These rays will follow each other in the same order, and will be of comparatively the same intensity as the light rays emanating from the object. Hence, when the rays from the lamp are projected onto the retina of the eye in rapid succession, they will cause an image to be built up before the eye, which will be composed of the varying light rays of the same strength and in the same order as those emanating from the original image.

The device shown in Fig. 3 has a receiver and a sender: each of the instruments comprises a selenium cell 5, positioned in front of which is the enlarging lens 4 and the reducing lens 3. Between these lenses is a double revolving shutter composed of discs 7 and 8. These are also shown in a detail sketch. Disc 7 has a series of square perforations 10, while disc 8 has a series of slots 11. It will be seen that as these discs revolve in opposite directions, each point of the picture is cut up successively and allowed to pass thru the optical lens system. Each of the receiving instruments also comprises a lamp 1 and enlarging lenses 2, 2. Between these lenses a ground glass plate is placed, upon which the final picture appears. Both receiving and sending instruments are connected by electrical lines as shown. The oppositely revolving discs are ordinarily actuated by means of the synchronous motor 10.

An interesting part of this invention is that these revolving shutters can be corrected if they do not run synchronously by means of handle 9. It becomes apparent that the two shutters must be brought into proper relation to one another; it can be easily determined when such a relation is found by observing the image coming from the receiving instrument. If the shutters are not in proper relation, the image will be nothing more than a blur, and before it can be distinctly seen, the shutters will have to be in appropriate relation to bring the openings into the desired position. The inventor therefore provides handles 9 which extend from the shutters and by turning these handles, the shutters can be revolved until they are brought into proper relation with one another, the operator determining when such position has been reached by observing the completeness of the image reproduced by the receiving instrument. Once the shutters are in proper relation with one another, the motors are then supposed to operate them synchronously. By studying the illustration, it will be noted that the lamps 6 are varied into their proper luminosity due to the selenium cells 5 receiving more or less light.

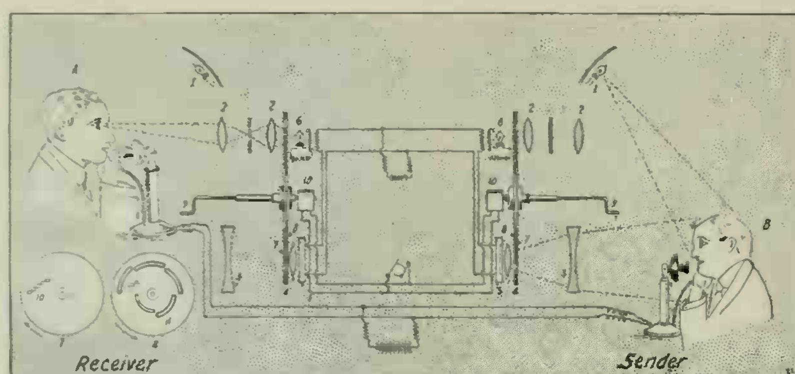

Fig. 3, the Hoglund Telephot Makes Use of Two Revolving Shutters, 7 and 8, Revolving in Opposite Directions. Selenium Cell 5 is Influenced by the Light Rays and the Picture at the Receiving Station Is Reconstructed by Means of the Light Variations of Lamp 6.

While this scheme looks very feasible on paper, we are afraid that the lamps 6 will not respond instantaneously to the current variations in the selenium cells 5, and at best the picture would seem to us to be formed rather blurred.

The next telephot which has also been patented in several countries is shown in Fig. 4. The inventor of this telephot is Boris Rosing of Petrograd, Russia. In order to eliminate the synchronous motor arrangements which have been the failure of almost all telephot schemes, Mr. Rosing does away entirely with them, substituting therefore a system comprising two oscillographs with movable reflecting surfaces. This will be apparent further on. The optical system at the transmitting station comprises two polyhedral rotary mirrors, 1 and 2, the axis of rotation of which are at right angles to each other. They are driven at such speeds that the angular velocity of one of the mirrors is several times greater than the other; and an objective or lens 5, the focal plane of which coincides with the plane of the screen 6 and the photo-electric receiver 7. The objective 5 is arranged in such a manner that rays emitted from any point of the field of vision arrive in the photo-electric receiver only after successive reflections by the two mirrors. When the mirrors 1 and 2 are rotated, the end 8 of the optical axis thus deflected traverses the field of the picture in a zig-zag path, so that from every portion thereof light is transmitted in a certain determinate order thru the opening of the screen 6 upon the photo-electric receiver 7. Permanent electric magnets carried by the mirrors 1 and 2 and stationary bobbins 3 together form small generators producing in the corresponding bobbins pulsating currents, the periodicity of which per revolution of the mirror corresponds to the number of reflecting surfaces thereof. The currents which are produced in the conductors 9, 10, 11, 12 and transmitted thru the receiving station are proportional to the components in the directions of the axes of a corresponding system of coördinates of angular movements which the optical axis 8 executes in the field of view.

At the receiving side we find two oscillographs provided with mirrors 13 and 14. The axes of both are arranged to correspond to the axes of rotation of the mirros 1 and 2. Lens 16 directs the rays proceeding from the luminous signaling point 15 on to the small mirror 13. There will therefore be imparted to the deflected optical axis 17 at the receiving station, the same movements in space which the deflected optical axis 8 at the sending station executes at the transmitting station. It goes without saying that the moving parts of the oscillographs naturally have much less inertia than do the revolving sets.

Fig. 4 Shows the Rosing Telephot. Use Is Made of Two Sets of Poly-Hedral Revolving Mirrors, 1 and 2, Throwing a Light Ray on Selenium Cell 7. At the Receiver Two Oscillographs Reconstruct the Picture Shown at B.

A different idea in Mr. Rosing's invention is shown in insert *C*, Fig. 4. Here instead of using oscillographs, the inventor

(*Continued on page* 124)

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The Dynatron—a New Vacuum Tube

THE *dynatron* belongs to the kenotron family of high vacuum, hot cathode devices which the research engineers of the General Electric Company have developed, and was described in a paper read before The Institute of Radio Engineers by Dr. Albert W. Hull. Two members of this family, the *kenotron* rectifier and the *pliotron*, have already been described in this journal. The fundamental characteristic of kenotrons is that their operation does not depend in any way upon the presence of *gas*.

In construction, the dynatron resembles the kenotron rectifier and the pliotron. In principle and operation, however, the three are fundamentally different. Each utilizes a single important principle of vacuum conduction. The kenotron rectifier utilizes the uni-directional property of the current between a hot and cold electrode in vacuum. The pliotron utilizes the space charge property of this current, which allows the current to be controlled by the electrostatic effect of a grid. The dynatron utilizes the secondary emission of electrons by a plate upon which the primary electrons fall. It is, as its name indicates, a *generator of electric power*, and feeds energy into any circuit to which it is connected. It is like a series generator, in that its voltage is proportional to the current thru it, but it is entirely free from hysteresis and lag that are inherent in generators and in all devices which depend upon *gaseous ionization*.

The dynatron consists essentially of an evacuated tube containing a filament, a perforated anode and a third electrode called the plate. The essential construction is shown in Fig. 1. The plate must be situated near the anode, in such a position that some of the electrons, set in motion by the anode voltage, will fall upon it. A battery is provided for maintaining the filament at incandescence and for maintaining the anode at a constant positive potential of 100 volts or more, with respect to the filament. This voltage is not varied during operation, and the anode plays no part in the operation of the tube, except to set in motion a stream of *primary* electrons, and to carry away the *secondary* electrons from the plate that is to supply the power.

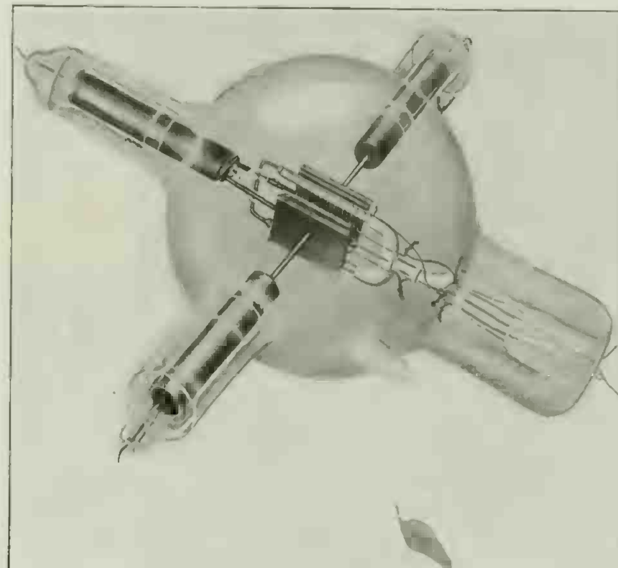

Fig. 3. The Latest Vacuum Tube Radio Generator and Amplifier—The "Pliodynatron."

The illustration, Fig. 2, shows the construction of one of the practical types of dynatron that have been developed. The plate, as will be observed, has been bent into the form of a cylinder, in order to utilize more fully the electron emission from the filament, and the anode has been provided with a large number of holes, instead of one. This is accomplisht by using a perforated cylinder, a spiral of stout wire, or a network of fine tungsten wire. The filament is a spiral of tungsten wire. The filament may be further provided with a heavy insulated wire along its axis or surrounded by an insulated spiral grid, making a "four member" tube, which is called a *pliodynatron*. The characteristics of the pliodynatron are discust later on.

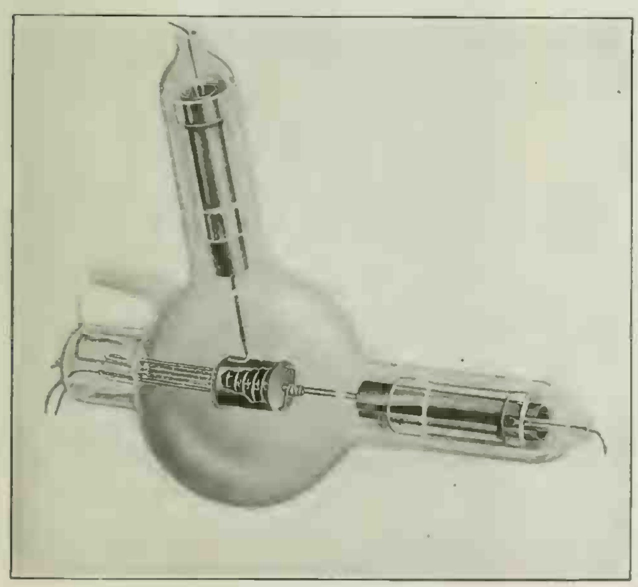

Fig. 2. Vacuum Tube Oscillator for Generating or Amplifying Radio Currents—The "Dynatron."

Electrons from the filament F (Figure 1) are set in motion by the electric field between F and the anode A. Some of them pass thru the holes in the anode and fall upon the plate P. If P is at a low potential with respect to the filament, these electrons will enter the plate and form a current of negative electricity in the external circuit. If the potential of P is raised, the velocity with which the electrons strike it will increase, and when this velocity becomes great enough, they will, by their impact, cause the emission of *secondary* electrons from the plate. These secondary electrons will be attracted to the more positive anode A. The net current of electrons, received by the plate, is the difference between the number of primary electrons that strike and enter it and the number of secondary electrons which leave it. The number of primary electrons depends on the temperature of the filament and is practically independent of the voltage of the plate. The number of secondary electrons, however, increases rapidly with the voltage difference between plate and filament, and may become very much larger than the number of primary electrons; that is, each primary electron may produce several secondary electrons, *as many as twenty* in some cases.

If the dynatron be left open-circuited, as in Figure 1, it is unstable.

The same instability occurs if the circuit of Figure 1, instead of being left open, is closed thru too high a resistance, so that the rate at which the plate receives electrons is greater than the rate at which these electrons can flow away thru the resistance.

(*Continued on page 122*)

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Major-General George O. Squier

MAJOR-GENERAL GEORGE OWEN SQUIER, well known to all electrical and radio men for his important achievements in telephony and telegraphy, is at the head of the U. S. Signal Corps, one of the most important branches of our army. General Squier has a large number of problems to contend with in his capacity, for besides his multitudinous duties in building up an efficient Signals Corps arm of the Service, equal numerically to our entire army before declaration of war, he has had charge of the aviation work of the Government.

Photo © by Harris & Ewing

Major-General George Owen Squier, Chief Signal Officer, U. S. Army. He Is a Brilliant Scientific Investigator as Well as a Thoro Military Director.

Major-General Squier was born in Dryden, Mich., March 21, 1865, in the old homestead which he still owns, and which was settled by his grandfather in 1835. In 1883 he was chosen for West Point, and in 1887 graduated seventh in a class of 65. Appointed second lieutenant in the Third Artillery at Fort McHenry, Baltimore, on June 12, 1887, he put in all his spare time studying physics at Johns Hopkins University under such leaders as Rowland, Remsen and Newcomb. There he laid the basis of his scientific knowledge, being made a fellow of the University during the years 1902, 1903, and 1904, and receiving his Ph.D. degree in 1903.

He announced before the American Institute of Electrical Engineers in 1897, a new method of rapid telegraphy, based on the use of the alternating current with the polarizing photo-chronograph. Three years later he announced to the same Society the adaptation of these principles to cable telegraphy, using the sine wave 'e. m. f.'s' as worked out in experiments begun the year before with Dr. A. C. Crehore.

In the meantime his military career claimed him, especially during the rush of the Spanish War. In 1900 he took the cable steamer *Burnside* from New York thru Suez to the Philippines, where he laid the inter-island cable still in use. During this time he rose thru various ranks till he was commissioned Major March 2, 1903.

In 1907, as Chief of Staff to General Allen, of the Signal Corps, he was entrusted with drawing up the first specifications for a military airplane ever issued by any government. On September 12, of the next year, when in charge of the first tests at Fort Myer, he made the first ascent as a passenger in an airplane ever made. That December he showed his faith in aviation by a public address stating that airplanes are fast *obliterating present national frontiers in conducting military operations.*

General Squier was sent, in 1912, to England as military attaché to the American embassy where he built up many of the friendships and secured much of the information, especially in the first two years of the war, that have since proved so useful. He also represented the United States at the International Radio Conference in London that year. It was there, too, in June, 1915, before the Physical Society that he made the announcement of his cable transmission invention, which later led to its adoption. It is estimated that this *doubled* the capacity of the cables.

It was in May, 1916, with the war two years old and the vital importance of aviation fully demonstrated, that he was recalled to America by President Wilson to reorganize the Air Service. On the 14th of the following February he was appointed Chief Signal Officer in charge of both aviation and the Signal Corps, with the rank of Brigadier General, which was increased to Major General on October 6, 1917.

During the brief eight months since he has been in charge, the Air Service has jumped from a strength of 2,000 to an authorized strength of 153,000; its appropriations have increased from about a million dollars in five years to $700,000,000 granted in one, and a billion asked in the next; its planes and aviators have increased from a handful to thousands. The Signal Corps itself has had to meet the needs of an army *eight times that* of a year ago.

General Squier is a Fellow of the Physical Society of London; a member of the Royal Institution of Great Britain; the American Mathematical Society; the Franklin Institute; the American Association for the Advancement of Science; the American Physical Society; the American Philosophical Society; the American Institute of Electrical Engineers; the Institute of Radio Engineers, and other scientific and professional bodies. He was awarded the John Scott Legacy Medal in 1896 by the city of Philadelphia for the polarizing photo-chronograph, and in 1912 the Elliott Cresson gold medal, the highest honor of the Franklin Institute, for his work in multiplex telegraphy on "wired wireless," by which half a dozen wireless messages run outside of, but are guided by a single wire. He has also issued inventions in the use of trees as antennæ in wireless telegraphy; the electro-chemical effects of magnetization, and the absorption of electro-magnetic waves by living vegetable organisms.

Electricity plays a tremendous part in the preparations being made for the reception of American troops in France. From the refrigeration of food to the fighting of first line trenches, electricity is employed at almost every step.

SOCIETY GIRLS WILL INSTRUCT DRAFTED MEN IN RADIO.

The Women's Radio Corps of America is training at New York headquarters a corps of young ladies, most of whom are prominent in New York social circles. The members of the corps will later instruct classes of drafted men in buzzer and radio signaling. The photo shows Sergt. Georgiana B. Davids (left) and Sergt. Elise Owen, who are in charge of the students.

This idea seems a capital one to our minds—instead of attempting to place women radio operators in hazardous war positions, why not train them to teach? Here's a big field, surely, one that is bound to expand as more and more of the flying cadets are marshalled in the training centers. And thousands, and even tens of thousands of these future flyers will have to be taught radio operating in the next year or so. In this way the women will find a most satisfying way of knowing and feeling that they are actually doing "their bit" for Uncle Sam.

Photo © by Central News Photo Service

Not Content With a Motor Corps, to Help Uncle Sam Along In His War Work, New York Women Now Have a Highly Efficient "Women's Radio Corps of America," Trained to Instruct National Army Men In Wireless Signaling. Here Are the Women In Charge: Sergt. Georgiana B. Davids (Left), and Sergt. Elise Owen.

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A "Fountain Pen" Radio Receiving Set

While not an entirely new innovation the average pocket wireless set has had the invariable drawbacks of all new devices, as well as lack of practical use. But now a new application has presented itself in that with so many "Spies" at large, it has become a necessity to detect many of these enemy aliens who undoubtedly are using secret wireless apparatus to communicate information to Germany, or between themselves.

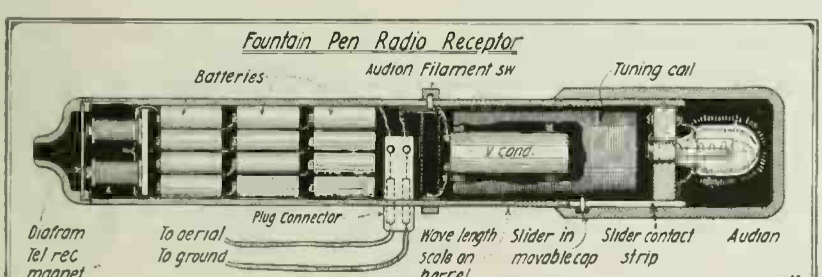
To Dr. Lee deForest must be given the credit for developing a receiver which is only slightly larger than an ordinary fountain pen. With it, a secret service man has but to walk in the vicinity where a "spy radio station" is suspected, with the chance that he may locate the informer at his instrument.

With this "fountain pen" Radio receiver it has been possible to hear stations eight to ten miles away, with little difficulty and only a small aerial. In the sectional view shown herewith may be seen how it is hooked up. This sensitive receiver depends entirely upon the Audion for its efficiency, and it is only this extremely sensitive detector that has made possible a truly practical receiver of this small type.

It has been found that by using what is known as a "soft" Audion a fair degree of sensitiveness is achieved with a battery of only four volts, whereas a standard Audion requires a potential many times that amount.

The tuning of the set is accomplisht by means of a small coil, wound with No. 40 magnet wire. Taps are taken off from the coil and led to a number of points over which slides a contact mounted on the movable cap at the end of the receiver. By moving the cap one way or another the wave-length is altered to conform with the in-coming wave. The tuning coil answers satisfactorily for short wave-lengths, and the Audion is connected directly to it, having an untuned secondary. The battery is placed in the middle of the receiver and at the end is placed the telephone receiver consisting of a special magnet, bobbin, diafram and earpiece. The antenna and ground connections are instantly made by a special double contact plug.

To operate the instrument the person using it has a metal plate attached to the heel of one shoe, to which is attached the ground wire leading to the set, the wire being past thru the trouser leg so as not to be seen. The wire to the antenna is run down thru the coat sleeve and into a hollow cane which may contain a spiral aerial or a similar arrangement.



Section Thru "Fountain Pen" Radio Receiving Set, Showing Disposition of Audion, Batteries, Telephone Receiver, Tuning Coil, Condenser, Etc.

Standing against an iron fixture which connects with the ground the operator places the metal electrode on the heel in contact with the same. The cane containing the antenna is held over the shoulder or in any position not likely to cause attraction. The earpiece is placed against the ear and the other end adjusted till the signals are heard loudest.

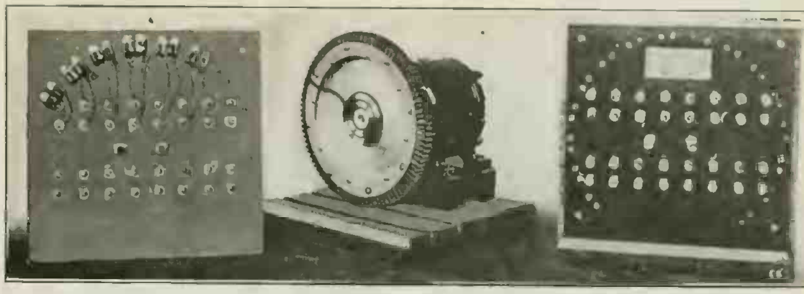
The transformer is about the most efficient piece of electrical apparatus, it having an efficiency of about 98%.

"Fountain Pen" Radio Receiving Set in Use.

SPECIAL RADIO SIGNAL GENERATOR FOR TEACHING STUDENTS.

By Geo. F. Paul

A specially built and cleverly contrived generator designed to give an exact reproduction of radio signals has been perfected and put into use at the Dunwoody Industrial Institute, in Minneapolis. This high frequency generator is used instead of a buzzer for producing the practise signals in the 'phones. The generator has 98 poles, the rotor, which is the field, is revolved at a speed sufficient to give a clear musical note of about 600 cycles. The frequency as well as the strength of the signals can be easily varied. As a result of this arrangement the student gets practise in receiving an exact imitation of the modern radio signals such as are sent out by undamped wave generators and quenched spark sets. The head 'phones are connected directly to the stator coils of the generator thru the transmitting keys. The generator is driven by a one-sixth horse-power electric motor.



This Special Yet Simple Form of High Frequency Generator is Used At a Leading Radio School to Supply the Proper Tone of 'Phone Current.

Dunwoody Institute has leaped into prominence as a training center for turning out skilled operatives in electrical lines for both army and navy service. For the naval radio service, men are sent to Dunwoody from the Great Lakes Naval Training Station, north of Chicago, and after six or eight weeks intensive training they are sent on to Harvard University where they receive final instructions before being assigned to active duty.

The operating room at Dunwoody Institute is fitted up with tables and head 'phones to accommodate one hundred students at a time. Two other large rooms are fitted with tables, blackboards, etc., for related work. The related work consists of instruction, demonstrations and lectures in theory of motors, batteries and dynamos; also the theory, installation, construction, operation and repair of radio apparatus. Each student is required to keep a "log" book and in this he writes all that he learns in class in addition to answering twenty questions on the week's work. These log books are turned into the instructor at the end of the week and graded; this grade is entered on the student's record card. An operating examination is also given each week and the student's operating ability in words per minute is recorded. By this system of records and examinations it is easy to note the student's progress thru the course. If he fails to improve in operating each week, he is clast as a drone and his grade is low accordingly. If a student fails to reach a receiving speed of 15 words per minute after six weeks of training, he is assigned to the drone class, and special attention is given to him for a period of two weeks. If at the end of that time he shows no signs of ever becoming a radio operator, he is sent back to the Great Lakes station to swab decks instead of manning a wireless key.

The fact that the study of wireless is very fascinating and mysterious seems to stimulate the student's enthusiasm and after he learns the code he is all the more anxious to become an efficient operator. The students are continually being reminded of the importance of capable operators in the present war, and this, of course, incites them all the more to become efficient operators.

Explorers can tell in what latitude they are by the determination of the pull of gravity by means of a "katers" pendulum.

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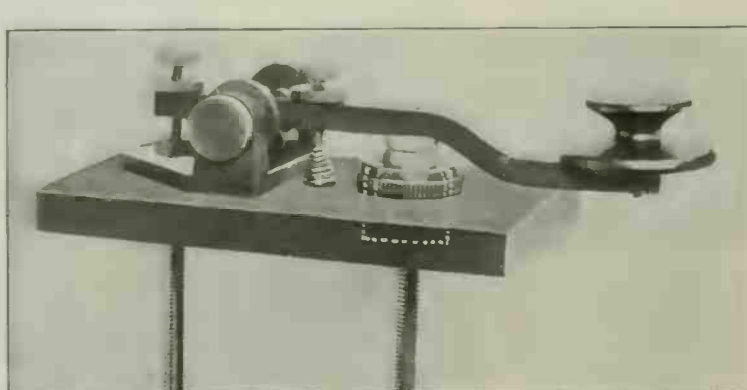
NEW RADIO KEY HAS BALL BEARING CONTACTS.

An interesting and highly efficient radio key recently perfected by a New York radio engineer, Mr. L. G. Pacent, is illustrated in the accompanying photo. It is built in a precisional manner thruout, having extra long, deep-seated pivot bearings for the key lever proper, which ensure long service and accurate functioning of the complete instrument. The key is mounted on a Bakelite base, giving entire freedom from dampness leakage, et cetera.



The Latest Heavy Duty Radio Transmitting Key Here Shown Is Fitted With a "Ball-Bearing" Lower Contact. It Is Thus a Simple Matter to Quickly Align the Two Large Silver Contacts. A Clamping Ring Locks the Contact Firmly.

The contacts are extra large and made of silver. All radio men know how difficult it is to properly align key contacts, especially when badly burned, even after they have been carefully filed clean and flat again. Ingenuity on the part of the designer of the present key has solved this problem in an admirable manner. He mounts the upper contact on the key lever in the usual way; the lower contact is mounted on a ball and socket joint. With this means provided it is the work of but a moment to loosen the lock nut clamping the ball-supported bottom contact and to align it accurately with the top contact. The key has been approved by the Navy Department.

RADIO OPERATING IN ALASKA.

By Howard S. Pyle,
Electrician-Radio, U. S. N.

It may be of interest to the readers of the Electrical Experimenter to know what we of the Pacific Coast have to combat in the way of mountain ranges and other natural causes which contribute in making a commercial operator's life in Alaska, one of constant speculation as to whether his business is going to get thru or will be hung up somewhere because a station can't "get thru."

I recently completed a trip on the S. S. *Rush* of Everett, Wash., from Everett to Herendeen Bay, Alaska, in the Bering Sea, by way of what is known as the inside passage, that is; hugging the coast of British Columbia all the way north, between the main land and numerous islands.

My outfit was one of the new Kilbourne and Clark two kilowatt, 500 cycle mercury-arc quenched transmitters and at that time was probably the most efficient type of marine equipment in use on this coast. The receiver was of the ordinary, inductively tuned type with silicon-arsenic detector, but as my crystals were of a very poor quality, I had no opportunity to hang up any receiving records. My antenna also was very small, being only about sixty-five feet long and about thirty-five feet high, six wire, inverted "L" type.

Our first week past with only one obstruction to communication—this being in Seymour Narrows, a point at which the channel is but a thousand feet wide, between steep mountains that tower way above the vessel on either side. Here I was practically in a "dead hole," not hearing a signal during the time of passing thru except from the S. S. *Zapora*, WPQ, who was just ahead of us—*in plain sight*. After leaving the Canadian coast and entering Alaskan waters we were coming very close to Ketchikan, Alaska, (KPB) but owing to intervening mountain ranges could hear his signals only about fifty miles on either side, altho there is a very efficient and powerful installation there. A vessel as close as we were has difficulty in working with him, but at a distance he is easily readable clearing business with Astoria, Oregon, every day. We progrest up the Alaskan coast and when attempting to work Sitka, (NPB) found it almost impossible, except when we were almost opposite him, being on the east side of the island. This was due to mountainous country intervening between.

After leaving Hoonah, Alaska, we struck straight across for Cordova and Kodiak and had no trouble working either of them all the way across. When we entered the water between Kodiak Island and the mainland, I lost Kodiak's signals (NPS) altogether, until exactly opposite him when I handled a little business direct, losing him again shortly afterward. I then tried to get in touch with Dutch Harbor (NPR), but could hear nothing of him until within one hundred miles, when he came in strong. I kept in touch with him for about two hundred miles of travel in the Bering Sea and then lost him and picked up St. Paul Island, (NPQ). I kept in communication with him all the way to Port Moller, where we anchored a few day on account of the ice. When we finally proceeded into Herendeen Bay we immediately lost everyone. Could hear NPR, NPQ, S. S. *Winber*, WND, at Chignik and S. S. *Norwood*, WSG, at King Cove very good at Port Moller, but five miles into the bay everything faded out entirely. We lay in the bay for two weeks, during which time I was compelled to relay everything thru KWR at Port Moller, even tho the S. S. *Winber* was only fifty miles due south and with Audion equipment could not hear me. I could hear nothing of her either, in spite of her using high power or full two kilowatts.

Do our Radio brothers of the east coast have these troubles?

CODE BUZZER TRICKS.

By E. Duskis

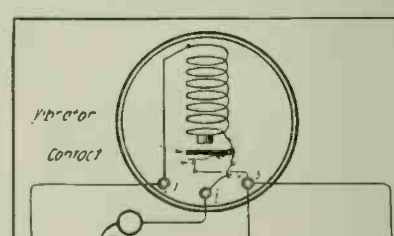
Of late there have come out on the market some wireless practise buzzers which are very good in every way for learning and practising the code. The general form of these buzzers consists of an arrangement as shown in the diagram, Fig. 1. This is also the standard hook-up given with these buzzers.

Of course the above arrangement is satisfactory, but there may be too loud a note produced in the telephone receivers; in fact, so loud as to do harm to one's eardrums. With the end in view of reducing the intensity of the signals in the telephone receivers, to signals of equal intensity as usually received in a wireless station, the following methods are proposed. They work well, as they have all been tried out.

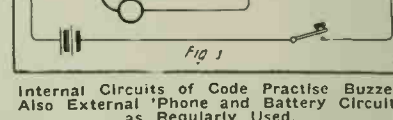
The first method of connecting the buzzer in the manner shown in Fig. 1-A has the advantage of reducing the intensity of the signals just to the strength of the wireless signals.

The second method gives equally good results to the preceding method, but uses a small fixt condenser in series with the 'phones connected as shown. This condenser can be the standard condenser that is usually shunted across the 'phones in wireless circuits. The advantage of this method is that, while the key is open, no current flows in any part of the circuit, but while it has this advantage it must be seen (when comparing it with method No. 1) that it necessitates the use of a condenser, which costs more than a switch.

When using the hook-up given in method number one, it is imperative that the connections be made as per diagram given in Fig. 1-A, for if the connections are made as shown here in this diagram, No. 3, there will be a click, followed by the high pitch note, in the telephone receivers. It is to be noted in connection with diagram No. 3, however, that, while it possesses the disadvantage of giving a click and then the high pitch, it is an advantage, because under these conditions it provides a fine means for *learning the Morse code*, and



Internal Circuits of Code Practise Buzzer. Also External 'Phone and Battery Circuits as Regularly Used.



Special External Connections for Code Buzzer So That Both Radio and Morse Signals Can Be Learned.

still sending in continental, (radio), i. e., to say it opens a new field in the practise game, whereby a Morse and continental student can converse together.

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About Learning the Code

By ALAN C. ROCKWOOD

IN the January issue of the ELECTRICAL EXPERIMENTER, Thomas Reed proposed a new scheme of mnemonics for learning the Continental Code (page 615). Several years ago I attempted to learn the code by a similar system, but I never succeeded until I tried another plan. Therefore I shall tell my experiences with plan and the reasons it was unsuccessful as an aid to memory.

In learning to receive by ear the ultimate object is to be able to write down the letter as soon as the sound is heard. If this proficiency is attained the reception of a letter consists of three steps:

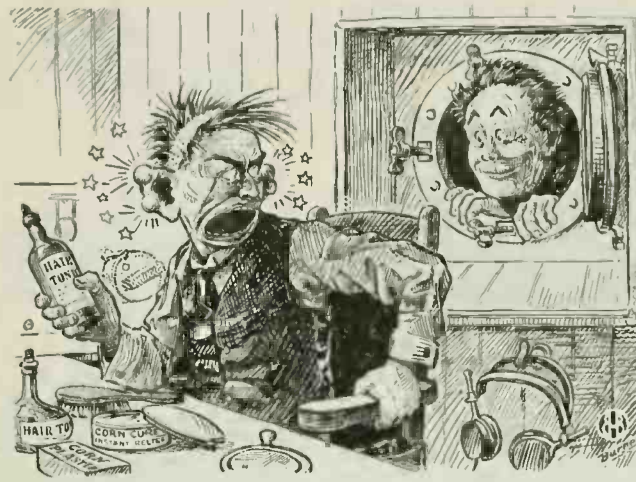
1. The operator hears the signal.
2. The operator thinks of the letter represented by association of ideas.
3. The operator writes down the letter.

In practise this becomes so natural that there are only two steps: the operator writes down the letter without consciously thinking.

In contrast with this process there is the method by which most people try to learn the code, by calling off the dots and dashes for each letter. In this method there are four steps:

1. The operator hears the signal, (say .—).
2. The operator thinks of the sound as heard in the terms of dots and dashes. ("dot-dash").
3. The operator associates the combination of dots and dashes with the letter (in this case "a").
4. He writes down the letter.

The second step takes the longest time of all because the operator has to change the sound to a visual picture of the dots and dashes. In the third step he must change from the visual picture of the dots and dashes to the picture of the letter. As this takes times and must be dropt as soon as the operator is proficient, it would be much better to learn the code in some manner in which it would not be necessary to waste the time in making the transition from one process of connecting the sound with the letter to another. In my view, therefore, the most perfect system of mnemonics would be one whereby each



Voice From the Port—"Well, Well! If it 'Aint Me Ol' Friend 'Georgie' Startin' a Beauty Parlor. M—M—M—M—." All of Which Applies If You're a Regular "Radio Op" Used to Wearing the "Cans" for 8 to 10 Hours a Day. Corns On Your Ears and a Bald Strip Over Your Dome Are the Usual Things, If We Can Believe Mr. Burney Who Drew This Cartoon, and Who, By the Way, is a Radio Operator Himself

student learned each letter by the exact sound it made in the receivers.

Upon examining the proposed plan it is seen that it does not conform to this standard, but is open to the same objection as the process of memorizing the letters by dots and dashes. It merely substitutes for the second and third steps of the second plan, as outlined in the preceding paragraph, the linking of the sound with a "Fonetic Catchword" and the linking of this with the desired letter. This is simpler because the catchword is aural, the same as the signal received, but it does not remove the entire difficulty. The extra step is there which must be learned and unlearned. It is desirable to have a system in which it will be necessary to unlearn as little as possible. Another objection which I discovered when I tried to learn the alphabet by this method is that it is hard to keep the catchwords separate and linked with the letters they belonged with. For instance, the catchword for J was Je-*ru-sa-lem* and for L was Lo-*ben*-gu-la. Both of these were of the same number of syllables and I found, when receiving, that I would often think of them as Je-*ru*-sa-lem and Lo-*ben-gu-la*. Therefore, at those times I would get .——— as L and .—. . as J. I believe that Mr. Reed's plan would be open to the same difficulty of confusion of characters and that some other method should be considered.

The Oscillator.

"Now What In Thunder Is De—Da—De—Da?" Ponders This Radio Student. He Learned It So Nicely, Too, But My, How Different It Sounds When He Hears the Dot and Dash Code Signals in the 'Phones, for the First Time. The Article Herewith By Mr. Rockwood Explains What This Ambitious Sailor Is Trying to Master.

In considering the plan to be devised it is necessary to consider what we are striving for. The perfect plan would be the one that makes the easiest transition from one stage to another or in which there is no such transition. Under this each student, from the first, would know each letter by the sounds in the receiver. This is the object in telegraph schools in beginning the code practise with the letters, repeated over and over. Each student will associate the sound he hears with a particular letter. If everyone was able to have the letters sent to him individually until he could receive them without effort no other aid would be necessary. This is not the case, however, and everyone likes to practise over the code between lessons to make sure of himself. As it is not possible to imitate the radio signals exactly it becomes necessary either to repeat the words dot and dash for each letter, to use catchwords, or to approximate the sounds of the letters. This last scheme is the best because by its use the change from the carrying thru of each of the three steps in detail to the immediate perception of the letter is gradual. This fulfills the requirements because nothing need be forgotten. The only question is how to approximate the sound best.

Mr. Reed says that for "Y" the receiver says "siss-a-siss-siss." This is an approach to it, but this cannot be used at the rate of even 20 letters per minute. Try it! The plan that was used successfully in the Iowa City High School Radio Club last year was as follows:

a. For a dash use the syllable dah (a as in arm).

b. For an initial dot use tuh (u as in up).

c. For a dot not initial use duh (u as in up).

By remembering that a dash is equal to three dots in length, that the space between parts of letter is equal to one dot, and that the space between letters is equal to three dots the cadence is gained. Thus A is tuh-d a h, B is dah-duh-duh-duh, C is d a h-duh-d a h-duh, and so on.

I know personally of over a dozen people who have learned the code as I have suggested and have only heard of one who learned by catchwords—and he learned it only for visual signaling. If you have had any experience with either method or know of any better system write it in to the Editor and he will pay you for it if publisht.

Don't miss the article on "Harmonics—Part II"—by Prof. F. E. Austin, in the next issue of the "Electrical Experimenter." It explains the analysis of irregular shaped alternating curves.

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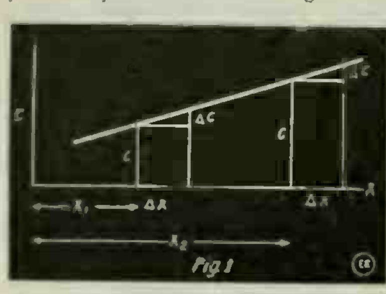
The Design and Use of the Wave-Meter

PART III

By MORTON W. STERNS

(Continued from the April issue)

FOR most of the data and description of the Kolster Decremeter the author acknowledges indebtedness to the Bureau of Standards Bulletin No. 235 on the same subject. Due to the complex theory in back of the design of the condenser the reader must pardon some higher mathematics necessary in order to properly explain the design of the condensers.

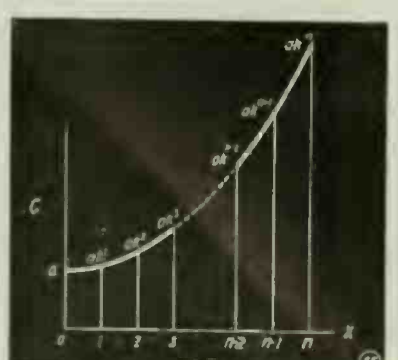


The Shape of the Ordinary Variable Condenser Moving Plate Is Such That for Equal Angular Displacements From the Position of Minimum to That of Maximum Capacity, an Approximately Straight Line Variation of Capacity Is Obtained.

The shape of the moving plate of the ordinary variable condenser in common use is such that for equal angular displacements of these surfaces from the position of minimum capacity to that of maximum capacity, an approximately straight line variation of capacity is obtained as in Fig. 1. It is evident from the figure that for any given displacement ΔX the percentage change $\frac{\Delta C}{C}$ of capacity will *not* be equal all over the scale.

In order that the instrument may be direct reading as to decrements the *capacity variation in per cent must be constant over the entire range* from maximum to minimum. *i.e.*, $\frac{\Delta C}{C}$ must be a constant.

By a mathematical solution which the interested reader can find in the original paper the author points out that the capacity of the variable condenser must vary in accordance with the law of geometrical progression, and it is easy to formulate the equation between the value of capacity and the position of the moving plates. Since the curve of capacity must obey the law of geometric progression, we have in Fig. 2:



In the Kolster Decremeter the Variable Condenser Capacity Varies in Accordance With the Law of Geometrical Progression as Here Shown.

$$\begin{aligned} \text{at } x = 0 \text{ let } & C_0 = aK^0 = a \\ x = 1 \quad & C_1 = aK^1 \\ x = 2 \quad & C_2 = aK^2 \\ x = 3 \quad & C_3 = aK^3 \\ x = n^n \quad & C_n = aK^n \end{aligned}$$

$$\text{in general } C = aK^x \ldots\ldots\ldots\ldots\ldots (9)$$

A simpler deduction is as follows: in accordance with differential calculus, the following fundamental requirement of the condenser may be written:

$$\frac{dc}{C} = ndx \ldots\ldots (10)$$

$$\therefore \log C = nx + h$$

$$C = E^{nx+h} = AE^{nx}$$

Since this is equivalent to equation (9) we may say for a rotary variable condenser where θ is the displacement angle in degrees.

$$C = AE^{m\theta} \ldots\ldots (11)$$

We know, neglecting edge effects, that the capacity of a condenser is directly proportional to the active area of the movable plates or

$$A = bE^{m\theta}$$

where

A = active area of moving plates
b & m = constants deduced later
θ = angular displacement
E = base of napierian logarithms—2.71828

By analogy with equation (10)

$$\frac{dA}{A} = md\theta$$

$$(12) \text{ or } dA = bmE^{m\theta}d\theta$$

$$\text{Eq.}(13)\; A = \int_0^\pi bmE^{m\theta}d\theta = bmE^{\pi m} - bm = bm(E^{\pi m} - 1)$$

Referring to Fig. 3.

$$(14) \quad dA = \tfrac{1}{2}(\rho^2 - r^2)d\theta$$

ρ being distance from center O to enveloping curve of the plate, or radius vector, and r being radius of small circular space (inactive), occupied by the separating washers between plates.

From (12) and (14):

$$\tfrac{1}{2}\rho^2 - \tfrac{1}{2}r^2 = bmE^{m\theta}$$

and

$$(15) \quad \rho = \sqrt{2bmE^{m\theta} + r^2}$$

where b and m are constants which determine the maximum and minimum value of capacity.

Since equations (10) and (11) are identical we may write

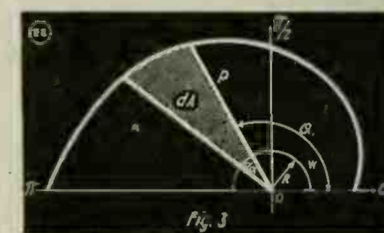
$$K^x = E^{m\theta}$$

$$\text{or } x \log K = m\theta$$

$$m = \frac{x \log K}{\theta} \ldots\ldots (16)$$

where K is the ratio of maximum to minimum capacity.

In the first article it was shown that 6 to 1 is a good ratio of maximum to minimum capacity, so substituting in (16), assuming $x = 1$ when $\theta = 180$:



Method Used in Determining the Shape of the Moving Plates in the Variable Condenser of the Kolster Decremeter.

$$X = \frac{\theta}{180}$$

$$m = \frac{\log K}{180} = \frac{\log 6}{180} = \frac{.77815}{180} = .0043$$

$$\therefore C = AE^{\frac{\log K}{180}\theta}, \text{ for finding capacity}$$

which we assumed to be .003 mf.

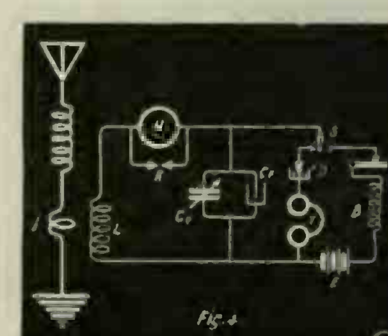
If we assume some value of area in square inches for a movable plate and substitute in (13) we can find $b = \frac{A}{m(E^{\pi m} - 1)}$.

Assume a value of r the radius of the washer and calculate ρ for various angles θ to give the shape of the curve which will be a *logarithmic spiral*. This of course is done by using equation (15).

Now knowing the capacity wanted and the area of the plates and thickness of spacing washers we determine definitely the number of moving plates and since it is more convenient to make the stationary plates semi-circular it is merely a mechanical trick to assemble our condenser.

In the actual *Kolster decremeter* the capacity of the variable condenser is slightly

(*Continued on page* 140)



Schematic Diagram of Kolster Decremeter Circuits. It Is Shown Here Inductively Connected to the Antenna Circuit.

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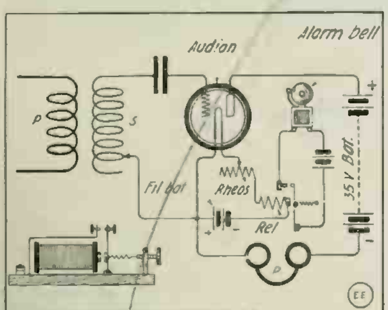
TO PREVENT BURNING OUT AUDION FILAMENTS.

Audion bulbs are being burned out daily just because some inexperienced or even experienced operator raises the current up to what he visibly thinks is a safe point and then (ziff) out goes said bulb and also your pocketbook gives a long squeal.



Ever Turn On the Audion Filament Current Too Strong and Incapacitate Said Audion for Further Action? Here's How to Let Yourself Know When the Filament Current Reaches the Danger Point.

In the accompanying drawing I show how this can be eliminated, merely by using some means of warning. Build a small relay as shown, then adjust the spring so as it will only close the bell circuit when the danger point is about to be reached. Of course Audion circuits provided with ammeters are quite safe in this respect, but even with this precaution I have seen bulbs burned out.

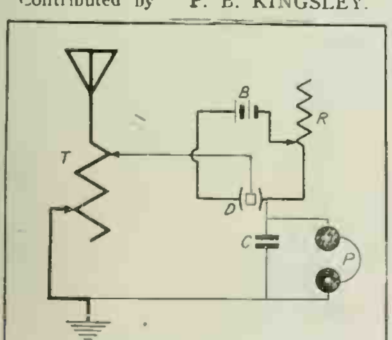
I think the alarm shown in the diagram will save many a bulb; when the danger point is about to be reached, it closes the circuit and rings the bell, thus warning the operator who is adjusting the filament battery.

Contributed by E. T. J.

A DETECTOR HINT.

I have a detector which has *two* cups placed opposite each other and made adjustable by turning a knob. I use galena, with a light phosphor bronze wire contact. I found that by attaching a battery and rheostat in series with the cups, that the signals were greatly increased in intensity and the range of my set was greater by far; I picked up stations impossible to hear without the battery attached. Too much current will fuse the crystal. The best voltage will be determined by experiment.

Contributed by P. B. KINGSLEY.



An Effective Way of Connecting Battery Current to a Detector Crystal So as to Intensify the Signal Strength.

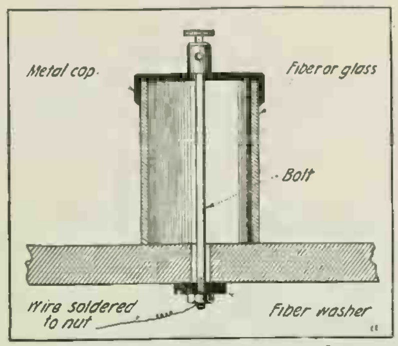
FILING GLASS.

A file is generally employed only on metals, and glass is about the last substance that one would expect to be capable of being filed. Glass can be shaped with a file, in cases where the usual blowpipe methods are not applicable, if the file is kept wet with turpentine. A still better lubricant is made by steeping camphor in turpentine and using the resulting solution. A simple alternative method, not quite so satisfactory as the above, is to immerse the glass in water while the filing proceeds. A piece of sheet glass can be cut with a pair of scissors under water.

Contributed by H. J. GRAY.

HIGH TENSION BINDING POSTS.

Old blown out cartridge fuses can be used very economically in a high tension binding post for step up transformers, spark coils, etc., requiring a binding post that will not "leak." Take one of the old fuses (about 60 ampere) and cut it in two with a hack saw. A hole is drilled thru the metal



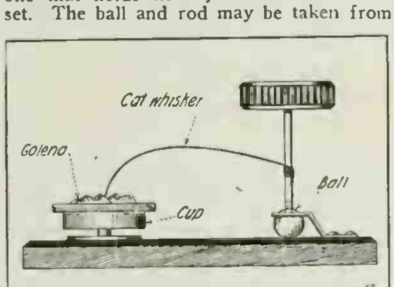
No Use Talking—"High Tension" Currents Will Leak Thru Wood. This Glass or Fiber Tube Scheme Will Help to Hold Them In Their Place.

cap large enough to take a bolt that will hold a binding post from an old battery or any good binding post. The bolt is long enough to reach thru the fuse and fasten on the top of the instrument. The connection is made on the nut under the top of the cover.

Contributed by LOUIS LOOTENS.

A SIMPLE BALL-JOINT DETECTOR.

Here is a detector stand for the amateur who wishes one for quick adjustment and one that holds its adjustment when once set. The ball and rod may be taken from



A Brass or Steel Ball (Annealed), a Knob, a Cup, a Cat-Whisker Wire, and You Have the Ingredients Necessary to Make This Clever Detector.

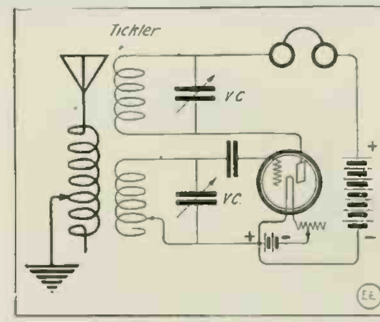
an old spark gap. A brass spring with a hole in it large enough to allow the rod to turn and swing freely, should be fastened over the ball to hold it in any desired position. A knob is fastened on the upper end of the rod. Any kind of detector cup can be used, the one here used is a rotary sliding cup from an E. I. Co. detector.

Contributed by CLARENCE SOUSLEY.

IMPROVED TICKLER COIL HOOK-UP.

I give herewith a diagram showing an improvement on the Audion circuit. By connecting a variable condenser across the tickler coil more selective tuning can be had. After using one so connected for any length of time it is indispensible.

A variable condenser shunted across the tickler coil gives more selective adjustment. Bulb was made to oscillate when it was found almost impossible to do so on certain wavelengths, especially short waves, by means of variable condenser across tickler coil.—Contributed by E. T. J.



Simple Form of "Tickler Circuit" for Audion Which Gives Highly Selective Tuning, as Practical Experience Demonstrates.

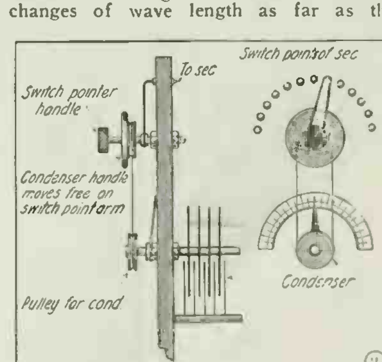
HOW TO SOLDER ALUMINUM WIRE.

Contrary to the ordinary opinion aluminum wire may be soldered. This joint is electrically, but not mechanically perfect. To prevent breaking, wire about No. 18-20 (bare copper) must be wound around it. First, clean the ends of the wire with sandpaper for about 2 inches, then dip the ends in muriatic acid for a few seconds. As soon as the acid begins to act remove the wire and wipe off the surplus acid. Now, dip the ends into a concentrated solution of copper sulfate for a few seconds, remove and clean with a rag. Repeat this till the copper becomes fairly thick, leaving it in longer each time. Now place the ends of the wire together and wind the joint with bare copper wire (about No. 18-20) spacing the turns about ⅛-inch. You can now place on a non-corrosive soldering paste and solder in the usual manner, with iron or torch, torch preferred. This joint may be used for electrolytic rectifiers, aerial wires, etc.

Contributed by E. L. COOKE.

SIMPLIFYING THE TUNING OPERATION.

The sketch herewith shows a new wrinkle for correcting loss of time in making changes of wave length as far as the



Here's a Good Method of Simplifying the Tuning of a Radio Condenser and Inductance. The Shaft Is Belted or Geared to the Inductance Switch Handle. The Condenser Shaft Is Belted or Geared to the Inductance Switch Handle.

secondary is concerned. It is easily seen that both condenser and inductance can be changed without the use of both hands, thereby leaving the other hand free to be used in changing primary adjustments, etc.

Contributed by E. T. J.

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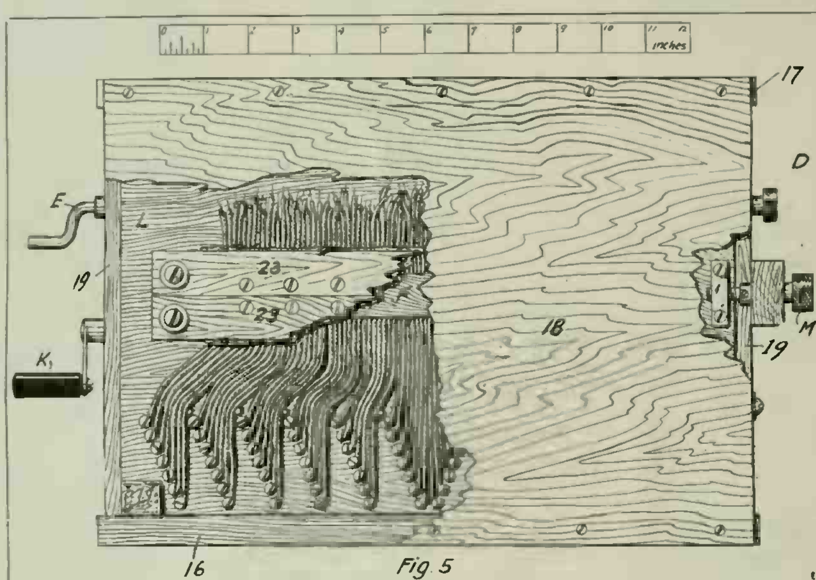
Building an Electric Piano Player

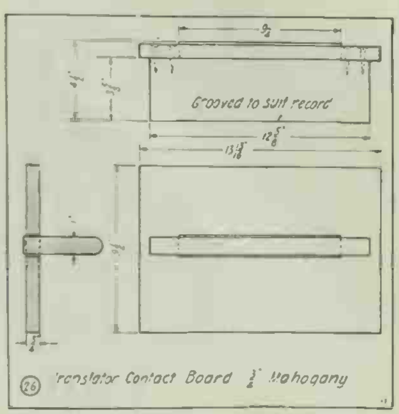
By CHARLES HORTON, Consulting Engineer

(CONCLUDED)

SINCE there must be eighty-eight contacts, a simple method had to be developed for forming them. They are, in this model, formed of cotton-covered magnet wires of, say, No. 12 B. & S. gage, each one being fastened under a screw in the back of the board *L*, then led forward over the tracker bar and back again where it is connected to its magnet wire. This is clearly shown in Fig. 6 and Fig. 5. The contact wires are inserted one by one over the tracker bar and finally all clamped tight by means of the strips 23 and 24. When this is finished several coats of thin white shellac are applied to them, and when the shellac is set hard a file is used to bare the copper wires at the highest point on the tracker bar. This is the same method used formerly in making adjustable tuning coils and is very satisfactory for this purpose. Careful examination of the drawing will be essential to a proper understanding of the arrangement, which is really very much simpler than it looks at first sight.



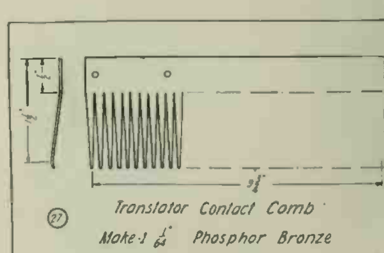
Rear View of Translator Cabinet for Electric Piano Player. Each Wire Corresponds to One Solenoid Circuit.



Detail of the Translator Contact Board Which Is Made of Well-Seasoned Mahogany.

A wiring diagram is given in Fig. 7. This shows the connections for one contact and one magnet, and, of course, all are similar. The parts are given the same letters and numbers as in the other views. At the point *N* the return wires from all the magnets are joined and a heavy wire leads from this point to the battery *O* and thru the rheostat *P* (which may be used to control the loudness of the music and may be of any suitable type) and thence to the comb *G* on the translator box. A six-volt storage battery is best for exciting the apparatus, as considerable current is used.

Referring now to the details, detail 6 is the magnet bobbin; this is, as before stated, best made of brass or fiber and must not be of iron. The length is best determined by making up one striker unit (a single magnet) and *trying it out on your piano* because the longer this solenoid is, the stronger the magnet and the harder the blow. The author found various lengths from 1" for soft playing, to 3" for loud work, desirable. This depends to a large extent on the *stiffness* of the piano used. No. 18 double cotton-covered copper magnet wire should be used. Detail 10 is of the striking core and should be best made of black iron altho mild steel will do if iron cannot be had; detail 13 is the striker return spring and must also be determined by trial on one magnet. It should be strong enough to cause a quick return of the striker. Detail 3 is one of the seven boards forming the bottom of the striker box and has twelve holes for the twelve bobbins for one octave and other holes for the retaining bolts. These retaining bolts are one-quarter inch stove bolts and should be of iron or mild steel, as it will be seen on examination that they not only hold the magnets in place, but also complete the magnet circuits of the magnets, thus making them stronger in action. Detail 11 and 12 are iron or mild steel pieces used in place of washers for retaining the third and fourth row of magnets; 8, 5, 16, 17 and 18 need no further explanation; 14 and 15 are tubes of brass slipt on between the striker cores and the heads of the bolts forming the striking knobs to properly space them; 25 shows the supports for the translator comb. Detail 22 is the comb bar. The comb is shown as detail 27 and would best be made in several sections and screwed to the bar 22 by means of No. 6x32 machine screws. Detail 23 is the contact wire holding bars at the back of the tracker bar; 24 is the contact-wire-securing pieces shown on the top and the bottom of the tracker bar; 20 are pieces screwed inside the translator box to guide the slide *L* (shown best in Fig. 6).



The Teeth of This Metal Comb Make Contact With the Tracker Bar Contacts Thru the Perforations in the Music Roll.

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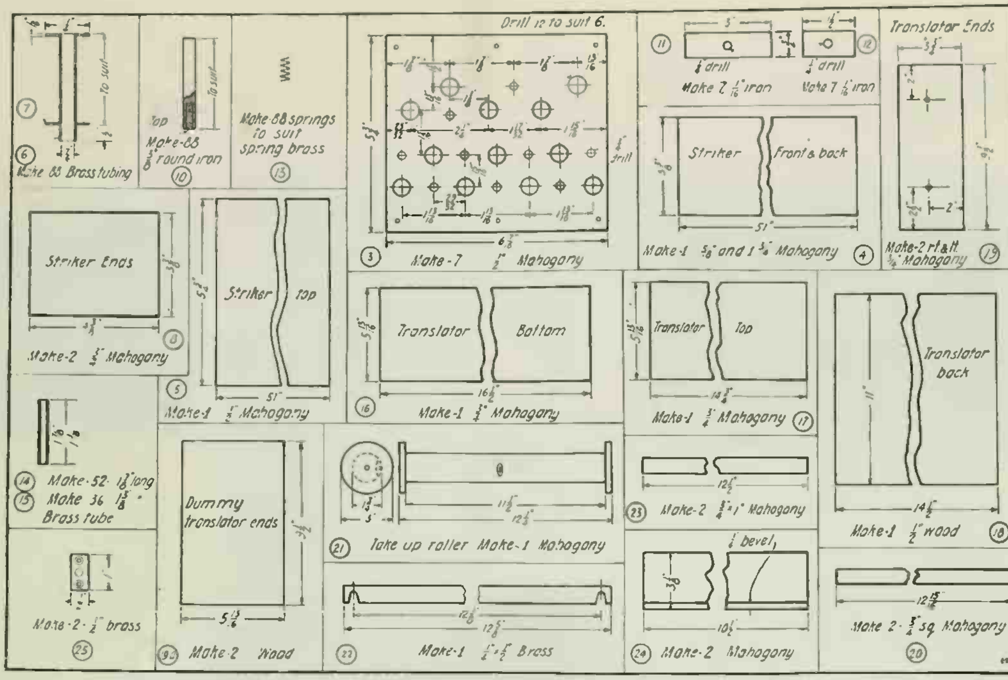
All parts should be carefully made as the results will make it well worth while. All electrical connections should be *soldered*.

Mahogany is specified but, of course, cheaper woods may be used if desired and stained. The best finish is shellac applied in many coats, rubbing down with sandpaper between coats and finishing up with pumice stone and oil or water. The final coat should be piano varnish.

If care and persistence is used in the making of the *electric piano player* here described, a vast field of pleasure will be opened to the builder which he probably never dreamt of till he has one of these machines in operation.

The best way to determine the spacing for the tracker contacts and the teeth of the comb is to buy a cheap record roll and lay them out according to this. The author could give the exact dimensions but as they run into thousandths of an inch this would only be confusing. It is a simple matter, however, if a record is used for this purpose and there is then no chance of making a mistake in the layout.

The scales shown in the various views may be cut out and used to measure any parts not dimensioned in each respective figure.

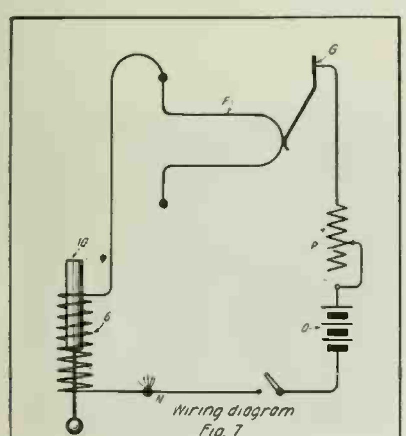


This Drawing Contains the Dimensions of All the Principal Parts Necessary in Building the Electric Piano Player.

CORRECTION IN PROF. AUSTIN'S ARTICLE.

In the article *"Theory of Tuning, Wave Lengths and Harmonics,"* by Prof. F. E. Austin, which appeared in the May issue, page 32, note that the inductance formula at the foot of the third column should be used only for calculating the inductance of *air* core coils; *not* coils having an *iron* core. The formula given is a general one applicable to inductances having a relatively great length compared to their diameter. It applies to medium length coils but not for accurate results. The formula given in the article referred to, as well as all other inductance formulae for *air* core coils applies to such coils when they happen to be provided with iron cores, it being necessary only to multiply the inductance found by such formulae by the value of the *permeability* of the iron at the flux density used, this factor being usually represented by the symbol "μ."

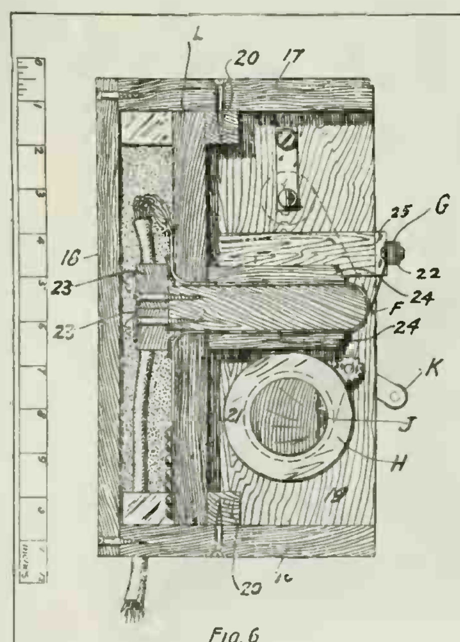
[*Those interested in the calculation of the inductance of coils for radio or alternating current work, should read the series of three articles on this subject which appeared in the March, April and September, 1917, issues of the* "ELECTRICAL EXPERIMENTER," *supplied at 20 cents each or 50 cents for the set of three issues.*]



Elemental Circuit of Electric Piano Player, Thru One Solenoid for Striking One Key, With Common Battery and Rheostat for Regulating the Loudness of the Music.

ELECTRICALLY OPERATED TUNING FORK FOR TIME MEASUREMENTS.

This device, which has been in use in meter testing for about five years, reads directly to 0.05 second. An electrically operated tuning fork having a period of 0.05 second closes a contact which controls an electromagnetic counting device. By using a key in this circuit the arrangement acts as a stop watch. Special care has to be used to drive the fork at a uniform rate. This has now been accomplisht by operating it directly from a chronometer clock circuit. With slight modification it has been found feasible to use commercial "cycle counters" in place of the special counters previously used. It has also been found that the method can be used with a fork having a frequency of 100, thus reading to 0.01 second. Several meter-testing laboratories have installed duplicates of the Bureau of Standards apparatus. The electrically operated tuning fork is usually arranged with a small magnet coil between the prongs and whose circuit is suitably interrupted by a contact carried on the vibrating fork.



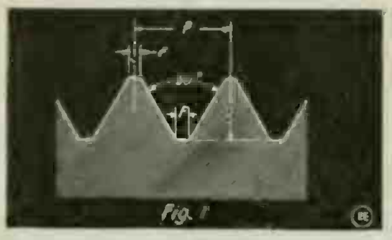
Side View of Translator Cabinet Showing Tracker Bar With Its Contacts, Perforated Paper Roll and Player Crank.

Experimental Mechanics

By SAMUEL COHEN

LESSON IV.

ONE of the most important uses of the lathe in a shop is its accurate means of generating a screw or the cutting of a thread on a circular form. The thread can be cut on an outside or inside surface, both of which processes will be explained in detail.



This Shows the Shape and Formation of the U. S. Standard Machine Screw Thread. Note the Flat Edge and Bottom.

We have several standards for various screw threads. However, in this country the general practise is to use what we call the U. S. Standard thread.

The thread of Fig. 1 shows the U. S. Standard screw thread. The pitch P is the distance of the centers between two teeth, and is numerically equal to the reciprocal of the number of threads per inch, thus:

$$P = \text{Pitch} = \frac{1}{\text{No. threads per inch.}}$$

The depth of each tooth D is numerically equal to $D = \text{Depth} = P \times .64952$.

The flat or the width of the upper portion of the tooth is equal to $F = \text{Flat} = \frac{P}{8}$.

We also employ what we call a sharp "V" standard screw thread and this is shown in Fig. 2; this is also U. S. standard. This form of thread is generally used in small pitch threads where a large number of teeth is necessary in a given length.

The relation of pitch and depth of a sharp "V" standard screw thread is as follows:

$$\text{Pitch} = P = \frac{1}{\text{No. threads per inch.}}$$

$$\text{Depth} = D = P \times .86603$$

The simplest way of cutting an accurate thread in a lathe is by means of employing our automatic feed on the slide rest which guides our cutting tool. In the first lesson the writer has described the *feed screw* which causes the carriage to move along the bed of the lathe when said feed screw is connected to the live spindle.

Like everything else, screw cutting to the beginner seems a very perplexing problem, as for instance, how to manipulate the various gears on the feed necessary to make a thread of certain pitch, etc. It is therefore the purpose of this lesson to show the amateur machinist in a simple way how to go about the work.

The first thing that we have to do is to traverse the tool along the work revolving between the lathe centers, at such ratio to the speed of the revolution as shall produce a screw of the desired fineness or coarseness, which is called the *pitch*, and usually exprest as so many threads to the inch, in length of screw.

It will now be obvious that if equal sized gears be used to connect the spindle of the headstock and the lead or feed screw which traverses the carriage and with it the cutting tool along the lathe bed, then the speed of the revolution of the spindle will be the same as that of the lead screw, and the screw produced will be precisely a counterpart in *pitch* to that on the feed screw. This may often be required. Every set of change gears is supplied with one pair having an equal number of teeth, usually forty or sixty teeth, and to vary this ratio of speed the other twenty gears are required.

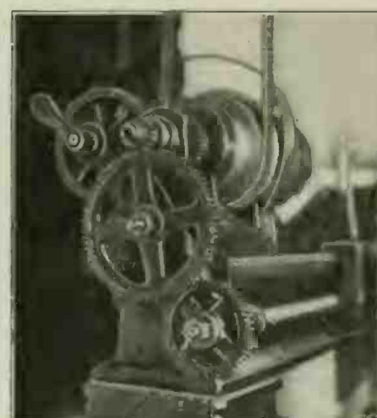
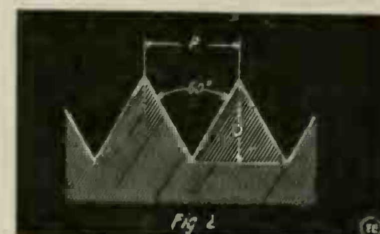


Fig. 3. Photo of Simple Gear Set-Up For Screw Cutting On Lathe.

Therefore, our object is to see how to change these various gears so as to traverse the thread-cutting tool in such a relative speed to the speed of the live spindle, as shall cut our screw of the desired pitch.

A modern screw cutting lathe is usually provided with a fixt pinion on the tail of the spindle as shown in the lathe drawing of the second lesson, or as indicated in Fig. 3 and Fig. 4. This fixt pinion is connected to the lead screw gear by any other convenient size gear, which is fixt on a movable arm; this is called the *intermediate* gear. This method of gearing is called *simple gearing*, and is used to cut a *right-hand* thread. In order to cut a *left-hand* thread, it is necessary to cause the carriage to travel in the opposite direction to that for a right-hand thread and in order to accomplish this we introduce a *fourth* gear to the present simple gearing arrangement. Fig. 5 clearly shows how the addition of the fourth gear accomplishes the result. An adjustable arm or *swing frame* (also called a *quadrant plate*) is provided for holding these intermediate gears for the purpose of connecting the spindle pinion and lead screw gear. This swing frame or quadrant plate, as it is sometimes called, swivels at the end of the screw and is provided with one or two slots, having a stud and sleeve long enough to admit of two wheels side by side, and adjustable along this slot. With this means, and the swivelling motion of the quadrant plate, it will be found that any gearing may be arranged to connect the spindle with the screw. The sleeve revolving on the sliding stud of the swing frame is called the *stud* and the driven wheel on it is called the *stud wheel*; should there be occasion to use a second wheel on this sleeve, it will be called the pinion. Thus we have: *Spindle, Stud, Pinion, Screw*, or as they are frequently called—Driver Driven Driver Driven.



U. S. Standard Sharp "V" Screw Thread. This Form Is Most Generally Cut On the Lathe.

In Fig. 4 is shown a simple change of gears for cutting a *right-hand* thread, while Fig. 5 delineates two stud gears employed for making a *left-hand* screw. These drawings show clearly how the gears are attached to the swing frame.

We have now to consider the changing

(*Continued on page* 120)

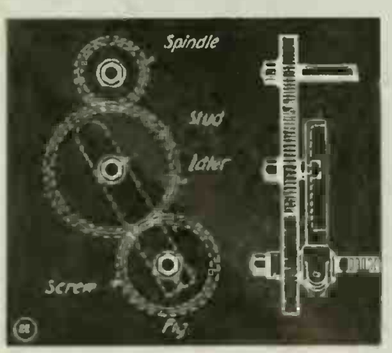


Fig. 4. Simple Gear Set-Up On Head of Lathe For Screw Cutting, Showing Spindle Pinion, "Intermediate" Gear On Stud, and Lead Screw Gear.

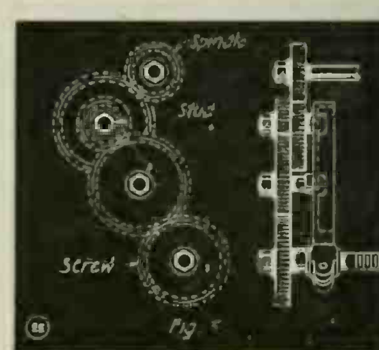


Fig. 5. Arrangement of "Reverse" Gearing For Cutting Left-Hand Threads On the Lathe.

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RADIO PROBLEM.

A peculiar phenomenon which has never been explained well is that which takes place at several points along the Atlantic Coast. There are times when a vessel is in radio communication with another and the signals gradually die out and then increase to their normal sound. A similar effect has been noted by amateurs who, when sending in one direction, can cover *much* greater distances.

HOW I CAUGHT A COPPER THIEF.

At the State Institution, where I am employed as electrician, we once had a motor-driven pump which was located in a field about one-fourth mile from the Institution. The line carrying the current to this pump was double O solid copper wire. Other arrangements having been made for the water supply, this pump was discontinued. A few days later we discovered that we had been visited by "Copper Thieves" who, evidently, knew something about "Juice," about 300 feet of wire having been stolen and the ends carefully left clear of "grounds" and "short-circuits."

I then devised an electric "Thief Catcher," a sketch of which I give here. This device was located in the boiler room and a duplex telephone wire carefully "Camouflaged" about one of the OO wires, and connected at the extremity of the line, across the line, of course.

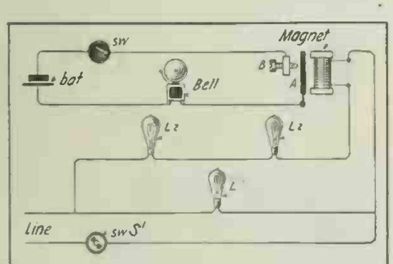
This alarm consists of a bell, 2 or 3 dry cells, a magnet coil from an old 110 volt, D. C. rheostat, and three 16 C. P. bulbs with sockets.

I have tried to make this sketch self explanatory. Lamps L2 are placed in series with the magnet, acting as a resistance. As long as current is flowing thru the line the magnet will hold spring A. When the circuit is broken the magnet releases spring A, which then makes contact with B, completing circuit thru batteries and bell, causing the bell to ring. If one of the lamps L2, should burn out, the circuit thru the magnet would be broken, thus causing a "false alarm." For this reason lamp L1 is placed in multiple. If bell should ring and lamp L1 continue to burn, we would know it to be a "false alarm," but if bell should ring and lamp L1 cease burning, we would know that the circuit had been broken. The necessary switches were placed on the board to cut it out of service during the day.

The thieves paid us another visit, the alarm worked, and while they were not captured, they were given a run for their life, their haste being so great that they left part of their tools behind. And that was their last visit.

Contributed by

E. E. CONYER.



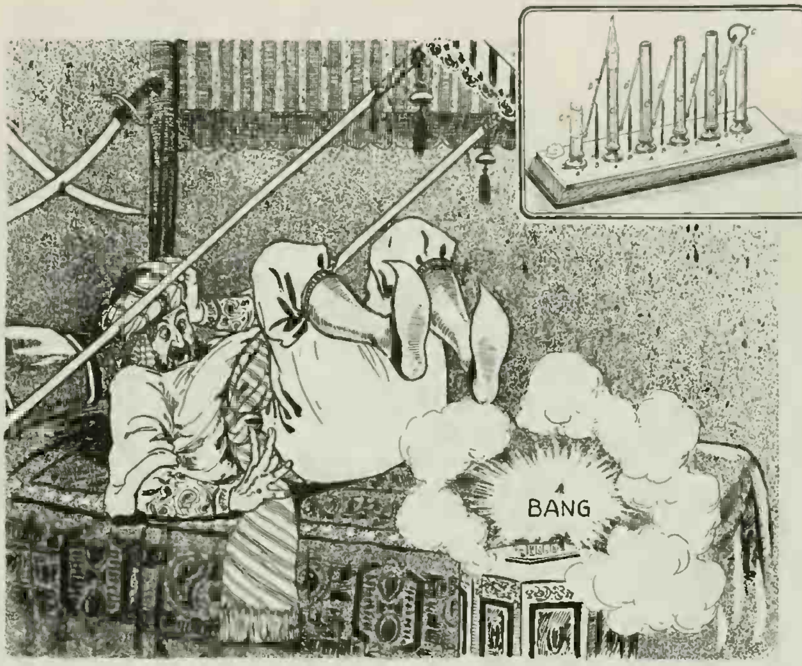
Clever Lamp and Bell Circuit Alarm Successfully Used to Catch "Copper Thieves," Who Cut the Line and Attempted to Depart Hence With a Goodly Length of It.

Perpetual motion, i.e., in the sense of *creating* energy is impossible, for by the law of conservation of energy, energy cannot be destroyed nor created.

Curious Arabian Timepiece

By THOMAS REED

STUDENTS of the history of clock-making will, we are sure, be interested in the accompanying reproduction of an early alarm-clock, common in Arabia and other countries under Mohammedan influence during the reigns of the immediate successors of the Prophet.



This Truly Ingenious and Highly Novel "Cigarette" Alarm Clock Was Used By the Arabians Many Centuries Ago—So Thomas Reed Tells Us, and He Surely Ought to Know, for He Was There. What's That?—Yes, We Believe In Reincarnation—Sometimes. You See, It's This Way. First You Light the First Cigarette: It Burns Slowly, Ignites Match Which Lights Second Cigarette, Etc., Etc. The Last Match Ignites a Giant Fire-Cracker. Bang! No Wonder the "Sheik" Awoke.

This mechanism, wonderfully effective in its simplicity, was in very extensive use. Many examples are found in our museums, ranging from the humble clay utensil of the camel-driver to the costly knick-knack of the sheik, with its base of jasper or chrysolite and its carved sockets of silver, or even gold.

The *daili buj* (to give it its Arabic name), consisted essentially of a series of alternate sockets, A, A, and upright, sharp-pointed pins, B, B. To set the device for operation at a desired hour, a cigarette (C) was inserted in each socket and a match (D) impaled on each pin, as shown.

The action is evident. C, having smouldered, at a known rate, down to its base, ignites D, which in turn carries the fire to the upper end of the following C. This process continues according to the number of the sockets and pins with which the particular *buj* is provided. The common *buja* of the poor seldom contained more than three sockets, the corresponding amount of sleep being the utmost they could hope to snatch from their exacting toil; but the ornate ones of the rich, who could afford to sleep as their wishes dictated, far exceeded this figure, often occurring in the sacred numbers 7 and 11, or multiples of these.

It remains to describe the sounding-device by which the sleeper is aroused. The last socket of the series (marked E in the figure) contains, instead of a cigarette, a firecracker (F) with its fuse (G) wound about the upper end of the final match. When this is ignited the more or less rapid combustion of F interrupts, momentarily, the period of silence measured off by C, and by the rule of contrasts almost invariably causes in the sleeper a tendency to resume consciousness.

The importation from China of firecrackers for use in *buja* was a well-recognized branch of trade in those times. Indeed, so important were these articles considered that we find, in the celebrated Code of Sasi Baba, severe penalties against the sale of adulterated "crackers," or those kept too long in storage.

As to the matches, these were derived in great part from—from—well, er—will you pardon me for a moment? I have a call on the other 'phone. . . .

(Sequel to the above. Time—*O tempora o mores.* Place—Editor's sanctum, Fulton St., N. Y. *Personae dramatis*—H. Gernsback, H. W. Secor, Editorturers.)

H. G. Listen, H. W. S., what do you think Tom Reed is trying to do? Kid us, or kid the readers, or both?

H. W. S. (after long and painful deliberation). Damifino!

H. G. Vote we put his blamed M.S. in a firecracker and return it to him. It's not electrical, anyway.

H. W. S. Vote is seconded and carried.

(Exit M S. in fire-cracker.)

(2nd Sequel to above.) Ha, Ha, Messrs. Editors, Tom Reed fooled you. Didn't know that he has a cousin working at your printer's did you? Well he sent the M.S. to *me*, I set it up, inserted it on this page, and there *you* are! I'm quitting my job anyway next Saturday, so I should worry!! —*The Printer's Devil.*

You, the Reader: Think you New York fellows are smart, don't you? Well, you can't kid *me.* I saw thru the whole blamed scheme at once. Your time is wasted, gentlemen, you are only fooling yourselves.

Chorus: *H. G.; H. W. S.; Tom Reed; Printer's Devil:* Now, what does HE mean????

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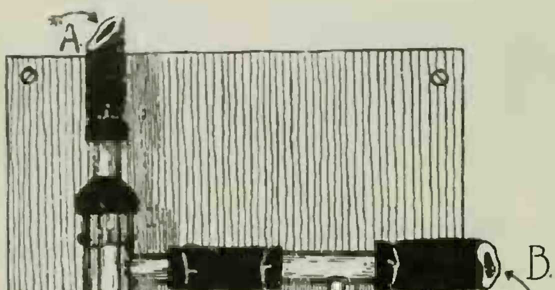
How to Make a Water Jet Vacuum Pump

By PROF. HERBERT EDMOND METCALF

AN efficient vacuum pump is a welcome addition to any laboratory, therefore one which can easily be made by anyone for a few cents and with a little patience ought to be in every amateur's collection of apparatus. With it many interesting electrical and chemical experiments may be performed, which would be impossible otherwise.



Making a Water Jet Vacuum Pump. A—Water Inlet. Rubber Tubing Attached to Jet Which Fits Inside Larger Tube and Is Sealed In with Sealing Wax; B—Air Inlet. Connection for Suction. Made Out of Heavy Pressure Tubing; C—Mercury Manometer of the U-Tube Form. Works by the Expansion of Small Amount of Air In the Closed End. Must Be Corrected With a Mercury Column; D—Water Outlet. This Must Be Pinched to Start Pump Functioning. If No Rubber Tube Used Then Outlet Must Be Bent Into an S-Shape; The Whole Can Be Conveniently Mounted on a Board and Screwed to the Wall.

The pump to be described is made out of glass. The equipment necessary to make it consists of an alcohol or gas flame, and a small blow-pipe. The material comprises two pieces of glass tubing, one of which will fit loosely inside of the other.

Begin by selecting a piece of the larger tubing about a foot long. In the flame draw out a *constriction* about one and a half inches from one end. Make the diameter of the hole thru the constriction about two or three millimeters. Put a cork in one end of the tube and direct a thin narrow flame with the blow-pipe upon a spot just above the constriction. As soon as this small spot gets white hot and bends in under the force of the flame, blow into the open end of the tube, thereby blowing a hole or a bubble thru the side of the tube.

Melt down the edges of the hole, and then heat one end of another small length of glass tubing the size of the first. When both are white hot stick them firmly together. They are not yet fused. Do not let the joint cool, but put a cork in the end of the tube, leaving only one opening to blow into. Direct the pointed blow-pipe flame on a portion of the joint until it bends in under the force of the flame. Then very gently blow thru the open tube until the bent-in portion is back into place. Do this removed from the flame. Go all around the joint in this manner finally flaming the entire joint. When finished the joint should be covered with soot in the flame, and laid on an asbestos pad to cool. If put on metal it will crack while cooling. If these directions are followed there will be no trouble in fusing.

The jet is now made by drawing out the smaller tube in the flame until the hole in the end is about one millimeter smaller than the hole in the constriction in the larger tube. This is done by drawing out a constriction and then cutting it in the middle with a file. The jet is then sealed in the larger tube with sealing wax, running the end of the jet nearly, but not quite, down to the constriction. The pump is now ready to try. Connect the jet to the water supply with heavy walled rubber tubing, slip a piece of tubing on the exhaust pipe, and one on the "T" for the suction.

If used without rubber tubing on the exhaust then the exhaust should be bent in order that back pressure may start the vacuum. If rubber tubing is used then it may be pinched to start the pump. Once started, it will continue.

The pump may be connected by a "T" to a mercury *manometer*. This may be a "U-tube" worked by the expansion of a small bubble of air in the closed end, or by a glass tube 35 inches long, one end being put in a vessel of mercury, and the other connected to the pump. The rubber tubing on the vacuum side should be heavy walled pressure tubing in order to prevent the collapse caused by atmospheric pressure. All connections should be made air-tight with vaseline and then wired, as the slightest leakage will spoil the vacuum.

The uses of the pump are many and various. It may be used to start siphons where it is not wise to suck with the lips. It will lift water at least 20 feet or more It will suck water thru the pump as well as air and can be used to suck liquids out of inaccessable corners of vessels. It may be connected to glass tubing having platinum wires sealed in, and a study made of the behavior of electricity under varying degrees of vacuum. Or, by using a small bottle connected to the pump with a rubber stopper perforated by a glass tube, water may be boiled. Also by filling this bottle half full of sulfuric ether a miniature ice machine may be made. Under a bell jar with the air exhausted, water may be boiled and frozen at the same time. These are only a few of the interesting experiments which will instantly suggest themselves to the experimenter.

One word of caution. ALWAYS release the vacuum before shutting off or turning down the water. Otherwise the air will "blow back" by the contraction of the rarefied air in the container.

Such a machine as described, carefully made, will cost only a few cents, will raise mercury 29 inches at a barometer reading of 30 inches at sea level, and have a capacity for suction of from 2 to 3 liters of water per minute.

ANOTHER SILENT ELECTRIC ALARM CLOCK!!

This device is a silent electric alarm clock. Its great advantage lies in the fact that it accomplishes its purpose of waking its owner without having a corresponding effect on everyone within a hundred yards or so radius, as is the case with the common "garden variety" of alarm clock, thus saving much annoyance (profanity, possibly)on the part of those unduly disturbed.

Briefly stated, the device consists of a 75 ohm "Pony" telephone receiver, and a means to rapidly interrupt its circuit with a current source at a definite predetermined hour. An Ingersoll watch with minute and second hands removed is used for the time switch, a copper wire resting on the dial at the hour figure desired. When the hour hand revolves it touches the copper wire contact at the hour set, thus making a connection between the wire and the watch case, and completing a buzzer circuit. The 'phone is connected across the grounded binding post and the interrupter of the buzzer. The watch, buzzer and a battery switch may be mounted inside a cigar box, and the two sets of binding posts on the side. The current source may be a dry cell, or better a four or six volt storage battery, possest by most experimenters. The buzzer should be packed in cotton to deaden the noise.

In operation, the watch is removed, wound and set, and then replaced. The copper wire is then made to rest on the proper place; for instance if it were desired to set the alarm for seven o'clock, the wire would be placed on the figure seven. The receiver may be placed under the pillow or at the head of the bed. You know the kind of discipline the Kaiser's boys are brought up to—they wear special crimpers on their faces at night to train their mustaches up, like Papa Wilhelm's. So perhaps, if your discipline is rigid, you won't object to wearing a head-band while you sleep, which will hold George's "silent alarm" right against your ear. Selah.

Contributed by GEORGE F. GEIS.

Do You Wish for a Silent Alarm Clock? Here's How One Can Be Made—Just Take an Ingersoll, Clip Off the Minute Hand, Arrange an Adjustable Contact Over the Dial, and Connect Up This Innocent-Looking Combination to a Buzzer and Telephone Receiver. You'll Wake Up—Oh! Yes!

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My Experimental Electrical Laboratory.

By FRANK HUSKINSON

SPECIAL $5.00 LABORATORY PRIZE

BEING very much interested in electricity, and living in a town with several other young men who were also interested in the why's and where'fors of any thing electrical, I got busy and organized an electrical class, for the purpose of learning the rudiments of electricity.

The enclosed pictures show the apparatus, etc., that I used in my experiments. There is a complete wireless outfit, consisting of one sending station and one receiving station. There are furthermore all the parts of a standard type local battery magneto telephone, also different types of receivers and transmitters, a complete acid-lead type storage battery and a complete set of renewal plates, a complete Edison nickle-iron-alkaline storage battery and a complete set of renewal parts, a series-wound motor, a shunt-wound motor, a compound wound motor, a reversing switch, a galvanometer, compasses, magnets, a large solenoid, electro-magnets, a voltmeter, an ammeter, telegraph-sounder, relay and key, condensers, miniature lamps, sockets and receptacles, bells and buzzers, push buttons, switches, induction coils, resistances, magnetos, ringers, hydrometers, lightning arresters, samples of all kinds of wires and small electrical fittings, etc., etc.

An Exceptionally Fine Electrical Laboratory, Owned by Mr. Frank Huskinson. Several Students Who Learned Practical Electricity with This Well Selected Apparatus Are Now Serving Uncle Sam as Electrical Experts.

The principles of magnetism were illustrated by the aid of magnets, iron filings, nails, compasses, electro-magnets, dry cells and solenoids. The action and principles of electric motors were well explained with the use of the three small motors.

Primary and storage batteries were taken apart and rebuilt. Lighting systems were illustrated by the use of the miniature lamps and dry cells, also with the aid of a bell-ringing transformer. The principles of alternating current generators were demonstrated by the use of a large telephone magneto-generator.

The two induction coils were used to illustrate the operation of transformers by wiring them in series with a 32 c.p. lamp. On the primary side it gave a potential of 2 volts between either outside line and the neutral wire, while the voltage across the two outside lines was 4; it represented a miniature Edison three-wire system of distribution.

The various experiments that we made with this set of electrical apparatus is too long to explain; enough is said when I can tell you that today there are six young men "doing their bit" OVER THERE, by the time you read this, who acquired their first knowledge of electricity with this experimental outfit. Three of these young fellows are in the Navy, and three are in the Army, and all of them are working for Uncle Sam in the electrical trades.

The Old Bunsen Burner

By R. M. Cobb

HOW dear to my heart is the old apparatus,
The chemistry stuff that I'm using no more!
The beakers, the pincers, the test tubes and holders,
And all the old stuff that my damage bore;
The pneumatic trough and the jars that stood by it,
The flasks, and the stoppers with two holes or four;
The Kipp generator, the hoods that were nigh it,
And e'en the old burner that stuck in the drawer.
The old Bunsen burner, the leaky old burner,
The rust-covered burner that stuck in the drawer.

The rust-covered burner I hailed as a treasure,
For often at noon when returned to the lab,
I found it the source of an exquisite pleasure,
The sweetest and best that a student can nab.
How ardent I sneezed when it started a-burning,
And quick to the top of the ceiling 'twould go;
Then soon, my deep chuckles to mock terror turning,
And smelling like thunder, it gave off C O.
The old Bunsen Burner, the leaky old burner,
The rust-covered burner, it gave off C O.

The first time I used it, it burned me quite badly,
The second, it blew up and gave us a fright.
The pupils around me were murmuring sadly,
"'Fore Cobbie gets thru with that burner, 'Good night!'"
It broke all my test tubes and melted the holder,
'Twas always too hot (when it wasn't too cool).
I wondered at times if I'd live to be older,
When using that burner, the worst in the school.
The old Bunsen burner, the leaky old burner,
The rust-covered burner, the worst in the school.

How sweet from the dim mussy drawer to receive it,
As, stuck right across, it stayed in with great ease!
No electric furnace could tempt me to leave it,
Tho 'twould heat a thing up to a million degrees.
And now, far removed from the loved place for messing,
The tears of regret from my eyes gently pour,
As fancy reverts in a manner distressing,
To the old Bunsen burner that stuck in the drawer.
The old Bunsen burner, the leaky old burner,
The rust-covered burner that stuck in the drawer.

CHEMICAL HINTS FOR THE EXPERIMENTER.

Never grind phosphorus and potassium chlorat in a mortar or an explosion will result. Sulfur and potassium chlorat also are liable to produce an explosion when ground. It is safest never to grind two substances together unless advised to do so by an expert.

Don't open a bottle of ether near a naked flame. Ether vaporizes very rapidly and the vapor when mixed with air is explosive. The vapor is heavier than air and will roll along the floor to a flame even if it be on the opposite side of the room.

When experimenting with hydrogen always be sure the bottle contains no air mixed with it. Collect a test-tube of the untested gas and ignite. If it burns quietly it is safe to use. If it explodes it is very dangerous to use.

Never add water to acids, but add the acid slowly to the water, stirring at the same time.

When you are thru using any apparatus clean it thoroly and return to its place. It may take quite a while to clean anything that has been standing, whereas it would take but a few seconds to clean if it is done immediately after the particular experiment.

Altho test tubes may be heated in an open flame, flasks, retorts beakers, etc., should be protected by wire gauze, asbestos pad, sand or water baths.

Contributed by CLAUDE CRAVEN.

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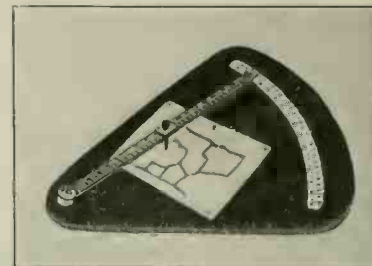
A Novel Map and Sketch Transmitter

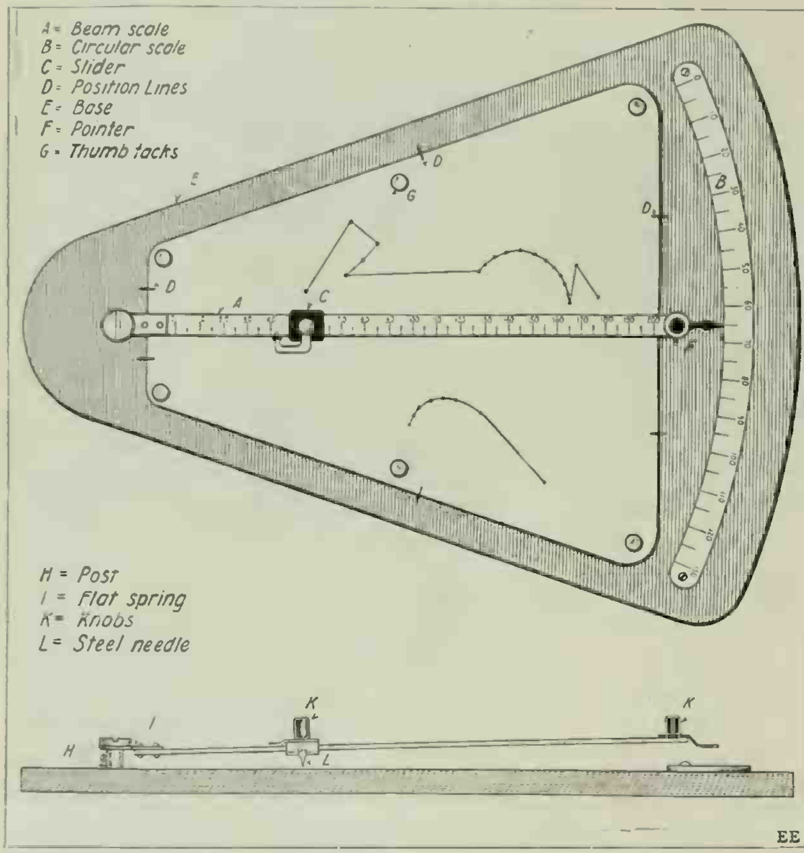
By GERALD FENSTERMAKER

HERE is a novel means of transmitting over radio, telegraph or telephone systems, maps, drawings, etc. The idea is to have two of these plotting instruments exactly alike, one instrument at each end of the line of communication. The sender, making his sketch and placing it on the board, would retrace the sketch with the steel needle on the movable slider, by placing the needle at a starting point of the drawing and noting what the figures read on the beam scale and circular arc scale, and then placing the needle to the next intersecting line or angle and again noting figures, and so on. Thus by transmitting the co-ordinate figures to the other end of the line of communication, the recipient can move the pointers on his instrument to correspond to the figures received. The arm is then prest downward, making an impression of the needle on the paper and thus by drawing from point to point, as received, an exact reproduction of the drawing or sketch can be made. In order to get irregular lines or circles it requires the impressions to be made more closely together.

Carbon paper could be placed beneath the receiving copy, thus duplicating the drawing. Duplicate maps can be placed in the instruments and the exact location of a line of trenches, batteries or points of importance could be communicated over any distance. Any combination of figures or letters can be used on the scales. It has been recommended by military experts.



Photograph of New and Highly Efficient Map and Sketch Transmitting Instrument. By Means of Its Two Graduated Scales It Permits of Very Rapid Location of the Map Co-ordinates.



Working Drawing of Newly Perfected Map and Sketch Transmitter Which Can Be Used Equally Well on Telegraph, Telephone or Radio Systems of Army or Navy Communication. It Has Been Highly Recommended by Military Experts and Should Be Adopted by All "Boy Scout" and Similar Military Organizations.

TREMENDOUS FORCE EXERTED BY SHORT-CIRCUIT.

"Some indication of the enormous force exerted when a short-circuit takes place close to a station was given recently when cable trouble occurred on the lines of a large Western company," writes George W. Leffean in the *Electrical Review*. "In searching for the damage done a slight bulge was observed on the joint sleeve, where the cable joined a submarine cable. The joint was opened and it appeared that the conductors had been crowded forward into the joint 2 in. (5.1 cm.).

"On testing the damaged submarine cable from the street end it was found that the conductors showed all three legs short-circuited and grounded, while a test from the station end showed the three conductors short-circuited but free from ground, indicating that the cable had burned apart. Resistance tests indicated that the failure had taken place three-quarters of the way between the station and the street end. The cable was dug up at this point, the break discovered and the cable found to be damaged for a distance of about 4 ft. (1.2 m.), with no damage to adjacent cables. At the point of failure the lead sheath and steel jacket were badly ruptured, while on the station end the copper conductors with their paper insulation had been forced out of the lead jacket for a distance of 2 ft. (0.6 m.). The mighty force which caused the rupture was great enough to push the cable in its jacket of steel forward, causing the bulging in the sleeve referred to before. The distance between the failure and the sleeve was 150 ft. (45.7 m.)."

A SIMPLE HELIOGRAPH.

The *heliograph* is handy for "Boy Scout" camping parties and the like, enabling them to use the sun's rays to keep in touch with one another over considerable distances.

This set works on the same principle as the more expensive ones built for the Army. An ordinary strap key is utilized in this design, a small hole being drilled in the center of the lever and tapt to take a stirrup clamp from a head band. Secure a small pocket mirror, and make a small depression in each side of the rim to permit the mirror being balanced between set screws Y-Y. The mirror must also have an unsilvered spot C, about ⅛-inch in diameter made at the center. This spot retains its position thru all movements in any place.

The operation is as follows:—the rays of the sun are brought on to the distant station by turning the mirror A until the operator, looking thru the unsilvered center of mirror sights the distant receiving station. The heliograph is now "set" and signals are made by pressing and releasing the key B, the same as with regular telegraph instruments.

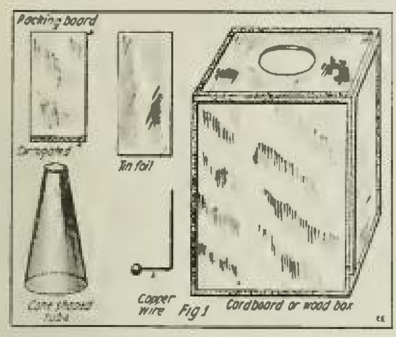
A Simply Made "Heliograph" Similar to That Used By Army Signal Corps. It Will Prove Very Effective for "Boy Scout" Signaling Work.

www.americanradiohistory.com

How to Build a Spark Coil Ozonator

By FREDERICK VON LICHTENOW

IT is a well-known fact that the electric discharge across an air-gap liberates "ozone" freely, and further, that the production of this ozone may be many times increased by allowing the discharge to pass between metal sheets, preferably tinfoil.



Details of Cardboard or Wooden Box Used in Constructing Spark-Coil Ozonator, as Well as Sparking Electrodes and Inhalation Cone.

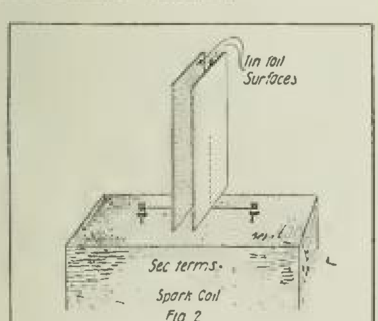
Making use of these facts, the simple "ozonator"—attachment here shown constitutes a practical piece of auxiliary apparatus for any spark coil of 1-inch rating or more.

Two oblong sheets of corrugated packing board of equal dimensions; two sheets of heavy tinfoil cut to approximately the same size, but slightly longer; two pieces of medium gage copper wire, a wooden or cardboard box (without cover), and a cone-shaped tube of some material, other than metal, form the essential parts for its construction (Fig. 1).

An application of paste or shellac secures the tinfoil to the packing board, which merely serves as a support for the foil.

The foil extensions—due to its being longer—are pasted around over the exposed corrugations at either end of the packing board, ending with the back edge of the latter. The whole is then fastened to the wire by running the same thru the foil into one of the centermost corrugations, at the same time furnishing the necessary electrical contact between wire and foil (Fig. 2).

The distance between the foil sheets and their respective size are governed entirely by the rated spark length of the coil employed, with a proportionate amount of generated ozone as a consequence. They should, at any rate, be placed in a position parallel to one another (in the same plane) and at such a distance where a silent discharge (in reality there is a heavy "brush-discharge," consisting of a stream of violet-colored spark-threads passing between the foil sheets, which can be easily ascertained in a dimly-lighted room) manifests itself, allowing only an occasional spark to pass. (This distance is somewhere in the neighborhood of one-half of that of the spark discharge between needle points.)

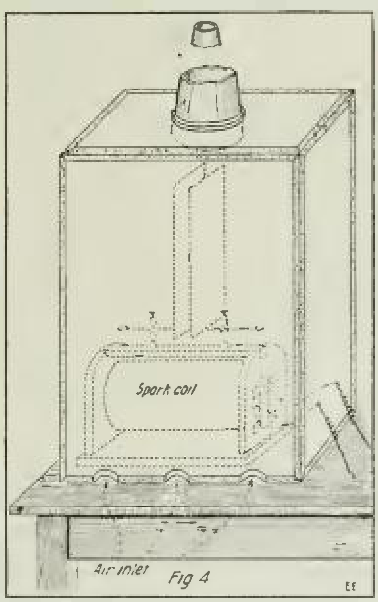


This Shows How Ozone Is Best Produced by Employing Relatively Large Sparking Surfaces, Between Which a Heavy Brush Discharge Is Caused to Take Place.

The cone is secured to the box by being pushed thru the opening on top of the latter from the inside until it fits tight. Some friction tape is finally run over the seams of the box as well as around the joint of the latter, with the cone and the whole placed over the generating apparatus (Fig. 3).

The box should be only slightly wider than the top of the spark coil, just wide enough to allow air to pass thru, and there should be ample room inside of it to clear the foil sheets all around by several inches.

An important point is that the packing board be perfectly straight and the tinfoil applied smoothly, in order to insure uniform distribution of the electrical stress between the foil surfaces. Otherwise, the discharge will localize upon certain spots, resulting in a decreased ozone output.



In This Form of Home-Made Ozonator the Concentration Cabinet Is Designed to Enclose the Spark Coil. Air Vents Are Provided at the Base of the Enclosure.

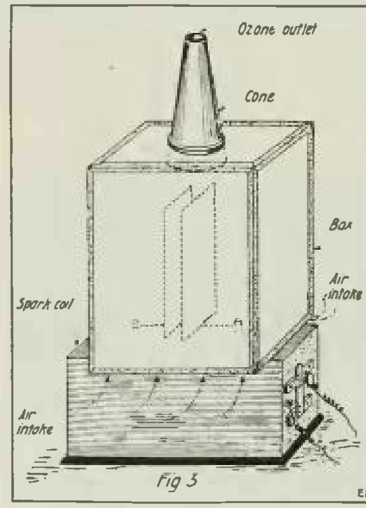
The "ozonator" is used for air purifying, inhaling or experimental purposes in general.

If an "Electro-Bulldog" coil is available then a taller box will be required and the same slipt over the spark coil as well.

Semi-circular cuts on two sides for the passage of air and two small holes on one side of the box for the insertion of the primary wires are to be provided (Fig. 4).

The author has a zinc spark gap mounted across the coil secondaries, which is of a great advantage, in that it permits of a far finer adjustment of the sheet electrodes than could be possibly had by using the regulation style of binding post terminals.

Good results are obtained with both types of arrangements as outlined in the foregoing.



Another Form of Ozone-Concentration Cabinet Made to Fit on Top of the Spark Coil. Air Intake Vents Are Provided in the Bottom of the Enclosure.

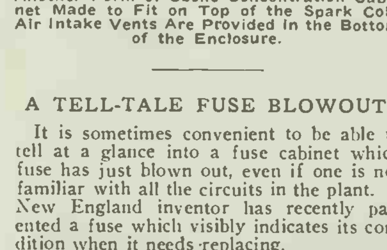
A TELL-TALE FUSE BLOWOUT.

It is sometimes convenient to be able to tell at a glance into a fuse cabinet which fuse has just blown out, even if one is not familiar with all the circuits in the plant. A New England inventor has recently patented a fuse which visibly indicates its condition when it needs replacing.

The sketch shows the construction of his invention. A shunt wire, of high resistance, passes thru the fuse and is connected to the end caps. This shunt carries very little current until the true fuse wire is blown. An indicating spring strip outside the shell is held down by a filament connected to a small mass of some material easily melted by heat. A wire gauze cage incloses the melted material to prevent it being blown thru the hole in the shell, and is placed close to the shunt wire.

When the fuse blows a rush of heavy current passes thru the shunt, bringing the wire to a high temperature, thus melting the holding material and releasing the indicating spring strip.

Contributed by JOHN F. MAHONEY.



Something Every Electrical Maintenance Man Will Appreciate—a "Tell-Tale" Fuse Blowout. When the Fuse Blows the Indicator Spring Is Released As Noted.

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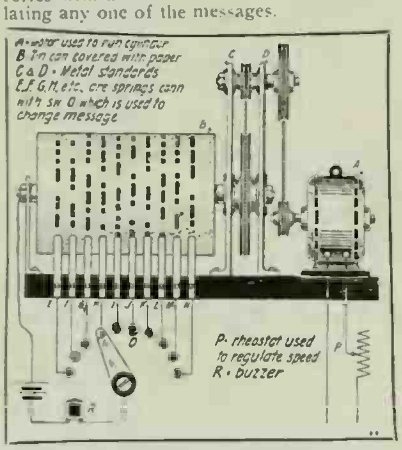
This department will award the following monthly prizes: First Prize, $3.00; Second Prize, $2.00; Third Prize, $1.00.
The purpose of this department is to stimulate experimenters towards accomplishing new things with old apparatus or old material, and for the most useful, practical and original idea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

FIRST PRIZE, $3.00

HOME-MADE "OMNIGRAPH" OF WIDE RANGE.

Often indeed does the amateur wish for an *Omnigraph*, but almost as often does he do without one because of the expense. So I submit herewith an easily made and inexpensive omnigraph which I find does the work.

The instrument consists primarily of a tin can, covered with heavy paper, in which are cut holes corresponding to the dots and dashes of the code. This breaks the current since one wire of the circuit is connected to a series of springs making contact thru these holes and the other the tin can. A switch is connected to these springs in series with a sounder or buzzer, thus translating any one of the messages.



With This Home-Made "Omnigraph" You Have Available a Wide Variety of Radio Signals Which Can Be Changed Instantly by Moving a Switch.

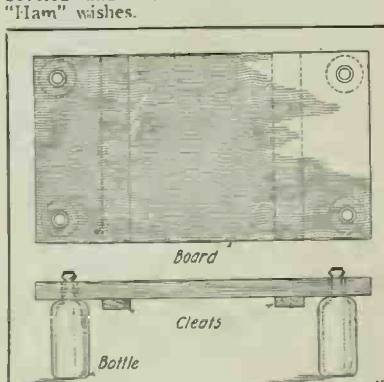
This instrument may be run in various ways, the best of which is by an electric motor. However, it may be operated by a spring motor or even by hand, the number and size of the pulleys depending upon the speed of the driving motor. If an electric motor is used, a rheostat may be inserted to vary the speed. If it is so desired, the cylinders may be made interchangeable, thus giving the instrument a wider range of use altho it is surprising how much can be placed on a single one.

Contributed by P. G. EDWARDS.

INSULATED STOOL FOR "TESLA STUNTS."

A stool like this is a necessity for the "Ham" who is experimenting with high-frequency or frictional electricity. All that is needed is a good strong board about one and one-half feet by two feet, four strong bottles of the same size (I used soda pop bottles), and two wooden cleats.

Four holes are bored in the large board, one at each corner. They should be just large enough for the neck of the bottle to pass thru, so that the board rests on the shoulders of the bottles. The cleats are nailed on to the bottom of the board across the grain to strengthen the board and keep it from warping. The finished stool can be beveled and stained whatever color the "Ham" wishes.



Efficient Static and High Frequency Insulating Stool.

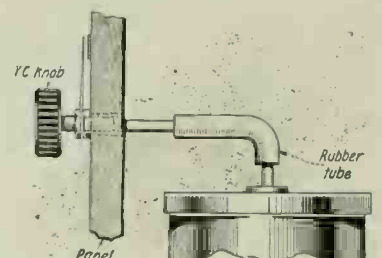
The advantages of this stool are that it can be made easily and at little cost from almost anything, that it will stand a high voltage, and that it can be easily taken apart; all that has to be done is to draw the bottles out of the holes.

Contributed by CHAS. F. FILSTEAD.

SECOND PRIZE, $2.00

VARIABLE CONDENSER CONTROL FOR PANEL SETS.

As most radio receiving sets are now made in the panel type, and most variable condensers work best when mounted upright, I suggest these methods of mounting them.



An Ingenious Method of Connecting a Horizontal Condenser Knob With the Condenser Shaft Proper. A Piece of Rubber Tubing Does the Trick.

The knob is removed from the condenser and mounted on the panel. It connects with the condenser shaft by means of a piece of soft rubber tubing inserted as a flexible shaft. Also it is thoroly practicable to use a fairly stiff spiral spring as a flexible shaft.

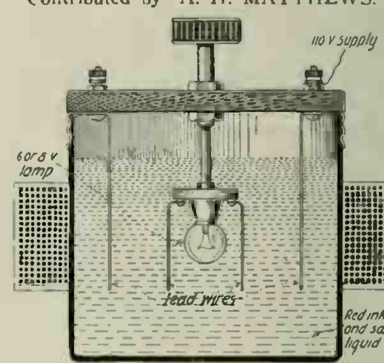
Contributed by WALTER PETERSON.

THIRD PRIZE, $1.00

A NOVEL "DARK ROOM" LAMP.

I present herewith a drawing of a novel "dark room" lamp, which I have been using for some time. The light is adjusted by turning the knob. Any small jar with a screw top will serve the purpose. The center part of the metal cover is cut away and a wood or fiber block fitted to it. The receptacle is dipt in melted wax after the lamp is in place. Do not use too much salt or else the liquid may get too hot. I use about one teaspoonful in a jar 3 inches in diameter, 4 inches high. The solution is composed of red ink and water. I use this lamp with films and find it safe.

Contributed by A. H. MATTHEWS.



A Somewhat Different Electric Dark-Room Lamp for the Photographer. It Is Used on a 110 Volt Circuit in Series With a 110 Volt, 16 C.P. or 20 Watt Lamp. The Battery Lamp Should Be Thoroly Water-Proofed.

TESTS FOR WATER.

Hard or Soft Water Test.—Dissolve a small bit of soap in alcohol, let a few drops fall in a glass of water; if the water turns milky it is *hard*, if not it is *soft*.

Alkali Test.—Immerse litmus paper dipt in vinegar in the water, if the paper turns to its original color, the water contains no alkali or earthy matter.

Test for Carbonic Acid.—Take equal parts of water and lime water, on mixing if a precipitat is seen, the water contains carbonic acid.

Test for Iron.—Boil a few nut-galls in water, then add some to the water to be tested; if the water turns grey, iron is present.

Test for Lime.—Put two drops of oxalic acid in a glass of water, then blow on it; if it turns milky, lime is present.

Test for Acid.—If blue litmus paper is turned red by the water, it contains an acid.

Contributed by G. W. BONAVIA.

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A HOME-MADE HYGROMETER.

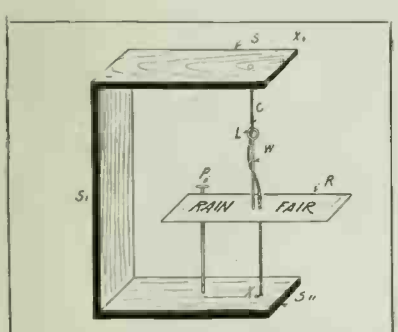
The *Hygrometer*, as we know, is an instrument for measuring the quantity of moisture in the atmosphere. It depends on the property possest by some substances of readily absorbing moisture from the air, and being thereby changed in dimensions or in weight. Of this kind is the Hygrometer of Saussure, in which a hair, that will expand and contract in length accordingly, as the air is more or less moist, was made to move an indicator. Similar instruments were also devised by Deluc and J. F. Daniell.

The writer recently constructed a simple Hygrometer, with which he could fortell the approach of a rain sixteen to twenty-four hours in advance. A description of the instrument follows: Referring to sketch: S. S' and S" form a wooden support. (The experimenter can construct this to suit himself, some preferring to make a more fancy one than others.) W. is a small, stiff wire, about 3" long and attached to a thin piece of wood which has been planed down to 3" by ½" by 1/16". A cat-gut string is then procured—C. (Such as the "A" string on a violin.) This string is fastened securely at the top of the support, by boring a small hole, inserting the string and then plugging the hole with a small wooden plug. X' The free end of the wire, before described, is then bent into a small loop about ¼" in diameter and is shown at L.

Next we thread the string thru the loop and give it one-half turn around the wire. It is then lead thru the indicator "R" by boring a small hole of slightly larger diameter than the cat-gut. The hole should be bored as near as possible to where the wire is secured to the indicator. The cat-gut string should now be pulled taut and plugged in the bottom of the support at "X."

A small nail P is then driven into the support S to act as a stopping point. Its duty is to allow the indicator to swing about in one direction only. "Fair" and "Rain" may now be painted on the indicator and our mechanical weather-man is completed.

The builder may desire to construct a more elaborate support which he can do by making a small wooden house and decorating it with pieces of bark to give a novel log-cabin effect. However, the front must be constructed open to allow the indicator to swing around. The instrument is then placed in some open but sheltered place and is ready for use.



A Home-Made "Hygrometer" Constructed From a Piece of Suspended Wood, Shaved Down Thin, Thru Which Runs a Piece of Cat-Gut.

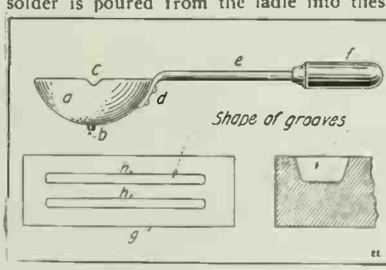
The action is as follows: When the cat-gut is taut it exerts a twisting motion on the wire and tends to twist the end of the indicator marked "Rain" against the stopping point "P." When there is a great deal of moisture in the atmosphere the cat-gut string will become slack and allow the end marked "Rain" to swing half way around.

In this way we can all become modern weather prophets.

Contributed by WALTER E. CUSTIS.

CASTING BARS OF SOLDER.

In the drawing herewith (a) is a gong from an electric bell with a dent (c) bent in one side of it with a pair of pincers; (b) is a rivet past thru the hole in the gong, while (e) is an iron rod riveted to (a) at (d). A pea shooter makes an admirable substitute for the iron rod. Here (f) is a wooden handle. (g) a block of hard wood in which grooves (hh) are made. The solder is poured from the ladle into these



Simple Outfit for Casting Your Own Bars of Solder. A Handy Ladle Is Made From a Bell Gong Fitted With a Handle.

grooves. Sandpaper the grooves well and the solder can be easily removed.

Contributed by ALBERT RUFF.

FINE INK AND MAGIC PAPER.

Fine Ink.—This experiment is most effective in a dark room. Dissolve ½ teaspoonful of potassium nitrat in a little water (about 1½ teaspoonfuls). Now use this liquid as an ink, writing on unglazed paper any design, making broad and heavy strokes and be sure to connect all lines. When the paper is thoroly dry, apply a light to the end of the writing—putting out any flame that arises. If all directions have been carefully followed a glowing spark will travel the length of the design. The effect is most mysterious and best results are obtained by using soft paper and writing all lines broad and heavy.

Magic Paper.—If some people don't believe you can write black lines with plain water show them this experiment:

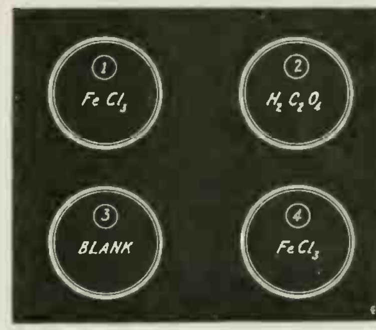
On a sheet of writing paper rub this mixture—equal parts of tannic acid (powder) and tannic ammonium sulfate thoroly mixed. After the mixture has been rubbed into the paper blow off all remaining particles. The paper is now ready. Write with a clean pen, dip in water and black lines will appear.

Contributed by M. SANGENT.

THE "REAL" WINE AND WATER TRICK.

By Albert H. Beiler.

Many of you have heard of or seen the so-called "wine and water trick" wherein



Arrangement of Four Glasses as Used in Producing "Wine and Water Trick" as Described by Mr. Beiler.

a liquid, presumably water, is poured from a bottle into different glasses, which are apparently empty, and produces wine (don't drink it, for the love of Mike!) in some glasses and water in others. Various chemicals are used to produce this effect. One way is to have a crystal of potassium permanganate, $K\,Mn\,O_4$, in one glass, a solution of oxalic acid in another, and two glasses empty. Warm water when poured from a bottle into three of them will produce no result, but in the $K\,Mn\,O_4$ glass a red color results. When all three glasses are mixed together the oxallic acid decolorizes the $K\,Mn\,O_4$. Still another method utilizes potassium-sulpho-cyanide and an iron salt, and a third method, phenolphthalein.

The writer has tried all of these with varying success. And then one day we talked to one of these wonderful prestidigitators (oh, yes; it's in the dictionary) and got the only and original formula for the real wine and water trick. You have only to try it to know it's the REAL one.

First secure four glasses. Put a very small drop of $Fe\,Cl_3$ (iron chlorid) in each of two of them, and fill another half full of $H_2C_2O_4$ (oxalic acid). The other one remains empty. The glasses with the chemicals should be farthest from the Audience. Fill a flask with a solution of $OHC_6H_4CO_2H$ (salicylic acid). The table shows how to perform the separate operations of the trick in their proper order. That is, first pour some liquid from the flask into glass No. 3. Result—colorless. Then into No. 1. Result—red due to the formation of iron salicylate. Then into No. 2, colorless. Then into No. 4, red.

Two and four combined give colorless. One and three give red. All together give colorless. See table herewith:

$3 + OHC_6H_4CO_2H$	Colorless
$1 + OHC_6H_4CO_2H$	Red
$2 + OHC_6H_4CO_2H$	Colorless
$4 + OHC_6H_4CO_2H$	Red
$2 + 4$	Colorless
$1 + 3$	Red
$1 + 2 + 3 + 4$	Colorless

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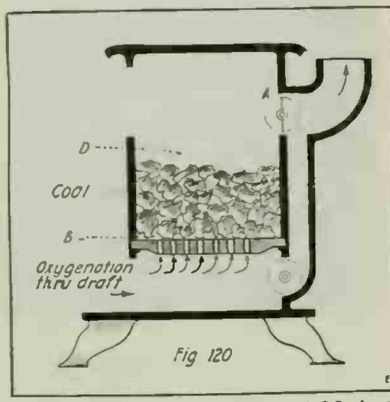
Experimental Chemistry

By ALBERT W. WILSDON

Twenty-Fifth Lesson

OXIDES OF CARBON—CARBON DIOXID.

VAN HELMONT, an alchemist of the seventeenth century, noticed that the gas obtained from burning wood, fermentation, or the action of an acid on limestone, possest different properties than ordinary air, in that it was capable of extinguishing fire. He designated "*wild gas*" as an appropriate name for



Showing the Formation of CO and CO_2 in a Coal Stove, Otherwise Known as "Coal Gas." The Damper in the Chimney Pipe Must Be Left Partly Open, Especially at Night, or Else the Gas May Leak Out and Asphyxiate Those Slumbering.

it. Van Helmont possest an idea that vegetation was dependent for growth upon water alone. He set out to prove to his own satisfaction that this was the case, and after carefully weighing a small willow tree of 5 pounds and planting it in a pot containing exactly 200 pounds of *dried* earth, he watered it with rain and distilled water, and in five years he removed the tree and again weighed it, finding that its weight had increased to 169 pounds and 3 ounces, and that the earth had only depreciated 2 ounces in weight. His ignorance of *carbon dioxid* and its functions in the air, at this time, made him believe that the tree actually fed on water alone.

Black obtained it from the carbonates of sodium and potassium, in which he said it was "fixt," and called it "*fixt air*." Lavoisier recognized the chemical nature of the gas and proved its composition to be carbon and oxygen. Dalton showed that the molecule consisted of one atom of carbon, united with two atoms of oxygen, thus illustrating its volume composition. Faraday was the first to *liquify it*.

Names:—Carbon dioxid; carbonic acid; carbonic acid gas; carbonic anhydrid.

Occurrence:—Carbon dioxid occurs free and uncombined in the atmosphere, of which it forms from .03% to .06%, the average being about 4 parts in 10,000 of air. It is found in all terrestrial waters, some springs being heavily charged, and is given off in large quantities from the earth in many volcanic regions. It collects in caves, mines and wells, and is quite often termed "choke-damp." Combined with various bases as carbonates it is still more abundantly distributed. The principal one of these compounds is calcium carbonate, which, as marble, limestone, and chalk, is one of the most abundant of minerals.

Preparation:—1. When heated, carbonates and bicarbonates yield the gas according to the following equations:

$$CaCO_3 = CaO + CO_2$$
$$2NaHCO_3 = Na_2CO_3 + H_2O + CO_2$$

2. When small quantities are desired it may be rapidly and conveniently prepared from a carbonate and an acid. In general, most acids will act on any carbonate and liberate carbon dioxid. Calcium Carbonate (Marble, $CaCO_3$) and hydrochloric acid is most suitable for preparation in the laboratory.

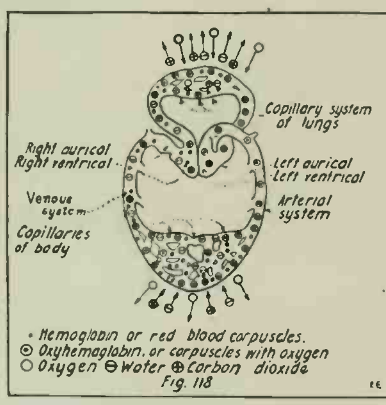
$$CaCO_3 + 2HCl = CaCl_2 + H_2CO_3$$
$$H_2CO_3 = H_2O + CO_2$$

Carbonic acid is probably the first product, but, being very unstable, at once breaks up, as shown by the equations. A high temperature will cause decomposition of carbonates into carbon dioxid and the oxid of the metal. Heat will decompose oxalates also, liberating carbon dioxid and carbon monoxid and leaving the metallic oxid, thus:

$$CaC_2O_4 = CaO + CO_2 + CO$$

3. When a current of air is past over red-hot carbon the product is *carbon dioxid*, provided the air has been kept in excess. This and the method by heating a carbonate are used for furnishing the gas in the manufacture of carbonates on a large scale.

Carbon dioxid is formed whenever carbon in any form or its compounds with



The Circulation of the Blood. It Circulates From the Capillary System of Lungs, Thru the Left Auricle, Left Ventricle, Arterial System, Body Capillaries, Venous System, Right Auricle, and Right Ventricle. Arrows Indicate Direction of Movement of Oxygen, Water and Carbon Dioxid.

hydrogen burn with plenty of oxygen. It is formed by all animals, for example, as a product of *respiration*; in the *decay* of plants and animals, and in almost every kind of *fermentation*.

Properties—(Physical): It is a colorless, odorless gas, with a weak acid taste.

It is quite soluble in water. One volume of water dissolves 1 volume of the gas at ordinary atmospheric pressure. With every increase of one atmosphere in pressure, the solubility of the gas is increased 1 volume. It is more soluble in alcohol than in water.

It diffuses slowly and thus accumulates in old wells, etc.

It liquefies at 0 deg., under 35 atmospheres to a colorless, mobile liquid. When liquid carbon dioxid is suddenly released from pressure, a part instantly volatilizes, absorbing so much heat as to produce an intense degree of cold, thereby causing a portion of the liquid to solidify to snow-like flakes. It solidifies at about —80 deg. by its own evaporation.

It is quite beneficial as a beverage, which is known as "*soda-water*," which is a solution containing about 5 *volumes of the gas in water*.

(Chemical): It is a *non-supporter* of combustion and is *non-combustible*, though sodium, potassium and magnesium burn in it. This property may be illustrated by lowering a lighted splint or taper into a vessel containing it, or, since it is heavier than air, by *pouring* it down an inclined board upon which is placed a number of lighted candles.

Four per cent of carbon dioxid in the air prevents combustion; thus it is a far superior fire extinguisher compared to nitrogen.

It is not respirable, because it shuts out the oxygen necessary for respiration.

Its action on hydroxides is to form carbonates. It is a very stable compound which is decomposed only at a temperature of 1,300 degrees, or by the continued action of the electric arc, yielding carbon monoxid and oxygen.

In the dry state it is neutral. In aqueous solutions it is capable of coloring blue litmus a faint red, which disappears on drying. It does not neutralize alkalies.

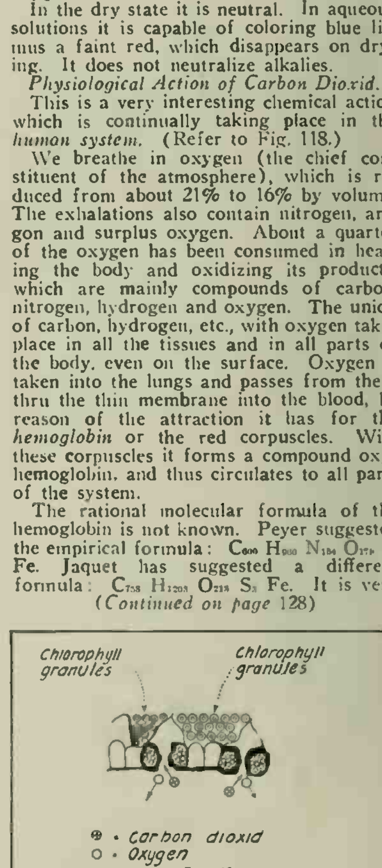
Physiological Action of Carbon Dioxid.

This is a very interesting chemical action which is continually taking place in the *human system*. (Refer to Fig. 118.)

We breathe in oxygen (the chief constituent of the atmosphere), which is reduced from about 21% to 16% by volume. The exhalations also contain nitrogen, argon and surplus oxygen. About a quarter of the oxygen has been consumed in heating the body and oxidizing its products, which are mainly compounds of carbon, nitrogen, hydrogen and oxygen. The union of carbon, hydrogen, etc., with oxygen takes place in all the tissues and in all parts of the body, even on the surface. Oxygen is taken into the lungs and passes from there thru the thin membrane into the blood, by reason of the attraction it has for the *hemoglobin* or the red corpuscles. With these corpuscles it forms a compound oxyhemoglobin, and thus circulates to all parts of the system.

The rational molecular formula of the hemoglobin is not known. Peyer suggested the empirical formula: $C_{600} H_{960} N_{154} O_{179} S_3$ Fe. Jaquet has suggested a different formula: $C_{758} H_{1203} O_{218} S_3$ Fe. It is very

(*Continued on page* 128)



A Partial Vertical Section of Plant Leaf Much Magnified, Showing Carbon Dioxid Entering Stomata on Under-Side of Leaf and Oxygen Emerging. Plants are Air Purifiers.

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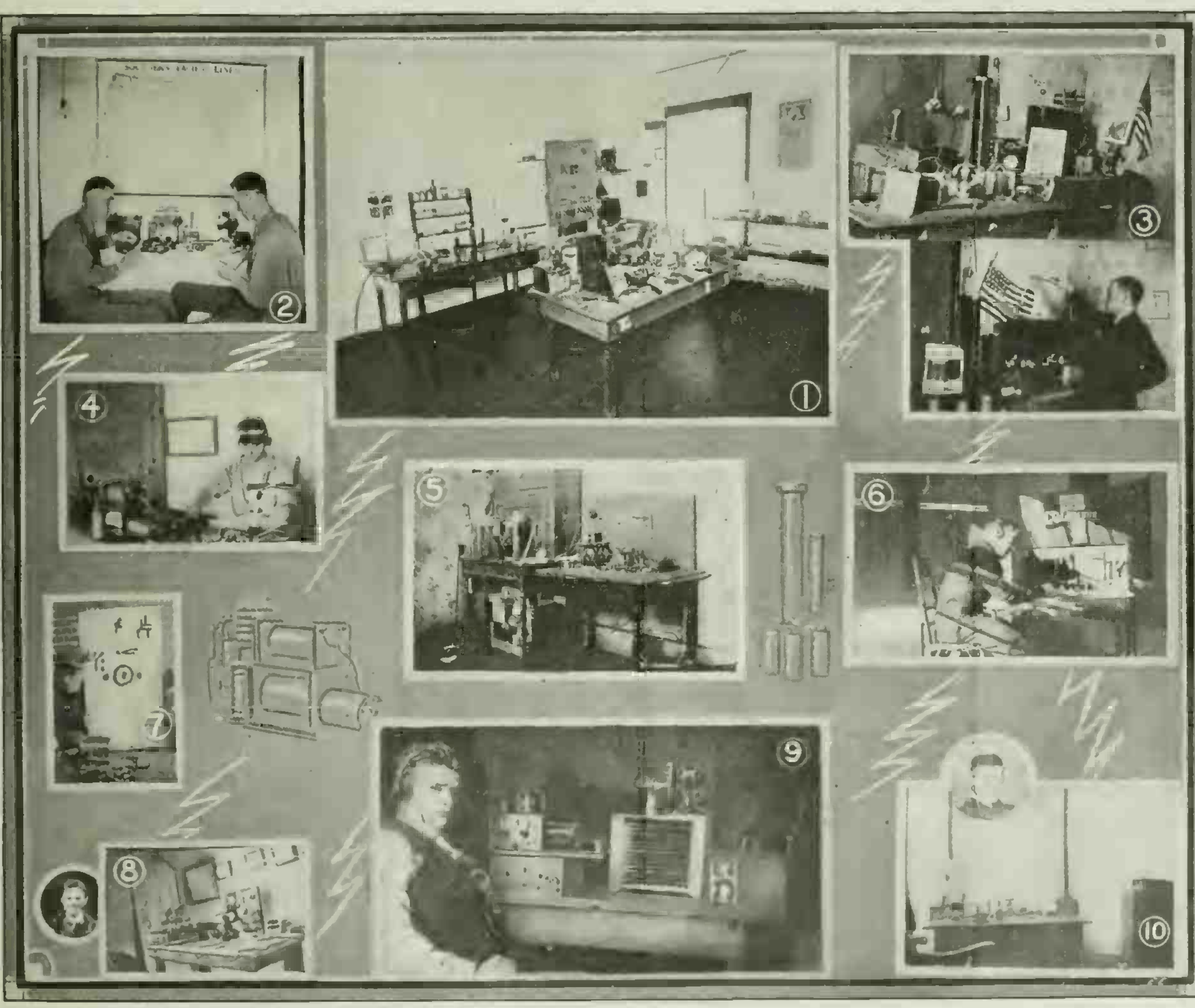
Our Amateur Laboratory Contest is open to all readers, whether subscribers or not. The photos are judged for best arrangement and efficiency of the apparatus. To increase the interest of this department we make it a rule not to publish photos of apparatus unaccompanied by that of the owner. Dark photos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

"Electrical Laboratory" Contest

In this issue we publish an interesting story with an excellent photo, describing one Amateur Electrician's experimental laboratory. Now "Bugs"—we want to publish a similar article each month. Here's our proposition: Why not write up your "Electrical Lab.," in not more than 500 words. Dress it up with several good, clear photographs. If we think it good enough we will publish the article in display style and pay you well for it. The remuneration for such articles will range from $5.00 to $10.00. And "Bugs"—don't forget to make your article interesting. Don't write—"I have a voltmeter, an ammeter, a switchboard," etc., *ad infinitum*. For the love of Pete put some punch in it! Tell us what you do with your instruments and apparatus. You don't mean to tell us that every Experimenter does exactly the same thing. "We" know different—but from the general run of such articles which we have received in the past, one would naturally think every "Lab." exactly alike. Remember—send a photo of YOURSELF along. Typewritten articles preferred.



A GROUP OF REPRESENTATIVE AMERICAN AMATEUR LABORATORIES.
Electrical Laboratories of, 1—Charles Stewart, Cadiz, Ohio, (Prize Winner); 2—Seefred Brothers, Los Angeles, Calif.; 3—Joe Haskell, Jr., Cliftondale, Mass.; Radio Laboratories of, 4—Paul Williams, Shorewood, Wisc.; 5—H. F. Innis, Jr., Bellflower, Ill.; 6—Thomas J. Donohoe, Columbus, Ohio; 7—Maynard Bodley, St. Paul, Minn.; 8—George W. J. Miller, Manitou, Colo.; 9—Ralph V. Korhnak, Braddock, Pa.; 10—H. Bamborough, Highland Park, Ill.

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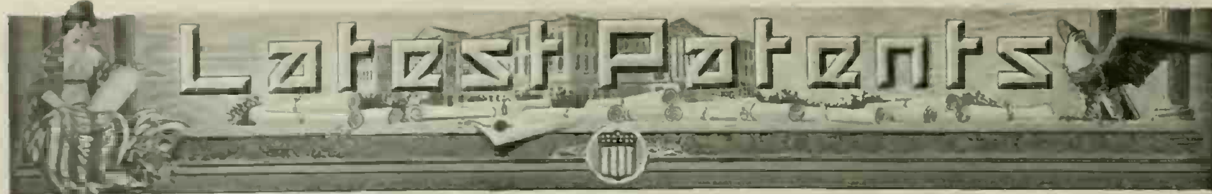
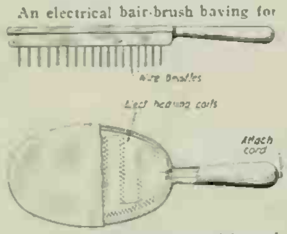


Electric Hair-Brush.

(No. 1,258,375; issued to V. V. Stewart.)

An electrical hair-brush having for

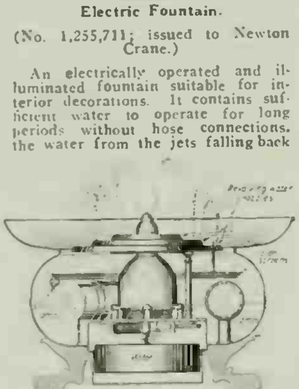


one of its objects the provision of a device especially adapted for straightening and drying hair. It is provided with an electrically heated plate to which are attached a plurality of metallic teeth, that are heated by the plates, whereby the hair of a person may be readily dried and straightened. This metal plate is enclosed within the hollow casing as shown, a suitable electrical heating coil being placed in position over the plate.

Electric Fountain.

(No. 1,255,711; issued to Newton Crane.)

An electrically operated and illuminated fountain suitable for interior decorations. It contains sufficient water to operate for long periods without hose connections, the water from the jets falling back

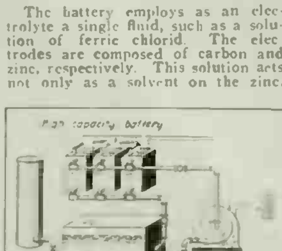


into a basin and reservoir, from where it is pumped up thru the jets again. An electric motor rotates the pump concealed in the base of the fountain. The triple water jet ring also rotates and electric lights in water-tight globes throw their rays upward thru the revolving jets, while changing color discs cause the jets to take on beautiful hues.

Primary Battery.

(No. 1,258,266; issued to Edward Sokal.)

The battery employs as an electrolyte a single fluid, such as a solution of ferric chlorid. The electrodes are composed of carbon and zinc, respectively. This solution acts not only as a solvent on the zinc,

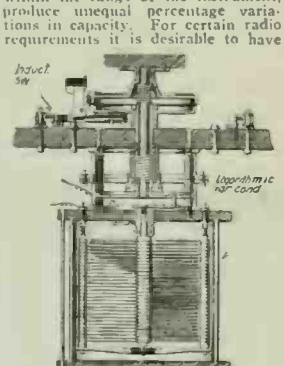


but also as a depolarizer. No porus diafram or cup is used. The battery has a high E.M.F. or 1.5 volts. Circulation of the electrolyte thru the battery is provided for by virtue of a small motor-driven pump.

Variable Radio Condenser.

(No. 1,258,423; issued to F. Lowenstein.)

A very clever variable condenser for use in radio or other circuits, having its rotary plates cut off at such different angles as to produce a logarithmic capacity variation characteristic. In the ordinary rotary variable condenser equal angular movements of the movable plates within the range of the instrument, produce unequal percentage variations in capacity. For certain radio requirements it is desirable to have

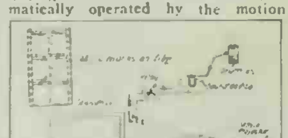


a logarithmic characteristic condenser, but heretofore it has been a complicated matter to design and build them owing to the peculiar form of moving plate required; in the present type this result is simply achieved, equal angular movements of the rotary plates producing equal percentage changes in capacity.

Talking Motion Pictures.

(No. 1,254,684; issued to Elmer Lewis.)

This patent aims to provide means for synchronously producing or causing to be produced supplemental musical sounds in conjunction with motion pictures. The inventor prefers to provide a means such that the several musical and sound producing instruments shall be automatically operated by the motion

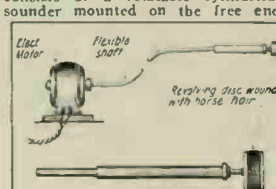


picture itself. To do this he photographs on the film itself a series of lines or marks, as noted in the drawing, which run parallel to the length of the film. Each line may represent a certain note or operating pedal. The light from the "movie" projector passes thru these transparent "sound marks" and is intercepted at the screen, falling upon a series of exposed, separate, selenium cells. An individual cell is provided for each "sound mark" on the film, and each ray of light is directed by a system of slots and guides to exactly register with its corresponding cell.

Motor Player for Stringed Instruments.

(No. 1,258,463; issued to W. A. Richter.)

A motor-operated hand manipulated playing device for stringed instruments, such as violins, banjos, mandolins, zithers, etc. The device consists of a rotatable cylindrical sounder mounted on the free end

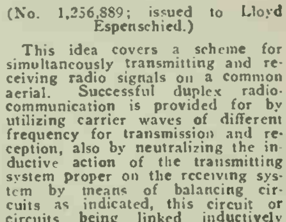


of a flexible shaft connected with a small electric motor at one end. By means of the handle sleeve provided, the rapidly rotating disc (which for playing the violin is covered with horse hair) can be brought successively into contact with the musical strings to be vibrated.

Duplex Wireless System.

(No. 1,256,889; issued to Lloyd Espenschied.)

This idea covers a scheme for simultaneously transmitting and receiving radio signals on a common aerial. Successful duplex radiocommunication is provided for by utilizing carrier waves of different frequency for transmission and reception, also by neutralizing the inductive action of the transmitting system proper on the receiving system by means of balancing circuits as indicated, this circuit or circuits being linked inductively with both the transmitting and re-

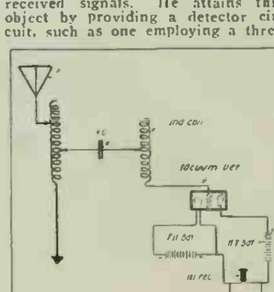


ceiving circuits. The function of the balancing circuit is to neutralize, with respect to the receiving circuit, the effect of the transmission current flowing in the radiating aerial circuit.

Radio Receiving Circuit.

(No. 1,257,672; issued to Elmer E. Butcher.)

A scheme whereby the Inventor claims to greatly increase the sensitiveness of the detector used in radio-telegraphy or telephony, so as to amplify minute impulses of weak received signals. He attains this object by providing a detector circuit, such as one employing a three

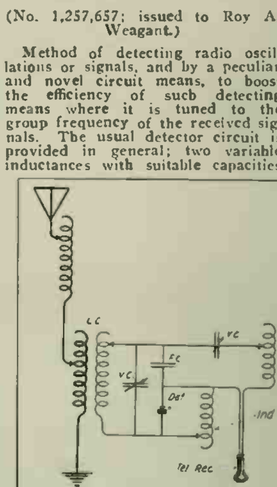


electrode valve detector, in which the highest possible potential obtainable from a given amount of energy received is imprest upon the detector. To accomplish this end the secondary circuit contains practically nothing but inductance.

Receiver of Radio Oscillations.

(No. 1,257,657; issued to Roy A. Weagant.)

Method of detecting radio oscillations or signals, and by a peculiar and novel circuit means, to boost the efficiency of such detecting means where it is tuned to the group frequency of the received signals. The usual detector circuit is provided in general; two variable inductances with suitable capacities

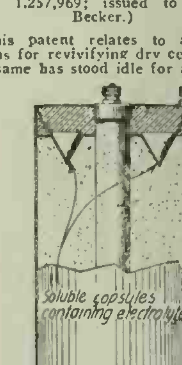


are connected up in shunt with the detector. The ratio between the auxiliary inductances and that of the loose coupler secondary may be such that they each have about 1,000 times the secondary value.

Dry Cell Renewal Device.

(No. 1,257,969; issued to E. H. Becker.)

This patent relates to a novel means for revivifying dry cells after the same has stood idle for a period



of time or has been in use and has become weakened. As shown in the sketch, two or more soluble metal (zinc) capsules are embedded in the cell when manufactured, these capsules containing either water or an electrolyte. The capsules are made of a material which is positive to the negative element, and of varying thickness so that the action of the battery will automatically liberate the contents at any predetermined time, depending upon the results desired. These capsules are electrically connected to the zinc shell of the dry cell by copper wires

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

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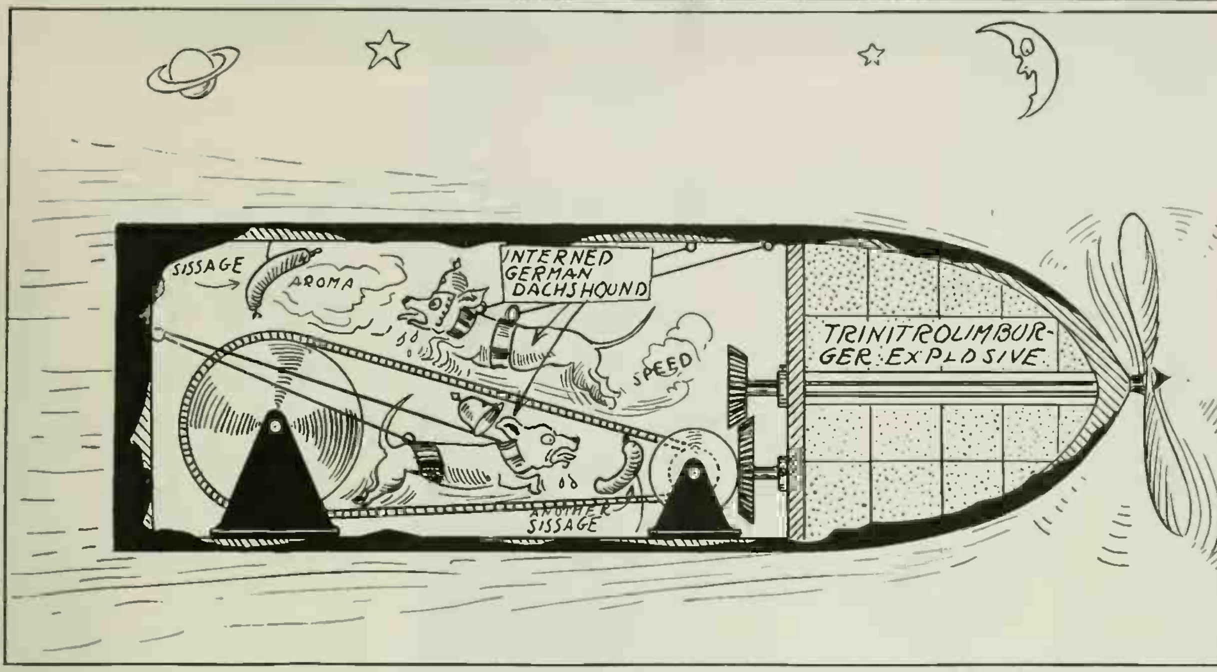
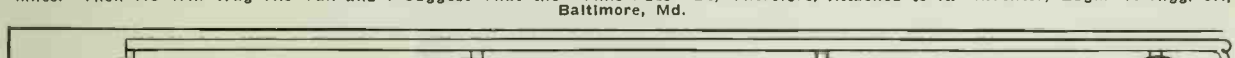


Prize Winner. THE "DACHSHUND 500 MILE SHELL." Here's a New and Wonderfully Powerful Long Range 500 Mile Shell Which the Allies Can Use in Their Present Howitzers and Siege Guns and Beat "Fritz" at His Own Game. The Big Guns Ordinarily Fire Shells 20 to 25 Miles. By Installing a Dog Tread-Power in Each of These Shells, and Placing a Pair of Interned Dachshunds in Each Shell Before Firing, With a Piece of "Kultur" Sausage in Position as Shown, the Range Can Be Increased to at Least 500 Miles! The Dog-Power Is Transmitted by Bevel Gears to the Propeller on the Front of the Shell. I Offer This Timely and Heretofore Unthought of Invention to General Foch and His Engineers to Retaliate Against the "Hun," for I Believe "Fritz" Really Finds His Mark at Paris by Utilizing "Paris-Bred," French Poodles in Those 76 Mile Range Shells. As History Proves, a Dog Will Find His Home, Even Tho He Has to Travel Hundreds of Miles. Then He Will Wag His Tail and I Suggest That the "Time Fuse" Be, Therefore, Attached to it. Inventor, Edgar T. Rigg, Jr., Baltimore, Md.



Electric "SCHOOL-ROOM COAL-SAVER." Being a True Friend of Dr. Garfield and the Fuel Administration, I Herewith Dedicate to Them and the American Coal-Famine Sufferers a Brilliant Idea Which Struck Me Last New Year's Night, When I Had Speeded Up My Mental Faculties by Imbibing 18½ Milkshakes, 13 Walnut Sundaes, and $4\frac{11}{16}$ Banana Splits. Here It Is: Install in Every School-Room Thruout the Land My Compress Air-Electric Generating System as Illustrated. As Students Arise to Recite and Sit Down, Especially on a Tack, They Will Work the Seat Bellows; This Compresses Air Thru the Pipe System to the Air Tank; Compress Air Runs Engine Belted to Dynamo and Storage Battery. Electric Heat and Light Is Thus Obtained Absolutely Free and In Great Abundance. Think of It! 15,000,000 School Children Rising and Falling on My Pneumatic-Electric Generators! "Doc" Garfield Should Give Me a "Croix de Bituma"—What? Inventor, John Plunkett, Newton Highlands, Mass.

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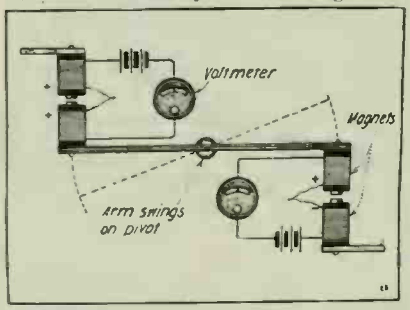
The "Oracle" is for the sole benefit of all electrical experimenters. Questions will be answered here for the benefit of all, but only matter of sufficient interest will be publisht. Rules under which questions will be answered:

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

RELATIVE FORCE OF MAGNETIC ATTRACTION AND REPULSION.

(926) J. C. Kane, Detroit, Mich., writes:

Q. 1. With the apparatus shown in the diagram I find that the magnetic attraction between 2 "unlike" poles is much greater than the repulsion between 2 "like" poles. Why is this?



Arrangement of Two Pairs of Electro-Magnets for Testing Relative "Attraction" and "Repulsion."

A. 1. Referring to your diagram of the arrangement of four electro-magnets each having the same number of lines of force per pole and having these electro-magnets in pairs, one pair having a north (+) and (—) south pole, and the other pair having two north (+) or south poles (—) and pivoted as shown, the force exerted by the magnets (+ and —) appears to be greater because of the *law of inverse squares.* This law says that the force exerted between any two bodies varies inversely as the square of the distance between these bodies.

Furthermore, when the current is turned on, producing unlike poles, attraction at once begins to take place. However as the attraction is taking place the distance between each pole is becoming less and less; hence the force becoming greater and greater. When the poles are magnetized (+ and +) or (— and —) the converse action takes place. The distance between the poles becomes greater and greater, causing the force to become less and less. Thus it is seen that while the two original forces (that is, the forces exerted when the distance was the same) are the same, one increases and the other decreases according to the natural law.

The force of attraction is always equal to the force of repulsion, but in the case cited by you we must make note of the following facts: If the forces were of repulsion, they would cause the pivot-arrangement to be deflected thru a certain angular distance. Now if we increased this angular distance by a very small amount and changed the polarity of the magnets, the pivoted bar would not be attracted, but if we placed the bar at the same angular distance that it was repelled thru, and the changed polarity remained the same, the bar would at once be attracted. In your case, you began with the pivoted bar at a certain distance away from the poles.

WIRELESS TEXT-BOOKS.

(927) Chas. H. Hook, Mt. Washington, Pittsburgh, Pa., asks:

Q. 1. What good wireless text-book can you recommend which give the design details for high power radio stations?

A. 1. We would suggest that you obtain a copy of Professor Johann Zenneck's book entitled "Wireless Telegraphy" which our "Book Department" can supply at $4.15 prepaid. This book is one of the best that has appeared, and contains many practical chapters on the design of high power radio equipment. Also you will find Dr. J. A. Fleming's classic work entitled "The Principles of Electric Wave Telegraphy and Telephony" very valuable. This book is worth $10.00 net, and is available thru our "Book Department" also.

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

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

IS ORDINARY WATER A CONDUCTOR?

(928) Thomas H. Hill, Washington, D. C., wishes to know:

Q. 1. Is ordinary water a conductor of electricity? I don't mean chemically pure water but just ordinary drinking water as found in city systems.

A. 1. Relative to the question as to whether or not water will conduct electricity, it is generally found that chemically pure water will not conduct electricity excepting when very high voltages are applied to it. This matter as we see it, boils down to the fact of its conductivity or non-conductivity as related to the presence of certain foreign chemical ingredients in the water. As you state you wish to know whether ordinary water as used for everyday drinking, cooking and other general use will conduct an electric current, we would say that it will. It may not do it very perfectly, but as an example of this condition, we might mention the following fact: When firemen have to fight a city fire where the stream of water is liable to come in contact with a live wire of even moderate voltage, a call is generally sent to the power station to have the current shut off, as it has often happened that the firemen under these conditions have been knocked out by the shock received from the current passing along the stream of water to the brass nozzle on the hose, and thence thru their body or bodies to earth.

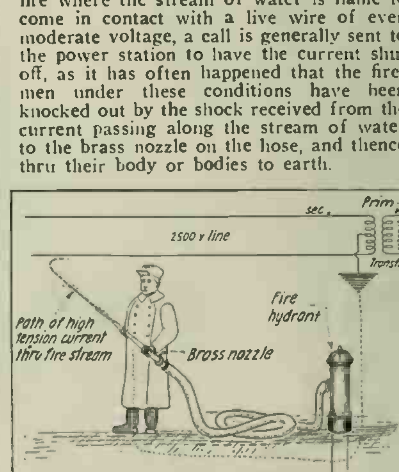

Diagram Showing How a Fireman Can Receive An Electric Shock Thru a Stream of Water From a Fire Hose.

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STATIC MACHINE VOLTAGES.

(929) C. H. Denniston, Pulteney, N. Y., asks:

Q. 1. Several questions regarding the voltages of static machine sparks and the danger of shocks from these sparks.

A. 1. For every 1-inch spark 20,000 volts is usually figured, and as most small static machines give 3-inch sparks, naturally the voltage is 60,000.

This potential of 60,000 volts for a 3-inch static machine spark is to be considered as the *root-mean-square* value, and not the maximum voltage. The *maximum* potential of static machines is generally computed at approximately 50,000 volts per 1-inch spark; this gives 150,000 volts *maximum* value for your machine. Moreover it is the maximum or peak value which you feel as a shock or that kills a person when the amperage and wave form of the potential are of a certain proportion. The *amplitude factor* of the potential determines what the R. M. S. and the corresponding maximum or peak value shall be. For example, in the case of the static machine just cited, the *amplitude factor* can be taken as 2.5 and therefore if the 3-inch spark is taken as having a R. M. S. voltage of 60,000 volts, then 2.5 times this potential gives 150,000 volts. A similar value for maximum potentials of induction coil sparks is often used.

It has been stated that 1-20 ampere past thru the human heart is sufficient to cause death. To pass this current thru the heart you must of course have sufficient voltage—this depends upon the health of the individual and the condition of the blood and nerves. A potential of 1,800 volts is used generally for electrocuting criminals.

The average electrical man will tell you, that the reason why you don't mind the shock from a spark coil or static machine is because of the lack of current—or amperage. This is so only partly—and it has been proven that at least for these cases, it is not the usual explanation—no amperage—that fails to spell fatal results, but sharpness of wave form and the instantaneous potential effect. When the victim of the electric chair "gets his"—he receives a slowly undulating wave of say 1,800 volts R.M.S. potential. The current sinks in—generally it burns the heart. But when a person gets an induction coil or static machine discharge thru his body, even a heavy one, it is invariably the case that he only receives the current for a very small fraction of time—the nerves and muscles are not affected. This theory is concurred in by several high authorities in the electrical engineering field. A more full explanation is given in an article entitled "The Measurement of High Potentials" by H. W. Secor, in the August, 1913, issue of *Modern Electrics*.

WAVE METER TO MEASURE 12,000 METER WAVES.

(930) H. Holmberg, Bottineau, N. D., asks:

Q. 1. For data on an inductance coil to be used with .001 m.f. variable condenser to measure waves 12,000 meters in length.

A. 1. An inductance for use in connection with a wave meter so that wave lengths up to 12,000 meters can be measured, when a variable capacity up to .001 m.f. is shunted across the inductance, will require approximately 500 feet of *litzendraht* wire consisting of 10 stands of No. 38 B&S gage.

The above result was derived in the following manner. Referring to the articles on Inductance and Capacity by Messrs. Secor and Cohen in the March, April and September issues of the ELECTRICAL EXPERIMENTER, we find that the inductance required is equal to 40,540,000 cms.

From the above you can see that it is very easy to calculate the inductance re-

When Marriage Is a Crime!

LIONEL STRONGFORT

The world's strongest and most perfect athlete, whose unaccepted challenge of competition to the greatest living "strong men" still stands.

THE man who deliberately marries a good, pure, wholesome woman, knowing in his heart of hearts, that he is not 100% perfect, that he has abused Nature and is otherwise unfit to be the father of those innocent souls he is about to bring into the world, is unworthy the name of Man—unworthy to be a Citizen of this great Nation—unworthy of happiness or financial success—He actually commits the worst crime known to Civilization, because he abuses the love and confidence of the woman he pretends to love and who confides in him and places her future in his hands—because it is the progeny of just such beasts that are filling our hospitals, our jails and our asylums—don't do it, my brother. Don't do it—come to me, confide in me and I will make you worthy of the best woman in the world—worthy of the deepest respect of your fellow man. I will build you up so that you can look the whole world in the face and say "I am a Man—100% man."

To Err Is Human and To Correct These Errors Is Manly

The man who admits he has physical defects has taken his first step toward manhood and honesty, but he must not stop there; he must see to it that he gets good competent advice and attention, and to do this he must go to the one who can prove by his own physical condition, that he is able to really give him **that health, strength and physique he desires—go to a man who practices what he preaches—I am that man**: I built myself up first, I experimented with my own body, until I made myself what I am to-day, what those competent to judge say I am, "The living illustration of the perfection of the human form, according to the highest standard." I don't care a rap what has caused your present unfitness, whether you have been brought to your rundown physically unfit condition by your own indiscretions, your own folly, or whether it has been caused by circumstances over which you have no control. **I will rebuild you. I will make a man of you, not a 50% man, but a Man—a 100% man.** I accomplish all this in Nature's own way. **No drugging, no medicines, no fads of any kind.** Simple scientific instructions added to the proper method of living, and what's more I care not who your physician has been, for I guarantee you that I will accomplish all I undertake and I won't undertake what I cannot accomplish.

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..Colds	..Torpid Liver
..Catarrh	..Indigestion
..Asthma	..Nervousness
..Obesity	..Poor Memory
..Headache	..Rheumatism
..Thinness	..Impotency
..Rupture	..Vital Losses
..Lumbago	..Youthful Errors
..Neuritis	..Gastritis
..Neuralgia	..Heartweakness
..Flat Chest	..Poor Circulation
..Deformity (describe)	..Skin Disorders
..Insomnia	..Despondency
..Short Wind	..Round Shoulders
..Flat Feet	..Lung Troubles
..Stomach Disorders	..Increased Height
..Constipation	..Stoop Shoulders
..Biliousness	..Muscular Development
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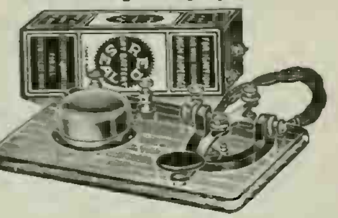
Mesco Telegraph Practice Set

For Learning Telegraph Codes



The Practice Set comprises a regular telegraph key, without circuit breaker, a special high pitch buzzer, one cell Red Seal Dry Battery, and four feet of green silk covered flexible cord.

The key and buzzer are mounted on a highly finished wood base, and three nickel plated binding posts are so connected that the set may be used for five different purposes.

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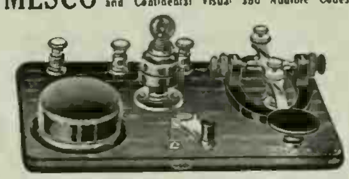
MESCO Combination Practice Set for learning the Morse and Continental Visual and Audible Codes



This outfit is the only reliable instrument which will enable students to become proficient operators in the U. S. Naval Service, because it is equipped with a buzzer and miniature lamp enabling the user to master both the visual and audible signals quickly.

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quired without much difficulty. As to which way would be better in winding, we advise using staggered winding, a description of the method of which has been given in past issues of the ELECTRICAL EXPERIMENTER.

RADIUM AND WIRELESS.

(931) Louis Morten Faulkner, Washington, Conn., inquires:

Q. 1. Has any reasearch ever been conducted on the effect of radio-activity as related to the propagation of wireless waves?

A. 1. We have consulted several authorities on the subject, and find that in 1912 Professor Dieckmman of Germany conducted some tests to ascertain whether any radio-active elements were deposited upon antenna by incoming radio waves. In this connection he used the electroscope. It was shown that a slight deposit is noticeable upon the antenna, altho it might be said that the air itself contains radio-active elements.

Further, there is no record of an electroscope ever being used for the actual reception of radio waves, and believe there is a very good field open in this direction for research work.

EXPERIMENTAL MECHANICS.

(*Continued from page 106*)

of the wheels on these three centers, to give the requisite ratio of speed between spindle and screw.

In order to cut a thread below 12 pitch, a single set of three gears is used, namely one driver on the spindle; one driven, on the screw, and one intermediate gear on the stud. It is worth remembering that a mere idler or intermediate wheel does not effect the ratio between spindle and screw speed; it is merely used to convey motion. The size of the change of gears, that is the number of teeth, must bear the same ratio as does the screw to be cut to the lead screw of the lathe; hence we will adopt the following rule:

Take the pitch of the lead screw as the numerator of a fraction and the pitch of the screw as denominator, multiply both by 5 or 10, and the products will be the wheels required—the numerator being the spindle gear or driver, and the denominator the screw gear or driven. In order to fully appreciate this simple rule, let us take an example. Suppose we desire to cut eight threads per inch with the lead screw having five threads per inch. The thing we want to know is, what size gears will be required to obtain this thread? Applying the rule we get:

$$\frac{\text{lead screw}}{\text{screw to be cut}} = \frac{5}{8} \times 5 = \frac{25 \text{ spindle or driver}}{40 \text{ screw or driven}}$$

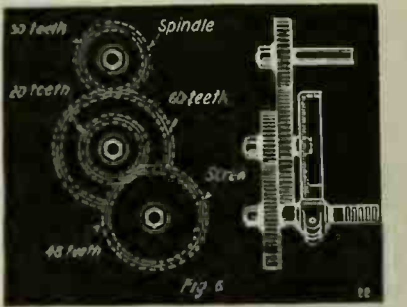
The gears required.

To cut a thread of screw pitch higher than 12 per inch may require for convenience of gearing or bringing the sizes within the compass of the wheels usually supplied, that a double train (four gears) be employed; this scheme is called *compounding* and this method is shown in Fig. 6.

In order to compound the gears, proceed with our first rule, setting forth the ratio of screw to be cut to lead screw in a simple fraction form, then assume any two other equal wheels, for second driver and driven. Also set forth in fraction form, and divide one driver and one driven by any convenient divisor to bring the figures within the compass of your gears. Thus applying the above rule to a particular example, of cutting a screw of 25 threads per inch, with a lead screw having four threads per inch, we have:

$$\frac{4}{25} \times 10 = \frac{40}{250} \quad \text{Assume } \frac{100}{100}$$

divide one driver and one driven by five, and we get $\frac{40}{50}$; $\frac{20}{100}$; the four wheels required. Another problem; wanted to cut nineteen threads per inch with a lead screw



Set Up of Four Gears Known As "Compounding," For Cutting Fine Thread On the Lathe.

of four threads per inch. Here we have:

$$4 \times 10 = 40, \text{ assume } \frac{100}{100} \div 2 = \frac{40}{95} : \frac{50}{100}.$$

A little study on the part of the experimenter on the above will make him a master in handling the above simple rules and allow him to figure out any combination of gears both simple and compound, for cutting a thread of any desired pitch.

When adjusting the stud, take care that the gears do not go too deeply in mesh, or they will bind against each other. The stud should be so adjusted that the gears all run easily and smoothly. It makes no difference what gear is used on the stud, as it does not enter in any way into the calculation for the pitch of the thread to be cut. If a left-hand thread is to be cut it may be necessary to use two studs as shown in Fig. 5.

All modern lathes are furnished with a key called an *index plate* which gives the relation of gears for cutting any desired thread. A typical index plate is shown in Fig. 7. You will note that the size of desired thread is given in the first row, while in the second the size of the spindle gear and the last the screw gear. To find the size of gear necessary to cut a particular thread, look for the figure corresponding to the desired thread, then opposite you will find given the size of the spindle and lead screw gears. Any size gear is placed on the change gear bracket which will properly connect the spindle and lead screw gear.

THD.	SPINDLE	SCREW
4	64	32
5	64	40
6	64	48
7	64	56
8	32	32
9	64	72
10	32	40
11	32	44
11½	32	46
12	32	48
13	32	52
14	32	56
16	32	64
18	32	72
20	32	80
22	16	44
24	16	48
26	16	52
28	16	56
30	16	60
32	16	64
36	16	72
40	16	80

Typical Lathe Index Plate Giving Gear Ratios For Screw Cutting.

In this lesson we have considered the subject of setting the various gears necessary to cut a particular thread, while in the next lesson we shall further consider the subject of thread cutting by taking up "How to cut the thread on the work."

(*To be continued.*)

Stray electric currents from a railroad are supposed to cause trees on one side of a Brussels (Belgium) street to bud again and sometimes blossom after they have shed their leaves in the fall.

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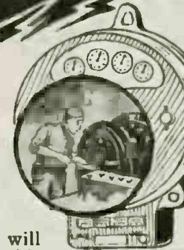

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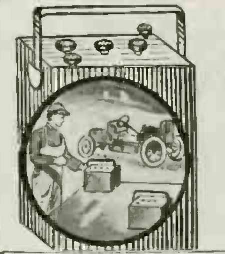

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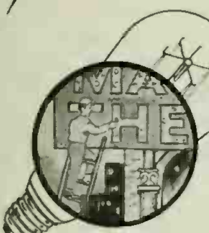

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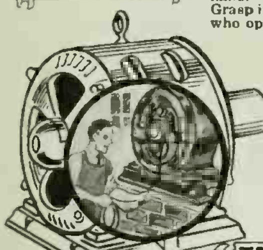

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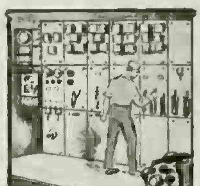

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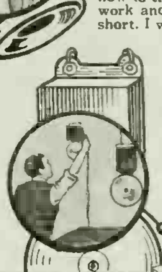

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THE DYNATRON—A NEW VACUUM TUBE.

(*Continued from page* 97)

If the circuit contains inductance and capacity, as well as resistance, a similar action takes place. The plate charges up thru the vacuum, at a rate depending on the capacity and *negative resistance,* and discharge thru the circuit at a rate depending on the inductance and positive resistance. If the inductance is too high, the plate will receive electrons more rapidly than they can flow away thru the inductance and will charge up to some point beyond the point at which the rate of charge and discharge are instantaneously equal. The inertia of the inductance will then carry it backward, and if the resistance is not too great it will act so as to oscillate continuously. Whether the circuit will oscillate continuously, or come to rest, depends on the relations between inductance, positive and negative resistance and capacity.

An ordinary dynatron short-circuited by a few turns of heavy wire will give a frequency of about 20,000,000 *cycles per second,* and it is possible to go continuously from this to a frequency of *less than* 1 *cycle per second* by simply changing the inductance and capacity values.

A profound change in characteristics is produced by placing the cylindrical type of dynatron shown in Fig. 2 in a *magnetic field* parallel to the axis of the cylinder. The electrons from the filament, which in the absence of the magnetic field move in nearly straight lines to the anode and pass freely thru its holes, are constrained by the field to move in spirals, and strike the anode more or less tangentially, so that a much larger proportion are stopt by it. The result is to diminish greatly the number of electrons reaching the plate. Superimposed upon this effect is a restraining effect of the field upon the secondary electrons which try to leave the plate, resulting in a change from *negative* resistance to *positive* resistance characteristic. It is thus possible, by varying the magnetic field, to control the behavior of the dynatron. This method of control is especially applicable to the radiophone.

The Pliodynatron.

An *electrostatic* field may be used instead of a magnetic field to control the number of electrons reaching the plate. It has been shown that the effect of changing the number of electrons leaving the filament by varying its temperature, is to change the negative resistance without affecting the other characteristics of the current voltage relation. If the temperature of the filament could be easily and rapidly changed, this would be an effective means of controlling the dynatron. The same result may be accomplisht, however, by the electrostatic action of a grid close to the filament: that is, by the application of the pliotron principle. The dynatron which thus utilizes the pliotron principle is called a *pliodynatron* (see Fig. 3.) Its construction is the same as that of the simple dynatron with the addition of a "control member," which may be a grid surrounding the filament, or a metal rod inside the (spiral) filament.

The negative resistance of the pliodynatron makes it a powerful amplifier. An increase of grid potential, by increasing the current thru the load in the plate circuit and hence the voltage drop over the load, lowers the voltage of the plate. In the pliotron this lowering of plate voltage tends to decrease the plate current, and thus opposes the effect of the grid. In the pliodynatron, however, a decrease in plate volt-

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age means an increase in current, which may be very large if positive and negative resistance are nearly equal. For example, the maximum aperiodic voltage amplification thus far obtained with a pliotron is about 15-fold, while with a pliodynatron a value of 1,000-fold has been obtained.

It has been shown that the dynatron will oscillate when $Rr < \frac{L}{C}$, where R and r

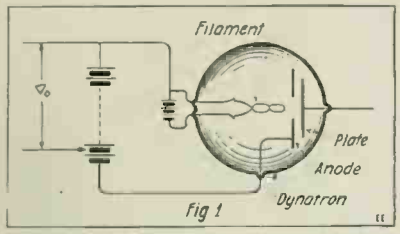

Fig. 1. Diagram of the "Dynatron" Vacuum Tube Which Possesses the Characteristic of "Negative Resistance."

are the positive and negative resistance, respectively, of the circuit, L the inductance and C the capacity. The frequency of oscillation is approximately $\frac{1}{2\pi\sqrt{LC}}$ and may be given any value from 1 to 10,000,000 by changing inductance and capacity alone. It has also been shown that for low frequencies the oscillations are very nearly *pure sine waves*, provided $\frac{L}{C}$ is not too great compared with Rr. Theory indicates that this should be true for all frequencies, and a search for *harmonics* at radio frequencies has verified the expectation.

The dynatron, therefore, satisfied all the requirements of a radio generator, and has the advantage that its operation is invariable and free from lag, and that the frequency may be given any value by changing a single inductance or capacity. Its oscillations may be controlled either by opening and closing the main circuit, or by changing any one of the four factors L, C, R, and r in accordance with the condition of oscillation given above. Its efficiency is low, probably less than 50 per cent under best conditions. This is not, however, a serious limitation, except as regards the cost of power, since the tubes are capable of running very hot without deterioration. The maximum output at radio frequency of the tubes thus far constructed is about 100

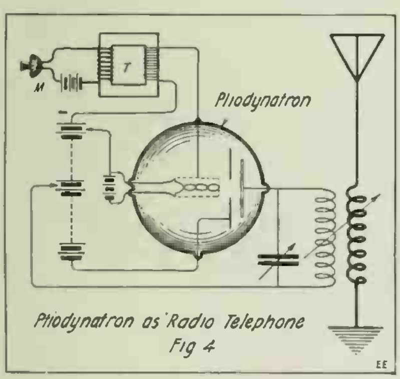

Fig. 4. Circuit Used With the "Pliodynatron" For Radiophony, Utilizing Microphonic Modulation of the Oscillations Produced By the Bulb.

watts, but no effort has been made to develop a high power tube. It is generally necessary to transform the radio energy by means of a coupled circuit.

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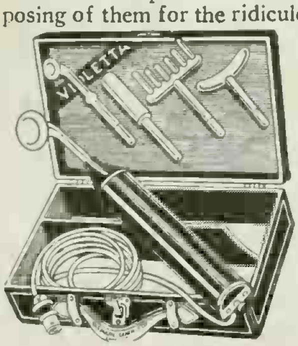

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The simplest method of controlling the oscillations of the dynatron is to vary the negative resistance, by means of a grid around the filament, as in the pliodynatron. It has been shown that the negative resistance of the pliodynatron is *inversely proportional* to grid potential. Hence, if the ratio of inductance to capacity and resistance be initially just large enough to produce oscillation (which is also the condition for producing pure sine waves), a slight decrease in grid potential will stop the oscillations.

This is exactly what is required for the radiophone, and it is easy to make pliodynatrons which have this characteristic.

The connections are shown in Fig. 4. The oscillating circuit has the pliodynatron connected up as shown, and is coupled inductively to the antenna. A microphone M, coupled thru the transformer T to the grid circuit of the pliodynatron, serves to control the amplitude of the oscillations. A battery of a few volts, between grid and filament, keeps the grid always *negative* with respect to the filament.

It is found that, with a proper ratio of inductance to capacity, the amplitude of the radio waves is very nearly proportional to the grid potential, and hence to the instantaneous displacement in the vocal (speech) wave. This was proved for constant grid potential by means of a hot wire ammeter in the antenna circuit, and for alternating grid potentials by impressing a sine wave on the transformer T, and observing the form of the rectified radio waves in a coupled circuit containing a kenotron rectifier and oscillograph.

Under these circumstances, it was found that speech transmitted to the microphone M, and received at a station a few miles distant suffered very little more distortion than in the ordinary wire telephone. With a small tube giving about 10 watts, it was possible to talk wirelessly 16 miles (26 km.) with good intensity and articulation. No attempt has been made to telephone greater distances, or to develop high power pliodynatrons. The maximum output of a single tube which it has been possible to control thus far is about 60 watts.

It has been found that a pliodynatron in series with a suitable resistance is capable of producing an aperiodic voltage *amplification of* 1,000-*fold. To maintain this* amplification requires constant batteries and continuous attention. A value of 100-fold is, however, very easy to maintain. By connecting two pliodynatrons in series a total *amplification of* 10,000-*fold has been* obtained. With this amplification it should be possible to receive radiograms on an aperiodic antenna.

[Ed note: Those interested in this article in detail would do best to refer to the Proceedings of The Institute of Radio Engineers, Vol. 6, No. 1, copy of which can be procured thru our Book Department.]

Television and the Telephot

(Continued from page 96)

makes use of a cathode tube, the wires 9 and 10 from the revolving mirror sender 1 being connected to wires 9 and 10 which in turn go to an electro-magnet *G*. Wires 11 and 12 from revolving-mirror sender 2 go to 11 and 12 which are also connected to another electro-magnet *H placed at right angles* to electro-magnet *G*. A pencil of cathode rays is thrown upon the screen in back of the tube, and this ray is influenced by the electro-magnets *H* and *G* synchronously to the revolving mirrors 1 and 2 of the sender. Consequently a picture should be traced out on the screen of the cathode tube point by point, and it is conceivable that a perfect picture could be readily obtained by this means. A condenser *K* is also arranged in the cathode tube to steady the cathode rays, and for certain other purposes which it is not necessary to delve into in this article. This is a particularly clever invention, but we do not have any information on hand showing if it has ever been tried in practise. It certainly looks more promising than any of the others, particularly as it requires only four wires.

We must also mention a certain other type of telephot which strictly speaking is not a telephot at all in the ordinary sense of the word because it does not transmit pictures by electricity, but optically. It shows how a picture can be transmitted practically *by means of a single light ray*. This idea was patented by Mr. Alf Sinding-Larsen of Christiania, Norway. The idea is to have two mirrors vibrating at a dif-

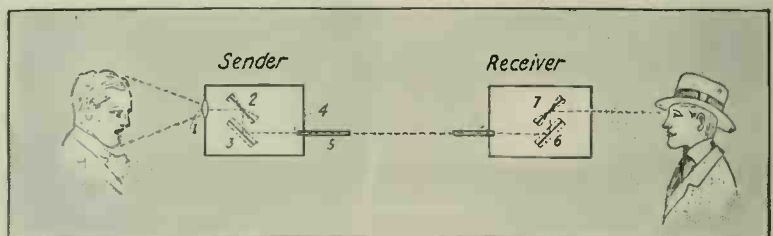

Fig. 5 Depicts the Sinding-Larsen Telephot. Two Mirrors Vibrating at Different Frequencies Cut Up the Light Rays. These Light Rays Are Past Thru a Metallic Tube Having Strong Reflecting Inner Surfaces. At the Receiver, the Light Rays Arer Past Thru a Similar System as the Sender and the Picture Is Thus Reconstructed.

ferent frequency of vibrations, which mirrors cut up the light ray into its components. For transmitting the pictures directly, the inventor makes use of a narrow tube with strongly reflecting inner surfaces which tube is arranged with its rear opening behind the light orifice in the transmitter. The optical system forming the image is arranged in such a manner that the rays form the individual image points across one another at a very acute angle. By this the inventor is enabled to cause the light taken up in the mouth of the tube to be transmitted thru the tube without being materially weakened in its passage to the other end of the tube and the image surface of the receiver.

The synchronous movement of the mirrors is effected by coupling them in series the electro-magnets serving to keep the mirrors moving. Reference is made to Fig. 5, where the sender and the receiver are connected with the aforementioned reflection tube 5; 1 is an object lens of the receiving station camera in which are placed two mirrors 2 and 3. The mirror 2 oscillating very fast on an axis perpendicular to the plane of the drawing, while the mirror 3 oscillates more slowly on an axis

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lying on the same plane and is perpendicular to the axis of oscillation of mirror 2. By these means, the elements of the image formed by the lens 1 are in succession following a continuous zig-zag line transferred to the focus of a lens 4 placed in the opening of the reflection tube 5, said lens parallelizing the rays which meet the image point. At the receiver two similar mirrors 6 and 7 oscillating synchronously with the mirrors 2 and 3 respectively, throw the train of rays emerging from the reflection tube to the eye of an observer as indicated. The synchronous vibration of the respective pairs of mirrors is accomplished by ingenious means outside the scope of this article. It becomes apparent from this invention that by substituting for the lens 4 some electrical means such as a combination of selenium cell with a revolving shutter, pictures may thus be transmitted electrically without using reflection tubes such as are shown in 5.

In fact, a system of this sort was tried some years ago by the Russian inventor Szcepanich.

Any reader interested in the aforegoing patents, by sending a self-addrest envelop to the author can ascertain the numbers of the patents which have been discust in this article. Most of these patents are very ingenious, and contain a good deal of information on television which has not so far appeared in print outside of the patent office records.

RESEARCH AND ITS IMPORTANCE TO HUMAN PROGRESS.

By Dr. W. R. Whitney

(Concluded from May Issue)

make a practical success.

A SMALL electric furnace was then devised for baking the rods and this was so arranged that the rate of rise of temperature, the maximum temperature reached and the duration of heat at any temperature, was under control and was also recorded. The desired result was obtained and this work was thus finished. It gave us a certain stock of knowledge and assurance.

At that time a very similar problem was bothering one of the engineering departments. Lightning arrester rods, part of the apparatus for protecting power lines from lightning, were needed. Their dimensions were ¾x6 inches and they needed to have a definite, but, in this case, *low* resistance, and could apparently not be baked in a porcelain kiln. The necessary variations in such a kiln are so great that, in practise, many thousand rods were repeatedly fired and afterward tested to yield a few hundred of satisfactory product. It was evident that regulation and control of temperature was necessary. This was found to be impracticable in case any considerable number were to be fired at one time, as the heated mass was so great that the rods near the walls of the retort received a very different heat treatment from those near the middle and were consequently electrically different. This difficulty led to experiments along the line of a heated pipe, thru which the rods could be automatically past. Some time was spent trying to make a practical furnace out of a length of ordinary iron pipe, which was so arranged as to carry enough electric current to be heated to the proper baking temperature. Troubles here with oxidation of the iron finally led to substitution of carbon pipes. This resulted in a carbon tube furnace, which is merely a collection of six-foot carbon pipes, embedded in coke powder to prevent combustion, and held at the ends in water-cooled copper clamps, which introduce the electric current. By control of this cur-

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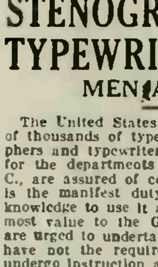

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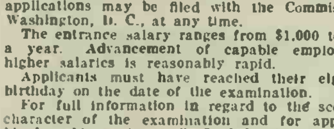

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rent the temperature could be kept constant at any point desired. When this was combined with a constant rate of mechanical feed of the air-dried rods of porcelain mixture a good product was obtained. For seven years this furnace has turned out all the arrester rods, the number produced the last year being over 100,000 units.

The electric furnace, consisting of the carbon tube packed in coke, was a good tool for other work, and among other things we heated the carbon filaments for incandescent lamps in it. We were actuated by a theory that the high temperature thus obtained would benefit the filament by removal of ash-ingredients, which we knew the ordinary firing methods left there. While these were removed, the results did not prove the correctness of the theory, but rather the usefulness of trying experiments. It was found by experiment that the grafite coat on the ordinary lamp filament was so completely changed as to permit of a hundred per cent increase in the lamp life, or of a 20 per cent increase in the efficiency of the lamp for the same life. This is the *metallized*, or Gem lamp.

Naturally, this work started a great deal of other work along the lines of incandescent lamp improvement. At no time has such work been stopt, but, in addition to it, the new lines of metallic filament lamps were taken up. In fact, a very large proportion of our entire work has been done along the line of metallic tungsten incandescent lamps. In this way we have been able to keep in the van of this line of manufacture.

The carbon tube furnace has been elaborated for other purposes, so as to cover the action under high pressures and in vacuo. Particularly in the latter case a great deal of experimental work has been carried out, contributing to such as that connected with rare metals. In such a furnace, materials which would react with gases have been studied to advantage. Our experience with the metallized grafite led to production of a special carbon for contact surfaces in railway signal devices, where ordinary carbon was inferior, and suggested the possibility of our contributing to improvements in carbon motor and generator brushes. On the basis of our previous experience and by using the usual factory methods, we became acquainted with the difficulties in producing carbon and grafite motor brushes with the reliability and regularity demanded by the motor art. Furnace firing was a prime difficulty. Here again we resorted to special electrically heated muffles, where the temperatures, even below redness, could be carefully controlled and automatically recorded. This care, aided by much experimentation along the line of composition, of proportionality between several kinds of carbon in the brush, etc., put us into a position to make really superior brushes.

This carbon work naturally led to other applications of the identical processes or materials. Circuit breakers, for example, are now equipt with a specially hard carbon contact, made somewhat as motor brushes are made.

FOR years we in the laboratory worked in every conceivable way to remove the last traces of gas from incandescent lamps. We carefully determined the effect of the last molecule of every gas which could possibly enter a lamp and some which could not. As a result, Dr. Langmuir discovered the hitherto unsuspected fact that a *better* tungsten lamp can be made by filling the bulb with nitrogen or argon. There had been a long time when we felt we knew with certainty that the vacuum was necessary. But there were relevant things we did not know even then. New knowledge changed the looks of things. During the vacuum work I certainly lacked faith in the beneficent effect of gases. Nature was ready with the new facts when we made suitable inquiry.

I remember also that after we had tried to increase the resistance of our early tungsten filaments by introduction of rare oxids and other material which we hoped would remain in the filament when hot, and had seen them distil out at the temperature of operation, someone suggested adding traces of such oxides for the purpose of increasing the life of the filament. It seemed a futile experiment, but the traces served the new purpose, while greater quantities had failed.

Why should we force new knowledge to come by such difficult and circuitous routes? Can we not train ourselves to be more ready for it, more open-minded for its reception and more stinted in our satisfaction with present knowledge?

We seem to live in a rapidly changing environment so far as Nature's laws are concerned. Of a truth, we ourselves and our conception of things, are the variables, and when we have once realized this much, there comes the possibility of directing our hope and expectations, our visions and experiments along what we may call a pragmatic path. This means more care and respect for the contents of the future.

Every chemist, even in his freshman days, handles the identical substances with which all material advances will be made. Because he cannot always handle them in the ways of the advanced industry, he is led to imagine that research is closed to him. Yet so much useful pioneer work in all fields has been done with simple material equipment coupled with good mental equipment, that it almost seems as tho this was the rule. The telegraph and telephone started with a few little pieces of wire wound by hand with paper insulation. The basic work on heredity was carried out by an Austrian monk with a few garden peas. The steam engine came from the kitchen fire, and wireless from the tricks of a little spark gap. There was, however, the same general kind of mind behind each one of these discoveries—the mind of the inquisitive thinker.

When Professor Hertz was making observations which were based on the effect of one spark gap on another at a distance, and concluded that he was dealing with electric waves in space, he was not trying to improve the telegraph or telephone. He was like an inquisitive child, making what to him were interesting experiments. He was well trained to observe, but otherwise he was like a youth guided solely by the interest in the new things he was finding. When he had added to our knowledge the few simple facts which he observed, the results of trying things, he had laid the foundation for a Marconi. His ability was no accident, his service no unsought nor unsupported thing. He had been trained by Helmholtz, and all his life he was employed in German universities to do pure research work and to encourage others to do it likewise. This is the important point.

The reason why we should take most interest in this type of research is that it most develops the people who support it. The American manufacturers are probably wise enough to measure the value of direct attack on their specific problems, and they will more and more effectually employ men to solve them as men appear who are competent. In this way much that is new will be discovered, but not enough, nor of the right kind. The discoveries in separate industries are usually those of further refinement, or improvement. The natural ex-

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tensions of present known paths, the more or less obvious additions or economies, these are the studies of the industries. By industrial research as usually successfully carried on, few new fields of human endeavor are likely to be opened up.

Therefore, one in America must do all one possibly can to encourage that kind of seeking after the new possibilities in nature which may be called the fundamentals, the truths of matter. Some call this "pure scientific research." No matter what its name, it is the learning by trial about the things the Creator has put into our hands. Gradually and continually we must learn the new and ever-broadening uses. I say this merely because this has been the path by which civilization has thus far traveled most successfully.

It is harder to produce high voltage low wattage lamps as compared to lamps of equal wattage for use on low voltage circuits, which is due to the fact that thinner wires, which are used on the high voltage circuits are harder to make.

BURNT-OUT LAMP CONTEST.

(*Continued from page* 92)

should be somewhat stronger. The *negative* pole is the one upon which the small gas bubbles appear, the other is the positive pole.

Figure 6 shows a match holder or match safe submitted by a gentleman residing at 911 Hancock St., Brooklyn, N. Y., who however, must remain nameless until next month, being that he forgot to sign his name to the letter. The illustration clearly shows how this match holder is made. This is some more work for our ladies, and should prove rather an attractive idea. The main thing to remember, however, is that the sharp upper edge should be gone over with a Bunsen burner or other hot flame to take off the cutting edge. Otherwise "Pa-Paw" is likely to throw it into the ash barrel the first time he cuts his fingers.

Figure 7 shows an electric distiller or still suggested by Mr. Robert Lindsay, 563 Brighton St., El Centro, Cal. The illustration in this instance also furnishes nearly all details. A cork is inserted into the top part of the burnt-out bulb and a glass tube is inserted in the cork. If the 110-volt current is turned on, the water will become hot and steam will soon be generated. Distilled water is formed in the other vessel as shown. Other liquids besides water can be used.

Caution: No moonshining now, boys!

Figure 8 shows the idea of Solly Weitzer, 119 Lewis Ave., Westmount, Quebec, Canada. It is an emergency fuse made from the remains of a burnt-out lamp bulb. It should prove quite attractive for our many bugs. It seems such a simple idea that it is surprising no one ever thought of it before, until this Lamp Contest came along. Then it went over the top with a big whoop, almost a dozen contributors duplicating this idea!

Two good ideas were submitted by Mr. Carl Knutson, 8028 Coles Ave., Chicago, Ill., and are shown in Figure 9. The first is a rain alarm, the idea being to fill part of the bulb with diluted sulfuric acid which *must* come below the level of the two

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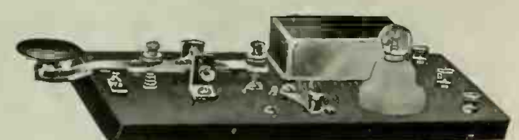

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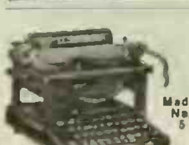

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protruding lead wires. It will be seen that as soon as it starts raining, the electrolyte will rise in the vessel which will establish a good connection between two wires which in turn will cause the rain alarm to ring. The next idea shows an electrolytic interrupter. It is made by utilizing a bulb as shown, inverted and having the two lead wires ground off smooth with the glass. The two wires of the receptacle are joined together and form the positive pole of the interrupter; the negative pole goes to the lead strip screwed to the paraffined wooden cover, and bent around as shown. The vessel is filled with 5 parts of water and one part of sulfuric acid. This makes a fair electrolytic interrupter which, however, will not last very long, as the active wires soon give out, or the glass cracks due to the heat. For short experimenting it will prove satisfactory, however. It works on 110 volts in series with any spark coil. No resistance is required.

Figure 10 shows a deflagrating globe which was suggested by Mr. Thos. W. Benson, 1365 E. Carey St., Philadelphia, Pa. Such globes are used extensively in chemical experiments as frequently described in Experimental Chemistry in this magazine.

Figure 11 shows how to make a Florence style flask as well as an Erlenmyer flask. These were suggested by Mr. Paul De Paolis, 20 William St., Geneva, N. Y. Naturally, these flasks require large bulbs and the 100 watt or larger variety of nitrogen or Tungsten lamps lend themselves admirably for this purpose. The illustrations clearly show how the flasks are made. Ideas along this line are quite profitable, being that the glass of such bulbs is usually a good grade, and the resulting flasks are not of a bad kind at all.

Figure 12 shows a chemical retort made from a 100 watt nitrogen lamp, and this idea is along the same lines as that shown in Fig. 11. Quite a good retort can be made from a bulb of this kind, and we are quite certain it will prove satisfactory to the chemical experimenter. This idea is suggested by Edwin J. Farmer, 621 S. Freedom, Alliance, Ohio.

(This finishes our Contest for this month, and we hope to have some new suggestions for July.)

EXPERIMENTAL CHEMISTRY

(Continued from page 114)

evident from this that the molecule is of enormous size and exceedingly complex.

The oxyhemoglobin parts with its oxygen wherever it finds compounds of carbon, hydrogen, etc., ready to be oxidized, forming with them carbon dioxid and water. The products are carried back thru the veins to the lungs, whence they are exhaled. The system is in this way purified and the waste is supplied by the digestion and assimilation of food. The *oxidation of food products, after assimilation,* keeps up the heat of the body as really as the combustion of carbon or sulfur liberates heat. The average temperature in man is 37 deg. C. (98.6 deg. F.). Any excess of heat produces perspiration or is changed into other forms of energy. The maintenance of temperature at nearly a fixt degree is necessary to health and life, but in disease the temperature of the body deviates to some extent from the normal. In Asiatic cholera it is sometimes as low as 25-26 deg. C (77-79 deg. F.), while in pneumonia it may rise to over 41 deg. C. (106-107 deg. F.). Considerably higher temperature than these have been noted; but if this condition is continued the blood corpuscles are killed and the person dies.

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Deoxidation in Plants.

Since carbon dioxid is so constantly poured into the atmosphere, why is there not more carbon dioxid and less *free oxygen* in the air to-day than a thousand years ago? The answer may be found in the growth of vegetation. In the leaf of every plant are thousands of little "chemical laboratories." A single tree often has *acres* of foliage surface exposed to sunlight and air; carbon dioxid, diffused in small quantities in the air, passes into the leaf, mainly from the under-side thru the *stomata*, or little mouths. (See vertical section of leaf, Fig. 119.) Within the leaf, probably in the green chlorophyll grains, it is decomposed by the *radiant energy* of the *sun*. The reaction supposed to take place is:

$$6CO_2 + 5H_2O = C_6H_{10}O_5 + 12O$$

Oxygen is given back to the air; starch ($C_6H_{10}O_5$) is retained in the leaf and is transformed into sugar and cellulose, the latter of which constitutes the fiber of the wood and which has practically the same symbol as starch or sugar, namely, $C_6H_{10}O_5$, or a multiple of it. Carbon dioxid contributes to the growth of plants. Oxygen, to that of animals, and the constituents of the atmosphere, vary but little from one age to another. The compensation of nature is here well shown. *Plants feed upon what animals discard*, transforming it into material for the sustenance of the latter, while animals prepare food for plants. Practically all the carbon in plants comes from the carbon dioxid in the atmosphere. Animals obtain their supply of carbon from plants. The utility of the small percentage of carbon dioxid in the air is thus seen.

Uses.

Carbonic acid gas is used for making soda-water, and as a basis of mineral waters and effervescing drinks of all sorts. It is also used in bread making (causing the dough to rise by its formation), and is employed very extensively in alkali manufacture, for example, in sodium carbonate. In chemical fire engines sulfuric acid is in one tank and is let into another tank containing sodium carbonate solution, thus rapidly liberating carbon dioxid, which is forced on to the fire in its early stages. Carbon dioxid is also used for *refrigeration.*

Carbon Monoxid.

History

Lassone first discovered this gas about 1776. Priestly obtained it and named it *"Phlogisticated water."* about 20 years after Lassone. Lavoisier supposed it to be hydrogen. Cruikshank, in 1880, proved it an oxid of carbon.

Names: Carbon monoxid; carbon protoxid; carbonic oxid.

Occurrence.

Probably the gas carbon monoxid does not occur naturally anywhere, except as a product of combustion of coal with an incomplete supply of air, and in furnaces under like conditions. It may be easily recognized in the combustion of anthracite coal by its peculiar blue flame. Almost identical with this formation of it, is the one obtained by passing carbon dioxid over red-hot charcoal.

$$CO_2 + C = 2CO.$$

Preparation.

One way of preparing this gas is to act upon oxalic acid ($H_2C_2O_4$) with sulfuric acid and heat. It will be seen that oxalic acid, which is a solid, consists of H, C, and and O in the exact proportion to form water H_2O, carbon dioxid CO_2, and carbon monoxid CO. Heat alone will break up the acid into these constituents, but sulfuric acid aids in the operation and also absorbs the water leaving the two gases, carbon dioxid and carbon monoxid, completely intermingled. Remembering the affinity which carbon dioxid has for soluble hydroxides, we can separate it by passing the mixture into a solution of sodium hydroxid, or of potassium, or of calcium hydroxid.

$$CO_2 + CO + 2NaOH = Na_2CO_3 + H_2O + CO$$

The carbon monoxid, being insoluble in water, can be collected like hydrogen.

The gas can also be prepared by the action of sulfuric acid on formic acid or potassium ferrocyanid ($K_4Fe(CN)_6$), or by heating certain oxides, as zinc oxid or carbon dioxid, with charcoal.

$$H_2CO_2 = H_2O + CO$$
$$K_4Fe(CN)_6 + 5H_2SO_4 + 6H_2O = 2K_2SO_4 + FeSO_4 + 3(NH_4)_2SO_4 + 6CO.$$
$$ZnO + C = Zn + CO.$$

The economical method and the one that will yield the gas rapidly, is that involving the heating of finely powdered potassium ferrocyanid with eight or ten times its weight of strong sulfuric acid, which reaction takes place according to the second equation above.

As soon as the reaction commences the heat must be removed and the vessel cooled, if necessary, in order to prevent too rapid evolution of the gas. The water required in the above reaction is derived from the water of crystallization of the potassium ferrocyanid and from the small quantity in the commercial sulfuric acid.

Properties

(Physical): It is a colorless gas.

It is very slightly soluble in water.

It is very poisonous, one per cent having produced death.

It liquefies at 140 deg., 36 atmospheres, and boils at —190 deg. It solidifies at —199 deg.

(Chemical): It unites with chlorin to form carbonyl chlorid ($COCl_2$).

It combines with the hemoglobin of the blood to form carbon monoxid hemoglobin, a stronger compound than oxyhemoglobin; hence oxygen does not displace it and it rapidly poisons. Its poisonous effects are almost instantaneous, judging from deaths resulting from inhaling water gas.

It is a non-supporter of ordinary combustion, but red-hot carbon robs carbon dioxid of half its oxygen to form carbon monoxid in the presence of no free oxygen.

Uses.

Carbon monoxid is a diluent in water gas and a reducing agent in ore reductions, particularly iron. As a constituent of illuminating gas, it is sometimes used to asphyxiate dogs and other animals.

The formation of CO and CO_2 in a coal stove:

The fact that CO_2 is formed with abundance of oxygen, and CO with a limited amount, is well shown in a coal fire. (See Fig. 120.) Air carrying plenty of oxygen enters thru the draft, and carbon dioxid is first formed at B.

$$C + 2O = CO_2$$

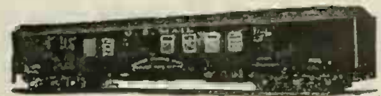
But as this rises to the middle of the hot coal, where oxygen is wanting, it gives half its oxygen to the carbon and becomes reduced to carbon monoxid.

$$CO_2 + C = 2CO$$

Here, carbon acts as a reducer, CO_2 acts as the oxidizer, CO as reduction product. Reaching the surface D, however, where there is plenty of oxygen, the CO becomes CO_2, burning with a blue flame.

$$CO + O = CO_2$$

The danger of having the back draft A closed when the stove door is open arises from the unburned CO being forced into the room, to be breathed by the occupants.



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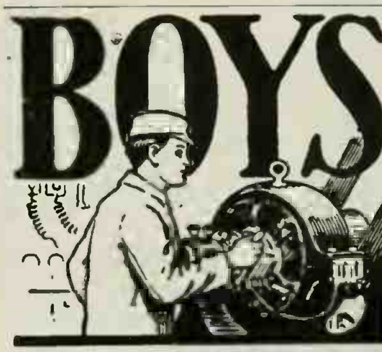

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- Mechanical Draftsman
- Machine Shop Practice
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- CIVIL ENGINEER
- Surveying and Mapping
- MINE FOREM'N OR ENG'R
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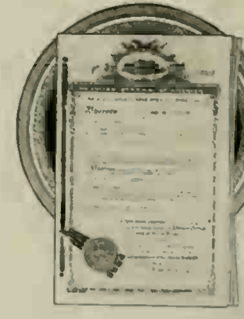

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In this Department we publish such matter as is of interest to inventors and particularly to those who are in doubt as to certain Patent Phases. Regular inquiries addrest to "Patent Advice" cannot be answered by mail free of charge. Such inquiries are publisht here for the benefit of all readers. If the idea is thought to be of importance, we make it a rule not to divulge details, in order to protect the inventor as far as it is possible to do so.

Should advice be desired by mail a nominal charge of $1.00 is made for each question. Sketches and descriptions must be clear and explicit. Only one side of sheet should be written on.

TOY ENGINE.

(227) Howard Anderson, Torrington, Conn., submits drawings of a toy armored engine. The engine has also a certain number of imitation machine guns set on pivots, so that they can be turned in the slots of the engine tower. Our advice is asked if the combination is patentable and of value.

A. We see nothing new contained in this idea, nor do we think that a patent can be obtained upon it, altho intrinsically the idea seems to be good. It is one of those things that, while good, cannot be patented, because they are simply *designs.* Of course a *design patent* could be obtained upon a combination of this kind, but we doubt if it would be of value.

AUTOMATIC LIGHTING SYSTEM.

(228) John R. Pell, Jr., Parkersburg, W. Va., sends us an idea of an automatic light scheme, the purpose of the arrangement being that when one lamp breaks or burns out the circuit is broken; this releases the armature of an electro-magnet which closes a contact, and in turn lights another light. Our advice is asked.

A. This is a very ancient idea, and has been used as far back as 1870, when the first automatic arc lamps were invented by Jablochkoff of Paris. It is also used at present on certain automobiles to give warning when the rear light should break or burn out. Years ago, the Editor had a system of this kind on the market working on the same principle which he termed the "Tell-Tale Tail Lamp." This was on the market in 1906.

INSULATOR.

(229) H. H., Glace Bay., Nova Scotia, Can., has submitted drawings of a certain insulator, whereby the wire can be attached to the insulator without any additional means. Our advice is asked.

A. This seems to be a very good idea, except that if the insulator is made in porcelain there would be trouble with the two screw parts, as porcelain does not lend

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ADVICE

H. GERNSBACK.

itself very well for threading purposes. There is apt to be too much variation of the thread in *firing*, and the thread for this reason must be very coarse. If the insulator can be made in a composition, such as Electrose, etc., the idea would work out to much better advantage. We think a patent can be obtained on the idea.

FUSE.

(230) Alvin Messall, Colorado Springs, Col., submits drawings and designs whereby a fuse is incorporated right into the lamp socket, which idea he thinks would make it possible for anyone to see just exactly where the fuse had blown.

A. This is not a practical idea to our mind, as it would necessitate too many fuses which are not at all necessary. We do not think that anyone would wish to adopt a plan of this kind.

WAR AEROPLANE.

(231) J. A. Aniba, *U. S. S. Gallup*, submits an idea of a war aeroplane using a new form of propulsion. The idea is to use a boiler, and instead of water he proposes alcohol. This is one of the main features of the scheme.

A. We are afraid that such an aeroplane, while it might leave the ground, would be far too heavy, and the idea of using alcohol instead of water we think would be looked upon with disfavor by the average aviator, at least at the present time. We do not believe that such a boiler has been far enough advanced to be used on an aeroplane.

AUTOMATIC TELEGRAPH TRANSMITTER.

(232) Marins Zaayer, Boston, Mass., has noted a description of an automatic telepraph transmitter in the ELECTRICAL EXPERIMENTER of October, 1916, page 404. He fails to see how we come to the conclusion that such a time-saving device, in order to be patentable and marketable, should cost only five to ten dollars. This is in criticism of our *Patent Advice* in a recent issue of the EXPERIMENTER.

A. Our advice given at that time was merely from a manufacturing standpoint, and we still insist that if the instrument should be a success from an amateur standpoint, it must sell cheap. Of course, the advice which we gave was meant for an amateur instrument, not for a commercial instrument, such as was described in our October, 1916, issue.

Our correspondent also desires all possible information about automatic keyboard transmitters of this kind.

A. We respectfully refer him to a patent

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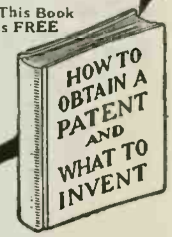

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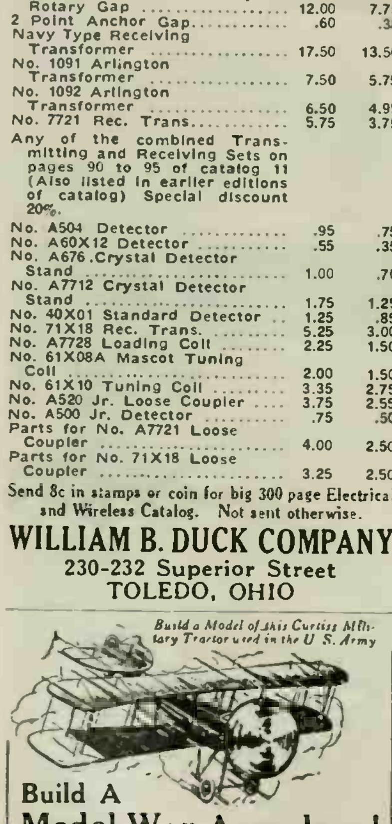

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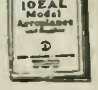

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attorney for search in the Patent Office for patents of this class. A search of this kind can be made for a few dollars by any reputable patent attorney.

GAS GUN.

(233) H. W. Seeley, Bridgeport, Conn., claims that he has experimented for some time with what he terms a "Gas Gun." The cannon is supposed to be built of brass or steel and is to be fired with gas. Certain other information is given as to how to operate the gun, as well as other various details. He also claims that with such a gun he has hurled objects with considerable force for fairly long distances, but he admits that of necessity he used a very small gun. Our advice is asked.

A. In view of the fact that late advices from Germany thru Swiss sources mention that the famous 74-mile gun which the Germans used in shelling Paris are supposed to be using gas, our correspondent's idea seems feasible. How practical such a device is, is not known to us. Until the German came along no one ever spoke of gas guns, but there is a good chance that there might be something in an idea of this kind. We would advise our correspondent to proceed cautiously, and have a thoro patent search made before applying for patent.

AUDION.

(234) E. F. Johnson, Waseca, Minn., thinks he can use an A. C. current step-down transformer in connection with an Audion. He shows several schemes to be used in connection with the idea.

A. We think it is impossible to use A. C. current in connection with such a sensitive device as an Audion, as we are almost certain that a loud hum will result in the telephone receivers, and we doubt if the same can be overcome entirely to make the operation of the instrument suitable. Furthermore, no matter what arrangement is used in connection with the transformer, the constantly changing potential of the line is certain to interfere with the operation of the Audion. Everytime somebody down the line turns on a number of lights there is a disturbance along the entire circuit, which will certainly manifest itself in the Audion.

AN ELECTRIC AEROPLANE SHOOTING GALLERY.

(*Continued from page* 77)

pathway, the target being preferably in the form of a miniature aeroplane as here illustrated.

In the front portion of the gallery there is arranged a shooter's stand and in the rear are traveling targets adapted to be shot at by the shooters or gunmen standing on the stand. The shooter's stand is preferably in the form of an aeroplane suspended in mid-air and adapted to rock from side to side. The lower wing of the stand forms a floor for the shooters to stand on and a set of steps lead to the end portions of this floor so that the shooters can board the "aeroplane" readily.

Various mechanical means may be employed for suspending the shooter's stand and for imparting a rocking thereto, for instance, as shown in the drawings, the floor on which the marksmen stand is hung at its ends on upwardly extending rods, connected at their upper ends with the cranks attached to crank shafts journaled in suitable bearings arranged on brackets and attached to an overhead beam extending along the ceiling of the gallery. The crank shafts are provided with bevel gear wheels meshing with a second set of bevel gear wheels secured on a shaft driven by an electric motor. When the motor is running then a rotary motion is transmitted by the gearing described to the shaft and cranks, whereby a rotary motion is given the links and imparting a sidewise rocking motion to the shooter's stand, as will be readily understood by reference to the illustration.

The rear of the suspended stand is provided with propellers driven by a sprocket wheel and sprocket chain mechanism from an electric motor mounted on the floor, and the propellers are preferably inclosed in a wire netting protector. When the motor is running a rotary motion is thus given to the propellers, whereby an air current is induced in a lengthwise direction, producing a very realistic aeroplane effect to the shooters standing on the floor as well as to the onlookers in front of the shooting gallery.

Each of the miniature aeroplane targets is provided on top with an eye detachably engaging the return bent end of a holder, in the form of a rod provided with a flanged wheel, traveling in an endless slot formed in the target background extending across the gallery in the rear of the targets. The rear end of each holder is attached to an endless traveling sprocket chain passing around a series of sprocket wheels located in such a position as to guide the sprocket chain along the slot as is readily understood. A suitable electric driving motor is connected with one of the sprocket chain shafts to impart a traveling motion to the chain and targets.

As the marksmen hit the aeroplane targets they can thus be easily replaced by an attendant located at one side of the target rack, as they are only hooked on any of the slowly moving shafts.

To give a truly realistic effect to the whole affair the inventor mentions that a moving cloud panorama can be flashed on the target board, so that the resemblance to the "real thing" will be greatly heightened thereby. Also it is not necessary to have the shooting gallery in the open; it can be very effectively placed in an enclosure so that a moving earth panorama can be projected on the floor between the plane and the target.

A 100-MILE ELECTRO-MAGNETIC GUN.

(*Continued from page* 81)

has a possible range of 90 to 100 miles when properly designed and elevated to a maximum range angle of 45 degrees. The principle of the electro-magnetic gun is best understood by reference to the line drawing here shown. Prof. Kristian Birkeland, inventor of the gigantic solenoid gun mentioned, his patent being dated *March* 15, 1914, tried out a simple experiment to prove that his design was feasible and practical. This experiment was made with a single magnetic solenoid or coil weighing about 24 lbs., and having the dimensions given in sketch. Here is what he found: With a current of 230 amperes sent thru the solenoid, the iron rod was sucked in and propelled with a magnetic pull of 170 lbs. The heat generated in the coil at the end of *one second* was not so great but that the solenoid would have safely withstood *ten times* as heavy a current for *one-tenth second*, in which event the force acting upon the rod would be about 1700 lbs. per square inch. If instead of an iron rod a body made up of coils thru which a current is past is made use of, the magnetic suction of the solenoid may be vastly increased, points out Prof. Birkeland.

As an introductory explanation reference may be made in this connection to one of

(*Continued on page* 134)

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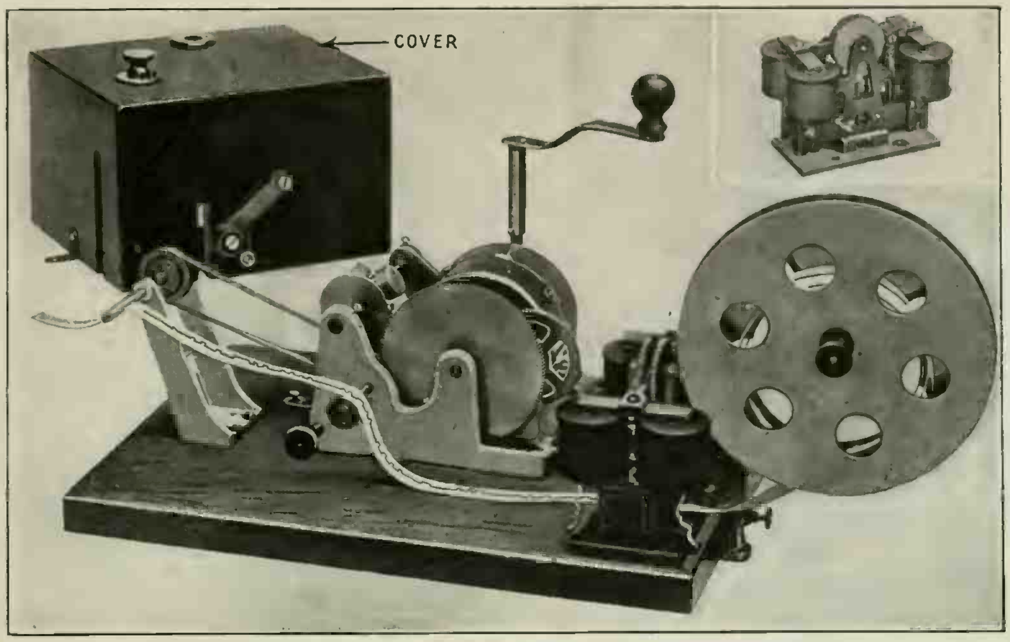

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This machine has a truly wonderful spring motor. It is absolutely silent and has a centrifugal regulator speed-adjuster and stop arrangement. **At the highest speed the motor runs 18 minutes, at the slowest speed 65 minutes continuously.** Over all dimensions of machine are 19½ x 9½ x 8½. Diameter of holes punched 1/16". The width of paper tape is ½". Aluminum reel 6½" dia. The magnets measure 1½" dia. and are 1¼" high. **The net weight of the machine is 18 lbs.** Our ills. shows machine with cover removed to show motor. The small insert shows the beautiful tandem electro-magnet arrangement, the ratchet wheels and perforating equipment. All wood work is solid mahogany.

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The receiver is our No. 1024 style with the difference that no magnet is used in the same for the reason that the function of this instrument is electro magnetic, the same as all loud-talking phones.

CEK205

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This instrument works best on two dry cells, and particular attention is called to the fact that in order to work, the loud-talker requires a fairly heavy current and for that reason thick wires must be used for connecting the transmitter with the loud-talker. If this is not done, the voice will be weakened considerably. If no heavy wire is at hand, more batteries must be used to compensate.

With this instrument **no switch is required;** if one is through talking all that is necessary is to lay the transmitter **face up,** which automatically cuts out the current.

USES: This instrument can be used to transmit phonograph music from one room to another; used as a Detectiphone; as a Radio Amplifier; as a telephone extension (by placing the regular telephone receiver against the sensitive transmitter with the loud-talker. If this is not done, the voice will be weakened at a distance; for salesmen to talk "through" window (Loud-Talker outside in street, microphone transmitter for salesman, talking into same); for restaurants for talking to the chef, and a hundred other uses. Many young experimenters are developing a lucrative business selling this appliance to various merchants at a good profit.

Outside of the two instrument parts, one three foot cord is furnished with sensitive microphone as shown. Blueprint, instructions, etc., are furnished.

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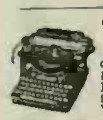

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A 100-MILE ELECTRO-MAGNETIC GUN.

(*Continued from page* 132)

the small line drawings herewith, showing a simple three coil electro-magnetic gun, and undoubtedly the reader will then be able to grasp, with the aid of the following explanatory remarks, about how the various inventors of the electro-magnetic guns intend hurling their projectiles at the enemy with astonishing rapidity and accuracy.

For the sake of simplicity, we may consider that but three electro-magnetic coils are in use as at 1, 2 and 3 along the gun barrel. It may be said that invariably such a gun barrel should have an inner lining of brass or bronze, so that the projectile which is usually made of a magnetic material (such as iron or steel), will not bind within the barrel. The barrel proper can be made of iron properly divided, but an all-brass barrel is common. Now consider that the three magnet coils, 1, 2 and 3, are connected up to a switch as shown. If, then, an iron projectile is placed in the position A, and the current caused to flow thru the coil 1, the electro-magnetic field of force set up within the gun barrel will tend to pull the projectile forward in the direction of the arrow. It should be mentioned before going further that the iron barrel (if used) of the cannon or gun is divided up into several distinct sections so as to localize and intensify the magnetic pull on the projectile at each new impulse.

When the projectile has reached the position of coil 1 the control switch is moved so as to cut out coil 1 and to connect coil 2 into circuit. If this is done quickly the projectile will have been *sucked forward* on a line with coil 2. The operation is again repeated and the switch is moved so that coil 3 will be put into the circuit and coils 1 and 2 opened. Thus the projectile will again be pulled forward to section 3, and at the instant it reaches the center of the *final coil* the current is cut off and the momentum acquired by the projectile is relied upon to carry it on and out of the muzzle of the gun at B.

In one of the illustrations there is shown a probable development of a large electromagnetic field gun mounted on a massive iron frame-work fitted with large caterpillar wheels, as observed, so that it is mobile enough to be quickly hauled from one place to another on the battlefield or for siege purposes. When used for portable requirements it will invariably be necessary, if such guns are ever adopted, to provide a complete portable electric, generating plant as is shown in the picture. This would comprise a powerful gasoline engine direct connected to a suitable electric dynamo.

Some idea of the probable size of such guns may be obtained when it is stated that one of the best designs ever worked out on this principle, and due to Prof. Birkeland, has a barrel 90 *feet in length.* The projectiles used in this gun would be about 9 *feet long* and have a *diameter of* 19 *inches.* Also to gain the maximum magnetic pull by this arrangement it is recommended that the projectile be wound with coils of wire so as to be electro-magnetically reactive in conjunction with the regular magnetic disc coils placed along the barrel of the gun as perceived. It is estimated that the shells would have to leave the gun barrel with a velocity of 4,000 ft. per second. In order to facilitate the passage of the projectile thru the barrel of the gun with the least friction we strongly suggest that suitable lubrication be provided by means of grease or oil cups placed along the barrel at intervals; these may be observed in our illustration.

It must be remembered that these guns would not heat to any appreciable extent and not at all compared to the heat produced in the modern high powered guns using explosive charges of powder. Due to this and other obvious reasons such a gun as this can fire a great number of larger caliber shells per minute, possibly

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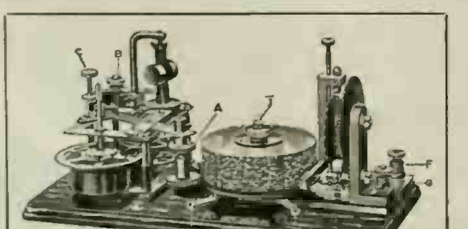

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fifty to seventy-five shells in one minute. It will be seen from the foregoing that such a discharge of 19-inch two-ton shells, each of which contains a 1,000 lb. high explosive powder charge, would serve to quickly rout the enemy, no matter how well he might be entrenched or ensconced behind fortified embankments. A rain of such monster shells would batter down almost any fortification whether natural or built by man.

A method is suggested in the illustration of this electro-magnetic gun whereby a constant supply of shells for rapid firing can be always maintained before the open breach of the gun. The shells might be hoisted by means of a gasoline engine and run on the platform at the left and then allowed to slide by gravity down the inclined chute. As fast as one of the shells is sucked into the breach of the gun barrel it is followed by another one right after it successively. It is easily possible to have means of firing the shells as far apart, in respect to time, as is deemed advisable, of course. The electric current supplied thru the coils along the gun barrel can be controlled thru a suitable switch by the man aiming the gun and who may be located alongside of the breach of the monster as indicated in our illustration.

The second large electromagnetic gun illustrated in the line drawing is a design suggested by Mr. Paul T. Kenny, a New York electrical engineer. This basic design principle is similar to Prof. Birkeland's, namely, to apply a very large electric current to the magnet coils surrounding the gun barrel for a fraction of a second, or in other words to create an enormous magnetic suction to act on the projectile before the magnet coils have had time to heat up, *time* being one of the factors governing the heating effect in any case. The shorter the time the current is on, the less the amount of heat produced. Thus does it become possible to overload the coils on the magnetic gun 10 to 12 times their normal current carrying capacity, and as pointed out before to thus realize a corresponding increase in the strength of magnetic field produced.

Mr. Kenny says that he offered it to the United States Government in 1908, and proposed to throw a shell *ninety miles,* from New York to Philadelphia, to prove what it could do, but his offer was refused, on the ground of "no appropriation." Subsequently Mr. Kenny went to Berlin, where he was associated with Ambassador Gerard, and in 1913 he submitted his invention to the German military authorities. The latter acknowledged its practicability and asked him to supervise the construction of one of the war terrors at the Krupp works in Essen. Pressing business interfered and Mr. Kenny, leaving the secret of his terrible weapon behind, returned to the United States. He is confident that the Teutons may be preparing or have already used an electro-magnetic cannon of giant size built on the design he suggested at that time.

Mr. Kenny gives the following description of his invention:

"The gun itself is a huge telescope shaped funnel of steel from 200 to 300 feet in length, open at both ends and supported by struts of steel in bridgework construction so that the broader end, which is the muzzle of the gun, is elevated and movable. This funnel is nowhere near the weight of a sixteen-inch gun, for there is no strain on any part of it during 'firing' except that of its own weight.

"This gun is wrapt from the breech to the muzzle with coils of wire, thru which electric current from a dynamo may pass. The coils at the breech are of very fine wire capable of producing an electro-magnetic force of five horse power. The next set of coils are of heavier wire to carry heavier current, and so by progression the strength of the coils increases until at the muzzle the fifteenth coil would possess a throwing force of 83,920 *horsepower!*

"The shell, which is constructed so that the action of the magnetic force upon it will cause it to revolve without the necessity or rifling the bore of the gun, is introduced into the breech. The operation of the current in the first coil throws it forward, and the shell itself closes connection by a tripper or trigger set in the bore. It passes under the influence of the next coil, with the momentum already gained—and so on until the last and greatest thrust forward comes from the coil possessing 83,920 horsepower. With terrific muzzle velocity the shell then soars on its high trajectory toward the object to be destroyed."

The map illustration shows the frightful range of one of these 90 to 100 miles electro-magnetic cannon. It could, if located on Staten Island, in New York harbor, bombard Atlantic City, Philadelphia, Camden, Poughkeepsie, New Haven, and hundreds of interlying cities, such as Trenton, New Brunswick, Elizabeth, etc. The day of the 100 mile electro-magnetic gun may not only be near, but actually present. The Teutons keep their secrets well.

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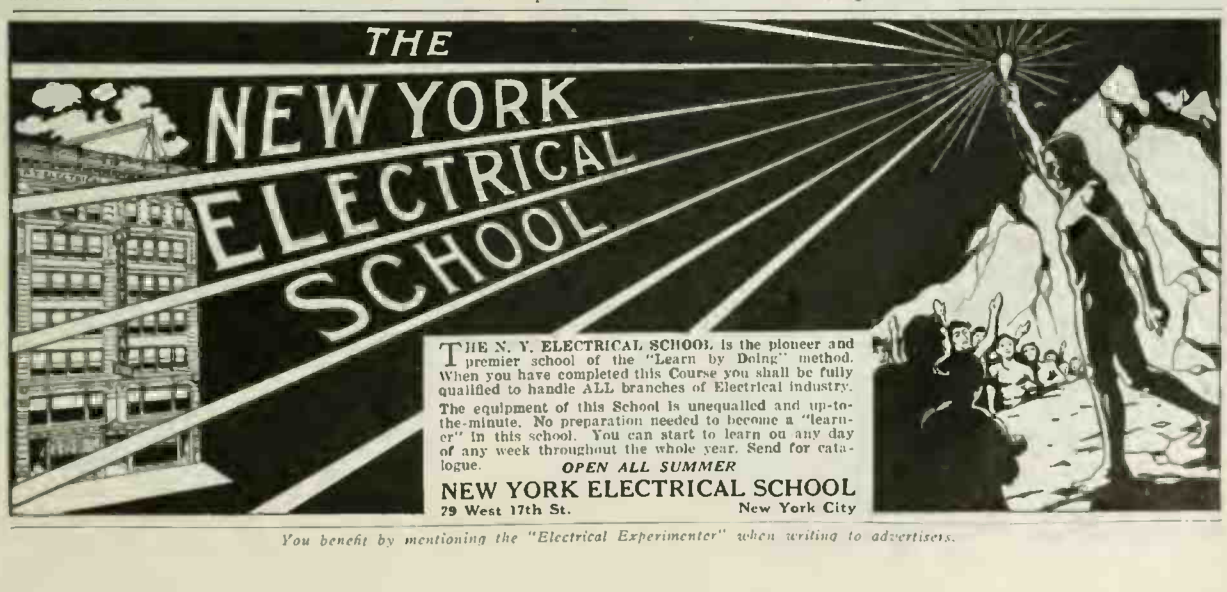

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(*Continued from page* 88)

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(*Continued from page* 78)

from a powerful arc lamp is projected thru the galvanometer and in a greatly magnified form throws the shadow of the moving wire on the steadily moving film behind a narrow horizontal slot.

The film passes thru the camera at the rate of 20 images per second, while its movement thru the sound recorder is continuous, for the reason that it is not feasible to reproduce images and sound records side by side.

The string galvanometer has received much thought and attention as to its design as it really is the heart of the invention. In the earlier form the inventor used a single wire which made a record similar to the small piece of film shown herewith. In his more recent form use is made of two wires. When current passes thru them they operate in opposite directions, so that a double row of sound waves are recorded with the points of the peaks facing each other.

In projecting the film with the sound waves on the same it has been found that these various dark and light portions of the sound lines will influence a selenium cell, which in turn will operate a suitable form of acoustic receiver or reproducer. The film in showing, passes thru the projector proper at a slight increase of speed (the regulation film runs at 16 images per second, while Mr. Lauste's film runs at 20) and then thru the sound reproducer.

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HOW TO AVOID ELECTRIC SHOCKS.

(*Continued from page 82*)

may lie on a sidewalk or street in a very harmless looking manner.

If a person has been caught by a live wire and conditions demand that you try to relieve them, the first thing to do is to endeavor to remove the wire from the body, if it is coiled about the victim, by means of a dry stick of wood several feet in length, or, cases have been recorded that such a rescue was made by means of a dry coat or other cloth, if several thicknesses of the cloth are used, when a person may in an emergency grasp such a live wire, if it is not carrying too high a voltage, say not over 3,000 volts, and pull it from the victim's body. If possible, a person attempting such a maneuver should in every case endeavor to insulate himself from the ground by all means, such as by standing on a piece of dry wood, or on a coat, or several thicknesses of heavy dry paper. Rubber gloves, such as linemen use or even heavy leather gloves will often serve to release the wire from the victim, and rubber boots are also effective in such a contingency. Another word of caution is that when a person is in touch with such a high potential wire, their body is at a similar potential, and therefore, the would-be rescuer should not touch the victim's body or clothing without taking the aforementioned precautions.

Persons have been fatally shocked when using a telephone after a storm as our artist has portrayed in Fig. 6. Such a shock may be received due to several reasons among which are the following: A severe electric (thunder) storm may cause a strong lightning surge to be set up in the telephone circuit, and the current due to this surge may give rise to a dangerous potential being manifested at a subscriber's telephone apparatus momentarily, or just at the moment when a person might remove the receiver from the hook and attempt to use the instrument. Another cause for receiving fatal shocks of this nature, and which are on record, is due to the fact that in suburban districts particularly, it is the case now and then that the heavy wind of a storm may blow down a high potential feed wire, so that it crosses a telephone wire, in which event a telephone circuit would be charged with a dangerously high voltage current as becomes evident, and a person using a telephone instrument might innocently become the victim of such circumstances.

The women folks are gradually becoming more attached to the excellent facilities afforded by the use of electric toilet appliances, etc., and in Fig. 7 we have illustrated a condition which might occur, in which a lady would receive a shock thru her body by placing her feet on a radiator or heating register, when an electric curling iron is used. Ordinarily of course, these electrical appliances are thoroly insulated when manufactured and rarely break down. It is the exception and not the rule we wish to point out, that electrical appliances break down so that the outer covering or metal shell of the apparatus becomes what electricians term *grounded, i. e.*, when the insulation breaks down between the electrical heating or other circuit inside the apparatus, and allows the current to leak across the metal enclosing shell.

The apparatus in this condition is liable to give users thereof a surprising shock if they happen to permit their body for a moment to get in contact with any grounded piping.

Boys will be boys, but we cannot too strongly caution the young dare-devils among the rising generation not to throw a wire over trolley lines! The writer can remember when he had this same big idea when he was a boy ten years of age; it is invariably the case for a youth of this age to want to do unusual things. "Always something spectacular" is their unvarying motto it seems, and many a boy has met his doom thru just such tactics as this, *viz.*, by throwing a wire or even a wet string over a trolley line, and tho he does not stand on the trolley track (thru which the current on trolley systems is returned to the power house and which completes the circuit from a trolley wire in any case), but on the ground alongside the track, he is quite likely to receive such a severe shock that it may prove fatal. Trolley systems usually employ a current of 550 to 600 volts potential, and a shock from this current or even a part of it may prove fatal. Horses have frequently succumbed to a shock of this kind due to a falling trolley wire, or by their coming in contact with a fallen trolley conductor. (See Fig. 8.)

Illustration Fig. 9 shows how the "live" *third rail* is applied in numerous electrified railroad systems, and which is also found on many city electric traction systems such as in the subways and on elevated roads. There are a few pertinent facts concerning *third rails* which everybody should study next to the Bible, and these are the following:

Remember first that a current of *600 volts potential* and in some cases a higher potential *is always present between the third rail and either one of the regular car rails* lying adjacent to it, and therefore never step on a third rail under any condition! If you do, you will quite possibly receive a full 600-volt shock thru your lower extremities, the current passing from the third rail up thru one leg, thru the lower abdominal organs, with a chance of reaching the victim's heart and killing him, and out thru the other leg to the car rail. You do not have to stand on a third rail and a car rail to receive a very unpleasant or dangerous shock, for if you happen to touch the third rail with one foot, with the other foot on the ground or a wet wooden tie, you are liable to receive a thoroly sufficient *leak or shunt current* in this way also.

In this connection, we might mention a little dialog which occurred a few years ago between two men who were standing on an elevated railroad plaform in New York City, and which is moreover scientifically correct, but a "stunt" which we do not recommend anyone to try, for it is always fraught with danger. One of the men bet the other that he could walk on the third rail without receiving any shock. His friend took up the bet, and true to his promise the first bettor proceeded to win the bet as follows: He jumped from the station platform down to the roadbed—from the roadbed he jumped on the third rail, and took a few steps along it—then he jumped off the third rail with *both feet simultaneously* back on to the roadbed, and thence climbed up to the platform and collected his bet. He never received any shock of course, whatsoever, owing to the fact that when he stood on the third rail, he did so with *two feet* and not with one foot on the ground or in touch with any other oppositely charged electrode or body. This also explains how a bird can alight on high tension wires, which people frequently are amazed at. The answer is simple, as in the above case. This is so for the reason that to receive a shock you must be in contact with *both* the *positive* and *negative* sides of a circuit, or in other words, you have got to complete a circuit charged at a certain potential to the op-

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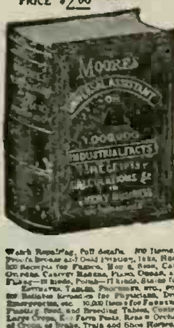

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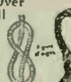

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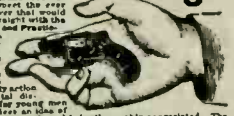

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posite side of that circuit charged at an opposite potential.

In Fig. 10 there is shown a very common way in which persons working in factories and particularly in foundries and similar shops provided with earth floors receive shocks, as under these conditions they will frequently and carelessly touch the "live" blade of a switch in starting up a motor, or they may allow their fingers to get in contact with "live" metal parts on motor starting boxes, speed controllers, etc. Under this condition they receive a shock which sometimes proves fatal, the current passing from the live metal part of the starting box, which they happen to touch, down thru the body to the earth on which they are standing, and thence back to the opposite side of the circuit thru the usual ground connections of such systems. The rule to follow here is—to always stand on a piece of dry board, a wooden box or several thicknesses of dry paper; further they should always be careful not to touch any "live" parts of the switch or starting box.

Electricians and others often receive disagreeable shocks while repairing dynamos and other machinery as well as electric light sockets when they sometimes have to stand on an earth floor as in foundries and in other locations, when the danger of receiving such a shock may be readily eliminated by standing on a piece of dry board or several thicknesses of dry paper.

The writer recollects a very peculiar case when an electrician attempted to repair a live electric light socket in a fish market—but this is no fish story, and can be vouched for. The electrician had to climb up on something in order to reach the socket, and grabbed hold of several small convenient boxes which he placed one on top of the other, and these he placed in turn on a large marble slab which was used in the fish market for cleaning fish. Well here's what happened in a few words, and a more surprised electrician you never saw. The boxes looked thoroly dry, and they were dry to all appearances, but when he mounted the third box and touched one side of the socket connection he got a severe jolt, which of course at once told him that he was receiving a shock thru his body to earth, but how? The answer was soon evident on a little reflection. The marble slab, owing to frequent usage, was thoroly impregnated with salt brine as were also the boxes. The problem was solved by going outside on the street and purchasing a couple of newspapers for two cents. Going back to the job on hand, the electrician folded the papers several times and placed them on top of the uppermost box. No more shocks were received after thus solving the problem.

It has often happened that firemen have been severely shocked or killed while fighting fires, when a stream of water happened to come in contact with high tension electric light wires. The illustration herewith, Fig. 12, shows how a fireman, or in fact any person using a hose such as a garden hose for instance, may protect themselves against such a contingency by not touching the brass nozzle of the hose. They should be careful to keep hold of the rubber hose which must not be wet and which will act as an insulator, but if they grasp the brass nozzle, and in case the stream of water touches the electric light wires on the house, etc., a current is liable to pass along the stream of water, and if it touches the nozzle it may pass thru his body to earth. It frequently happens that high potential feed wires pass in close proximity to houses, carrying as high as 2,500 to 5,000 volts, and thus it is possible for a person fighting a conflagration under

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such conditions to receive a very severe and indeed fatal shock.

Therefore, in endeavoring to avoid electric shocks—*always think first*, then act. Don't take chances with electric wires, fittings or apparatus. If you walk along a road and see a wire down, which you believe to be "alive" and dangerous to other people, report the matter to the police, or better still notify the electric power company of the trouble and its approximate location. They will shut off the power in most cases at once, and send a repair staff to the spot.

POWERFUL ELECTRO-MAGNETS —WHAT THEY CAN LIFT.

(*Continued from page 89*)

at 40 to 60 miles per hour, and to niftily haul them out of the water before they can hit the vessel's hull and damage it. The torpedo in the first place is backed by a 200 H. P. compress air engine and, traveling at express-train speed, its momentum can readily be imagined. Such a powerful magnet as here described would not deflect a modern automobile torpedo to any practical degree, by any known application of the magnetism produced by it, is the firm opinion of the Naval experts.

With these large magnets the attractive force on a steel plate is not as great as the layman would expect, on account of the small cross section in the plate available for the magnetic flux. Many schemes are presented to us for recovering sunken vessels by means of such large magnets acting on the plates. The large magnet here described acting on a plate 5 to 6 inches thick in contact with the magnet, would have an attractive force of about 100,000 lbs. On a ¼" deck-plate, however, this lift would probably not exceed *10,000 lbs.* See Figs. D and E. The effect of decreasing the thickness of the piece to be lifted is thus clearly illustrated. Thin plates cannot carry sufficient magnetic flux to render the magnet efficient. The heavy plate can carry more of the total flux produced by the magnet, hence the combination acts more efficiently. In the case of the thin plate, a large proportion of the flux is wasted by leakage thru the air, hence, the lesser lifting power.

With a 1-inch steel plate, covering about the same area as that of the magnet, the lift would only be somewhere between *one and two feet*. The same "lift distance" would apply to the *60- to 100-lb. steel billet*, illustrated at Fig. F.

[EDITOR'S NOTE:—*As pointed out elsewhere in this issue, particularly in the article on "Magnetic Guns," it is possible to greatly increase the strength of electromagnets momentarily by overloading them for a few moments. Prof. Birkeland, inventor of the most efficient magnetic gun design yet devised, thus manages to set up an ultra-powerful magnetic field for the fraction of a second by greatly increasing the current past thru the magnetic coils. In most practical applications of the electromagnet, however, this "flashing" of the magnet current is of little or no utility. A steady, even pull is most always desired and provided for.*]

THE PHENOMENA OF ELECTRICAL CONDUCTION IN GASES.

(*Continued from page 94*)

INCANDESCENT SOLIDS.

When metallic wires are heated to incandescence ions are produced. At low temperatures positive ions are usually given off and at higher temperatures negatives are also emitted. J. J. Thomson explains the *production of ions by incandescence* by saying that there must be free electrons in the metal which, when their kinetic energy is increased by the heating of the wire, finally break away from the wire as free negative ions. The production of the positive ions is more difficult to explain, as many experiments seem to show that they are not uniform in size, sometimes being much larger than molecules. Evidently the heat and electrical energy together causes a disintegration in the wire itself which sets these particles free. C. T. R. Wilson devised a very clever experiment to show the existence of these particles about an incandescent filament. First he surrounds the filament with moist air which he then allows to expand. At this point a visible cloud appears around the filament showing that in the neighborhood of the filament there are particles of matter thrown off by it, about which the moisture condenses to form the small visible drops of the cloud.

The salt of most any metal will produce ionization if thrown in a flame. Many phosfates, nitrates, and chlorides give off positive ions when heated. On the other hand, many other compounds give off negative ions freely, such as the oxides of barium, strontium, calcium, etc. A carbon filament as distinguished from most metallic filaments also gives off electrons when heated. It is this principle upon which the *Edison effect* depends, in which a current can be made to go from a separate electrode to an incandescent carbon filament, but not in the opposite direction. Something similar to this effect is also found in *electric arcs*.

ELECTRIC ARCS.

Dr. J. A. Fleming, who made a study of the Edison effect in carbon filaments, also made a special investigation of electric arcs, in which there are very great numbers of positive and negative ions. He found the positive pole to be worn out in a crater shape due to electrons emitted by the cathode striking it and dislodging large positive particles. He further found that to get a current to flow between the anode A and cathode C, Fig. 3, it was not necessary that both poles be incandescent and giving off ions. Fleming explored the arc with an auxiliary pole E, and he found that while the arc was burning he could get a current between E and C but not between A and E, keeping E cold. In other words, he could get a current between two carbons when one was giving off negatives, but not when one was giving off positives. This he interpreted to show that comparatively few positives are given off and that the negatives carry most of the current. Such ions as these in electric arcs are very interesting on account of the number present and the fact that they are of various types. It seems that the *negatives* are usually *electrons*, and the *positives* are frequently *clusters or groups*.

COLLISION.

Early scientists decided that if the pressure of a gas never decreases, the collisions of the molecules must be perfectly elastic, and this seems to be true at ordinary velocities. However, if two particles are moving fast enough collision will cause them to produce ionization, and the amount of energy which such a particle must possess represents what is called the *ionizing energy*. Furthermore, a modern scientist, Hertz, has proved that if a moving ion just

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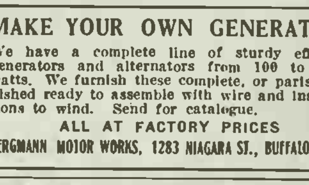

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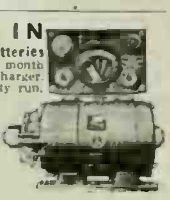

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has this much energy, its collision will be inelastic and it will become inert. That is to say, if an ion has that much energy or less it will not be reflected upon collision. If it has more than that amount of energy, reflection will take place, and it will have some energy left over. Up to the time of this discovery molecules were always thought to be perfectly elastic, and if at times they are not, this information should add quite a little to our knowledge of the constitution of matter.

Franck and Hertz proved the matter in this way. They took a tube such as in Fig. 4, containing a platinum filament AA, from which ions are given off. A battery B is arranged so as to force the ions with a certain velocity toward a screen CD. If the battery does not give them sufficient velocity to produce other ions by collision before reaching the screen, then they will be projected back on the plate E, behind the screen which will become charged, and produce a deflection on the galvanometer G. If, however, the battery pressure is increased until the ions have enough energy to produce other ions by collision just before reaching the screen, the ions will become inert on collision. That is they will become inelastic, will stop suddenly and not reach E, hence the galvanometer will, just at this point, be undeflected.

Every such fact as this about matter, either in the form of *ions*, *atoms*, or *molecules* gives us just that much more of a glimpse of the real nature of matter and that much more knowledge concerning its fundamental constitution.

THE DESIGN AND USE OF THE WAVE-METER.

(*Continued from page* 102)

smaller than necessary and this is shunted by a small adjustable fixt air condenser which allows the ratio of maximum to minimum capacity to be so adjusted as to fit the scales which are standard for all instruments.

Since it has been shown that the capacity of the instrument varies in accordance with the law of geometric progression, the term $\frac{C_r - C}{C}$ in the formula.

$$(17)\quad \delta_1+\delta_2=\pi\frac{C_r-C}{C}\sqrt{\frac{I_2}{I_r^2-I^2}}=\pi\frac{C_r-C}{C}$$

$$\text{when } I^2=\tfrac{1}{2}I_r^2$$

will remain constant for any given angular displacement of the rotary plates thruout the range of motion from 0° to 180°.

By means of a mathematical treatment which the interested reader can find in the original paper the author shows that various decrements are equivalent to various angular displacements of the condenser.

A simple way to show this is to examine equation (11), which demonstrates that the capacity is dependent on the angular displacement of the plates, and since C is proportional to θ, substituting in (17) we can see δ is proportional to θ.

The author then works out in several cases the angular displacements proportional to decrements of .05 to .3, and finds that the angular displacements vary from one to eight degrees. In order to make the scale of decrements easier to read, the scale is geared to the condenser shaft in a 6-to-1 ratio, thereby opening the divisions on the scale in the ratio of 6 to 1. The scale has a zero point in the centre and goes to .3 on both sides.

Measurement of Logarithmic Decrement

The condenser is set at the position of complete resonance as shown by the maximum deflection on the sensitive hot-wire instrument, whose readings are proportional to I^2. The capacity is now decreased until the meter reads one-half of the former value, and the decrement scale, which can be independently rotated, is set at zero and clamped so as to rotate with the condenser. The condenser is now turned so as to increase the capacity so that the meter reading at present $\frac{1}{2}I_r^2$ will increase to I_r^2 and again decrease to $\frac{1}{2}I_r^2$. The scale reading now opposite the index mark 0 is the value of $\delta_1+\delta_2$, δ_1 being the decrement of the circuit under test, and δ_2 being the known decrement of the instrument.

By referring to the second article of this series, we see from the resonance curve that the rate of change of capacity at the points corresponding to $\frac{1}{2}I_r^2$ are greater than at the point corresponding to I_r^2; therefore, any decrement formula eliminating the necessity of locating the point corresponding to I_r^2 is to be preferred, since the points corresponding to $\frac{1}{2}I_r^2$ are more sharply defined.

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The method of measuring the decrement just explained makes use of this very property and involves the formula:

$$\delta_1+\delta_2=\pi\frac{C_2-C_1}{C_2+C_1}$$

which has been explained in a previous paper. C_2 corresponding to capacity above resonance, giving current $\frac{1}{2}I_r^2$, and C_1 being capacity below resonance, corresponding to $\frac{1}{2}I_r^2$.

Fig. 4 shows a schematic diagram of the circuit of the *Kolster decremeter*. I is a single-turn coil which may be connected in the antenna circuit under test, and since the inductance of this coil is small as compared to the total inductance, the tuning adjustment will not be changed in the majority of cases.

The coil L is the inductance of the meter, either one of the three coils furnished to cover the various wave-length ranges of from 300 to 2500 meters may be used. Coil L is so arranged that the mutual inductance between it and coil I can be easily varied. In order that the measuring circuit has no reaction on the circuit under test, and also that the hot-wire instrument H is not damaged by excessive current, the coupling between I and L must be kept very small.

C_v is the variable condenser, independent of which the wave-length scale is attached, and to which the decrement scale is geared. In parallel with C_v is a small condenser, C_f, which remains fixt after proper adjustments, *i. e.*, after the pointer reads wave-length correctly.

H represents a hot-wire watt-meter, or

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current-squared meter, while K is a short-circuiting device which prevents current from the buzzer battery E from damaging the meter whenever the circuit is excited by the buzzer B.

By means of the switch S either the buzzer B and battery E, or else the crystal detector and telephones T can be connected to the instrument for calibration purposes.

Since the capacity of the condenser in this instrument varies according to a definitely known law, it is possible to attach to the condenser a predetermined scale indicating wave lengths directly. The graduations are determined by calculation in the following manner:

Knowing $C = ae^{m\theta}$ (Eq. 11)

Wave length λ is proportional to $\sqrt{C}$

λ " " " $\sqrt{E^{m\theta}}$

or λ " " " $E^{\frac{m\theta}{2}} = E^{n\theta}$

—where $n = \frac{m}{2}$

Let λ_1 be any wave length within the range of the meter and λ_2 any other λ desired.

$$\text{then } \frac{\lambda_1}{\lambda_2} = \frac{E^{n\theta_2}}{E^{n\theta_1}} = E^{n(\theta_2 - \theta_1)}$$

$$\text{and } \log \frac{\lambda_2}{\lambda_1} = n(\theta_2 - \theta_1)$$

$$\text{or } \theta_2 - \theta_1 = \frac{1}{n} \log \frac{\lambda_2}{\lambda_1} = \frac{2}{m} \log \frac{\lambda_2}{\lambda_1}$$

Therefore:

$$\theta_2 = \theta_1 \pm \frac{2}{m} \log \frac{\lambda_2}{\lambda_1}$$

Supposing λ_1 is any wave length, say 600 meters. Let θ_1 be O°, for convenience, then:

$$\theta_2 = \pm \frac{2}{m} \log \frac{\lambda_2}{600}$$

Showing θ_2 can be calculated for any wave length λ_2.

In the actual instrument the scale can be moved about the shaft of the condenser, but can be clamped in any position. On the shaft of the condenser is a pointer which moves over the scale.

The condenser is set at 180° and the pointer is set at the mark corresponding to the coil in use; then, as the condenser is rotated, the pointer shows directly the wave length on the scale.

The calibration of this instrument is a very interesting procedure, and from a manufacturing viewpoint ideal. The decrement and wave-length scales are previously engraved as a standard for all instruments. The fixt condenser in shunt to the variable condenser is adjusted so as to make the decrement scale read correctly, then the marks 1,—2, and 3, are stamped on the wave-length scale in the position the pointer is in, when the condenser is at 180°. These points are determined experimentally, and the pointer reads the wave-lengths correctly over the respective ranges of the various coils.

When the instrument is used as a receiver with detector and telephones, or as a transmitter using the buzzer, the wave-length scale does not strictly apply for the wave-length range below the 90° position of the condenser. In these cases it is necessary to refer to calibration curves for the small correction.

An interesting point to remember in using a wave-meter, detector and telephones on undamped waves, is to start the buzzer and receive the harmonics of the arc, etc., by the heterodyne effect produced by the buzzer and exciting circuit.

We see from the above discussion what an exceedingly simple and ingenious device the *Kolster decremeter* is, and great credit is due to Mr. F. A. Kolster for his unique development of the theory of this instrument. By his pioneer work along this line he has made the tuning of ship transmitters by government inspectors a very simple and rapid process and eliminated to a large extent the long periods of interference due to the key being deprest for lengthy periods while taking a tedious series of readings.

While the object of this series of articles was primarily to develop the theory of the decremeter and wave-meter in the simplest possible terms and with the most elementary mathematics, the author considers the *Kolster decremeter* such an important piece of modern radio engineering research that the student is amply repaid for the time spent in going over the theory of this instrument.

I have tried to handle this complex subject in as simple a mathematical way as possible and have only brought in higher mathematics in places where it was absolutely needed.

The concluding article of this series will be, I am sure, the most interesting to the average reader, and will give a complete set of instructions for making all tests that can be made in a laboratory with a decremeter or wave-meter.

(To be Concluded.)

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Before me, a Notary Public in and for the State and county aforesaid, personally appeared Hugo Gernsback, who, having been duly sworn according to law, deposes and says that he is the Editor of the ELECTRICAL EXPERIMENTER and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc, of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, The Experimenter Publishing Co., 233 Fulton St., New York City; Editor, Hugo Gernshack, 233 Fulton St., New York City; Managing Editor, H. W. Secor, 233 Fulton St., New York City; Business Manager, Hugo Gernsback, 233 Fulton St., New York City.

2. The the owners are: The Experimenter Publishing Co., 233 Fulton St., New York City; Hugo Gernshack, 233 Fulton St., New York City; Sidney Gernsback, 233 Fulton St., New York City; Mrs. K. Hymes, 3800 B'way, New York City; H. W. Secor, 233 Fulton St., New York City.

3. The the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company, but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

H. GERNSBACK.

Sworn to and subscribed before me this 3rd day of April, 1918.
ROBERT R. VELIE,
(My commission expires March 20, 1920.)

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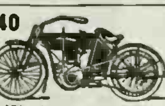

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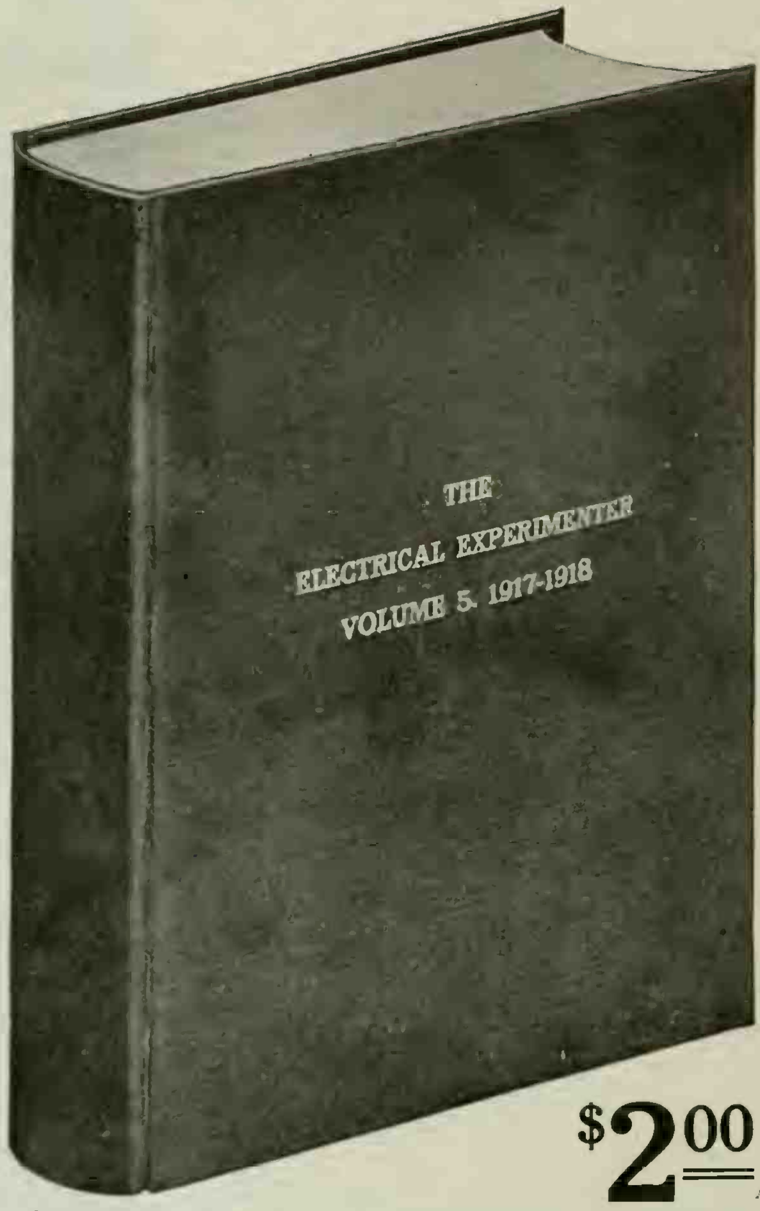

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FIRE SALE OF SLIGHTLY DAMAGED BOOKS. Due to fire in our stock rooms, a great many of our books were water stained, but not otherwise damaged. Rather than dispose of them to dealers we prefer to give our readers the benefit. Look at this list! Our celebrated Wireless Course, 160 pages, 400 illustrations; Experimental Electricity Course, 160 pages, 350 illustrations; How to Make Wireless Sending Instruments. These three books for $1.00 prepaid. Regular selling price of these three books is $2.50. We guarantee you will be satisfied. Experimenter Publishing Co., Inc., 233 Fulton St., New York City.

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Dec.	"	"	"
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Dec.	"	"	"
1917.			
Jan.	"	"	$.35
Feb.	"	"	"
March ..	"	"	"
April ...	"	"	.20
May ...	"	"	"
June ...	"	"	"
July	"	"	"
Aug. ...	"	"	"
Sept. ...	"	"	"
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Nov. ...	"	"	"
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We can fill orders at once upon receipt of your remittance, and if you have not these numbers already now is your chance to get them, as they probably will be snapped up very quickly. Experimenter Publishing Co., 233 Fulton St., New York City.

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HELP WANTED

BOYS—We want you to distribute our seeds, good pay to the right kind of boys or girls. Write at once. Palm Villa Greenhouses, Pierson, Fla.

MOTORCYCLES

MOTORCYCLES FROM $25 UP—New and second-hand. Easy terms, large list to choose from, all makes. Send 4c stamps for Bulletin "A." Peerless Motorcycle Co., Watertown, Mass.

Do These Ads Pay ?

Here is one live enterprising firm who found the results from the classified columns of the "Experimenter" so remarkably good that they have enlarged their copy and are taking display space.

Montclair, N. J.
149 Valley Rd.
April 22, 1918.

Advertising Dept.,
Experimenter Publishing Co.,
New York City.

Gentlemen.

Enclosed please find copy for the June, 1918, Issue of your Journal. Kindly display this "ad" in space of 1 inch by 1 column.

The results already obtained are very satisfactory, and we trust that those in the future will warrant our taking larger space.

Thanking you for past favors, we are
Very truly,
JOHN F. O'BRIEN.

MISCELLANEOUS

GENUINE DIAMOND GLASS CUTTER, ONE DOLLAR. Leo Hirsh, Elkhart, Indiana.

EXPERIMENTAL GOODS—Send stamp for list. Laskaris, Union City, Pa.

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SPRING CALIPERS—Inside, Outside Dividers, 4-inch size. Set of three, $1. Money-back guarantee. Every mechanic needs this set for accurately working. LARKIN COMPANY, 1988 Bedford Ave., Brooklyn, N. Y.

SEVENTEEN SALES-LETTERS—Constructed by 17 Experts for 17 Business houses in 17 different lines, " pulled" Big Business. Adapt them to yours. Cost, $5. Will sell all 17 for $1. Victor-King Co., 36 Bromfield St., Boston, Mass.

AMATEURS, ATTENTION!!! We have on hand a small quantity of slightly damaged pure Bakelite bases. Bases are new, except slightly imperfect at one side, edgewise.
Size 5½x7¾x¼ inch thick. Each 50c.
Size 4¾x4¾x¼ inch thick. Each 30c.
Send sufficient amount for postage. Electro Importing Co., 231 Fulton St., N. Y. C.

BIG BARGAIN IN TENNIS RACKETS—We have a small supply of Tennis Rackets, made by one of the largest firms in the country, on hand which we will close out at the following prices:
No. 2375—Extra best Tennis Racket, $5 grade, air dried ash, popular long oval form, concave walnut wedge, superior quality of gut; each, $2.75.
No. 2377—First grade Tennis Racket, second growth ash, walnut and maple throat, very good grade of gut; handle of cedar with leather cap; a $3.25 grade; each $1.85.
No. 2376—Medium grade Tennis Racket made of the same stock as No. 2377 except the gut. A perfect $2.25 grade. Ideal for beginners. Each $1.35.
Shipping weight of each size two pounds. Send for one today. Our stock is limited and policy is: "First Come, First Served." Don't forget to include money for postage, or we ship express collect. The Electro Importing Co., 233 Fulton St., New York City.

WE HAVE a limited number of beautiful art pictures on hand of Nikola Tesla and Dr. Lee De Forest. These make a handsome decoration for any laboratory or workshop and should be prominently displayed. Price for both, prepaid, 10c. Experimenter Pub. Co., 233 Fulton St., New York City.

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5-INCH SPOTLIGHT FOR YOUR AUTO, $3.50. Complete with Lamp. Switch and Cord. POWERFUL LIGHT OVER 400 FEET. Can be used on Bicycles. Send stamp for particulars. Baer Electric Company, Van Wert, Ohio.

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SUBMARINE SIGNALING and Distant Operation of Underwater Devices by Sound Waves. Experimenters, Inventors, here is your only chance to get high grade accessories for Subsea Radio work. A new field for striking possibilities for inventions: Actuating Submarine Mines by Sound Waves; Subsea Radio, etc. Astonishingly low prices. Submarine Sound Detector, $3.75 up. Personal expert advice of renowned Signaling Engineer. Write. James Campo, 32 Nassau St., New York City.

SELL—Electrical apparatus. Christner, 1007 Mt. Vernon, Philadelphia, Pa.

INSTRUCTIONS: How to make a Bell Ringing or Toy Transformer. Send 10c coin. Lloyd Stultz, Middletown, Maryland.

FOR SALE—50 Code Learners. Used by wireless class. 10c each. Martin Flavian, Munhall, Pa.

FOR SALE—Big Bargain—Ferranti Wattmeters. 10 and 25 Amp. 220 Volt, only $2.50 each. Anderson, 618 Mulvey Ave., Winnipeg, Canada.

LOOK—$2.50 Step Down Transformers for 75c. Postage extra. Goodman Laboratory, 418 W. Court, Flint, Mich.

FIRST $9 gets my new Rotary Spark Gap 110 volt alternating current motor. Have ten one inch spark coils $1.75 each. Three two inch coils $2.25 each. High Frequency Audion Coil, $2.50. Walter Hester, Easley, S. C.

WILL SWAP $8 Oudin Transformers complete, for cameras, rifles, etc. Eisgran, 1520 St. Marks Ave., Brooklyn, N. Y.

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UNDOUBTEDLY you have at the present time some things for which you have no further use. Do you wish to exchange them for something for which you have immediate use? There is no surer and quicker way to do this than by advertising your articles in these columns. The *Very* people, the *Only* people, who could possibly have a use for your things read this journal. More than 100,000 interested people will see your ad. It is furthermore the cheapest advertising medium for you in the country. Dealers advertising accepted in Opportunity Exchange columns only.

The rates are: *Five cents per word* (name and address to be counted). *Remittance must accompany all orders.* No advertisement for less then 50c accepted.

We reserve to ourselves the right to refuse any advertisement which we consider misleading or objectionable. Advertisements for the July issue should reach us not later than May 22.

The Classified Columns of the "Electrical Experimenter" Bring Positive Results

OVER 100,000 NET PAID CIRCULATION GUARANTEED, A. B. C. AUDIT

WANTED—2 amp. 5 volt Dynamo. Shunt. Write, Fred Wagner, 1004 Starr Ave., Burlington, Iowa.

FOR SALE—Single cylinder Curtis motorcycle engine without muffler or spark coil, $11. 16 shot 22 Winchester rifle, $9. WANTED—Volumes 1 and 2 of the Electrical Experimenter magazine; either bound or loose copies. Edward Penick, 1516 Weber St., Houston, Texas.

FOR SALE—½ K.W. Transformer 250-500 volts. Will trade for motor wheel or sell. Earl Boyer, 106 Monroe, Fremont, Ohio.

AUDIONS WANTED—Several Audion Amplifier Tubes, state number and cash price. Karl Kraft, 401 E. 87th St., New York City.

FOR SALE—Fully equipped Chemical Laboratory, $10. Includes over 125 different chemicals. Write for list. Peter A. Stover, Marengo, Iowa.

SELL—SS Dynamo, Navy Coupler, Variable, etc. $10 Meccano, $5. Want Trombone case. Enclose stamp. Glenn Kruwell, Holstein, Iowa.

FOR SALE AND EXCHANGE—One set, Lydekker's Natural Histories, 6 vol., cloth in original case; one Winchester 38-55 rifle; one 43 Mauser; one double hammerless 12 gauge; one 455 Enfield Revolver; one International Correspondence Schools' Interior Wiring Course, complete. Exchange for International Auto course. Edgar Anticknap, Pilot, Butte, Sask., Canada.

TRADE—Smith Premier No. 10 for Corona typewriter, first class condition but too large for the ARMY. Lieut. Ira C. Kinney, 339th Infantry, Camp Custer, Mich.

EXCHANGE—Chemicals for good bicycle lamp and Kodak. Robert Pearsall, Chestnut Hill, Philadelphia, Pa.

EXCHANGE—Wireless and Experimental goods for two cylinder motorcycle engine, or what have you. Paul Studdard, Leavenworth, Kansas. R. 4.

FOR SALE—Fine 1 H.P. Horizontal Steam Engine, $20; Boiler, $5; 2½ H.P. Gas Engine, $18; Water Motor, $3; 4-40 Storage Battery, $3.50. Write for list of other apparatus. Anthony R. Spartana 1110 Thomsen St., Baltimore, Md.

FOR SALE—Pierce 4 cylinder motorcycle, or will sell parts; engine perfect. Want outboard marine engine. Send for list. Glenn Hall, Central Square, N. Y.

BARGAINS—Large Tesla Coil 26" spark, $12. Two Goodell-Pratt "Champion" lathes, $6 each. Lionel $10 electric train, $5.50. Two 1/30 H.P. 110 Volt A. C. motors, large Westinghouse 1/6 H.P. 110 Volt D. C. motor, 6 volt ¼ H.P. Dynamo-motor, large Minute Camera and outfit, copper wire all sizes. Other bargains. Best offer takes them. Brent Daniel, Amarillo, Texas.

"WANT TO SWAP"?

Do you realize that these "Scientific Exchange Columns" are the World's most renowned "Swap" market? "THE ELECTRICAL EXPERIMENTER" prints 100,000 copies of this issue; that means that at least 180,000 readers see this page and probably a great many more. Our readers who advertise here seldom advertise the same thing twice—usually within five days after the issue is out the advertised article has been sold, or swapped. The many testimonials which we print here from time to time are ample proof of the almost miraculous pulling power of these columns.

Look around in your attic or workshop and you will find dozens of long forgotten articles, useless to you now, but very useful to someone else. At a ridiculously low cost you can either sell or swap such articles.

And remember this fact: The U. S. Postal Laws protect you. No one can "do" or cheat you. Of 3,495 "ads" published in these columns during the past five years, only twelve complaints were reported to us, and each and every one was adjusted to the full satisfaction of the complainant.

It matters not if you have old books or magazines, a kodak, electrical or chemical apparatus, scientific instruments, bicycles, typewriters, moving picture machines, air rifles, watches, structural toys, etc., etc. All these and countless others can be speedily disposed of here. Try it and be convinced.

Montezuma, Iowa.

Experimenter Publishing Co.,
233 Fulton St.,
New York, N. Y.

Dear Sir:

I am taking this opportunity to write you concerning the results obtained from my ad which was placed in the Exchange Columns of the ELECTRICAL EXPERIMENTER some few weeks ago. I was very much surprised at the number of answers which I received; some one hundred in all. These came from all parts of the country, including Canada and Honolulu, T. H. I will surely recommend it to all who wish to sell apparatus of any sort.

Yours very truly,
RAY J. FARMER.

FOR SALE—Small post drill rachet feed, $10. Drill chuck, hand power, $15. Good condition. Peter Beaudry, 12 Cutts St., Biddeford, Me.

FOR SALE OR EXCHANGE: Complete sending and receiving wireless outfits; damped and undamped waves; sale cheap or exchange for good gun. M. Guyton, Cotton Plant, Miss.

7500 Coupler, $6. 1" coil, $3. Loader, $1.75. Condensers. Roland Place, Fall River, Mass.

SACRIFICE—Brand new 3,200 meter Receiving Cabinet, $24. 15,000 meter loading coil, $6. Catwhisker detector, $2. Skates, size 11½, $5. 0-150 direct reading volt meter $10. Premo No. 1 camera, $1.50. Wireless Phones, $2. Articles sold separately. $45 will take all. B. J. Rinim, 46 Congress Ave., Waterbury, Conn.

HAVE YOU—Omnigraph, Brandes Transformer or Navy phones, tubular bulbs, binoculars? Will pay cash or write for radio and sporting goods to exchange. L. Mason, Forsyth, Montana.

WILL EXCHANGE—Static machine and 22 repeating rifle for pair amplifying phones. C. V. Harney, Kinsley, Kansas.

FOR SALE—Motor Bob Cyclecar at $55. A bargain. Jacob Rau, Bathgate, N. D.

NOTICE—Have Cyclopedia of Applied Electricity, 7 volumes, cost $19.80; Cyclopedia of Drawing, 4 volumes, cost $12. All new. Also wireless apparatus. Will sell or trade for Smith motor wheel, rowboat motor or what have you? F. H. Ransford, Dalton, Mass.

FOR SALE—Compound microscope, old style, two eye-pieces, two objectives, $15. Address, Ticket Agent, N. Y., N. H. & H. RR., Hartford, Conn.

BRAND NEW DeForest Double Grid, Plate, and Filament Audion Bulb, $5. Cost $10.50. R. Cuthbert, 119 Penn. Ave., Washington, D. C.

SACRIFICE—First check for $50 takes screw cutting bench lathe. Centers 2", swings 12" over bed, 7" over carriage, compound rest, back geared. Apron so that automatic cross feed may be easily fitted. Three step cone, 2" flat belt. Includes 6" chuck and 8" face plate. An ideal experimenter's lathe. Write, V. Davenport, Silverton, Colo. Box F.

WANTED—Copy of book "Michael Faraday, His Life and Work" by Sylvanus Thompson. Also an ohmeter of the Roller-Smith type or a Wheatstone bridge; must be in first-class condition, and include galvanometer. H. W. Secor, c/o ELECTRICAL EXPERIMENTER, 233 Fulton St., New York City.

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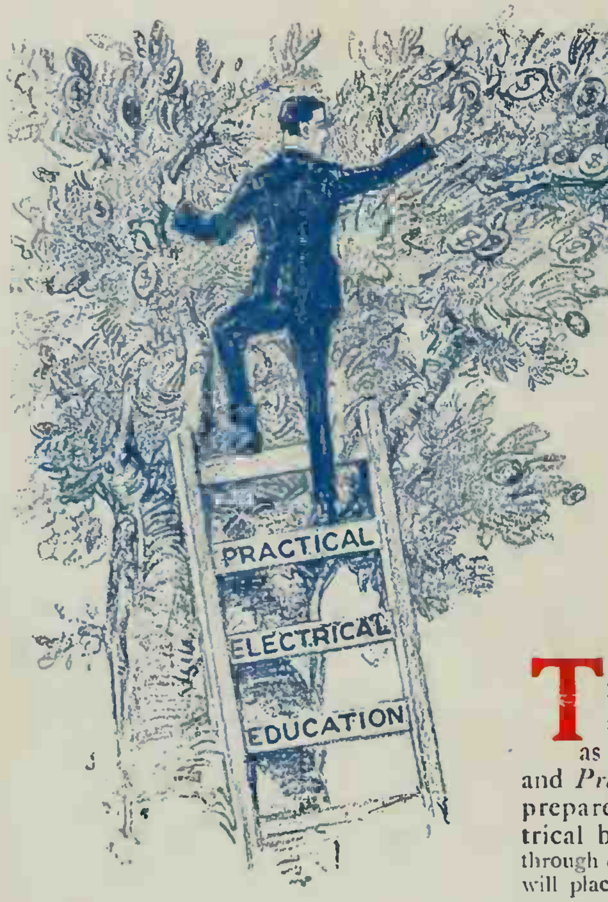

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