AUG. 1918 15 CTS.

ELECTRICAL EXPERIMENTER

SCIENCE AND INVENTION

OVER 175 ILLUST.

AERIAL MONO-FLYER OF THE FUTURE

SEE PAGE 228

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This outfit has been gotten up solely for the Experimenter and for this reason we are selling it "Knocked Down." In other words, the instruments come all ready for you to assemble, all the parts, screws, nuts, washers, etc., being furnished. Complete directions how to assemble accompany each set. With a pair of pliers and a screw-driver, the outfit can be readily put together in less than twenty minutes.

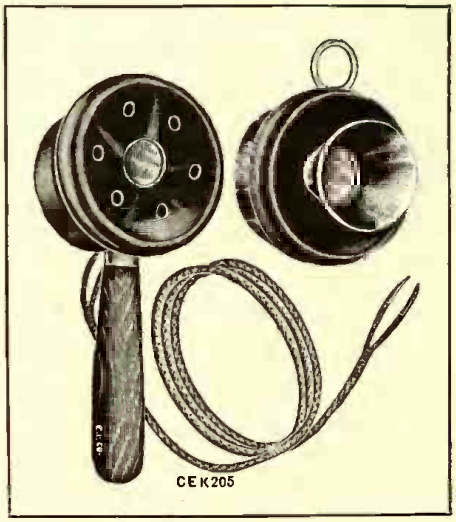
The most important point is that the telephone receiver spool comes already wound complete, and the Experimenter will, therefore, not need to wind his own spool.

The outfit when assembled comprises a highly sensitive CARBON GRAIN MICROPHONE with carbon diaphragm of exactly the same type as is used with our $15.00 Detectiphone. (See our Cat. No. 19.)

The receiver is a special low resistance double pole type 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.

The spool is wound with special enamel wire for five ohms, standard with our Detectiphone.

This instrument works best on four 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.


CEK205

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); for salesmen to talk "through" window (Loud-Talker outside in street, microphone transmitter for salesmen, 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; instructions, etc., are furnished.

No. AEK204 "Electro" Loud-Talker Outfit Parts "Knocked Down," complete..... $1.50

No. CEK205 "Electro" Loud-Talker Outfit, same as above except that it is already assembled and tested at factory. Set complete..... $3.50

Shipping weight 2 lbs.

Immediate Shipments

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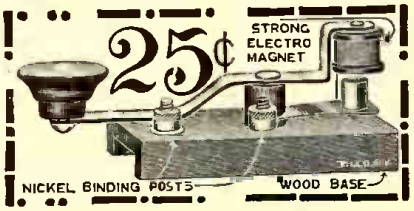
Learner's Telegraph Outfit for 25c Prepaid

In the 15 years of its existence our company has never offered such a bargain as the present one. Just think of it, a real electric learner's telegraph outfit with which to learn the code or to telegraph to your friend six blocks away, for 25 cts.!! Impossible—you say. Quite so. We do sell them at cost, but we do it solely to get you acquainted with us and place our wonderful catalog in your hands. And if this telegraph pleases, you will order other things from us. This telegraph has a red-lacquered wooden base, strong electromagnet, nickel binding posts, generous telegraph knob and nickel clicker. Telegraph measures 3½ x 1½ x 1½" over all. Full directions for learning the code, and a fine CODE CHART go with the telegraph, all packed in neat box. Telegraph works easily on a single dry cell. Two instruments may be ordered for 50 cts. if wanted, to telegraph between two rooms or two houses.



If the telegraph does not come up to expectation will cheerfully refund money. Boys order 6 to 25 of these instruments. Sell like hot cakes to friends for 30 to 40 cts. each. So small can be slipped into pocket. LEARN THE CODE DURING SPARE TIME. TELEGRAPH OPERATORS ARE SCARCE. UNCLE SAM NEEDS THOUSANDS.

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Vol. VI Whole No. 64 AUGUST, 1918 No. 4

EDITORIAL

WAR INVENTIONS

HOMER'S *Iliad* tells us how the Greeks, tho beleaguering Troy for over ten years, were unable to take the city, nor could they force the Trojans to surrender. Finally, so the legend goes, the Greeks constructed a huge wooden horse, which in its interior concealed many Greek warriors. This horse was rolled triumphantly into Troy by the Trojans, but during the night the Greek men escaped from the horse and threw open the portals of the city. The Greek hosts having returned now swarmed into the city and sacked Troy. This was over two thousand years ago. Legends such as these, it seems, were just as popular then as they are now; at any rate the longing in the human breast for the spectacular during wartime seems hard to eradicate.

It is only natural that war weary people should be fond of giving their imagination free reign and of hoping that by some miracle a wonderful invention will suddenly appear which will end the war with one stroke.

Unfortunately, history, with hardly any exceptions, teaches us that but few wars were won by means of any one war invention. Wars in recent times from Napoleon down to this day were not won by means of any particular invention. Napoleon did not surrender on account of a war weapon that was known only to his conquerors. Nor were the American Civil War, the Franco-Prussian War, or the Russo-Japanese War won or lost by a new war machine.

If this is true of all other great wars, how much truer is it of the present cataclysm. Unheard and undreamt of inventions, that would have staggered humanity twenty years ago, have been thrown into this inferno, and to what good? The bombing aeroplane, the submarine, wireless, trinitrotoluol, poison gas, the war tank, liquid fire, the 75 mile gun, are all first class war inventions, every one of which would have spelled victory to Napoleon, had he possest the secret. And wonderful as every one of these inventions is, none of them alone have been able to bring about a decision. Nor are they likely to do so. The Germans thought the submarine would bring a decision, their experts staking almost their last card upon it. It has proven a ghastly failure, otherwise how could a million American soldiers have landed in France, with hardly a loss worth speaking about? They tried Chlorin gas in a surprise action on the Canadians, putting several thousands of them out of the fighting, but as a whole it had no effect upon the war.

Suppose we send ten thousand bombing aeroplanes over Germany. They alone will not win the war. Ten thousand or fifty thousand tanks alone will not win the war. A thousand land battleships or a thousand other fearful land cruisers alone will not win the war. Raining death and destruction upon the civil population as a rule has only one result: It inflames the people to greater deeds, to greater sacrifices, to greater hate, to greater determination to win the war. France, England and Italy are shining examples of this.

No, any one invention is not likely to win the war. Some day, perhaps, some one will invent an *Atomic Ray* which is capable of pulverizing whole regiments at a stroke. Nothing of this sort is impossible. But it is not very probable. Rather it is the wholehearted devotion of the non-combatants to a great and just cause that will win the war. The nation that can throw into the scales the greatest amount of war implements, the heaviest weight of metal, the greatest amount of fighters, coupled with a prodigious use of ALL of the best war inventions will win in the end—PROVIDING THAT EVERY MAN AND WOMAN BEHIND THE LINES CONSTANTLY THINKS AND DREAMS OF WAR AND VICTORY AND IS PREPARED TO PUT EVERY LAST OUNCE OF STRENGTH AS WELL AS ALL WORLDLY BELONGINGS INTO THE RIGHTEOUS CAUSE WITHOUT STINT OR RESTRAINT.

THE GREATEST WAR INVENTION IS THE FIERY UNDYING WILL TO WIN.

H. GERNSBACK.

The ELECTRICAL EXPERIMENTER is publisht on the 15th of each month at 233 Fulton Street, New York. There are 12 numbers per year. Subscription price is $1.50 a year in U. S. and possessions. Canada and foreign countries, $2.00 a year. U. S. coin as well as U. S. stamps accepted (no foreign coins or stamps). Single copies, 15 cents each. A sample copy will be sent gratis on request. Checks and money orders should be drawn to order of EXPERIMENTER PUBLISHING CO., INC. If you change your address notify us promptly, in order that copies are not miscarried or lost. A green wrapper indicates expiration. No copies sent after expiration.

All communications and contributions to this journal should be addrest to: Editor. ELECTRICAL EXPERIMENTER, 233 Fulton Street, New York. Unaccepted contributions cannot be returned unless full postage has been included. ALL accepted contributions are paid for on publication. A special rate is paid for novel experiments; good photographs accompanying them are highly desirable.

ELECTRICAL EXPERIMENTER. Monthly. Entered as second-class matter at the New York Post Office under Act of Congress of March 3, 1879. Title registered U. S. Patent Office.

The ELECTRICAL EXPERIMENTER is for sale at all newsstands in the United States and Canada; also at Brentano's, 37 Avenue de l'Opera, Paris.

Vol. VI. Whole No. 64 AUGUST, 1918 Number 4

A Gigantic Exposition and Amusement Park in the Making

The New York International Exposition Which Is to Mark the 300th Anniversary of the Settlement of The Bronx

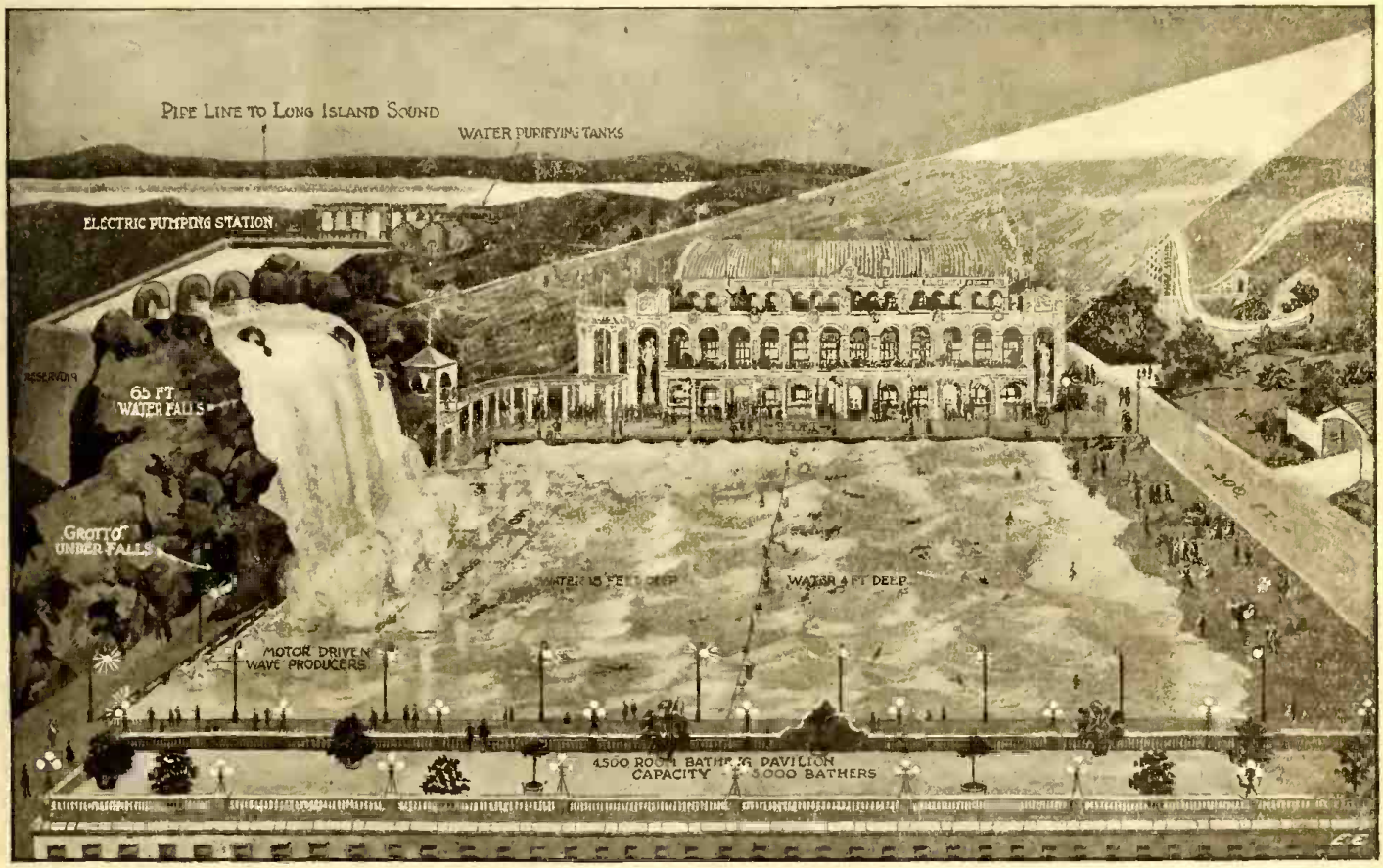
By GEORGE HOLMES

OURS is indeed an age of wondrous achievement. Altho we are in the midst of the world's greatest war, it is not to be said that we are the least bit doubtful or disconcerted with regard to the ultimate finish. Therefore, while we are doing all we can to destroy autocracy and promote world-wide democracy and freedom our "after-the-war" army is already busy preparing for the great industrial struggle that is to come. With the gigantic Merchant Marine now in the making it will eclipse all others and our flag will flutter in the breeze of every seaport in the world.

But to obtain all this foreign trade we must needs have some way of inducing the buyers to see our goods and products in such a way that they will be imprest. With this ultimate point in view there is today being erected and soon to be thrown open to the general public, one of the largest industrial expositions ever seen east of the Mississippi.

It is to be a permanent enterprise on the general style of Shepherd's Bush and Earl's Court in London. It is destined to be a clearing house of industrial ideas, efforts and inventions and real accomplishments.

A central market place where the manufacturers of America can show to the buyers of foreign lands the triumph of American industrial genius.

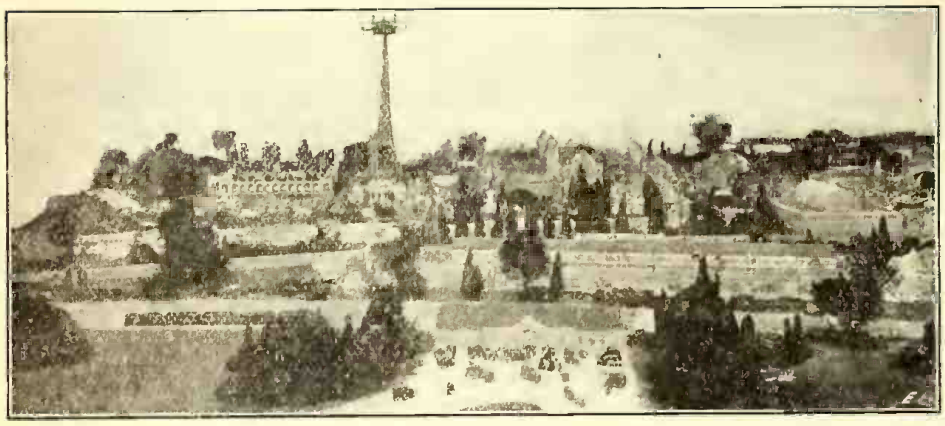


Night Scene at the New New York International Exposition, Where Science, the Arts and Industry Will Hold Your Attention Every Year from May to November. The Beautifully Illuminated Swimming Pool Here Shown Is the Largest in the World. It Has a Glass Bottom Thru Which Vari-colored Lights Glow While the Sixty-five Foot Water-falls Is a Dazzling, Shimmering Mound of Ever-changing Colors. Electric Pumps Constantly Change the Water in the Pool so as to Keep It Fresh and Pure, the Sea Water Being Past Thru Chlorid Purifying Tanks and Then Liberated over the "Falls," Which Aerate and Revitalize It.

It is to be a vast educational institution for the instruction of the people along scientific, hygienic and artistic lines.

And, withal, a huge recreation center and playground where 250,000 persons can be accommodated each day.

The Exposition will be held each year from May 30 to November 1. The exhibits this year will number about 250, representing eight countries and will be housed in twenty-five magnificent buildings. There will also be Government exhibits from five departments and it is planned to add more each succeeding year.



Daylight View of "Bronx Exposition"—Gigantic Sea Water Swimming Pool Can Be Seen at Left of Photo, and 65 Foot Electrified Water-Falls at Extreme Left.

This vast enterprise is backed and under the guidance of some of the most prominent men of the commercial world in the United States. They believe that the struggle for commercial supremacy will naturally center in New York, hence this location for the Exposition.

The plans for the *New York International Exposition* are the most stupendous yet conceived from beginning to end. Of the twenty-five buildings some will be devoted to the display of scientific, artistic and industrial triumphs of the world, others to entertainments of the better class.

The exhibit buildings will be known as the Palace of American Achievements, Palace of Pan-American Exhibits, Palace of Fine Arts, Palace of Manufactures and Liberal Arts, Palace of Varied Industries, Horticultural and Agricultural Hall, Machinery Hall and Automobile Salon. In each of these will be displayed exhibits in keeping with the name of the building.

That these displays will be most interesting is evidenced by the fact that already the United States Government has announced its intention of participating with an exhibit by the Bureau of Mines of the Department of the Interior, and by exhibits from the Army and Navy Departments.

There also will be a department devoted to food conservation, dehydration and scientific cookery, which will be under the direction of Mrs. A. Louise Andrea, one of the best known cooking experts of the United States, who conducted a similar department at the San Francisco Exposition in 1915.

The entire Exposition, however, is not of the serious nature to be found in the Exhibit buildings. The management knows that the people must be entertained as well as instructed, and to this end there are being erected a number of entertainment features that bid fair to rival anything ever attempted before, either at an Exposition or Amusement Park.

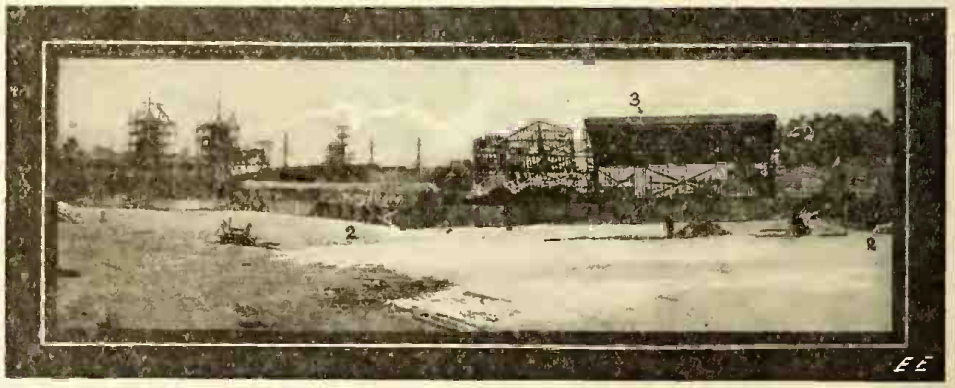
With the opening date but a short distance away the grounds represent a veritable bee-hive of activity, there being close on to 500 carpenters, electricians, painters, plasterers, laborers, supervisors and other officials engaged in making New York's new Exposition a real, live-wire affair. The grounds cover a total of 28½ acres fronting on the Bronx River at 177th Street, a tract of land belonging to William Waldorf Astor. To start with the site resembled a large swamp; by gradual cutting and filling some semblance of order was finally secured, but not until many feet of solid rock had been blasted away to make room for the numerous gas, water, sewer and electric pipes and conduits. For the water supply to the various buildings and fire hydrants, over a mile and a half of main pipes have been laid down, not to mention eleven miles of small water pipes that branch out from the main supply pipe somewhat like the branches of a giant tree. There will also be a very large number of electrical conduits and as our friend, the publicity manager, said with a mournful note—"three hundred thousand dollars have been buried in these grounds where the public will never see them."

Biggest and best of all will be the amusement features that will be the delight of the kiddies and make the grown-ups feel like little tots again. First will be the greatest inland pool ever made with real salt water from the Atlantic Ocean! It will be three hundred by three hundred and fifty feet and will have a sand beach three hundred feet long by fifty feet wide, wherein one may acquire a beautiful coat of tan or make sand houses or some equally non-called-for feat which nevertheless serves to amuse. In addition to the beach there will be a gigantic wave motion machine operating mechanically by means of big plungers. These plungers are kept in constant motion by special gears and huge electric motors, producing rolling foaming breakers that bid fair to rival any that his majesty, Father Neptune, ever splashed Coney's bathers with. The pool proper will contain something like 2,500,000 gallons of water and gradually slopes down from the level to a four-foot depth, at which point will be placed the "life lines"; beyond this point the drop is fairly rapid until a ten-foot depth is reached, where there will be the usual dare-devil platforms, chutes and other swimmers' paraphernalia.

Beneath this deep section on the floor of the pool there is set a series of spaces covered by a heavy glass frame, underneath which will be various colored electric light combinations. These lamps are controlled from shore and when lit up at night present a very beautiful spectacle, not to mention the series of flood and searchlights which will play on the scene.

Perhaps the greatest spectacle of all will be the gigantic illuminated waterfall at the deep end of the pool. At this end there will be a very pretty back-ground of mountains, hills, Alpine houses, mountain streams, etc., and over these will trickle the water and spray, while in the center of this imposing array will be the sheer drop, like a plate of glass from the top of the mountain to the water sixty-five feet below of a dazzling waterfall, which, while a wonderful novelty in itself, will also improve the purity of the water in the pool. Then there will be a very pretty grotto in back of this waterfall, where one may observe the seething foam below and the great array of lights.

Besides having the waterfall to purify the water, provision is made so that it can be kept going continuously, thereby adding new and clean water all the time and draining away the old water in proportion. Water is pumped about a mile to the grounds from a point where there is an 11-foot tide, this being right near Long Island Sound. The intake pipe is five feet below low tide; by having it so arranged it is possible to avoid sucking in all the drift scum and other foreign matter which accumulates on the surface. In addition to this there are placed over the opening several metal screens of a very fine mesh. Passing thru the pipe line the water will be pumped by the aid of large electric pumps into a large reservoir capable of containing several hundred thousand gallons of water. This reservoir is "V" shaped and situated at the back of the pool and the waterfall. Here the water is allowed to settle and then it is again pumped thru six large lime chlorid filters and then thru the pipe line to the top of the "falls," where it is sent hurtling over the top into the foment below. All in all the pumping



Before the "Bronx Exposition" Swimming Pool Was Filled With Millions of Gallons of Sea Water. 1—Bath House; 2—Motor Driven "Wave Producers"; 3—Framework for 65 Foot Artificial Water-Falls and Rocks.

(*Continued on page 267*)

Electric Whirling Disk to Start and Stop Aeroplanes

NOW that we have instituted a daily aerial mail service between New York and Washington and also between New York and Philadephia as well as Boston, the matter of making sure that the *mail-planes* start off on their journey on time is a critical problem and moreover, the Post Office authorities at New York have bethought themselves that it is really going around the bush to send the aerial mail sacks via train to a flying ground, located fifteen miles from the Post Office in the center of the city. It has recently been suggested in the daily press by various writers that some scheme should be available whereby the mail-planes can fly directly over the city and alight on the Post Office building itself, and in this way save several hours daily in delivering the aerial post, as well as gaining a considerable amount of time in starting on their journey.

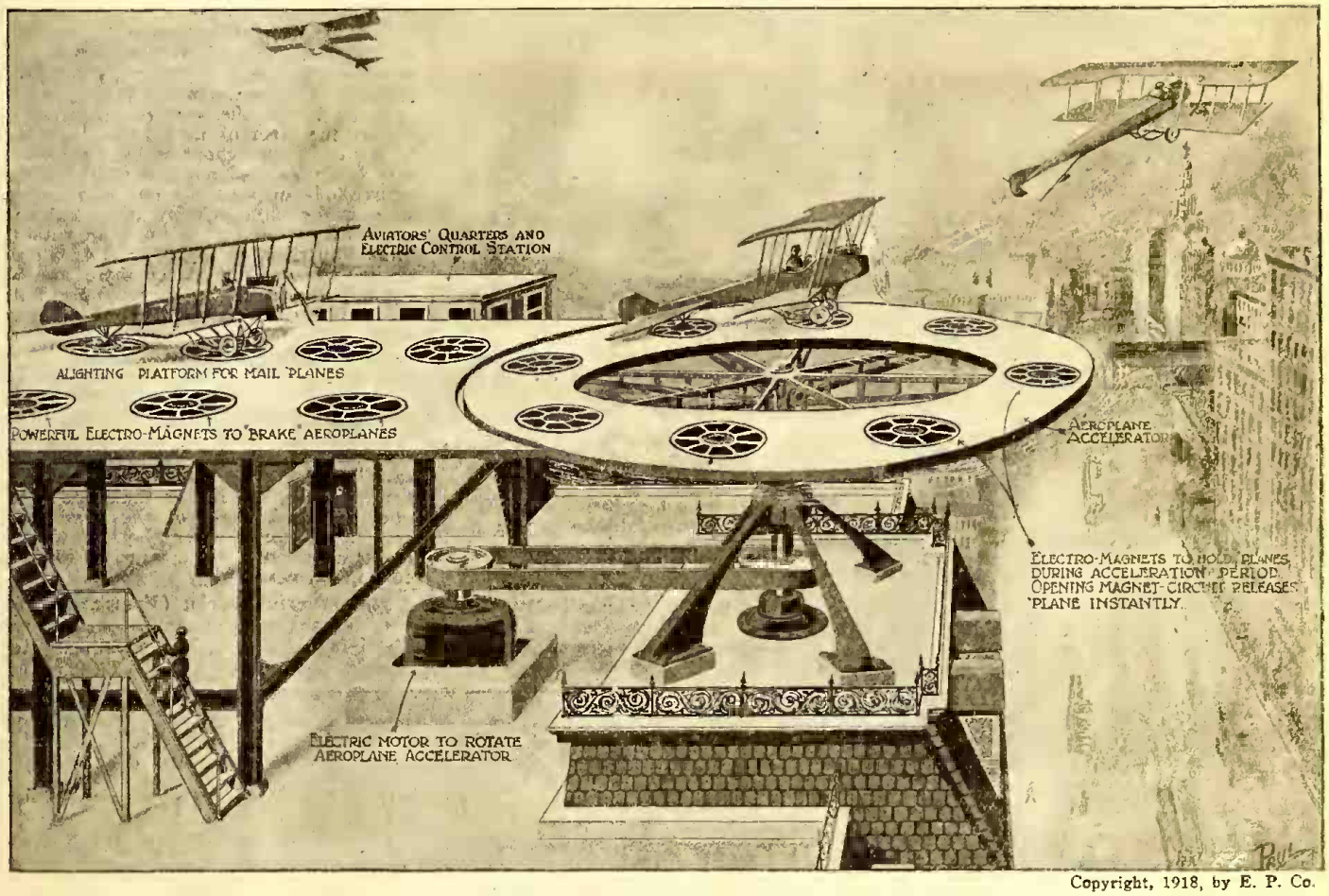
It was stated by Superintendent of Mails, E. M. Norris, in regard to these suggestions, that it was entirely feasible for aeroplane mail to be dropt on the roof of the New York Post Office, and provided the high buildings of the metropolis would permit the aeroplanes to fly sufficiently low, that the mail could be easily dropt as suggested, on the roof of the Post Office under most conditions, but that it could not be picked up by machines starting to Washington or Boston. He further stated that representatives from several aeroplane concerns had measured the roof of the New York Post Office and reported that in their estimation it was entirely feasible and practicable for the mail-planes to start and alight on the roof thereof. They proposed to build an aeroplane accelerating and decelerating machine for starting and stopping the aeroplanes in such a space, at a cost of something like $50,000.

The proposed scheme is illustrated herewith, and as can be seen, it possesses many novel points. It resembles in general a carousel or merry-go-round, by which means the aeroplanes are supposed to be spun around in starting until their propellers have attained sufficient speed and then be suddenly released, when they will be thrown off the disk tangentially by centrifugal force by means of a quick-acting release clutch or better still, by the utilization of powerful electro-magnets arranged around the electric motor-driven disk as proposed by Mr. H. Gernsback in the June issue of the ELECTRICAL EXPERIMENTER.

This remarkable apparatus is also supposed to prove efficacious in decelerating or gradually stopping aeroplanes as they alight from the air.

In this case there are two schemes which might be employed; the first working on the principle that the rotating disk be driven in an opposite direction to that of the aeroplane, which will in this case tend to quickly decelerate and come to a stop. The second arrangement would be to use large electro-magnets as shown herewith, and in this case the revolving disk could be driven in the same direction as that followed by the alighting 'plane, and by applying the current to the magnets gradually, and thus increasing their strength, the speed of the alighting 'plane and its attached iron armature would be reduced by co-action with the electro-magnets in such a way as to simulate mechanical friction of gradually increasing magnitude.

It thus becomes evident that those in charge of the plant, and stationed in an observation tower on the roof, may readily exert perfect control over the accelerator, both as regards the speed of the electric driving motor, the direction in which the disk is rotated, the strength of the electro-magnets, the moment of breaking their circuit, etc. A storage platform for extra or disabled 'planes is arranged at one side of the accelerating machine, and this can be supplied with electro-magnets for holding the 'planes securely as shown in the illustration. It is possible that the device may be soon tried out.



The Aerial Mail Has Arrived at Last. Every Day the Mail-planes Soar Thru the Air from New York to Washington, and Vice Versa, as Well as Between Boston and New York. At New York, Owing to the Many High Buildings, the 'Planes Cannot Leave the City Post-Office at Present. It Has Been Proposed to Erect a Gigantic Merry-go-round Accelerator Device, Such as Here Pictured, for the Purpose of Speeding Up the 'Planes at Starting and to Decelerate Them as They Land from the sky.

Electric Sirens Warn Paris of Air Raids

AMERICANS are not just yet accustomed to aerial raid warnings, but those who live in cities near the Atlantic Coast are shortly to be initiated in all the arts and graces of "crawling into a rat hole," when the giant alarm sirens sound. In Paris and London the people are thoroly trained in the procedure to run for cover when an aerial raid alarm sounds. Suitable underground caves and caverns are provided and properly labeled, so that the inhabitants can quickly find cover. In Paris there are now several underground theatres, as well as a host of subterranean restaurants and cafes. Even blasé "little old New York" has awakened to the imminent danger of being attacked by U-boat hydroplanes at night, and the military and police authorities have had a number of powerful electric sirens installed, as well as numerous anti-aircraft guns.

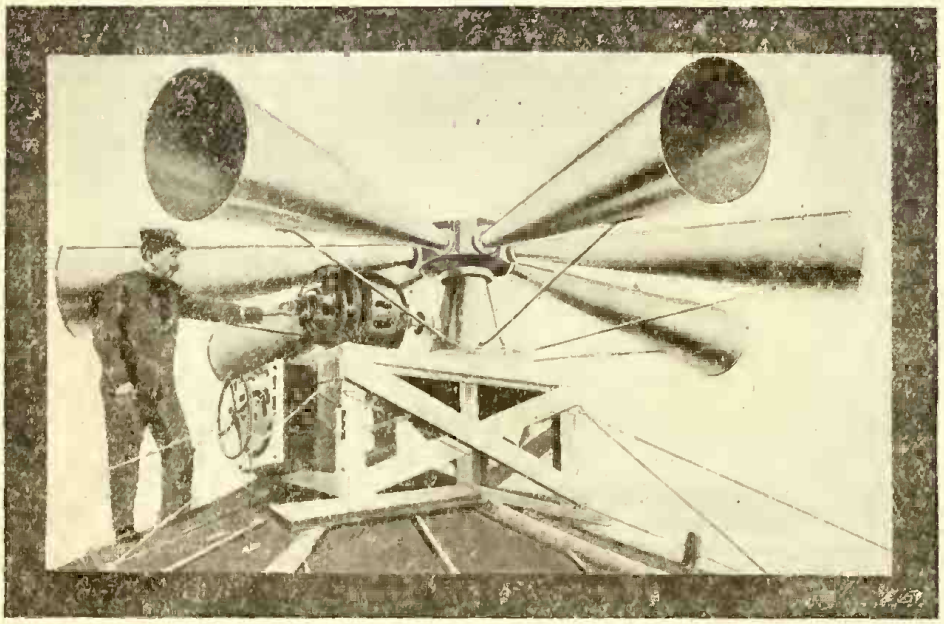


Fig. 1. This Gigantic Electric Siren, Installed on the Tower of Notre Dame, is but One of the Twenty-six Fixt "Aerial Alarm" Sirens Installed All Over Paris to Warn the People.

The gigantic electric siren shown in Fig. 1, is placed on the tower of Notre Dame in Paris and is one of the 26 fixt sirens that are being installed all over Paris to warn the people of air raids or the approach of the shells from the long range 76-mile German gun. The sound from each of these sirens will carry a distance of 1,500 meters, or for nearly one mile. One of these sirens will be placed on each of the other prominent Paris monuments. The operating motor is observed near the electrician's hand. It requires quite a powerful electric motor to whirl the siren blades of these extra large warning signals.

The illustration, Fig. 2, shows another installation of an "air raid" warning siren on a Parisian house-top. Note the three electric feed wires running over to the motor, which is located in the base of the siren. This particular siren is installed on the top of a chimney, as are many others in Paris, but this would hardly prove pleasant for the machinery, in America, as the Yankees make use of all their chimneys more or less regularly. In Paris, however, the chimney-top is a safe location for any such device, for smoke and heat will not bother it here. The French do not use stoves the way we do; they are acclimated to the chilling air which often blows over this part of Europe and it greatly amuses a Frenchman to see a Yankee shivering like a leaf, and calling loudly for "heat." The chimney is a long beloved mark of distinction and artistic display on Parisian houses and some are quite large affairs. At last the war has found a practical use for them, for the chimneys, projecting up above the roofs as they do, provide the necessary elevations on which to mount the siren alarm equipment. The acoustic sound waves set up in the air by the siren must have a clear way thru the air in all directions to carry any appreciable distance; they must not be impeded by any obstruction or else they will be greatly weakened, or even dissipated in a very short distance.

These powerful sirens are practically all electrically operated and controlled and involve many unique features. Some of them operate on a blast of comprest air, which is caused to blow a large whistle or vibratory diafram whenever a magnetically controlled valve is opened. Others are designed upon the principle of the true siren as found in the physics laboratory, and based upon the fact that if we rapidly rotate a perforated disc in front of a stream of air, such as from a nozzle, then a shrill, whistling sound will be produced and the higher the speed of the disc the higher the pitch of the sound. The blast of air to be thus chopt up by a perforated disc or drum need not be supplied from a source of compest air but may be that due to the high velocity of a revolving perforated drum, as is the case with the siren illustrated in Figs. 1 and 4. In this design of sound producer there are two similar drums or rings, each perforated with an equal number of periferal openings as shown. The outer drum is stationary, while the inner drum is rapidly revolved by an electric or other motor. The inner revolving drum is designed to give a fan effect and sucks in the air, in this way creating a strong air blast thru the openings in the two drums as they are rapidly opened and closed. The faster the drum rotates, the higher the pitch of the note produced. Some of the large sirens require a motor of several horse-power, the revolving siren blade measuring 10 to 15 feet in diameter.

The powerful Blériot (French) electric siren of the vertical motor-operated type illustrated at Fig. 3, is interesting. Here

Photo © by Underwood & Underwood

Fig. 4. First Electric Siren Installed in New York City in the Theater District for Warning Against Aerial Attacks. Many of These Will Be Used Thruout the City.

the base 1 contains the electric motor which drives a vertical spindle or shaft, to which are attached the necessary fan and siren elements within the casings 5 and 6. The air is drawn in thru opening 10. The siren sound waves emerge from openings 6, at the top. An electric "commande" or controller is fitted at the top of this siren, in the cap 7. To this magnetic controller there is connected a circuit linked up with a source of power and a Morse key 9. It is thus possible to actually telegraph with this siren, its shrill-piercing note having been heard at a distance of 2,500 meters or about 1½ miles when the actuating motor and siren drums revolved at 5,000 revolutions per minute.

The internal arrangement of this electric telegraph siren is very ingenious. To shut off the sound rapidly, as in telegraphing, the inventor provides a third or intermediate perforated drum having openings equal in number and size to the usual fixt and revolving members. This intermediate drum can be moved back and forth around its axis by means of the electro-magnetic controller 7, so as to more or less line up its openings with those in the fixt and rotary drums; the nearer the openings in the three drums align, the greater the volume of sound liberated from the apparatus. The driving motor 1 revolves at constant speed. Where the signals are to be broken up at relatively long periods, say every five minutes, then it is only necessary to utilize a plain type of motor-driven siren, when by opening and closing the motor switch the desired intermittent signals will be given. Figs. 4 and 5 show an American type of Duplex siren, driven by a two-horse electric motor. At one of the southern flying fields in Texas, there is in use a powerful electric siren that gives out the "fog" and other warnings to aviators, which can be heard five miles away.

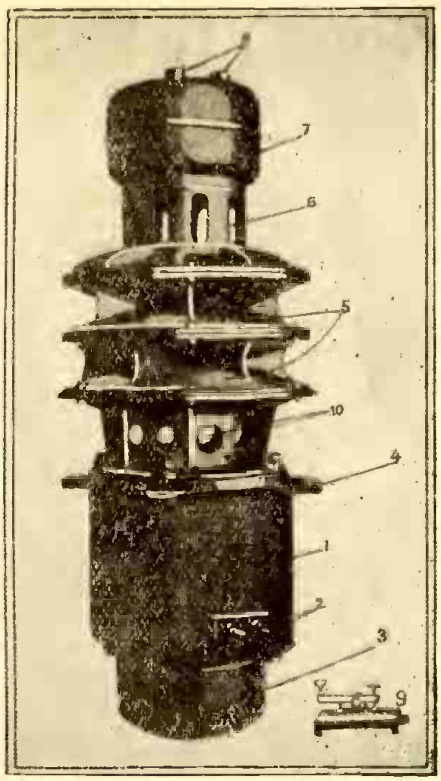


Fig. 3. A French Electric Siren of the Bleriot Vertical Type. It Is Operated By a Motor In the Base and Is Provided With a Magnetic Controller at the Top, which Permits of Rapidly Opening and Closing Its Raucous Throat, So That Telegraphic Signals Can Be Transmitted When Desired.

ACCOUNTING FOR THOSE 100,000 READERS.

By Thomas Reed

IT was a big surprise, eh, Bugs, to learn that our Magazine had grown to 100,000 circulation? What do you think of our Little Maggie hot-footing it down the road in a cloud of dust, in the wake of the *Saturday Evening Post?* I'll say that's going some!

We've got to account for it in some way, same as any other weird phenomenon—make up our minds what it was punched Maggie's accelerator so. And my guess is that it's our Editor's propensity for "starting something."

I'll bet that fellow starts things in his sleep. He isn't satisfied with digging up for us the newest apparatus and processes, and researches and theories, but he must have our laboratory-pictures, and "dope" how to make things with nothing to make 'em of, and burned-out lamp competitions—all sorts of stimulants to keep us awake and thinking. If one of his suggestions seems to go dead, no matter, he leaves it and starts something else.

But do they ever go dead? I don't believe so. Now and then one of 'em may appear to bury itself in the soil of Bugdom, like the "dud" shells they talk about, and be lost; but somewhere or other I'll warrant there's an obscure but diligent Bug sitting on the lost idea, prying away at its nose-cap with a screw-driver, bent on making something out of it, and in a fair way to succeed if he lasts long enough.

Different minds are open to different ideas, you see. For instance, mine's absolutely closed to this utilization of burned-out lamps. I might as well be a wooden man, for all the chance I stand in the contest. I rack my weary bean, and nothing comes out but an opaque Fool Idea, that stands in the door and blocks the passage for anything sensible. What do you suppose it is?—a nest-egg! It's dead wrong—don't lecture me, I realize it. A china nest-egg's demoralizing enough, but at least it's full of air, and the hen is encouraged to put something inside her product. But an actual vacuum—no; if she ever got wise that people paid money for that sort of contents—good night!

But, because I'm floored is no sign that some other Bug won't come across with a wonderful use for defunct Mazdas—something that will lift the mortgage from the home, maybe, or provide Big Sister with a beau. Give him time.

Meanwhile, let's give due credit to our hard-working Ed. Give it to him now, while it's worth something—not wait till he's so obvious that the Sunday supplements are writing him up. If you wait till then before you say "Him? Oh, yes, I useter know him," you're liable to get back a sarcastic "Yes, you did! You knew all the celebrities, didn't you, from Steve Brodie to the Ahkond of Swat!" Wouldn't that be tough, when you really did know him after all?

I'll say right now that I'm looking for some Bug to develop an idea from "E. E." into one of the big inventions of the world. It might surprise the Ed., tho it wouldn't me, if some day one of those conscientious insects should stroll into 233 Fulton Street with a bag full of bills, and remark, "Doc, the wife says your paper was what started my invention, and here's a million dollars she held out of the last pay-envelope for you, with our compliments!"*

Success to "E. E." and the next 100,000 soon!

*Thanks, awfully, Tom! I compromise with the "insect" on 50% *i.e.*, $490,000, (the $10,000 deduction represents a cash discount of 2%) if he or it shows up *at once!!* And if the "insect" insists that I take the other 50%—well, I'll not be harsh. I'll get out a fine supplement for the next issue, presenting each reader with a $5.00 W. S. S.!! For you see, it's the readers who by their support make possible the "E. E."!—"Ed."

"GARABED" A FAILURE, SAY GOVERNMENT EXPERTS.

"Garabed," which was to revolutionize the world by the production of an unlimited free energy, is a failure. This was the report of the board of five scientists appointed by congressional resolution, made public by the Interior department July 1.

The report says the principles of the invention of Garabed T. K. Giragossian are unsound.

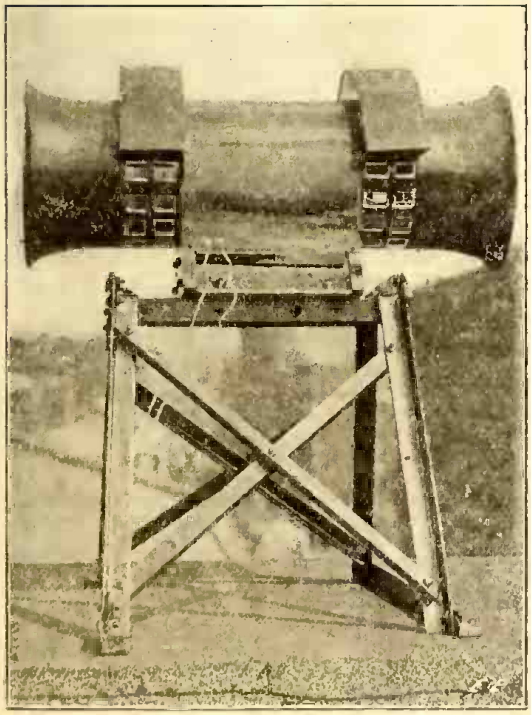


Photo © by Underwood & Underwood

Fig. 5. Another View of the New York Electric Siren Shown In Fig. 4. It Is Fitted With a Two Horsepower Motor and Can Be Heard for Two Miles.

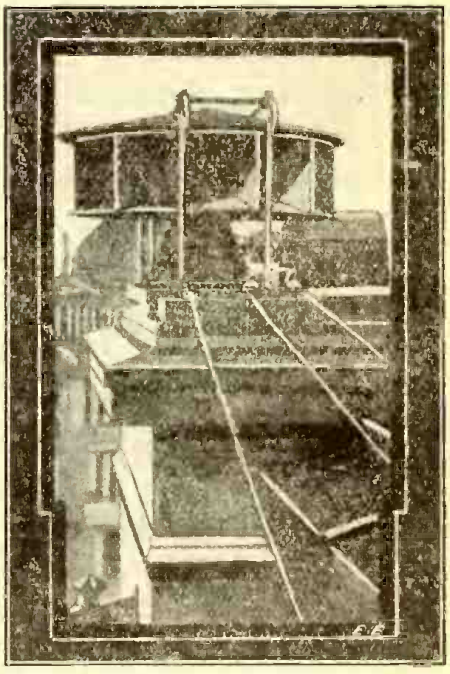


Fig. 2. Paris Has Many of These Electric Sirens Installed on Chimney Tops and Other Elevated Points to Warn of Aerial Attacks.

How Three New York Subways Meet and Pass One Another

THOSE of us who do not use the great subway systems of the larger cities such as New York are often prone to forget entirely some of the really wonderful engineering work carried out in the bowels of Mother Earth. The subway construction engineers of New York City, and including Brooklyn in this consideration, have solved in recent years some of the most difficult subway construction problems imaginable. This is so for a number of reasons, among which are the present subway plans of this first city of America, calling for a great number of intersections and cross-overs on the different lines, many of which take place under ground. Moreover, some of these underground tubes must be built under existing subways, without in any way interfering with the normal daily traffic. New York City has one of the most extensive subway systems in the world, comprising as it does more than *two hundred miles of underground railway*. Some of these subway routes which honeycomb the soil of the great metropolis have necessitated the boring of tubes under the East river, at enormous cost, and under difficulties which would seem to require almost superhuman endeavor.

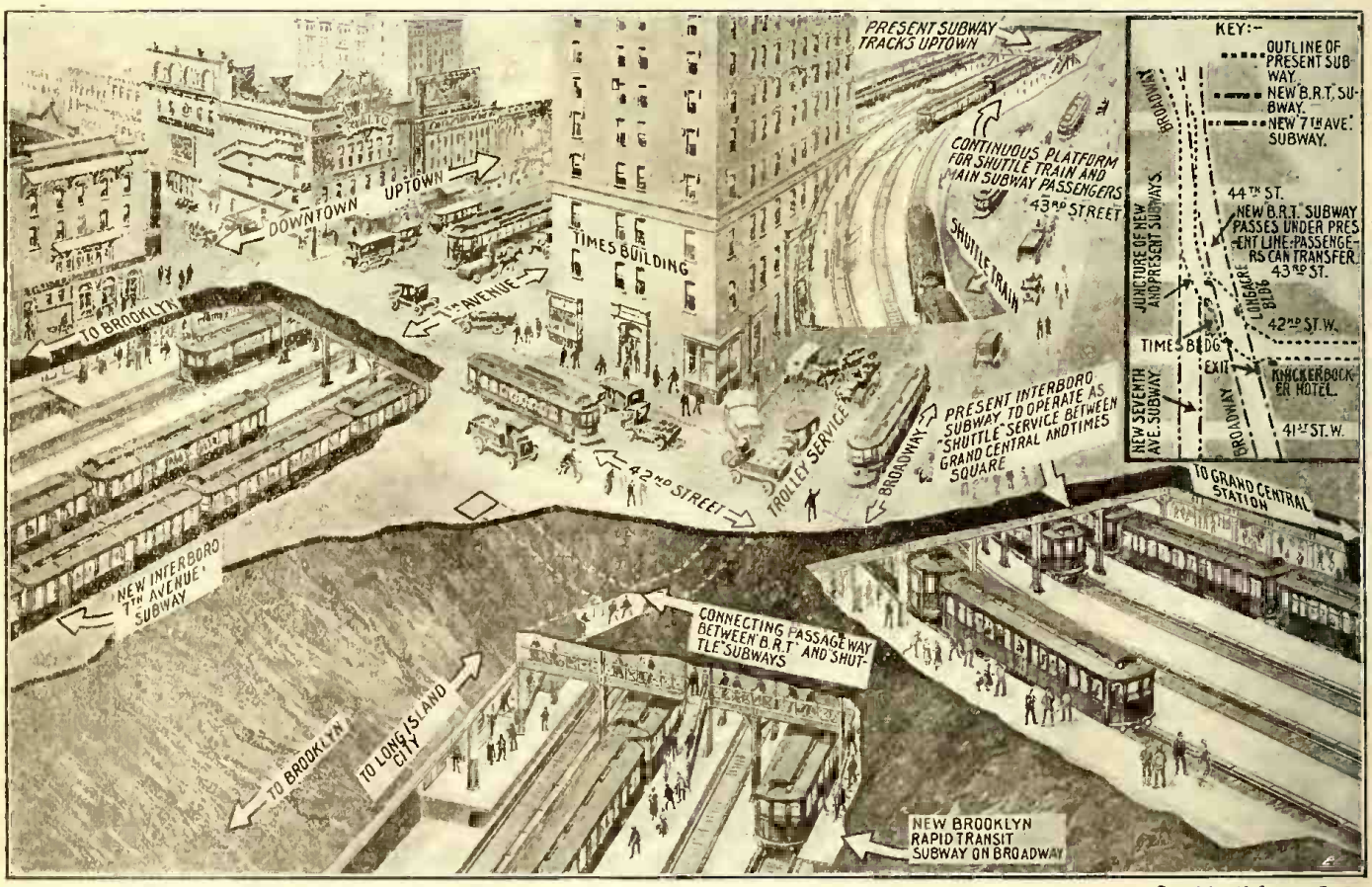
The present illustration shows in a vivid manner one of the greatest subway engineering feats ever performed. Three great arteries of underground traffic now meet at the corner of Broadway and 42nd Street, better known as "Times Square," and it is at this point, extending over an area from 42nd Street to 46th Street along 7th Avenue and also Broadway, that the new Brooklyn Rapid Transit subway has been constructed, so as to run *under* the present subway, which proceeds along 42nd Street, and all this work was done without interfering with normal traffic. The entire re-arrangement of the "Times Square" subway station and the interconnecting passageways joining the new B. R. T. subway (running along Broadway) with the old subway, which is to be operated simply as a "shuttle" between "Times Square" and the "Grand Central" terminal, will be made more apparent by inspecting the street plan of these subway changes given herewith.

The previous or existing subway system runs in the lower part of New York along Fourth Avenue to the "Grand Central" terminal which is the terminus of the New York Central Railway, the N. Y., N. H., and Hartford R. R., and other systems, from which point it proceeds westward along 42nd Street, to the "Times Square" station situated at Broadway and 42nd Street, and from this point it runs along Broadway uptown to 96th Street, etc. The new B. R. T. subway crosses under the East River from Brooklyn and enters New York City proper near the Battery, from which point it runs up Broadway, and as the bird's-eye view clearly indicates, it proceeds to dip under the old subway line at 42nd Street, but has no track connection with any other subway. The new B. R. T. Broadway line then extends northward to the south end of Central Park, or 59th Street, and from this point it runs directly east across the East River to Long Island City.

The new 7th Avenue subway on Manhattan Island will extend from the Battery uptown on 7th Avenue and will branch into the existing subway system just above 42nd Street and Broadway as the illustration delineates. Express service will be maintained on this route thru the new station at "Times Square," and on uptown over the old subway tracks.

If you should happen to be downtown near the Brooklyn Bridge, and wisht to use the old subway system, you would take an express to "Grand Central" terminal; from that point you would take the "shuttle" train across 42nd Street to the "Times Square" station from which point you have the choice of several directions. You can go uptown either on the old subway system via a 7th Avenue express, or you could by the same means proceed downtown. If you so desired, you might pass thru the underground passageway downstairs to the B. R. T. subway, running below you via Broadway, and by passing thru a turn-stile and

(*Continued on page* 284)



New York City Has Undoubtedly Solved Some of the Most Complex Subway Problems in the World. Here's a Typical Case:—At the Corner of 42nd Street and Broadway Three Subways, All Heavy Arteries of Traffic, Meet and Pass on Their Way. The Old Subway Transports its Passengers by "Shuttle" train from "Grand Central" to "Times Square". Here They Can Descend to the New B. R. T. Subway, Which Dives Under the Present Interboro Tracks as Shown, or They Can Take a "Seventh Avenue" Express Uptown or Downtown. Counting the Trolley Service, Three Track Levels Are in Use at This Veritable "Hub" of New York's Traffic.

Searchlights—The Night Eyes of the Army

By FRANK C. PERKINS

THE accompanying photograph shows a recent design of American portable auto searchlight for military field use as demonstrated at the Marine Barracks, League Island Navy Yard, Philadelphia, Pa. It was also tested out before the Engineering Department at the Washington Barracks, and the Maryland State Militia made very interesting experiments with it in their maneuvers. It is stated that after the first test was made at League Island, a very thoro report was made by the officer in charge, which showed that on a dark night with sleet falling, each lamp gave good illumination at distances up to 1,500 yards. The military officials have taken particular interest in this auto searchlight because of the conditions in the European war and during the operations of the American Marine Corps at Vera Cruz and Culebra showed the need and the varied uses for such an equipment.

It is pointed out that the features to be incorporated in any such portable light must include reliability, ruggedness, ease of carriage and construction of such nature that all of the set may be quickly assembled and placed in operation. The electrical apparatus of the equipment is mounted on a special body on an autocar chassis. The body is designed so as to furnish protection for the power plant, and to support the four reels of flexible cable, and the spring mounted tracks on which the two searchlight hand trucks rest. These springs are quite essential in eliminating road shocks from the delicate mechanism of the lamps.

It is of interest to note that the power plant consists of a gasoline motor with 4¼" x 4½" cylinders, coupled direct to a 7-kilowatt direct-current generator. This generator is designed to run at 1200 revolutions per minute, at which speed it gives 125 volts and delivers 56 amperes. The motor is equipt with a fly-ball governor, regulating the speed within very close limits. The motor driving this generator is supplied with its own gasoline tank, and also an independent radiator kept cool by a high-speed fan.

It may be stated that the two hand trucks which carry the searchlights and reels of flexible wire are constructed entirely of steel and aluminum, and have each two wire wheels equipt with 28" x 3" pneumatic tires. These trucks are light in weight and rigid in construction, and so designed that they have large road clearance beneath the light to enable them to be operated in very rough country.

For supplying the necessary current each light carries 1350 feet of cable, divided into two lengths of 675 feet each, so that each lamp can be operated independently of the other at a distance of one-quarter mile from the generating plant. By means of specially designed attachment plugs and reel arrangement, the light can be operated at any distance within the limits of the cable from the power plant without unreeling all of the wire to get at the inner end. The inner ends are arranged to pass thru the heads of the drums, so that the attachment may be readily made. Each searchlight measures 14 inches in diameter and has an arc of five thousand candle-power, and is effective up to a mile on a good clear night.

It is declared that in order to get the maximum value of the lamp, the observer stands at some distance to one side, and by means of a field telephone the officers control the operation of the light as found necessary. Some of these field searchlights are fitted with remote control attachments so that the beam can be focust on the target or object by simply pressing a series of buttons a quarter of a mile away.

The Italian army held a mountain pass, at the base of which ran a turbulent stream. The Austrians were in force on the opposite cliff. This is what the sons of Garibaldi did: they prepared a powerful battery of electric searchlights near the top of the mountain, well camouflaged. At night they flashed a perfect blast of blinding white light down on the Austrian lines, while in the cover of abrupt darkness below their searchlight beams, the brave Italian engineers worked like demons and swung rope bridges across the stream, which was of considerable width.

One of the photos herewith shows a new U. S. Army electric searchlight, fitted with a collapsible steel mast of considerable height. These searchlights are intended for special work and can be removed from the truck when desired. They are fitted with reels of flexible cables as will be seen, these reels maintaining continuous contact with the feed wires from the dynamo at all times, by means of a brush and ring arrangement.

Electric searchlights are invaluable as a protection against enemy air raids upon towns or cities. Since many coast cities are now in darkness at this time, these pictures are of added interest.

One of the photos shows a climbing mast fully elevated. This elevating attachment is used in case the lights are hidden behind trees, walls or bushes for the purpose of concealing them from the enemy observers. This photo was made at the Mobile Anti-Aircraft Section of the Engineering Corps, Washington Barracks, Washington, D. C.

The third photo illustrates a battery of searchlights in operation at night locating aeroplanes that are sent up for the purpose of detecting enemy aircraft.

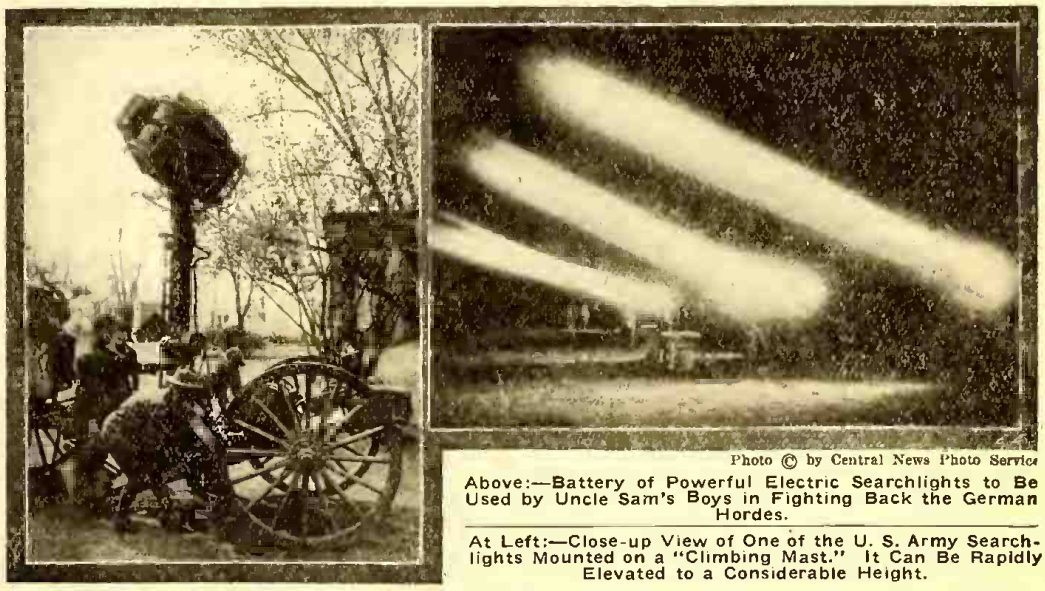


Photo © by Central News Photo Service

Above:—Battery of Powerful Electric Searchlights to Be Used by Uncle Sam's Boys in Fighting Back the German Hordes.

At Left:—Close-up View of One of the U. S. Army Searchlights Mounted on a "Climbing Mast." It Can Be Rapidly Elevated to a Considerable Height.

For Rapid Maneuvering of Troops at Night the U. S. Forces Will Have Available a Large Supply of These Auto-truck Searchlights.

Aerial Mono-Flyer of the Future

By H. WINFIELD SECOR

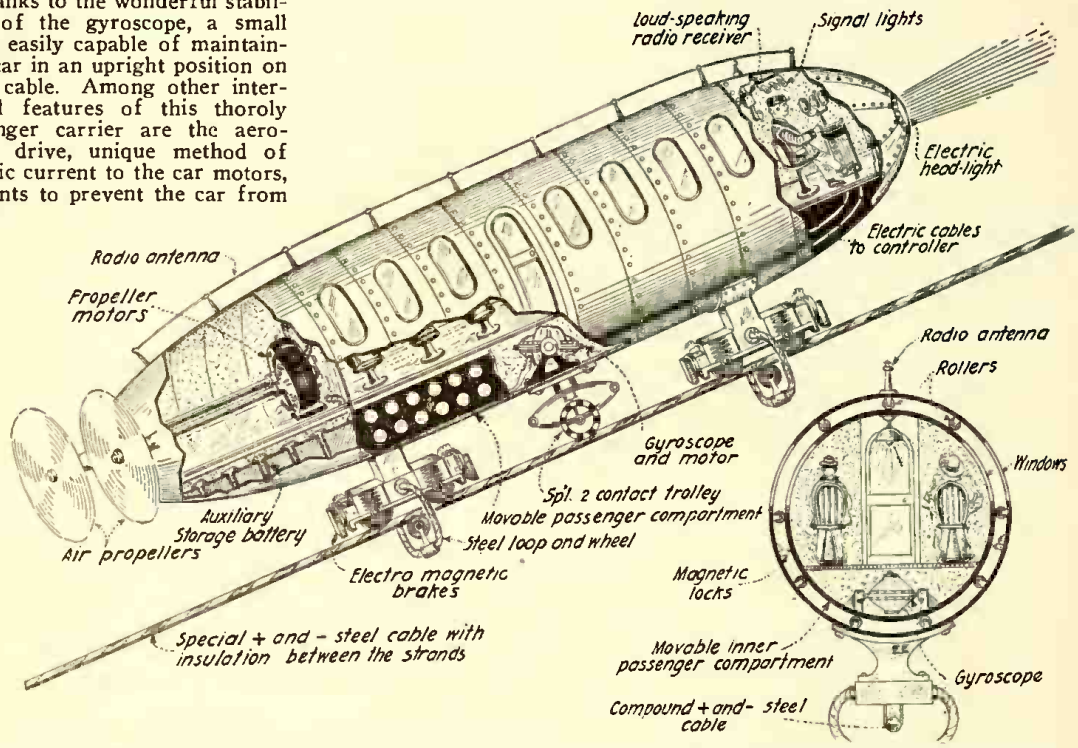
THE high-speed electric train of the future will undoubtedly be radically different in design from the railroad cars of the present day. For many locations, especially in mountainous regions the electrically operated mono-rail car, illustrated on our front cover as well as on this page, will prove of particular value. To begin with this aerial mono-flyer is enabled to run along at speeds of 200 miles per hour or faster on a single rail or cable, thanks to the wonderful stabilizing qualities of the gyroscope, a small sized one being easily capable of maintaining a 100-foot car in an upright position on a mono-rail or cable. Among other interesting technical features of this thoroly practical passenger carrier are the aeroplane propeller drive, unique method of supplying electric current to the car motors, safety attachments to prevent the car from dropping should the gyroscope fail, and a number of other interesting departures, based on sound engineering principles which our technical experts are quite familiar with, but which have not as yet found practical application.

The mono-rail flyer is not as impractical as would at first appear for such a single-rail car carrying a passenger had been operated by Brennan, the English engineer, several years ago. His car, fitted with a small stabilizing gyroscope, travelled along upright on a single rail very successfully. If you wish to demonstrate this remarkable power of the gyroscope go to the nearest toy-shop and purchase a 25 cent gyro. You will find that if you stretch a piece of string horizontally or at an angle that the upright gyro, spinning at high speed, of course, will travel along the string upright. Another important fact is that as the gyro's speed decreases it cants over *gradually* more and more, which action you can readily demonstrate for yourself; moreover, this shows that if the mono-flyer's gyroscope should fail at any time then the car would cant over easily, not rapidly, owing to the great momentum of the gyro wheel. Thus it is the decelerating gyro and car slowly reach a neutral or hanging position, which it will safely assume when provided with guard rings and cable wheels as our illustrations show. An ingenious arrangement of the inner passenger compartment of the mono-flyer has been worked out for such emergency conditions, and this involves the free suspension of this compartment on roller bearings as indicated in the end-wise sectional view of the car. The inner cab is not free to rotate on its axis normally, but as soon as the gage in front of the motorman indicates that the gyroscope is failing, due to lack of current, etc., he immediately pushes the emergency button which releases a set of *magnetic locks;* these locks set the inner compartment free and as the whole car of the mono-flyer slowly turns over about the cable, as already explained, the passengers are kept on an "even keel" as it were.

The method of propelling the car, either along cableways over mountain passes as here shown, or over regular mono-rail land systems, is by high speed air propellers. This idea may not seem feasible at first but the practicability of the scheme is attested by the gigantic Caproni triplanes, as well as large English bombing planes, some of which have as many as four propellers and a carrying capacity of fifteen to twenty passengers. The mono-flyer propellers are driven by electric motors controlled by the motorman at the front of the car.

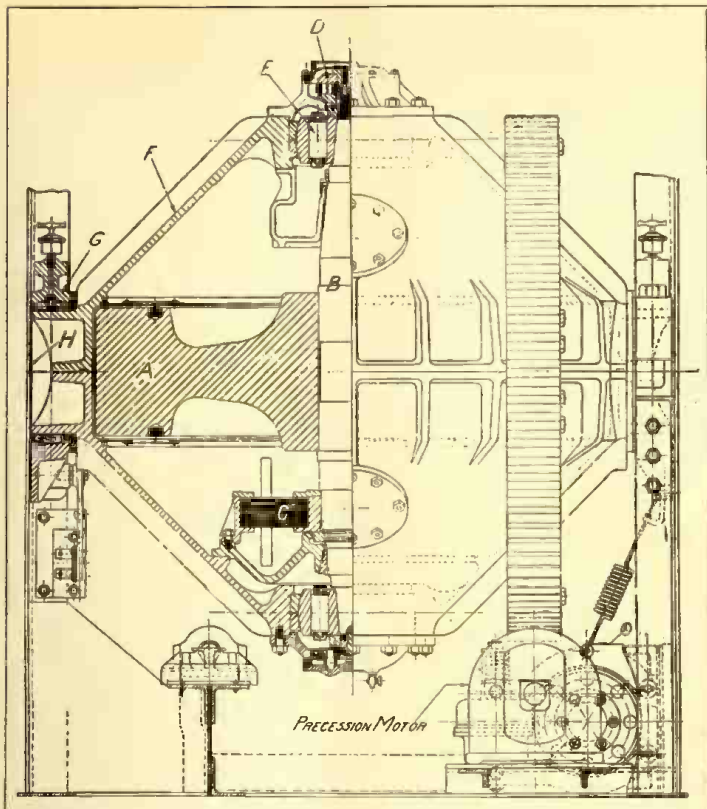
The next proposition is how to supply the car with current. There are three methods by which the car can be electrically operated. The first is to employ a gasoline-electric power plant; in this unit a petrol motor drives a dynamo and the current delivered by it is supplied to the propeller and gyroscope motors thru regulating rheostats in the usual manner. The second scheme is the one illustrated herewith in which the positive and negative currents are carried by a special duplex cable, so wound as to provide alternate + and — contact surfaces continuously along its surface. A specially contrived + and — contact trolley wheel rolls on this double polarity cable, gathering the positive and negative electric currents respectively. Owing to the peculiar construction of this contact wheel, with its spiral shoes and the spiral arrangement of the opposite conductors in the cable, the circuit is completed effectively. Either direct or alternating current can be utilized.

A third way of supplying electric current to the mono-flyer is by the *one-wire,* high tension, high frequency system of Tesla. In his works on high frequency currents Dr. Tesla shows and describes a *one-wire* motor which he built and demonstrated successfully. This method of distributing electric energy is ideally applicable to the present railway. The steel cable upon which the car travels could be charged by a high frequency, unipolar current and the motors operated on the Tesla one-wire method. Also, to intensify the *corona* transmission a light feeder cable could be run along just above the car, the two cables being oppositely charged with a high tension, high frequency current. The corona leakage between such highly charged conductors is enormous, and not easily appreciated by anyone who has never seen such a discharge. This corona is like a silent effluve and will fill the air space between two oppositely charged conductors separated 6 to 8 feet apart, when charged by such potentials as 150,000 volts. A number of the long distance transmission lines of today utilize voltages of this order, and the reader may gasp when he thinks of what might happen if our mono-flyer was rolling along peacefully between two cables charged at 200,000 volts and a short-circuit should occur. Well he might hold his breath if the current were of 60 cycles frequency, for then there would be some fireworks. Sixty cycle current kills. But this same 200,000 volt alternating current if oscillating at half-a-million cycles per second would be harmless. Besides, the passengers in the steel car would be protected from any shock as the currents, in the event of a short-circuit, would pass thru the steel frame.

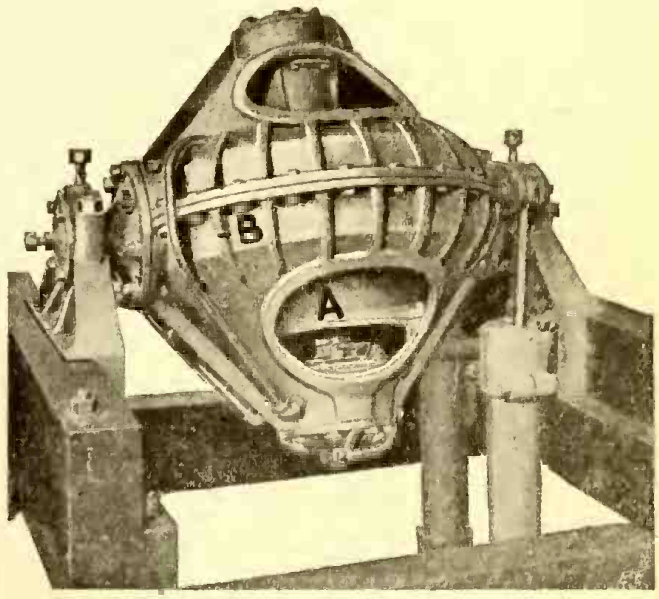


Semi-sectional Side View and Center of the "Aerial Mono-flyer of the Future," Which Can Run Along a Single Steel Cable Stretching Across Deep Ravines and Canyons. It Is Propelled by Powerful Air Propellers Driven by Electric Motors. The Motors, Lights and Signals Are Furnished with Current thru a Special Duplex Cable and a Double-contact Trolley Wheel.

Two views of a Sperry ship-stabilizing gyroscope of the electric motor-driven type are illustrated herewith as of interest to readers of this article. The sectional view shows the driving motor mounted inside the casing of the 24-inch diameter gyro rotor. The motor is an A. C. squirrel cage induction motor. The gyro is fitted with a motor-operated vacuum pump which keeps the gyro chamber exhausted of air, in this way eliminating considerable losses due to the windage of the massive high



Sectional View Thru Modern Electric Gyroscopic Stabilizer for Use on Ship-board. "A" Is the Heavy Steel Rotor Wheel Driven by the Electric Motor "C". The Gyro Usually Weighs Less Than One Per-cent of the Vessel's Gross Weight.



Appearance of Electric Stabilizing Gyroscope of the Sperry Type, Intended for Installation on a Fast Submarine Chaser. A Is the Small Electric Motor Driving 24-Inch Diameter Rotor at 4,000 R.P.M. It Prevents the Ship Rolling On Heavy Seas.

speed wheel. The precession of such gyroscopes is taken care of automatically by a special motor gear as shown in the sectional view. Here A is the heavy steel rotor wheel, revolved on a vertical shaft B, by means of the squirrel cage induction motor C. A heavy roller bearing D, carries the thrust load while the radial bearings E transmit the gyroscopic loads thru the case F to the gudgeon G, secured to the ship's or car's structure. Great gyros of this type and measuring 20 to 25 feet have been successfully installed on large battle-ships to prevent their rolling in a heavy sea, and thus provide a steady platform from which the big guns could be accurately fired. The wonderful stabilizing power possest by even the smallest gyroscope can be gleaned from the fact that in computing the size of gyro for stabilizing a certain ship, the engineers figure on the complete gyro equipment to weigh about *one per cent* of the ship's total displacement. Thus for a 500-ton craft the gyro equipment would weigh but 5 tons while for a 10,000-ton battle-ship it would be only 80 tons or eight-tenths of one per cent.

The idea as here exprest is susceptible of many improvements to be sure. For one thing it is not conceivable that we have found the most efficient form of air propulsion mechanism at all. Possibly the air propelled craft of the future will have propellers shaped like huge augers and worm their way thru the air—who knows?

WILLIAM J. HAMMER NOW A MAJOR IN U. S. NATIONAL ARMY.

It is with extreme pleasure that we can announce that Mr. William J. Hammer, Consulting Electrical Engineer of New York City, and who has contributed numerous interesting electrical articles to the Electrical Experimenter in the past several years, has been appointed as a major in the U. S. National Army, and is at present located at Washington, D. C. The U. S. Government is to be congratulated upon obtaining the services of so distinguished and accomplished a scholar as a co-worker to aid in solving the many diversified problems now besetting it. Mr. Hammer, who was for a number of years an early associate of Thomas A. Edison in the development and application of the electric light, has traveled extensively in Europe, and is therefore thoroly conversant with electrical inventions and developments both in Great Britain and on the Continent. Major Hammer may be addrest in care of the Inventions Section, War Plans Division, General Staff, War College, Washington, D. C. He received his appointment on June 4th, 1918.

THE VALUE OF A KILOWATT AND HOW TO SAVE IT.

By John J. Dempsey

Vice-President Brooklyn Rapid Transit Lines.

WHAT is a kilowatt?

In terms of economy—of power saving—which is in a double sense a burning issue to every industry and the nation at large today, a kilowatt represents the consumption of *three pounds of coal.*

In the much-discust matter of heat, for instance: The operation of trains *without* heat requires *four kilowatts per car mile.* With three points of heat on, it requires between five and one-half and *six kilowatts per car mile.* Thus the heating of a car requires 30 *per cent* of the power required to operate it.

Obviously, then, it is the duty of every conductor to keep in mind the amount of energy wasted in the opening and closing of doors. With due care in this regard alone, a proper temperature could be maintained in the cars on from one-third to one-half less power.

During the cold weather conductors on surface cars should keep the rear doors closed as much as possible and, during non-rush hours, ask passengers to use the rear entrance entirely, thus keeping the front doors closed and contributing to the comfort of passengers. When conductors find it necessary to confer with motormen they should be careful not to stand with head and shoulders thrust out thru the open front door, but should rather step onto the front platfrom and close the door behind them.

Motormen, for their part, should remember that every time a brake is applied a certain amount of energy is taken out of the train, and that to restore it a further consumption of power is necessary. When a motorman, running thru a congested district, or where cars are blocked, keeps "nosing up" by throwing his power on and off to the jerky accompaniment of the brake, he might as well be shovelling coal out of the Company's bins, or money out of the Company's pockets into a ditch. The Company could really better afford to *pay such a man to stay at home and not work at all.*

Proper and economical operation requires a motorman to use his brake as seldom as possible consistently with safety and to coast as long and as frequently as possible consistently with his schedule.

So far as the public is concerned, it is perhaps not unnatural for persons who have no sense of the amount of coal necessary to operate a system like the Brooklyn Rapid Transit to think, because we have what seems a great quantity of coal in our bins that that is sufficient to operate almost indefinitely and furnish ample heat as well. But that is only because they view the situation from the standpoint of their own coal consumption. If they stopt to think that it takes *one and a half tons of coal* to run *one* five-car train from Union Square to Coney Island and back and that two such round trips consume more coal than the average family uses in a year, they would, if fair-minded, be disposed to withhold judgment.

Reclaiming the U-Boats' Toll by Novel Salvage Operations

THE toll of sunken ships occasioned by the advent of unrestricted U-boat warfare and "spurlos versenkt" promises to be a large one by the end of the war, in spite of all of the anti-submarine devices and protective means that have been promulgated and put into active practise. As we approach the close of four years of the World War with twenty nations locked in a titanic struggle to see whether Democracy or Autocracy shall prove to be the "survival of the fittest," the toll of the German U-boats and mines has mounted up into the hundreds of thousands of tons of shipping. Certain it is, from the present aspects of the one thousand and one problems of reconstruction which will come to our hands in the great aftermath of the World War that we shall be confronted with the unmistakable and undoubted need of a greatly increased tonnage of ships to carry much needed supplies to the various countries now being devastated. Therefore, as we cannot build ships sufficiently fast to catch up with the gigantic shipping requirements which are sure to face us the day after peace is declared, we will have but one other ultimatum—that is, to devise some means of accurately locating and raising the hundreds of ships, both large and small, which have been sunk by the enemy submarines.

There has been a veritable flood of patents issued in the past few years on many apparently feasible as well as many impractical schemes for raising sunken ships. In the present instance we shall examine the claims of three recent patentees who aim to provide apparatus for locating and raising the victims of the greatest submarine warfare ever conducted.

The first patent concerns a powerful telescopic electric searchlight for locating and inspecting sunken vessels. The details of this scheme are indicated in illustration "A," and were evolved by the fertile brain of Mr. William Zach Pulliam. This invention relates to submarine telescopes to aid in salvaging sunken vessels and the like, and as the patentee states in his specifications, the primary object of his invention is to "provide a new and improved construction of telescope as well as a novel manner of mounting it upon the wrecking barge. Another object of the invention is to provide a telescope of the character illustrated and having an improved form of the objective fitted with a ring of powerful, incandescent electric lamps in such a manner that a more efficient use of the telescope may be obtained."

As is evident from the illustration, the collapsible telescope may be swung either up or down in a vertical plane, or from right to left in a horizontal plane, by virtue of its ball-mounted pedestal. The device is quite a large affair as may be imagined, and the operator sits in a seat placed on a carriage secured to the base of the telescope; in this way he may keep his gaze centered thru the telescope and objective lens, the latter having an opening at the center to permit the operator seeing thru it. Electric feed wires pass down thru the interior of the telescope to supply current for the powerful electric lamps placed in front of the parabolic reflector which is mounted just back of the objective lens.

In order to operate this large exploring searchlight, the operator is equipt with a loud-speaking telephone running to the engineer's post on the barge carrying the apparatus, and in this way he does not have to turn or move his position while inspecting a wreck, or when issuing orders to the engineer for raising or lowering the telescope cables. Current for the electric lamps is derived from a small dynamo driven by the steam engine of the hoisting derrick on the barge, or it can be supplied by storage batteries.

The telescopic searchlight just described is for the purpose of inspecting salvaging operations, or for locating sunken ships, et cetera, while the illustrations at Figs. "B" and "C" show two novel schemes devised for the actual work of salvaging a submerged wreck.

The salvaging apparatus illustrated in Fig. "B" was invented by Mr. John D. Hilliard, of Glens Falls, New York. This idea involves one of the most ingenious applications of electro-magnetism that we have encountered for some time. We have described from time to time in the ELECTRICAL EXPERIMENTER the famous "wireless pup" and the "sound-controlled dog," but the present electro-magnetic animal devised by Mr. Hilliard can only be known by one name — "sand-hog," — for sand-hog it certainly is. The series of operations to be carried out in Mr. Hillard's ship salvage scheme is somewhat as follows:

He first provides an electro-magnetic, self-propelled double-wheeled pilot or "sand-hog," as we may call it. The detailed view of this most ingenious mechanism is shown at the right of Fig. "B." In brief, this almost human electro-magnetic pilot comprises a small double-wheeled truck or carriage attached to one end of a flexible hose or tube, thru which electric control wires, etc., may be carried. It is also possible to project a comprest air or high pressure water blast thru this flexible tube and out thru a nozzle fitted on the front of the sand-hog. The wheels of this curious looking self-propelled pilot are caused to revolve by means of a hydrostatic (water pressure) or electric motor, controlled from above. Powerful electro-magnetic coils encircle the steel axled wheels, magnetizing them powerfully. Thus we see that a very curious and novel condition is provided, viz.,—that as the electric motor tends to rotate the wheels, either *backward* or *forward* as may be desired, these same steel wheels are strongly magnetized owing to the effect of the magnet coils just described, and the sang-hog will therefore, if lowered into the water near the side of a submerged iron hull, tend to crawl along the surface of the hull without slipping.

Armed with this semi-intelligent mechanism, the salvage engineers proceed to lower the magnetic pilot and its attached cable from the working barge in such a direction that the sand-hog will take hold of the steel side of the ship and start working its way down toward the keel. As the illustrations at Fig. "B" clearly indicate, the sand-hog manages to cling to the steel surface of the ship's hull, and by means of the comprest air or water jet blast, a path is cleared for it continuously thru the mud or sand in which the hull may lie. It is evident that as the magnetic pilot progresses it will blow a channel or trench for itself clear around and under the bottom of the hull, until it is once more in a vertical position on the opposite side of the hull.

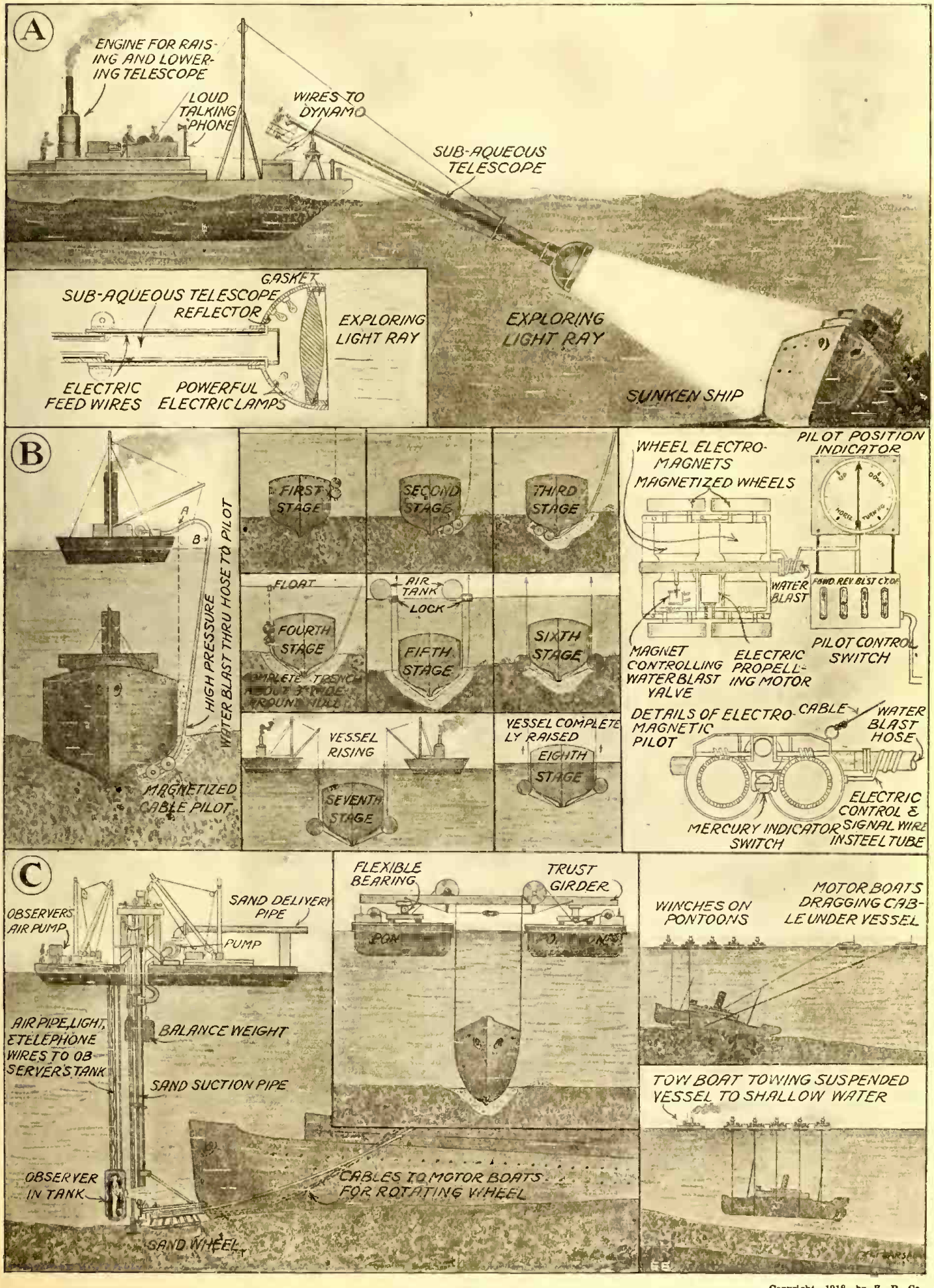
When the sand-hog has reached the position just mentioned, that is a vertical position on the opposite side of the hull, with the water jet nozzle pointing upward toward the surface, as indicated by means of a special electrical position-indicator attached to the pilot, then the time has arrived when a buoyant float attached to a light line can be shot thru the hose pipe by comprest air. The float emerges from the nozzle of the sand-hog and, due to its buoyancy it shoots to the surface of the water and is made fast to a second barge. The sand-hog now has its propelling motor started up, but in a *reverse* direction, so that it *backs up* along the path it has previously pursued in crawling around the hull. It is then hauled into the starting position for a second trip under the hull, the line attached to the float having been secured at both ends. The successive operations are now easily understood so far as the sand-hog is concerned, and it is past around the hull as many times as is required in order to place the proper number of cables or chains around the ship. Cables or chains of increasing strength and size may be progressively pulled around under the hull, starting with the thin float line, which is attached at first to a light cable and then a heavier one, et cetera.

Mr. Hilliard also provides a novel scheme embodying the use of buoyant caissons or tanks for raising the wreck. His method of getting these caissons into position about the hull is very ingenious and may be easily understood by reference to drawing, Fig. "B." The first operation is to float the caissons into the proper position on the surface of the water. The cables from the opposite sides of the submerged hull are secured to other caissons, so that when the respective cables are pulled upward by the derricks and engines on the salvage barges, they will act *oppositely* so to speak, with the result that the caissons above one side of the hull will be pulled downward into position, while those above the *opposite* side of the wreck will be pulled down into their respective positions. In order to cause the caissons to sink easily their valves are opened so that water can be admitted; when they have been pulled down into position about the submerged hull, the water is blown out by comprest air thru a hose connecting them with powerful air compressors on the barges at the surface. When all of the caissons or tanks have been blown out, and provided they have been selected properly as to size and number, their total buoyancy will be sufficient to raise the submerged wreck. It is best, however, to have their total buoyancy a trifle less than that just required to raise the wreck and to supply the small extra lifting power required from the barge derricks in order to have better control of the entire operation; otherwise the hull will rise too quickly. After the hull has been raised it can have any holes in its plates repaired by divers and the water pumped out. The salvaged ship can then be towed to the nearest dry-dock and repaired.

The scheme for raising sunken vessels illustrated at Fig. "C," is due to Mr. Charles B. Dawson, of Seattle, Washington. Mr. Dawson's ideas are in some ways quite elaborate, but he has them well worked out, and while in some cases it may be rather

(*Continued on page* 280)

VARIOUS SCHEMES FOR RAISING SUNKEN SHIPS



(For full description see opposite page)

The Magnetic Storm

By H. GERNSBACK

"WHY" Sparks had stopt reading the New York *Evening World:* He contemplated his old meerschaum pipe meditatively while with his long and lanky index finger, stained by many acids, he carefully rubbed a long, thin and quivering nose. This was always a sign of deep, concentrated thought of the nose's owner. It also, as a rule, induced the birth of a great idea.

Again, and very slowly he re-read the article, which millions that same day had read casually, without a quiver, let alone, a nose quiver. The newspaper item was simple enough:

NEW YORK, Aug. 10, 1917.—An electromagnetic storm of great violence swept over the eastern section of the United States last night. Due to a brilliant Aurora Borealis,—the Northern Lights,—telegraph and long distance telephone, as well as cable communications were interrupted for hours. No telegraphic traffic was possible between New York and points West. It was impossible to work any of the transatlantic cables between 12:15 A. M. and 9:15 A. M., every one of them having "gone dead." The Aurora Borealis disturbances affected all telegraph and telephone lines extending between Chicago and the eastern cities. On telegraph wires of the Postal Telegraph Co. without regular battery being applied at terminal offices, grounded lines showed a potential of 425 volts positive, varying to 225 volts negative; the disturbance continuing between 12:15 A. M. and 9:15 A. M.

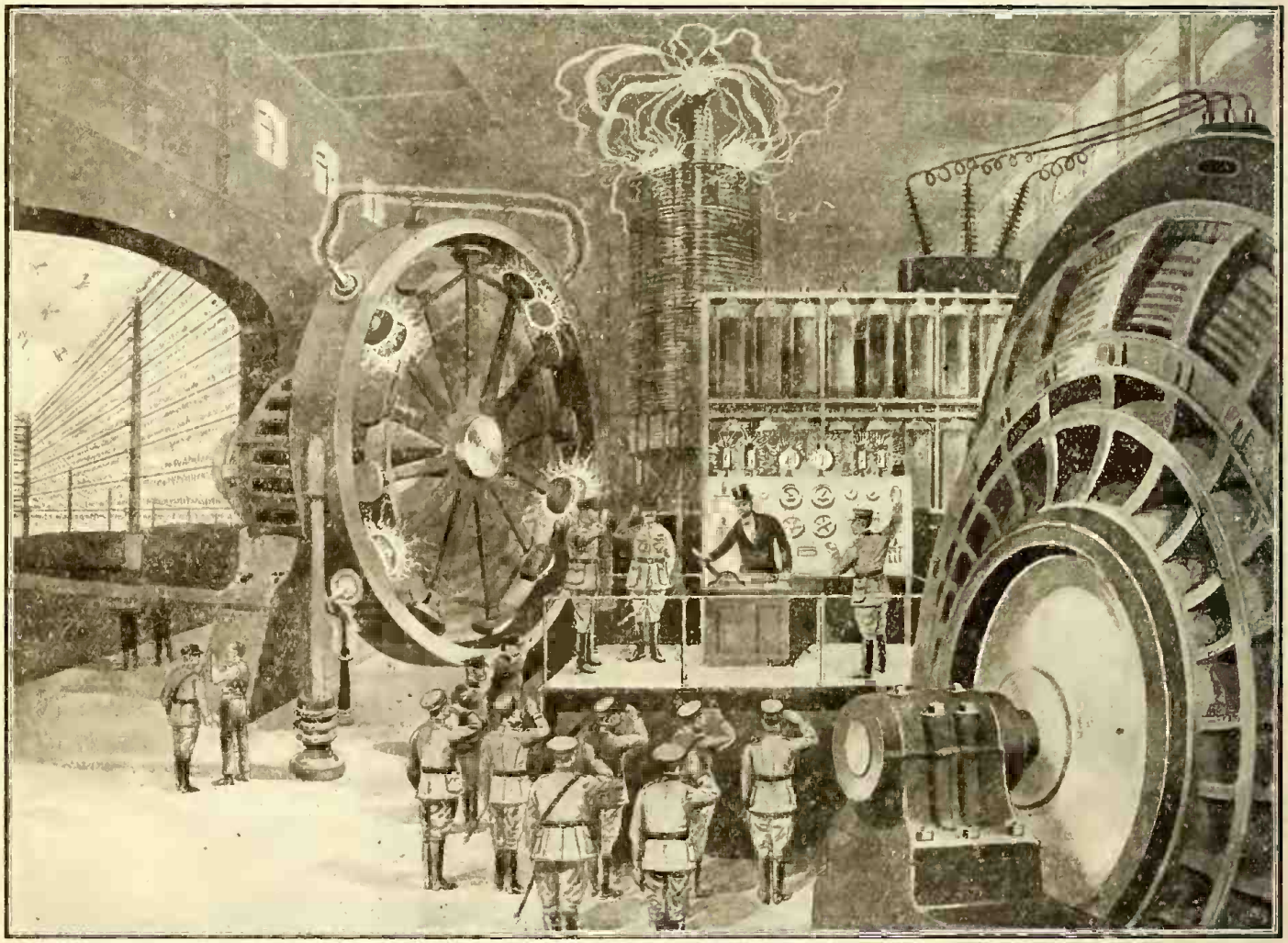
At Newark, N. J., in the Broad Street office a Western Union operator was severely shocked, trying to operate the key, while long sparks played about his instruments.

Sparks rose excitedly and began pacing the cement floor of the vast Tesla laboratory, totally oblivious to the fact that he was sucking a cold pipe. The more he paced about, the more excited he became. Finally he flung himself into a chair and began feverishly to make sketches on big white sheets of drawing paper.

"Why" Sparks had been just an ordinary "Bug," an experimenter, when he entered Tesla's great research laboratory at the beginning of the great war in 1914. Tesla liked the keen, red-haired tousled boy, who always seemed to divine your thoughts before you had uttered five words. His clear blue eyes, lying deep in their sockets, sparkled with life and intelligence and what Sparks did not know about electricity was mighty little indeed. I believe there is no electrical book in existence that Sparks had not devoured ravenously in his spare hours, while having lunch or else while in bed, in the small hours of the morning. His thirst for electrical knowledge was unbounded, and he soaked up every bit of information like a sponge. Yes, and he retained it, too. In short, the young prodigy was a living electrical cyclopedia and highly valued by his associates. No wonder Tesla in three short years had made him superintendent of the laboratory.

Of course, Sparks' first name was not really "Why." But someone had dubbed him with this sobriquet because of his eternal "But *why* is this,"—"*Why*, why should we not do it this way"—"*Why* do you try to do that?" In short his first word always seemed to be "Why"—it had to be, in his unending quest for knowledge. And his "Why" was always *very* emphatic, explosive-like, imperative, from which there was no escape.

Ah, yes, his first name. To tell the honest



. . . The President of the Glorious French Republic Shouts Dramatically: "Messieurs . . . le Jour de Gloire est Arrivé . . . VIVE-LA-FRANCE!!"—and Throws in the Huge Switch With Its Long Ebonite Handle. . . .

truth I don't know it. Last year in the spring when I went up to the laboratory, I thought I would find out. So when I finally located the young wonder, behind a bus bar, where he was drawing fat, blue sparks by means of a screwdriver, I told him that I intended to write something about him and his wonderful electrical knowledge. Would he be good enough to give me his *real* first name?

He was watching a big fuse critically, and in an absent-minded manner exploded: *"Why"?* That finished my mission. So for all I know his real name is "Why" Sparks.

But we left Sparks with his drawings, in the laboratory. That was on a certain evening last fall. To be exact it was about 10 o'clock. At 10:05 Tesla accompanied by two high Army officials strolled into the laboratory where Sparks was still feverishly engaged with sketches lying all about him.

Tesla who was working out a certain apparatus for the Government had dropt in late to show Major General McQuire the result of six weeks' labors. The apparatus had been completed that day and the General, a military electrical expert, had come over specially from Washington to see the "thing" work.

But before Tesla had a chance to throw in the switch of the large rotary converter, Sparks had leaped up, and was waving excitedly a large drawing in Tesla's face. He gushed forth a torrent of sentences, and for fully five minutes Tesla and the two Army officials were listening spell-bound to the young inventor. For a minute or two the three men were speechless, looking awe-struck at Sparks, who having delivered himself of his latest outburst, now became normal again and lit up his still cold pipe.

It was Tesla who first found his voice. "Wonderful, wonderful. Absolutely wonder-ful, Sparks. In a month you will be the most talked of man on this planet. And his *idea is* sound." This to the General. "Absolutely without a flaw. And so simple. Why, oh why! did I not think of it before? Come, let me shake the hand of America's youngest and greatest genius!" Which he did.

There then followed an excited thirty-minute conversation with the two army men and an endless long distance talk with the War Department at Washington. Then there was a rush trip to Washington by Tesla and Sparks, conferences at the War Department, and finally a few days later Sparks went to the White House and was presented to the President, who was highly enthusiastic about the model which Sparks and Tesla demonstrated to the head of the Nation. Still later there were certain rush orders from the War Department to the General Electric and Westinghouse Companies for many big, queer machines, and these same machines were shortly . . . But here the Censor bids us an emphatic "Halt." One may not even now divulge certain military information. You appreciate that.

* * * *

Baron von Unterrichter's flying "Circus" was getting ready to bomb a certain American depot behind the lines. The Americans of late had shot down entirely too many of the Baron's flyers. Only yesterday von der Halberstadt—a German ace himself—and one of von Unterrichter's closest friends had been downed, and killed right inside of the German lines. So the Baron was out for blood this sunny morning. As he put it:

*"Verdammte Yankee Schweinehunde,** we will show them who is master of the air hereabouts," shaking his fist at the American lines beyond.

*For translation of foreign terms see end of this story.

"Sie, Müller," this to an orderly.

"Zu Befehl, Herr Leutnant," replied the young orderly as he came on the run, clicking his heels together, hand at his cap.

"Versammlung, sofort," barked the chief, as he hastened Müller off to summon post haste every man of the aerial squadron for the usual conference before the attack.

In less than ten minutes the thirty flyers were standing drawn up at military attention before their chief, forming a half circle about him. Von Unterrichter's instructions were simple enough. This was a reprisal raid; von der Halberstadt's death must be avenged, fearfully avenged. No quarter was to be given.

IN THE SEPTEMBER "E.E." YOU WILL FIND:

"New Aerial Lasso to Destroy Enemy Aeroplanes," by H. Gernsback.

"Recent Electrical Ideas Applied to Submarines and Torpedoes."

"Telephoning Directly To and From Moving Trains."

"A New Wave Motor That Uses the Energy in Every Motion," by E. D. Stodder, an expert on Wave Motors.

"The Einthoven Galvanometer—Its Theory and Construction Details with Photos of Instrument Actually Built," by Samuel D. Cohen.

"Coney Island's New 1918 War Feature—'Over There'—Read How Electricity Works the Whole Show," by George Holmes.

"Artificial Diamonds and Rubies—How They Are Made in the Electric Furnace."

"The Phenomena of Electrical Conduction in Gases V—Weighing an Ion," by Rogers D. Rusk, M.A.

"An Electrical Laboratory Switchboard—How to Build a Real One." by Harlan Danner.

"Glass-blowing Lessons—How to Heat and Bend, As Well As Build Glass Chemical Apparatus—Part I," by Prof. Herbert E. Metcalf.

"Ohm's Law Applied to Alternating Current Circuits—A Clear Exposition of All the Usual Problems," by Arno A. Kluge, Instructor in Radio, University of Nebraska.

"New Direct Reading Radio Chart Which Solves All Calculations in Wave-length, Inductance and Capacity," prepared by a Marconi Radio Engineer.

"Popular Astronomy — Third Paper," by Isabel M. Lewis.

"How and Why of Radio Apparatus—Part X," by H. Winfield Secor.

"Dieses Amerikanische Gesindel!"—here his voice rose to a shrill pitch, "must be taught to respect us, as never before. The orders are to bomb every American base hospital within the sector. . . ."

At this several of the men recoiled involuntarily, which did not escape the keen eye of von Unterrichter, who now incensed to blind fury, by this show of "softheartedness," as he put it, exhorted his men in his harshest possible terms. "And as for their flyers, you must not give quarter. You must not be satisfied with disabling their machines. Kill them! *Schiesst die Lumpen zusammen!* Pump nickel into them, if you see that they may land unharmed"—this in direct violation of all flying etiquette—a thing abhorred by any decent flyer as a rule. It is bad enough to have your machine shot down, but "sitting on a disabled enemy's tail," and pouring machine gun fire into a helpless man, struggling in mid-air,—where was German prestige coming to with such methods. Plainly the men did not like such liberties with their honor, but orders are orders. They grumbled audibly and cast not very encouraging looks at their chief. Even his parting shout: *"Vorwärts—für Gott und Vaterland,"* failed to bring the usual cheers.

Promptly on the minute of 10 fifteen flyers of the "Circus" rose, like a flock of big white sea gulls, heading in "V" formation towards the American lines. Von Unterrichter was leading his herd in a big *Fokker.* He was out for blood and he meant to have it. His face was set, his jaws clenched like a vise. Hate was written in large characters over every feature of his face. . . . Why didn't these *Dollarjäger* stay home and mind their own business chasing their dollars? What right did they have in this fray, anyway. *"Elendige Schweinebande,"* he spoke out loud, to better vent his overpowering hate.

But where were the Yankee *Flieger* today? The Baron's "Circus" was up one thousand meters and less than a mile away from the American first line trenches, but still no machine in sight, either American or French. Strange. Quite an unheard of occurrence. Afraid? *"Unsinn,"* he muttered to himself, they were not the sort to be afraid. Von Unterrichter knew that. For the first time he felt a vague sort of uneasiness creeping over him. He could not understand. There was not a *Flieger* anywhere in sight. None on the ground either, as he scanned the vast saucer below him thru his *Zeiss.* Was it a new trick, was . . .

Before he finished his train of thought, his engine stopt dead. Cursing volubly he made ready to "bank" his machine in order to volplane down behind his own lines. He congratulated himself that his engine had not stopt later while over the enemy's lines, but his pleasure was short-lived. For he suddenly became aware of the fact that there was a supreme quiet reigning all about him. Why did he not hear the loud roar of the other fourteen engines, now that his own engine was quiet? Looking around he perceived with horror that every one of the fourteen machines of the "Circus" had simultaneously "gone dead," too, *all of them now volplaning earthward.*

Sick with an unknown terror, von Unterrichter made a clumsy landing in the midst of his other flyers, all of them pale, some shaking, some with a strange animal expression in their eyes. *What unknown, invisible hand had with one stroke disabled the fifteen engines, one thousand meters above the ground?*

"Himmelkreuzdonnerwetter," shrieked von Unterrichter jumping to the ground, near his airdrome. "I . . . I . . . cannot" . . . here his voice broke. For the first time in his life the young Prussian was speechless. He then stamped his foot in a frenzied fury, but finally gave vent to a full round of cursing, as only a Prussian can curse. At last he collected his senses sufficiently to look for the cause of the mysterious occurrence. It only took five minutes to find it. His mechanician pointed to the magneto.

"Kaput," he said laconically, if not grammatically.

"Auseinander nehmen," commanded the chief.

It took the deft mechanician but a minute to take the magneto apart, and to withdraw the armature. He gave it one look and with a sickly smile uttered:

"Ausgebrannt, Herr Leutnant." *Herr Leutnant* took the armature into his own hands and inspected it critically. Sure enough it was burnt out, if ever there was a burnt out armature. Perhaps fused would be a better term. The armature was

(*Continued on page* 267)

Electricity and the Range-Finder in War

AS many people are aware, the matter of determining accurately the range between a certain gun or battery of guns and the enemy target, is a very important factor in all military and naval maneuvers. Not so many years ago when the range of artillery was quite insignificant compared to that of today, the matter of *range-finding* as it is known, was an unknown study. All that the officer in charge of a gun battery had to do in those days was to check up the first few shots fired and by watching the effect and the point hit by the projectile thru his telescope, or in many cases simply with the naked eye, the particular gun firing the shots could be readily elevated or lowered so as to change the trajectory of the projectile. But in the past twenty-five years the hit and miss principle of range-finding has been done away with, and a number of more or less accurate range-finding instruments developed, some of which are very ingenious indeed, and extremely accurate for comparatively long ranges.

The photograph herewith shows one of Uncle Sam's latest types of accurate range-finding instruments installed on board a modern dreadnought. The Jackies are shown in the act of determining the range of an object which has been selected as a target for the ship's giant guns, several of which can be seen in the background protruding from their turrets. The operator peering so intently into the eye-piece of the range-finder, and who is wearing a pair of sensitive telephone receivers as well as a transmitter strapt to his person, is one of the most important men in the crew of any fighting ship whether large or small, for if he makes an error in reading the dials of the range-finder, then the enemy may escape being hit. As becomes evident, time is the essence of every naval engagement, for in a few minutes time the enemy if not disabled by your own guns will in all probability plant the major part of a broadside on your superstructure and gun deck, possibly disabling your own battery.

Thus we see that the man at the range-finder has a very important mission to fulfill, when he straps the head 'phones and transmitter on, and proceeds to turn the lenses and other paraphernalia fitted on the range-finding tube, for it is he who controls the sighting of the big guns. It is he who determines the range or changes in range, etc. He telephones these figures to a staff of engineers who are in constant touch with the "gun pointers" in the turrets below. A single range-finder may be quickly disabled even in a long range engagement, and so every war-ship carries at least two range-finders. The large super-dreadnoughts carry as many as a dozen on board, some of them being situated on top of the steel fire-control masts, while others are located in less conspicuous locations.

The diagramatic illustration herewith will help to explain how the modern range-finder does its work. Referring to Fig. A, we have a sectional view of the present day "one-man" range-finder. This comprises two prisms known as the right and left prisms, which are made adjustable by means of thumb screws protruding from the casing of the apparatus. The right and left prism telescopes can be trained on the distant object, and the refracted rays from the prisms are past thru a pair of objective lenses in the manner illustrated. These right and left rays pass along thru the center of the blackened range-finder tube and meet in the center where there is positioned two central reflectors. At this juncture it is well to note the two views shown in the circles at the bottom of Fig. A. These two views show the image of a distant target (a church) as it appears in the eye-piece of the range-finder, before the right and left prisms are adjusted to "coincidence" and "after coincidence," the latter or right hand view being the one observed by the range-finding officer at the point where the instrument indicates on a specially calibrated dial the *correct range in yards.* As will be noted from Fig. A, the upper semi-circular image is the one reflected by the left hand prism. A dividing line separates the two images, and in the present case the instrument is adjusted until the tower of the church slides along toward the left until it is exactly in line with the remaining portion of the tower appearing in the lower image.

So much for the physical action of the "one-man" range-finder. But this does not tell us yet just how the range is determined, excepting that we have learned that when the images coincide, that the instrument indicates the range in yards on a calibrated dial. Probably we will do best to go back a few years to the time of the Boer War in South Africa. At that time the English Army had considerable range-finding to do down among the Köpjes of "Oom Paul's" land. Briefly explained, the "two-man" range-finder then used works after the fashion illustrated in Fig. B. It must be considered before going further, that every

(*Continued on page 278*)

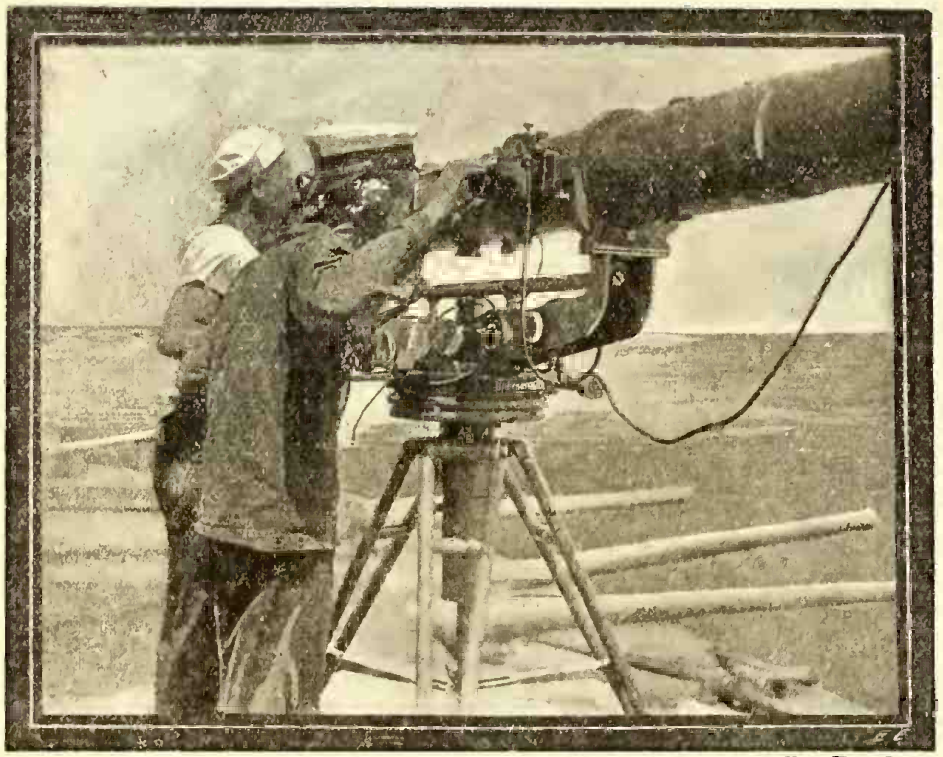
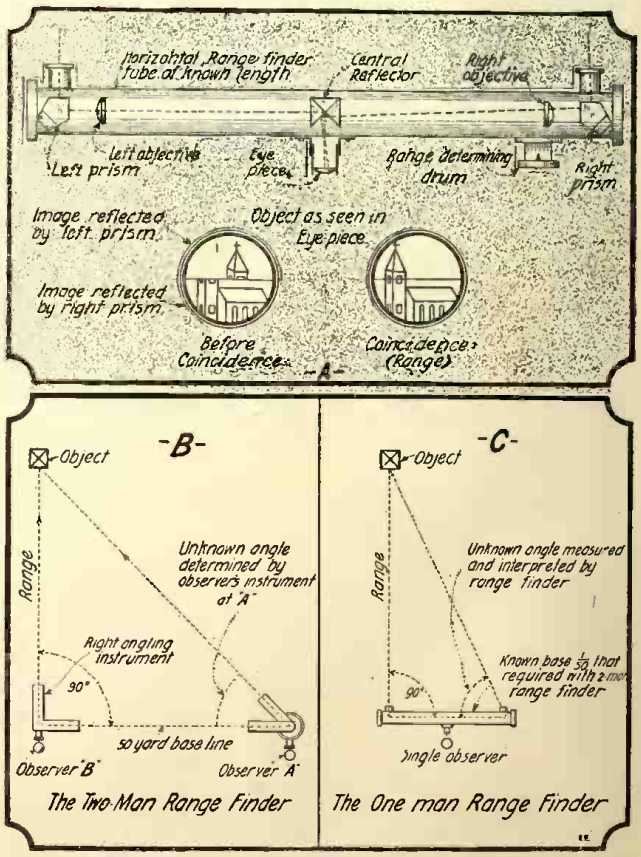


Photo by Central News Photo Service

Getting the Range. Jackies on an American Battleship Getting the Range by Means of the "Range-finder." The Man with the Telephone Apparatus Attached to His Head Controls the Sighting of the Gun and Telephones the Men in the Turret When the Object Is In Range.



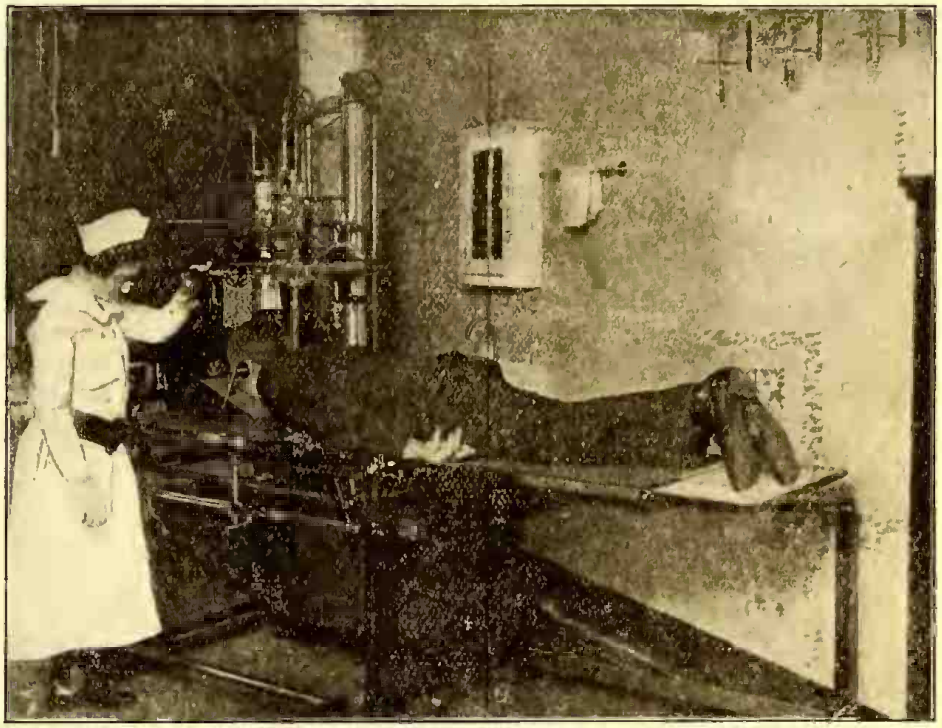
Details of Range-finder and How the Range Is Automatically Calculated When the Base and One Angle of a Right-angled Triangle Are Known.

WOMEN TO LEARN X-RAY WORK.

IT seems that with the war's progress, and its constant inroads upon our male population, it behooves itself upon the women-folk who are left at home to in some way fill these vacancies, so that the speed of war preparations may be kept up to the highest standard.

Also it is to be noted that a steady drain is being made from the ranks of technically trained men which of necessity cripples to quite a large extent the wheels of industry. Women have been excluded from the regular service of both the Army and Navy with a few exceptions, such as Yeoman, etc., but it is undoubtedly a fact that their services would be much in demand in civilian walks of life were they properly trained to fill the constantly growing vacancies.

Foremost in the ranks of institutions who have started in the work of training women for war work may be mentioned the Hunter College of New York City. We have published from time to time the activities of the women folk in the radio service, including the training of drafted men. Now a new branch of scientific study is about to be placed at their service and one that will yield a substantial remuneration for the time and expense of the course, while at the same time aiding the country in its fight for Democracy.



How Young Women Are Being Taught X-ray Technique at a New York College. They Are Put Thru a Rigid and Thoro Course Which Fits Them for Service with Uncle Sam's Fighting Legions Whenever They Are Called.

The course is a special term from June 3rd to August 10th in X-ray work. So far there have been several hundred requests for admission to the course but the school will only be able to handle a limited number of classes. There will be ten students to a class and in making up these classes preference will be shown to those who have been nurses or are acquainted with medical practise. This was only decided upon after due consideration, and it was shown that those already having some training would be all the quicker able to fill the many vacancies at present.

The installation of the apparatus will be taken care of by a large New York X-ray apparatus concern and the cost will be near the three thousand mark. It will be of the best and capable of a very wide range of work.

The course itself will be under the supervision of Dr. Raymond Bartlett Earle. Dr. Elsie Fox, Roentgenologist in charge, City Hospital, will be the X-ray instructor, and an advisory board of prominent doctors and surgeons will complete the list. There will be an afternoon course and also one in the evening consisting of the following subjects: X-ray, including the action, care and operation of the machine, anatomy, French conversation and physics lectures, after which will come the hospital observation in which the students will act as assistants in the taking of actual X-ray photos.

The course will be very thoro, making it necessary for one undertaking it to apply oneself conscientiously to the serious work in hand and none but those attaining a mark of eighty per cent or more will receive a certificate. It is not to be doubted that all taking it up will have the ambition to make good in order that the government may call upon them when necessary.

MOBILE X-RAY NOW USED AT FRONT-LINE TRENCHES.

The Committee on Public Information, Division on Woman's War Work, issues the following:

The X-ray is now carried to the front-line trench for the benefit of wounded soldiers, so that no time may be lost in ascertaining the condition of wounds. The Army Medical Department has developed a mobile X-ray outfit, carried on a standard Army ambulance slightly modified.

This outfit includes an X-ray table, a dark room, also a complete set of apparatus for the localization of foreign bodies. Fully as expert work can be done with this mobile outfit as in any base hospital X-ray department. Its use in the field makes it possible for the surgeon at the front to send a complete report of a soldier's condition when a man is transferred to a hospital back of the lines.

ELECTRIC MACHINE MAKES FIFTY YARDS OF BANDAGES A MINUTE.

The machine being operated by this nurse is expected to revolutionize the making of gauze bandages. It is the invention of J. A. Butler, of Boston, and has been installed in the New England Surgical Dressings Committee workroom.

According to reports the machine is working very satisfactorily. It produces two sizes of folded bandages, one four inches and the other three inches wide. They are folded four or eight times as desired. The machine is capable of turning out 50 yards of bandages in a minute depending on the skill of the operator, which is a great deal faster than the usual method of hand manufacture.

Photo © by Underwood & Underwood

This Remarkable Electric Bandage Maker Turns Out Fifty Yards of Bandage a Minute. It Produces Two Sizes of Folded Bandages, One Four Inches and the Other Three Inches Wide.

How Birds Take Their Own Pictures Electrically

By Dr. E. BADE

IT is difficult to take good animal pictures in the open for the simple reason that the camera sees differently than the human eye. The various colors of nature do not sensitize the film in proportion to their light values, and since the film is color blind, it interprets little more than light and dark.

The difficulties of approaching the animal one desires to photograph can be surmounted with the following electrical device. This contrivance consists of three dry cells, an electric bell, a small electro-magnet, and a contact or switch box. The contact box consists of a strong wooden base upon which is screwed a support for a movable scale-like contrivance. A strong wire rod, or a long nail is used for a pivot. One arm of the scale extends about four inches. At the extremity of this arm a light twig is fastened. Just behind the pivot the other arms slopes gently downward and ends in a box-like receptacle into which stones, pieces of iron, or lead are placed, so that this end little more than counterbalances the other arm. The first arm, to which the twig was fastened, also carries the contacts which only closes the circuit when a bird is sitting on the branch. As can be seen from the accompanying drawing, the wires carrying the current are here interrupted and flattened. One end of the wire is rounded into a shallow groove, while the other is flat. Just above the two flattened wires is a "V" shaped piece of copper, supported by a piece of wood which in turn is fastened to the movable scale-like arm. The "V" shaped piece of metal fits loosely between the wooden support and slides with its heavier end in the groove. When the twig is pushed downward the lighter end of the metal touches the flattened wire. This closes the circuit.

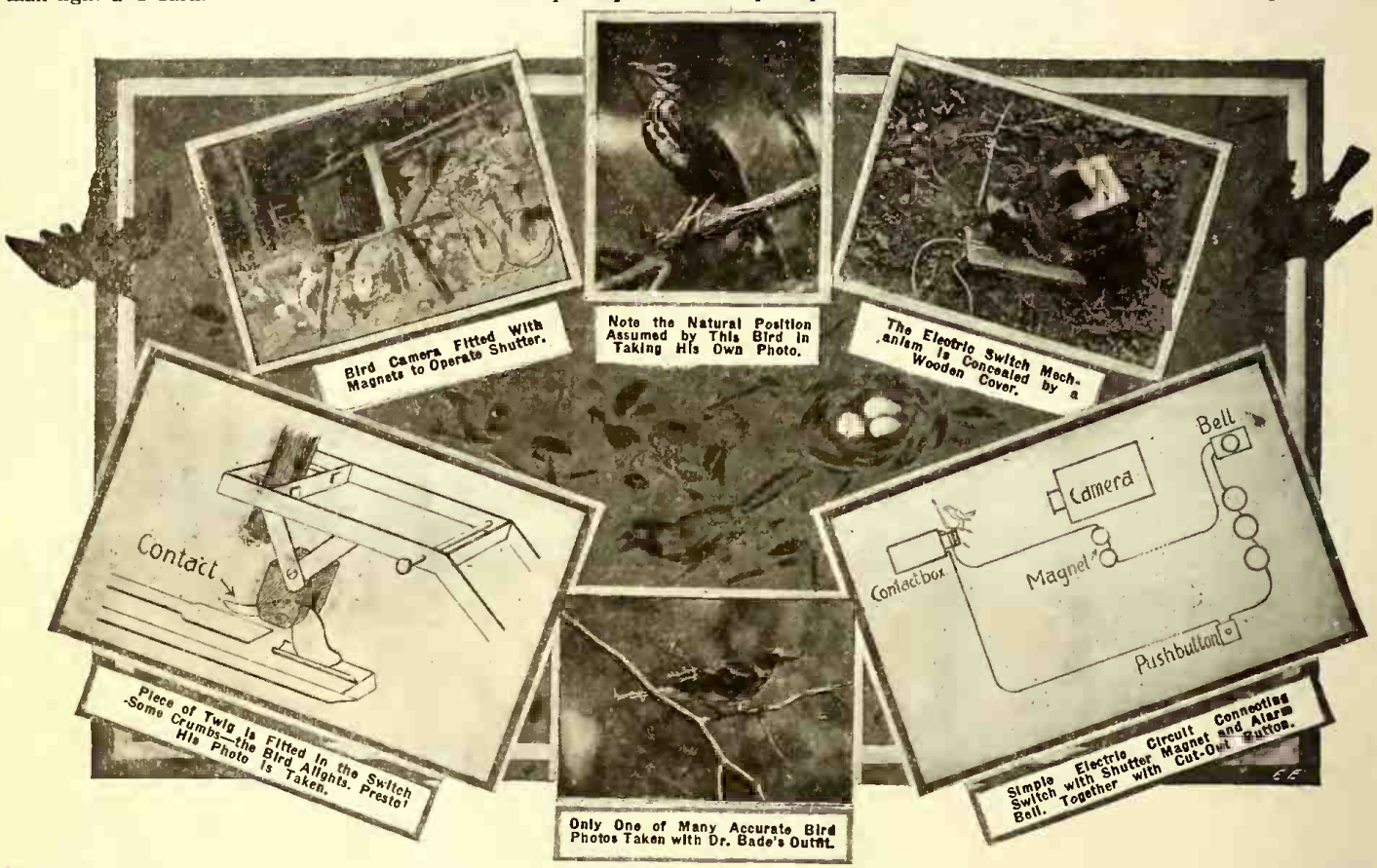
The camera is placed upon a small table or an especially contrived tripod upon which the electro-magnets are fastened. The camera used in this case was a Graflex, having a push button which releases the shutter. A large angle iron was taken, a knob placed at one end, and a weight at the other. The knob was adjusted so as to come into contact with the push button, while the weight at the other end of the iron was increased until a slight pressure released the shutter. The magnets were then placed upon a projecting support so that they came within an eighth of an inch of the angle iron.

The camera is now focust upon a twig or any other suitable object fastened to the arm. The instant a bird hops upon the twig the circuit is closed and the magnet is energized, instantly drawing the angle iron downward. This releases the shutter and the photo of the bird is secured.

It will be found advantageous to introduce an electric bell into the circuit as it instantly rings when a picture has been taken, thus enabling the operator to reload the camera at once.

It will be found that certain birds frequent certain places more than others. Now, in order to secure a variety of birds, an electric push button is also introduced into the circuit. This button is placed at a little distance from the camera but still within sight of it. When the operator sees a bird advancing towards the contact box, he presses the button and the picture of the animal will be taken, provided that the birds jumps upon the twig. When he sees that other birds are in the vicinity which he does not desire to photograph, the push button is released. Should the bird hop on the twig, the circuit will not be closed, and no picture will be taken, since the circuit at the push button remains open. But press the button and the picture of the bird is instantly taken.

Of course, this device must be placed where from previous observation birds have been frequently seen. These places are usually found near or at bird-houses or bird-baths. The birds can also be attracted to certain places by food. This is placed out a few days before the camera is used so that the birds will become accustomed to this contrivance.



BIG TURBINE FOR NEW YORK.

The United Electric Light and Power Company of New York City has recently placed an order with a large Pittsburgh electric manufacturing company for a 22,000 kilowatt turbo-generator set. The gigantic generator will be rated at 25,900 kva. at 85 per cent power factor, 8,000 volts, 3-phase, 62½ cycles. It will be direct-connected to a steam turbine. The order includes a 40,000 sq. ft. surface condenser and the usual auxiliaries.

The Electrical Women of England

By ALBERT H. BRIDGE

(London Correspondent ELECTRICAL EXPERIMENTER.)

QUITE early in the war it became obvious to the British Ministry of Munitions that if fighting men were to be released from industry without reducing the output of war requirements, women must take their places.

Those of us who have been more or less closely and sympathetically observing the course of such matters all along, know something of the difficulties that have lifted their ugly forms and spread themselves across the path of progress; we also know with what tact, adaptability and determination each new critical situation has had to be negotiated. Prejudices from employers and prejudices from workmen, had to be broken down a bit at a time, and all the while headway had to be made with the suitable training of educated and other women. Only the most imperative demand of absolute necessity made the change possible so that it may be said that under the influences of compulsion we have been able to secure practical experience of inestimable engineering value which we might not have had in decades of normal operations.

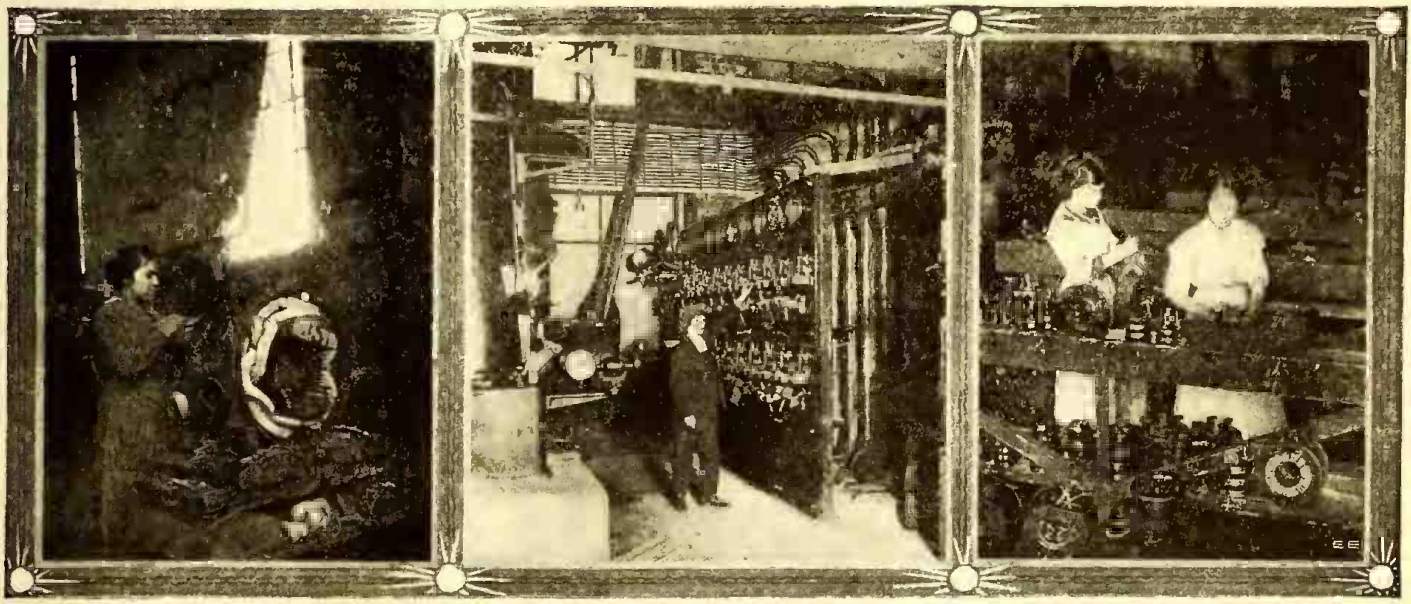
Gradually our women were brought under training for special operations, and work to which women had never previously put their hand was soon proved to be well within the compass of their strength and their adaptability. In practise such results have been obtained as should demolish absolutely all prejudices so far as individual or ultimate efficiency is concerned. Just now, when still more men of military age are leaving the bench for the camp and the trench, experience and necessity are working hand in hand to that end.

It was, of course, no new thing for women and girls to be engaged upon many small electrical manufacturing operations. Years before the war the writer had witnest their efficient employment in electric wire and cable factories, in armature winding work, electric lamp manufacturing and testing, in conduit and switch work, and in the making of numerous small accessories. In one case in London a factory was run for a time in which crippled girls, exclusively, were engaged in the manufacture of electric lamps in which substitutes for platinum formed a special feature. But where in the old days ten women were engaged in electrical manufacturing activity, there are now thousands of them and the number of operations, or classes of service rendered by them, have increased correspondingly.

By courtesy of the Ministry of Munitions the writer is able to illustrate some typical examples of what English women are doing in electrical works. Before the war we regarded with distinct amusement a novel departure in American electrical practise when we read in the electrical press that at some small out of the way station in the States a woman part-proprietor ran the plant. We even looked upon it as a freak—perhaps you Americans did so too—but such is not the case today. We now have women working in some of the largest power stations in the United Kingdom. Experience with them on the whole is not unsatisfactory, yet I believe I should feel pretty safe if I had to predict what would happen in this particular connection after the war.

One of the accompanying photographs shows a woman engaged in electricity works service—in charge of a switchboard for 500 kilowatts. I recently inspected the most complete and educative official collection of specimens of electrical work the product of woman skill and labor—and I saw photographs of women engaged in charge of a 1,000 horsepower steam engine, another attending a 300 kilowatt direct coupled engine set, others building small commutators, operating presses for armature work, assembling ironclad switchgear, erecting switchboards, driving 40 ton cranes, driving electric trucks, conducting electric welding operations, making electric contact mines, making parts for internal combustion engines, sparking plug parts, magnetos, lampholders, lighting switchboards for mechanical transport work, etc.,—indeed a mere catalog of the different occupations in which they are engaged, tho it would prove their multitudinous and multifarious nature, would be monotonous. Yet what is happening in the electrical world is but an illustration of the deftness, skill, ability and willingness that women are demonstrating every day in a host of other departments of industry directly or indirectly connected with munitions production.

The position up to date is: there are 950,000 women engaged on munitions products! Mr. Ben H. Morgan, who was for two years Dilution officer under the British Ministry of Munitions gives us to understand that they are turning out *nearly one-third of the total output!*



How the Women of England Are "Doing Their Bit" by Building and Operating Electrical Machinery. Left—Winding A. C. Induction Motors; Center—One of the Many Central and Sub-station Switch-board Operators; Right—Assembling Small Motor Commutators.

NAVAL AVIATION WIDE OPEN FOR YOUR TRADE.

"Here's a chance to enroll in the United States Naval Reserve Force and work at your own trade.

The naval aviation section needs a great number of men immediately. Good ratings and good pay are possible for qualified men. Here is the list of ratings and the necessary trades.

Machinists' Mates—General machinists, automobile mechanics and assemblers, toolmakers, diemakers and similar mechanical trades.

Quartermasters—Cutters and cloth fitters, upholsterers, canvas workers, painters, tent riggers.

Carpenter's Mates—Woodworkers of all kinds.

Blacksmiths—Toolsmiths, forge men, furnace men, etc.

Shipfitters—and all kinds of sheet metal workers.

Coppersmiths—

Applicants must be American citizens from 18 to 35 years of age. Draft registrants will be accepted upon presentation of a letter from their local boards.

Men of the foregoing trades will be sent to school for special training.

Applicants may enroll at 51 Chambers Street, New York, or at any Naval Recruiting Station in the United States.

There you are. Now sign up and help the Navy Airboats get the U-boats."

Popular Astronomy

THE GASEOUS NEBULAE—SECOND PAPER

By ISABEL M. LEWIS

Of the U. S. Naval Observatory

THERE exists in the heavens, at a conservative estimate, from half a million to a million nebulae that are visible in the greatest telescopes. A very few of these, notably the Great Nebula in Orion, the Great Spiral Nebula in Andromeda and a particularly bright nebula in the Southern Hemisphere can be faintly distinguisht without telescopic aid. So extremely faint are the great majority, however, that it requires all the light-gathering power of the most powerful telescopes, aided by photographic exposures of several hours' duration, to bring out the details of their varied and intricate structure.

An Irregular Nebula in Cygnus (N. G. C., 6960). Photographed by G. W. Ritchey with the two-foot reflector of the Yerkes Observatory.) This Nebula Appears in One of the Denser Portions of the Milky Way. Note That it Extends Across Regions Occupied by Many Stars, a Proof of its Tremendous Size.

Altho the nebulae are most diversified in their general appearance, they may all be classified into three groups: the vast *irregular nebulae*, the comparatively rare *planetary nebulae*, and the mysterious *spiral nebulae*. Members of the first two groups are strictly gaseous in their nature, but the last group, which includes by far the greater number of all the nebulae, has characteristics that seem to point to an entirely different origin.

In fact, it may turn out that the *spiral nebulae* are not nebulae at all. This most puzzling group which has been the subject of an unusual amount of investigation and discussion in the past few years will be treated of separately in another article. We will consider here only the true *gaseous nebulae*—the *planetary* and *irregular nebulae*.

Gaseous nebulae can be distinguisht by the nature of their light which gives, when examined with the spectroscope, what is known as a bright-line spectrum. According to the first law of spectrum analysis such a spectrum is characteristic of incandescent gases shining only by their own light under low pressure. What these gases are can be determined from the positions of the lines in the spectrum, since to each chemical element belongs always the same line or set of lines in the spectrum. It has been found that all gaseous nebulae are composed of hydrogen and helium gas and an unknown gas found only in gaseous nebulae and named for that reason *nebulium*. This peculiar gas is characterized by a bright line in the green part of the spectrum that gives a greenish tinge to the gaseous nebulae. They are for this reason sometimes referred to as the *green nebulae* to distinguish them from the white or spiral nebulae. It is believed that the presence of nebulium may be due to some form of electrical excitations existing in extremely rare gases.

The irregular nebulae are, there is every reason to believe, the primordial stuff from which the stars are made. They fill a tremendous volume of space but possess very low density and small total mass. This is evident from the fact that they are certainly as distant as the stars, with which they are frequently associated and yet they cover an apparent space in the heavens that would be filled normally by hundreds, or in some cases thousands of stars. When we consider that the average diameter of a star is about a million miles and that within a sphere whose radius is, according to Newcomb, 412,500 times the radius of the earth's orbit (the radius of the earth's orbit being 93,000,000 miles) there exists but one visible star, on the average, we begin to realize how enormous must be the volume of space filled by the vast irregular nebulae. Were they not of small mass and low density, their gravitational force would be so great that they would draw to them all the neighboring stars.

Estimates of the densities of the gaseous nebulae are usually placed between one

A Typical Planetary Nebula—Note Strong Central Star-like Condensation. (Photographed with the Crossley Reflector of the Lick Observatory.)

hundred thousandth and one millionth of the density of the earth's atmosphere. It has been found very difficult to explain how the luminosity of the gaseous nebulae is maintained under the conditions of extremely low temperature and pressure that must prevail everywhere, except in the more central portions of the nebulae. It is believed that the light of the gaseous nebulae must be due partly to some form of electrical excitation. It is not understood, moreover, how the nebulae can show the complex structure that characterizes them under the force of gravitation alone. Some other forces such as electrical repulsion or radiation or light pressure must be at work as well.

Irregular and planetary nebulae bear a strong resemblance to each other in some respects, yet differ radically in others. Both types show a marked preference for the plane of the Milky Way, the fundamental plane of the sidereal universe. They are found most frequently where the star clouds are densest, and they are as often as not associated with stars that are classified as *young* stars. They are never connected with stars of an advanced type. The stars enmeshed in the gaseous nebulae are the helium stars, or as they are frequently called the *Orion stars*, because they occur in such great numbers in the Great Orion Nebula and its extensions. They are characterized by their extremely low density and intense blue light. Great star groups such as the *Pleiades* and the chief stars of the constellation Orion are sometimes enwrapt in one vast irregular nebula which often condenses locally around conspicuous stars of the group. At the very center of the Great Orion Nebula is a multiple star of six components that is beyond a doubt physically connected with the Great Nebula. All the conspicuous stars of the Pleiades are surrounded by a faint nebulous haze which appears to shine partly by reflected light from these stars and partly by its own luminosity.

Portions of these great irregular nebulae are non-luminous; dark streaks and lanes are frequently observed in the bright gaseous nebulae singularly devoid of stars as if dark absorbing matter shut off the light from stars lying beyond.

Observations of the Great Orion Nebula have shown a whirling motion of its parts, tho as a whole this vast nebula is almost stationary in space. This brings us to the most marked point of difference between the irregular and the planetary nebulae, that of their motion thru space. The irregular nebulae are the most slowly moving of all celestial objects, being practically at rest or simply drifting thru space, while the planetary nebulae are to be classified among the most rapidly moving objects in the heavens, their speed averaging much higher than that of the stars. The *planetaries* are also extremely small as compared to the irregular nebulae, receiving their name from their resemblance to faint planetary disks. They are usually associated with a single star or show a star-like condensation at the center. There are, moreover, comparatively few of these objects, not more than one hundred and fifty being catalogued up to the present time. The latest observations seem to indicate that these small nebulae have arisen as a result of some celestial collision or catastrophe, and that they have an unusual origin. Recent observations show that some of them are in rapid rotation. The temptation to connect these in some way with the temporary stars or *Novae* (new stars) that apparently owe their origin to some celestial encounter is very great, especially since the Novae are observed at a later stage to be surrounded by a nebulous haze bearing a strong resemblance in composition and general appearance to the planetary nebulae.

The spectrum of the planetaries is, on the other hand, very similar to a certain rare class of stars known as *Wolf-Rayet* stars. These stars, the Novae and the planetary nebulae are all closely confined to the plane of the Milky Way and some relationship between the three classes of objects may be traced as a result of further observations.

We may now briefly summarize the

(*Continued on page* 280)

The Great Nebula in Orion (Photographed by G. W. Ritchey with the Two-foot Reflector of the Yerkes Observatory). This is Generally Considered to Be the Finest of all Nebulae as Well as One of the Most Magnificent Objects in the Heavens. The Distance of the Great Nebula Is Uncertain, Tho It Cannot Be Less Than Several Hundred Light Years. According to Recent Investigations by Prof. W. H. Pickering, the Nebula Is 6,250 Light Years Distant and Its Diameter, Including All the Ramifications That Envelope the Entire Constellation, Is 1,700 Light Years. Upon This Assumption the More Central Portion Photographed Above, Showing the Multiple Star Theta Physically Connected with the Nebula, Has an Extent of Nearly One Hundred Light Years or More Than Six Million Times the Distance from the Earth to the Sun. The Entire Nebula Forms One Seething, Tumultuous Mass of Incandescent Gases Whose Density Has Been Estimated as Low as One-millionth of the Density of the Earth's Atmosphere.

The Ring Nebula in the Constellation Lyra (Photographed by G. W. Ritchey with the Five-foot Reflector of the Mount Wilson Solar Observatory). One of the Finest of the Annular Nebulae, a Variety of the Irregular Type of Gaseous Nebulae. Note the Central Star, Which Is Physically Connected with the Nebula.

The Phenomena of Electrical Conduction in Gases

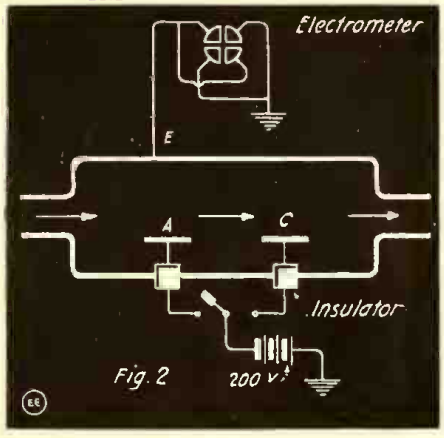
PART IV—WHY IONS DISAPPEAR

By ROGERS D. RUSK, M. A.

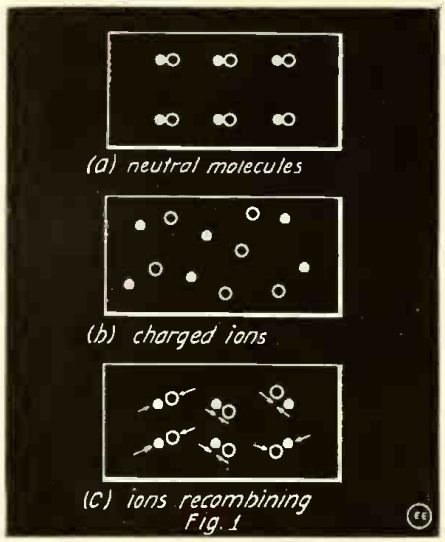
THE behavior of the electrically charged particles of a gas is at times almost magical in nature. Unseen forces may suddenly produce them and other unseen forces may as suddenly make them disappear. The scientist who wants to know whether or not a gas will conduct electricity must first know whether there are any ions present in the gas. If he wants to know just how much electricity will pass thru the gas he must also know how many ions have been produced and how many have disappeared. It is a well-known fact that if an ionized gas is allowed to stand for some time it will in some way lose its ions and its power to conduct electricity. This seemingly mysterious phenomena, however, can be very easily explained by two words—diffusion and recombination.

Diffusion is the scattering of ions and their migration to a conductor where they lose their charge and *recombination* is the reuniting of the ions of a molecule again. The numerical figures which represent the rates at which these processes continue are called respectively the *coefficient of diffusion* and the *coefficient of recombination.*

In order to obtain these coefficients or rates of disappearance of the ions it is necessary in some way or other to count the ions or determine their relative numbers at different times. An ion, however, is far too small to be visible even in the highest powered microscope. Moreover it is too small to ever be visible to the human eye. That may seem like a rash statement in this day and age of scientific miracles, and yet it must be remembered that the human eye is only sensitive to certain wave lengths of light. Now the ion would either reflect only a single pulse of light which would give it neither size nor shape, or it would reflect waves of light many, many times too short to affect the human eye. As long then as the human eye retains its present limitations, the ion will remain invisible. Notwithstanding the fact that we cannot see these particles we can prove their presence by means of the *electroscope* or *electrometer*, and we can obtain a measure of the total number present by measuring the total effect on the instrument. Much work of this kind, including the determination of the above two coefficients, has been done quite recently by the world's leading physicists, including J. S. Townsend and J. J. Thomson of England.

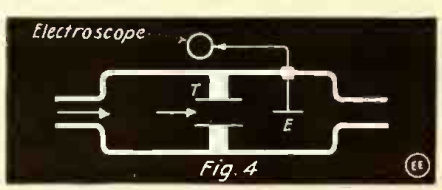


Form of Tube Used for Measuring the Disappearance of Ions by Recombination, with the Aid of a Quadrant Electrometer.



Showing Arrangement of Neutral Molecules, Charged Ions and Ions Recombining.

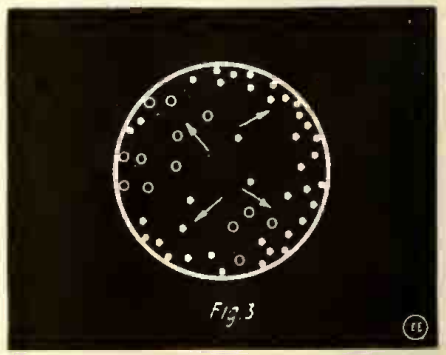
Recombination is a very natural consequence of ionization and as its name implies, means the recombination of positive and negative ions just after they have been formed. For instance when a neutral molecule experiences the force of some ionizing agency it is torn asunder and forms *two equal and oppositely charged* ions; now these oppositely charged particles attract each other according to the laws of electric attraction, and if they are not suddenly driven far apart by some force, this attraction will cause them to reunite and thus form neutrally charged molecules again. This can be shown diagramatically as in Fig. 1, where each stage of the action is shown. In any ionized gas then, where there are equal numbers of positives and negatives, recombination will finally remove the conductivity of the gas. If there are unequal numbers of positives and negatives, the rate of recombination will depend upon the relative numbers of each. If the ions are removed from the field as fast as they are formed, that is by a saturation current, recombination will not take place. If, however, there is no electric field acting to remove the ions, the number will increase until they are so close together that they recombine as fast as they are formed or, in other words, the rates of recombination and ionization are equal; then the gas will have reached a steady state and the number of ions will be a maximum.



Method Used In Determining How Fast Ions Disappear By Diffusion By Means of An Electroscope, Which Measures the Amount of Charge in the Gas Passing Thru the Tube.

Scientists define the rate of recombination mathematically as $\frac{dn}{dt}$ and put it equal to αn^2 where α is called the coefficient of recombination and "n" is the number of ions of either sign present. It can be seen that α is merely a constant which expresses the relation between the rate of recombination and the number of ions present. As the amount of current which will pass thru a gas depends upon the number of ions present in the gas and the number of ions depends upon the rate of recombination, then the current depends on the rate of recombination.

One of the earliest determinations of the coefficient of recombination was made by E. Rutherford in 1897, by the use of a metal tube similar to the one shown in Fig. 2, by blowing a current of ionized air thru it and measuring the conductivity at different distances along the source. For instance if the current from electrode C to E, is one-half what it is from A to E, then half of the ions have disappeared and the time taken for them to disappear was the time for the gas to travel from A to C down the tube. The only measurement it is necessary to take are the currents thru the gas at A and C, and the rate of flow of the gas from A to C. The rate of recombination has been found to vary with the different methods of producing ions,



The Way In Which Ions Diffuse to the Sides of a Containing Vessel.

showing that the kinds of ions that are produced, vary with the nature of the gas, and with the temperature and pressure.

Under certain conditions the disappearance of ions by *diffusion* is even greater than by recombination, hence it must be taken into very careful consideration. Diffusion is the thinning out or migration of ions which may be due to the following causes: If there is a greater density of ions in one part of a certain volume of gas than in another part, the ions will spread out toward the less dense part. If ions of one sign only have been generated in a gas, any adjacent particles being of similar charge will repel each other and all of the ions will tend to spread as far away from each other as possible. This is true of like ions when both positives and negatives are present. Then when ions by any means approach the wall of the containing vessel or any

(*Continued on page 279*)

FARMERS LEARN ELECTRICITY.

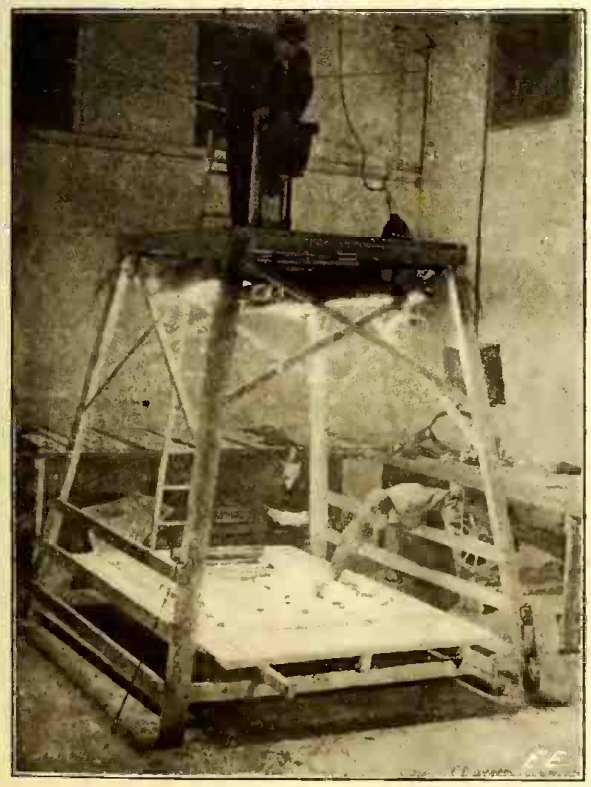
The University of California is teaching farmers to use electricity. In the near future the indications are that the efficiency of electricity on the farm will be generally recognized and adapted.

PHOTOGRAPHING AUTO PARTS WITH MERCURY VAPOR LAMPS.

A complete and accurate catalog of parts is one of the necessities for every automobile manufacturer. Every detail must be illustrated, either separately or assembled with others into one of the parts of the car. A unique method of taking the photographs necessary for these catalogs has been worked out by a prominent automobile manufacturer.

Use is made of an elevated platform under which can be placed a large flat wooden table. On this are arranged various items, each with its appropriate title and number, printed on a card, laid beside or below it. The boundary of the photograph is marked by black wooden strips. Thru a hole in the platform the photographer focusses his camera upon the display below. Light is furnished by four mercury-vapor tubes, hung underneath and near the edges of the platform. Due to the highly actinic quality of the mercury-vapor light, the exposure is much shorter than with other illuminants having the same apparent brilliancy.

This arrangement possesses numerous advantages, among which are that it enables the various parts to be associated with descriptive text, or explanations of the workings of complex apparatus. Much greater speed can be made in getting out instructions, since only one photograph need be taken of the entire group. Photographing from above is also very much quicker than from in front, because the parts can be much more easily arranged on the horizontal platforms and removed or rearranged for the next picture, than where it is necessary to tack up the parts on a vertical background.—*Courtesy Willys-Overland Co.*



Photographing Automobile Parts With Mercury Vapor Lamps and Camera Set Vertically Above the Objects, Thus Saving Much Time in Arranging the Display.

HUNS HAVE DEVICE TO HELP U-BOAT CREWS TO SURFACE AFTER WRECK.

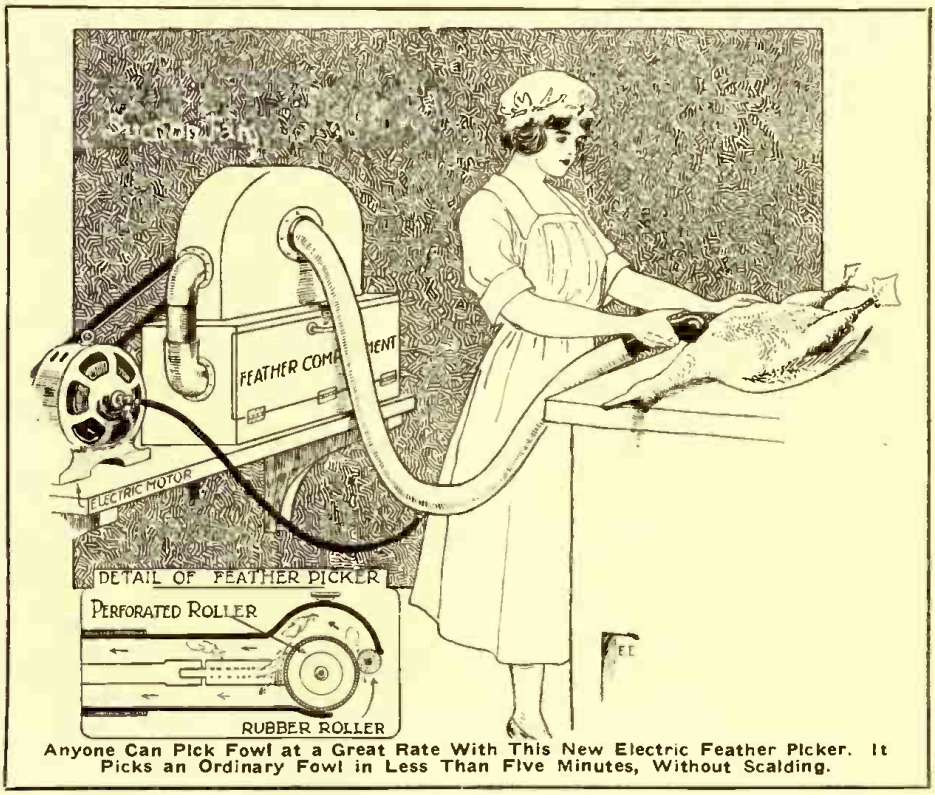
Dutch newspapers describe a new method by which crews of U-boats escape from their boats to the surface after they have been destroyed or wrecked. Statistics prepared by the German Admiralty show that, despite popular belief, a submarine runs less danger in its operations than does the cruiser or other ship of war, and that despite the terrific strain, there has been a very small loss of life among the crews.

When the U-boat is wrecked or disabled and lies on the bottom of the sea a little compartment on top is opened and a buoy which has been filled with air is released and at once rises to the top, carrying attached to it a steel cable. Equipt with "swimming vests," also inflated with air, the men climb to the surface by means of the cable. During this climb to the surface each man wears over his mouth and nose a small apparatus containing pure air, so that he is enabled to breathe oxygen. This apparatus at the same time purifies the carbonic acid, and keeps the air pure for several hours. The buoy on the surface also is equipt with an electrical apparatus so that electric waves can be sent thru the water calling for assistance. The buoys are large enough to accommodate nearly all the men of the crew.

When danger threatens the alarm is at once sounded and this new life saving apparatus is at once prepared for use, so that the men can leave a U-boat within a few minutes. It is said that this apparatus will make the operation of the U-boats as safe as can be devised for their crews. Thus it seems the Germans do find time to invent safety devices.

ELECTRIC CHICK PICKER.

A machine invented by O. G. Rieske, of Buffalo, picks an ordinary fowl naked in less than five minutes. Moreover, no feathers are scattered. A small electric motor turns a suction fan, and also a roller contained within the instrument itself, the power being transmitted by means of flexible cable. The roller is hollow and its outer surface is pierced by a number of slits which permit the incoming blast produced by the fan to pass freely thru it. The top of the instrument is hooded and attached to this hood in a little rubber roller which rests firmly against the surface of the large drum-like wheel. The feathers of the fowl, sucked up against the two rollers, are plucked by having to squeeze between the rollers, after which they are blown to a tank. A thumb contact permits the hood to be moved around on its axis, and thus the relative positions of the two rollers are adjusted according to the needs of each case. The smallest wild fowl or the biggest turkey may be plucked with equal ease. A fowl can readily be picked in the dry state, but ordinarily it is scalded.



Anyone Can Pick Fowl at a Great Rate With This New Electric Feather Picker. It Picks an Ordinary Fowl in Less Than Five Minutes, Without Scalding.

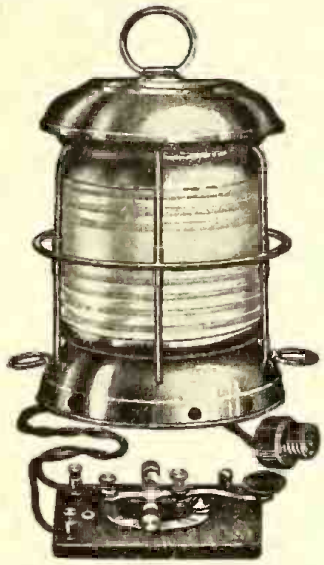
EMISSIVE PROPERTIES OF TUNGSTEN.

The emissive properties of tungsten have been investigated by two methods. One investigation consisted in the determination of the selective reflection of plane, highly polished mirrors of tungsten in the visable and in the infra-red spectrum. A depression was found at 0.8 in the reflectivity curve, which is the cause of a marked selective emission band found in incandescent tungsten.

The second investigation was on the selective emission of straight and helical filaments of tungsten, in which it was shown that the increased brightness within the helix is due almost entirely to multiple reflection. The most important deduction is that the radiation from within the helix is not sufficiently close to that of a uniformly heated inclosure to be used in the calibration of pyrometers.

A NEW TELEGRAPHIC SIGNAL LAMP FOR MOTOR-BOATS.

In the accompanying illustration a telegraphic signal lamp is shown which is now



New Water-Proof Signal Lamp for Small Vessels. Easily Operated With Telegraph Key.

being offered by a Boston concern. This lamp as illustrated, consists of a 7-inch by 10-inch brass anchor light with "Fresnal" lens. For use with it in signaling, a specially constructed Morse key is provided with heavy platinum points, the base of which encloses a condenser connected across points of the key to prevent arcing and to shorten the lag between make and break. An attachment plug and cord is provided so that the signal can be connected to any voltage electric circuit. It is very substantial and will stand any weather.

A PORTABLE ELECTRIC AIR COMPRESSOR.

Here is a novel and efficient electric air compressor that is really portable. It is built as a compact unit, with electric motor, high pressure compressor and transmission all enclosed in one frame. All one has to do is plug in the nearest lamp socket, either direct or alternating current, connect the hose to your tire and turn on the switch.

The particular features in the construction of this portable compressor are that it is built as an integral unit, self-contained

For Autoists—A Portable Electric Air Compressor.

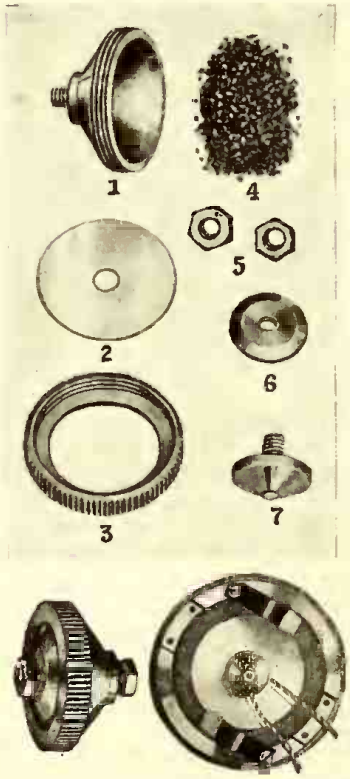
in a metal housing; its efficiency is increased by means of forced air draft ventilation, operated automatically, keeping the motor and cylinders cool at all times. There is no water to freeze or to evaporate.

The motor is of the compensated series, interpoled type, which will operate on either direct or alternating current, so that a different machine is not required every time you move.

The wick feed system of lubrication is used.

NEW SELF-CONTAINED MICROPHONE BUTTON.

If standard transmitters cost only a trifle, and were not much bigger than a thimble, every repair man could carry a few in his pocket. Then when a subscriber's instrument refused to talk for reasons unknown to the subscriber, and the repair man's ten mile trip disclosed a faulty transmitter, he could take a new one out of his pocket, screw it into place, and be on his way. A Chicago inventor, J. Skinderviken, has so nearly approximated this desirable condition that he leaves little to be desired in the way of transmitter repairs. He has been allowed a patent on a self-contained transmitter button which meets practically all the conditions of our first problem. Externally the button is merely a cone-



Assembly and Exploded View of Remarkable New Transmitter Button. It "Talks" in Any Position and Requires no Rear Bridge Support.

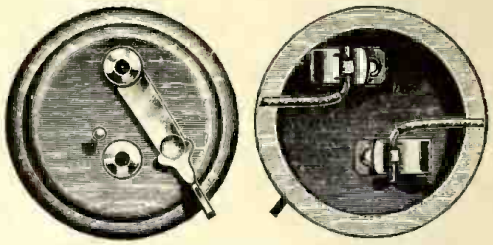
shaped bit of brass with a threaded stem, a nut and a lock-nut to fit the hole in the standard transmitter diafram.

It has at least one paramount advantage over the regular transmitter. It talks equally well in all positions—vertical, horizontal, inverted, or at any angle. The method of repair used with this unique microphone button is to remove with a small screw-driver the metal bridge common to all standard transmitters. This bridge the repair man puts in his pocket, to be referred later to the scrap heap. The button then is screwed directly to the transmitter diafram, without any support but its own screw stem. The whole affair can be executed in little more than a minute.

This universal position feature makes the Skinderviken button very useful also in repairing hand-microphones, which are commonly subjected to the most severe distortions of position. The same is true to a lesser extent of the desk stand.

NEW BATTERY SWITCH FITTED WITH SPRING BINDING POSTS.

A one point and two point wooden battery switch which is equipt with the spring binding posts are now on the market. The handle of this switch is made in one piece and all the metal parts of it, including the binding posts, are fastened to the wooden handle by means of eyelets. This, it is



One Point Battery Switch Provided With Spring Binding Posts.

pointed out by the maker, eliminates all screws and does away with the loosening of any parts. The switch can be quickly wired on account of the convenient construction of the spring clip binding posts which are employed, without the use of any tools.

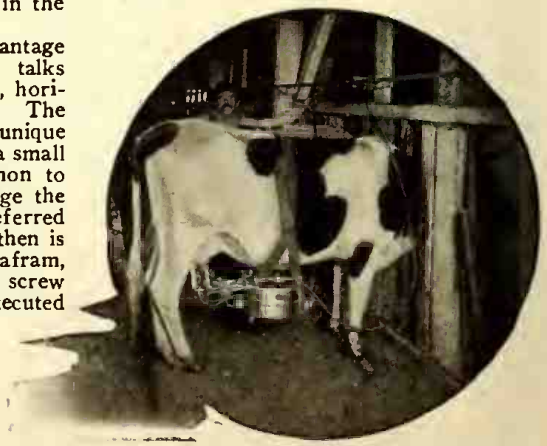
A NEW MILKING MACHINE.

This new electric milking machine profits by all the mistakes made by others, it is claimed. The new milking machine has no rubber milk tubes. It is suspended under the cow and can't be kicked off; nor can the teat cups drop off and suck up dirt. It can milk a three- or two-teated cow as easily as a four-teated one, and can milk each teat independently. It has an exclusive type—three-sided inflation that positively insures a three-sided collapse from tip of teat to udder. It does not milk four teats at once, but two at a time, *alternately*.

The milk from each teat passes thru an unbreakable, transparent, straight celluloid tube that is easily cleaned. You can see the milk flow, and as each quarter is milked you can stop the action on it. These small unbreakable tubes take the place of the long rubber hose, an essential part of most milkers, and insure getting milk always as clean and pure as it is in the cow's udder. It also has a float valve that absolutely prevents the milk being drawn back to the vacuum tank if the pail becomes full.

And it can be operated by an electric motor and in conjunction with any lighting plant.

The teat cups are radically new in design and exert a compound action; first it sucks milk from the teat by vacuum and then shuts it off completely by atmospheric release, exactly duplicating the natural hand method.—*Photo courtesy Western Electric Co.*



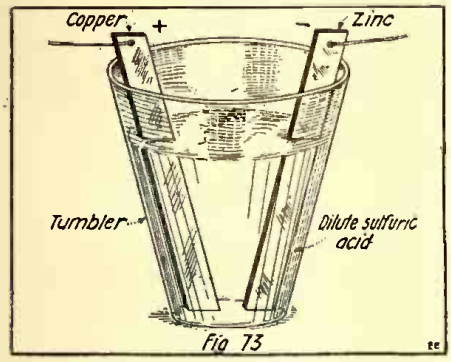
Note How Surcingle Holds Pail of This New Electric Milker Firmly In Place.

Experimental Physics

By JOHN J. FURIA, A. B., M. A., (Columbia University)

Lesson 14—Current Electricity

An electrical charge in motion is called an *electric current.* Experiment 80.—When a Leyden jar is discharged, we get a momentary current. If this momentary current is allowed to pass thru a coil of insulated

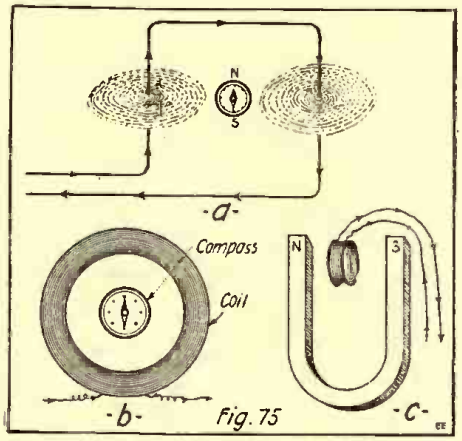


The Voltaic Cell—It Produces an Electric Current by the Chemical Action of Dilute Sulfuric Acid on Zinc and Copper.

copper wire which surrounds a knitting needle, we find that the needle has become magnetized. (See Lesson 11 for test of magnetism.) It is important to note that *electricity in motion produces a magnetic effect,* since so much of the value of electricity depends upon this effect. (This effect was discovered by Prof. Hans Christian Oersted of the University of Copenhagen in 1819. His experiment, known as *Oersted's Experiment,* marked the beginning of modern electricity.

Experiment 81—Only a small amount of electricity passes thru the wire in experiment 80 because the current lasts for so small a fraction of a second. Galvani in 1786 discovered a chemical method for producing a continuous current and Volta in 1800 invented the voltaic cell (sometimes called galvanic cell). He placed a strip of zinc and a strip of copper in dilute sulfuric acid (see figure 73). If the terminals of this cell are connected to the coil surrounding the knitting needle for several seconds, we find the needle more strongly magnetized than in experiment 80. Hold the wire connecting the terminals of the cell over a compass needle; the compass needle will be strongly deflected, i.e., the wire connecting the terminals carries an electric current. (This was Oersted's experiment). That the terminals of the cell are electrically charged before they are connected, can be shown by use of the electroscope of Lesson 13. On testing for the sign of the charge we find the copper + and the zinc —. See Fig. 73.

Experiment 82—Allow the current from a voltaic cell to pass thru a vertical wire (see Fig. 74) and sift small iron filings around the wire. We find that the magnetic field consists of concentric circles lying in a horizontal plane. On exploring with a small compass we get results as in Fig. 74. On reversing the current the compass reverses. The direction of the magnetic field (the direction in which the N pole of a compass points) is related to the direction of the current by the right hand rule which is stated as follows: *"Grasp the wire in which current is flowing by the right hand so that the thumb points in the direction in which the current is flowing; then the magnetic lines encircle the wire in the same direction as do the fingers of the hand."* If instead of passing the current thru a single vertical wire we allow it to

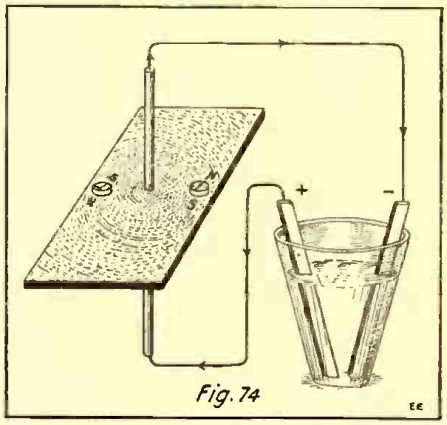


Various Actions of Magnetic Fields. The Galvanometer Works Upon the Principle That A Magnetic Needle (b) In a Coil, or a Current-Carrying Coil in a Magnetic Field (c) Will Tend to Move.

pass thru a wire bent as in Fig. 75 (a) we have a still stronger magnetic field and if we use a coil as in Fig. 75 (b) the strength is increased still more, since each turn adds to it. Using more current also adds to the strength of the field. A compass needle placed in the center of the coil 75 (b) will be deflected and the greater the current the greater the deflection. All instruments for measuring current consist essentially either of a compass needle at the center of a fixt coil as in Fig. 75 (b) or of a moving coil suspended between the poles of a fixt magnet as in Fig. 75 (c). The passing of the current thru the coil produces a deflection as in Fig. 75 (b) of the needle and in Fig. 75 (c) of the coil.

Such an instrument is known as a *galvanometer.* When calibrated to give the strength of current directly it is called an *ammeter.* The ammeter has low resistance so as to oppose the passage of electricity thru it practically not at all. Because of the practically nil obstruction, all the current passes thru it and therefore we get a true measure of it. The *voltmeter* or instrument for measuring electrical pressure, is similar to the ammeter but has a high resistance. This allows only a small amount of electricity to pass thru it. Hence no electricity is lost and the pressure remains "full up" and is all measured.

Experiment 83—Allow the current from several cells to pass thru (a) ten feet of

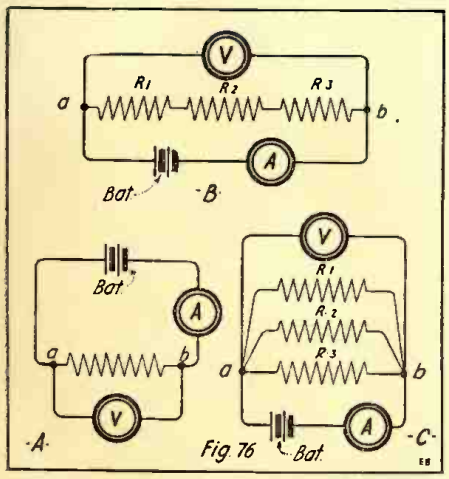


A Practical Experiment Showing How the Current in a Conductor Sets Up Magnetic Whirls in Iron Filings; Also, Reversing the Current Reverses the Direction of the Whirls As a Compass Needle Demonstrates.

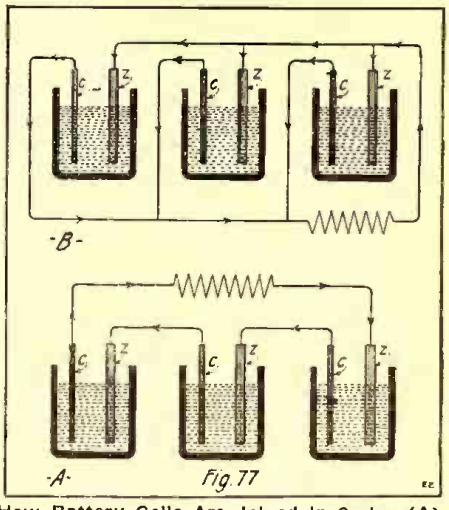
number 30 copper wire, (b) 20 feet of number 30 copper wire, (c) 20 feet of number 20 copper wire and (d) 20 feet of number 30 German silver wire respectively, and at the same time thru the galvanometer of Fig. 75. We find that less current passes thru the smaller diameter copper wire than thru the other. Also less current passes thru the German silver than thru the copper; again, less current passes thru the 20 feet of copper wire than thru the 10 feet. Hence we say that German silver offers more resistance to the passage of electricity than does copper. Also the longer the wire the more the resistance, and finally the smaller the diameter of the wire the greater the resistance.

Comparing the wire to a water pipe it is obvious that the smaller the diameter of the wire or pipe the less the electricity or water passing thru and hence the more the resistance. (*The unit of resistance* is called the *Ohm* and is equal to the resistance of 9.35 feet of number 30 copper wire).

(*Continued on page 279*)



Various Problems in Ohm's Law. Simple Resistance At A; B—Resistances In Series; C—Resistances In Parallel.



How Battery Cells Are Joined In Series (A) for High Voltage and In Parallel (B) for High Current. For High External Resistance Use a High E.M.F. and Vice Versa.

Notice to All Radio Readers

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

This is a very important consideration, especially to those who are readers of the ELECTRICAL EXPERIMENTER, *for the reason that we desire to continue to publish valuable articles on the wireless art from time to time, and which may treat on both transmitting and receiving apparatus. In the first place, there are a great many students among our readers who will demand and expect a continuation of the usual class of Radio subjects, which we have published in the past four years, and secondly, there will be hundreds and even thousands of new radio pupils in the various naval and civilian schools thruout the country who will be benefited by up-to-date wireless articles treating on both the transmitting as well as receiving equipment. Remember that you must not connect up radio apparatus to any form of antenna.—The Editors.*

John Bottomley, Director, Marconi Co., Dies

COMMERCIAL wireless lost a pioneer from its ranks when John Bottomley, third vice-president, secretary and treasurer of the Marconi Wireless Telegraph Company of America, died in the Post Graduate Hospital, New York, on Sunday, June 16th. Mr. Bottomley was in his seventy-first year.

The Late John Bottomley, Third Vice-President, Secretary and Treasurer of the Marconi Wireless Telegraph Company of America. He introduced the Marconi System to the American Business World.

Twenty years of ceaseless activity in the radio field are credited to the deceased, for it was in 1898 that he first met Marconi and took up the responsible task of introducing wireless telegraphy to the American world of commerce. In 1902, he became the active head of the American Marconi Company. At the time of his death he was vice-president and a director of the associated Marconi Telegraph-Cable Companies, treasurer of the Pan-American Wireless Telegraph and Telephone Company, treasurer and director of the Wireless Press and treasurer of the Marconi Institute. Mr. Bottomley had been president of the New York Electrical Society and was an active member of the Engineers Club, vice-president of the Harlem Library, now incorporated with the Public Library, vice-president of the Harlem Dispensary and trustee of the Empire City Savings Bank.

He was born in Belfast, Ireland, in 1848, where he received his early education, later entering Queen's College. At the age of twenty-two he was placed in charge of a large exporting house, where he remained for ten years, coming to America in 1880. Here he studied law and was admitted to the Bar, being engaged in this profession up to the time when wireless claimed him.

Mr. Bottomley was a nephew of Lord Kelvin, the noted electrician, and a grandson of James Thomson. A brother, James T. Bottomley, is a scientist in Scotland. He is survived by his wife, two sons and two daughters.

BRITISH GIRLS STUDY RADIO.

English girls are taking up wireless telegraphy in earnest. The Marconi company has started a special school for training women in wireless telegraphy at its North Wales Station.

The course deals with slip reading, punching, record reading and the general duties of a wireless station. The girls will be drafted to land stations when efficient and will go on night duty in rotation.

It is not proposed to extend the use of women to ships for the present, but if this is to be altered it probably will apply only to coastwise shipping.

MAJOR J. O. MAUBORGNE, SIGNAL CORPS, U. S. A.

Wireless men everywhere will remember the useful and timely hand-book on the Wavemeter, written by former Lieutenant J. O. Mauborgne, U. S. A., now Major Mauborgne, and who has been in charge of the electrical engineering section of the Signal Corps since March, 1918. He was born in 1881 in New York City. He was graduated in 1901 from the College of St. Francis Xavier and recommended to the War Department as standing highest in the military department upon graduation. Two years later he was commissioned second lieutenant in the regular army, and he was promoted to first lieutenant in April, 1909. He was graduated in 1910 from the Army Signal School at Fort Leavenworth, Kan., and for the next three years was instructor there in radio telegraphy and other branches of engineering and in charge of the electrical laboratory. During 1914 and 1915 he was in charge of the army radio construction work in the Philippine Islands, and from October, 1916, to October, 1917, he was on duty at the Fort Leavenworth Army Signal School, acting as its director from October, 1916, to May, 1917.

He was promoted to captain of the Signal Corps in September, 1916, and to major in August, 1917. Since October, 1917, he has been on duty in the office of the chief signal officer of the army. Major Mauborgne has had ten years of experimental work in radio-telegraphy and is the author of "Practical Uses of the Wave Meter in Wireless Telegraphy, 1914," and articles on radio research in the technical press of both America and Europe. He is also a member of the Institute of Radio Engineers, and a member of the advisory board of the invention section, War Plans Division, General Staff, U. S. A.

Major J. O. Mauborgne, in Charge of the Electrical Engineering Section of the Signal Corps, Is One of the Best Known Radio Experts in This Country. Wireless Men Everywhere Find His Timely and Eminently Useful Book on the Wavemeter Invaluable.

MEMORIZING THE CODE.

I read with interest "A Short-cut to Code Learning" in the January number by Thomas Reed. I will try to describe a method used by the Swiss Boy Scouts that has proved very successful, and, in fact, so successful that it is the only way they know the code.

Each letter of the code is represented by a word that begins with the same letter, so as to simplify recognition. Also each "dot" or "dash" of the code is represented by a syllable (of the word). And, last, every syllable containing the vowel "o" means a dash in the code.

A few examples will make the process clear. Take for instance — B = — . . . = Bonaparte. Bonaparte contains four syllables; the first syllable contains the vowel "o" which means that the letter in the code begins with a dash; the other syllables do not contain "o" and therefore are dots. Thus:

G = Gondole = — — .
A = Arnold = . —
H = Hilarité = ...
F = Farandole = . . — .
S = Sardine = . . .
M = Moto = — —
E = Eh! = .

I will not give the equivalents for all the alphabet, as all these words are unfortunately in French and would be of no use, but it would be easy with enough time to make one up in English.

However, I do not think learning the code by these methods are efficient, as they only help to make the code more easy to the beginner and later he will have to memorize it, the usual way.

II. Simplifying Receiving

I think that simplifying receiving would be of some help to the beginners and the method I will now describe is very useful. This method is also used in Switzerland by the Boy Scouts. (I do not know if it is used elsewhere.) And I think not only helping beginners in wireless, but it would be of service for heliograph receivers.

This method requires a chart containing the alphabet and numerals (see illustration). The letters are divided into two groups—those beginning by a "dot" and those beginning by a "dash."

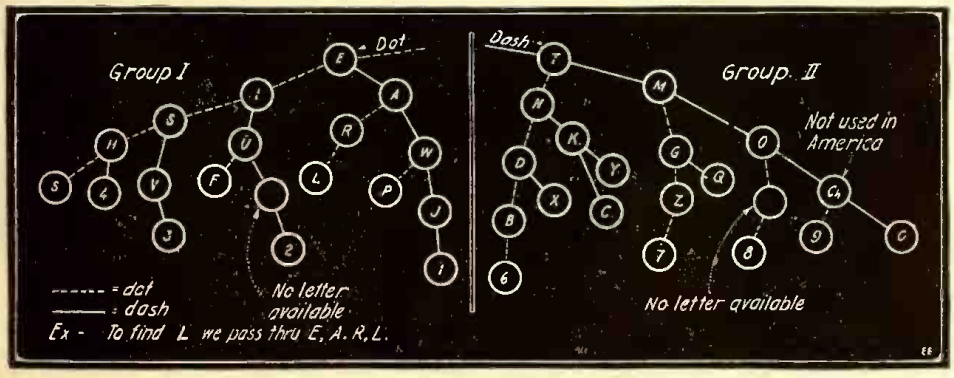
Also a straight line (———) represents a "dash" and a dotted line a "dot" (. . .). Thus when a letter begins with a "dot" look at group I and if with a dash at group II.

Take for instance letter A (. —).

(1) Look at group I. (2) As the next symbol is a "dash," follow the straight line and we come to A.

Now take the letter Z (— — . .).

(1) Look at group II. (2) Follow the straight line. (3) Follow the dotted line. (4) Follow the dotted line. Thus to find the letter we pass thru T, M, G, and Z.



Simplified Code Chart for Quickly Memorizing the Mysterious Dots and Dashes, as Described by Mr. Bauman. To Find "Z," for Instance: Look at Group II, Pass Thru T, M, G, and Z; Thus "Z" Is Dash, Dash, Dot, Dot.

This, I think, is the easiest method to decipher a code and by looking at the diagram it is readily understood. Hoping this will interest some amateurs.

Contributed by
HAROLD A. BAUMAN.

BOYS' WIRELESS SEIZED; NAVY GETS TWO RECRUITS.

Zzz-szx) (*!-**?.-sszzxz- sz-splutter!

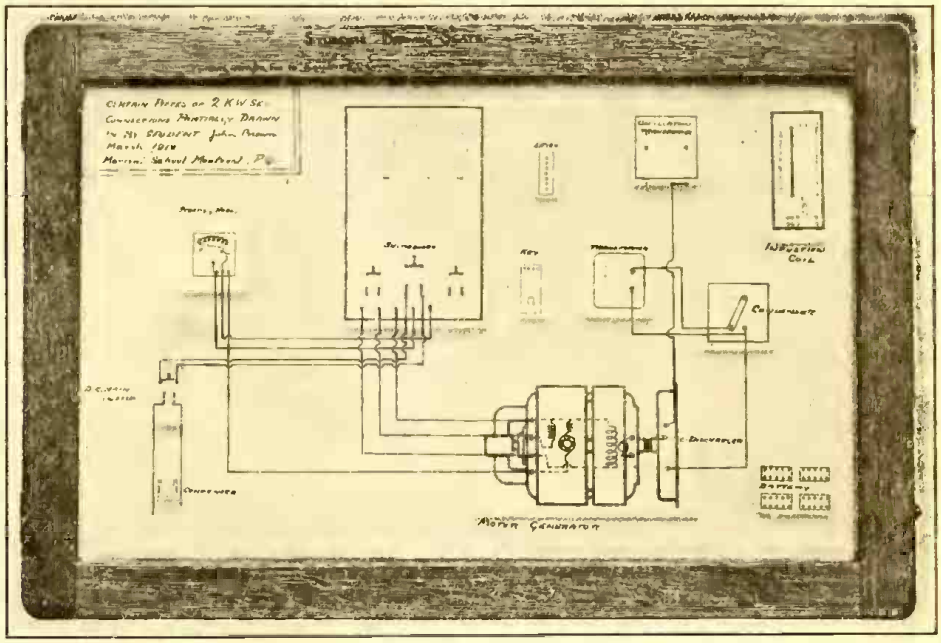
"German spies," gasped a neighbor as he heard the hissing noise and watched the sparks flashing from the home of Mrs. Patrick O'Shaugnessy, at New Canaan, Conn.

Again came the hiss and the spark. The neighbor jumped to the telephone and the next day Federal raiders swooped down on the O'Shaugnessy cottage. Mrs. O'Shaugnessy sobbed a plea that her only boys, William, twenty, and Thomas Francis, eighteen, be forgiven this time. But the raiders frowned. It was against the law for amateurs to fool with wireless apparatus in war time. "Shucks," laughed Tommie, "we were just studying so we could get in the navy wireless branch."

The Federal officials learned the statement was true, but had to confiscate the machine. They suggested in leaving that the boys could get practical wireless experience without interference by joining the navy. "That's what we will do," agreed the boys. And they did. Mrs. O'Shaugnessy presented herself to Chief Yeowoman Mrs. George Wheelock at the Naval Recruiting headquarters. She had Tom in tow. She explained she had tried to keep the boy at home, but had to yield.

Tom was found to be 100 per cent physically fit and easily past the wireless tests.

We regret to hear of these indiscreet ventures of American "Radio-bugs," for they should set a perfect example in their respective localities of just what a "good" American citizen is! Remember, Amateur Radio Men, that you are being watched closely all the time by those whom you least suspect. Therefore strive to hold your head high; if you are ambitious and can't hold your radio aspirations any longer, then go and enlist at once. Your Uncle Sam needs you!!!



How to Teach Hook-ups to Radio Men? That Was the Problem. A Canadian Instructor Finally Evolved This Ground Glass Slate, Under Which the Various Apparatus Are Placed. The Student Must Draw the Circuit Lines in with a Pencil.

NEW "GLASS SLATE" FOR TEACHING HOOK-UPS.

Patents have recently been applied for in various countries on a drawing slate invented by a Canadian Wireless Instructor to meet the difficulty of teaching students to memorize and understand the connections of various pieces of apparatus as required by Government examiners.

The wireless student who has learned to draw the connections of apparatus arranged always according to a particular plan, invariably encounters trouble when presented with a diagram representing the same pieces of apparatus placed in entirely different positions with respect to each other, and it is only then that he realizes he has wasted considerable time in merely accustoming himself to repeatedly drawing the same connecting lines in the same order, without grasping their meaning.

The present invention, a direct product of necessity, takes the form of a framed sheet of ground glass, beneath which representations of the various parts comprising a wireless or other electrical equipment, printed in heavy black lines upon blocks of Beaver Board, are arranged, and upon the ground upper surface of which the proper connections are to be drawn in pencil with the aid of a ruler or set square. The blocks are tightly clamped between the glossy under side of the glass and a wooden back to which the frame is hinged, so that the slate may be past round among several students, each of whom will draw in the connections and afterwards erase the pencil lines with water, or preferably a few drops of gasoline applied with a sponge or piece of rag. When required, the blocks may be re-arranged or replaced with representations of parts comprising some other standard equipment. The blocks are very inexpensive and can be supplied in sets making up complete wireless installations.

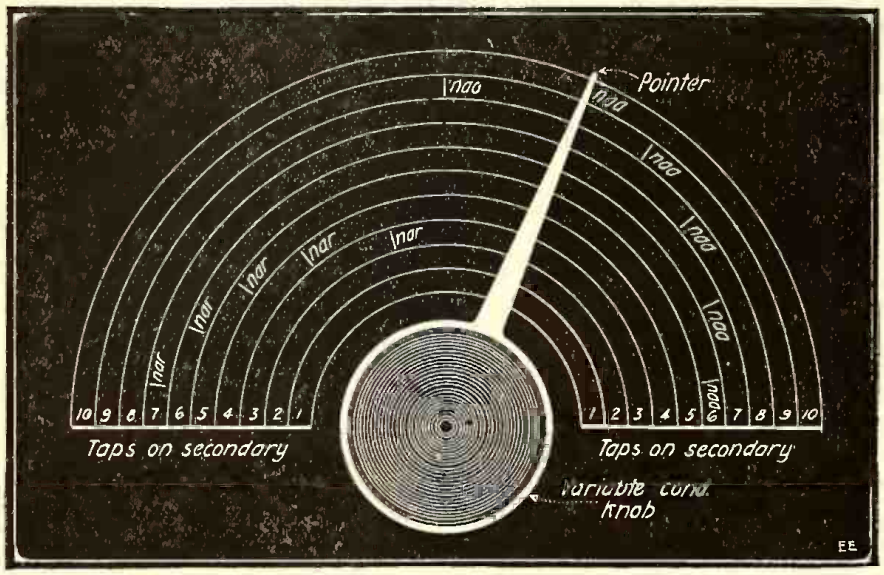
Essential details of standard receivers of all types, automatic starting devices, motor generators, etc., can also be printed on the blocks enabling students to understand the relation of each part to the other. Blocks representing Chemistry Apparatus can also be supplied.

AN IMPROVED CONDENSER SCALE.

The drawing shows a special graduated scale which, when substituted for the condenser scale, will show the exact position of the condenser for each number of taps of the secondary. As you will notice by the drawing, as the turns of the secondary are increased the condenser is brought nearer zero, and in the case of NAA the more taps are taken off the greater the condenser capacity used. This, of course, is naturally necessary, but the idea of the arrangement is to show when for instance four taps are used the condenser scale will be at an indicated point. By this method, after noting on the scale where different stations come in, it will be an easy matter to tune in these same stations again when desired.

I have been using this method to great advantage, especially when time is the prime factor, that is when one wishes to listen for two or even three stations at once, by merely changing the secondary taps and a lot of unnecessary time formerly lost by moving the condenser to the exact point and having to hunt for each one is saved.

Contributed by T. T. J., U.S.N.R.F.



By Making a Special Scale for the Variable Condenser of a Radio Receiving Set, It Becomes a Simple Matter to Instantly Set the Condenser to Correspond With a Certain Tap for a Given Call.

UNIVERSITY OF PITTSBURGH GIVES RADIO ENGINEERING COURSE.

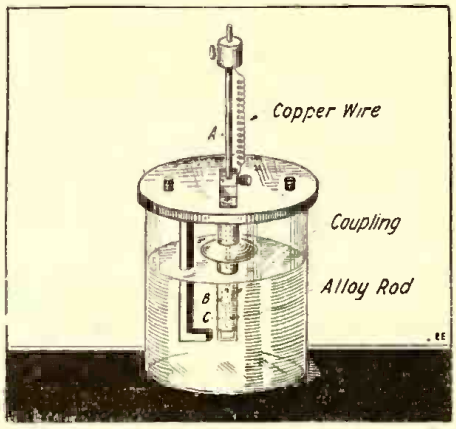
A course in Radio Engineering for technical graduates is being given at the University of Pittsburgh which comprises a term lasting eight weeks. This course will be open only to graduates in electrical or mechanical engineering who are recorded in Class I of the National Army Draft. Men enrolling in it will be placed by the Government in Class V until completion of the course, when they will be inducted into the Signal Corps and sent to an army school for further training. The need for men familiar with the technique of radio-communication is great, and the chances for obtaining a commission ultimately are good. There will be no charge for tuition, but students must provide their own living and travel expenses.

As the number of men is limited, application should be made at once to Prof. H. E. Dyche, Department of Electrical Engineering, University of Pittsburgh, Pittsburgh, Pa.

HOW TO USE SHORT INTERRUPTER RODS.

Procure a miniature coupling from an Erector building outfit, take an alloy rod that has become too short for ordinary use, put this thru the hole in the cover, take off the tube from the interrupter, and place the coupling in the tube with a piece of straight copper wire A in one end, and alloy rod C in the other. Replace tube and the interrupter is ready for use. This is a very economical way of using these alloy rods as they can be used to the last inch.

Contributed by JOHN ROGERS.



By Means of a Small Wire Connector It Becomes Possible to Use Up Short Bits of Electrolytic Interrupter Rods In the Manner Illustrated.

RADIO WRITERS — ATTENTION ! ! !

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

VICTROLA NOW TEACHES WIRELESS.

One of the largest talking machine companies has just announced a special course of instruction in wireless telegraphy by means of disc records and accompanying books of instruction. In announcing the course the company says in part:

"The United States Army and Navy are in need of thousands of skilled wireless operators, and a complete course of study may be carried on by means of these records, in camp and at home, at a very small fraction of the expense that is ordinarily involved.

"The course consists of six ten-inch double-faced records with book of instructions."

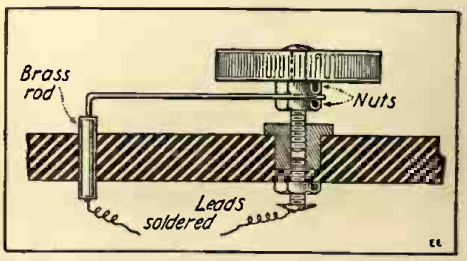
A SOMEWHAT DIFFERENT ROTARY SWITCH.

Many amateurs are building receiving sets with a receiving transformer using rotary switches for regulating the number of turns of wire in use. These switch knobs and assemblies are quite expensive when bought, but can be easily and cheaply constructed at home without machine tools of any kind. The material needed will be a piece of one-fourth inch rubber or fiber sheet, a brass battery bolt with the nuts, a binding post as shown in the dotted line in the drawing, and some spring brass for the lever of the switch. Determine the size of knob you wish, lay out the circle of the proper diameter on the fiber or rubber, and then cut out the disk. A heavy gasket cutter will help do this if the knob is made of fiber. If hard rubber is used, it can be cut out by chipping off pieces with pliers till a rough disk is secured. Then this is filed down till perfectly round.

Drill a hole in the center and in this place a long battery binding post, whose flat end has been filed smooth and polished. Fasten it with a nut that has been rounded, to match the round handle. Then cut a piece of spring brass to the desired shape, making it narrow at the outer end. Punch a hole at the wide end and fasten it on the bolt in the knob by means of another nut.

Next drill a hole in the board or panel on which the switch is to be mounted. This hole should be large enough to admit the binding post shown in the sketch, but not so large that it will let the collar or wide part slip thru. A binding post of this kind can be found in practically every experimenter's shop. It is threaded at both ends to fit a battery bolt. Push the small end of this binding post in this hole, then from the rear insert a binding post on which a washer and a nut have been placed. Draw up the binding post into the hole by means of the nut at the back. Then screw the knob screw into the hole in the binding post at the front far enough so that it will not have any play and so that the blade makes good electrical contact with the switch points. If a little judgment is used in designing the layout of the switch and contacts, it will look better than many high priced switches, and will be just as serviceable.

Contributed by FRANK SAHLMANN.



A New Wrinkle In Building Rotary Switches. The Switch Points Comprise Short Pieces of Brass Rod Forced Into Holes of Slightly Smaller Diameter Than the Rod.

Analysis of Irregular Wave Shaped Alternating Curves

Harmonics—Part II

By Prof. F. E. AUSTIN *

Instructor of Electrical Engineering, Thayer School of Civil Engineering, Dartmouth College

ACCORDING to the discovery of Fourier, any periodic or regularly recurring wave of any shape whatever, is in reality the resultant obtained by adding together a number, (usually a large number, sometimes an infinite number) of sine waves, one of which has the same frequency or same periodic time as the original or *resultant curve.*

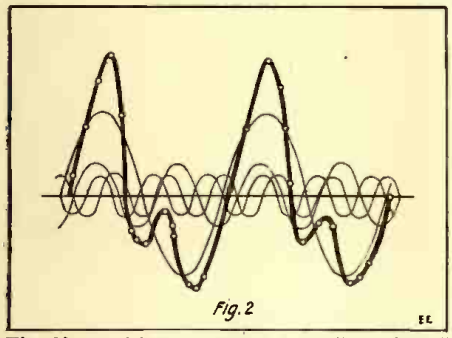


Fig. 2

The Heavy Line Represents the "Resultant" Curve Made up of Four Simple Sine Curves; the Latter Are Known as the Harmonic Components and Each Has a Definite Frequency and Wave Length.

Any alternating current or pressure of any shape whatsoever according to Fourier's theory, is made up of the sum of a definite number of simple sine waves of current or pressure, having various amplitudes and different wave lengths or frequencies.

Many surprising results may be obtained by simply arranging sine curves on cross section paper, and adding *algebraically* their heights at various points and drawing a curve thru the points so located. This may be illustrated by Fig. 1, in which three sine curves are arranged as indicated, and their altitudes added together algebraically forming the resultant curve, drawn in heavy lines. It may be noted that if at any chosen position two or more sine curve heights are positive, that is extend above the horizontal *datum line,* then the sum of the sine curve heights extending downward below the horizontal datum line must be *subtracted* from the sum of the sine curve heights extending above the datum line. If the sum of the downward or negative heights exceeds the sum of the upward or positive heights, then the point of the resultant curve is located below the datum line. It may happen that the sum of two negative heights may have to be subtracted from a *single* positive height. Any irregular but periodic curve of current or pressure, meaning one that repeats the same irregular shape during each succeeding interval of time, may be exactly reproduced on paper by the proper selection of sine curves. Fig. 2 shows an alternating curve made up of four simple sine curves. The building up of such irregular periodic resultant curves is called *synthesis.* Of course it is not possible to build up curves of any *particular* shape until it is definitely known exactly how many sine curves are necessary; their frequency, their amplitudes, and their starting points relative to each other. The determination of the number, frequency, amplitudes, and position of the component sine curves making up any resultant curve is called *analysis;* which is a somewhat complex operation; depending upon certain known mathematical relation and physical laws.

It may be well to consider for a moment why an alternating current or an alternating pressure does not have a perfectly simple form. The alternating pressure obtained from a generator depends at each instant of time upon the speed of the moving inductor and upon the strength of the magnetic field thru which the inductor is moving. If for example the motion of the inductor should be perfectly uniform, but the field should be variable, then the induced pressure would vary accordingly; on the other hand should the magnetic field be perfectly uniform, but the motion of the inductor be variable then the resulting induced pressure would be irregular to conform. Again both of the variable conditions might act simultaneously, either in unison to increase the induced pressure or in opposition to reduce it.

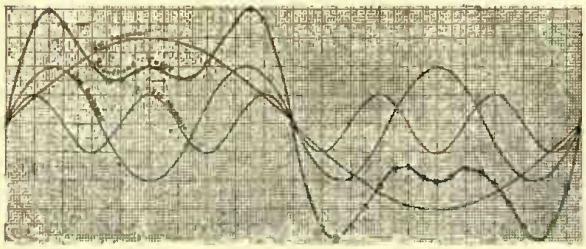


Fig. 1, Showing How the Three Sine Wave Components, When Added Together, Produce a Certain Form of "Resultant" Curve. The "Resultant" Varies in Shape as the Harmonics or Components Composing It Vary.

There may also be other causes of pressure and current distortion resulting from apparatus connected into the generator circuit; such as condensers, motors, telephones, and coils of all kinds.

As it is often desirable and necessary to obtain the number and maximum values of the component sine waves or *harmonics,* which combine together to form alternating pressure waves, whose shapes may be obtained in practice by the point by point method, employing a telephone receiver or other indicating device, or which combine to form the current waves which may be recorded by employing the oscillograph, a few of the simpler laws governing the forming of wave shapes will be considered.

If a curve having any irregular shape, which exactly repeats itself during each regularly recurring interval, has its two half-waves exactly similar, (one-half being entirely above the horizontal datum and the other half being entirely below the same horizontal datum) both as regards their *shape* and their *position,* then the curve is made up of sine wave components whose frequencies or periodic times are *odd* multiples of the original or the resultant curve.

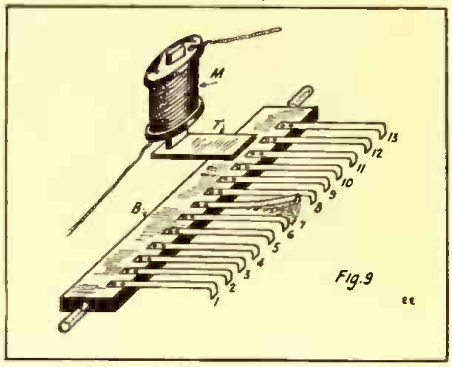


Fig. 9

One Practical Method of Exploring the Predominating Harmonics Constituting a Resultant Wave Current is by Means of the Frequency Meter. Each Reed Responds to a Definite Frequency.

This important feature, which may always be ascertained by inspection, renders it possible to eliminate from any system of wave shape analysis, all component sine waves whose frequencies are even multiples of the resultant curve.

This feature is illustrated by Figs. 3 and 4. Fig. 3 shows an alternating current wave, or periodic curve in wide line, which is the curve resulting from the *sum* of the

(*Continued on page* 281)

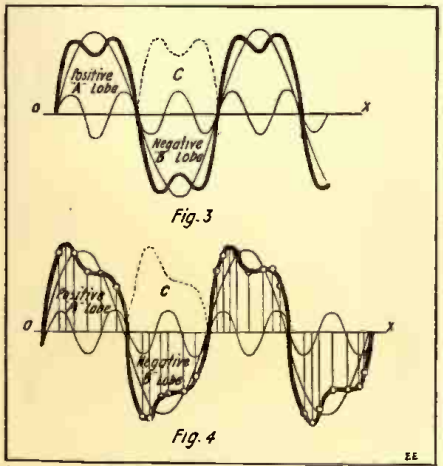


Fig. 4 Shows the Change in the "Resultant" Curve Produced by the Harmonic Components of Fig. 3 Being Slightly Displaced.

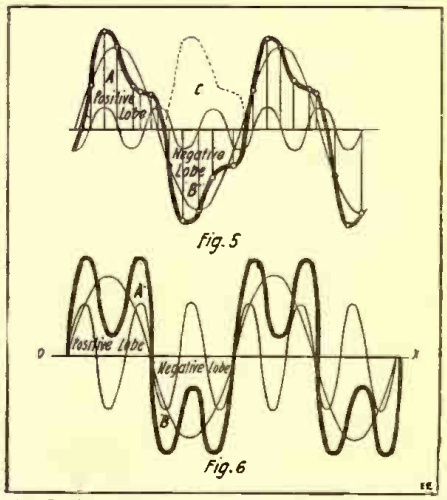


Fig. 5 Shows the Component Waves of Fig. 3 Still Further Displaced—Note the "Resultant." Fig. 6—Effect of Simply Changing the Maximum Value of Only One of the Components.

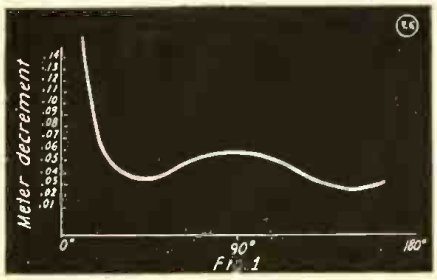
* Copyright by the author.

The Design and Use of the Wave-Meter

PART IV

By MORTON W. STERNS

IN calibrating a decremeter a source of undamped oscillations is used and the usual formulae for decrement are employed which make use of the decrements of the coupled circuits $\delta_1 + \delta_2$; however in this case the decrement of the



Characteristic Decrement Curve of a Decremeter Coil Showing How the Meter Decrement Varies With the Capacity.

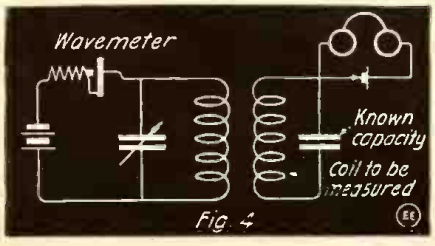
source is zero (undamped waves), and the measurements calculated are the meter decrements.

This meter decrement varies with the capacity and is kept below .05 if possible. A characteristic decrement curve of a decremeter coil is shown in the accompanying figure 1.

Wave meter coils generally overlap 20% in wave length, the idea being to allow a check of certain waves on two coils: this also shows if the calibration of the meter has changed or not.

In the new Marconi type No. 28 wave meter there is a correcting wave-meter consisting of fixt inductances and capacities which may be excited by means of a buzzer, and picked up on the main wave-meter. By this means it can be seen if the calibration has changed; and if so it can be corrected by adding or subtracting capacity on a correcting condenser, which is permanently connected around the main condenser. It is, of course, understood that the main wave-meter was calibrated with this correcting condenser half in, thus allowing an addition or subtraction of capacity to correct the calibration. The correcting condenser had a capacity of one-tenth of that of the main condenser.

Now a word in regard to the hot-wire meter used in the decremeter of to-day. As a rule a hot-wire type instrument is used, on account of the high frequency A. C. that is to be measured, but a D. C. milli-voltmeter shunted across a thermo-couple would also be satisfactory. Several meters of the latter type with self-contained thermo-couples are on the market at present.



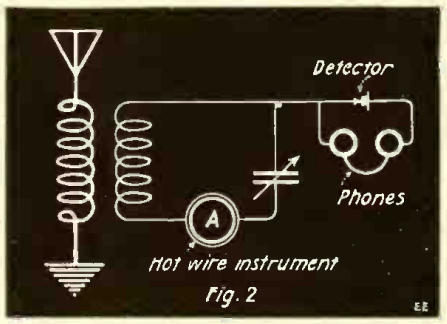
Measuring the Inductance of a Coil With the Wave-Meter.

However, the hot-wire type is the most generally used because of its lower internal resistance, which is a very important consideration in the design of the decremeter.

A very popular type of instrument on the market at present is made by an American concern, and is called a *hot-wire wattmeter.* Its scale is divided into one hundred divisions according to the square of the current flowing thru it. Its resistance is 6 ohms and it requires 80 milli-amperes for full scale deflection (.0384 watt).

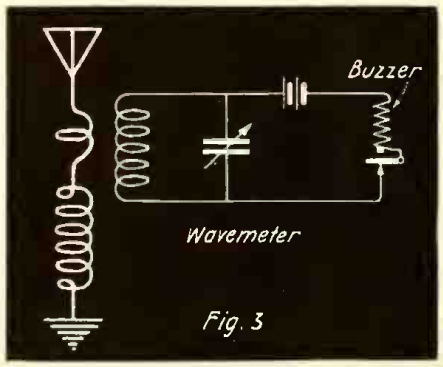
In case only a direct reading milli-ammeter is available, if we make $I^2 = \frac{1}{2} I^2_m$; if I^2_m is equal to 100, then I^2 must be equal to 70.7 or $\frac{1}{\sqrt{2}}$

In part I of this series the author has listed the various measurements that can



Method of Using Wave-Meter In Determining Transmitted Wave-Lengths, Utilizing Either a Hot Wire Meter or Detector and 'Phones.

be made with a wave-meter and as can be readily seen it includes practically all the

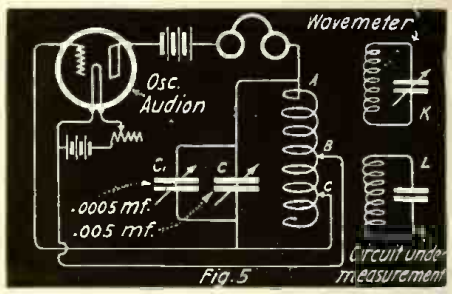


Coupling the Wave-Meter Inductively to the Receiving Antenna In Order to Measure Wave-Length of Received Signal.

important measurements used in Radio Engineering to-day. We will now take up the various measurements in order.

MEASUREMENT OF TRANSMITTED OR RECEIVED WAVE-LENGTHS

The wave-length of a transmitter can be measured by bringing the inductance coil in proximity to the antenna lead of the transmitter and varying the condenser over the scale with the various coils in circuit to give the required range. The resonance point is the point at which the hot-wire instrument gives the *maximum deflection* or the point at which the *loudest signal* is heard in the head telephones, if a crystal detector and telephones are used. By noting this resonance point in degrees and re-



Where Many Measurements Are to Be Made It Is Well to Have An Oscillating Audion Circuit Hooked Up As Indicated to Act As An Exciter for the Circuits Under Measurement.

ferring to the wave-length curves furnished with the meter, the emitted wave-length can be readily found.

Figure 2 illustrates the method used in measuring transmitted wave-lengths and is familiar to all.

Figure 3 shows the wave-meter excited by a buzzer and coupled to the antenna thru a single turn.

If the receiver is tuned to the incoming signal and the coupling between the wave-meter and the single turn in the antenna lead made small, the buzzer signal will be superimposed on the incoming signals and will be weak enough so as not to interfere with the reception of messages.

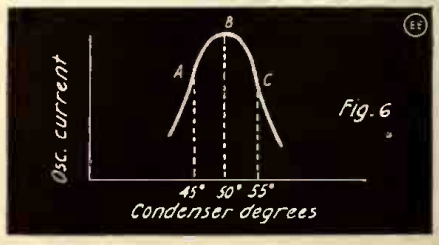
The point on the wave-meter that gives the *loudest signal* in the receivers is then the wave-length at which the incoming message is being received.

An alternative method is to couple the wave-meter closely to the antenna circuit and when a signal is tuned in on the receiver, the wave-meter is varied until the signal dies out or becomes very weak, the minimum point being the wave-length of the received signal.

The reason the signal becomes weakened is due to the fact that the wave-meter absorbs most of the received energy at the resonance point, due to its close coupling.

II. Measurement of Decrement.

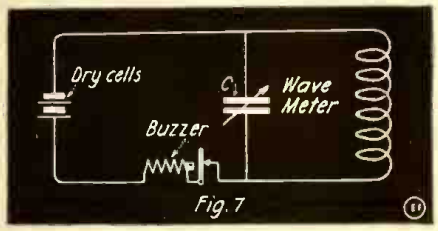
In Part III of this series, the method of measuring decrement with the *Kolster decremeter* was fully described.



In Making Measurements With the Oscillating Audion a Mean Value of the Condenser Readings Is Chosen, Varying Between A and B.

The usual method of measurement with the ordinary decremeter or wave-meter may bear repetition, as it is one of the most difficult and at the same time most useful measurements in Radio Engineering.

The coil of the decremeter is brought into



One Method of Exciting a Wave-Meter With a Buzzer. The Current for the Buzzer Passes Around Thru the Inductance Coil.

inductive relation with the circuit under measurement and the condenser is varied until the resonance point is found as shown by the maximum deflection on the indicating instrument. The coupling between the decremeter and the circuit under measurement is then increased until large deflections of the indicating instrument are obtained, care being taken that the meter is not burned out at the resonance point.

Now if we are using a direct reading milli-ammeter of the thermo-couple type, the maximum current at the resonance point is noted and also the capacity of the condenser. Then the capacity is decreased until the current reads 70.7% of its former value and the capacity again noted. We then have sufficient data to substitute in Bjerkness formula and calculate the decrement. From this value of decrement subtract the *instrument decrement* at the resonance point and the decrement of the emitted oscillation is directly obtained.

The reason the current was decreased to 70.7% of maximum value is as follows: In order to make the current radical,

$$\sqrt{\frac{I^2}{I_r^2 - I^2}}$$

equal to unity, I^2 must equal $\frac{1}{2} I_r^2$. If we consider $I_r^2 = 1$, then $I^2 = \frac{1}{2}$ and $I = \frac{1}{\sqrt{2}} = .707$. Therefore, I must equal 70.7% of I_r. Of course, if a current squared meter is used we take any reading at resonance and decrease to ½ reading on scale, then $I^2 = \frac{1}{2} I_r^2$, because readings are proportional to the square of the current I^2.

III.—Measurement of Inductance and Capacity

Capacity and inductance can be quite easily measured by means of a wave-meter, because knowing either the inductance or the capacity in the circuit, the other can be found by substituting in the fundamental equation:

$$\lambda = 59.6 \sqrt{L\,C}$$

where λ = wave-length measured by wave-meter.
L = inductance in cms.
C = Capacity in microfarads.

Thus it is shown that in order to measure inductances a standard of capacity is needed and *vice versa*. I will describe the measurement of inductance but the reader will readily see that the same procedure is followed in measuring capacity.

The question now arises as to how to make the measurements simply and quickly rather than to explain the theory. I will therefore explain a simple method I have used and which will save many hours of time.

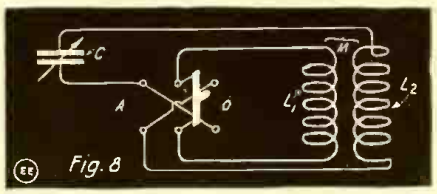
If only a few measurements are to be made, the simplest method is to connect the standard inductance in parallel with the condenser of known value and use a unilateral connection for the detector and 'phones. The unilateral connection is used so as to make the readings more accurate and to eliminate the high resistance of the detector and 'phones around the condenser.

Fig. 4 explains the method: The wave-meter duly excited by a buzzer is brought into inductive relation with the coil under measurement. As the condenser in the wave-meter is varied the sound of the buzzer will be heard at a sharply defined resonance point in the telephones. Then noting the wave-length shown on the wave-meter and knowing the capacity in circuit B we substitute in $\lambda = 59.6 \sqrt{L\,C}$, and find L directly by the formula, $L = \frac{\lambda^2}{3550 \times C}$

If many measurements are to be made, it is best to have a permanent set-up in place around the laboratory, so that one can go right to the corner and make measurements in a few minutes. The author has a circuit like the one described in constant use and has saved much time thereby. It is a very compact arrangement and has a range of 50-30,000 meters.

Coil A is a long bank-wound coil tapt at various points to give continuous wave-length ranges with the two condensers C and C_1, see Fig. 5. The points B and C are made as clips to clip on the coil for the various ranges, the point B always being about half-way between A and C.

C is a .005 m. f. condenser connected in



Arrangement for Measuring the Mutual Inductance Between Two Coils, Such as the Windings of a Variometer with the Aid of a Wave-Meter.

parallel with a smaller condenser having about .0005 m. f.

The circuit L under measurement and containing a known capacity is brought into inductive relation with the coil of the oscillating Audion circuit and the condenser C varied until resonance is obtained. Resonance can be determined by hearing a sharply defined point that gives a "kissing" sound in the 'phones of the Audion circuit. The distance between the coils is varied until the "kissing" sound in the 'phones is heard on moving the fine adjustment condenser C_1 one degree in either direction.

Then allowing the Audion circuit to remain adjusted, the wave-meter is brought near and the point at which the "kissing" sound is heard is noted. We then know the wave-length and the capacity and substituting in the usual formula, L is found.

This method is very rapid and accurate and results can be checked very easily to a small fraction of a degree. The accuracy of the method is apparent as no attachment of any sort is needed to be connected to the wave-meter.

The principle under which the method operates is that when a resonant circuit is brought near the "osculating" (pardon the pun) Audion, energy is withdrawn from the circuit at a faster rate than the B-battery can supply it, and the bulb stops oscillating, which gives the kissing sound in the 'phones.

The accompanying diagrams shows the only point to be looked out for in this procedure.

The circuit L is brought near the Audion coil and the condensers C and C_1 varied; resonance should be obtained at 50°, but due to the energy withdrawn, oscillations cease at 45° when increasing capacity and at 55° when decreasing capacity in each case, causing the characteristic "kiss," and neither point being the true resonance point. If now the coupling between the two circuits is diminished, A and C will approach B as a limit and soon the adjustment will be so sharp that the two points A and C will be less than one degree apart on the small condenser, and the *mean* of the two readings will determine B quite accurately. It is to be noticed that the values of inductance and capacity in the Audion circuit need not be known.

IV. Making Resonance Curves

The whole procedure of plotting a resonance curve was explained in Part II, and should be referred to by the reader, as this is a rather important measurement to be made.

V. Making Various Antenna Measurements

To measure the effective capacity of the antenna find the natural period of the antenna by exciting it with an induction coil, connected across a spark gap, one side of which is grounded and the other side of which is connected to the antenna. A coil consisting of a turn or two of wire of negligible inductance is connected in series with the antenna in order to allow the wave-meter to be coupled to the antenna.

When the induction coil is energized a spark will jump the gap and the antenna will oscillate at its natural period, which we will designate as λ_1. A known capacity, C_1, is then inserted in the ground lead and the wave-length λ_2, obviously smaller than λ_1, is measured.

Then $C = \frac{\lambda_1^2 - \lambda_2^2}{\lambda_1^2} C_1$

where C = the effective capacity of the antenna in microfarads. Care must be taken that C_1 is chosen of such a value that λ_2 does not vary more than 20% from λ_1, as the effective capacity of the antenna varies somewhat with the wave-length.

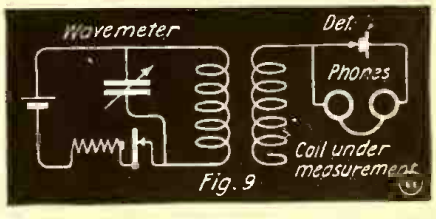
Knowing the natural period of the antenna and its effective capacity, then its inductance can be simply calculated. Another method would be to place a known inductance in series with the antenna and measuring the wave-length λ_2, then knowing the natural period of the antenna λ_1, we find the inductance of the antenna from:

$$L = \frac{\lambda_1^2 L_1}{(\lambda_2^2 - \lambda_1^2)}$$

L = Inductance of antenna in cms.
L_1 = Inductance of standard in cms.

VI. An Exciter Emitting Waves of Predetermined Length

Figure 7 shows how a buzzer is connected to excite a wave-meter. By setting the



Hook-Up of Radio Instruments for Measuring the Natural Period or Wave-Length of a Coil. The Coil Under Test Is Connected Unilaterally to the Detector and 'Phones.

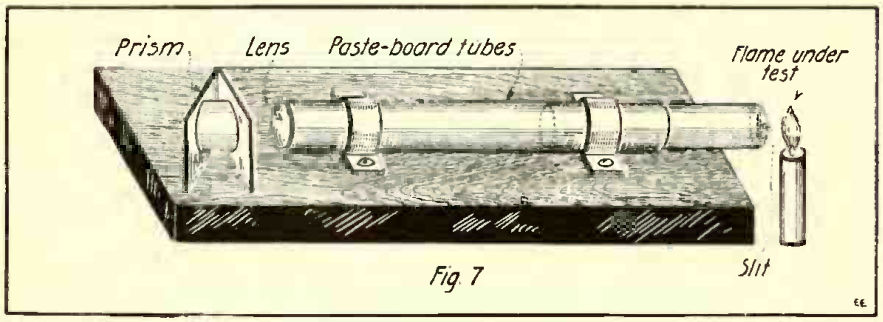
condenser at any value any predetermined wave can be emitted. The theory is that the *inductive kick* due to the breaking of

(*Continued on page* 284)

How to Make a Simple Spectroscope

By DONALD S. BINNINGTON

IT is a well-known fact that when white light of any description (whether from a gas, oil or electric source) is past in a narrow band thru a prism, it is broken up into its component colors. On this fact is based the principle of the *Spectroscope*, an instrument that is considerably used in both Chemical Analysis and various experimental work. An instrument of the kind here described can be made for about one dollar and will prove a welcome addition to any experimental laboratory.



The Finished Spectroscope, Which May Be Constructed at a Cost Not Exceeding One Dollar. Every Student of Science Should Familiarize Himself with the Workings of This Instrument.

The main requirement is a prism, and the best and most efficient form is made as follows: Procure, or cut a piece of glass tubing of 1 inch bore and 1½ inches long. Break this with a glass cutter or the wards of a key, till it has the shape shown in Fig. 1. Those who do not want to make the prism can purchase one at small cost from any optical shop. Then grind the edges smooth by rubbing on a piece of emery cloth moistened with turpentine in which a little camphor has been dissolved. Finally grind on very fine emery paper until the edges are smooth and at an angle of 60 degrees (Fig. 2). Then drill a small hole in the upper side of the prism, or if the tube used is thin chemical glass tubing, the hole may be made by heating (before grinding) the side of the tube with a small blowpipe flame with the ends corked up. The heated air in the tube having no other room for expansion will blow out a small projection, which can be filed and smoothed off. When this method is not available, the hole can be made by drilling with the *broken* point of a round file. When this has been done it should appear as in Fig. 2.

Now cut or procure two pieces of flat glass about 1½" x 1½". These must be cemented on to the ends of the glass tube. The cement for this purpose is made by dissolving some glue in hot water and adding a little glycerin. Care must be taken not to smear the glue over the glass. If these directions have been followed carefully it will have the appearance shown in Fig. 3, which shows the completed prism.

Now procure about 1½ to 2 ounces carbon disulfid from a drug store or chemical supply house, and fill the prism with it, using if necessary a small glass funnel made by drawing and widening out a piece of glass tubing, Fig 4. Plug up the hole with a small cork afterward.

Next, procure from an optician's reading glass, a lens having about 12 inches or less focus. This will cost about 35 to 50 cents. Proceed to make a tube by rolling up several thicknesses of brown paper into a tube about the diameter of the lens and about 10 inches long. Make a similar paper tube to just fit into this about 6 inches long. These two tubes must be blackened inside. The black pigment is made as follows: Moisten a little lampblack with a very little kerosene and rub on to the inside of the tubes. *This must not dry shiny.*

The last item on the list is the *slit*. This is made by taking a circular piece of brass or copper, marking a line exactly across the center; filing till half thru; then carefully cut with a knife blade till the slit is just thru. The length of this slit must be one-third the diameter of the lens used. This slit is shown in Fig. 5. This completes the parts. All that now remains to be done is to assemble the instrument. This is done as follows: The lens is placed in one end of the larger tube and the "slit" disc in the smaller tube.

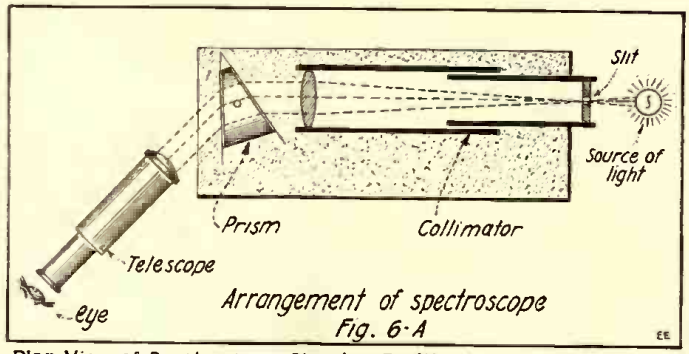
The assembled apparatus is shown in Fig. 6.

The prism is glued on to a piece of pasteboard, which is in turn glued on to the base-board, the base measuring 9" long by 4" wide and ¾" thick. The *collimating tube*, as the pasteboard tubes are called, is fastened on with strips of tin. A groove is cut around the prism base to take a small pasteboard box, Fig. 7, which must be carefully blackened inside.

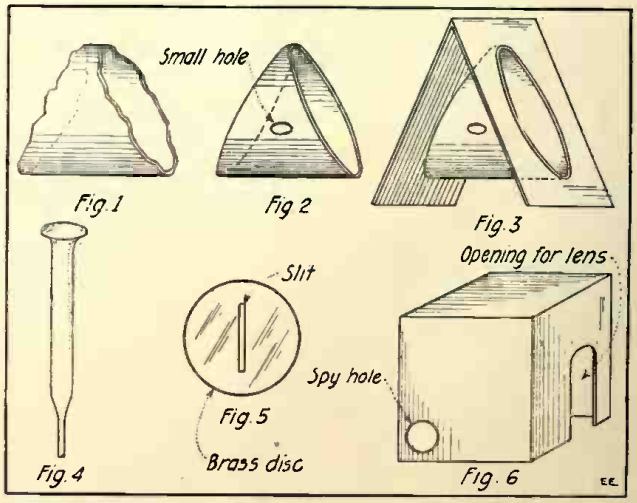
The apparatus is now ready for use, and an ordinary telescope or a lens placed against the spy hole will magnify the spectrum if a gas or electric light is placed in front of the slit, when a band of colors will be seen in the spy hole. If now a colorless flame is placed in front of the hole (as an alcohol lamp) no spectrum will be seen. If now a little salt (sodium chlorid) is introduced into the flame on a wire, a *yellow band* will be seen in the spectrum. If a potash salt is used, a *violet band*. If a lime (calcium) salt, a whole collection of reds and yellows and greens, is seen. Many further experiments will be found in any text-book on Chemistry or Physics.

Note: Great care must be taken to keep the carbon disulfid away from flames, as it is extremely inflammable.

[Editorial Note: A sequel article describing experiments with the spectroscope will appear in an early issue.]



Plan View of Spectroscope, Showing Position of Flame Under Test, Eye and Telescope, Prism, and Collimator or Focussing Tube.



Details of Home-Made Spectroscope, Showing How the Prism Can Be Made from a Piece of Glass Tube and Two Sheets of Glass.

A FREAK SELF-CHARGING ELECTROSCOPE.

With this piece of apparatus you can puzzle those of your friends who think they know something about electricity.

The constructional details are illustrated herewith. A brass tube of any desirable length and a glass tube that will make a snug fit inside the brass tube is required.

The glass tube is to hold the *dry pile* that charges the gold leaves. This is made by taking several sheets of bond paper and coating one side of each sheet with a thin coat of bronze paint and the other side with oxid of manganese. Now lay the sheets on top of each other after they have dried, all the same side up, so that a bronze side and an oxide of manganese side will always be together.

Take a leather punch that has the same inside diameter as the glass tube and with a hammer proceed to cut disks out of the several thicknesses of paper. As fast as they come thru the top of the punch they should be carefully pushed into the glass tube. Continue this until the tube is full, coating more sheets if necessary.

Now take the brass tube, solder a brass ball on one end of it, insert a wad of tinfoil in the glass tube and push it up into the brass tube. In this way contact is made between the dry pile and the brass tube.

The brass tube is now inserted into a cork and its end fitted with a small stirrup to hold the gold foil. The open end of the tube may be plugged with fiber if desired.

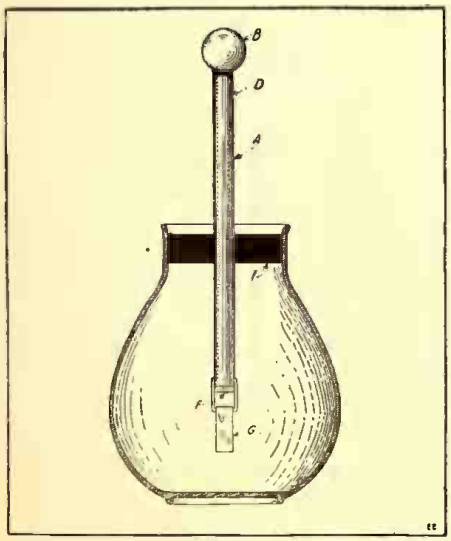
The trick electroscope is now complete; allow it to stand awhile and the leaves will begin to spread, indicating a *charged* state. Touching the ball with the finger will allow this charge to escape, but the dry pile will again charge it. The electricity is formed by the dry pile in the same manner as in the Volta pile. The bronze paint and the oxid of manganese form the electrodes of the cells and the slight amount of moisture present in the paper is the electrolyte.

These cells have a very long life and the one described will continue to charge the electroscope for several years before it finally gives out.

A is the brass tube; B, brass ball; D, glass tube; I, paraffined cork; F, tinfoil; G, gold leaves.

Try this instrument on some wise guy who always likes to show his superior (?) knowledge of things electrical.

Contributed by THOS. W. BENSON.



Want to Have Some Fun with That Smart Electric Friend? Try Him On This Self-Charging Electroscope and Hear Him Rave About Electrons, the Quantum Theory, ad Infinitum.

Clockworks Without Gears

By THOMAS REED

SOMETHING tells me that many "Bugs" would have liked to make an electric clock as described in my articles last summer, but were discouraged by the difficulty of the *wheelwork*. I don't blame them. Geared movements *are* hard to make, there's no disguising the fact.

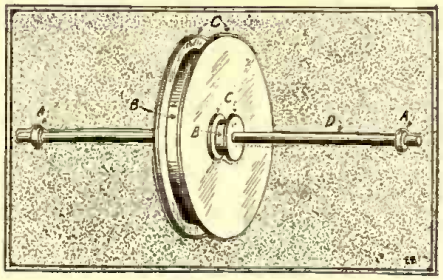
But I'll tell you now how to make a movement without any gears at all—without even the use of a lathe, if you haven't one, tho a lathe would make a prettier looking job.

The trick consists in substituting for the gears, plain wooden flanged pulleys, with very small rubber bands for belts.

Of course this construction couldn't possibly be used in a mechanical clock, for in those clocks the driving power is applied in a relatively large mass, by spring or weight. No belt could hold that stored power, and retail it out without slipping or undue tightness.

But in the electric clock, the power is applied at the other end of the train, in very small quantities, but constantly. So the only power or strain ever present in the wheelwork is such as one dry-cell can produce, spread over eight months; and if you'll calculate that for any given moment (in terms of *flea-power*) you'll see that a thread-like rubber band, tight enough only to keep it straight, will easily transmit that power.

Now, then. Your first job is to find, either in your sister's workbox or a notion store, some of those smooth glass beads, the size of shot and nearly as spherical in shape that are (or were) used in fancy work.



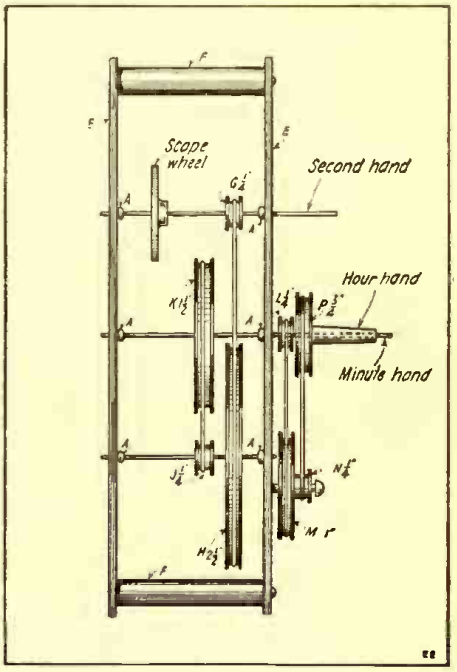
Detail of Gear-less Clock as Described by Mr. Reed. A—Glass beads; B—Wooden Pulleys; C—Cardboard Flanges and D—Arbor of Knitting-Needle Stock.

Having found your beads, find some knitting-needles that will just go thru the holes, fitting well, but not tight enough to bind. These will give you your "arbors" or axles (*D*, in the figures) and the beads *A* are to form the shoulders, to keep the arbor running in the proper plane.

The beads are attached to the arbors by sealing wax, hard pitch, or rosin. Hold the bead in the proper position, and after applying the wax or rosin, heat it by holding a hot nail near, till it bubbles and runs, and adheres firmly to both the bead and arbor; don't rely on simply dropping the wax on to cold surfaces.

The pulleys *B* can be jig-sawed out of thin wood, such as cigar box material, and the faces smoothed carefully. The diameters, of course, are very important; but a little eccentricity or wobbling, due to not drilling the hole quite accurately, won't matter, as that will be taken care of by the rubber band. The flanges *C* are separate discs, cut out of cardboard and glued to the pulley. The pulleys are fastened to the arbors in the same way as the beads.

The front and back plates of the framework *E* as well as the posts *F* may be made of wood.



Ever See a Gear-less Clock? Here's One You Can Make with Rubber Bands for Belts. The Pulley Ratios Are as Follows: G, ¼ In. to H, 2½ in., Ratio 1 to 10; J, ¼ In. to K, 1½ In., Ratio 1 to 6; L, ¼ In. to M, 1 In., Ratio 1 to 4; N, ¼ In. to P, ¾ In., Ratio 1 to 3.

The outfit above described may seem unsubstantial, but I'll guarantee it to outlast the lifetime of any one of you. The rubber bands, of course, would have to be renewed every three or four years, but everything else would easily withstand such wear as it would get.

CHEMICAL "SPONTANEOUS COMBUSTION."

Purchase from your nearest drug store a small quantity of perchlorat of potash (potassium chlorat). Then powder a lump of sugar in a mortar; after which the two are mixed to the following proportions (*one* part of loaf sugar to *two* parts of potassium chlorat).

Caution:—Do not mix in the mortar, but either on a paper or in a dish.

When ready for the combustion, place a small quantity in a tin or *old* dish and add *one* drop of sulfuric acid (H_2SO_4).

Contributed by
W. DOUGLAS GELDERT.

CELLULOID CEMENT.

Herewith is a formula for celluloid or film cement.

Formula: 4 oz. collodion
3 oz. ether
1 oz. denatured alcohol
1 oz. camphor.

Mix thoroly, then add 2 feet of moving picture film that has had the emulsion removed.

Contributed by GEO. W. LUCE.

GLASS-BLOWING LESSONS.

In the September number there will appear the first paper of a series by Prof. Herbert Metcalf on the art of glass-blowing. These lessons will explain every step with clear illustrations, so that you can learn the subject easily.

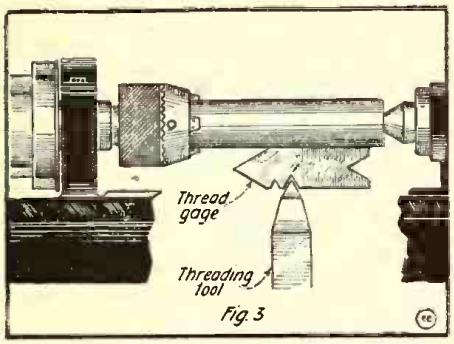
Experimental Mechanics

By SAMUEL D. COHEN

LESSON V.

THREAD CUTTING

HAVING become thoroly familiar with the changing of the spindle, lead, and intermediate gears on the lathe, the student will be instructed in the present article regarding the subject of *thread cutting*, by

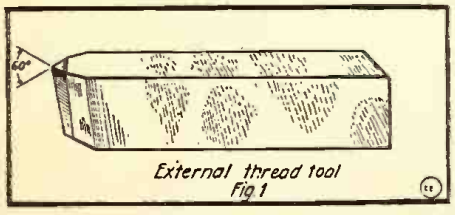


Setting and Testing the Thread Tool for Cutting External Threads, by Means of a Thread or Center Gage.

taking up the successive operations necessary to cut a sharp, accurate thread.

The first and very important consideration in the cutting of a thread is to see that the object is properly secured to the *live* spindle and to see that the article is revolving truly on its axis. In lesson III the writer has given full particulars how to find the *true center* and how to secure the work to the spindle by means of a *dog*. This means of support is very accurate and suitable for all kinds of work.

Let us suppose the work has been secured in the lathe. The next thing is to provide the proper cutting tool and to see that its cutting edge or face is properly ground. If we are to consider the cutting of an external thread, we will use the outside thread-cutting tool, Fig. 1; if an inside thread is desired, the tool in Fig. 2 is used. It will be noticed that the tools used in thread cutting are similar to the ordinary turning tool, with the exception that their points are ground to 60° "V" shape, the angle of the "V" corresponding exactly with the correct angle for the screw to be cut. There is one important difference, however, between the shape of a turning tool, i.e., that the tool point is sloped or canted at an angle. This is necessary in the screw cutting tool to prevent it from rubbing against the sides of the thread, owing to the slope or rake of the latter. The rake of a thread depends on the pitch of the screw and the diameter of the work on which it is cut; thus a screw of one-eighth pitch cut on a bolt of one inch diameter, will have a greater rake or slope than that of a thread of the same pitch cut on a bolt of two



The External Thread Tool Is Stronger Than the Internal Threading Tool. It Should Have a Good Clearance and Be Accurately Ground to the Correct Angle. Self-hardening Steel Is Often Used for Such Tools.

inches diameter. In other words, we must carefully consider the diameter of the stock being threaded.

In actual practise, however, it is not necessary to make a separate tool for each pitch of thread when cutting "V" threads of reasonably small pitch and diameter, the clearance angle given to the cutting edges of the tool usually being sufficient to allow for variations in the rake of the thread.

It is very essential to see that the tool is ground to the correct shape. One way is to grind it to fit between the threads of an ordinary plug-tap, but a special screw cutting gage is provided for such purposes, and it is advised that this should be in the amateur's tool kit. Fig. 3 shows how it is used and how it helps in properly setting the tool with respect to the work. Illustration in Fig. 4, shows how to set the inside thread-cutting tool with respect to the work with the use of the center or thread gage. It will be noticed that a flat steel plate "P" is laid across the end of the work "W" to form a true surface for the end of the gage to rest against.

Having carefully considered the preliminaries of this topic, we shall go into the actual cutting of threads on the object. The work being mounted between the centers and firmly secured to the face plate by means of the dog, the tool properly ground and fastened to the tool post of the slide

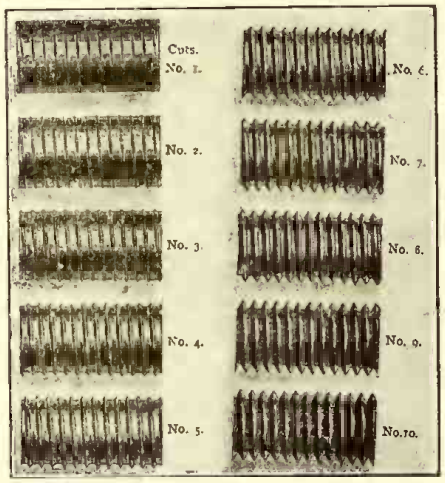
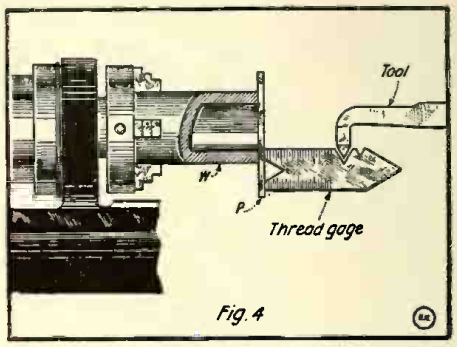


Fig. 5.—Successive "Cuts" Necessary to Machine a Good Thread in the Lathe, Either External or Internal.

rest, and the proper screw cutting change wheels in place, the lathe is then started and a first preliminary cut taken along the work. The tool is then withdrawn, the carriage starting lever (see Lesson II) disengaged from the lead screw, the carriage is brought back to the starting point, and the tool is now set in a trifle deeper than before, the clasp being dropt into gear with the lead screw again and a second cut is taken. This series of operations is repeated until the thread is cut to a sufficient depth.

A screw-cutting tool, by reason of its shape, is weak at the point and is therefore easily broken. Consequently, the depth of cut should not be greater than the tool can easily stand, and this should be regulated in a systematic manner. A simple way is to mark with a piece of chalk the position of the cross-slide handle with which the tool is fed to the work. When the tool is withdrawn after the cut has been taken, it is wound in again before taking the next cut, so that the chalk mark is in exactly the same position as before. This shows the position of the tool during the previous



How an Internal Thread Cutting Tool Is Set and Checked Up with a Center or Thread Gage. The Gage Is Squared Up Against a Steel Plate Set on the True End of the Work.

cut, so that the operator can now readily judge how much further to turn the handle around to advance the tool sufficiently for the next cut. This done the old chalk mark is wiped out, and a fresh one substituted, the marking being repeated as each successive cut is taken.

Some lathes are provided with a small graduated disk on the handle of the cross feed, a fixt pointer being attached to the lathe carriage. In this case, of course, the expedients already described are unnecessary.

The second or most important precaution necessary to be observed by the novice is that the tool shall follow in the same path at each successive cut. There will be no trouble on this point when cutting any thread which is an exact multiple of the thread on the lead screw. However, if the lead screw has four threads per inch, and the screw to be cut has twelve threads per inch, the work will always be in the right position for the tool to follow in the thread when the carriage starting lever is engaged with the lead screw. It will also be true if the screw to be cut has 8, 16, 20 or any number of threads per inch which is divisible by four. This is true because the change wheel on the spindle and the change wheel on the lead screw are in exactly the same proportion to each other as the threads on the lead screw and the screw being cut.

However, to cut a thread of twelve per inch, as in the case previously mentioned, a wheel with forty teeth would be placed on the spindle and a wheel with one hundred

The Thread Cutting Tool, In This Case for Internal Threads, Should Be Ground to Have Plenty of Clearance and Tested with a Thread or Center Gage.

and twenty teeth on the lead screw. The spindle would therefore make three complete revolutions for each revolution of the lead screw, and the commencement of the screw thread on the work would accordingly be brought to exactly the same position in relation to the tool each time the starting carriage lever became engaged with the lead screw.

Suppose a ten thread per inch screw is desired to be cut instead of a twelve; then the wheels required would be forty on the spindle and one hundred on the lead screw. The spindle will now make only two and one-half revolutions, and the work will therefore be half a revolution behind its proper position, thus causing the point of the tool to come on top of the thread instead of in the groove between the threads, if the carriage starting lever is engaged with the lead screw. If the lead screw were allowed to make another complete revolution before engaging with the starting carriage lever, the work will then make another two and one-half revolutions which will bring it into the right position again for starting the tool in the proper groove. The work is therefore only in the correct position for starting a cut once during every two revolutions of the lead screw, similar to other threads which are not exact multiples of the threads of the lead screw. It will be found that to bring the tool to the right position, the starting carriage lever must only be engaged at intermediate positions of the change wheel.

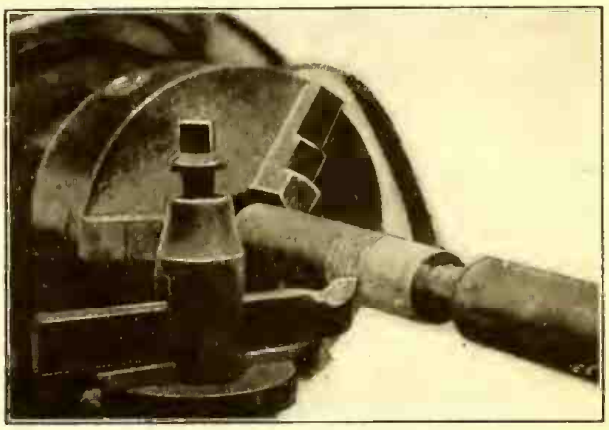
In order to prevent any mistakes arising, the usual plan is to stop the lathe before the tool commences its first cut along the work, chalking a tooth on the spindle wheel and a tooth on the leading screw wheel, placing another chalk mark on the headstock opposite the former, and a chalk mark on the lathe bed opposite the latter, the starting cariage lever being then engaged with the lead screw and another cut taken. The carriage is run back to the starting point after each cut and as soon as both chalk marks on the wheels come opposite to the stationary marks again, at the same instant, the starting carriage lever may be engaged with the lead screw and another cut taken.

The writer has found from actual experience that the above troubles relative to the advancement of the tool at each starting cut can be remedied as follows: The first cut is started and ended at the proper place; then the lathe is stopt at that point. Then withdraw the tool from the work, and turn the spindle and work in the opposite direction thus bringing the carriage and tool to the starting point without disengaging the carriage from the lead screw. By starting the lathe in the proper cutting point and setting the point of the tool with proper reference to depth and by noting the position of the graduation on the transverse spindle the second cut is then proceeded with. This procedure is followed until the thread is cut to the proper depth. The only objection to this scheme is that it wastes considerable time by running the tool post and carriage back each time.

The above scheme of setting the carriage with respect to the lead screw and not disengaging therefrom during the complete cutting of the thread has been found to give excellent results. It is, however, advised that the novice should become thoroly familiar with the first as it will give considerable practise in handling the lathe.

In cutting *internal* or *inside threads* the same methods are followed as when cutting an outside thread with the exception that an inside cutting tool is utilized and set as shown in Fig. 4. It should be remembered, however, when cutting internal threads that the diameter of the hole should be equal to the diameter at the bottom of the screw thread which is to fit into it; thus the hole intended for an inch bolt, having eight threads per inch on it, would be bored out to just under seven-eighths inch in diameter.

A very good illustration showing the various cuts and the number necessary to make a good thread is given in Fig. 5.



Lathe Set up to Cut External Threads on a Cylindrical Rod. The Stock to Be Threaded Is Fastened in the Chuck and Is Driven by It.

AUTHORS!!!

All matter intended for publication—not only by us, but by any other magazine or newspaper as well—should be written on one side of the paper only and in ink. If it isn't, somebody else must copy part of it off on another sheet before it is given to the printer.

It will be found at first that the amateur will spoil a great deal of work before he obtains a perfect thread on his work, and he is advised to continue to practise cutting threads of all different pitches on old stock until he thoroly masters the art. Old round stock should be used for practise work.

(To be Continued)

PHARAOH'S "SERPENT'S EGGS" TRICK.

ONE of the most amusing tricks in fireworks is the serpent's egg trick, where a little pellet when lighted, turns into a horrible snake, many, many times the size of the pellet. How awe-inspiring it is to the youngsters! Most people have no idea what in the world causes the snake to appear. The explanation is simple. Mercury sulphocyanid burns with a voluminous ash. The little pellet is nothing more than some mercury sulphocyanid. The heat causes the ash to move off so quickly from the burning pellet that it writhes and distorts itself into the shape of a miniature snake.

It requires only a little preparation and a slight knowledge of chemistry to prepare some of this compound.

Mercuric nitrat $Hg(NO_3)_2$ and ammonium sulphocyanat (or cyanid) are used in its preparation. In case these are not at hand the mercuric salt may be prepared by adding 75 c.c. of 1.2 sp. gr. nitrate acid to 25 c.c. metallic mercury and slowly warming till all the metal is dissolved. The excess acid should then be boiled off and the concentrated mercury salt diluted to form about a liter of solution.

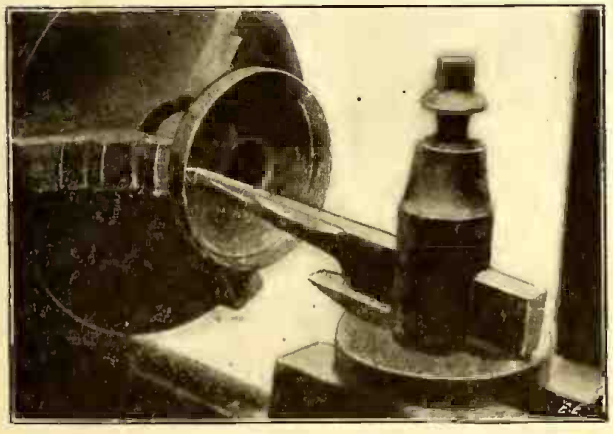
The ammonia salt is prepared by adding potassium cyanid to ammonium polysulphid, and heating slowly to dryness. (A water bath should be used if possible; if not the container holding the solution should be partly immersed in a larger container holding water so as to form a double boiler.) 25 c.c. of the KCNS (ammonium sulphocyanid) should be dissolved in 500 c.c. of water. Add 10 drops iron chlorid ($FeCl_3$) to the $Hg(NO_3)_2$. This will be used as an indicator. Slowly add the KCNS solution stirring constantly. A red color of Fe CNS (iron sulphocyanid) will momentarily appear but vanishes as soon as the solution is stirred. A curdy white precipitat will form. When a point is reached where the red color refuses to disappear the reaction is complete and no more of the ammonium salt need be added.

The precipitat should be filtered, washed and then about 1.5 g. dextrine disolved in 10 c.c. of water should be added after removing the precipitat from the filter paper. The two are then thoroly mixed and then dried for 48 hours.

When dry, the cake may be cut into little pellets of about ¼ inch cubed. A match applied to this will produce the snakes.

Caution:—The fumes given off when burning are poisonous mercury gases and care should be taken not to inhale them.

Contributed by ALBERT H. BEILER.



Internal Thread-cutting Tool Set up on Lathe Carriage for Threading Inside of Telephone Receiver Cap.

AMATEUR ELECTRICIANS! ATTENTION!!

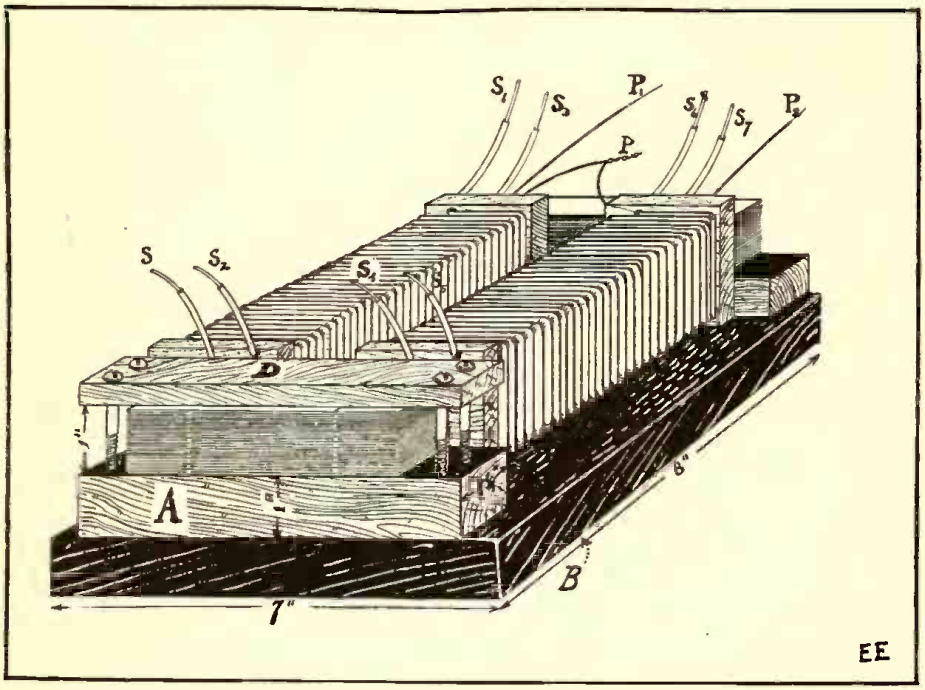
Did you read the prize contest article entitled "Utilizing Burnt-out Lamp Bulbs," which appeared in the April number of this journal? If not, procure a copy to-day. Here is your chance to make some money. Prizes are offered for the best ideas—"What to do with burnt-out lamp bulbs," and prizes will be awarded as follows: First prize, $3.00; second prize, $2.00, and third prize, one year's subscription to the ELECTRICAL EXPERIMENTER. Get busy, boys, and watch for the September issue.

On the Construction of Small Transformers

By Prof. F. E. AUSTIN

AS many questions are continually arising in the mind of the amateur and experimenter regarding the windings on transformers to meet certain conditions, a few fundamental principles may be explained that will enable those who so desire to either construct transformers to meet certain requirements or to remodel transformers already constructed to meet new conditions of service.

Suppose a transformer has been constructed similar to the one shown in illustration, having a core one square inch in cross section, 6½ inches long on the limbs, containing the coils and 2¼ inches on the shorter limbs. This core is made up of soft iron plates, of, say, ordinary black stove pipe iron, or even of ordinary "roofing tin," which is thin iron or soft steel coated over with tin. The strips to build up the iron core are therefore 1 inch wide, and the longer strips 6½ inches long, and the shorter ones 3¼ inches long.



Typical Design of Efficient Closed-Core Transformer Treated On In the Present Article. This Design is Adaptable to Either Step-Up Or Step-Down Requirements.

If this transformer is designed for connection with a 110 volt service main, the primary coils should be wound with a total of 520 turns of No. 25 B. & S. gage copper magnet wire, double cotton covered. This of course means 260 turns on each spool or coil. If there are 520 turns total and the applied pressure is 110 volts, the volts *per turn* of the primary will be

$$\frac{110}{520} = 0.21 \text{ volt.}$$

Considering the matter from another standpoint, about five turns represent one volt.

If now one turn of a secondary winding is wound on the spool or form over the primary winding, one turn of this secondary will have between its terminals a pressure of very nearly 0.21 volts. If this one turn were of No. 25 copper, its resistance would be so great that even were the ends of the single turn brought into contact with each other the current resulting would not be great, and therefore no very noticeable load would be supplied by the primary.

If, on the other hand, the single turns were made of a band or flat ribbon of thick copper, then short-circuiting the ends of such a turn would cause a very considerable current, because of the very low resistance of the band and a very considerable amount of electrical energy will be supplied by the primary.

In other words, it makes no difference what the cross-section of the wire is so far as the induced pressure is concerned, but does make a difference so far as the current is concerned. So far as the load on the transformer is concerned, one turn of very large wire will produce as great a load as a large number of turns of fine wire.

It was said that the *per turn* pressure on the primary is very nearly the same as the *per turn* pressure on the secondary. Were the efficiency of the transformer 100%, meaning that just as much electrical power could be obtained from it as was supplied to it, then the *per turn* pressure of both primary and secondary would be exactly the same. If the efficiency of a transformer is 50%, then the *per turn* pressure of the secondary is about *one-half* the *per turn* pressure of the primary. Of course the efficiency of 50% occurs when the transformer is in operation, delivering electrical power. At no-load output, or at open-circuited secondary, the *per turn* pressure of the primary and secondary are the same in a well-designed transformer. When, however, the load is applied to a transformer, there is an internal pressure drop exprest by the resistance of the windings multiplied by the current in the windings. If the resistance of the windings does not vary in value but the current does, then the internal pressure drop will vary. As the current increases due to increased load the internal drop increases, and therefore the terminal pressure *decreases*.

The applied pressure is kept constant and the demanded increase in energy is supplied by the governing devices at the central station furnishing power.

For electro-welding only low pressures are required, but large currents are necessary in order to supply the necessary heat at the junctions of the two pieces of metal to be welded. A transformer for welding purposes will therefore have its secondary made of very large copper bands, and consisting of but few turns. If the same number or turns are wound on each limb or coil, then the two may be connected together in parallel, in order that the current may be doubled.

In connecting the two coils together, it will be necessary to duly regard the polarity of the terminals, as at every instant the terminals have relatively *positive* and *negative* relation with each other. If two coils happen to be connected so that two positive and two negative terminals are together, the resulting pressure will be zero, provided the pressures of the coils are the same.

If the secondary winding of a transformer such as in the figure consists of two sections, each having two layers of 50 turns each of No. 14 B. & S. gage copper wire, the terminal pressure of each layer will be about 5 volts at a load of about 300 watts, or a trifle less than one-half horse-power.

If copper strip about ½ inch in width is wound on or over the secondary of No. 14 forming 2 coils of five turns each, a welding transformer will be formed, allowing, if desired, the two windings to be connected together in parallel to produce *twice the current* but only *one-half the pressure* effect.

As described the transformer is a *step-down* transformer, stepping the applied primary pressure of 110 volts down to 5, 10, 15, 20, or 1 or 2 volts as desired by attaching to the proper terminals.

If instead of being wound with No. 14 wire, the secondary were wound with say 1040 turns of No. 28 B. & S. gage copper magnet wire, the transformer would become a *step-up* transformer, stepping the pressure up from 110 volts to about 200 volts.

Were a transformer capable of operating at 100% efficiency, then the pressure times the current in the secondary would be exactly equal to the pressure times the current in the primary. Then if the secondary pressure were twice the primary pressure, the secondary current would be one-half the primary current. This at once shows why a step-up transformer requires a smaller size of wire in the secondary than in the primary. In a step-down transformer the secondary is made of much larger wire than the primary.

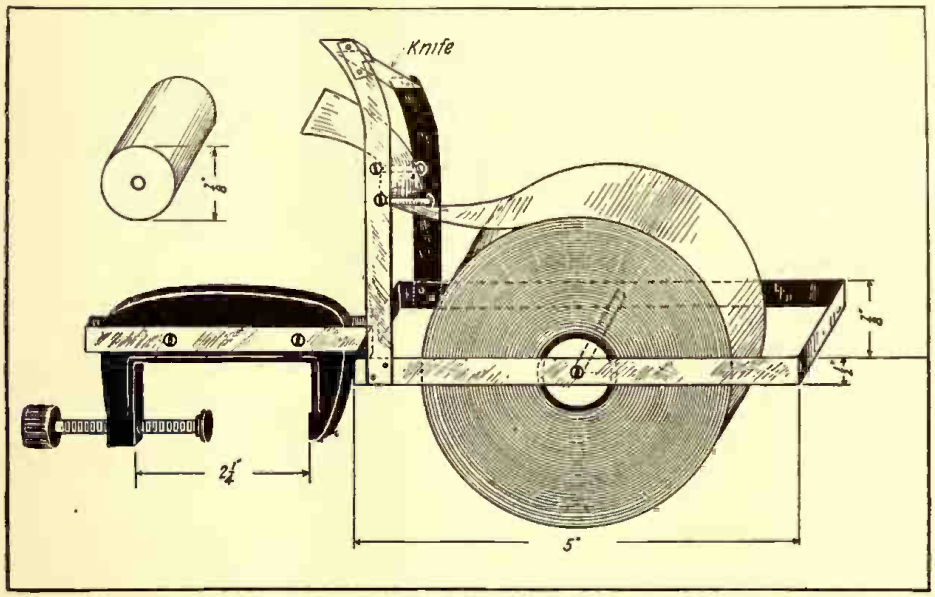
PROPERTIES OF ELECTROLYTICALLY DEPOSITED COPPER.

A preliminary report has been publisht of the studies of copper electrodeposition in electrotyping baths by the U. S. Bureau of Standards. These studies have resulted in establishing tentative specifications for the deposition of such copper, concerning the composition of bath, current density, etc.

In connection with this work there has been publisht (Transactions of American Institute of Metals, 1916) an article, giving a description of the microscopic structure of electro-deposited copper. The occurrence and effect of twinned copper crystals or grains as deposited are discust. The conclusion is reached that the grain size of such deposits does not alone determine the physical properties.

Handy Tape Holder and Cutter

The diagram herewith shows a handy friction Tape Holder and Cutter for armature winders. Without such a device one is forever hunting for the tape, besides trying to cut it with one hand.



A Tape Holder and Cutter Useful In Every Shop and Laboratory, Which Can Be Made In a Few Minutes' Time by the Experimenter. The Clamp Is Best Purchased at Your Hardware Dealers.

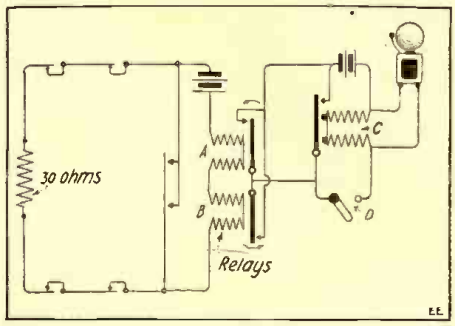
As all of us know, there is much laying down and picking up of armature winders' tools, and you are obliged to look all over your tray each time for the tool you want. Now this device can be clamped to the tray just where it will be the most handy and will always be found in the same place when wanted. You can pull off as much tape as you want, and then by pulling it sharply across the knife it will cut the tape. One side of the arms that hold the knife should be longer than the other and the knife set so that the tape will be cut on the bias. The knife, as you observe will do away with the handling of your shears.

As I find this a great aid to my work, I pass it on to others.

Contributed by CHARLES A. SMITH.

IMPROVED BURGLAR ALARM CIRCUIT.

In your March, 1917, number of ELECTRICAL EXPERIMENTER, on page 821 is described a "balanced burglar alarm system," contributed by Mr. T. W. Benson, which I do not think will work very good. The contacts shown in his Figs. 1 and 2, and the battery Fig. 6, I think are all very good. The balanced relay, Fig. 3, however, will not operate exactly as described: If a "polarized" ringer coil is used and the tapper arm bent so that it will drop to one side, and is connected as shown in his Fig. 4, the tapper will drop to one side according to the direction the current from the battery is flowing in, and stay there. I do not believe any adjustment can be made to permanently balance this relay as shown. If the permanent magnet would be removed from the ringer, the pull of the one coil would be equal to the pull of the other coil, but as the tapper arm is slightly bent, when the battery circuit is closed the tapper will fall in the direction it is bent, and remain there. Even if it would be possible to balance this relay, any slight vibration would cause it to drop to one side and close the contact. Another poor feature in my estimation:—When the open circuit line is closed, it will not unbalance the relay, but only allow a larger amount of current to flow thru the relay coils, due to the fact that the 20 ohm resistance is cut out of this circuit.



Improved Circuit for Burglar Alarm, Using Simple Yet Very Effective Arrangement of Relays.

I submit a diagram for your consideration which I think will work better and be more reliable. As far as the contacts are concerned, Mr. Benson's would work very satisfactory. In the closed circuit three gravity cells would be used.

The two relays are connected in series. Any style of relay having resistance of about 35 ohms would work. The armature of relay "A" is adjusted so that it will stand normally open, but will close when the open circuit contacts are closed, or if the line should be short circuited. Relay "B" has a back contact, and is adjusted so that the armature is normally pulled up. When a closed circuit contact is opened or any change in the resistance of the line is made, relay "B" will open.

Relay "C" (according to my diagram) is so wired that when the contact on either relay "A" or "B" is closed, the contact on relay "C" will close and remain so, regardless of whether the contacts of relays "A" and "B" resume their normal positions. This will cause the bell to ring, or give some other alarm until switch "D" is opened.

While a separate battery is shown in the bell circuit, a connection could be made to the gravity battery to ring the bell.

Contributed by

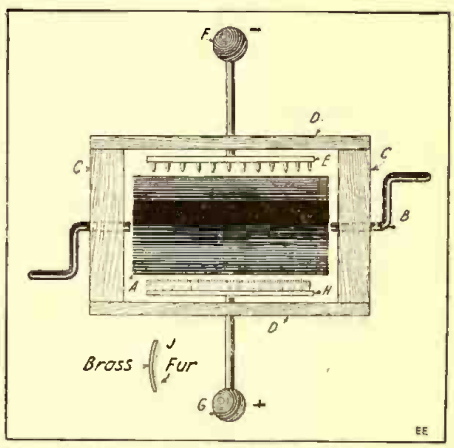
ROBERT M. WEAVER.

A NOVEL ELECTROSTATIC EXCITER.

The little machine here illustrated is very convenient for exciting influence (static) machines and for a variety of purposes when a stream of very small sparks of either + or — electricity is required. It consists of a 3-inch length of ebonite (hard rubber) tube, A, 1½ inches in diameter, closed at the ends with corks, so that it can be fixed to an axle, B, of stout brass wire, passing thru holes in the center of two small pieces of varnished wood, C-C, 2½ inches long. The ends of the axle are afterward bent into handles, as shown. Two thick strips of ebonite, D D, 4½ inches long, are screwed to the wooden end pieces. A hole is made in the center of each to take a 3-inch length of brass tube, which must make a tight fit. One of these has a collecting comb, E, soldered to one end and a large brass ball, F, screwed to the other. The second tube has a similar ball, G, fixt to one end, and a fur "rubber," H, at the opposite end. The rubber is 2½ inches long and ¾-inch wide. It is curved, as shown at J, the degree of curvature being the same as that of the ebonite tube, and consists of a piece of any suitable fur (the writer has used moleskin, though cat-skin is best) fixt to a curved strip of brass with glue. The metal backing is, of course, previously soldered to the brass tube.

It will be understood that the rubber must press very lightly against the revolving ebonite tube, while the teeth of the collecting comb must clear the tube by about ⅛-inch. The operation of the machine is very simple. Upon turning either handle the ebonite tube is caused to revolve against the fur-rubber. Both become electrified in consequence, the fur positively and the ebonite negatively. The capacity of the machine is, of course, very limited, and only very small charges accumulate on the metal conductors. In order to obtain a constant stream of sparks, therefore, one of the conductors must be grasped in the hand to conduct away its charge as fast as it is collected. Hold F, and positive sparks are obtained from G; hold G, and negative sparks may be taken from F, as long as the handle is turned. This is the reason for making a handle at both ends.

Contributed by H. J. GRAY



A Small Electrostatic Exciter Such as Here Illustrated Is Very Convenient for Exciting Large Static Machines and for Conducting Simple Experiments With.

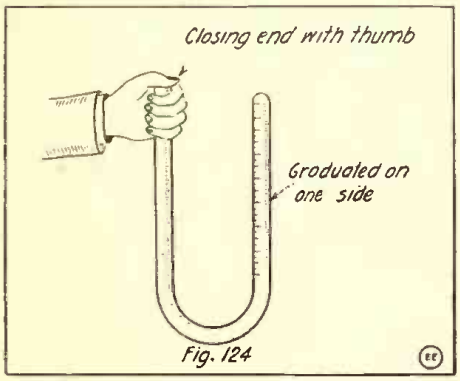
Experimental Chemistry

By ALBERT W. WILSDON

Twenty-Seventh Lesson

WATER: History

WITH the observation of Cavendish in 1781, that water was the product of the combustion of hydrogen, the ancient belief in its elementary nature was broken down. Lavoisier, in 1873, confirmed the experiment of Cavendish, and he decomposed



Eure's "Eudiometer," a Graduated Glass Tube, Used in the Analysis of Water by Electrolysis.

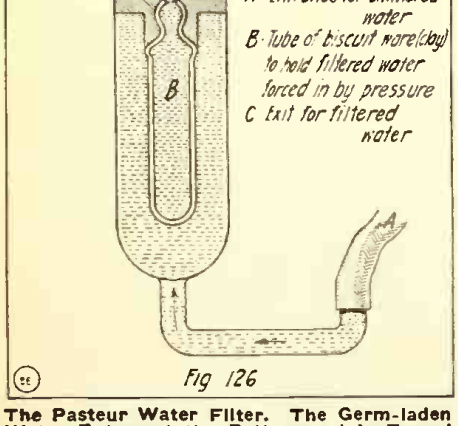
water into its elements and conclusively demonstrated that it was composed of one part, by weight, of hydrogen, and eight parts, by weight, of oxygen. The volumetric composition was proven by Gay-Lussac in 1805 to consist of two volumes of hydrogen and one volume of oxygen.

Occurrence.

Aside from its abundant natural occurrence, as we are accustomed to see it, water is very widely distributed in such a manner as to evade casual observation. In other words it is in places where we would be least likely to look. It is present in green plants to the extent of from 70 to 90 per cent; in fruits 80 to 95 per cent; in the animal body from 75 to 80 per cent; while the soil averaged from 5 to 20 per cent of moisture.

Preparation.

The simplest and most convenient method of forming this compound from its elements, *i. e.*, hydrogen and oxygen, and proving the product to be water, is to burn a jet of hydrogen in air, and hold over the flame of a cool bell-jar, which will immediately become coated with a film of moisture. When a mixture of the two gases is brought in contact with a flame, a violent explosion results. If, however, they are brought together at the moment of their combination, so as to prevent explosion, the mixture will burn with a very intense heat. The oxyhydrogen blowpipe is the apparatus by which this may be accomplisht. Reference is hereby made to Experimental Chemistry, Fifth Lesson, October, 1916, issue of this journal, for a more complete description of the blowpipe with illustrations.



The Pasteur Water Filter. The Germ-laden Water Enters at the Bottom and Is Forced Thru a Porous Clay Tube "B," from Which the Purified Water Emerges Thru Pipe "C."

Composition.

Analytically, the composition of water may be demonstrated thru the electrolysis of water (acidulated with a small quantity of sulfuric acid) which when carried out by means of an *eudiometer*, yields two volumes of hydrogen, which collects in the arm containing the negative electrode, and one volume of oxygen in the other containing the positive electrode.

Synthetically the composition of water may be proven either by volume or weight. Volumetrically, by introducing exactly 1 volume of oxygen and 2 volumes of hydrogen over a column of mercury contained in an eudiometer tube (see Fig. 124). After exploding this mixture by means of an electric spark, all the gas will have disappeared and the tube will be filled with mercury, excepting a very small quantity of water which has been formed. Should the two gases introduced be in proportions other than the above, any excess of one or the other will remain after the explosion. Gravimetrically, the quantitative synthesis of water is carried out by conducting pure dry hydrogen over a weighed quantity of heated copper oxid, the resulting water being collected and weighed. The weight of the copper oxid after the reduction is also noted. The loss in weight sustained by the copper oxid represents the oxygen consumed, and this subtracted from the water formed is the hydrogen. For example: 6.57 grams of copper oxid lost 1.31 grams of oxygen, which in turn yielded 1.475 grams of water. The hydrogen consumed would be equivalent to 1.475 — 1.31, equals 0.165 gram. Then the ratio of hydrogen to oxygen would be 0.165 to 1.31, or 1 to 7.94, which represents the combining weights of these two gases. Since the vapor density of water is 8.94, its molecular weight must be 17.88 (2×8.94.), and of this 2 parts by weight, or two atoms, are hydrogen, and 15.88 parts by weight, or one atom, of oxygen.

Properties: Physical.

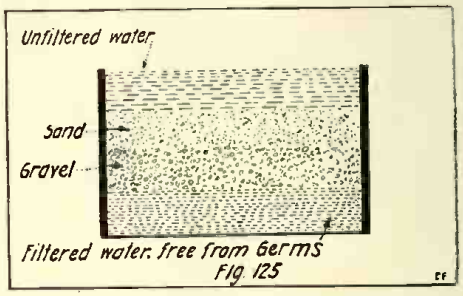
Water consists in three states, *i. e.*, solid, (ice), liquid, and gaseous (steam) within 100 degrees (C).

It freezes at 0 deg. C. and boils at 100 deg. C. at 760 mm. pressure. Under 10 atmospheres it boils at about 180 deg. Diminished pressure lowers the boiling point.

The specific gravity of water at its greatest density has been selected as 1.000; at 0 deg. it is 0.99987, thus *ice* (0.9173) *floats in water.*

When water crystallizes, heat is set free, while, on the other hand, when ice is fused, heat is absorbed; this is true of all fluids and solids when they pass from one state of aggregation into another. With ice or water this heat consumption or liberation amounts to 79 calories. That is, in order to fuse 1 kilo of ice, a quantity of heat will be required which is capable of raising 79 kilos of water thru one degree centigrade.

Water is the greatest solvent known. Substances dissolved in it raise its boiling point and lower its freezing point.



How Water Is Filtered by Means of Filter Beds Constructed in the Manner Illustrated. The Unfiltered Water Enters at the Top and Trickles Down thru the Sand and Gravel Layers, Which Purify It.

Evaporation takes place at all temperatures, even from ice. Evaporation increases in rapidity with the temperature and diminishes with the increase of pressure and tension of the aqueous vapor of the atmosphere above.

It has the highest specific heat of liquids.

Chemical.

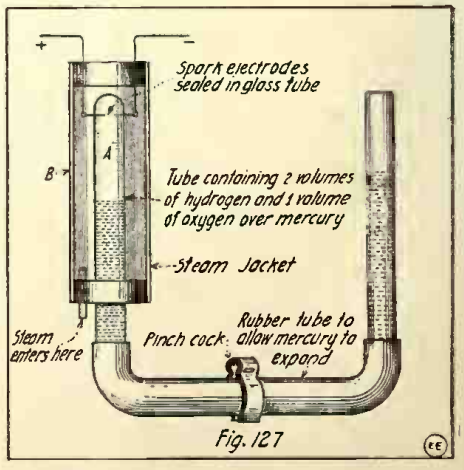
Water begins to dissociate at 1000 deg, but is completely broken up at 2500 to 3000 deg. Thus it is one of the most permanent of compounds. Below the latter points it will extinguish flame, but above them it feeds the flame.

It decomposes electrolytes into *plus* and *minus* ions.

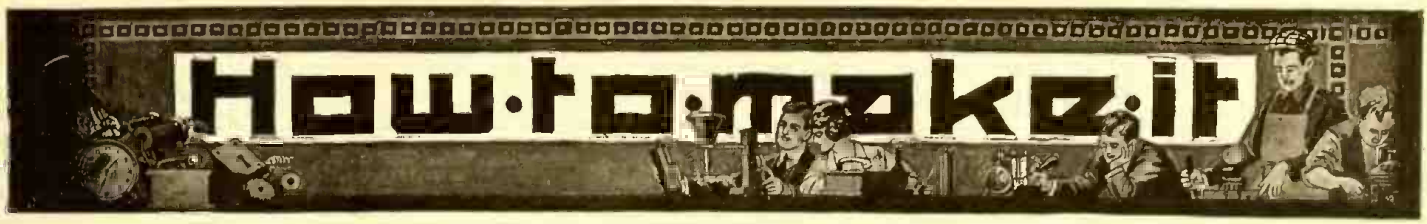
It reacts with certain metals -Na, K, Li— to form alkalies. Thus Sodium and Potassium, as we have seen from experiments already conducted, decompose water at ordinary temperature with the liberation of Hydrogen. $K_2 + 2H_2O = 2KOH + H_2$.

With metallic oxides it often forms bases.

(*Continued on page 273*)



Simple Experimental Apparatus to Be Made by the Experimenter for the Synthesis of Water.

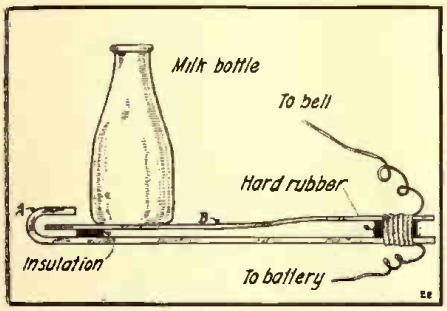


This department will award the following monthly prizes: First Prize, $3.00; Second Prize, $2.00; Third Prize, $1.00.
The purpose of this department is to stimulate experimenters towards accomplishing new things with old apparatus or old material, and for the most useful, practical and original idea 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

A MILK BOTTLE ALARM.

A is a piece of brass cut as shown in Fig. 1, with a piece of tape or fiber (for insulation) as shown. B is a piece of spring brass cut as shown and both ends of A and B are separated by a piece of hard rubber



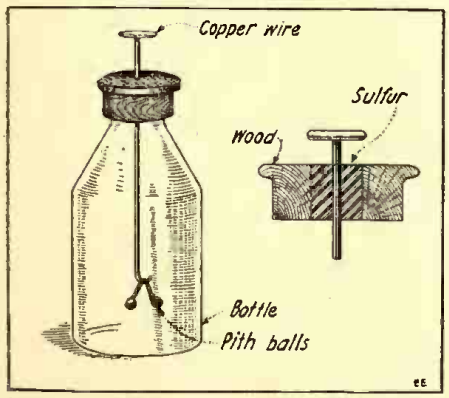
When the Milk-man Takes Your Milk Bottle from This Switch, It Closes an Electric Alarm Bell Circuit.

with tape wound around them, or else clamped together by fiber blocks. Place a bottle on the brass arm B, and as soon as anybody picks up the bottle, it causes a connection between A and B and the bell rings.

Contributed by
EDWIN WOLBER.

A SIMPLE PITH-BALL "ELECTROSCOPE."

A simple but efficient electroscope is made as follows: A bottle made of good, clear glass and of the shape shown is necessary. A thin copper wire is bent in the shape indicated after being mounted in a tight-fitting cork. The copper wire is mounted in a poured sulfur bushing in the center of the cork. A small piece of silk thread is tied or pasted to each pith-ball and the other end is tied to the hook in the wire. When finished the pith-balls should hang two or three inches from the bottom



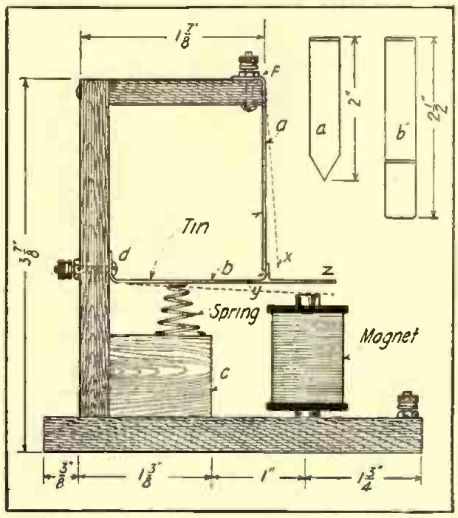
A Handy Testing Instrument for the Amateur Electrician Is the Pith-ball Electroscope Here Illustrated.

SECOND PRIZE, $2.00

A CIRCUIT-BREAKER FOR BATTERY CURRENTS.

This circuit-breaker, of which a sketch is here given, has proven to be very efficient. The base and uprights may be made of boxwood. The binding posts may be obtained from an old battery; the magnet can easily be made or obtained from a discarded doorbell. The dimensions may be altered but I have found the ones given very convenient. In making parts "a" and "b" care must be taken to allow for the bends at "d" and "F." The height at "d" depends on the size of the magnet; the same with the length of "a." Point "y" must fall below "x" when "z" touches the core of the magnet.

Contributed by CARL KOESTER.



A Miniature Circuit-breaker Such as This May Save the Life of Your Batteries Many Times.

of the bottle. Be sure the pith-balls hang exactly even in the bottle.

Contributed by MANSELL SARGENT.

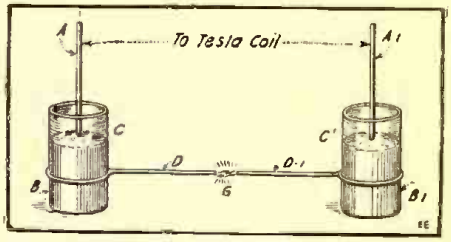
TESLA CURRENT PASSES THRU GLASS.

When amateur wireless stations were closed by the government, upon the entrance of the United States into the war, many operators constructed Tesla coils and resonators for use with their transformers. I am submitting a description of an experiment which requires practically no preparation, and which has a startling effect. The fact that electricity at high voltages cannot be confined by ordinary electrical insulation is well illustrated.

The action is as follows: When current flows thru the Tesla coil sparks leap from A and A_1 to the surface of the water. A steady stream of sparks also flows between D and D_1 at the gap G. The electricity evidently flows from A to A_1, thru the glasses without puncturing the glasses. If the current is allowed to flow long enough *the water becomes heated.*

Contributed by GEO. B. GATES.

A pretty experiment, but our contributor has taken a wrong conclusion. The tumblers with water, the inside wire, as well as the outside loop forms a small Leyden jar (a condenser). Hence the easy flow of the current. However, Tesla currents easily pass thru glass.—EDITOR.

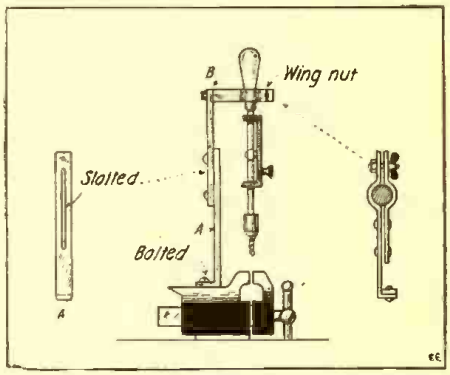


Apparently the Tesla High Frequency Current Passes Thru the Glass of the Leyden Jars, Causing a Discharge at the Gap G.

THIRD PRIZE, $1.00

A USEFUL HAND DRILL ATTACHMENT.

Its principal function is to hold the hand drill straight, thus making it easier to do accurate work. Dimensions are left to be



To Drill Holes Accurately With a Hand Drill is Always a Difficult Job. This Vise Attachment Makes a "Drill Press" Out of Any Hand Drill.

calculated by the builder to fit his particular drill. The main standard "A" 1 inch by 3/16 inch band iron, is formed by drilling several holes in one end and then bent at an angle to fit the flat anvil on an ordinary vise. A slot may be cut in it by drilling several holes in a row, chopt out with a cold chisel, and finished with files. The upper part of standard "B," is also made of 1 inch by 3/16 inch band, then it is bolted loosely to "A," with washers and nuts on opposite side. A clamp made of lighter material is bolted to the top to receive hand drill. To operate it is only necessary to apply pressure to top of drill.

Contributed by LEO HAASE.

DRILLS MADE FROM NEEDLES.

Having occasion to use many small drills, and not wishing to incur the expense of continually repairing old ones, I used the following trick:

I procured several sewing needles of the same diameter as the drill I needed. After breaking off the eye, I ground the needle slightly flat on both sides of the large end. I then shaped the flattened end according to the sketch. These drills will do good work and will not break so easily.

Contributed by R. DANKS.

REMOVING STAINS OF ALL KINDS.

Solution No. 1. 20% solution of acetic acid or tartaric acid.

Solution No. 2. Five grams of bleaching powder (CaClO). Boil in 100 cc of water until a pink color appears. Filter and add 50 cc of cold water.

To remove ink, coffee, tea, fruit, and dye stains, wet the spot thoroly with No. 1. Absorb the superfluous liquid with a blotter and apply No. 2. Rinse and repeat if necessary.

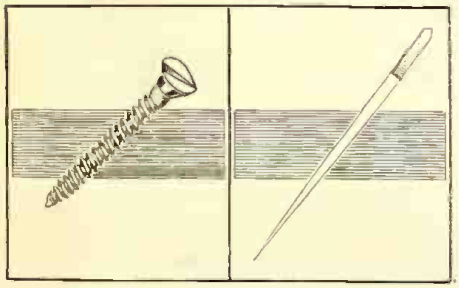
For removing common stains, treat as shown in the following table:

STAIN	REMOVED BY
Acids	Cold water, Nos. 1 & 2.
Grass and fruit	Cold water, alcohol, Nos. 1 and 2.
Grease	Gasoline, carbon tetrachlorid, chloroform, ether, carbon bisulfid, ammonia, soap-suds, warm fullers earth (cover with a blotter and apply a warm iron.)
Dyes, coal tar or of vegetable origin	Nos. 1 and 2, ammonia.
Mildew	Nos. 1 and 2, sunlight.
Inks	Nos. 1 and 2.
Inks, indelible (silver)	Potassium cyanid, 10%. Use great caution — intensely POISONOUS, Sodium hyposulfite 20% solution.
Iodin	Methyl alcohol, potassium iodid Sol. 10%.
Iron Rust	Warm oxalic or citric acid, 10%. If in silk, let it alone.
Paint, varnish	Turpentine, benzine, carbon tetrachlorid. Use no turpentine on silk.
Tar, wagon grease	Soap and oil, turpentine.

Contributed by JOHN D. COLEMAN.

A WOOD SCREW WHICH CANNOT BE UNSCREWED.

Many times the experimenter has need of a wood screw which can be screwed into a



Now Don't Get All Mother's Needles. Remember She Has to Darn Your Stockings!—And You Can't Unscrew This Wood-Screw!

piece of wood, but cannot be taken out. A screw of this kind can easily be made by taking an ordinary wood screw and filing down each side of the head, as shown in the illustration.

It will readily be seen that while it can be screwed into the wood, it cannot be unscrewed.

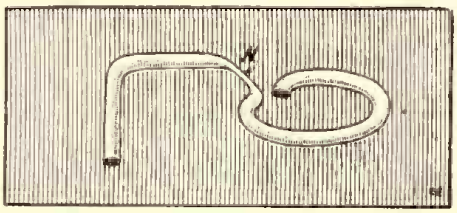
Contributed by G. COLEMAN.

A CHEMICAL SIPHON.

This will be especially useful to electrochemists for siphoning off liquids from gravity batteries, etc. It is easily made by heating a glass tube till soft and drawing it out until of quite small diameter at the bend; it is bent as shown in sketch (aided by using a fish tail burner).

Its principle of operation is the "ram" action. Immersing it, keeping one finger closed over one end, and lower it horizontally into the shallow liquid. Remove finger and liquid will rush into tube, its velocity being sufficient to carry it up the narrow portion marked N, and over the bend.

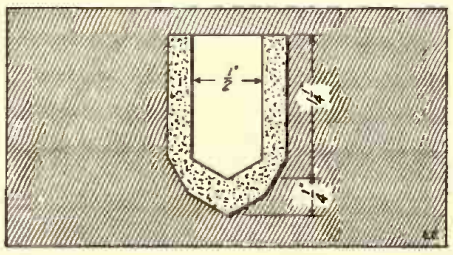
Contributed by K. CLARK.



Simply Bend a Piece of Glass and Presto! That Much Desired Siphon is Ready. Simple!

A HOME-MADE CARBON CRUCIBLE.

It is often that the experimenter desires to melt a small quantity of metal and mould it into a certain shape, or he might want to mix a special amalgam. But he is stopt by the lack of some suitable container or crucible; and he does not want to buy



Make Your Own Crucibles and Build an Electric Furnace to Make Diamonds.—S'easy!

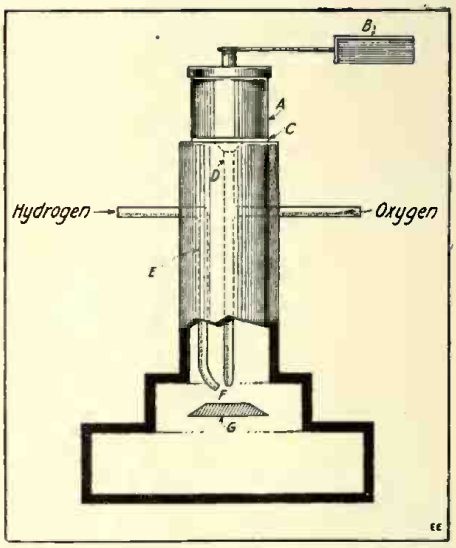
one. Herewith are given the directions for making a crucible that will stand a very high temperature.

From a round battery carbon cut a piece 1½" long. From the top drill a ½" hole 1¼"deep. Round off the bottom and the result will be a good carbon crucible. The contributor has melted iron in a crucible of the above design. By using a dry plaster of Paris mould the metal may be cast into the desired shape.

Contributed by WILLIAM F. WINTER, JR.

"THE SYNTHETIC PRODUCTION OF RUBIES."

During the last few years, practically all of the beautiful minerals of the corundum family have been produced synthetically in



Do You Know That Rubies Are More Valuable Than Diamonds? With This Furnace You Can Make 'Em By the Pound. Don't Forget to Send Us a Few Pounds!

the laboratory. These artificial gems are identical in beauty, hardness, and chemical composition to those obtained from the mines. The accompanying diagram shows a furnace commonly used in producing the gems.

The operations are as follows:

A trace of chrome alum is added to a solution of common alum, the chrome alum being the coloring constituent.

Then ammonia is added and a gelatinous precipitat of the hydrates of alum and chrome is formed.

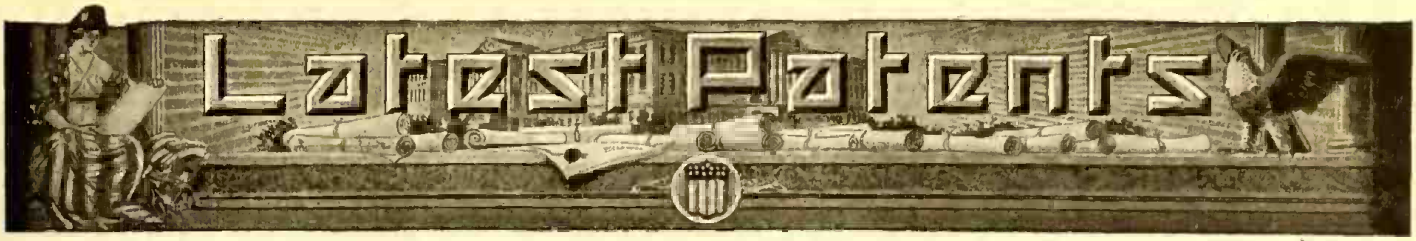
This precipitat is filtered off, evaporated to dryness and calcined in a furnace at a temperature of 1000° F. into an ultimate mixture of alumina and chromic oxid. The proportion in which these two chemicals occur in the ruby are:

Alumina 98%
Chromic Oxid..... 2%

The mixture is then ground into a powder and placed in the hopper "A." "B" is an electrical tapper which shakes the powder thru the sieve "C" into the tube "D." Thru this tube the oxygen is also supplied. Hydrogen is supplied thru the tube "E." The two gases are ignited at "F." "G" is a platform made of a highly refractory substance against which the flame strikes and on which the ruby is formed in a pear-shaped mass. The rate of flow of the powder and the temperature of the oxy-hydrogen flame must be regulated very carefully. When a bead of sufficient size has formed the heat is gradually lowered so that the gem may be free from great stresses. When it has cooled, it is broken off the base and sent to the cutter who finishes the gem.

It is important that the ingredients used in producing the minerals be of the purest obtainable.

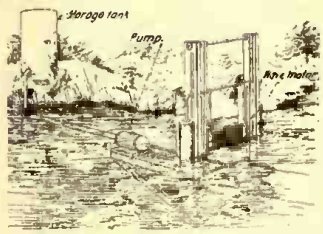
Contributed by W. A. SCHILDKNECHT.



Wave-Motor.

(No. 1,263,888; issued to Leander W. Hammond.)

Adapted to amateur requirements in developing electric light, etc. The paddle member, which is pivoted so

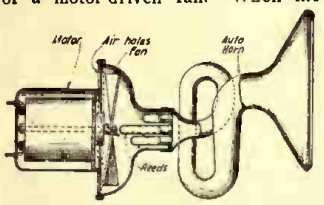


as to be swung back and forth by the wave action, is supported in an adjustable frame, which rises and falls with the tide, thus keeping the wave paddle at the proper height to work effectively at all times. The to-and-fro motions of the paddle cause a mechanical connected pump to force water into a tank in the manner apparent. The supply of water, which may be under pressure, in the tank on shore may be utlized for operating a water turbine or the like, the turbine being connected to a dynamo, etc.

Electric Horn for Autos.

(No. 1,264,841; issued to Henry A. Neuwiller.)

A unique electric wind horn for autos and other vehicles which has a particular application to a sound-producing instrument, wherein the air currents are generated by means of a motor-driven fan. When the

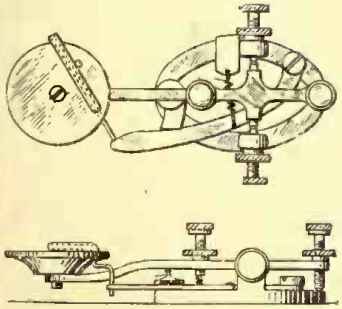


motor circuit is closed, it quickly accelerates the fan which draws in air thru screened openings at the rear of the fan chamber. In emerging thru the horn member the current encounters a series of tuned musical reeds, which may be three or more in number. In this way the reeds are vibrated by the air currents passing by them.

Telegraph Key Circuit-Closer.

(No. 1,264,465; issued to James L. White.)

On the top of the key knob is a small lever which is normally held in such a position that the lower end of this lever permits the switch knife to close the circuit in the well-

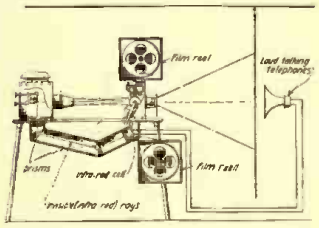


known manner. A spiral spring causes the switch knife to be normally held in the switch jaw mounted under the lower key contact. The operator when ready to send, simply pushes the switch trip to the left or against the pin on the knob, and proceeds to transmit. As soon as the knob is released, the switch closes automatically.

Talking Motion Pictures.

(No. 1,260,337; issued to Richard M. Craig.)

He utilizes a film containing the motion pictures, and on this same film he also records the speech record in such a manner that the sound record is formed of a substance which does not affect the transmission of ordinary white light, but which will affect the passage of rays beyond the visible rays of the spectrum. Also, the sound record on the film is made capable of transmitting ordinary white light, but is impervious to the transmission of infra-red rays. The patent covers details

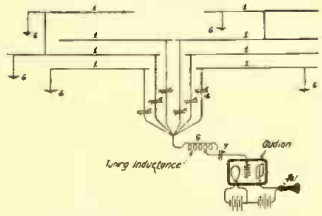


whereby the film moves intermittently past the image projecting lens, but moves steadily thru a second translating chamber in which the invisible or infra-red rays are projected thru the film and caused to fall upon a suitable electric instrument (bolometer or tasimeter) whereby the fluctuations of the invisible rays will cause the reproduction of sound vibrations in an associated electrical circuit, containing loud-talking telephones.

Radio Receiving Circuit.

(No. 1,263,204; issued to Elmer E. Butcher.)

Intended to operate with aerial or other collecting circuits which are out of resonance with the received oscillations, contrary to the usual practise, their purpose being merely to intercept them and transmit them



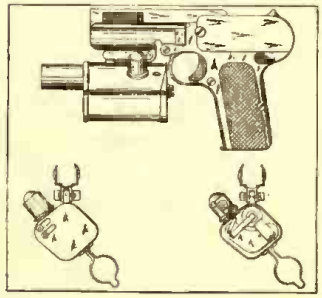
to the detector, which may be of the crystal or vacuum valve type. As the diagram shows, the detector is connected unilaterally. The variable condenser, 4, is not absolutely necessary; 6 is a variable inductance, and 7 a variable condenser. Coil 6 is preferably of considerable length, with a large inductance and a relatively low distributed capacity, and acts as a linear oscillator, thus producing a point of maximum potential to which the detector is connected. Condenser 7 has a relatively small capacity, while the inductance, 6, is principally used to tune in the received oscillations.

Flash-Lamp for Firearms.

(No. 1,262,270; issued to Paul Schmidt and Carl Dobslaw.)

This patent covers a design for an electric flash-lamp adapted to be detachably secured to the barrels of small firearms such as pistols and revolvers, for the purpose of lighting the target in the dark.

By means of two switch buttons

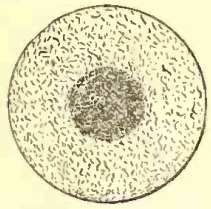


at the rear of the battery case, either lamp can be lighted. One lamp lens gives a white angle light for the use of the flashlight in general illumination, and the other lens a small angle beam sharply focust for use in lighting a target.

Sound-Reproducing Diafram.

(No. 1,264,219; issued to John A. Steurer.)

Diafram made, for instance, of blotting paper. This is saturated with a thin solution of a phenolic condensation product, such as bakelite or condensite, which is then dried. A circular central portion of the diafram so formed is then treated with a greater amount of the solution of such condensation product, and this part of the diafram is then

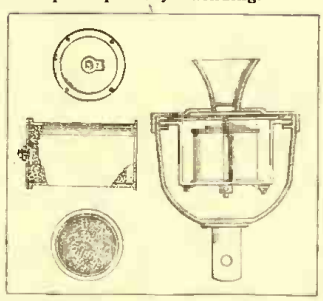


permitted to dry, with the result that the central part of the diafram will absorb a much larger quantity of the solution, and secondly be much more dense. The diafram is baked to make it hard and elastic, and it has a uniform thickness, while possessing much different characteristics from an ordinary diafram of uniform density.

Heavy Current Microphone.

(No. 1,263,140; issued to Lonnie Burnett Stone.)

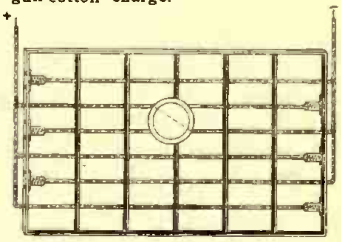
A novel design of heavy current or high duty telephone transmitter, employing a plurality of microphonic units. These multiple microphonic units, which comprise a series of tubular chambers or shells in which carbon granules are place, are connected in multiple with a suitable induction coil having a three-part primary winding.



Electrical Torpedo Net.

(No. 1,264,926; issued to Albert Hedina.)

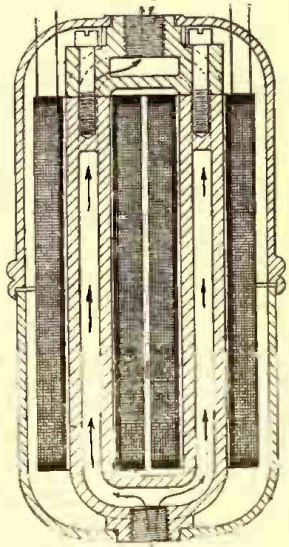
A net which may be used in sections, or which can be utilized separately by being arranged on a boom swung outwardly from a ship or in groups, so as to form a continuous curtain about the ship. This net is provided with a series of oppositely charged and specially insulated electrical conductors, arranged in such a manner that if a metal torpedo shell hits the net, it will cause a current to flow thru the torpedo from the oppositely charged conductors, and by virtue of the resistance offered by the passage of this current thru the shell of the torpedo, will thereby cause heat to be generated, and this heat in turn to cause an explosion of the torpedo's gun-cotton charge.



A. C. Induction Water-Heater.

(No. 1,261,470; issued to Charles A. Backstrom.)

An induction type of electric water heater intended for use on alternating current circuits. This design of heater has for one of its objects a higher operating efficiency, whereby a loss in the return magnetic circuit is utilized for heating the water. As shown, there is provided a U-shaped iron core on which the magnetizing coils are wound. At the upper end of the core a hollow cap plate is held in



position by means of machine screws or bolts, this cap plate being made of iron or steel. The hollow passages thru the upright coil cores register at their upper ends with the passageway thru the cap, so that when water is admitted at the bottom of the heater, it will pass thru the hollow cores and be discharged at the upper end. When connected to alternating current, the reduced core cross-section causes considerable heat to be developed.

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

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

"Amateur Electrical Laboratory" Contest

In this issue we publish some interesting facts with excellent photos, describing one Amateur Electrician's experimental laboratory. Now "Bugs"—we want to publish a snappy one like it 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 photgraphs. If we think it good enough we will publish the article in display style and pay you well for it. The prize awarded to such articles will range from $3.00 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." made in the same mould. Remember—send a photo of YOURSELF along. Typewritten articles preferred.

THIS MONTH'S $3.00 PRIZE WINNER—ELMER HUTCHINSON

MOST fellows do not realize the fun in having an experimental laboratory. I am in partnership with Wilbert Hartle, who lives near by. I firmly believe in partnership of two boys as one may have one thing while the other will have something else of value.

Our laboratory measures about fifteen feet by fifteen feet. We have just enough room altho as we are purchasing and making apparatus constantly we are soon going to be somewhat crowded. On one side are a chemical laboratory and a desk (Fig. 1). We use the desk for correspondence, studying and drawing. In the drawers we keep magazines and catalogs. We have about three years straight of the ELECTRICAL EXPERIMENTER. Fig. 1 shows the arrangement of chemicals. We have a compound of almost every metal and salt and can therefore make any chemicals we need. We learned analysis by having one of us mixing up something for the other to analyze.

On one side is a work bench extending almost to both ends of the shop. We have a full equipment of tools for wood work, wood and metal turning, forging, foundry work, drawing and pipe fitting. The box on the lower right hand side of bench (Fig. 4) is a cabinet for holding nails, screws, tacks, bolts, and small "junk." We made the switchboard and have used it very successfully. An electric motor runs the shafting and machinery.

We installed all the shafts and countershafts ourselves and connected up the screw-cutting lathe as shown in Fig. 3. We have found this lathe very handy for turning small parts of apparatus. The small lathe (Fig. 4) is not in use at present, but as soon as we get enough time, money and room we will set it up. The grinding wheel and dynamo are connected to the same line shaft. The drill press is not run by the motor because it is used for work that is too heavy for the motor.

The pictures do not show much of the electrical apparatus among which are motors, an electric furnace, dynamo, step-up and step-down transformers, condensers, batteries, meters, etc. We have a complete "dismantled" wireless outfit.

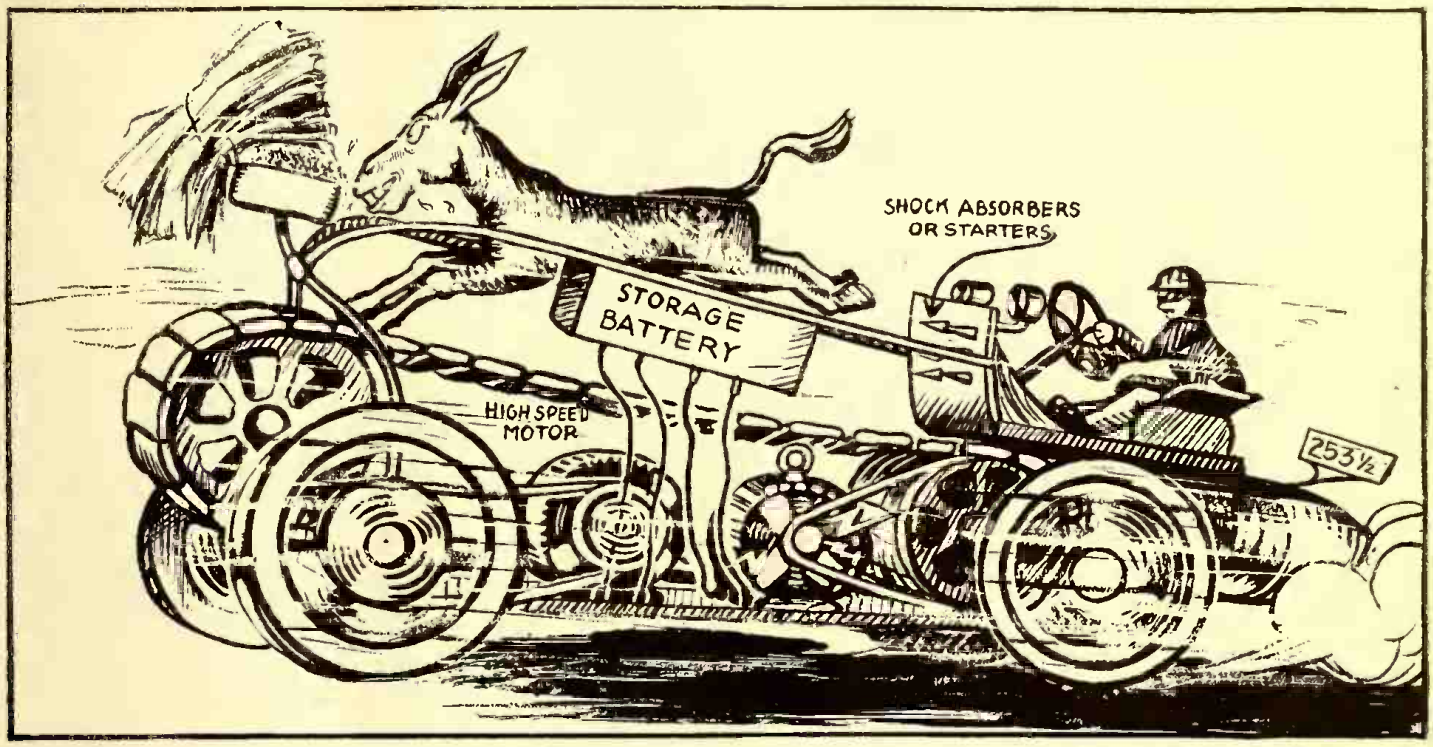
We have many books, such as a complete set of "Hawkins Electric Guides," besides chemical, physical, drawing, astronomy and mechanical books, and many I. C. S. hand-books. We learn more from our laboratory than we do from any school or books.—Elmer Hutchinson.

Views of Excellent Electrical Laboratory, Owned and Operated by Elmer Hutchinson and Wilbert Hartle.
1—The Chemical "Lab." Corner, Where Hundreds of Metals and Salts Are Carefully Stored In Glass Stoppered Bottles.
2—A Part of the Laboratory Tool Equipment and a Corner of the Switchboard.
3—"Our Lathe"—a Very Essential Luxury In Every Well-Appointed Experimental Electrical Laboratory.
4—This Corner Contains the "Lab." Desk, Book and Magazine Collection; Also a Drill Press and the Electric Motor Driving the "Line Shaft"—Get That—Fellow Bugs—LINE SHAFT!! This Is a Regular "Lab."—What?

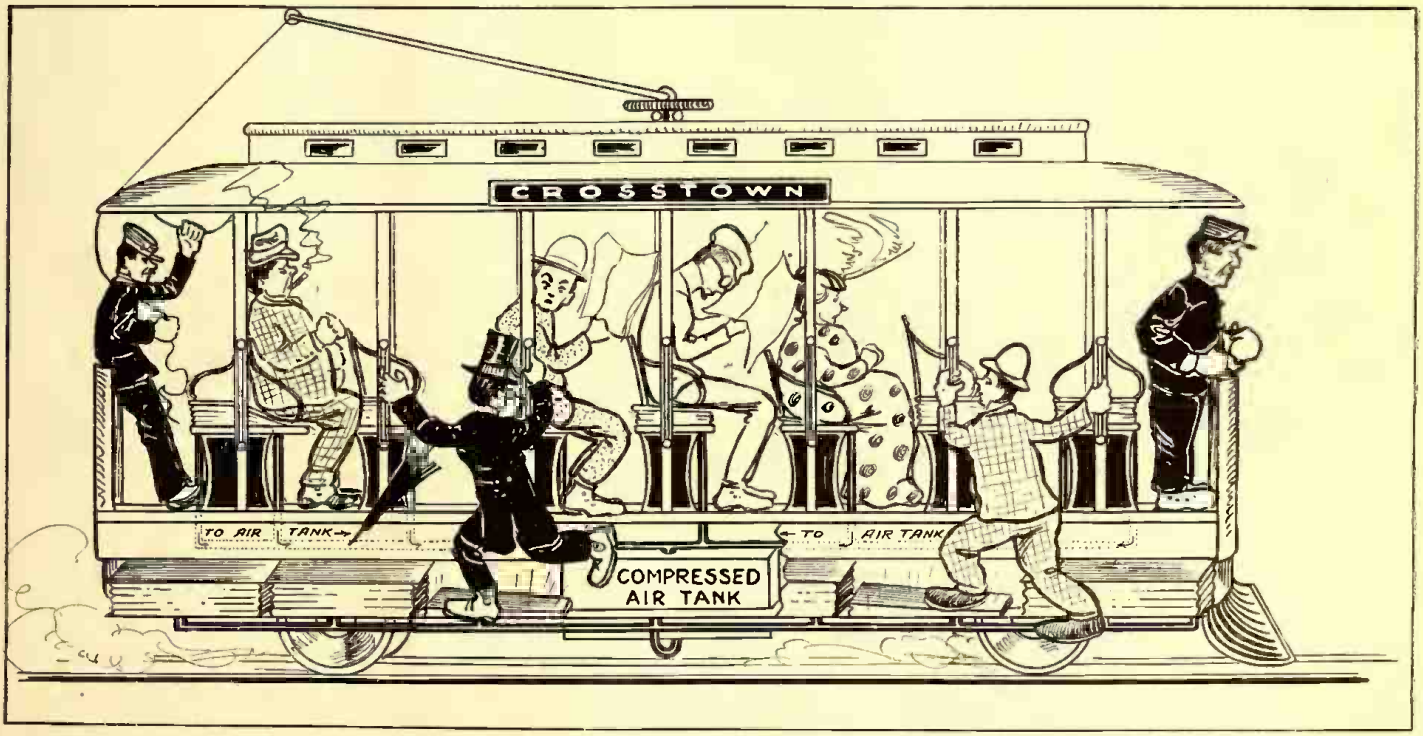
Phoney Patents

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

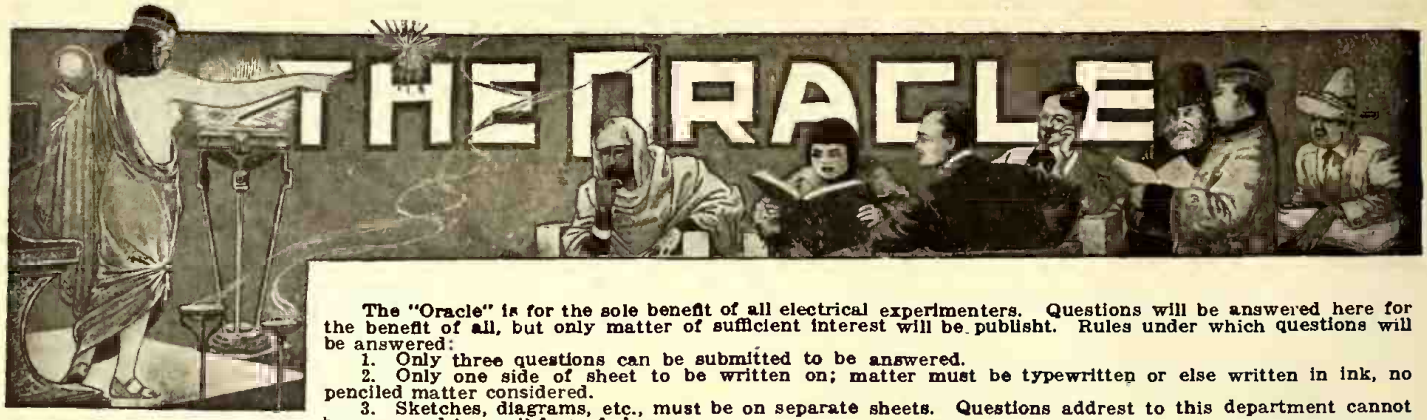
We are revolutionizing the Patent business and OFFER YOU THREE DOLLARS ($3.00) FOR THE BEST PATENT. If you take your Phoney Patent to Washington, they charge you $20.00 for the initial fee and then you haven't a smell of a Patent yet. After they have allowed the Patent, you must pay another $20.00 as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



Prize Winner: JACKASSOMOBILE. Now that the price of gasoline has soared so high that only aeroplanes can follow its skyward rise, my new Jackassomobile will come as a boon to all gas-weary autoists. Jackass runs on endless tread in mad endeavor to eat his oats. Endless belt drives dynamo charging storage batteries. The latter, run the 60 H.P. high-speed motor which propels auto. Surplus juice feeds electric headlights, also the jackass electric spark accelerator, to urge on the jackass, should he become a speed slacker. Inventor, Julius Lantz, Maywood, Ill.



AUTO-TROLLEY. In order to conserve our coal supply I propose to equip all trolley-cars thruout the land with spring bellows along the running-board as well as under every seat. Passengers boarding car then pump air into comprest air tank. When sitting down passengers also do likewise, and furthermore more air will be pumped into tank every time they are bounced up and down. Comprest air not only works pneumatic brakes but runs the car and the surplus power runs a dynamo which pumps juice thru trolley wire into power house. Hence power house needs no coal at all. Inventor, E. Paul Gangewere, Chattanooga, Tenn.



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 pencilled matter considered.

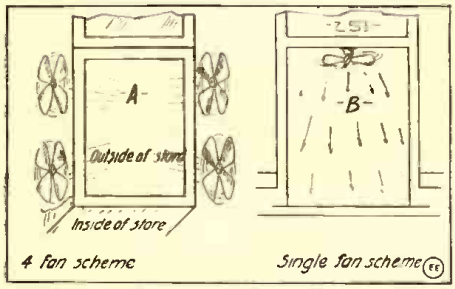
3. Sketches, diagrams, etc., must be on separate sheets. Questions addrest to this department cannot be answered by mail free of charge.

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.

ELECTRIC FAN PROBLEM.

(940) Arthur A. Everts Co., Dallas, Tex., inquire:

Q 1. We have a large electric fan about eight feet above the entrance to our store, directly at the door, which gives small results. This is a large four-blade fan. We realize that many customers are kept out



Flies May Be Kept from Entering Store Doors by Properly Placing Electric Fans as Shown at "A" or "B," to Create a Constant Draft in the Doorway.

of our store thru the necessity of opening a screen door, which we must use in conjunction with the present fan. Would one of unusual power do the work?

A 1. There is only one other way that you can combat the fly nuisance, and that is by mounting several fans as shown in our diagram "A." In this manner, the fans will always blow towards the entrance and if you can arrange the fans in such a way that all the space is covered by them; in other words that no part of the entrance is without a certain amount of draft due to the fans, then in that case we are quite certain no flies will enter.

If the door is quite large it has been found that by putting a fan directly above the entrance as shown in sketch "B," that this will prevent flies from entering the shop. However, the fan in this instance would have to be quite powerful, say a 16" fan.

MAGNETIZING STEEL BAR.

(941) J. C. Miller, Caney, Kan., writes the Oracle:

Q 1. That he has trouble in magnetizing a steel bar.

A. 1. From your description we conceive that the trouble with your electro-magnet is that it is not powerful enough to produce the results you desire. We advise using a stronger magnetizing electro-magnet, and offer the following pointer in regard to magnetizing steel permanently.

When the steel bar is placed over the poles of the electro-magnet, you should gently tap the steel. This is done so as to shake up the molecules of the steel, and to cause them to set themselves all in the same direction. If you will adhere to the above, we are sure you will meet with success.

AERIAL TORPEDO.

(942) Mr. A. Fiocco, Allentown, Pa., writes that:

Q. 1. He has been working upon an aerial torpedo and wishes our advice on its practicability.

A. 1. Relative to your Aerial Torpedo, quite possibly this may find a practical application in future military and naval operations, but at the present time, or at least to put it in another way, we would say that the efforts made by various inventors along this line, up to the present, have not been very promising.

Your idea of releasing several of the aerial torpedos so as to have them strike the water in the path of an on-coming U-boat torpedo is nothing new, as this scheme was proposed already last year by Mr. H. Gernsback. In an article in this journal was described a new form of motor-torpedo, a number of which were to be carried along on each merchant vessel.

A number of inventors have worked on the scheme of aerial torpedoes to be controlled by wireless or other automatic and self-contained mechanisms, but up to this time these ideas have not proven particularly successful, so far as we are aware.

It might pay you, however, to work along the lines of a radio controlled aerial torpedo, or one that could be accurately controlled by some other means.

ODD PHOTOS WANTED AT $1.00 EACH!!!

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

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.*

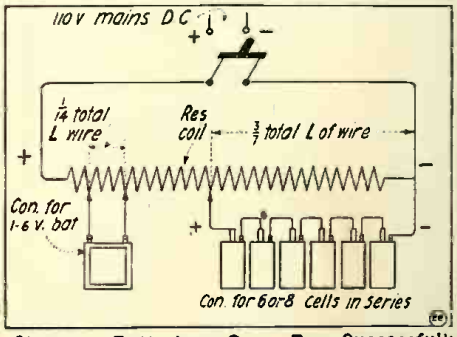
110 VOLT D. C. BATTERY CHARGING.

(943) W. H. Jackson, New York, N. Y., asks:

Q. 1. What size resistance to use in charging small storage batteries from 110 volt D. C. service.

A. 1. The amount of wire for a resistance to be used directly in the 110 volt D. C. line for charging storage batteries is as follows:

Use 250 feet of No. 18 German silver resistance wire, connected as shown.



Storage Batteries Can Be Successfully Charged by Tapping off at the Proper Points Along a Resistance Coil, Connected to a Direct-Current Circuit in this Manner.

DOES A DYNAMO "PRODUCE" ELECTRICITY.

(944) Richard Bohannon, Boonville. Ind., asks:

Q. 1. Does a dynamo *produce* electricity from the air?

A. 1. As to the original source of energy as developed in the dynamo, this is a rather mooted question even among the best engineers of today. It is generally considered that the dynamo does not *produce* electrical energy in the usual sense of the word, as the first law of physics states that energy cannot be produced—neither

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can it be destroyed. According to the latest theories advanced by scientists, a dynamo simply acts as a converter or transformer, if we might so call it, in that it sets in activity latent electrical forces which are always existent in the dynamo before the armature is ever rotated.

In other words, the field magnet of the dynamo produces a magnet field which, as we now know is one form of electricity. When the armature with its numerous wires or inductors is rotated in this magnetic field, a conversion takes place, so that electric currents are caused to develop and flow along the armature inductors to the collecting commutator mounted on the armature shaft and from which the current passes out into the external circuit thru suitable brushes, etc.

It might be said in a broad way, that the static machine derives its electrical energy or charge from the air, but it is not correct to say that a dynamo derives its apparent energy from the air.

EFFICIENCY OF DYNAMO.

(945) Chas. A. Bazino, North Bennington, Vt., writes the Oracle:

Q. 1. In Mr. Cohen's article on the testing of small motors and dynamos, I fail to see how he obtains an efficiency of 40.2%; I figured it as 4.02%.

A. 1. Relative to Mr. Samuel Cohen's article on the "Testing of Small Electric Motors and Dynamos" in a recent number of the ELECTRICAL EXPERIMENTER, we would advise that the efficiency in the example there cited is 40.2% as he states, and not 4.02% as your figures show. This is so for the reason that 150 watts divided by 373 watts equal .402, and this value must be multiplied by 100 in order to give the result in per cent, and we therefore have 40.2%.

ELECTROLYTIC DECOMPOSITION OF WATER PIPES.

(946) W. W. Brinckerhoff, Mt. Vernon, N. Y., writes:

Q. 1. Can electricity destroy water pipes in the ground due to leakage currents, etc.?

A. 1. Regarding the decomposition of underground water pipes due to the effect of a considerable leakage of electric current from the railroad tracks as you mention, this is a frequent occurrence in cities or other locations where there is liable to be any appreciable leakage of the electric current.

We would recommend that you look up this matter in any book treating on modern electric railway practise at your local library in which you will find the present practise outlined for obviating or overcoming this difficulty. In general, there should not be such an excess leakage of electric current from railroad tracks or trolley rails, that it will cause water or other pipes to be honeycombed and decomposed, often resulting in a dangerous condition or a burst water main, but these cases happen right along. It is generally due to a high resistance joint or a series of high resistance joints in the rails, which may be caused by the fact that they are not properly bonded at the joints between the rails. It has also been found to occur where the rails were of such high electrical resistance that they could not carry properly the returned current to the power house. It is often the case that to overcome this trouble, electrical cables are run along parallel with the rails and connected to them at frequent intervals, and in this way they safely and properly conduct the returned current to the dynamos at the central station.

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NAVAL ELECTRICIAN'S TEXT-BOOK, by Captain W. H. G. Bullard, U. S. Navy. Cloth Bound. 1530 pages, 560 illustrations, price $10.00 net. Two volumes. Published by U. S. Naval Institute, Annapolis, Md.

This set of two volumes forms really a complete library for either those in the service or civilian students, the extent of the work treated being very wide, and including both theory and practise. The books are ably edited, and well illustrated, with clear line cuts, diagrams and photographs where necessary.

Volume one covers the theoretical study of electricity, including radio-telegraphy, and treats on such important topics as direct current, machines, instruments, devices and apparatus, alternating currents and circuits, storage and primary batteries, the theory of the generation of electromotive-force, dynamo construction, based on experiments with dynamo electric machines, incandescent lamps, arc lamps, faults of generators and motors, telephones, principles of radio-telegraphy, et cetera.

The second volume treats in a very thoro and easily understood manner, on the practical aspects of the subject in hand and together with volume one forms a very valuable work of reference, which should be in the library of every electrician and engineer. Volume two deals with the practical discussion of the parts of generators and motors, including various wiring diagrams of connections, showing the various types of speed controllers and starting resistances used on board U. S. war-ships, and the reviewer does not hesitate to mention that the "land lubber" will have his eyes open when he starts to peruse these excellent books, for they abound with a great wealth of valuable diagrams and hook-ups of motors and controllers, together with various simple, yet not ordinarily very well understood, signaling apparatus, et cetera.

Some of the sections included in volume two on practical work, are: Service generators, service motors, motor starting and controlling devices, application of motors, motive power for generators, switch-boards and distribution panels, wires and wiring, electrical interior communications, care of electric plant and accessories, et cetera. These volumes cover all of the latest electrical apparatus found on board naval ships, including the Sperry gyroscopic compass, and to those interested in this particular subject, these books are alone worth their price.

ELECTRIC TRACTION, by A. T. Dover. 667 pages. Cloth bound, 518 illustrations, 5 folding plates, size 6 x 9 inches. Publishers, the Macmillan Co., New York, 1917. Price $5.50.

A great stride in the advancement of a subject that is of distinct moment at the present time has been accomplisht by the author in this work on Electrification of Railroads. Where such large demands are being made upon railroad facilities to ship supplies, troops, etc., the present steam locomotives can bearly cope with the situation.

Many noted engineers have maintained that, were all the roads electrified and coal conserved in this way, and all available water power used, the work accomplisht of the roads would be two-fold, besides a great saving of fuel which would prevent to a great extent a recurrence of Dr. Garfield's famous "heatless" days.

Space does not permit to say all that is of value between the covers, but the following list of chapters will enable the reader to realize the importance of this volume.

Introduction—The Mechanics of Train Movement, Continuous Current Traction Motors, Single Phase Traction Motors, Polyphase Traction Motors, The Testing of Traction Motors, The Control of Continuous-Current Tramway Motors, The Control of Continuous Current Railway Motors, the Control of Single-Phase Railway Motors, The Control of Three-Phase Railway Motors, The Control of Continuous-Current and Alternating Current Motors for Regenerative Braking—Auxiliary Electrical Equipment for Tramcars, Auxiliary Electrical Equipment for Electric Locomotives and Motor Coaches, Rolling Stock for Electric Tramways, Electric Locomotives, Train Resistance, Track Construction, Conductor Rails, Overhead Construction on Railways and Tramways, Feeding and Distribution Systems for Tramways and Railways. Substation Converting Machinery, Switchgear, etc.

The book is profusely illustrated showing foreign and American applications, various types of locomotives, switchboards, motor construction, etc., also complete diagrams for motor control, etc. Several large plates are included showing constructional details and wiring of standard electric locomotives.

More cannot he said as the work must be seen and read to fully realize its great worth and it men, however remotely interested in harnessing must needs find a ready demand from all electrical electricity to the railroad problem.

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THE ORACLE.

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The editor of this department recollects a case like this which happened in an Eastern city several years ago, when a large 30-inch water main, which was situated about 12 to 15 feet from the trolley rails, had by *electrolysis* or leakage currents from the rails, become practically honeycombed where the current left the pipe line to return to the rails, and before the condition of the pipe line was discovered, the pipe burst one night, flooding the street and surrounding cellars with several thousand gallons of water before it was shut off. The street had to be excavated all along the pipe line for about one block, and a new pipe installed. The city authorities charged the trolley company with improperly maintaining their trolley rail system, and the traction company had to overhaul their entire trackage thruout the city. The resistance of the rail joints when bonded is tested by means of a specially sensitive millivolmeter periodically, in all well maintained traction and electrified railroad systems.

BOOK REVIEW.

(*Continued from opposite page*)

DYKE'S AUTO AND GAS ENGINE ENCYCLOPEDIA. Seventh Edition, 1918. Cloth bound, 916 pages; size 10 x 7 inches. Price $3.50. Publisht by A. L. Dyke, St. Louis, Mo.

Probably no better recommendation of this book can be given than that the Royal Flying Corps of England have sanctioned the book and propose using it for instructional purposes.

Each and every subject has been carefully revised and brought up to date. For instance, under Carburetion, the reader begins with the simplest form of the carburetor; after he becomes familiar with the fundamental principles, he then learns the purpose and meaning of metering-pins, air-valves, dash-pots, and finally, the very latest Pitot or "plain-tube" principle, which is now becoming very popular. In just this manner, the reader or student progresses from the first principle of an engine to the complicated parts of a twelve cylinder engine.

The ignition subject is made very simple and clear, as is also the subject of electric starting and generating systems by means of special drawings and photographs.

The repair subject deserves special mention. Every part of a car or engine is thoroly treated. One has but to refer to the index to find out how to "take up" bearings, connecting rods, grind valves, test compression, and just what to do to give an engine more power. Every detail is illustrated and the explanation is so simple that he has but to follow directions.

There are many new additions to the seventh edition, such subjects as Trucks, Tractors, Motorcycles, Airplanes and Airplane Engines, are thoroly covered.

Under the subject of Trucks, not only the construction, care and operation of a truck are explained, but how to dis-assemble and repair a truck engine is also explained.

The Tractor subject deals with different drive methods, as "chain" and "rail-track" treads, transmission system, tractor engines, ignition, carburetion, Holley kerosene vaporizer, air washers, etc. The Ford, "Twin-City," Caterpillar and Cleveland are used as examples.

Motorcycle subject treats on just those points one wants to know about; how a twin "V" engine fires, name of all parts, how the valves are operated and timed, how the magneto and electric system is operated, etc. The Indian and Harley-Davidson Motorcycles are fully explained and illustrated.

Airplane engines are fully illustrated. Some of the subjects are: types of airplanes, name of parts, control members and instruments, showing their location and purpose; how the airplane is made to ascend and descend, how the landing is made, principle of flight, glossary of aeronautical words and terms. Then we find Airplane Engine construction, types of engines, how they differ from automobile engines, cooling, lubrication, carburetion, ignition, valve timing, adjustments, etc.

There is a dictionary of motoring terms, also an English-French dictionary of motoring words and terms. Ford Supplement revised and improved. Packard Supplement in two colors, dealing with the 1918 model.

Inserts:—There are four large two-color inserts, No. 3 illustrates the Dixie Magneto with many large illustrations, showing all parts, their names and purpose. Also the Dixie Motorcycle Magneto and how it fires a twin-cylinder engine. The Indian and Harley-Davidson motorcycle engines are illus-

trated with sectional views with all parts lettered; No. 4 is a large two-color illustration of a four-cylinder engine, especially adapted for class room use.

SOLDERING KINKS. Illustrated, 70 pages; paper covers; size 6 x 9 inches. Publisht by The M. W. Dunton Co., Providence, R. I. Third Edition, 1917. Price 25 cents.

An extremely interesting manual for the practical man, containing a complete discourse on the art of soldering in all its branches. It tells the how, when and where: everything from the care of the iron to the proper fire, cleansing of joints, flux, etc.

A large number of handy "kinks" are illustrated and described, some from practical experience of those who have actually accomplisht stunts as noted and others from experiments, etc. Some of the more difficult work is illustrated so that there may be no slip-up when doing the actual work.

As an all-around hand-book for the amateur electrical man, this work is sure to find a host of interested readers, be they practical men or just plain, everyday Experimenters.

RADIODYNAMICS, by B. F. Miessner. Cloth bound, 211 pages; 112 illustrations; size, 5½ x 8¼ inches. Publisht by D. Van Nostrand Co., New York. Price, $2.00.

The author, who is well known among the radio fraternity, has brought forth a book of high-sounding title at least, and one which should prove of interest to those working along the lines of radio-controlled apparatus.

Its chapters cover every point from the first effort in this direction to the more successful latter-day attempts of John Hays Hammond, Jr. It has been written in such a manner as to be equally interesting to the layman and scientific reader, without sacrificing the technical matter valuable to the trained engineer.

The following few section heads give a very good outline of what has been covered in this volume: Historical and Practical Applications of Wireless Telegraphy, Electro-Static Telegraphy, Electro-Magnetic Wave System, Sound Waves (with some very interesting data on Prof. R. A. Fessenden's submarine signalling apparatus), infra-Red and Ultra-Violet Waves, Hertzian Waves, The Advent of Wireless-Controlled Torpedoes, with a discussion of Dr. Nikola Tesla's Tel-automaton—the first radio-dynamic boat; also Robert's wirelessly directed airship. Various types of selectors, relays, coherers and detectors are explained, with interesting notes on the application of the Audion as a relay and indicating instrument. A complete chapter is devoted to the wonderful work accomplisht by Hammond in this field, which all inventors and radio men will find deeply interesting.

Taken all in all, it's a highly interesting work, even tho it does not cover the details and systems that one might infer from its ambitious title. It would seem that much of the matter presented, especially that describing proposed detectors and relays, might have been substituted by a little more practical explanation of such radio control systems as have been found workable, at least to a reasonable extent. In other words, there is too much mooted theory and not enough practise given.

PRACTICAL ELECTRIC ILLUMINATION, by Terrell Croft. First edition, 225 pages; fully illustrated; cloth bound; size, 5¾ x 8½ inches. McGraw-Hill Book Co., New York, publishers, 1917. Price, $2.00.

The author must be credited for the great field he has covered in this work. Every phase of illumination has been covered carefully, with much attention to detail. It should prove of distinct value to illumination engineers in general and much matter contained will also be useful to electrical engineers, contractors, students and electricians.

The first section is devoted to explanations and illustrations of the fundamental ideas of Light Radiation, The Velocity and Vibrations of Light, etc., which are all intelligently shown and described.

The practical applications of light cover the main text of the work, including data on correct reflectors for various needs. All types of lamps are described and illustrated—Incandescent, Arc, Nernst, Mercury-Vapor Tube, etcetera—showing the adaption of these various forms to industrial, residential, street and window lighting.

The principles of Illumination Design are covered in a clear and interesting manner, as well as the design and installation of Interior and Exterior Illumination with examples and illustrations covering almost every conceivable application in use to-day.

A work which is very thoro, technically correct, and complete. It will appeal to all those interested in the subject of correct illumination.

A GIGANTIC EXPOSITION AND AMUSEMENT PARK IN THE MAKING.

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plant and filters have a daily combined capacity for handling nigh onto 3,000,000 gallons.

A ride which will attract thousands will be the greatest scenic railway ever constructed, and a spectacular novelty will be "Creation of the World."

An exhibit known as "No Man's Land" will consist of practical working trenches under the command of wounded allied soldiers, and the construction will be supervised by a regular officer of the United States army, the construction work being done by soldiers who have lived amid these crude surroundings at the battlefront of Europe.

"No Man's Land" will occupy a space approximately three hundred by one hundred and fifty.

Another amusement feature will doubtless attract a great deal of interest, which will be a model Congo farm, upon which all of the workmen are monkeys, apes, baboons, chimpanzees, etc., which have been educated to work with miniature tractor plows, hoes, spades and other garden implements, and which was inspired by the Government's plea for more farm labor to help round out the country's crops.

Still another feature will be the large convention hall for the benefit of visiting organizations which may wish to hold business or social sessions to the exclusion of the general populace.

Last, but not least, amongst all these wonders, we find the largest carrousel in the world, where big and small can ride to their hearts' delight on the galloping horses, donkeys, pigs, mules and all the rest of the menagerie.

Everything will be of the best and it is estimated that on the day the gates open. an expenditure of three million dollars will be represented.

The electrical effects are to be something stupendous, having been designed by engineers of the General Electric Company in conjunction with the chief electrical engineer of the grounds, Mr. Frank C. Stillman. Pretty and subdued effects will be the main features and a new type of lamp is to be used to outline the buildings at night that will not have a glaring light but will serve to diffuse it. The crowning achievement of the art will be in the stately "Tower of Jewels." erected in the center of the grounds and rising to a height of 65 feet, all a-glitter both day and night with 10,000 cut glass jewels from the San Francisco Exposition. In back of each jewel will be a miniature lamp and when the switch is turned on in the evening, a splendor of radiance will shine forth second to none. The Exposition period each year will extend from May 30 to November 1.

SURVIVES 11,000-VOLT ELECTRIC SHOCK.

Horace R. Williams, manager of the Stevens County Power and Light Company of Colville, Wash., received a current of 11,000 volts at the power plant at Meyers Falls and emerged with only three burns in addition to the shock.

While insulating the Kettle Falls wires at the power house he came in contact with an exposed part of the wires. Both hands received the shock of the current, which escaped toward a bunch of keys in his pocket and burned his leg, emerging from the body at the point where the keys made a contact with adjacent metal. His hands were severely burned.

A physician drest the burns a few hours later and the victim then went to his office. Few persons have survived such an experience. His rubber-soled shoes, it is said, saved him from the full force of the current.

DR. CALDWELL DIES FROM X-RAY BURNS.

Dr. Eugene Wilson Caldwell, a noted X-ray expert and the inventor of many devices which have developed this science, died in Roosevelt Hospital in New York City recently as the result of burns he suffered many years ago while making experiments with the X-ray. Dr. Caldwell was a Major in the Medical Reserve Corps, and under the direction of Surgeon General Gorgas recently perfected a device for stereoscopic fluoroscopy adapted to war surgery.

From the commencement of his career Dr. Caldwell devoted much of his time to electricity, and, aside from regular medical work, had long been interested in the physical problems of the X-ray. He engaged in experimental work in telephoning to lightships under the United States Lighthouse Establishment in 1894 and 1895, and from 1895 to 1897 he was an assistant in the engineering department of the New York Telephone Company.

THE MAGNETIC STORM

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beyond repair, a child could see that. He flung it away and went over to the next nearest flyer. But the mechanic had already located the trouble—in the magneto. Burnt out, too!

Von Unterrichter unutterably sick at heart, aimlessly wandered about the other machines. In each case the result was the same: *Every magneto armature of the fifteen flyers was burnt out,* the wires fused together, all insulation gone!

"Aber so 'was", muttered von Unterrichter, looking about him helplessly. It took fully five minutes before it filtered thru his thick Prussian skull that this disaster that overtook his "circus" could by no means be a coincidence.

"Verfluchte Amerikaner", he said, "probably a new *Teufelmaschine* of Edison!"

But what would the *Kommando* say to this? Instantly he stiffened as he jumped into a waiting automobile, attached to the airdrome.

"Zum Kommando, schnell", he ordered the driver as he sank back into his seat. He must report this queer business to headquarters at once. The driver cranked the engine, then cranked it some more. Pfut . . . pfut . . . pfut . . . spluttered the engine asthmatic-like, but it did not start. He tried again. Same result.

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"Donnerwetter nochmal", stormed the Baron vexed over the delay, *"was ist denn jetzt los,* why in thunder don't you start, you miserable dog?" But the engine would not start. The perplexed chauffeur climbed into the seat of the old style car, which still had its faithful spark coils, so necessary to the ignition system. But the spark coil refused to work, altho the storage battery was fully charged and all the connections were right. Cautiously he pulled out one of the spark coil units from its box. One look told the story.

"Ausgebrannt, Herr Leutnant," he said weakly, for he had seen the burnt out magneto armatures a few minutes before.

Von Unterrichter, with eyes almost popping out of his head, was struck absolutely speechless for half a minute. *"Heiliger Strohsack"*, he muttered awe-struck, remembering his young sister's favorite expression, whenever something out of the ordinary happened to her. He finally collected himself sufficiently and jumped out of the car.

"Zum Telefon", he muttered to himself. He must report this uncanny occurrence at once to the *Kommando*. Not a second was to be lost. He at last understood that something momentous had happened. He made the airdrome on the run and tho it was only 200 yards away he surprised himself at the speed he made. Puffing volubly he arrived at the telephone. He gave the handle several quick turns, *grasped the receiver and simultaneously bellowed into the mouthpiece in front of him:

"Hallo, hallo" . . . but he went no further. The receiver flew from his ear, for there had been a loud clattering, rattling, earsplitting noise in the instrument that almost burst his eardrum. He made a foolish grimace, as he held his ear with his hand. Cautiously he approached the receiver to within a few inches of his other ear and listened. All was quiet, not a sound. Mechanically he unscrewed the receiver cap and looked at the two bobbins. *They were charred and black.* The telephone was dead. . . .

The instrument slipt from his hand and dangling by its red and purple cord went crashing against the wall of the airdrome, while von Unterrichter limply sank into a chair.

Once more he got up and walked out. He must get into touch with his General at all costs. This was becoming too serious. Ah . . . he had it, the field telegraph. There was one at the other end of the building. He went there as fast as his legs could carry him. He opened the door of the little office but one look sufficed. The young man in charge of the telegraph sat dejected in a corner, a dumb expression in his eyes. Long purple sparks were playing about the instruments on the table. A child could have seen that it was impossible to either send or receive a telegram under such conditions. . . . Ah! an inspiration. . . .

"Dummkopf", he muttered to himself, "Why didn't I think of it before. *Die Funkenstation!* Surely the wireless must work! Ha, ha, there are no wires *there* at least to burn out!"

The radio station was over a kilometer away. He knew it well, for he had flown over it a great many times. To get there quick, that was the question. The *Kommando* was at least eight kilometers to the rear, and he knew he could not make that distance on foot very quickly. Ah, yes, there was a horse somewhere around. The

*All German telephones are magneto operated. To call Central you must turn the handle of the ringing magneto.

cavalry horse was located soon, and as the young airman walked hurriedly about, troubled as he was, he could not help noticing the listless attitude of every man he past. Men were whispering in a hushed manner, alarm was plainly written in their faces—the fear of the unknown.

Von Unterrichter jumped on to his horse and galloped in the direction of the field radio station. It did not take him long to reach it, and long before he dismounted he could see the bright blue spark of the sending station.

"Gott sei Lob", he uttered to himself as he jumped to the ground, "at least that's working."

Note here the curious mechanism of the Prussian mind. A Prussian officer, the most arrogant, distasteful creature imaginable, is always the great brave hero when he knows that he is fighting with all the advantages on his side. As Heinrich Heine, the poet,—himself a German-hater,—puts it:

"The Germans have no self-respect. They are the only men in the world who, as private soldiers, will stand still while an officer kicks them or bespatters them with mud. They receive the mud with smiles and stand expectantly, cap in hand."

It is the Prussian-German sort of "honor" that makes a Zabern affair possible, where a foul-mouthed young officer, with his sword, beats a helpless, crippled Alsatian cobbler insensible.

A coward at heart, always ready to blaspheme his maker, when things go right, the Prussian quickly turns to his German *Gott*, as soon as things go against him.

Heine,—himself a German, and he ought to know,—will tell you so.

Now it so happened that von Unterrichter had been an expert wireless man before the war, and while he did not know a great deal about electricity, he well knew how to send and receive messages.

He ran to the wagon which carried the mobile radio field apparatus and peremptorily ordered the operator in charge away. *"Aber Herr Leutnant"*, expostulated the thus rudely interrupted man, "I tell you . . ."

"Maul halten", thundered von Unterrichter, with which he sat down, clamping the operator's receivers on his own head.

He prest the key impulsively, and noted with grim satisfaction that the loud blue spark crashed merrily in the not very up-to-date spark gap.

As he sent out the call mechanically, he wondered vaguely what the matter could be with the government, because it did not even supply a modern, up-to-date *Löschfunkenstrecke* — quenched spark gap — for field use. Things must be pretty bad when the government must economize even a few beggarly pounds of brass, so necessary for a noiseless spark gap.

But he could not give that matter further attention for he had thrown the aerial switch from "sending" to "receiving."

He had strained his ears for a reply from the operator from the *Kommando*, but, as the switch was thrown, instead of a reply there was a loud, constant roar in the receivers, so loud that it was painful. Off came the headgear, while von Unterrichter once more sank into a chair.

He was a pitiful spectacle to look at, the fate of a 20th Century man flung back a hundred years. His eyes roamed idly about till the distant railroad embankment struck his eye. No train was moving. Everything was at a standstill—how could a train move without a telegraph? How could a train be dispatched—there would be a thousand collisions. He turned to the radio operator, who as yet had not grasped the situation in its entirety.

"Nordlicht, nicht wahr, Herr Leutnant?" he began, thinking no doubt that the phenomenon was an ordinary form of Aurora Borealis,—the northern lights,—in other words, a magnetic storm, that would be over soon.

"Dummes Rindsvieh" . . . snapt the *Herr Leutnant,* who knew better by this time. Indeed he was to know still more at once, for while he was speaking there came to his ear a low dull roar, a sound he had heard once before, way back in 1914 when the Germans had retreated very much in a hurry beyond the Marne.

Panic seized him. Yes the sound was unmistakable. The German army once more was in full retreat—no it was a rout—a panic-stricken rabble that made its way back.

Like lightning the news had spread among the men at the front that uncanny things were afoot, that all communications had been annihilated with one stroke, that no orders could be sent or received except by prehistoric couriers, that the *Grosses Kommando* was cut off from the army, and that in short the German army as far as communication was concerned, had suddenly found itself a century back.

For what had happened to von Unterrichter that morning, had happened on a large scale not only to every one along the front, *but all over Germany as well!* Every train, every trolley car, every electric motor or dynamo, every telephone, every telegraph had been put out of commission. With one stroke Germany had been flung back into the days of Napoleon. Every modern industry, every means of traffic—except horse-drawn vehicles—were at a standstill. For days the German retirement went on, till on the fifteenth day, the entire German army had retired behind the natural defenses of the Rhine, the victorious Allies, pressing the fleeing hordes back irresistibly.

And it must have been a bitter pill for the German high command to swallow when they saw that the Allied fliers were constantly flying behind their own lines and that as the Allies advanced, *their* automobiles and *their* trains seemed to run as well as ever *behind* their own lines. But no German succeeded in flying an aeroplane or in running an automobile. That mysterious force obviously was trained only against the Huns, but was harmless behind the Allied lines. Nor did the Germans find out to this date what caused their undoing.

Peace having not been declared as yet, I cannot, of course, divulge the full details of the scheme of just how the Germans were finally flung across the Rhine. That, of course, is a military secret.

But I am permitted to give an outline of just what happened on that memorable morning, when the German "Kultur" was flung back into the dark ages where it belongs.

* * * *

But first we must go back to Tesla's laboratory once more, back to that evening when "Why" Sparks first overwhelmed Tesla and his companions with his idea. This is in part what Sparks said:

"Mr. Tesla! In 1898 while you were making your now historic high-frequency experiments in Colorado with your 300-kilowatt generator, you obtained sparks 100 feet in length. The noise of these sparks was like a roaring Niagara, and these spark discharges were the largest and most wonderful produced by man down to this very day. The Primary coil of your oscillator measured 51 *feet in diameter,* while you used 1100 amperes. The voltage probably was over 20 million. Now, then in your book, *High Frequency Currents,* among other things you state that the current which you produced by means of this mammoth electric oscillator was so terrific that its effect was felt 13 miles away. Altho there were no wires between your laboratory and the Colorado Electric Light & Power Co., five miles distant, your *"Wireless" Energy* burnt out several armatures of the large dynamo generators, *simply by long distance induction from your high frequency oscillator.* You subsequently raised such havoc with the Lighting Company's dynamos that you had to modify your experiments, altho you were over five miles away from the Lighting Company.*

"Now then, if in 1898, twenty years ago, you could do that, why, WHY cannot we go a step further in 1918, when we have at our command vastly more powerful generators and better machinery. If you can burn out dynamo armatures 13 miles distant with a paltry 300 kilowatts, *why* cannot we burn out every armature within a radius of 500 miles or more.

"The primary coil of your oscillator in 1898 was 51 feet in diameter. WHY *cannot we build a primary 'coil' from the English Channel down to Switzerland, paralleling the entire Western front?* This is not such a foolish, nor such a big undertaking as you might think. My calculations show that if we were to string highly insulated copper wires one-quarter inch thick on telegraph poles behind the front, the problem would become a simple one. Ordinary telegraph poles can be used, and each pole is to carry twenty wires. Beginning three feet above the ground, each wire is spaced two feet distant from the next one. These wires run continuous from the sea to Switzerland. Moreover, every ten miles or

*The above occurrences as well as the cited experiments and effects of the Tesla currents are actual facts checked by Mr. Tesla himself, who saw the proof of this story.—*Editor.*

so we place a huge 3,000 kilowatt generating plant with its necessary spark gaps, condensers, etc. The feed wires from these generating plants then run into the thick wires, strung along the telegraph poles, forming the gigantic Tesla Primary Coil. Of course, you realize that in a scheme of this kind it is not necessary to run the telegraph poles actually parallel with every curve of the actual front. That would be a waste of material. But we will build our line along a huge flat curve which will sometimes come to within one-half mile of the front, and sometimes it will be as much as fifteen miles behind it. The total length of the line I estimate to be about 400 miles. That gives us 40 generating plants or a total power of 120,000 kilowatts! A similar line is built along the Italian front, which is roughly one hundred miles long at present. That gives us another 30,000 kilowatts, bringing the total up to 150,000! Now then, the important part is to project the resultant force from this huge Tesla primary coil *in one direction only,* namely that facing our erstwhile friends, the Huns. This I find can be readily accomplished by screening the wires on the telegraph poles at the side facing our way as well as by using certain impedance coils. The screen is nothing else but ordinary thin wire netting fastened on a support wire between the telegraph poles. This screen will then act as a sort of electric reflector. So." . . . Sparks demonstrated by means of one of his sketches.

"Everything completed we turn on the high-frequency current into our line from the sea to little Switzerland. Immediately we shoot billions of volts over Germany and Austria, penetrating every corner of the Central empires. *Every closed coil of wire thruout Germany and Austria, be it a dynamo armature, or a telephone receiver coil, will be burnt out, due to the terrific electromotive force set up inductively to our primary current.* In other words every piece of electrical apparatus or machinery *will become the secondary of our Tesla coil, no matter where located.* Moreover the current is to be turned on in the day time only. It is switched off during the night. The night is made use of to advance the telegraph poles over the recaptured land,—new ones can be used with their huge primary coil wires, for I anticipate that the enemy *must* fall back. Turning off the power does not work to our disadvantage, for it is unreasonable to suppose that the Teutons will be able to wind and install new coils and armatures to replace all the millions that were burnt out during the day. Such a thing is impossible. Besides, once we get the Germans moving, it ought to be a simple matter to follow up our advantage, for you must not forget that we will destroy ALL their electrical communications with one stroke. No aeroplane, no automobile, will move thruout the Central States. In other words, we will create a titanic artificial *Magnetic Storm* such as the world has never seen. But its effect will be vastly greater and more disastrous than any natural magnetic storm that ever visited this earth. Nor can the Germans safeguard themselves against this electric storm any more than our telegraph companies can when a real magnetic storm sweeps over the earth. Also, every German telegraph or telegraph line in occupied France and Belgium will be our ally! These insulated metallic lines actually help us to "guide" our energy into the very heart of the enemy's countries. The more lines, the better for us, because all lines act as feed wires for our high frequency electrical torrents. . . ."

* * * *

A few kilometers north of Nancy, in the Department of Meurthe et Moselle, there is a little town by the name of Nomeny. It is a progressive, thrifty little French town of chief importance principally for the reason that here for four years during the great war the French army has been nearer to the German frontier than at any other point, with the exception of that small portion of Alsace actually in the hands of the French.

Nomeny in the military sense is in the Toul Sector, which sector early in 1918 was taken over by the Americans. If you happened to go up in a captive balloon near Nomeny you could see the spires of the Cathedral of Metz, the great German fortress, but 16 kilometers away, always presuming that the air was clear and you had a good glass.

On a recent warm summer morning there were queer doings at a certain point in the outskirts of Nomeny. All of a sudden this point seemed to have become the center of interest of the entire French, British and American armies. Since dawn the military autos of numerous high Allied officers had been arriving while the gray-blue uniforms of the French officers were forever mixing with the business-like khaki of the British and Americans.

The visitors first gave their attention to the camouflaged, odd-looking telegraph poles which looked like huge harps, with the difference that the many wires were running horizontally, the telegraph line stretching from one end of the horizon to the other. A few hundred yards back of this line there was an old brewery from which ran twenty thick wires, conecting the brewery with the telegraph poles. To this brewery the high officers next strolled. An inspection here revealed a ponderous 3,000 kilowatt generator purring almost silently. On its shining brass plate was the legend: "Made in U. S. A." There was also a huge wheel with large queer, round zinc pieces. Attached to the axis of this wheel was a big electric motor, but it was not running now. There were also dozens of huge glass jars on wooden racks lined against the wall. Ponderous copper cables connected the jars with the huge wheel.

One of the French officers, who previous to the war had been an enthusiastic Wireless Amateur, was much interested in the huge wheel and the large glass bottles. "Aha", said he, turning to his questioning American confrère, *"l' éclateur rotatif et les bouteilles de Leyde."*

There was little satisfaction in this, but just then a red-haired, tousled young man who seemed to be much at home in the brewery, came over and adjusted something on the huge wheel.

"What do you call all of these do-funnies?' 'our young officer asked of him, pointing at the mysterious objects.

"Rotary spark gap and Leyden jars," was the laconic reply. The officer nodded. Just then there was a big commotion. The door flew open and a French officer standing at attention shouted impressively:

"Le Président de la République!"

Instantly every man stood erect at attention, hand at the cap. A few seconds later and President Poincaré walked in slowly, at his side General Pétain. It was then five minutes to 10.

President Poincaré was introduced to the red-haired, tousled young man whom he addrest as *Monsieur* Sparks. *Monsieur* Sparks speaking a much dilapidated French, managed, however, to explain to his *excellence* all of the important machinery, thanks to a sleepless night with a French dictionary.

Monsieur Poincaré was much imprest and visibly moved, when a French officer had gone over Sparks' ground, and re-explained the finer details.

The President now takes his stand on an elevated platform near a huge switch which has an ebonite handle about a foot long. He then addresses the distinguished assembly with a short speech, all the while watching a dapper young French officer standing near him, chronometer in hand.

Somewhere a clock begins striking the hour of ten. The President still speaks but finishes a few seconds later. The distinguished assemblage applauds and cheers vociferously, only to be stopt by the dapper young officer who slowly raises his right hand, his eyes glued to the chronometer. Immediate silence prevails, only interrupted by the soft purring of the huge generator. The dapper young officer suddenly sings out:

"Monsieur le Président! A-ten-tion! ALLEZ!!"

The President of the glorious French Republic then shouts dramatically: *"Messieurs . . . le jour de gloire est arrivé . . . VIVE—LA—FRANCE!!"*—and throws in the huge switch with its long ebonite handle.

Instantly the ponderous rotary spark gap begins to revolve with a dizzying speed, while blinding blue-white sparks crash all along the inside circumference with a noise like a hundred cannons set off all at once. The large brewery hall intensifies the earsplitting racket so much that every one is compelled to close his ears with his hands.

Quickly stepping outside the party arrives just in time to see fifteen Boche airplanes volplaning down and disappearing behind the German lines. A French aerial officer who had observed the German aeroplanes, drops his glass, steps over to the President, salutes smartly and says impressively:

"Le 'cirque' du Baron d'Unterrichter! Ils sont hors de combat!"

Hors de combat is correct. Von Unterrichter was not to fly again for many a week.

We look around to tell the glad news to General Pétain, but the latter has disappeared into a low brick building where he now sits surrounded by his staff, poring over military maps ornamented with many vari-colored pencil marks, as well as little brightly-colored pin flags. Telephone and telegraph instruments are all about the room.

Again the President shakes hands with *Monsieur* Sparks, congratulating him on his achievement. Luncheon is then served in the former office of the brewery, gayly bedecked with the Allied flags along the walls. But even here, far from the titanic rotary spark gap, its crashing sparks are audible. Looking thru the window we see a wonderful sight. Altho it is broad daylight, the entire queer telegraph line is entirely enveloped in a huge violet spray of electric sparks. It is as if "heat-lightning" were playing continuously about the whole line. No one may venture within fifty feet of the line. It would mean instant death by this man-made lightning.

Luncheon is soon over and more speeches are made. Suddenly the door flings open and General Pétain steps in. One look at his remarkable features, and all talk stops as if by magic. He crosses the room towards the President, salutes and says in a calm voice, tho his eyes betray his deep emotion:

"Monsieur le Président, toute l'armée Allemande est en retraîte!!"

And so it was. The greatest and final retreat of the Kaiser's "invincible" hordes was in full swing towards the Rhine.

More congratulations are to be offered to Sparks. A medal, . . . Heavens, where is that young man? But Sparks has slipt over to his machines and is standing in front of the noisy "thunder and lightning" wheel eyeing it enthusiastically.

"Why, oh WHY, do they call you *éclateur!*" he says. "Spark Gap is good enough for me!" "Oh, boy!! But you aren't doing a thing to those *Germins!*"

THE END

Translation of German and French Terms Used in This Story.

GERMAN

Verdammte Yankee Schweinehunde: Damned Yankee Pig-Dogs!
Sie, Müller: You, Müller!
Zu Befehl, Herr Leutnant: At your orders, Lieutenant!
Versammlung, sofort: Assembly, at once!
Dieses Amerikanische Gesindel: This American rabble!
Schiesst die Lumpen zusammen: Shoot the ragamuffins together!
Vorwärts für Gott und Vaterland: Onward, for God and Fatherland!
Dollarjäger: Dollar Chasers.
Elendige Schweinebande: Miserable hand of pigs.
Unsinn: Nonsense.
Flieger: Flyer (aeroplane).
Himmelkreuzdonnerwetter: A popular German cuss word. Literally it means "sky-cross-thunder." English equivalent is "A thousand thunders."
Kaput: German slang, equivalent to our slang "busted."
Auseinander nehmen: Take it apart!
Ausgebrannt: Burnt-out.
Aber so 'was: Such a thing (of all things).
Verfluchte Amerikaner: Cursed Americans.
Teufelmaschine: Diabolic machine.
Zum Kommando, schnell: Quick, to Headquarters!
Donnerwetter nochmal: By all thunders!
Was ist denn jetzt los? What's up now?
Heiliger Strohsack: Holy hag-of-straw; equivalent to "Holy Gee."
Dummkopf: Blockhead.
Die Funkenstation: The Radio Station.
Gott sei Lob: God be thanked.
Aber, Herr Leutnant: But, Lieutenant!
Maul halten: Shut up.
Löschfunkenstrecke: Quenched Spark Gap.
Nordlicht, nicht wahr?: Northern lights, is it not?
Dummes Rindsvieh: Stupid piece of cattle.
Grosses Kommando: General Headquarters.

FRENCH

L'éclateur rotatif et les bouteilles de Leyde: Rotary spark gap and Leyden jars.
Le President de la République: The President of the Republic.
Monsieur le President! Attention! Allez! Mr. President! Ready! Go!
Messieurs, le jour de gloire est arrivé, vive la France!: Gentlemen, the day of glory has arrived, long live France!
(This is from the second verse of the "Marseillaise")
Le "cirque" du Baron d'Unterrichter! Ils sont hors de combat!: Baron von Unterrichter's circus! They are out of the fighting!
Monsieur le Président, toute l' armée Allemande est en retraite: Mr. President, the entire German army is in retreat.

EXPERIMENTAL CHEMISTRY.

(*Continued from page* 256)

Thus the most striking examples are certain *electro-positive* oxides, as Potassium Oxid (K_2O) and Calcium oxid (CaO).

$$K_2O + H_2O = 2KOH$$
$$CaO + H_2O = Ca(OH)_2$$

With the oxides of certain *electro-negative* it combines energetically to form acids.

$$SO_3 + H_2O = H_2SO_4$$
$$P_2O_5 + 3H_2O = 2H_3PO_4$$

these reactions being strongly exothermic.

Under certain conditions the halogens (Cl, Br, F) will decompose water with the liberation of oxygen, which in turn acts as an oxidizer, while the hydrogen forms a haloid acid.

$$2Cl + 2H_2O = 4HCl + O_2$$
$$I_2 + H_2SO_3 + H_2O = 2HI + H_2SO_4$$

Natural Waters. These include all such waters as occur naturally upon the surface of the earth which are more or less impure from the presence of dissolved gases and numerous inorganic substances. These waters may be clast as rain, spring, mineral and sea waters.

Rain water is the purest form of natural water, but it frequently contains such gases

as carbon dioxid, ammonia, sulfurous oxid and nitric acid in the vicinities of cities, and also contains small quantities of foreign matter which are present in the atmosphere and which are carried down by the rain drops.

Spring water is usually found to hold *salts in solution.* The water supply of cities is usually taken from lakes or rivers which are supplied from smaller streams and springs. These waters contain chiefly the carbonates and sulfates of calcium and magnesium, with smaller amounts of the alkalies, iron, silica, and organic matter, which may be either living or dead.

Hard and Soft waters. For domestic or manufacturing the chief factor which determines the value of the water is its hardness. This hardness is due to the presence of calcium and magnesium salts, which form insoluble precipitates with soap, which results in the lather failing to cleanse until these salts have been completely precipitated. When employed for feeding boilers hard waters form a more or less coherent deposit, commonly called *boiler scale,* which causes clogging and frequent burning out of the tubes. This is chiefly composed of carbonat and sulfate of calcium with some iron oxid and silica.

Hard water is of two kinds, *temporary hardness* and *permanent hardness.* Temporary hardness is caused by the presence of the bicarbonates of calcium and magnesium, which may be removed by boiling, whereby the free carbonic acid, which has held the insoluble carbonates in solution, passes off and the precipitation ensues. Thus

$$Ca(HCO_3)_2 + \text{Heat} = CaCO_3 + H_2O + CO_2$$

This temporary hardness may also be removed by the addition of alkali carbonates or hydroxides, thus:

$$Ca(HCO_3)_2 + Ca(OH)_2 = 2CaCO_3 + 2H_2O$$
$$Ca(HCO_3)_2 + Na_2CO_3 = CaCO_3 + 2NaHCO_3$$

Permanent Hardness. Permanent hard waters contain the sulfates or chlorides of magnesium and calcium, or both. Thus we may account for the more or less hardness of water after boiling. These may be removed throu the addition of soluble carbonates, as, for instance Sodium Carbonate or Ammonium Carbonate, whereby the calcium or magnesium precipitat as carbonates. The soluble alkali sulfat which remains in solution exerts a deleterious action when the water is used for boilers.

$$CaSO_4 + Na_2CO_3 = CaCO_3 + Na_2SO_4$$

Water is said to have one degree of hardness when it contains *one part of calcium carbonat or its equivalent in one hundred thousand.* The degree of hardness is determined by agitating the sample of the water with a standard solution of soap until a permanent lather is produced.

Purification of Waters. Water Supply is one of the most difficult questions confronting Mankind, especially in large cities. Ancient Rome brought her water in great aqueducts, some of which still remain, from the Apennine Mountains, forty or fifty miles away. Lake Michigan is the source of Chicago's supply. Boston has constructed a series of artificial lakes in the center of Massachusetts. These lakes are fed by water from surrounding streams. Waters from such sources cannot be pure. They contain (1) dissolved salts; (2) suspended matter; (3) Microörganisms which are usually harmless, but which may be and sometimes are the germs of disease. Epidemics of typhoid and scarlet fevers have often resulted from drinking such water. Most large city water supplies are now purified of germs by running the water over *filter beds* made of gravel, laid to the depth of several feet (refer to Fig. 125). After flowing thru the filter beds the germs are found to be mostly removed and the water is collected in reservoirs, whence it runs in pipes to consumers. After using one bed a short time the water is turned on to another, and the first dries in the sunlight, destroying the germs.

Even after thus filtering, the water is hardly pure enough for drinking. It may be treated in one of three ways. (1) Boiling the water for some time destroys organic life, both animal and vegetable, including microbes, thus rendering it harmless to drink. This *removes* nothing except volatile gases. (2) It may be *filtered* by forcing it thru a Pasteur or similar filter made of porous clay (see Fig. 126). This process does not take out any dissolved salts, but these are comparatively harmless. It does remove any suspended matter, including germs, and leaves the water looking pure and colorless. This is the usual process for purifying drinking water. (3) *Distilled water* is the *purest.* Distillation leaves behind any dissolved salts, but it does not remove gases or even liquids whose boiling point is as low as that of water (*i. e.,* 212 F.—100 C.); for example, if alcohol were mixed with water, it would distill before the bulk of the water, but would not be separated, as it boils 22 degrees lower than water. A Liebig condenser is usually employed in the laboratory for distilling water.

CHEMICAL TESTS OF WATER

Experiment No. 139.

Free Ammonia.

Nessler's Test. To determine such minute quantities as 0.0025 we make use of Nessler's Solution, an alkalin solution of mercuric iodid, in potassium iodid. When a few drops of it are added to a dilute solution of ammonia or of an ammonium salt, it forms a deep red precipitat, which, even in very small amounts, imparts a yellow or brownish tinge to water. Thus

$$2HgI_2 + NH_3 = NHg_2I + 3HI$$

This precipitat, which may be considered as ammonium iodid, with two mercury atoms in place of four atoms of hydrogen, is exceedingly heavy, one molecule of it weighing 541, as against 17 for one molecule of ammonia.

When using this test for quantitative work the ammonia in a given amount of the water, 500 c.c. or so, is concentrated by distillation with a little alkali. Its quantity is determined by comparing the color that a volume of the distillate gives with a little Nessler's solution, with the color produced by the reagent in the same volume of a very dilute standard ammonium chlorid solution. This test when used carefully, will determine accurately the presence of *one part of ammonia in one hundred million parts of water.*

Experiment No. 140.

Nitrites.

After the nitrogenous matter has been sufficiently decomposed to liberate ammonia, another series of microbes, the so-called nitrifying ferments, begin to oxidize this ammonia, first into nitrites and finally into nitrates.

The test, however, is not as delicate as Nessler's reaction; and, as the nitrites are probably a transition stage in the oxidation of nitrogenous matter, it is rather rare to get a good test for them in perfectly pure water. For this reason, probably the significance of their presence has frequently been somewhat exaggerated.

The reaction is based upon the formation of a scarlet coloring matter, one of the "Azo" dye stuffs, by the action of nitrous acid upon two aromatic organic bodies. The test is interesting as between a counterpart of the well known Ehrlick's reaction and where the nitrous and sulfanilic acids are mixed together and the compound corresponding to the naphthylamin salt is furnished by the urine.

Fill two large test tubes respectively with Croton and with well water. To each add a few drops of the saturated solutions of sulfanilic acid, and of naphthylamin hydrochlorat. A pink or red coloration appearing shows the presence of nitrites.

Notice the Croton water does not turn pink until it has stood for some time, and has absorbed some nitrites from the air.

Experiment No. 141.

Nitrates

We can test for these substances in two ways, either by reducing them to ammonia and using Nessler's solution, or else by directly producing a colored compound.

(a) *Reduction Method.* The best reducing agent is nascent hydrogen, which can be evolved in the water to be tested, by dissolving aluminum in an alkali (as Sodium or Potassium hydroxid).

$$Al_2 + 2KOH + 2H_2O = K_2Al_2O_4 + 3H_2$$

or else by the action of the water upon two different metals, such as zinc and copper. When these two, in close contact, are immersed in water, a true *galvanic couple* is formed, and the *positive* zinc is oxidized, and hydrogen is set free from the *negative* copper. This hydrogen slowly converts the nitrates first into nitrites and finally into ammonia, according to the following equations:

$$NaNO_3 + H_2 = NaNO_2 + H_2O$$
$$NaNO_2 + 3H_2 = NH_3 + NaOH + H_2O$$

This ammonia can be accurately determined by Nessler's Test, and the quantity of nitrates calculated accordingly.

(b) *Phenol-Sulfonic Acid Test.* We can estimate the quantity of nitrates directly by noticing the depth of color which they produce in a solution of phenol in strong sulfuric acid. The reactions being:

$$C_6H_5OH + H_2SO_4 = C_6H_4OH.SO_3H + H_2O$$

and then in the presence of traces of nitric acid or nitrates

$$C_6H_4.OH.SO_3H + HNO_3 = C_6H_4.OH.NO_2 + H_2SO_4$$

The color is intensified by the addition of an excess of alkali.

(a) *Reduction Method Experiments.* Clean the zinc in a wide-mouth bottle by adding some water and a little dilute hydrochloric acid, permitting it to effervesce for a minute or two, and then rinse out thoroly. After this, cover with water, add three or four drops of copper sulfate, and let stand for a few minutes until the zinc is fairly covered with a black deposit of metallic copper. Then rinse it out well, and fill the bottle with Croton water.

Test the reducing action of this "zinc-copper couple" on nitrates by adding two or three crystals of sodium nitrat to the water in the bottle, shaking it till they dissolve, and then letting it stand quietly until the end of the hour. Notice the slow but continuous evolution of hydrogen, and before leaving, test the solution for *nitrites* and for *free ammonia*, as previously described.

(b) *Phenol-Sulfonic Acid Test Experiment.* Add one or two drops of sodium carbonat to 50 cc. of the well-water, and evaporate the mixture to dryness in an evaporating dish. This can be done at first over the flame, but must be finished over the water-bath. Cover the residue with a solution of phenol-sulfonic acid, made by dissolving, *carefully*, in a test tube, a *few drops* of phenol with twenty times its bulk of common sulfuric acid. Then add about 10 cc. of Croton water and an excess of potassium hydroxid. If nitrates are present in the well-water, the mixture will have a *yellow* or even an *orange* color.

(*To be continued.*)

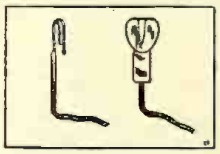
PATENT

Edited by

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 address 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.

Idea on a Pipe.



(244) William E. King, Monessen, Pa., has hit upon an idea to make a smoking pipe from a single piece of wood by splitting the entire pipe longitudinally. It would be held together while smoking by means of a metal cap. Our advice is asked on this idea.

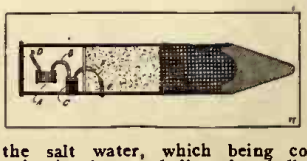
A. A clever idea, but it has no advantages whatsoever. As a matter of fact, it is not practical to our mind. By splitting a pipe, particularly the stem, it would certainly leak and would also create a false draft. While desirable from a hygienic standpoint, it certainly would not work out in practise.

Our correspondent furthermore submits a sample made of one piece of tin for tying packages. He wishes to know if this device is new and if a patent could be had on same.

A. This idea strikes us as quite feasible, being that it can be turned out at a few dollars per thousand, which is the all important necessity of such package tying devices. The United States Post Office as well as large mercantile houses require cheap devices of this kind continuously, and it seems to us that the device shown by our correspondent lends itself readily for such a purpose. We think a patent can be readily obtained.

Electrically Operated Shell.

245) Elbert B. White, New London, Ohio, submits an idea to us of an electrically operated shell, the illustration showing the *modus operandi*. This is a shell supposed to be shot off by an ordinary gun, it will not explode until it actually strikes the salt water, which being conductive completes the circuit between the outside of the shell and the insulated portion shown at E. A is the winding of a magnet wire to induce a small spark. B is a rubber tube or other non-conductor to insulate it in one place from the shell. C is a small battery. D is a wire from the small induction coil grounded with the shell. E is a wire from the battery thru a tube so as to go thru the shell and stick out of the latter a short way, but does not touch the shell as otherwise it would short the circuit. F is a contacting arrangement to set off the explosive charge. From this it will be seen that nothing occurs until the shell actually



strikes the salt water, which being conductive closes a circuit, thus exploding the shell.

A. This is a clever idea, and we have never seen anything quite like it, but we think there is just one thing wrong with it, and that is that it will explode too quickly. There should be some

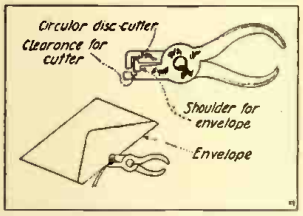
ADVICE

H. GERNSBACK

sort of retarding arrangement contained within the shell so that the explosion can be timed after the shell has sunk to a certain predetermined depth. We believe in this form the shell will prove practical, and we think a patent could be obtained.

Letter Opener.

(246) Henry Gruen, New York City, states: "Altho there are quite a number of letter opening devices, most of which are operated by elec-



tricity or by hand, I have invented a letter opener for office and pocket use which works on the principle of the finger nail nipper, having, instead of a blade, a small circular disc cutter, which cuts away a fine shred of paper, while the device is being past along the edge of an envelop. The illustration shows the device clearly. This device is not confined to envelops only, but may be used for straightening out sharp edges of sheets of paper having a torn edge. Please advise if this device is of any value, and if a patent can be obtained."

A. A very good idea, and we believe it can be readily patented. Firms opening many letters, or even small quantities, would, we believe, welcome a device of this kind.

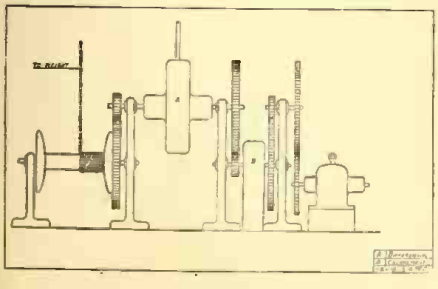
Sound Amplifier.

(247) Albert DeWolf, Chicago, Ill., has submitted an idea of what he calls sound amplifier. He makes use of certain *acoustic lens* to magnify the sound and to concentrate it upon a microphone in a certain manner.

A. This is a very good idea, and we have never seen it in use. Of course, acoustic lenses are not new, but in connection with a hyper-sensitive microphone it should prove of great value. We think this device can be patented.

Wind Power.

(248) Geo. Sparkman, Detroit, Mich., writes as follows: "I was very much interested in the article 'Electrical Power From Wind' in your March number. I have seen the plans of various devices,



but they all appear weak in one point. When the energy supplied by the wind is too great, there is some arrangement by which this excess energy is allowed to slide by. It is not used, but is a total loss. I am enclosing a sketch of mine which

BUZZER OPERATION TAUGHT IN 600 SCHOOLS.

The demand for specialists in the Army is increasing daily. Mechanics and technicians of all kinds, including radio and buzzer operators, are needed by the Signal Corps.

In nearly every large city the Federal Board of Vocational Training, thru local school authorities, has establisht schools of Radio-communication where men of draft age who have not been called may receive a preliminary course in the operation of radio and buzzer instruments. There are about 600 of these schools where instruction is given, usually in the afternoons and evenings. It takes about 200 hours for a student of average ability to obtain a speed of 20 words a minute, sending and receiving. Further information regarding schools may be secured from local school authorities. Electrical engineers and men with good fundamental training in engineering or physics are particularly in demand for Signal Corps work. Men of satisfactory qualifications are given three months' training in special schools, and have every opportunity to take examinations leading to promotion.

DE FOREST WIRELESS SUIT.

The trial of the patent infringement suit brought by the Marconi Wireless Telegraph Company against the DeForest Radio Telephone and Telegraph Company, which was to have commenced on June 12th in the New York Federal District Court, was, at the request of the Navy Department, suspended by Judge Mayer for the duration of the war.

remedies this fault. From this it will be seen that the main driven shaft is connected to a differential and the energy is transmitted thru a regulator to the motor. When the energy developed by the mill is greater than needed, the excess energy is used to wind up a weight. The wind is not a constant source of energy, and even when there is a moderately stiff breeze I have often noticed the wheel will stop for a few seconds. When this occurs, the weight descends and a ratchet prevents the shaft reversing the energy from the weight passing thru the differential and keeps the generator up to normal speed."

A. The illustration shows this invention, and we think it is a very clever idea, altho we do not have any means to tell how it will work out in actual practice. We believe that a patent can be obtained on this device; as far as is known to us, nothing like this exists.

Umbrella.

(249) A. G. Atchison, Santa Barbara, Cal., encloses sketch of an umbrella with a small front window which our correspondent claims is very desirable when walking against a strong wind. A small window which could be made of celluloid or isinglass is so placed on the lower side of the umbrella thru which the pedestrian is able to see the approaching person. Our advice is asked, if this idea is patentable.

A. This is not a new idea, a patent of this kind having been issued years ago, and similar umbrellas are actually being manufactured and sold.

Lamp.

(250) Harris Neil, Laurium, Mich., has thought out a bulb containing two filaments, one for bright light, the other for dim light, having the screw section extended to permit a switch to be operated. Our correspondent claims that there are several dimming devices on the market, but thinks that they are too expensive, while he believes his device can be manufactured cheaper.

A. In the sketch and illustration submitted to us we fail to see that our correspondent's device would work any better than the ones on the market now. Furthermore, we doubt very much if it can be manufactured at all due to technical difficulties.

NEW RESEARCHES ON THE ELECTRIC BASIS OF MATTER.

The science of electricity has now extended its range into almost all other branches of knowledge. The largest and perhaps ultimately the most important, is that of the strength and elasticity of materials. According to the researches of Dr. Herbert Chatley, of London University, who has contributed a series of papers to the Physical Society of London (England), the whole basis of molecular force is electrical.

It is now fully accepted by physical chemists that chemical affinity is due to the elementary charges on the atoms. Many believe in Stark's hypothesis that each valence bond is formed by a free electron so that a multivalent atom is like a multipolar magnet. Dr. Chatley has shown that the molecular force of cohesion between heavy molecules is ten to the thirtieth (a million-million-million-million) times greater than gravitation and about one hundredth the electrostatic force between a positive atom and an electron. He considers that the fields of the atoms and electrons do not lie wholly within those bodies and that there is a stray field in the adjacent ether which has the effect of making the groups (molecules) attract each other with forces of one or more per cent of those of the electrostatic linkage. These fields are not uniform but are complexly polarized, so causing crystallization when the molecules are free to settle in the positions of maximum stability. Within about one and one tenth molecular diameters at ordinary temperatures, these forces predominate over the repulsion due to the kinetic energy of oscillation of the molecules, but at greater distances they rapidly diminish until at about ten molecular diameters the effect is simply that of gravitation.

He thus provides a working hypothesis for the basing of the whole of physical science on electrical forces and motion. There is first the electron or primary ether whirl, which constitutes the elementary negative unit of electricity. Grouped about the mysterious *positive nucleus* the electrons form stable structures with immense kinetic energy, the atoms. Losing or gaining one or more superficial electrons, the atoms become charged and attract one another to form molecules. At close quarters there is a stray field which draws the molecules together and at remoter distances the excess of attraction between dissimilar charges over the repulsion between similar charges causes gravitation (Sutherland's hypothesis).

It is conceivable that this hypothesis, if true, may indicate new electrical methods of treating materials so as to greatly enhance or reduce their strength.

ELECTRICITY AND THE RANGE FINDER IN WAR.

(*Continued from page* 234)

range-finder no matter what type, operates on the principle that a fixed or known base line of a triangle must be utilized. So we find that with the "two-man" range-finder, used for a considerable number of years, that the procedure was as follows: The fixt and known base line was formed of an imaginary cord stretched between the two range observers "A" and "B." Suppose that observer "A" equipt with an angle-measuring instrument sights a certain object, let us say a factory, of which the range is desired. The second observer, "B," now advances to the point where, when sighting thru his right-angling instrument, he sees both the building in question which forms the "object," and also the sighting vane on observer "A's" instrument. At this moment "B" shouts, "On!" and observer "A" proceeds to adjust his range-finding (angle measuring) instrument until he also makes the reflection of "B's" sighting vane coincide with the object seen in the instrument, and the range is then read off the range-finder dial in yards. This arrangement is a simple one, but is difficult to apply in modern military maneuvers and battle conditions for the reason that a very long base line of about fifty yards length is required. As every student of trigonometry and geometry will perceive, the mathematical solution of the problem is quite simple, for it is based upon the elementary law of trigonometry that with a right-angle triangle having a known base, then the altitude can be determined when the angular value of the opposite angle is known.

The same principle holds good for the "one-man" range-finder shown schematically at Fig. C. In this case the range-finder tube is mounted on a tripod of suitable design so that it can be swung around on a vertical axis as required. This instrument is calibrated to solve the same unknown quantity, viz.; the *range,* by determining the angle at the lower corner of the right-angle triangle as shown. To take the range with this simplified instrument the operator proceeds to focus the right and left hand prism telescopes of the instrument on the object; he then rotates the range index which causes the right hand prism telescope to be inclined inward and he carefully adjusts this part of the apparatus until the two images in the central eye-piece accurately coincide, when the range in yards of the building or other object can be read off the calibrated index drum.

The photograph herewith showing American Jackies using a large range-finder on a battle-ship, illustrates one of the more recent and extremely high-power range-finders for use with long range guns which can fire a shell twenty to thirty miles. However, some of these "one-man" range-finders such as used in the Army and by the Marines, measures about one yard in length and can be readily carried by the observer or by his assistant. This small portable range-finder weighs but five and one-half pounds and the operator equipt with this truly remarkable and extremely simple instrument is enabled to rapidly and accurately determine the ranges of targets up to twenty-thousand yards distance.

EXPERIMENTAL PHYSICS.

(*Continued from page* 243)

In 1826, Simon Ohm, after whom the unit of resistance is named, discovered that the current flowing thru a circuit equals the electrical pressure divided by the resistance. This can be stated briefly $C = V/R$ where C is the current in amperes, V is the pressure in volts and R is the resistance in ohms.

EXPERIMENT 84—Resistances are measured by the ammeter-voltmeter method or by the *Wheatstone bridge*. The former method follows: Connect the unknown resistance a-b, ammeter A, voltmeter V and battery cell as in Fig. 76 (a). (The ammeter is said to be connected in series or directly in the circuit while the voltmeter is shunted or placed in parallel with the resistance.) Reading the deflections of the ammeter and voltmeter and substituting in the formula representing Ohm's law $C = V/R$ or $R = V/C$, we obtain the resistance in ohms of a-b. If we have several resistances R_1, R_2, R_3, etc., and connect them in series (see Fig. 76b) we find the joint resistance a-b of R_1, R_2, R_3, to equal $R_1 + R_2 + R_3$; that is, the resistance of several wires (or other forms of resistance) equals the sum of the individual resistances. If we measure the joint resistance in parallel (see Fig. 76c) we find that $1/R_1 + 1/R_2 + 1/R_3 = 1/r$ where r is their total resistance.

EXPERIMENT 85—If the plates of a voltaic cell giving current are watched carefully it will be found that bubbles form on the copper and that the zinc is gradually eaten up. This is always found to be the case, i.e., one plate is eaten up (called the negative plate) and something is deposited on the other (called the positive plate). By convention we say that the *current flows externally from the uneaten to the eaten plate* and hence *internally* from the eaten to the uneaten plate. Even when the cell is not giving current (unless pure zinc is used) we find bubbles forming on the zinc; the cause being that small electrical circuits are set up between the zinc and the impurities. This action is called *local action* and is obviously a *waste*, since the zinc is eaten while the cell is not giving any current. Local action is eliminated by either using pure zinc or by amalgamation —coating the impure zinc with mercury which dissolves the zinc and keeps back the impurities thus presenting to the solution only pure zinc.

EXPERIMENT 86—Watch the galvanometer thru which current from a simple voltaic cell is passing. The galvanometer deflections gradually fall until practically no current flows. The copper plate is now heavily covered with gas bubbles. Shake the copper plate and you will notice that the galvanometer now reads high again. This weakening of the current of a simple cell by the formation of deposit on the positive plate is known as *polarization*. The current is diminished as the cell *polarizes* because the surface of the positive plate is gradually covered, thereby preventing the solution from acting on it properly. The modern commercial cells, such as the dry cell and the wet cell, etc., have chemicals added to their make-up which combine with this formation on the positive plate, thus neutralizing it and preventing polarization. When using such cells continuously they polarize because the chemicals do not get the chance to act. However on allowing them to stay idle they recover as rapidly as the chemicals get at the formation on the positive plate. The *storage cell* does not store up electricity as is commonly supposed. It stores up *chemical energy*. Two plates of the same metal (lead) in dilute sulfuric acid solution will not form a galvanic cell, but if we first pass electricity thru, one lead plate will be chemically changed into lead peroxid, thus giving us two plates of different substance (lead and lead peroxid) which will now form a cell and give electricity. As the cell gives current the lead peroxid plate gradually changes to lead again. Thus, charging a storage battery is simply changing one of its plates so as to give us two dissimilar plates; discharging is causing the dissimilar plates to become similar again.

A word in regard to the connection of cells and we will close this lesson. Cells connected as in Fig. 77 (a) are said to be connected in *series*. The current is given by the formula $C = ne/R_e + nr_1$ where n is the number of cells, e is the voltage of each, R_e is the resistance of the external circuit and r_1 is the internal resistance of each cell. When all the positive plates are connected together and all the negative together, the cells are said to be in parallel (see Fig. 77 (b)). The current in this case is given by the formula $C = e/R_e + \frac{r_1}{n}$ where the symbols have the same meaning as in the series formula. When R_e is large the most current is gotten by connecting in series; when R_e is small, by connecting in parallel.

(*To be continued*)

THE PHENOMENA OF ELECTRICAL CONDUCTION IN GASES.

(*Continued from page* 240)

conducting surface, they will be attracted to it by induction, and eventually coming in contact with it they will give up their charges and disappear as ions or rather become ordinary *uncharged* particles. This disappearance is especially noticeable in small vessels or when an ionized gas is passing thru small tubes, and is there often more appreciable than that by recombination. Fig. 3, shows the *diffusion of ions* to the walls of a containing vessel. An easy means of determining the rates of diffusion is shown in Fig. 4, and is due to J. S. Townsend. The ionized air or gas is drawn thru the tube in the direction of the arrow at a steady rate and after it has past thru a tube T of definite length, the number of ions or the amount of the charge in the gas is measured by the electroscope by catching the charge on the electrode E. Next different length tubes are tried in place of T and the differences in the charges found at E is due to different amounts of diffusion in the tubes.

Thus it is that our ability to handle electricity and make it do the things we want it to do depends entirely on the sum total of our knowledge of what it will do and just how it does it. Nearly every modern scientific discovery is merely the development of a principle whose real meaning and secret power lay hidden until someone put enough study on the matter to see the practical connection. J. J. Thomson has calculated the entire quantity of electricity in any ionized gas by simply using two quantities, the coefficient of diffusion and the mobility of an ion (to be explained below). These measurements have led to others of the charge on *each ion*, etc., and so it is evident how closely these quantities are tied up with the important facts of electrical theory.

All ions may have at least two kinds of motion, the characteristic *motion of agitation* of the ions, due to their collision with gas molecules, and a *rectilinear motion* in the presence of an electric field. The former is equivalent to the average motion of the surrounding gas molecules when there is no superposed electric or magnetic field, and

when the ions are not close enough together to mutually influence each other. The distance then that any ion travels before it hits another particle of the gas is called the *mean free path.* When an ion is acted upon, however, by an electric field the velocity with which it is either *attracted to* or *repelled from* an electrode depends directly on the strength of the field. In order to compare the velocities of ions we must compare them in equal fields so we use the term *mobility.* The *mobility of an ion* is defined as the velocity of that ion in a field of unit potential gradient or a field of *one volt fall per centimeter.* Such a field of unit potential gradient would exist between two electrodes charged to 10 *volts* if they were 10 *centimeters apart.*

The determination of the mobilities of ions is only a special case in the determination of velocities discust in a previous paper, but it gives us a very convenient way of comparing ions in different gases and different kinds of ions to see how they behave in motion.

Early experiments showed that generally *negatives* travelled faster than *positives,* i.e., had greater mobility and that both travelled somewhat slower than ordinary molecules, so much so in fact that it was thought the ions must be larger, heavier bodies than molecules, consisting perhaps of from 2 to 20 molecules in a cluster, and that the negatives are always smaller. More recent work however has shown that in some gases negatives travel slower, while at lower temperatures neither travel as fast as would be expected, hence they may not be clusters after all, but the slowness of their motion may be due to some resistance offered to the charge on the ion. This is one of the most interesting points in Modern Physics, for it would mean that the weight of an ion depended upon its charge of electricity, and recent discoveries support this view which will be discust in the following paper. However this may be, it is important to note that recombination and diffusion tell us what the conductivity of a gas will be. It also gives us an idea of the size and charge of the ion.

(To be continued.)

POPULAR ASTRONOMY.

(Continued from page 239)

points of resemblance and difference of these two groups of gaseous nebulae.

They resemble each other in the nature of their light which gives the typical bright line spectrum of incandescent gases at low temperature and under low pressure. Their luminosity may also be due partly to reflected light from stars with which they are associated and partly to some form of electrical excitation as well as to light of incandescence. The gaseous elements that enter into the composition of both groups are hydrogen, helium and the unknown gas nebulium already mentioned. These gases are, moreover, present in both types in an extremely rarefied state and the mass and density of all the gaseous nebulae is very small in proportion to the great volume of space they fill tho the irregular nebulae are tremendously more extensive than the planetaries. Both types show the presence of dark as well as luminous matter and both types are associated only with *young stars.* The two groups are also alike in showing a decided preference for the fundamental plane of the sidereal universe and in occurring most frequently among the densest star clouds.

As to their most marked points of difference the planetary nebulae possess a small, rather sharply defined disk-like appearance with a strong, star-like condensation at the center. They are also moving thru space with a velocity greatly in excess of the average velocity of the stars, a fact very difficult to explain, while the irregular nebulae appear to be more nearly at rest than any other class of celestial objects. The planetaries are comparatively few in number. The irregular nebulae are quite numerous and diversified in appearance. Tho the origin of the planetaries appears to be due to exceptional conditions that are out of the ordinary run of star life such as possibly chance encounters of stars with nebulous tracts of matter, the great irregular nebulae appear to be the primordial stuff from which the stars are fashioned, possibly many at a time from a common nebula in the form of slowly moving groups possessing the same general drift. As the stars advance in age and gather in their nebulous appendages under the force of gravitation, they appear to quicken their pace but retain their community of motion. The tendency to move in groups and loose clusters is characteristic of stars well advanced in development as well as new stars and may possibly be due to a common origin in one vast irregular gaseous nebula.

(To be continued)

RECLAIMING THE U-BOATS' TOLL BY NOVEL SALVAGE APPARATUS.

(Continued from page 230)

difficult to apply his method of raising a submerged wreck, there would undoubtedly be a considerable field of application for this method of performing the operation successfully. To start with, Mr. Dawson is an economist of the first water, as we shall presently see, for he has had the forethought to perceive that not every salvage company will care to spend a large fortune in purchasing the necessary engines and other powerful hoisting apparatus with which to raise the sunken boat; therefore, he intends making use of the *tides,* which as we know exert a tremendous power when properly applied.

Mr. Dawson's scheme of raising sunken boats provides primarily for a large wrecking barge as shown in Fig. "C," and this carries a powerful engine or motor-driven suction pump. When this scheme is used a reasonable distance from shore, all of the power required may easily be supplied by electric cables from the shore, the cables being supported, at regular intervals if necessary, by means of floats or buoys. The pump on the barge is connected with a large suction pipe passing downward to the bow of the wreck . Adjacent to the base of the suction pipe there is placed a large rotary plow or *sand churner,* which can be rotated back and forth by means of a steel cable passing around a grooved pulley attached to it, and this cable being attached to two motor-boats on the surface, one of the boats drifting astern, while the other drives ahead, and vice versa. In this way the toothed sand plow is rotated back and forth rapidly, loosening the sand under the bow of the sunken vessel and allowing the sand to be drawn up the suction pipe.

In order to observe the progress of these operations the inventor provides a *submerging tank* as shown, and in which an inspector may be stationed. Where the depth is considerable the tank is supplied with the necessary air apparatus, as well as telephone and electric light. Other conveniences are provided for also. In cold weather or at great depths where severe dampness and sweating may occur on the steel walls of the tank, electric heaters serve to keep the interior dry and comfortable.

As the sand is drawn up thru the suction pipe by the pump on the barge, it is mixed with a considerable quantity of water, and may be discharged thru a pipe running to

shore, or, if this is not feasible, it may be discharged from a pipe of sufficient length to allow the sand to escape into the water at a considerable distance from the scene of the salvage operations.

After the sand has been sucked away from under the prow of the wreck, a steel cable is worked under the stern of the boat by the two motor-boats aforementioned, each motor-boat being fastened to one end of the cable and a see-saw action being maintained until the hawser is worked part way under the hull. For the purpose of raising the wreck, the inventor provides a number of scows or pontoons, arranged respectively in pairs, each pair being joined by a specially designed and powerful girder. These girders are mounted in roller joints or bearings on the pontoons so as to make each lifting unit flexible and not liable to damage by rough water. Powerful winches are supplied on each pontoon for taking up and holding firmly the cable ends as they are taken in. The steel cables are drawn under the wreck by successive operations of the motor-boats exerting a see-saw action on them as they are placed successively under the hull.

After the various cables have been successfully engaged under the vessel, the ends of the cables are delivered to the respective pontoons and applied to the various winches, and here the inventor's genius comes in. *He makes the tides raise the vessel* in the following manner:

As soon as there is a rise and fall of water surface due to tides, the pontoon cables need only be drawn taut by the winches at low tide, so that when the water rises, the buoyancy of the pontoons alone will exercise the necessary vessel-lifting force. When the vessel is thus supported by a series of pontoons, then at high tide the vessel and its attached pontoons may be towed by a powerful tug or tugs into shallow water. If the vessel has not been raised sufficiently so far, then by towing it into shallow water at low tide and taking up the slack of the cables on the pontoon winches, then at high tide the vessel will again be raised, and so on.

ANALYSIS OF IRREGULAR WAVE SHAPED ALTERNATING CURVES.

(*Continued from page 247*)

two simple sine waves, shown in light lines, as indicated. One of the sine curves has the same frequency as the resultant curve, while the other sine curve has *three* times this frequency.

The relative positions of the two component sine curves should be noted. Positive and negative lobes always start out from the zero starting point in the same direction, and always pass the horizontal datum line in the same direction. If the negative lobe *B* could be turned about the horizontal datum line as an axis until it comes into the same plane with the positive lobe *A*, as indicated by the dotted lines and designated by *C*, the complete similarity and *symmetry* of *A* and *C* may be made apparent.

Fig. 4 shows the same two component sine curves, *displaced* somewhat in position, horizontally, and added together, and forming a resultant curve having a very different shape from that shown in Fig. 3. However, the symmetry of the positive and negative lobes *A* and *C* is to be noted.

Fig. 5 shows the same two component sine curves displaced still more in position, with a still different shaped resultant.

It is evident then that many different shaped curves may result from the algebraical addition of only two sine curves, by simply displacing the two sine curves, without in any manner changing their maxima values. Many different shapes

would moreover result if the positions of the two sine curves were not changed while their maxima values were changed. Fig. 6 shows the effect of simply changing the maximum value of only one of the component sine curves. The resultant curve in this case should be compared with Fig. 3. The horizontal displacement of the component curves is the same in both these figures.

Another important feature to be noted in comparing the resultant curves in Figs. 3, 4, 5 and 6 is that in passing from *O* to *X* one would arrive at the crest of the resultant curves, before arriving at the lower humps. This is perhaps best noted in Figs. 5 and 6, the feature of similarity or symmetry may be clearly emphasized by imagining the lobe *C* slid along the horizontal datum line *OX* until its base coincides with the base of lobe *A*. Both lobes will then coincide in every respect.

A very different condition is shown in Fig. 7. The resultant curve is here obtained by adding two sine curves, one of which has *two* times the frequency of the other, and different amplitude as indicated. It may be noted in this figure that if the negative *B* lobe is turned into position *C* and then slid along until its base coincides with the base of the *A* lobe, the two lobes *do not coincide* in any respect. The same is true of the curve in Fig. 8, which shows the curve resulting from adding together two sine curves, one of which has *four* times the frequency of the other.

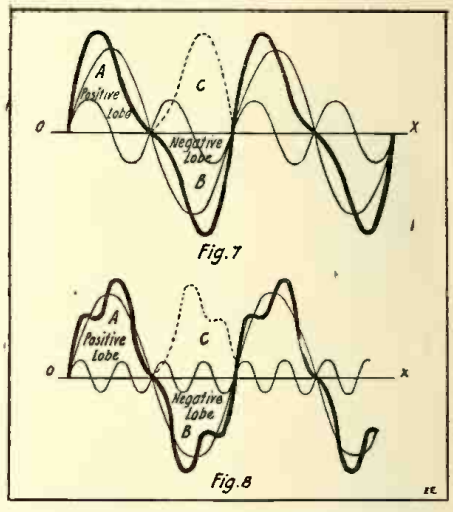
Curves resulting from the addition of sine curves whose frequencies are *even* multiples of the resultant curves are not symmetrical.

If then any alternating pressure or current curve obtained by experiment, is symmetrical as regards its positive and negative lobes, it is made up of sine-curve components whose frequencies are *odd* multiples of the fundamental frequency. Nearly all pressure and current waves found in practise, produced by electromagnetic induction, are symmetrical curves, and the statement is sometimes made that such curves or waves consist of the fundamental and its *odd harmonics.*

One practical method of determining a number of the harmonic curves or component sine waves composing any given resultant wave or curve, is by use of a *frequency meter.* One form of frequency meter, the vibrating reed form, is illustrated by Fig. 9. In this instrument a number of small elastic or springy metallic strips or reeds, 1, 2, 3, 4, etc., are carefully calibrated by filing or scraping them and all rigidly fastened to the same metal base, *B* having attached to it an iron tongue *T* that extends over the poles of an electromagnet, *M*. If an alternating current is allowed to pass around the electro-magnet the iron tongue and metal base will vibrate with the same frequency as that of the alternating current. The particular reed that has the *same natural frequency* as that of the alternating current, will vibrate with considerable amplitude; thus indicating, if the reeds are each marked, the frequency of the alternating current. Reed No. 7 is shown vibrating in the figure. If the frequency meter described has a large number of reeds arranged to cover a large range of vibration frequencies, a reed having a natural period of three times the fundamental will respond if the third harmonic is present in the resultant wave. The fifth, seventh, ninth, etc., harmonics might also be indicated by a properly designed frequency meter, provided they were present in the resultant curve. While a number of the harmonics might be indicated by the meter, their amplitudes could not be measured, nor could their relative phase positions be indicated, altho the relative amplitude of vibration of the reeds might in a measure indicate the comparative amplitudes of the indicated harmonics.

In general the fundamental principles mentioned in the foregoing discussion apply in both music and in wireless transmission. If Figs. 3 and 5 represent two musical notes, each having the same *pitch,* that is the same wave length or frequency, the two notes will have very different *quality.* The note A on a piano may be readily distinguished from the A of a violin. The two notes may have the same frequency or pitch, but are made up of a *different arrangement of sine waves.* Likewise two wireless stations might send out waves having the same wave length or frequency, yet one might readily be distinguished from the other because of the difference in quality.

The component sine curves making up resultant alternating or wireless waves are commonly alluded to as *harmonics.* The following table shows at a glance the frequencies and the wave lengths of the (upper) odd and even harmonics, from 1 to 15 inclusive.



Demonstrating the Peculiar Shape of the "Resultant" Curve Obtained by Adding Together Two Sine Curves, One of Which Has Four Times the Frequency of the Other.

f denotes the frequency of the resultant curve, in cycles per second.
λ denotes the wave length of the resultant curve.

UPPER HARMONICS

Odd Harmonics	Even Harmonics	Frequency of Harmonic	Wave length of Harmonic
1		$f_\lambda = 1f$	$\lambda_h = 1\lambda$
	2	$= 2f$	$= 1/2\lambda$
3		$= 3f$	$= 1/3\lambda$
	4	$= 4f$	$= 1/4\lambda$
5		$= 5f$	$= 1/5\lambda$
	6	$= 6f$	$= 1/6\lambda$
7		$= 7f$	$= 1/7\lambda$
	8	$= 8f$	$= 1/8\lambda$
9		$= 9f$	$= 1/9\lambda$
	10	$= 10f$	$= 1/10\lambda$
11		$= 11f$	$= 1/11\lambda$
	12	$= 12f$	$= 1/12\lambda$
13		$= 13f$	$= 1/13\lambda$
	14	$= 14f$	$= 1/14\lambda$
15		$= 15f$	$= 1/15\lambda$

The table gives the harmonics up to the 15th for higher frequency components only; for lower frequency components the student may construct a table himself, similar to that here given, excepting that each successive harmonic has a *lower frequency,* but a *higher wave length.* Thus the 4th lower harmonic has a frequency of $\frac{1}{4}f$ and a wave length of 4λ, etc. Those who are interested in this important subject should read the first article, which appeared in the *May,* 1918, issue.

How I Improved My Memory In One Evening

The Amazing Experience of Victor Jones

"Of *course* I place you! Mr. Addison Sims of Seattle.

"If I remember correctly—and I *do* remember correctly—Mr. Burroughs, the lumberman, introduced me to you at the luncheon of the Seattle Rotary Club three years ago in May. This is a pleasure indeed! I haven't laid eyes on you since that day. How is the grain business? And how did that amalgamation work out?"

The assurance of this speaker—in the crowded corridor of the Hotel McAlpin—compelled me to turn and look at him, though I must say it is not my usual habit to "listen in" even in a hotel lobby.

"He is David M. Roth, the most famous memory expert in the United States," said my friend Kennedy, answering my question before I could get it out. "He will show you a lot more wonderful things than that, before the evening is over."

And he did.

As we went into the banquet room the toastmaster was introducing a long line of the guests to Mr. Roth. I got in line and when it came my turn, Mr. Roth asked, "What are your initials, Mr. Jones, and your business connection and telephone number?" Why he asked this, I learned later, when he picked out from the crowd the 60 men he had met two hours before and called each by name without a mistake. What is more, he named each man's business and telephone number, for good measure.

I won't tell you all the other amazing things this man did except to tell how he called back, without a minute's hesitation, long lists of numbers, bank clearings, prices, lot numbers, parcel post rates and anything else the guests gave him in rapid order.

****

When I met Mr. Roth again—which you may be sure I did the first chance I got—he rather bowled me over by saying, in his quiet, modest way:

"There is nothing miraculous about my remembering anything I want to remember, whether it be names, faces, figures, facts or something I have read in a magazine.

"*You can do this just as easily as I do.* Anyone with an average mind can learn quickly to do exactly the same things which seem so miraculous when I do them.

"My own memory," continued Mr. Roth, "was originally very faulty. Yes it was—a really *poor* memory. On meeting a man I would lose his name in thirty seconds, while now there are probably 10,000 men and women in the United States, many of whom I have met but once, whose names I can call instantly on meeting them."

"That is all right for you, Mr. Roth," I interrupted, "you have given years to it. But how about me?"

"Mr. Jones," he replied, "I can teach you the secret of a good memory in one evening. This is not a guess, because I have done it with thousands of pupils. In the first of seven simple lessons which I have prepared for home study, I show you the basic principle of my whole system and you will find it—not hard work as you might fear—but just like playing a fascinating game. I will prove it to you."

He didn't have to prove it. His Course did: I got it the very next day from his publishers, the Independent Corporation.

When I tackled the first lesson, I suppose I was the most surprised man in forty-eight states to find that I had learned—in about one hour—how to remember a list of one hundred words so that I could call them off forward and back without a single mistake.

That first lesson *stuck*. And so did the other six.

Read this letter from C. Louis Allen, who at 32 years is president of a million dollar corporation, the Pyrene Manufacturing Company of New York, makers of the famous fire extinguisher:

> "Now that the Roth Memory Course is finished, I want to tell you how much I have *enjoyed* the study of this most fascinating subject. Usually these courses involve a great deal of drudgery, but this has been nothing but pure *pleasure* all the way through. I have derived much benefit from taking the course of instructions and feel that I shall continue to strengthen my memory. That is the best part of it. I shall be glad of an opportunity to recommend your work to my friends."

Mr. Allen didn't put it a bit too strong.

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VICTOR JONES

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E. E. 88

HOW THREE NEW YORK SUBWAYS MEET AND PASS ONE ANOTHER.

(*Continued from page 226*)

paying a new fare, you could then proceed to Long Island City, or to any intermediate stop. As aforementioned, this route extends downtown along Broadway to Brooklyn, via the Battery, and also has a by-pass route to Brooklyn via Canal Street. There are thus three distinct track levels at "Times Square," if we include the surface car or trolley system, while three distinct and important arteries of traffic congregate at this point as becomes evident.

The new 7th Avenue subway tracks which are four in number, two for local trains and two for express trains, join the old subway rails near 45th Street. The present four-track subway tunnels running along 42nd Street between "Times Square" and the "Grand Central" terminal, will undoubtedly take care of the heavy cross-traffic between the two systems.

Reverting once more to the old subway system, which extends northward in the lower part of Manhattan along 4th Avenue, this will be operated as previously and will be extended by the Interboro Rapid Transit Company so as to proceed from the "Grand Central" terminal northward along Lexington Avenue, cross under the Harlem River at 120th Street and from this point it will branch out underground along Mott Avenue, via subway to 157th Street, from which point it will operate as an elevated line along Jerome Avenue to Woodlawn Road. After crossing under the Harlem River, this subway route will have a second branch extending eastward to 147th Street and Southern Boulevard and from here it will run via subway along Southern Boulevard and eventually change to an elevated line at Bancroft street. From here it will operate as an "elevated" along Westchester Avenue to the Eastern Boulevard. The new Interboro subway plans call for the extension of the present "Bronx Park" division, via elevated road, northward to 241st Street.

THE DESIGN AND USE OF THE WAVE-METER.

(*Continued from page 249*)

the current thru the buzzer coils, charges up the condenser C of the wave-meter, which in turn discharges thru the inductance L, producing radio frequency oscillations in the circuit CL. These in turn are broken up into a group frequency depending on the pitch of the buzzer. Another oscillating circuit brought into inductive relation with the wave-meter will pick up energy as explained in several places thruout this article.

VII. Measurement of Mutual Inductance

Figure 8 shows the method used in measuring the mutual inductance between two coils such as the two coils of a variometer or loose coupler.

A known capacity C, is connected in shunt with the two inductances L_1 and L_2 which are connected in series with each other. A double-pole, double-throw switch is connected in circuit as shown so as to reverse the current in coil L_1. When the switch is thrown to the side A, current flows thru the two inductances in the same direction, thus causing the fluxes to be in the same direction or aid. In this position the two coils are said to be *aiding*.

When the switch is thrown to side O, current passes thru the coils in opposite directions, causing their fluxes to *oppose* each other. In this position the coils are said to be *opposing*. If now a wave-meter is brought near to the coils the wave-length of the circuit can be measured in each position of the switch. Then knowing the value of the capacity and the wave-length it responds to in each position of the switch, the value L_a and L_o can be computed.

For $L_a = L_1 + L_2 + 2M$

$L_o = L_1 + L_2 - 2M$

$L_a - L_o = 4M$

or $M = \dfrac{L_a - L_o}{4}$

where

M = mutual inductance between L_1 and L_2

L_a = inductance with the two coils aiding

L_o = inductance with coils opposing

L_1 and L_2 = self inductances of two coils

All values in cms.

Now measuring the mutual inductance for various positions of the coils with respect to one another, as for instance, the angle of displacement between the two coils of the variometer or the distance one coil is inside another, in the case of the loose coupler, we can plot a curve of mutual inductance against coil position.

VIII. Measurement of the Coefficient of Coupling

The measurement of coupling is a very important measurement in Radio Engineering, for upon it depends the sharpness of syntony of transmitters and receivers. Coupling is usually exprest in per cent, all over 20% being considered *tight* coupling and all below 20% being considered *loose* coupling.

In order to measure coupling, the following procedure is followed: The circuit is connected as in Fig. 8, and the mutual inductance (M) measured. Then the self-inductance of the coils is measured as explained under III, and from this data the coupling is found by substituting in the formula:

$$K = \frac{M}{\sqrt{L_1 L_2}} \times 100$$

where K = per cent coupling

M = mutual inductance in cms.

L_1 and L_2 = self-inductance of two coils in cms.

A curve can be plotted in this case also, showing the per cent coupling against the position of the coils.

IX. Measurement of the Distributed Capacity and Natural Period of Inductance Coils

Any coil has a certain amount of *distributed capacity* between turns, and this quantity combined with its self-inductance causes the coil to respond to some wave-length which is known as its *natural period*. A receiving set having a coil therein that has a natural period within the range of the receiver is very inefficient, because at some wave-length the coil is going to oscillate at its own natural period, and weaken the received signals considerably by absorbing energy in order to keep itself in a state of oscillation. The same holds true to a lesser degree with the transmiting helix, and for this reason helices usually have only enough turns to give the required inductance, while receiver inductances are split up into sections by means of end-turn switches or "dead-end" breaks.

The accompanying figure 9, delineates the method of measuring the *natural period* of a coil. The wave-meter is excited by a buzzer and inductively coupled to the coil under measurement which has a unilateral connection of the telephones and detector. As the condenser of the wave-meter is moved across the scale, a sharply defined point will be found that gives a loud signal in the telephones. This is the natural period of the coil.

Knowing the self-inductance and natural period of a coil the distributed capacity is calculated from the wave-length formula.

This method of measuring distributed capacity is not strictly accurate but is good enough for most practical purposes.

Conclusions

This concludes our series of articles on the wave-meter, and the author hopes he has duly imprest upon the reader the wide range and variety of usages to which a wave-meter can be put in practice. In fact it can be easily seen that a wave-meter is well-nigh indispensable in a Radio laboratory and with this one simple meter, practically every important measurement used in Radio Engineering can be made.

(*Conclusion*)

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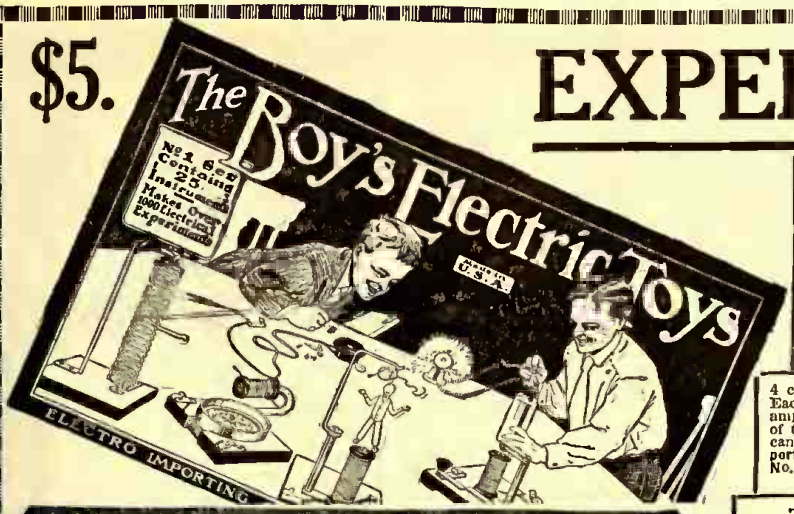

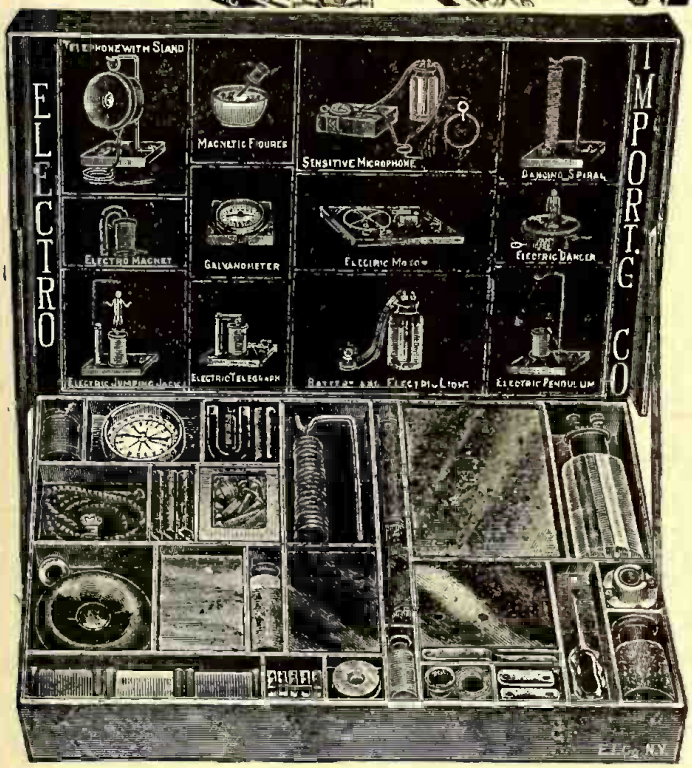

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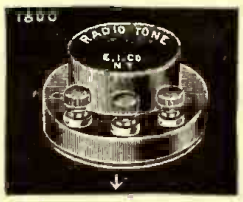

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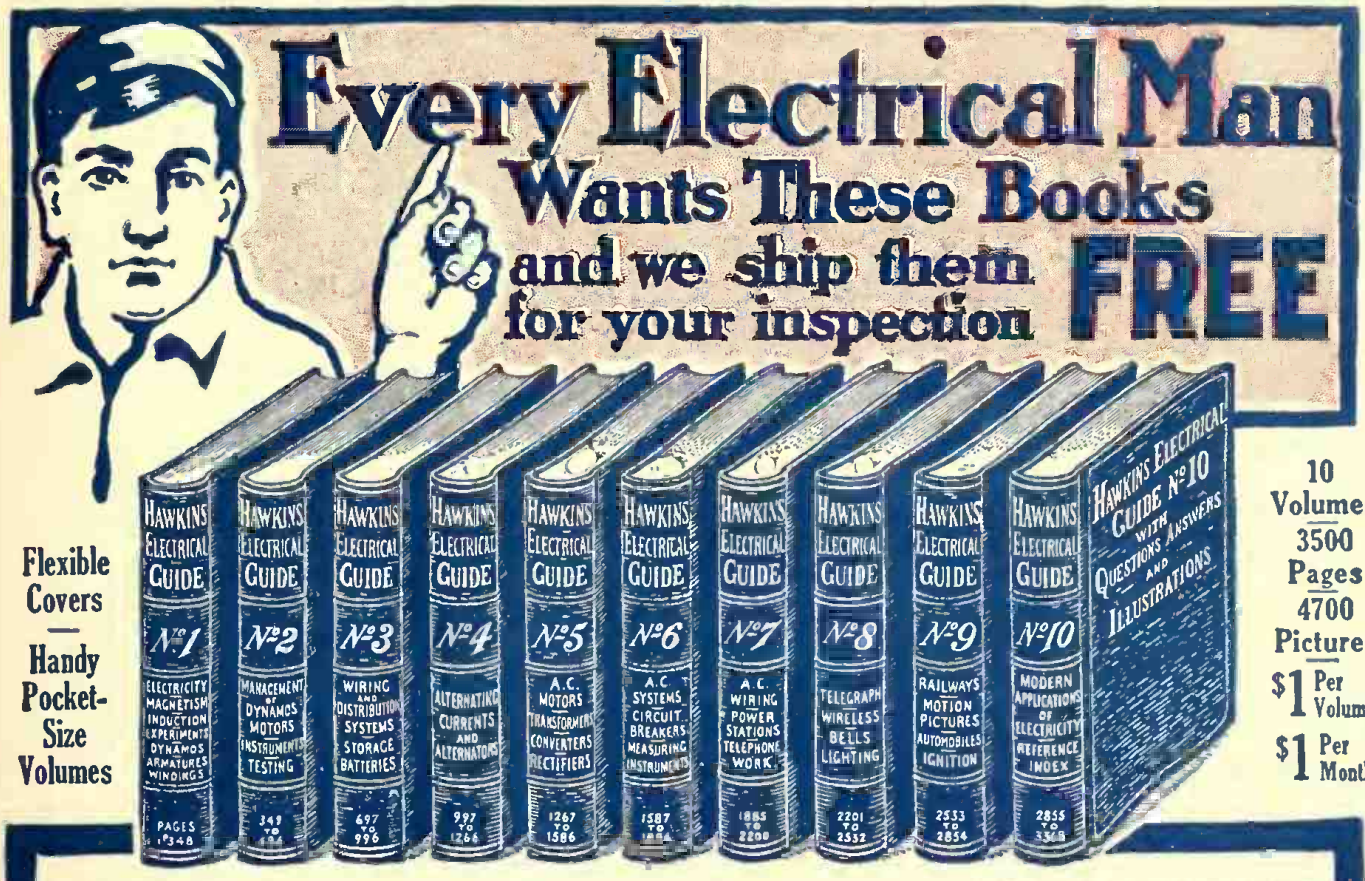

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