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THE AUTOMATIC SOLDIER

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Electrical Experimenter

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EDITORIAL

THE WAR MICROBE

If we go back to the dawn of the human race we find that at the beginning the population of the earth was very modest. It took literally hundreds and thousands of years before a million human being were actually living all at the same time on this globe. Man had many enemies who preyed on his existence and made life almost unendurable. Only very gradually did the race multiply. After man had conquered the more savage animals, had emerged from his forests and his caves and taken to agriculture, new enemies beset him to keep the race from increasing too rapidly. Man's arch-enemy was, and still is, hunger. As long as he dwelt in the forest, primordial man had sufficient meat, which he obtained by killing animals, and being well fed, his health was good. But as agricultural man multiplied and kept on multiplying, there was soon not enough to eat and he began to starve much and often. This weakened his body considerably and a new enemy sprang up to slay him by the million—disease.

This was Nature's inexorable method to propagate a healthy race, for only by slaying myriads of human beings, for whom there was nothing to eat, could the race be perpetuated.

The human race had and still has to contend with many forms of disease, whether it be pestilence, cholera, tuberculosis or war. All of these diseases are working for Nature to keep up her "average," i.e., the proportion of food to human beings. Let there be a food shortage for only a few years, and the population of the districts so affected will immediately dwindle. Often, too, the thus reduced and starving nation becomes diseased with war and falls upon the richer nation, which by high living can offer but a weak resistance as a rule and succumbs. Thus for a time a balance between the two nations is re-established by Nature.

But well-nourished man is not always immune from disease, as is well known. He may succumb to the cholera germ as well as to the war germ, strictly in accordance with Nature's farseeing plan.

Thus, nations who have enough to eat for the time being and who are consequently healthy, may become inoculated with the war microbe, as has happened so many times in history and as has occurred to the Huns in 1914. Here, too, we see Nature working out her "averages." Side by side were France and Germany, each country of about the same area. But in Germany there were 66 million human beings, in France only about 39 million. Nature in her omniscient way to bring about a "balance" inoculated the Germans with the war disease, and we now witness the result where Germany is losing from three to five males, to every French male, this for the reason that the French at the outbreak of the war summoned her Allies who, now greatly outnumbering the Huns, slay them, thus reducing their numbers, thereby inadvertently executing Nature's decree. Exactly the same thing happens in every beehive, where, in order to keep up "averages" between bees and food, the bees, after each swarming season is over, fall upon the males, the greater part of them being ruthlessly massacred by the workers, as if in dread of their consuming too much of the common store.

The human race has conquered many diseases and it will isolate the war microbe in time. But before that happens Nature will see to it that the non-food producing, prepondering city population is reduced in favor of the country population, so that there will be enough food for the rapidly increasing human race.

If we think of war as a disease, which finds its origin in hunger, and treat it as such, we will abolish it that much sooner.

H. Gernsback.

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OUR NEW 400,000 C. P. AEROPLANE FLARES

FOR carrying out night operations under war-time conditions the Teutons, as well as the Allied air forces have often resorted to the use of "flares" as they are called. These are usually dropt from airplanes or dirigible balloons and, suspended from parachutes, they give an intense illumination over considerable areas.

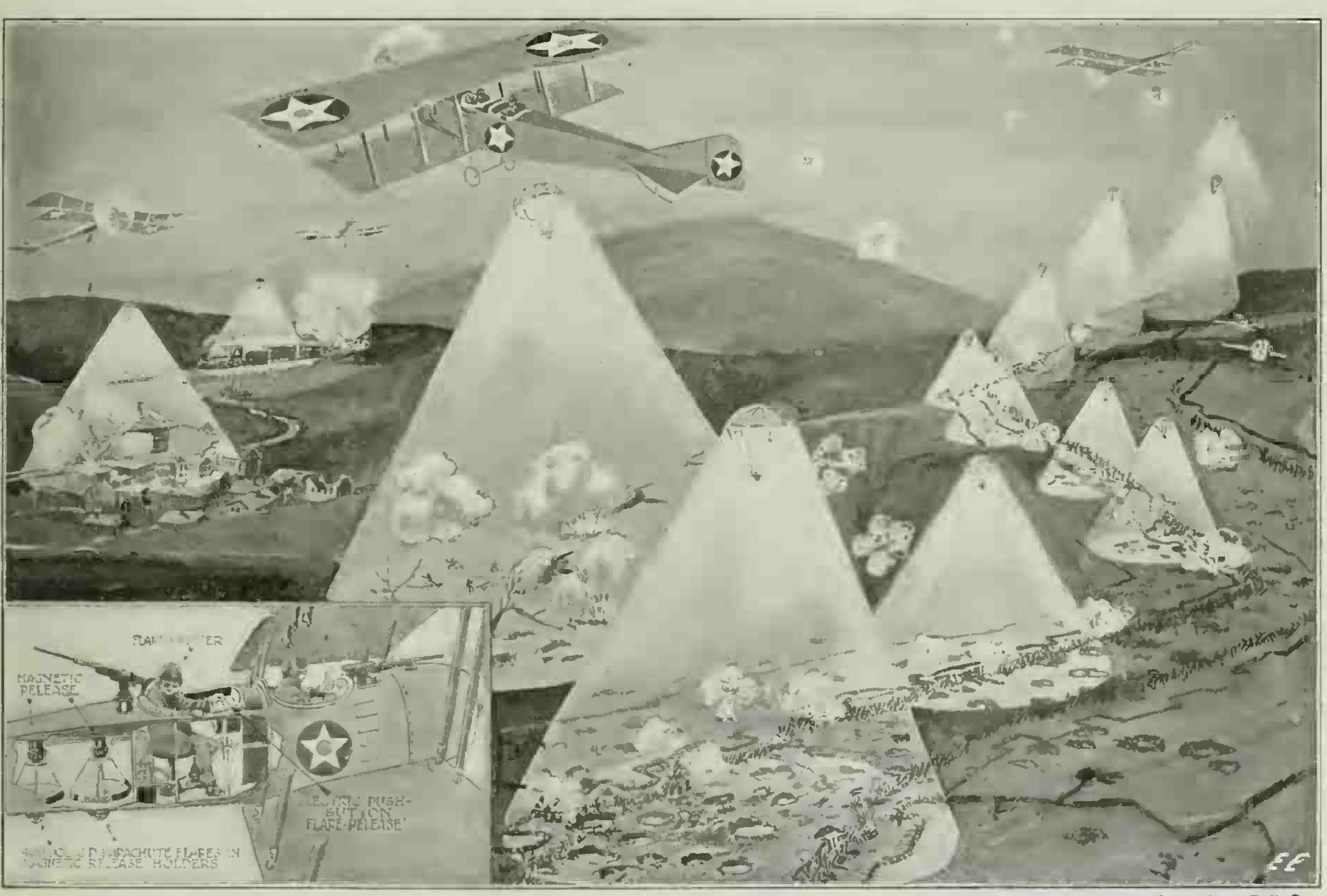
Uncle Sam's ordinance experts have something new to spring on the "All Highest" shortly—a new "flare" light that will give 400,000 candle-power, and light up a circular area one and one-half miles in diameter!

An airplane flare with a brilliancy equalling that of 400,000 candles has been perfected, says our official report from Washington. When hanging from its parachute over a German munition plant it lights up an area so brightly that an airman, thousands of feet in the air, can select any building he is directed to make a target for his aerial bomb, and, it may be added, American aviators are becoming so expert in bombing that they can usually hit the target at which they shoot.

In every European city within the zone of aerial raiding operations, the rule is rigidly enforced against the burning of lights in any building that might possibly be used as a target. Therefore, the airman must be able to supply his own means of locating the object of this attack.

When orders are received to bomb, say a particular railroad center, the aviator proceeds very much in the same manner as does the captain of a vessel. The cities and their environs are charted and the night-flyer proceeds by compass, due allowance, of course, being made for atmospheric conditions. He is also frequently aided by prominent markings, such as the reflection of moonlight from a river.

Having reached the particular district



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Uncle Sam's War Experts Have Recently Evolved Something Entirely New in "Flares." This Design Permits of Launching the "Flares" from Aeroplanes, and the Powerful, Prolonged Illumination They Provide Will Make the Visit of our Nocturnal Aërial Bombers One of Extreme Anxiety to the Inhabitants of German Towns and Cities. Each "Flare" develops 400,000 Candle-Power and Lights up an Area One and One-Half Miles in Diameter.

sought, he must locate the particular object of his attack from his position, which may be 5,000 or 10,000 feet, or even higher, above the earth. Equipt with the airplane

Photo © by French Pictorial Service

Just What a Night "Flare" Can Do Is Readily Imagined by Looking at This Photo of a British "Heavy" and Its Crew Lighted up by a German Star Shell. Note the Camouflage on the Barrel and also the Captured "Boches" Working at the Left.

flare, the aviator pulls a lever and releases it. In other cases the "flares" are held in an electro-magnetic device, so that all the "flare officer" has to do is to push the proper button. The button closes the battery circuit thru the particular release magnet; the magnet trips the frame finger holding the parachute and attached flare "powder capsule".

As it drops, the resistance offered by the air sets the fuse mechanism in operation. The result is the emission of a powerful light of from 300,000 to 400,000 candlepower, which completely illuminates the terrain below. The amount of light given is equal to that of a battery of from 150 to 175 street arc lamps, or of from 15,000 to 17,500 ordinary incandescent lamp bulbs such as are used in the home!

As soon as the flare gets into operation, a huge parachute made of the best quality of silk opens and holds the brilliant light in suspension in the air for a sufficient time to allow the aviator to select his objective or target. Having located the factory, railroad depot, ammunition dump, hangars, munition plant, or whatever the target may be, the aviator drops the bomb and proceeds on his way. His aim is certain to be most deadly with such perfect illumination as is provided by this newly perfected "flare" light.

The height at which an aviator flies when attacking depends, of course, on surrounding conditions. If the enemy is aware of his presence and is preparing for attack, he must keep up and out of range of anti-aircraft guns. An idea of the effective light thrown on the ground by this flare may be gained from the fact that, when suspended at a height of from 1,500 to 2,000 feet, it will clearly light a circular area *one and one-half miles in diameter.*

Photo © by Underwood & Underwood

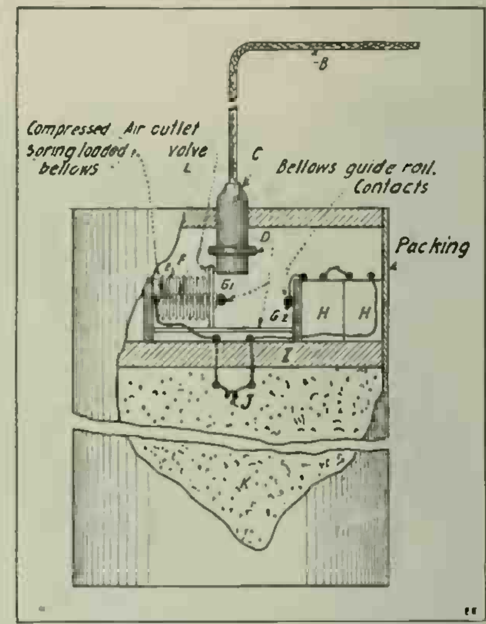
Special Form of Belgian Trench Mortar Firing Electric Bombs Used in Destroying Barbed Wire Fences. The Wires Catch on the Fence and Detonate the Bomb by an Electrical Device.

BELGIANS USE NEW ELECTRIC TRENCH MORTAR.

A new development in mortars on the Belgian frontier, makes use of electricity as the prime agent of operation. Its purpose is to clear the barbed wire entanglements in the line of advance. A very novel method of timing the explosion is employed.

It can be used in close quarters where there is not ample time for loading into the mortar, by grasping the shell by the wire and swinging it over the head, then throwing it into the enemy trench. When put to the latter use it functions the same as when fired from the trench mortar. The pin is pulled when the shell is lifted and swung by the wire; the action is explained by the accompanying diagram.

The shell shown here is one of the units that is placed into a metallic container and fired with its rear end forward. It is aimed



The Belgian Electric Trench Bomb Used for Destroying Barbed Wire Fences, Etc. It Can Also Be Used as a "Hand Grenade."

at the barbed wire enclosure and when fired it turns while in mid-air, thus leaving the wire B to trail behind and catch in the barbed wire. When caught the sub-shell A is pulled from the large shell containing the other subshells, and a sudden pull causes C to pull out until collar D prevents further outward motion. The spring loaded bellows E wherein F is the spring is now released from its compress position and slowly moves toward contact G^2, guided by rail M. The speed of the opening of the bellows is regulated by the air inlet valve L, and takes about two seconds to close contacts G^1 and G^2. H represents the flashlight batteries and when contact by the bellows is made, the filament or very thin wire J is made incandescent and the powder charge K ignited. A violent explosion occurs due to the charge B being under heavy pressure by packing I, and the barbed wire is broken and supporting posts shattered. Thus a clear road is made for the Doughboys to "go over the top."

The same operation follows the pulling of the wire when it is desired to use the shell as a hand grenade, and it proves to be a very effective two-in-one article.

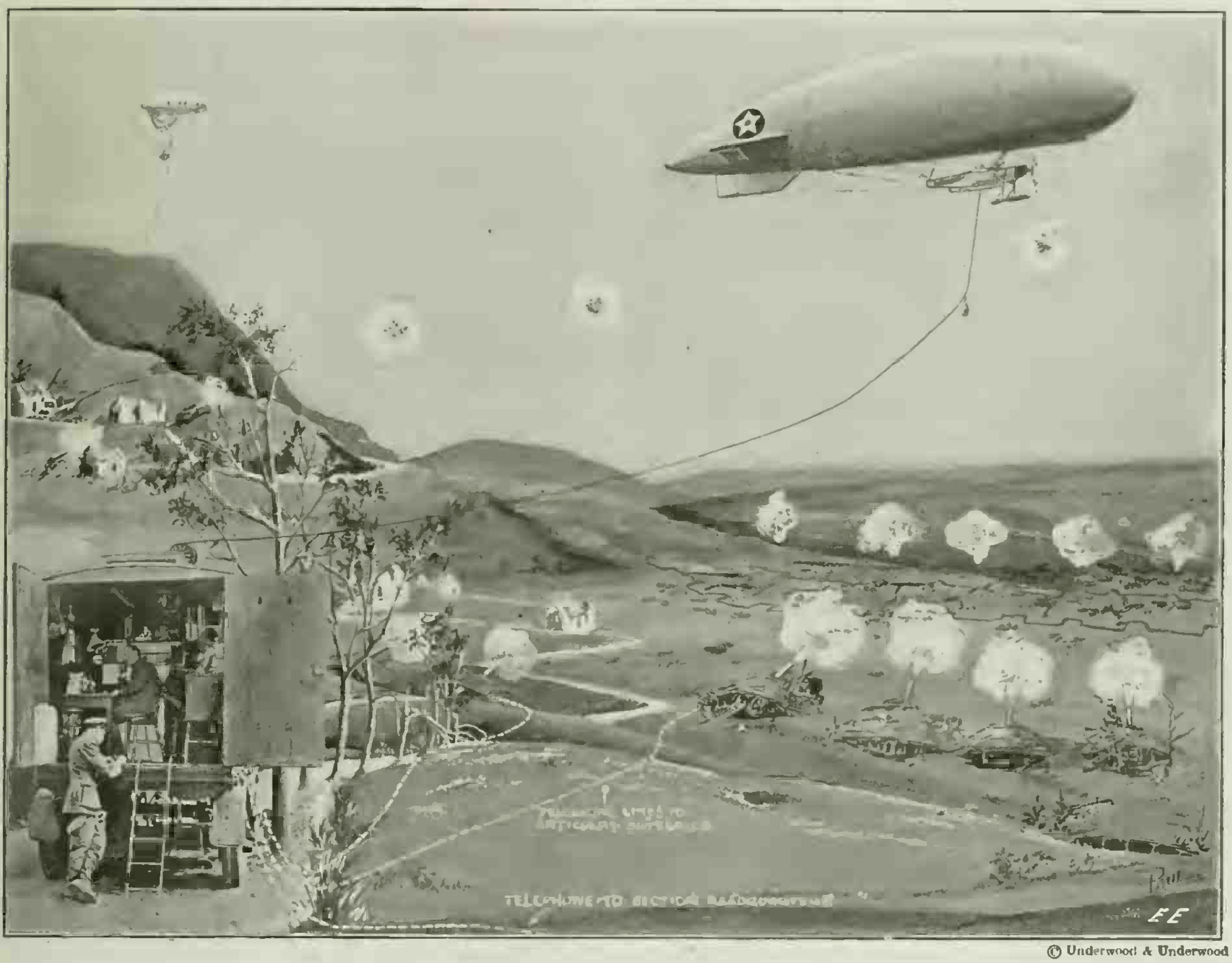
How "Blimps" and Telephone Aid Artillery

THE accompanying illustration shows a Telephone Exchange Lorry of the British Royal Air Force in communication with a dirigible balloon. Many of these balloons are used for observation purposes and the observer has to be ready for almost any emergency, as he is in constant danger of being attacked by enemy shell fire or aircraft. Should the observer be attacked he descends by means of a parachute. The observer is connected to this Lorry by telephone by which he can communicate with headquarters.

The balloons used for the purpose are of several types, some being of the simple gas-filled "blimp" variety, held by a steel cable from the upper end of which they swing about in the breeze, while others are of the dirigible gas-filled design here illustrated. The dirigible carries a gasoline engine power plant and propeller at the front of the nacelle or crew's basket, by which means it can move about in the air and maintain any desired position in a considerable wind. The dirigible balloon does not have to depend on an anchoring cable and winch to pull it down, but can ascend and descend by its own power, suitable rudders and planes being fitted to it for the purpose.

The majority of the balloons used for army observation purposes are plain blimps, anchored by a steel cable to a quick-acting drum or winch on the ground. It is interesting to note that these balloons are often filled with gas (hydrogen) made by electrolytic cells. The U. S. Army balloon school at Ft. Omaha, Neb., has one of the largest electrolytic gas generating plants existant. These generators have a series of large cells fitted with oppositely charged plates which are immersed in water. The passage of the electric current thru the water decomposes it into its constituents—hydrogen and oxygen gas (H_2O). The hydrogen gas is led off thru suitable passageways and pipes and fed into the balloons in their "beds." There are fifteen balloons now in use at Ft. Omaha.

This balloon instruction camp, one of the most efficient and best equipt, has recently installed besides the electrolytic gas generator, the first *silicon* plant in this country. In this new form of balloon gas plant hydrogen is made from caustic soda and ferro silicon. As many as twenty-two steel bottles, each with a capacity of 2,000 cubic feet, under compression of 200 pounds to the square inch, are filled in a single day. In actual war service on the battle-fields of Europe, powerful motor lorries, each loaded with several dozen of these gas bottles are dispatched to the various balloon depots as required. Sometimes the bottles of several trucks are all connected up to a common pipe leading to the balloon "beds."



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What Would the Artillery Officers Do Without the Scout 'Planes and "Blimps?" They Would Be Lost, for the Observers Who Fly About Midst Bursting Shrapnel Are the Men Who "Spot" and Telephone the Exact Ranges and "Shell Hits" to the Artillerists Below. A Dirigible "Blimp" Is Seen in the Foreground in the Act of Ascending. The Telephone Exchange Lorry Is One Belonging to the British Royal Air Force. The U. S. Army Is Training Many Students for Balloon and "Blimp" Observation Work.

To be a balloon observation officer is a real distinction, for besides being fully at the mercy of enemy aeroplanes, who may pump him full of bullets before he can down the attacker with his rifle or Hotchkiss gun, he must be an accomplished map reader and map draftsman—not to mention the knowledge of spotting shell hits instantly, radio operating, telephony and telegraphy, balloon rigging and maneuvers, weather forecasting, et cetera. When the balloonist leaves the U. S. Army school he must know all these things and many more, and be able to note and record shell hits at a distance of four miles.

An electrically operated vacuum cleaner for the teeth has been patented. Let's introduce them to our after dinner speakers!

The Artillery "Barrage"—How It Works

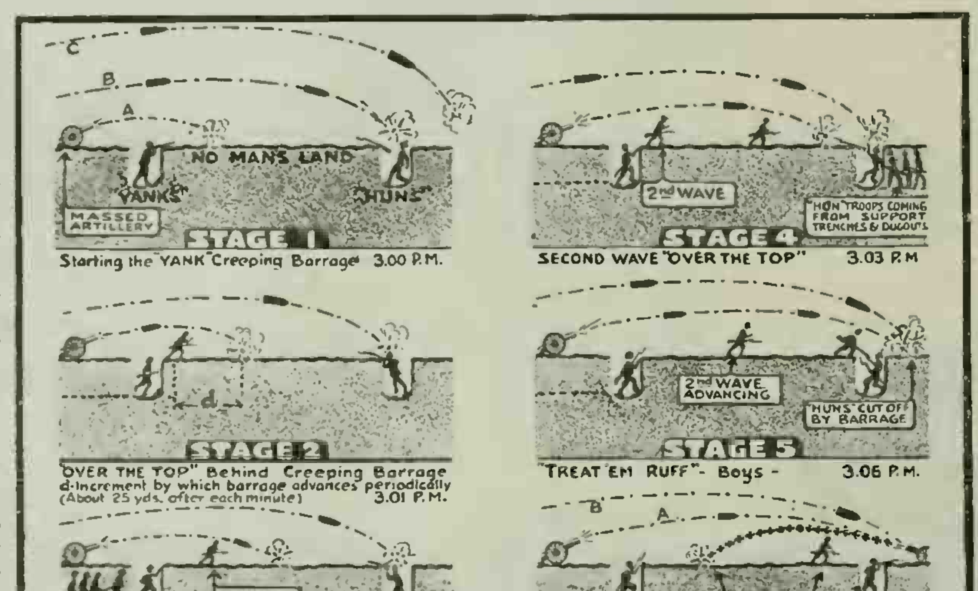
By H. WINFIELD SECOR

THE "barrage" fire as now practised by Allied and Teutonic artillerists represents one of the greatest advances of military science conceivable, for in order to achieve success in using the barrage, and in order not to kill many of your own men, hundreds of guns have to be fired simultaneously to the fraction of a second. Furthermore, all of these guns—in some cases as many as five hundred to one thousand cannon—are required to increase their range periodically so as to keep it just a certain distance ahead of the advancing troops. Telephony, radio, meteorology, ballistics and range finding, besides many other highly perfected ramifications of modern science figure in the barrage.

No one outstanding feature of the great war now raging across the sea has so imprest men of science as well as the lay student of military and naval affairs, as the wonderful advance in military fire, known technically as the "barrage" (pronounced bär - räg, with "g" pronounced as "zh" or having the sound of "raj" in rajah). Many accounts have been given from time to time by our war correspondents and other writers in the daily and periodical press, mentioning the wonders achieved by the Allied artillery officers with their modern and highly perfected barrage fire, by means of which it has become possible to carry out an offensive movement with infantry, even when an enemy trench, or series of trenches, is particularly well constructed and heavily manned. The importance of the barrage or "curtain of fire" will be the more strongly appreciated in relation to infantry maneuvers, when we consider that the trench lines have often lain dormant for months, during which time the enemy has usually succeeded in constructing an almost inconceivably strong breastworks with concrete-lined trench walls and machine gun emplacements, all of these connecting with elaborate underground galleries and dug-outs, some of which have been found to be capable of holding two regiments of soldiers and sustaining ordinary gun fire for days.

By means of the artillery barrage as it is usually employed, three major operations are carried out in a short space of time, once the hundreds of guns have been lined up almost hub to hub for the purpose, and these are as follows:—*First*, either a portion or all of the guns start firing on the second in a "searching barrage" extending over a considerable stretch of the enemy's ground behind his trenches for the purpose of cutting off his communications, preventing the bringing up of supplies, and reinforcements of troops. *Secondly*, and meanwhile some of the guns keep up a "standing barrage" on the enemy first and second line trenches. It is interesting to note that the watches used by the infantry officers in the Allied trenches, as well as those used by the artillery officers, are of the split-second type, because when the troops are to advance behind a barrage, *perfect coördination* must exist between the artillery and the infantry—in order that when the troops advance, the curtain of exploding shell* shall advance at a certain prearranged distance ahead of the wave or waves of infantry.

The "searching barrage" is set up several hours before the time that the infantry is ordered to advance, and it thoroly combs the enemy trenches, filling the landscape for several miles with shell holes and craters, and smashing his wagon and auto supply trains, not to mention the pulverizing of his once inhabitable front-line and support trenches. This veritable holocaust of exploding shrapnel and gas shell raises extreme havoc with the enemy morale, not to mention his casualties and the destruction of enemy gun positions and ammunition dumps.

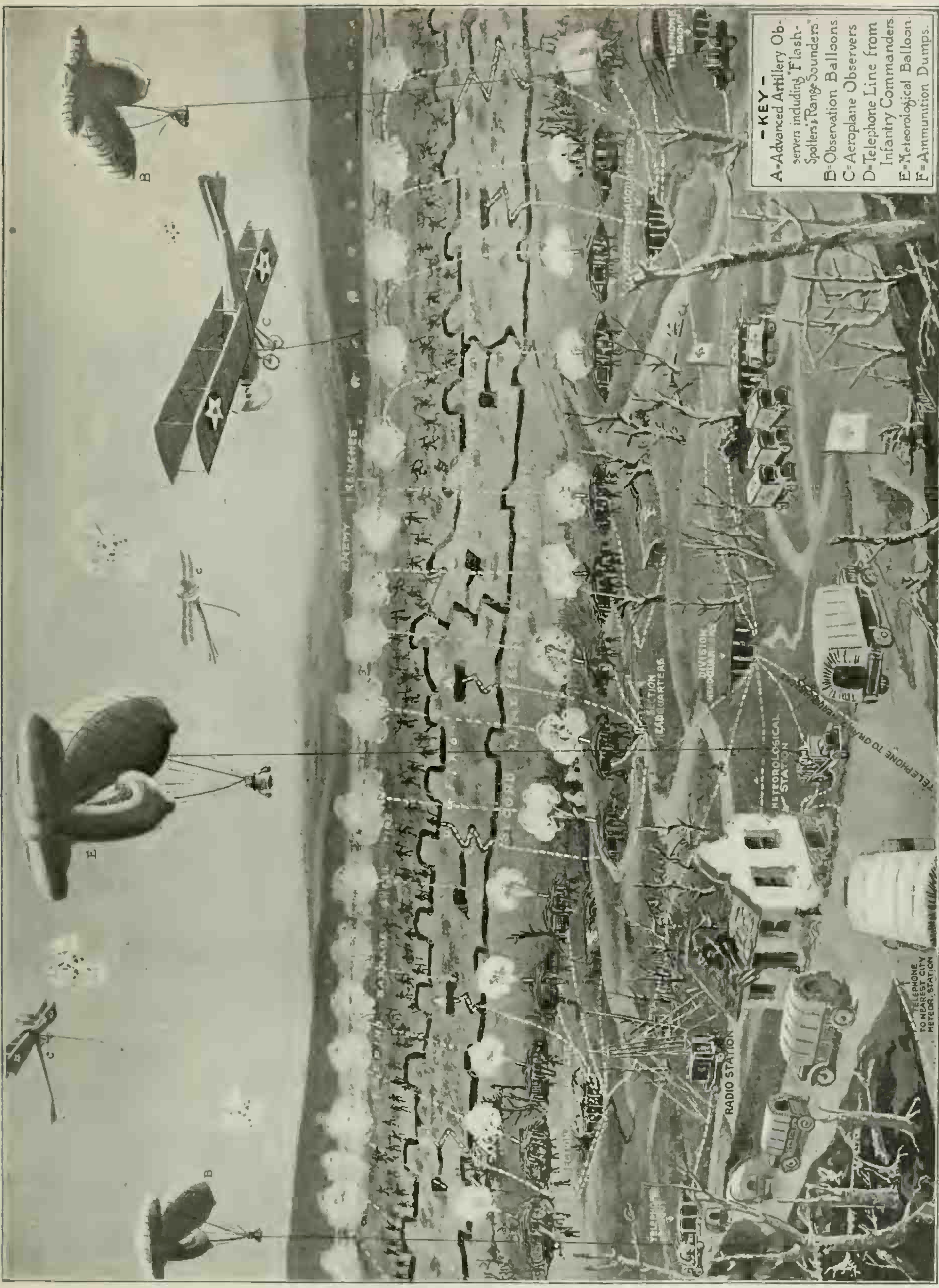


Thus far we have the preliminary "searching barrage" and the "standing barrage", which latter is kept playing on the enemy front-line trenches. We then come to the critical moment when the troops are to go "over the top", and this exact time is, of course, well known beforehand by all of the artillery and infantry officers concerned. Part of the artillery barrage batteries, just prior to the moment when the infantry is scheduled to go "over the top", is ordered to start the *third* operation or the "creeping barrage", behind which the "doughboys" are to advance and storm the enemy trenches. The accompanying diagram of a creeping barrage *time-table* shows how wonderful this operation actually is, especially when one stops to consider the several dozen different and highly diversified factors which enter into the firing of even a three-inch field gun. For who would believe that one could tell to a hair as to just what pressure a certain charge of explosive in a cannon barrel will create, and how far it will throw the projectile! Then again we have such scientific problems as the wind velocity, the humidity of the air, gun erosion or pitting due to wear, etc.

Reverting once more to the action of the "creeping barrage", and the troops' advance on the enemy trenches, we learn that the creeping curtain of shell-fire starts about twenty-five yards in front of the Allied trenches. In one minute the bar-

(*Continued on page* 431)

*The plural is shell, not shells.



A Comprehensive Panorama of a Section of the Western Battle-front When the "Doughboys" Make an Advance Behind a "Creeping Barrage" or Curtain of Shell-fire. For Hours Previous the "Searching Barrage" Has Combed the Enemy Trenches and Supports to a Depth of Several Miles. It Has Taken Days and Weeks to Prepare the "Barrage"—But It Is Worth It.

Movie Tricks Exposed

By W. EDOUARD HAEUSSLER

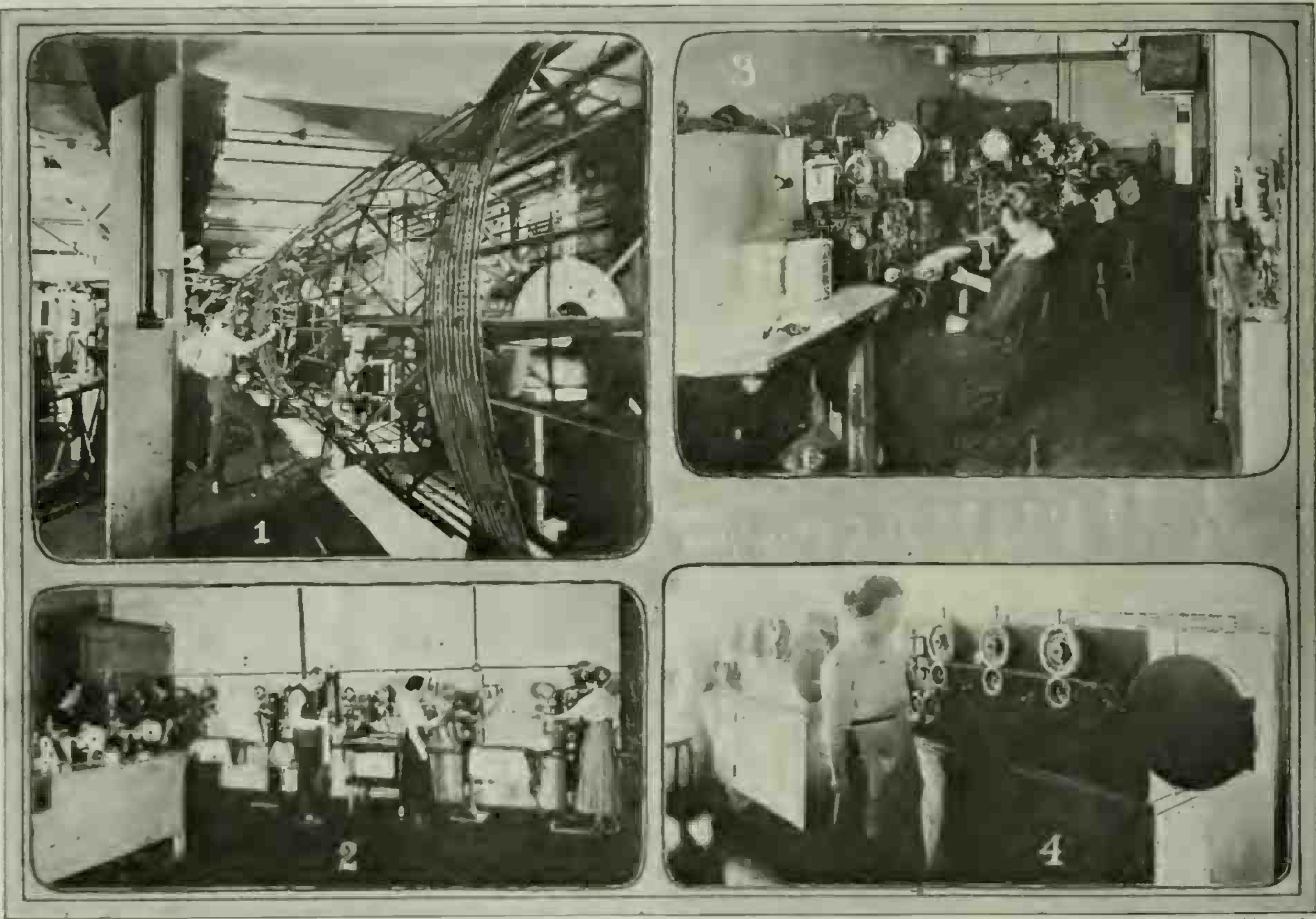
HOW often has it annoyed you, while lounging comfortably in your favorite motion picture theater, endeavoring to enjoy the latest photo-plays to be seated behind the pest who claimed to be on speaking terms with Francis X. Cushman and Mary Fordpick and who was forever "explaining" to his friends beside him how all of the mysteries and illusions of the movies were made and worked out in the studios.

Did you ever stop to reason how they make an automobile race toward you and at the psychological moment when the auto appears to come crashing into the camera, it stops and suddenly races away, *running backwards*. Friend Pest comes to the rescue by remarking that it is accomplisht by running the film backwards thru the projector. That was once the writer's impression until he learned that this backward motion effect was executed by reversing the "take up" belts in the camera employed in taking the picture. It can also be produced by placing the unexposed film in the upper magazine, if the camera is of the underfed type or vice versa in the overfed models. In both instances, however, the automobile actually moves toward the camera in a forward motion and is photographed in the usual way. The negative film in the camera that has been arranged to produce backward motion, registers this forward movement as *reverse motion*. This method is also employed to produce the illusion of a man jumping from the third-story window of a building to the sidewalk and then back again, without any mechanical means or hoisting apparatus.

The various films showing an enormous speed of action are of the "Speedex" class. This novelty was first released to the public in a series of screen travelogues by Burton Holmes. In one of the films showing a steamship passing thru several canal locks, the time for the actual operation of which is figured in *hours*, is very rapidly portrayed on the screen in the course of a few *minutes*. This method also enables one to see the action of very slow and hardly perceptible motions, extending over a long period of time. In this particular type of subject, the moving of a five-story house can be cited. A freak film can be obtained by camera and one is not surprised to see a ship racing thru the water at an unbelievable rate of speed. This unique process is accomplisht by taking the pictures at a reduced rate of speed, that is, less than 16 frames per second; and at successive intervals in the case of a subject, the completion of which may be a matter of weeks. When these films are projected on the screen at the normal rate of speed, they appear noticeably accelerated.

It is a peculiar fact that films photographed at a speed less than normal (16 pictures or frames per second) and projected at the normal speed show a very rapid motion. Likewise a film when exposed at a high rate of speed above normal attains a very slow action when projected.

The Ultra-cinematographic Film Camera is based on this latter principle. This type of film is exposed at the rate of 100 frames per second. When projected at normal speed, the photograph of an athlete jumping a hurdle is so slow in action, that every muscular movement can be analyzed and exceptional detailed action giving the entire hurdle jump a floating appearance as tho the athlete actually had a pair of wings.



Photos Courtesy Vitagraph

Fig. 1—The Film Drying Room. Here the Films, After Development, Are Whirled on Large Drums Until Thoroly Dried. Fig. 2—A Corner in a "Positive" Perforating Room. Fig. 3—Battery of Film "Printing" Machines. Fig. 4—The "Polishing" Machines Which Remove All Water Spots and Other Stains From the Film.

In Figure 5, is shown the chronological progression in the manufacture of a "movie" from the time that the camera first opens its shutter upon the scene until you are thrilled by the same scene at your favorite playhouse.

The second phase is the taking of ordinary photographs, termed "Stills". These photos are obtained during the taking of the scene at a signal from the director to *stand still*. The photo is then taken. In some instances after the scene has been filmed, the director calls for a reassemblage of some crucial tableau for a still picture. These "stills" are used for advertising purposes and are displayed in front of all Motion Picture theaters. A common belief

Fig. 5. The History of a "Movie" in One Reel. Movies Are Photographed at the Rate of 16 Pictures Per Second, Equal to One Foot of Film.

that one often hears exprest is to the effect that these advertising placards are made by enlarging the small ¾ x 1 inch frames. This is, of course, utterly impossible as a distinct and sharp outline could not be obtained were these small pictures to be enlarged to one of from four to five feet in size!

The developing of the exposed films is the third step of the process. After the films have been developed they are placed on large reels and whirled rapidly until thoroly, dry, as illustrated by Fig. 1. Black objects when photographed, appear as white on the master or negative film; white likewise appears as black. This condition is transposed in the fourth step, that of printing or the making of positive films.

Some firms procure the positive films is a non-perforated state and make use of the machine shown in Fig. 2.

These positive films are made by placing them upon the master film and exposing to a strong light. They are then fixt in a chemical bath so as to retain their images without fading.

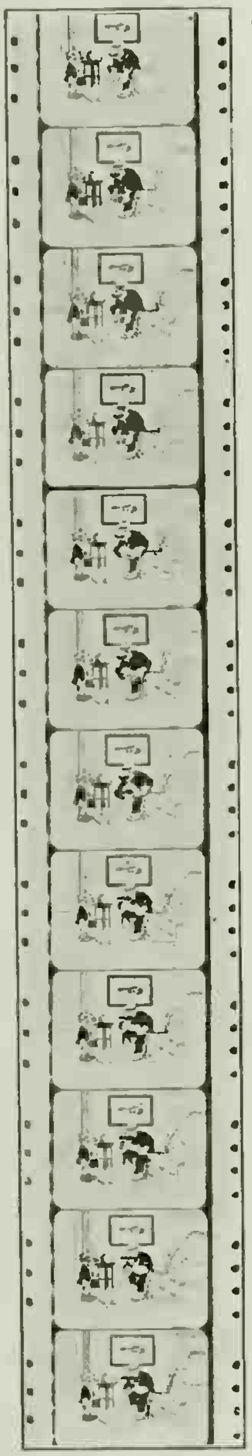


Fig. 6. A Strip of Animated Cartoons. These Are Cleverly and Rapidly Made From Actual Drawings Drawn by Artists. It Requires Several Weeks to Make a Reel of These "Phoney Films."

Figure 3 will give you an idea of the intricate and delicate machinery and instruments that are employed for this step.

After the films have been printed, these positives are run thru the polishing machine. This is an important operation, as it removes all surplus water, stains and dirt from the celluloid side of the film. A photograph of this machine is shown in Fig. 4.

Matching is the fifth and most tedious portion of film making. Under this heading all of the scenes are placed in proper sequence. This work is again checked up under the heading of Inspection. Here the film goes under the close scrutiny of a trained eye to pick out all mutilated sections, blurs, scratches and the operator cuts out faded, overexposed and blemished portions of the reel. The censor's review is the "anxious seat" of all films and if they are past upon, they are ready to be distributed to exchanges and to exhibitors thruout the various countries. The last phase is for you, Mr. and Mrs. Reader, to decide—that of the Audience, acting as a Board of Critics. For it is according to how you "take to" the film that determines its future success or failure. Film producers are attempting to please all manner of tastes and are succeeding remarkably well. This is proven beyond a doubt by the crowds that frequent the innumerable photo-play houses and theaters.

There is still another and most interesting part of the Cinematograph Industry known as *educational diagrams*. These diagrams are a series of visual lectures on the screen portrayed by animated drawings produced by the Bray Studios. Mr. J. R. Bray is the originator and creator of animated drawings and cartoons, a strip of which is shown in Fig. 6. His previous wonderful gift to the Motion Picture Followers of this distinct type of comedy has stood alone in its field. Its scope has been enlarged upon by Mr. Jacob F. Leventhal, an associate of Mr. Bray, by an ingenious adaptation of Mr. Bray's creation for scientific uses. It lends itself to an unlimited degree of adaptability in this work and has been most successfully applied. The most noteworthy use in the scientific field to which this class of motion picture film has been put, is to teach rapidly the art of warfare to "Our Boys" by this new method. The moving picture is being widely used in the training of American pilots in England. The young flying officers who are sent to the Armament School there to acquaint themselves with the use of airplane guns and gun gears find their three weeks' course a most interesting one, owing partly to the large share which the moving-picture machine plays in the instruction.

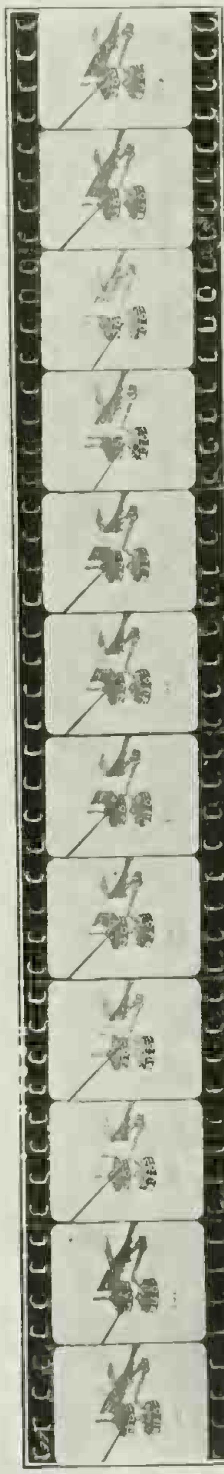


Fig. 8. This Is a Sample of the Films Being Used to Quickly Teach Our Soldiers and Sailors. They Show, Step by Step, the Action of Various Mechanisms, an "Adding Machine" in This Instance.

The pupil is not required to sit out a lengthy lecture read aloud from the notes of an instructor. Instead, the various branches of gunnery training, such as the stripping and assembling of guns and the various points to be observed before, during, and after flight, are demonstrated by films, accompanied by concise explanations by competent officers.

There are numerout and interesting tricks employed by the various producers to attain certain desired results. Take as an example a figure representing "Satan." He suddenly vanishes amid a cloud of smoke. This disappearing phenomena when portrayed on the screen is awe-inspiring and remarkably well executed. During the production of this scene the disappearance is (*Cont. on page* 408)

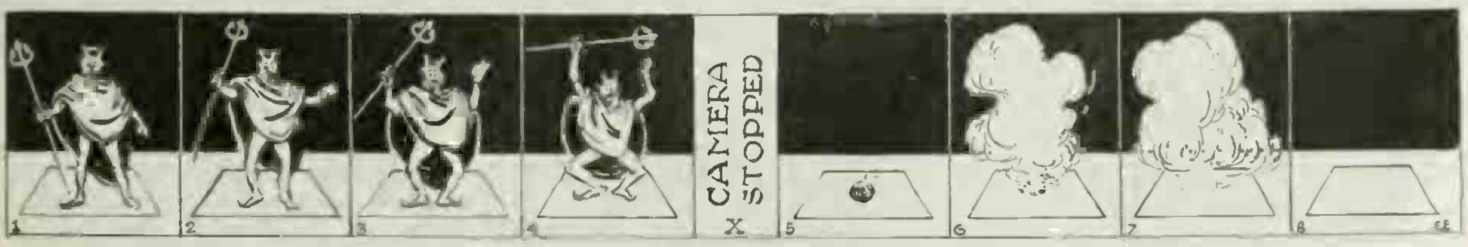


Fig. 7. This Strip Illustrates How "Magic" Film Stories Are Photographed. The Camera Is Stopt While the Figure Walks Off the Spot—the Bomb Is Lighted, the Camera Started Again, and Presto! You Wonder Where the Kaiser's Right-Hand Ally Went.

The Automatic Soldier

By H. GERNSBACK

As science advances, and as all sorts of infernal machines are thrown into a modern war, the men in the front line trenches become less and less anxious to bear the full brunt of high explosive shells, gas attacks, liquid fire and what not. No matter how courageous a body of soldiers, their morale is bound to deteriorate considerably under a murderous mustard gas attack, or under a modern barrage.

As has been so often demonstrated in this war, if the men in the first and second line trenches can be demoralized, the enemy as a rule can tear quite a gap into the lines, and make his assault in strength. If we could devise some sort of a soldier who was bomb and shell proof and who did not mind either liquid fire or the most vicious kind of gas, our front line trenches would be very much more secure than they are now. It would be difficult to storm such trenches.

This is exactly what a Danish engineer has had in mind when he recently obtained patents on a device which he terms an "Automatic Soldier." Trials recently made with a model automatic soldier are reported to have been eminently successful.

Our front cover as well as the accompanying illustration shows the device clearly. The automatic "soldier" briefly consists of a special double steel cylinder made of shell-proof Tungsten steel or the like. There is one outer, stationary cylinder and a second inner cylinder, the latter telescoping into the stationary one. The entire device is set into trenches as shown in our illustration, the contrivance taking the place of a human soldier. These automatons may be spaced from one to three yards apart, and the operation is as follows:

As already mentioned, there are two cylinders—one, the outer, in the form of a can, and the inner one, in can-shape, too, but with a dome at the top. The inner cylinder rises up and down vertically and normally the dome is level with the surrounding land. When the "soldier" goes into action, the inner cylinder rises eighteen inches, which brings it above the parapet of the trench. In other words, the automatic soldier normally is invisible, and only can be seen when the inner cylinder rises. The guns as well as the entire mechanism are entirely controlled by wireless, operated from five or more miles at a distance. If the commander wishes to open battle with his automatons—after the aerial observer has reported the approach of the enemy—he merely notifies his wireless control station, which immediately sends out impulses, and these in a well-known manner operate the automatic soldier.

The first impulse raises the inner cylinder above the trench. The second impulse pushes the machine guns thru the slots of the dome, while a third impulse may rotate the inner cylinder so as to direct the fire. The fourth impulse may set off the machine guns, each of which, according to its inventor, is able to fire four hundred rounds into any given direction.

Our front cover shows the disposition of the aerial wires which encircle the main steel cylinder.

It goes without saying that the fire of the machine gun can be stopt by radio by sending out the correct impulses at any desired moment. The aerial observer flying over the trench lines containing the automatic soldiers sends back his wireless reports so that the fire of the automatics can be directed where it does the most good. The action of the device is such that the instant the guns stop firing, the inner cylinder immediately sinks into the outer one, thus disappearing from view. It goes without saying that these automatons cannot only be used to pump bullets into the oncoming enemy, but they can be used as well for other purposes—such as to belch forth liquid fire or to let loose a gas attack as depicted in our cover illustration. Perhaps it would not be a bad idea to equip every sixth automatic soldier with a poison gas tank, all of which will certainly tend to stop the most gallant as well as vicious attack of the enemy.

While machines of this kind seem very cumbersome, and perhaps not efficient, because it may be argued that they cannot think, nevertheless they would often be very much more valuable than the average soldier. For one thing, the machine knows no morale—it never retreats. It is not much affected by rifle bullets, and only a direct shell hit during a barrage will put the automaton *hors de combat*.

The automatic soldier is not dependent upon the rear for victuals, as the only thing it eats is munitions with which it can be supplied at night by way of the trenches. It is not affected by shell shock nor mustard gas, and liquid fire has no effect upon it. It never surrenders and never turns traitor. In order to be overcome, the automatics must be destroyed one by one, possibly only by exploding large quantities of T.N.T. against its sides. As long as the ammunition lasts no soldier would care to approach it, as he would never know when the wireless would set it off, which would immediately bring the automaton into action, no doubt killing the attacker.

It is difficult to see how ordinary infantry could overcome these automatics if planted three or four lines deep. Each trench line would have to be won at tremendous odds, and there is not a soldier living who would stand up under the withering fire of such automatons who know no fear.

A device of this kind is, of course, not chimeric, but entirely within the realms of present day science, and we would be very much surprised, indeed, if the automatics would not make their appearance soon at strategical points along the front. Nor are they difficult or expensive in construction, each one of the automatons not necessarily costing more than five or six thousand dollars, which is but the price of a modern torpedo. The wireless apparatus does not take up much room, while the motors which drive the entire mechanism may be readily operated by a 24-volt storage battery placed at the bottom of the large cylinder. All the rest of the mechanism is readily worked by compress air which can be replenished easily at night after the automatics have gone into action during the day. This is the case also of ammunition, gas or chemicals for liquid fire, all of which can be replenished during the night time by men walking up to the machine thru lateral trenches.

Of course if there was no action during the day, there would be no need for replenishing anything.

It should also be understood that these automatics can be operated singly or in groups by means of electric cables buried into the trenches, if it is preferable to use this method instead of the not always so reliable wireless.

HISTORY OF THE RELAY WHEN "HUN" MET "YANK."

There is a curious fact connected with the history of the telegraph relay. It could not be patented in Germany, and therefore could not with safety be exposed. In 1848 two young Americans named Charles Robinson and Charles L. Chapin had gone there with Morse apparatus to try their fortunes in building lines. Wheatstone had a dial instrument in use on a short railroad line, but its action was feeble and unsatisfactory. Robinson and Chapin built a line of telegraph from Hamburg to Cuxhaven, a distance of ninety miles, by which to transmit marine news. The magnets, however, were carefully locked up in boxes, just as Alfred Vail did in Washington and Philadelphia. The line worked well. The registers clicked out loud and strong at either end. The German electricians scratched their heads and wondered. Finally, Steinheil was sent to make observations. He was a man of genius and culture and had a sort of telegraph at work in Europe before Morse in America. He looked carefully around, and his keen eyes soon saw the locked boxes. He asked to see their contents. But the view was courteously declined. So he turned and complained that the Yankees kept their secret locked, but that the action was magnificent. When, however, at a later date, he did finally know all, he gave Morse his hand, confest himself beaten, and the two were friends forever after.

HAS ANYBODY HERE SEEN S-P-E-R-R-Y??

Would you believe that "Sperry" was your good old friend the EXPERIMENTER in a new dress? Of course you wouldn't! But then you see it is like this: All is not gold that glitters and everything does not read as it sounds, hence we have EkSPERRYmenter! In other words, "SPERRY" is a new nickname for your good old friend "EXPERIMENTER". Now we admit that in our dull way of thinking, we never had an idea like it, and it had to come all the way from Malvern, which lies in sunny Australia, to put us wise to it. It also appears that the nickname for the "EXPERIMENTER" is "Sperry" in Australia. If you don't believe it, read the following:

Editor, ELECTRICAL EXPERIMENTER:

I have been reading the ELECTRICAL EXPERIMENTER now, for about two years, and I think it is absolutely the finest magazine on Electricity and Wireless. Long Life to *"Sperry"* as it is called out out here. I notice that it is going up in price (for Australia) with the next issue. Well, I'm sure I (and anybody else) don't mind paying double the price that it is going up to,

I am, sir,

Yours truly,
(Signed) S. ROBINSON,
87 Dandenong Road.
Malvern, Australia.

THE AUTOMATIC WIRELESS SOLDIER

The Latest Brilliantly Conceived and Patented Military Weapon is the Bullet-proof "Automatic Soldier." Loaded Up With Triple Machine Guns For Shooting Bullets, Liquid Fire and "Gas," and Finally—Controlled By Radio From a Bomb-proof Dugout—This Death-Dealing Invention Promises to Revolutionize Modern Warfare on Land.

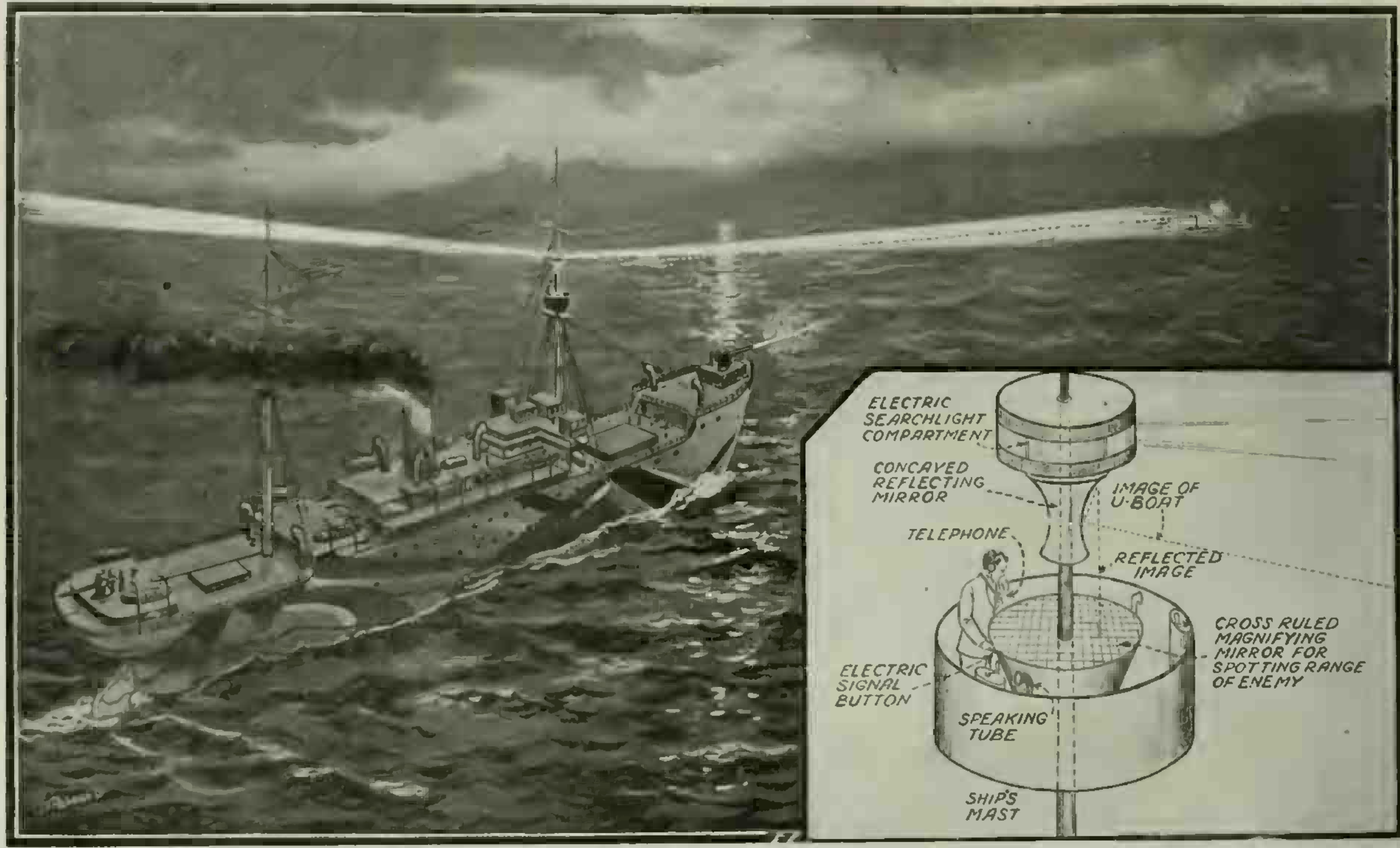
Locating Submarines by Reflection

DEVICES for locating or detecting the presence of submarines are in great demand nowadays, for once a war vessel or merchantman becomes apprised of the fact that he is face to face with a sub-sea fighter, the officer in charge will at once put himself on the *qui vive*. The gun crews can at once be summoned to quarters, and if the enemy is to be located at night, the searchlight can be caused to sweep the waters, and the vessel put over a *zig-zag* course, these precautions having saved many vessels from a disastrous finish as the press reports of such encounters have indicated in the past. Only recently there was a case where an English merchantman spotted the periscope of a submarine—in other words, he was at once apprised of the fact that he had to face two kinds of warfare, by torpedo and by gun fire. To show that it proved valuable for the skipper of this vessel to know what conditions he was up against, it can be said that the captain caused the vessel to pursue a zig-zag course, and shortly after starting this maneuver, the boat managed to just miss by a few yards a white-nosed German torpedo. Presently the submarine arose to the surface and started firing with her deck guns. The merchantman, however, had the best of the game, for being provided with guns both fore and aft, the U-boat was efficiently bombarded and after the twenty-sixth shot the sub-sea craft was rendered helpless, and according to the report of the merchantman's commander, the U-boat was undoubtedly sunk.

All of which leads us to the invention here presented which comprises an optical submarine detector invented by Edward S. Jones, of Mobile, Ala. In the words of the inventor, "This invention relates to improvements in a scientific instrument for locating submarines, floating mines, and other objects of menace to navigation, within a certain radius about the ship. It consists primarily of a series of reflectors, coöperatively so arranged as to show upon a magnifying mirror the surface of the sea and objects thereon within a given radius, so that it may be observed from the look-out cage at the top of the mast, as the illustration herewith depicts, thus enabling the proper officials on board the vessel to be instantly warned of any danger so as to defend the ship if armed, and to escape if unarmed."

As the drawing shows in detail, the look-out cage is fitted with speaking tubes as well as telephones for maintaining constant communication with the bridge and officers' quarters. In the form of the invention here illustrated, the reflecting mirror is concaved, and has its upper end broadened so as to reflect images on the surface of the water as indicated by the dotted lines on to the magnifying mirror, on which the officer looks. This magnifying mirror is preferably graduated by very fine lines running at right angles to each other, their purpose being to assist the observer in locating the distance the reflected image is from the ship. The farther away the submarine or mine happens to be, the smaller, of course, will its image appear on the magnifying mirror, and vice versa.

A powerful electric searchlight or series of searchlights are arranged above the optical locating device just described for use at night, and the searchlight compartment is arranged with suitable windows and shutters so that the one or more beams of light used can be swept over the water rapidly in any formation desired. The device is effective over 180 degrees of horizon.



Here's the Latest Anti-Submarine Invention. The Patentee of the Scheme Illustrated Proposes to Mount a Large Concaved Reflecting Mirror and a Magnifying Mirror at Some Elevated Point, as for Instance on the Mast of a Ship, and to Thus Pick Up by Reflection the Image of a U-Boat or Its Periscope. The Magnifying Mirror Is Ruled Off in Squares to Facilitate Measuring the U-Boat's Range and Direction.

GERMANS USING MEXICAN RADIO?

Activities of Germans or German-Americans from the United States across the Mexican Lower California border, where a wireless plant is located, are now under investigation by Government agents.

Reports indicate that for months groups of about fifty Germans, changing every week or ten days, have been found in Mexicali, a torrid little collection of baked shacks just across the border from Calexico, Cal.

The Germans, who were never known to visit the town before the war, now congregate at a store started recently by a German. This German is known to have been active in propaganda work in the United States before the war. The Germans have used the wireless station there, which is capable of communicating with Mexico City.

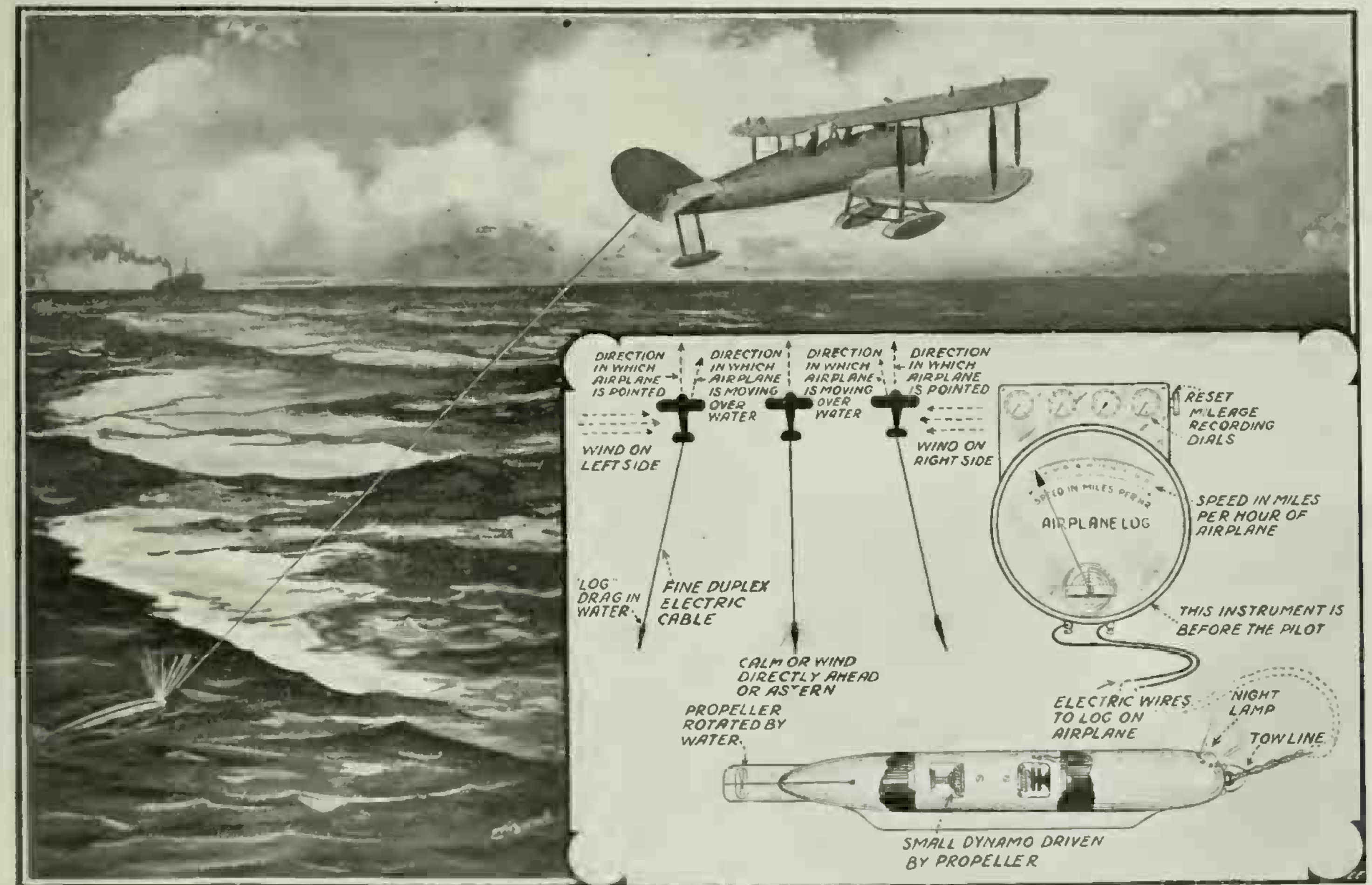
Government officials profess not to know how the Germans reached the town from the United States, since the railroad is carefully watched. It is suspected they crost the border at a number of points in sparsely settled communities.

An Electric Speed and Direction Indicator for Trans-Atlantic Planes

IT is easy enough to read of making a Trans-Atlantic aeroplane flight, but when it comes down to actually making such a trip, no one but an experienced aviator, or one who has studied the subject very closely, can imagine just what this means. In the first place, the layman thinks mostly in terms of horsepower and wing surface, and he argues: Given sufficient of these two quantities and a good pilot, there should be no trouble at all to fly across the Atlantic Ocean at its greatest breadth, of say three thousand miles or more. But he forgets one thing, and that is, that it is almost impossible for an aviator, no matter how experienced or well traveled he may be, to steer a course across such a vast expanse of water as the Atlantic Ocean, for he cannot check his route by any familiar or well-known land-marks; and even when using the latest scientific apparatus, such as the Sperry Synchronized Drift Set, which utilizes the wave movement or a succession of movements to warn the aviator how his machine is being drifted or forced sidewise from the desired and again—the wave crests might easily be very choppy, and have a more or less confused movement due to freakish air currents, and these would make it difficult indeed, if not impossible, for the pilot to accurately establish the true course of his flight in relation to the earth itself.

Therefore, inventors and aviators interested in such long flights as these have busied themselves with the devising of other schemes and methods which would make it possible in a Trans-Atlantic trip for the pilot to check up his course of flight with the greatest accuracy possible. What aviation engineers conceive to be one of the best solutions of this problem appears to be that recently suggested by Rear Admiral Bradley A. Fiske of New York. His proposition is illustrated herewith and involves the towing of a small floating body thru the water by an aeroplane. This plan kills three birds with one stone, for it, among other things, enables the distance covered in miles or kilometers to be recorded in the same manner as a ship's mechanical log; tallies the mileage covered of his proposition specifies that for long flights over water, an aeroplane should be made to steer as straight a course as possible, not only laterally, but also vertically. Thus we come to what we may call the "aeroplane log."

This is illustrated in detail, as also in actual use by an aeroplane in flight, in the accompanying illustration. Among other things, as Admiral Fiske has pointed out, the most important information that the aërial pilot needs to know, is not only the length of the flight, but the *direction of flight*, and this latter all-important quantity can be easily found by simply towing or hauling thru the water a small torpedo-shaped object such as the "aeroplane log" here illustrated. This log would measure about one foot in length and has a diameter of about one inch, and is secured to one end of a long light steel wire—such as piano wire. Before going further it is well to point out at this juncture, that it is perfectly feasible to utilize an "electric log" for this purpose, and not necessarily a purely mechanical log, as seems to be



The Crossing of the Atlantic Ocean by Aeroplane Is Not Such a Simple Task as it May Seem, Even for an Experienced Pilot. This Is so Because, Until the Invention of the "Aeroplane Log" by Admiral Fiske, There Was No Way of Establishing the "Direction of Flight." This Device Here Illustrated in Actual Use and in Detail, Not Only Shows the Direction of Flight but Integrates the Mileage Flown by the 'Plane.

course, he would be at a loss to utilize such an instrument whenever the visibility happened to be low, and particularly when low-flying clouds or mists were encountered, which would cut off his view of the underlying water. The same problem would confront him during night flying, especially when the moon happened to be obscured. each day, and also it provides physical contact with the earth, and supplies a visible index of the exact influence of air currents in forcing the aeroplane laterally from its intended compass course, besides indicating the speed in miles per hour. By Admiral Fiske's plan, the aeroplane would fly about 100 feet above the water. The first part the idea held by most of the aeronautical engineers who have discust this idea in the technical press. As has been pointed out in several of the discussions concerning this method of indicating the direction of flight of an aeroplane and the mileage covered, there is the objection, altho slight,

(*Continued on page 413*)

Searchlights Mounted on Anti-Aircraft Cannon

The electric searchlight has been advantageously combined with many different forms of war machinery in the past few years of the great international cataclysm across the sea, but possibly one of the most unusual adaptations of the electric searchlight is that shown herewith, which illustrates how the English cannon employed for the defense of London against enemy aircraft, was fitted with a small searchlight in order to increase the rapidity and accuracy of fire. The anti-aircraft gun is mounted on a tall building or promontory, or else on a high powered motor truck so as to speed rapidly from place to place. Such a combination spells deadly accuracy of fire, as anyone who has experimented with the electric flashlight pistol will have found, for when the searchlight or flashlight beam was centered on the target, and the shell or bullet dispatched, it struck the center of the spot of light on the target; in the present case, it would strike in the center of the beam from the searchlight. It can readily be imagined with what rapidity the gunners can "spot" an enemy aeroplane or dirigible and bring it down.

English Anti-Aircraft Guns Used In the Aerial Defense of London Have Been Fitted With Searchlights to Increase the Accuracy and Rapidity of Fire, This Unit Being Mounted on a Motor Truck.

McADOO WOULD ELECTRIFY ALL RAILROADS.

Director-General of Railroads McAdoo said recently on his return from a trip that his observation of the vast resources of water power during the two months he had been absent from Washington since the close of the last bond campaign, had impress him with the idea of electrifying the railroads of the United States. If the Government were to continue the administration of the railroads of the country for any prolonged period, he said, he would be in favor of resorting to the use of electricity just as far as it could be practically employed.

Director-General McAdoo said that for the present nothing could be done toward substituting water-power for coal-produced steam, but it might come as a plain matter of necessity while this war was on. It would first be desirable to keep up the volume of manufacturing power and then it would be required to relieve terminal needs. Ultimately electricity would be principally employed first of all in simplifying terminal problems.

The fact that the topography of the country was relieved by its many mountain ranges, all abounding in streams that would provide power, was a guaranty of the practical distribution of current in the sections that were now forging rapidly forward in manufacturing importance.

Some of the virgin ground of manufacturing development, such as the South along the Atlantic seaboard, especially invited the consideration of this plan to relieve the country from the thralldom of coal mining and shipment, according to Mr. McAdoo. He held that even if there were no such great necessity to conserve our coal supply, the fact that transportation limits the available power of our coal would of itself justify transforming many of our railroads to electrical systems.

The Secretary suggested that probably electrification would be actually undertaken while the Government had control of the railroads, and that the problem would be attacked at the most favorable points in the country where the static value of water was most obvious and the cost of making the change from steam to electricity would be comparatively slight.

U-BOAT IN SPANISH PORT DIRECTS RAIDS BY RADIO.

Investigation has disclosed that the German submarine U-56, which recently arrived at Santander, Spain, under its own power, had been in communication with other U-boats at sea.

Commander Reisser of the U-boat, repeatedly was seen signaling toward the sea, while the Spanish government intercepted wireless messages from the U-56 after a French steamer was sunk and its crew killed by a submarine.

It is quite obvious that the U-56 was sent to Santander to organize the destruction of Allied and Spanish shipping from a favorable spot, it is believed.

FRENCH VIEW OF ELECTRICITY IN MODERN WAR.

The important part played by electricity in the modern war game is set forth in an entire number recently given over to the subject by the leading French magazine, *Je Sais Tout*. Trench warfare has imposed the use of the telephone for the transmission of orders, for reports and for communications of all kinds. In order, however, that it should be the ideal agent of communication, there are certain features attending the use of electricity in this connection not necessary in times of peace.

Communication must be secret, and the wires must be placed so that they cannot be destroyed by shot or shell. In the first days of the war the Boches quite successfully tapt the French wires. Their listening posts were discovered, and the telephone officer attached to each regiment has so disposed of wires and currents that secrecy is now assured.

A means of making use of the electric magnet under water has been devised in Japan, and it promises to be of great assistance in locating sunken vessels, to recover which salvage operations on a big scale are expected after the war.

ARC-WELDING SAVES MONEY.

Arc-welding by electricity has been brought prominently before the public thro the fact that it was used to restore the broken engine castings of the interned German steamships. When breaking these castings the much learned (?) and foxy Germans thought they could not be repaired, and that it would require a year or more to replace them. However, even before the ships could be otherwise overhauled and made ready for transport service the broken castings had all been repaired and were good as new. This achievement has imprest the value of arc-welding upon the minds of many shop managers, and in many plants castings and other parts of apparatus which in the past would have been scrapped as hopelessly damaged, are now perfectly restored by the arc-welding process at small cost and great saving of time.

Welding High-Speed Steel Tips on Tool Shanks of Ordinary Steel by the Arc Method.

One large manufacturer, working on munitions, has installed an arc-welding equipment for the sole purpose of making tools for turning shells.

Ordinarily these tools are made from high speed steel and cost about $12.00 each. This manufacturer uses high-speed steel for the tip of the tool only, welding it to a shank of carbon- or machine-steel, and in this manner the tools are produced at a cost of $2.00 to $4.00. For some time this plant has been turning out 240 welded tools per day, the men working in shifts of four, which is the capacity of the outfit illustrated.—*Photo courtesy Westinghouse Electric Co.*

Why Not Electricity from the Ocean?

WHILE all of the vast resources of the country are being combed and recombed by the various experts connected with the National Government in order to produce the greatest output of war materials at the most economical cost, and also to conserve the great resources of the nation to the highest possible degree, a stupendous amount of power is daily and hourly going to waste, viz., that hydro-electric power which is not being developed as yet.

The rivers, lakes and waterfalls of the country represent a source of energy sufficient to care for a large proportion of all the needs required for our industrial and social life, if they could be harnest and applied to our requirements in an efficient manner; some of these waterpower developments, however, would prove uneconomical owing to the high initial cost in harnessing them to our needs.

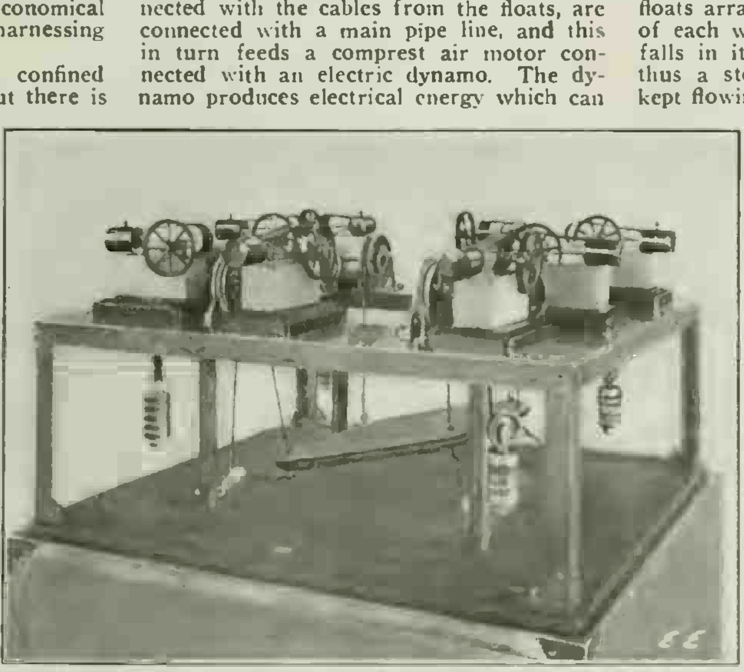
Waterpower is not, however, confined to rivers, lakes and waterfalls, but there is constantly millions of horsepower going to waste in the action of the *ocean waves* along our sea-coasts of which we have several thousand miles on the Atlantic and Pacific seaboards. With the idea in mind of utilizing the gigantic power inherent in this constant wave motion which perpetually rolls up on our beaches day after day, year in and year out, a Yankee inventor, Mr. E. T. Stodder of New Rochelle, N. Y., has given a large amount of his time to the study of *wave motors* and devices intended to turn to industrial uses the great power which they possess. His invention is shown in the illustrations herewith.

The larger view shows how Mr. Stodder's *wave motor* would be installed in a manner which much resembles one of the large steel piers to be found at any of our seashore resorts. The basic idea of this wave motor involves the utilization of the powerful lifting force exerted by the waves as they rise and fall, and to this end the inventor proposes the used of large steel float members, each float in a commercial sized machine to measure about eighty feet square, thus giving an area on which the wave can exert a lifting action, of 6,400 square feet, while a number of these floats can be placed along the pier as our illustration shows. At each end of these steel float members, which are airtight of course, there are two steel cables which lead upward to specially devised air compressors, so that no matter in which direction the float rises or falls, efficient work is performed by each and every movement of the float.

The Latest Idea in Wave Motors—It Comprises an Extended Series of Buoyant Tanks or "Floats." Each Float Rising and Falling with the Waves and Serving to Compress Air. The Compress Air Drives a Pneumatic Motor Connected to a Dynamo, Thus Producing Free Electricity From the Ocean Waves.

All of the compress air generators connected with the cables from the floats, are connected with a main pipe line, and this in turn feeds a compress air motor connected with an electric dynamo. The dynamo produces electrical energy which can be fed into storage batteries, and also to the wires supplying electric lights, etc. The smaller illustration shows a perfect model of this unique wave power plant built by Mr. Stodder, and in which the float member is shown suspended by the upper and lower end cables aforementioned, each cable being connected by suitable pulleys and balance weights to its own air compressor; which in this case was a small steam engine. As becomes evident, the inventor has used eight of these engines, and the model demonstrates very effectively the correctness of his theory and ideas along this line.

There are several very good features as disclosed by Mr. Stodder, and among others we find the following: By extending the pier out into the ocean, as the illustration shows, and by having a successive series of floats arranged along the pier, use is made of each wave as it progressively rises and falls in its motion toward the shore, and thus a steady stream of compress air is kept flowing thru the pipe line to the pneumatic motors and dynamos. Owing to the fact that while one float may be all the way down or part of the way up, another one may be two-thirds the way up to the limit of its motion, etc. By looking at the various positions of the successive floats in the illustration, this feature will be more clearly understood. The invention seems to be better in this respect than those designed to be installed in any one spot, and which are intended to absorb the energy from the waves as they pass that spot. In such a case it is evident that as the wave recedes from the side of the wave motor, then practically no power is given to the floats or other devices which may have been provided. Also, in one wave power turbine devised for the purpose, the receding waves could not clear the blades efficiently.



Model of New Wave Motor Built by Its Inventor, and Demonstrating How Each "Float" Operates Alternately Eight Air Compressors, Thus Utilizing Effectively Every Motion of the "Float."

(*Continued on page* 413)

This Car Carries a Complete "Power House"

What is believed to be the most powerful self-propelled car yet built in the United States has been placed in service on the lines of the Nashville, Chattanooga & St. Louis Railroad.

The Latest Type of Gas-Electric Car. It Is Driven by Electric Motors Which Derive Their Power from an Oil Engine Driven Dynamo. A Storage Battery Floats On the Electric System to Care for Extra Demands On Ascending Grades, Etc. No Trolley Is Required as the Power Plant Is Self-Contained. Electric Drive Is Used to Maintain Even Engine Speed and Great Flexibility of Drive.

Built by a New York locomotive concern, it has a 150-horsepower oil engine of the standard four-cycle eight cylinder marine type direct connected to a 100 K. W. differential compound wound 250-volt direct-current generator running at a constant speed of 1,000 r.p.m.

A storage battery having a rated capacity of 438 ampere hours at a five-hour rate is also installed, the combination of generator and storage battery providing ample reserve power for peak loads. The car is propelled by electric motors attached to the axles, thus providing the most flexible control possible. It is the same principle as that used in the new electric-drive warships, which have shown the quickest and most flexible control of any arrangement heretofore utilized. The engine burns either kerosene or fuel oil. The oil passes from the storage tank to a gas generator placed in the muffler of the exhaust. From the generator the gas passes directly to the cylinders of the engine, being mixed with air in the proportion of one part of gas to six of air.

The storage battery is suspended underneath the car body and operates in parallel with the generator, which is so constructed that the voltage automatically coincides with that of the battery. The generator will deliver current up to its capacity, while at the same time it works in unison with the storage battery which delivers any excess of current the load may require. The battery will deliver 400-horsepower for five minutes, 210-horsepower for fifteen minutes, 93-horsepower for one hour, and 30-horsepower for five hours. This power is in addition to the 150-horsepower developed by the generator, so that the car has an abundance of power for acceleration or while ascending heavy grades. With this arrangement the engine works at nearly full load at all times, and the efficiency is therefore a maximum. All the power required above the capacity of the engine is supplied by the battery, and all power generated by the engine and not required to drive the car is employed to charge the battery, which furnishes a convenient source of energy for starting the engine, lighting the car, operating the auxiliaries and in case of emergency driving the car itself.

According to an Italian scientist's figures, a square mile of the earth's surface in six hours of sunshine receives heat equivalent to the combustion of more than 2,600 tons of coal. And we scientific barbarians can't as yet harness 1/1,000 of one per cent. of it. Some day we may learn how.

ELECTRIC RIVETERS WORK RAPIDLY.

Electric riveting machines are now being used in the erection of the huge steel work. The machines hammer home the rivets in short order, and by their use some good speed is being made in the work.

An electric heater has been invented to prevent moisture collecting on an automobile wind shield.

MODERN ROTARY ELECTRIC BLUE-PRINTERS.

By Frank C. Perkins

The accompanying illustration shows a rapid, continuous electric blue-printing machine in operation in connection with an automatic washing and drying machine, as developed at Chicago, Ill., and showing the course of paper thru the machine.

It is pointed out that in these days of business activity every engineering department feels the necessity of having its own up-to-date blue-print plant. Today the blue-print is the expression of the finished work of the drafting-room and they are being used in an ever-increasing volume, especially by the Army and Navy Departments.

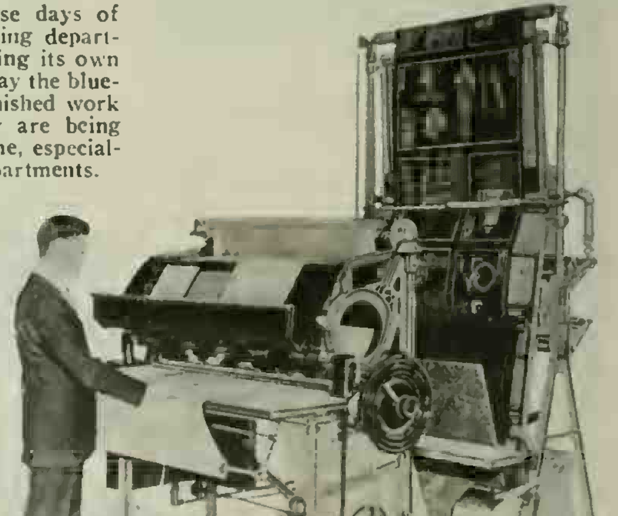
The photograph shows in operation a new blue-printing equipment, which is really three machines in one —printing, washing and drying by one continuous operation. No valuable space is taken up by open wash-trays and there are no wet floors and no lines of dripping prints. The equipment occupies only 5½ x 6½ feet of floor space, and is clean and noiseless.

There is only one operator required. He stands in front of the printer and places the tracings on the sensitized paper as it is passing thru the machine. Together the tracings and paper are carried up past a bank of powerful arc lamps, the tracings being returned automatically to the tray in front of the operator, while the exposed paper is carried back, passing first thru a bath of clear water, then thru a bath consisting of a weak solution of bichromat of potash or bichromat of soda, and lastly thru another clear-water wash, after which it passes up over the dryer and down into the rolling-up device at the back of the machine, where the finished prints are automatically wound up into a loose roll, perfectly free from wrinkles or distortions and ready for use. The entire process is accomplisht without waste.

It is claimed that these machines have a capacity of five to six linear feet per minute, or 100 to 120 yards (the equivalent of 150, 24 x 36-inch prints) per hour, which has been proven to be as fast as an operator can properly handle the average run of tracings and keep the paper covered. At this speed the greatest economy is effected; no light or paper is wasted, and the prints are thoroly washed and evenly dried. By this method blue-prints of the finest quality are produced on either paper or cloth.

It may be stated that the electric dryer is provided with a series of switches so that the heat can be regulated in accordance with the speed at which the printer is being run.

The arc lamps are especially rich in the actinic or violet ray necessary for blue-printing. Each lamp is independently connected in at the bottom, and is controlled by a knife switch mounted in a metal box of approved design, which is located at the left-hand end of the machine. It is only necessary to burn a sufficient number of lamps to cover the width of the paper being printed. Thus again no electricity is wasted. There is a fan for circulating the air mounted on the left-hand end of the printer, and obviates all danger of breakage of the contact glass.



A Remarkably Fast Electric Blue-Printing Machine. It Prints, Washes and Dries the Prints—All In One Continuous Operation. One of These Machines Has a Capacity of Five to Six Linear Feet of Finished Blue-Print Per Minute.

TREATING OLD MASTERS WITH X-RAY.

Interesting experiments have been conducted at Munich and Vienna in the examination of old portraits with Roentgen rays. One of the curators of the art museum used the X-rays on an old Madonna portrait and discovered evidence of a later overpainting. In Vienna, Prof. Max Dvorak applied the same test to a picture of the Mantegna School, which had been badly disfigured by later attempts at reconstruction. The X-ray photograph disclosed perfectly the original contour of the painting.

ELECTRIC ESCALATOR HANDLES RAILWAY STATION TRAFFIC.

Every railway terminal where the tracks are either elevated or deprest, or where passengers must be moved from level to level, will find the electric escalator or moving stairway of service.

The watchful and progressive railroad companies have spared no expense to make travel pleasant and comfortable, and now many of them are improving their terminal service by installing these escalators. The photo shows one of these interesting installations in the Pennsylvania Railroad Terminal in New York City.

During the morning hours the service is taxed practically to its capacity, about 11,000 people per hour. That the escalator is popular with the traveling public has been proved many times. Ninety-eight per cent of the people using this exit, travel on the escalator. The old-time stairway adjoining has been practically abandoned. No one will sap his strength or waste his energy in climbing stairs when he can ride, and many people will walk considerable distances to ride one or two stories on an escalator. The continuous stairway belt is driven by electric motors. They are so designed that the passengers clothes cannot be caught and furthermore when they reach either the upper or lower floor levels the peculiar shape of the step elements causes the feet to be pushed off on the floor without danger of catching.

Photo Courtesy Otis Elevator Co.

Electrically Operated Step Escalator, or Inclined Moving Stairway, For Transferring Passengers From Floor to Floor of a Store or Building, Which Eliminates Elevator Attendants. This Installation Is in the Pennsylvania Railroad Station, New York City.

TREATS ROENTGEN RAY ILLS WITH RADIUM.

The Journal of the American Medical Association publishes a paper by Dr. Robert Abbe on "Roentgen Ray Epithelions, curable by Radium, an Apparent Paradox," which was read at the last session of the association in San Francisco in which the surgeon after citing cases wherein were effected cures of Roentgen ray injuries, so common among those who work with the X-rays, says:

"I may say that no cases have presented themselves to me of chronic dermal Roentgen ray disease in the early stages of thick patches, cracked, ulcerated and painful, or of the epithelial growths of basil cell type on the back of the left hand of those who have in past years used that hand to test the tubes which have not yielded to radium therapy."

Dr. Abbe presented to a gathering of roentgenologists at the British Medical Association meeting two years ago the possibility of curing the disease in its early stage by radium, and most of the physicians were skeptical but he met one from Australia who had found in his own experience that the application of radium had kept his hands well. Dr. Abbe said that no efficient action of radium is beneficial in the advanced stage of epitheliomas, so far as he can yet see, but in the early stage of the disease, he said, the cure may be assured.

He treated his first case in 1903. The patient developed typical epithelioma of the back of the left hand, and one application of radium cured it. There has been no recurrence after twelve years. Ten cases of physicians whose hands, diseased by the Roentgen ray, were treated by him and all, he said, have shown the happy results of radium treatment.

"It seems almost a paradox of radiology," Dr. Abbe said, "that the accepted use of a heavy gamma radiation from a Roentgen tube will cause a diseased condition of the skin which a similar radiation from a tube of radium will cure. This becomes intelligible when we know that the output of the Roentgen ray tube is almost wholly composed of hard, penetrating, irritating gamma rays." This is indeed good news.

ELECTRIC AIR WARNING SIGNS USED IN ENGLAND.

In England the air warning signals are now supplemented by electric signs which flash out the unwelcome news as soon as

London and All the Larger English Cities Are Now Supplied With Electric "Air Raid" Warning Signs. As Soon As a "Boche" Aerial Attack Is Imminent the Signs Flash "Take Cover"—When the Raid is Over They Show "All Clear." Electric Bells and Sirens Give the Audible Signal.

the sirens start "booing." So as a measure of safety in Great Britain during the war, electric signs are now installed in all the large coastal cities to warn citizens against anticipated air raids. The signs are rectangular in shape, provided with clamps for mounting on lamp posts. They bear the wording "TAKE COVER—ALL CLEAR" with switching apparatus, so that the words "Take Cover" can be shown, and when the danger has past, the words "All Clear" can be illuminated.

RADIUM IN GOLF BALLS.

The use of radium in golf balls is explained in the following manner. It is not the radium itself, but the residue after the radium is extracted.

There is about 10 cents worth in the ball that is on the market now, which seems to be about the right proportion.

Uranium, which is the ore that radium is extracted from, is not expensive, but when it requires so many different processes to get the tiniest bit of the pure article, the cost amounts to a fabulous sum.

It is the heat in the radio-activity that warms the rubber and keeps the ball alive. Warm rubber will respond to the driver much quicker than if it were cold. Ouimet has used these balls with great success.

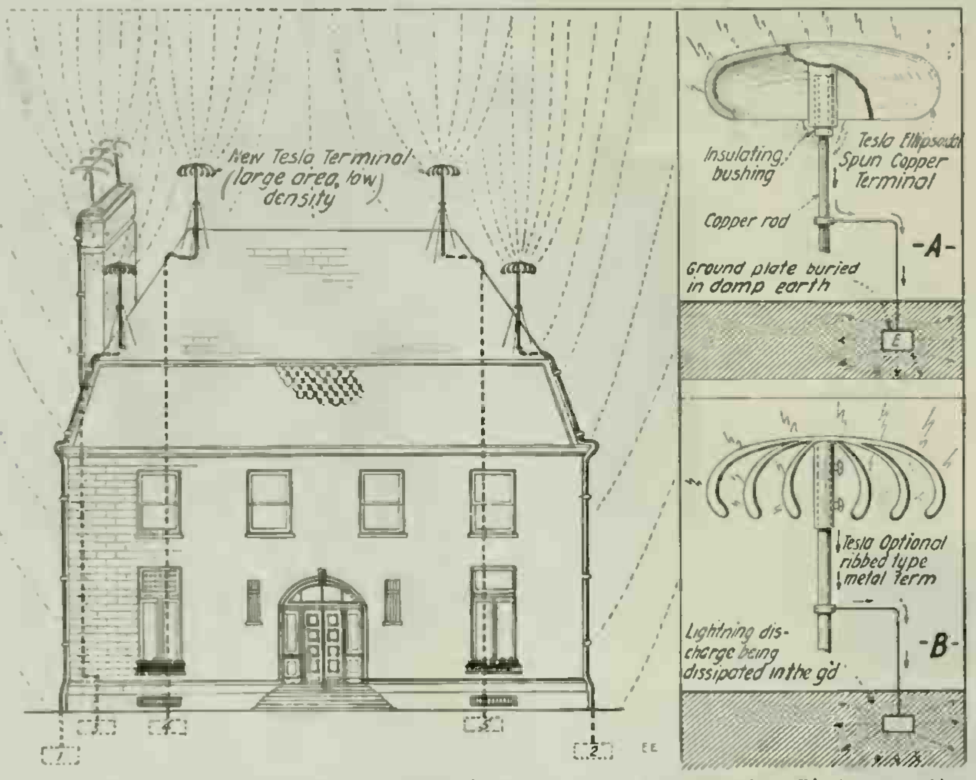
Tesla Has New Pointless Lightning Rod

SINCE the introduction of the lightning rod over one hundred years ago by Benjamin Franklin, its adoption as a means of protection against destructive atmospheric discharges such as lightning bolts, has been practically universal. In a recent discussion on the subject of lightning protection, Dr. Nikola Tesla of New York, brings out many interesting facts not generally known concerning the real efficacy of the ordinary lightning rod as installed on houses, barns and public buildings all over the world.

Says, Dr. Tesla, "The efficacy of the ordinary lightning rod is to a certain degree unquestionably establisht thru statistical records, but there is generally prevalent, nevertheless, a singular theoretical fallacy as to its operation, and its construction is radically defective in one feature, namely its typical pointed terminal." In his new form of lightning protecting rod and terminal here illustrated, Tesla avoids all such points on the metal parts facing skyward, and uses an entirely different form and arrangement of terminals.

In permitting leakage into the air, the needle-shaped lightning rod is popularly believed to perform two functions: one to drain the ground of its negative electricity, the other to neutralize the positive electricity of the clouds. To some degree it does both. But a systematic study of electrical disturbances in the earth has made it palpably evident that the action of Franklin's conductor, as commonly interpreted, is chiefly illusionary. Actual measurement proves the quantity of electricity escaping even from many points, to be entirely insignificant when compared with that induced within a considerable terrestrial area, and of no moment whatever in the process of dissipation. But it is true that the negatively charged air in the vicinity of the rod, rendered conductive thru the influence of the same, facilitates the passage of the bolt. Therefore it increases the probability of a lightning discharge in the vicinity. The fundamental facts underlying this type of lightning-rod are: First, it attracts lightning, so that it will be struck oftener than would be the building if it were not present; second, it renders harmless most, *but not all*, of the discharges which it receives; third, by rendering the air conductive, and for other reasons, it is sometimes the cause of damage to neighboring objects; and fourth, on the whole, its power of preventing injury predominates, more or less, over the hazards it invites.

By contrast, Tesla's new lightning protector is founded on principles diametrically opposite. Its terminal has a *large surface*. It secures a very *low density* and preserves the insulating qualities of the ambient medium, thereby minimizing leakage, and thus acting as a quasi-repellant to increase enormously the safety factor.



Nikola Tesla, Expert on High Frequency Currents, Such As Lightning Discharges, Has Recently Patented the New "Rounded" Form of Lightning Rod, Which He States is Superior to the Time-Honored "Pointed" Rods so Familiar to All of Us. Also, Dr. Tesla Has Good Reasons For This Radical Departure in Lightning Rod Design.

An understanding of but part of the truths relative to electrical discharges, and their misapplication due to the want of fuller appreciation has doubtless been responsible for the Franklin lightning rod taking its conventional *pointed form*, but theoretical considerations, and the important discoveries that have been made in the course of investigations with a Tesla wireless transmitter of great activity by which arcs of a volume and tension actually comparable to those occurring in nature were obtained, at once establish the fallacy of the hitherto prevailing notion on which the Franklin type of rod is based and show the distinctive novelty of this new lightning protector.

Practical estimates of the electrical quantities concerned in natural disturbances show, moreover, how absolutely impossible are the functions attributed to the pointed lightning conductor. A single cloud may contain several billion electric units, or more, inducing in the earth an equivalent amount, which a number of lightning rods *could not neutralize in many years*. Particularly to instance conditions that may have to be met, reference is made to an actual case (in 1904) wherein it appears that upon one occasion approximately 12,000 strokes occurred within two hours, all within a radius of less than 31 miles from the place of observation.

But altho the pointed lightning rod is quite ineffective in the one respect noted, it has the property of attracting lightning to a high degree,—first, on account of its shape and secondly, because it ionizes and renders conductive the surrounding air. This has been unquestionably establisht in long continued tests with the Tesla wireless transmitter above-mentioned, the inventor claims, and in this feature lies the chief disadvantage of the Franklin type of protector.

In Fig. A and Fig. B, different forms of such low density terminals and the arrangement of the same are illustrated. In Fig. A, there is a cast or spun metal shell of ellipsoidal outline, having on its under side a sleeve with a bushing of porcelain or other insulating material, adapted to be slipt tightly on a metal rod, which may be an ordinary lightning conductor. Fig. B shows another form of terminal made up of rounded or flat metal bars radiating from a central hub, which is supported directly on a metal rod and in electrical contact with the same. The special object of this type is to reduce the wind resistance, but it is essential that the bars have a *sufficient area to insure small electro-static density*, and also that they are close enough to make the aggregate capacity nearly equal to that of a continuous shell of the same outside dimensions. The general view of the building shows a cupola-shaped and earthed metal dome carried by a chimney, serving in this way the twofold practical purpose of hood and protector.

From the foregoing it will be clear that in all cases the new Tesla terminal prevents leakage of electricity and attendant ionization of the air. It is immaterial to this end whether it is insulated or not. Should it be struck the current will pass readily to the ground either directly or, as in Fig. A, thru a small air-gap between. But such an accident is rendered extremely improbable owing to the fact that there are everywhere points and projections on which the terrestrial charge attains a high density and where the air is ionized. Thus the action of the improved protector is equivalent to a repellant force. This being so, it is not necessary to support it at a great height, but the ground connection should be made with the usual care and the conductor leading to it must be of as small a self-induction and resistance as practicable. Tesla has taken out a patent on this new lightning protector.

ELECTRIC VEHICLES IN NORWAY.

Electric vehicles are now receiving considerable attention and encouragement in Norway for every form of mechanical propulsion. Heretofore gasoline cars have been practically the only machines in use in the country. For several months past no gasoline has been received, and as there are but few electric cars in Norway, automobiles have practically disappeared.

Are Aeroplane Parachutes Practical?

By W. EDOUARD HAEUSSLER

THE writer, who has been following aviation for the past few years, and who has had experience in actual flying, having owned an aeroplane, became interested in an editorial debate on the subject of "Airplane Parachutes," appearing in the New York *Times*, wherein Mr. Adrian Van Muffling, by profession a Chief Aero Engine Instructor at a New York Aeroplane School, gives utterance to such speeches as: "If an airplane comes down 'out of control' it is the duty as well as the natural tendency of the pilot to 'stick it out' and to do his uttermost to regain equilibrium. If he happens to be high enough the chances are in favor of his doing so before connection with the ground is made. By the time he realizes that it is too late for him to right his machine before crashing it will be too late for the parachute to open, provided he could possibly manage to jump clear of it into space."

Wherein he shows that his estimation of the value of an aviator, the cost of whose training aggregates some $10,000, is less than the value of the machine in which he is flying and further that if the machine comes down out of control it is the duty of the pilot to come down with it, and calmly "stick it out".

Were I to be granted the opportunity of seeing Mr. Muffling in a flying machine that was equipt with a "parachute," despite his weak reasons why this is impossible, I am most positive that he would use the parachute in the case of an accident and would not adhere to the duty of "sticking it out." The balance of his text explains in a large volume of words the idea that it is impossible to get out of the pilot's seat and fall clear of the dropping plane, by the use of a parachute.

The diagram shown in the semi-circular illustration below will give the reader a clear idea of the various positions in which the machine may fall while out of control, and that in these positions the parachute will operate with sufficient certainty that a great percentage of the fatalities up to date could have been prevented.

WATCH FOR THE NOVEMBER "E. E."

Do Aeroplanes Mind Aerial Barrage from Anti-Aircraft Guns? Read all about it in this special feature article.

"Blimps"—some things they do and do not do. How the balloonists escape—automobile and locomotive winches—electric gas generators—telephone communication—armament. By W. Edouard Haussler, Aviator.

A new 10,000 Horsepower Trans-Atlantic Aerial Flyer. Endorsed by the highest experts as practical and feasible.

Recent Electrical War Patents—electric rifles—machine guns—submarine net cutters—gasoline cannon.

A Practical Electric Photo Printer, by Dr. Bade, author of "How Birds Photograph Themselves."

With Uncle Sam's War-time Inventors. They propose some wonderful and fearful devices to "End the War."

"The Oscillograph"—Its mysteries made thoroly clear and understandable, by Prof. Lindley Pyle, of Washington University.

A practicol Hydrogen Sulfid Generator for the Amateur Chemist, by Kenneth Burnett.

A Sensitive Wireless Recorder, by Arno A. Kluge, Instructor of Radio, University of Nebraska.

The Secret of the Magnet Poles, clearly illustrated by Walter E. Keever.

The Phenomena of Electrical Conduction in Gases, by Rogers D. Rusk, M.A.

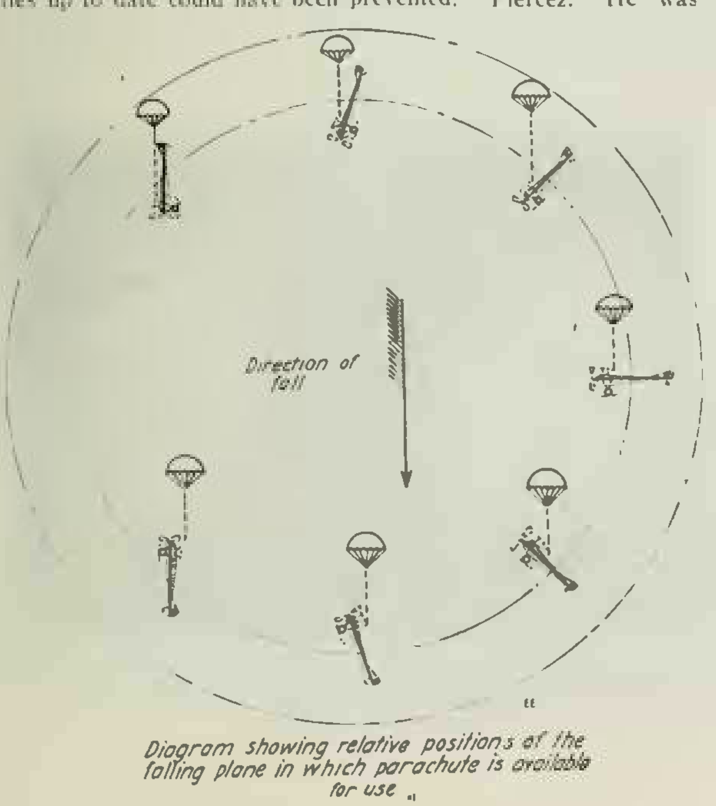
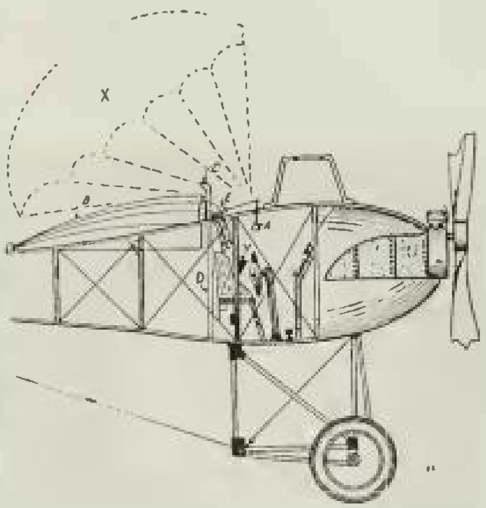


Diagram showing relative positions of the falling plane in which parachute is available for use

It may also be of interest to make reference here to a parachute being used successfully in Rheims on October 16th, 1913, by a young French airman, Louis Renault Piercez. He was the designer of the parachute device shown in our illustration and he attached his invention to a Nieuport monoplane. On the day that he made his test flight, he sat in the observer's seat and had the parachute strapt to his shoulder belt. Another aviator piloted the machine. The weather was squally and he was warned not to make the trip; he, however, started, heedless of the admonition and when about 2,000 feet in the air and making a turn, a sudden heavy gust of wind *struck his right plane and crumpled it! His life was saved by his parachute device*, while the pilot "stuck it out" and was killed!

Louis Piercez was killed in 1914 in an automobile accident, and his device has not been exploited any further, except by the Huns. The action of the device is simple and easy to understand. The lever marked A, is pulled when it is desired to release the parachute B, which is placed on the upper side of the fuselage.



Side Elevation, Wings Detached, of the Nieuport Monoplane, Used by Louis Piercez, with His Device Attached Wherein A is the Emergency lever, B the Collapsed Parachute, C the Wind Board, D the Guide Rail for Wind Board, E Bolt Liberating C, and X Position of the Parachute When Partially Inflated by the Forced Air Current Due to the Falling of the Plane Thru the Air.

The pulling of the lever causes air curtain C, to slide down or up, according to the position of the machine. It is spring loaded and is forced down with a snap. The forward or downward motion of the plane causes a rush of air which fills the parachute and lifts the pilot free of the machine; the machine dropping from under him. It therefore becomes apparent that he has not so difficult a task to become free from the machine as Mr. Muffling would have it. The *Times* editors, who are very keen on correcting letters from the readers that may in any way be misunderstood, make comment on Mr. Muffling's letter, under the heading of "His answer hardly convincing"—wherein one of the paragraphs is directly to the point and fully coincides with the writer's ideas on the subject. This editorial paragraph in part read: —*"that if this device were always at the aviator's command some of the fatalities that now occur could be prevented, or that to have the lives of even a few of these enormously valuable men would be worth while. Still less did the expert's argument meet the fact that, according to a report of trustworthy origin, a German aviator was seen, this week, to extricate himself and a parachute from an airplane that was falling in flames."* And that an aviator *"is not a man who can be replaced by the first man on whom the Government is willing to make another like expenditure. He is literally 'a rare bird' and to lose him unnecessarily is worse than unwise."* Therefore one may readily see that even the daily press is not falling in line and "gobbling up" mere mention of a certain thing being impossible, and letting it go at that. We are now living in an era where *impossible* and *can not* should be stricken from our vocabulary. This is the age of wonders and when an idea does not work against the principles of Nature, it *is* possible. At least let us try it out thoroly.

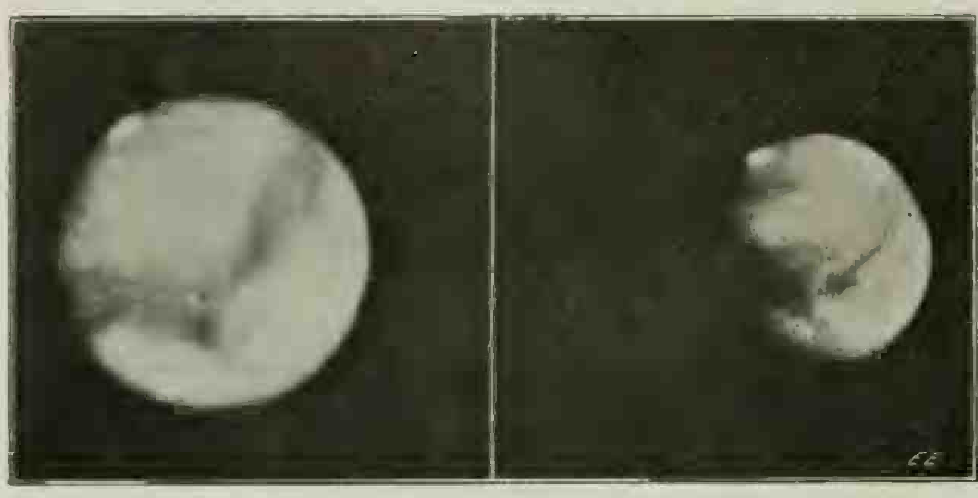
Popular Astronomy

THE PLANET MARS—FOURTH PAPER

By ISABEL M. LEWIS

Of the U. S. Naval Observatory

NO planet in our solar system arouses more interest in the popular mind than our near neighbor Mars. This is due partly to the nature of the surface markings of the ruddy planet, which are more clearly visible than those of any other planet, and partly to the strong possibility of the existence of life there.



Two Views of the Planet Mars, Photographed With the Mount Wilson 60-Inch Reflector. The Large View is a Photo Taken on October 4th, While the Small Photograph Was Taken on November 3rd. At the Time the First Picture Was Taken Mars Was Near Opposition and Consequently Showed Up Much Larger Than When the Second Picture Was Taken As By That Time Mars Had Receded Quite a Good Deal and Therefore Appears Smaller.

One would naturally expect that Venus,—the earth's twin planet in size, mass and density, the nearest to us of all the planets and as likely as Mars to be the abode of life, since it is possest of a dense atmosphere filled with water vapor,—would have a greater interest for us than Mars. However the great density of this planet's cloud-ladened atmosphere renders observations of its surface markings so difficult that even to the present day the period of its rotation on its axis, which determines the length of its day and night, is unknown. Moreover, the orbit of Venus, tho nearer to the earth than the orbit of Mars lies between the earth's orbit and the sun, which makes observation of this planet still more difficult. When best situated for observation Venus shows the phase of a half moon or crescent, half or more than half of its disk being unilluminated, and it is then within about forty-five degrees of the sun. Mars, on the other hand, is better situated for observation than any other planet. It is the only one of the *terrestrial* planets whose orbit lies beyond the earth's orbit. When in opposition to the sun it is on the meridian at midnight and is visible from sunset to sunrise. For these reasons, Venus, the most brilliant and beautiful of all the planets, is less interesting to observe telescopically than fiery Mars, which in size is next to the smallest of all the planets.

The orbit of Mars departs more from the circular form than that of any other planet with the exception of Mercury. Its eccentricity is nearly one-tenth and its distance from the sun at *perihelion*, or nearest approach, is twenty-six and a half million miles less than when it is in *aphelion* or the point in its orbit furthest from the sun. As a result the distance of Mars from the earth at opposition, when it is best seen, varies from thirty-five million miles for a near or favorable opposition to sixty-one million miles for a distant or unfavorable opposition, depending upon the position Mars occupies in its orbit at the time of the opposition. Of course the apparent diameter of the planet's disk and its brilliancy are considerably less when opposition occurs near the aphelion point in its orbit than when it occurs near the perihelion point. The relative brightness of the planet in the two positions are in the ratio of one to four. Favorable oppositions of the planet occur every fifteen or seventeen years and at such times the unusual brilliancy of the planet makes it a most striking object in the heavens, the rival of Jupiter in splendor. Furthermore, Mars is always easily distinguished from all the other planets by its deep red tinge.

The year of the Martians, granted there are such, is 687 days, or 1 year 10½ months in length, but the time that elapses between successive oppositions of Mars with the earth is greater, due to motion of the earth in the interval. It is equal to 780 days or a little more than two years, so observations of the planet, which can only be made satisfactorily near the time of opposition, are obtained in alternate years for several months preceding and following the date of opposition.

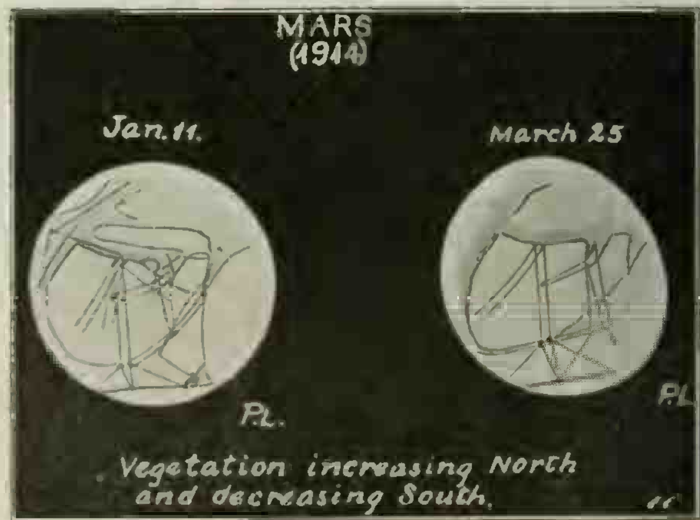
The equator of Mars is inclined nearly twenty-four degrees to the plane of its orbit, which is about half a degree more than the inclination of the earth's equator to its orbit. As a result Mars has seasons very similar to our own, a little more pronounced, since the inclination is greater, and nearly twice as long since the Martian year is nearly equal to two of our years.

Observations of surface markings on Mars have been recorded for more than two hundred and fifty years, the earliest observations being those of Hooke and Cassini in 1666. One result of these long continued observations has been a very accurate determination of the length of the Martian day, or the period of its rotation on its axis, which is given as 24h 37m 22.67s. This value is in error less than *two hundredths of a second* and shows to what a high degree of accuracy it is possible to determine certain astronomical results.

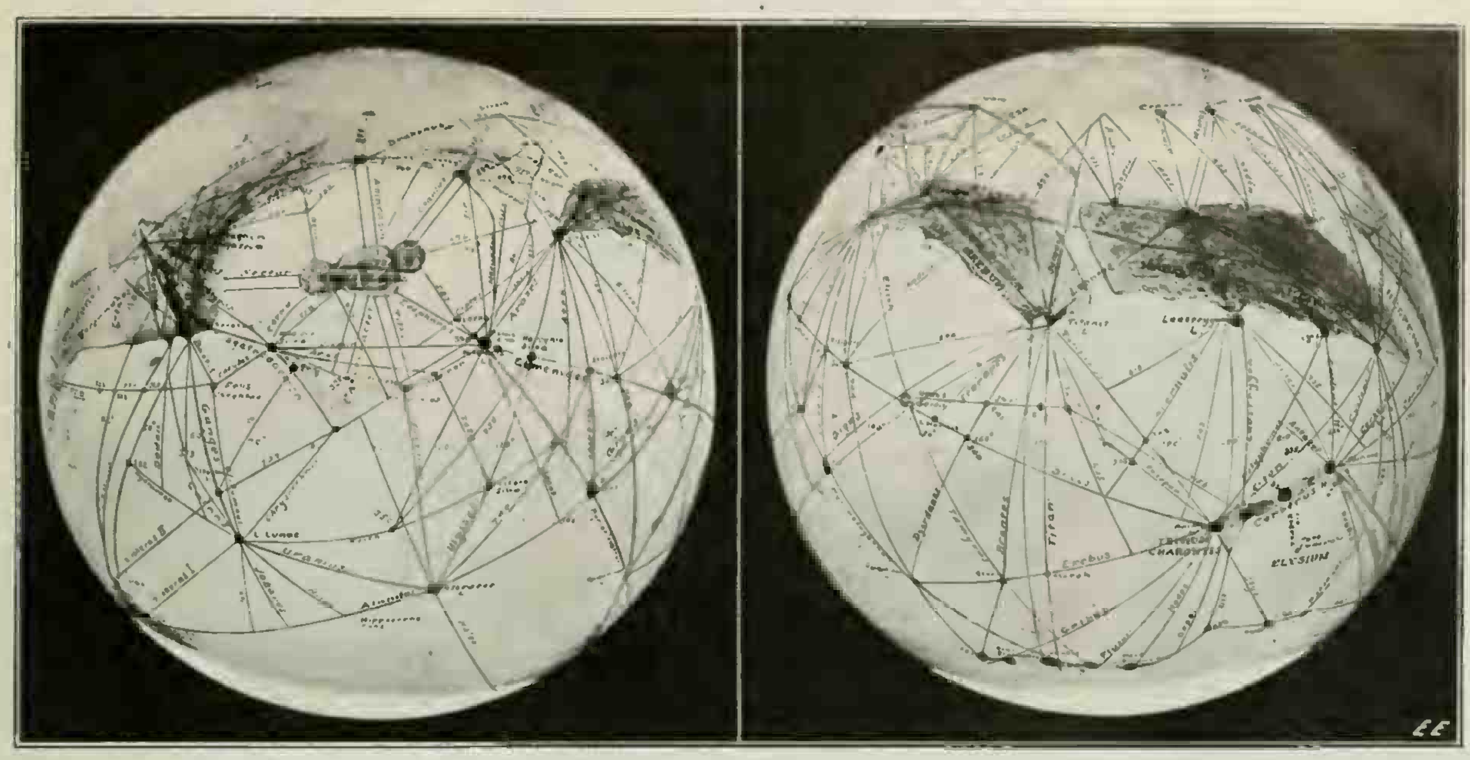
Mars, then, closely resembles the earth in the length of its day and night.

The mean annual temperature of the earth is 60° Fahrenheit. If it were situated at the distance of Mars from the sun it would receive per unit area only 43% of the light and heat that it now receives and it can be shown that its temperature would be 39° below zero on the Fahrenheit scale. If, then, the atmosphere of Mars were similar in composition and density to our own and if the nature of surfaces of the two planets were the same,—two very doubtful assumptions,—the temperature of Mars would approximate —39° F. There are reasons for assuming that this estimate of the average yearly Martian temperature is much too low. Prof. W. H. Pickering, one of the leading observers of the planet Mars at the present time, advances evidence to show that the mean daily temperature at the Martian equator thruout the year cannot be far from the freezing point and that tropical frosts are to be expected at any Martian season and, in fact, have been observed during the opposition just past in the Martian morning.

Even the early observers of Mars with the aid of telescopes far inferior to the best telescopes of to-day noted the most prominent markings of the planet's surface.



Interesting Photographs Showing Vegetation on Planet Mars Increasing North and Decreasing South. These Photographs Taken in 1914 Show Also Some of the More Prominent Canals. Photos by Lowell Observatory.



Two Different Views of the Planet Mars. As Mars Is Turning On Its Axis Once In Every Twenty-four Hours the Same as the Earth, We Are Able to See the Entire Surface of the Martian Globe During That Time. The Views Shown Here Are Taken Six Hours Apart From Each Other. Photographs Were Made During the Opposition of 1911 When Mars Was Some 47 Million Miles Distant From the Earth. In 1924 the Two Planets Will Be About 36 Million Miles Apart, the Smallest Distance Ever Reached Being 35 Million Miles. Photos Show the Top South—the Bottom North, as in the Telescope All Objects Are Turned Upside Down. The White Patch At the Bottom Is the North Polar Snow-cap. The Southern Cap Is Not In Evidence, It Having Already Melted At the Beginning of the Martian Summer. The Melted Water Has Been Conducted Equatorward By the Canals. The Light Areas Are Supposed to Be Deserts. Nearly All Canals Are Perfectly Straight, the Ones Near the Edges of the Photograph Appearing Curved Only Because We Are Looking on a Globe and Not on a Plane Surface. Photo Courtesy of the Late Prof. Percival Lowell, Flagstaff Observatory, Flagstaff, Ariz.

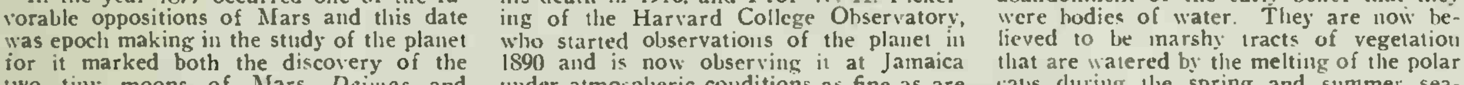
the white polar caps and their seasonal changes, the reddish or orange-colored tracts that cover five-sevenths of the planet's surface and which they spoke of as "deserts," and the greenish or greenish-grey regions which they incorrectly named "maria," considering them to be seas or lakes.

In the year 1877 occurred one of the favorable oppositions of Mars and this date was epoch making in the study of the planet for it marked both the discovery of the two tiny moons of Mars, *Deimos* and *Phobos*, by Prof. Asaph Hall, with the 26-inch equatorial, which had just been installed at the U. S. Naval Observatory and the discovery of the far-famed "canals" by the Italian astronomer Schiaparelli at Milan. This keen-eyed observer of Mars noted at the extremely favorable oppositions of 1877 and 1879 a number of fine, narrow, dark lines crossing the orange-colored regions in all directions and usually connecting the maria or dark regions. Schiaparelli gave these markings the name of "*canali*," meaning "channels," which has been translated, rather unfortunately, into "canals." Whatever the nature of these peculiar surface markings they bear no resemblance to terrestrial canals. The more conspicuous of these markings average from one thousand to two thousand miles in length and from one hundred to two hundred miles in width. Schiaparelli's discovery of the canals was confirmed by a number of observers, including Perrotin and Thollon at Nice, the late Prof. Lowell, who observed the planet continually under excellent atmospheric conditions at Flagstaff, Arizona, from 1894 to the date of his death in 1916, and Prof W. H. Pickering of the Harvard College Observatory, who started observations of the planet in 1890 and is now observing it at Jamaica under atmospheric conditions as fine as are to be found at the Lowell Observatory at Flagstaff. Prof. Lowell's observations of Mars are being continued at this observatory under the able directorship of Dr. V. M. Slipher, who was Prof. Lowell's assistant for many years. There are, however, many skilful observers who have been unable to see the canals, tho they have been aided by the largest reflectors and refractors in the country. Such observers include Barnard, with the 40-inch Yerkes refractor; Hale, with the 60-inch Mt. Wilson reflector, and Prof W. W. Campbell and other observers at the Lick Observatory. All these observers see a great variety of other surface marking, however. The canals of Mars are as much the subject of discussion and controversy to-day as they were twenty-five years ago and the reality of the canal system is still denied by certain astronomers.

The discovery, made by Lowell and a number of other observers, that the canals traversed the maria or seas as well as the desert tracts and also the variety of shade and detail visible in these dark green or greenish-grey regions, led to the gradual abandonment of the early belief that they were bodies of water. They are now believed to be marshy tracts of vegetation that are watered by the melting of the polar caps during the spring and summer seasons. A dark blue line is always observable on the border of the melting polar cap and since this dark line is not to be seen except when the polar cap is decreasing in size, or melting, it seems to prove conclusively that the Martian polar cap is similar to the terrestrial polar cap and consists of snow and ice. Moreover, the melting of the cap is attended by a decided darkening of the canal system and the greenish regions due, one would naturally assume, to the quickening of vegetations with the advent of spring.

The theory held by the late Prof. Lowell, that the canals are strips of vegetation bordering water-ways or irrigation ditches, built by intelligent beings to conserve the water supply of the planet, which is believed

(*Continued on page 428*)



Nine Different Telescopic Views of the Planet Mars Taken With the Yerkes 40-Inch Refracting Telescope at Short Intervals. A Slight Shift of the Martian Configuration Will be Noted Due to the Rotation of Mars on Its Axis. The Brilliant White Spot at the Top Is the South Polar Snow-Cap and It Is Summer in the Southern Hemisphere of Mars.

The Gyro-Electric Destroyer

ALTHO the ELECTRICAL EXPERIMENTER has only been out for the past ten days, as we go to press with this article, and altho the September issue of this magazine is not as yet in the hands of most of the readers, I feel rather encouraged at the result of my last month's article. In that issue, as will be remembered, I took the advice of several readers who suggested that I build a model of the Gyro-Electric destroyer, the latter to be turned over to our Government. The funds were to be supplied by "Experimenter" readers*

The magazine was hardly out in New York before many people whom I had never seen before began pouring into my office with their dollar bills and signed blanks. All were enthusiastic and earnest about the idea. all glad to be permitted to "do their bit" and to "wipe the Hun artillery from the face of the map," as one elderly gentleman put it when shaking hands with me and wishing luck to the enterprise.

Then remittances began to pour in, in amounts from $10.00 downward, and while the amounts so far received are relatively small, due to the fact that the magazine at this time of writing is hardly in the hands of 5% of our readers, all signs point to the actual building of the Gyro-Electric Destroyer.

In the November issue will be printed the first list of readers who subscribed to the funds, as well as the total amount collected up to that date. All amounts received up to September 23rd (the closing date for the November issue) will be found in the next issue.

This month I will content myself to print a few extracts from the letters of enthusiastic contributors to the Gyro-Electric Destroyer Fund. Here they are:

EVERY LITTLE HELPS.

". . . I am a regular E. E. reader and have watched the development of the idea from the start. I also have faith in it and therefore my support, altho it may be small, will help if all of the readers are as faithful and patriotic. Wishing you success in the matter, I remain"

Yours truly,
R. H. Reitz,
Trevorton, Pa.

HERE IS REAL FAITH.

"Enclosed find my dollar, that one I have been saving toward my subscription to the E. E., but I have confidence enough in myself to believe I can have a few more by the time it expires. I am studying electricity and it takes about all I can get to buy books and things that I need in my lab; but if you need another dollar let me know so I can help wipe the Huns off the globe. I have faith in the Gyro-E-D."

T. D. Cooper,
Winterville, N. C.

The Gyro-Electric Destroyer, a 45-Foot Monster, Built of Steel and Running at High Speed, Due to Its Large Circumference, Easily Rides Over Shell Holes and Trenches and Other Formidable Obstacles. Its Use Is Mainly to Harass and Put Out of Action Enemy Artillery by Either Grinding It Into the Ground or Otherwise Bomb the Artillerists With Their Guns Out of Their Positions. Experimenter Readers Are Going to Build a Model of This Machine to Be Turned Over to "Uncle Sam." The Above Illustration Shows the Front Cover Illustration of the Largest French Scientific Monthly Featuring This American Destroyer.

WE TOO HOPE!

"Hope all the other 'Bugs' do the same."

Theodore Collins
Kewamia, Ind.

"I HAVE FAITH."

". . . I have read 'Modern Electrics' and the ELECTRICAL EXPERIMENTER *ever since they first started. I have faith in your Gyro-Electric-Destroyer. Go to it and if more money is needed I can help a little at least."*

Yours for success,
F. A. Barber,
Manager of Service Department, Bosworth, De Frenes & Felton, Master Cinematographers, Wilkesbarre, Pa.

"ASTOUNDINGLY INTERESTING."

". . . In my estimation it is an 'astoundingly excellent' idea, and you have my best wishes for its early completion."

Yours,
Walter E. Hoagland.
c/o M. L. W. P. Co.,
Mays Landing, N. J.

GOOD LUCK—AND A P.S.

". . . Good luck to the 'E. E.' and to the Gyro-Electric Destroyer, and to you and to your organization. P. S. I may comes across with another dollar for the 'G. E. D.' in a few days."

A. L. Terry,
1422 Hurt Bldg.,
Atlanta, Ga.

"IT IS MY DUTY."

"I am not sending you this dollar because I want my name published in your magazine. I am sending it to you because it is my duty as an American citizen under the protection of the Stars and Stripes. Thanking the originator of the idea and yourselves, I remain"

Yours,
Ferdinand L. Westheimer,
3707 Washington Ave.,
Avondale, Cincinnati, Ohio.

SHORT AND TO THE POINT.

"Make it as soon as you can and give 'em h--l."

Marshall C. Howenstein,
602 N. Main St.,
Goshen, Ind.

*See February, 1918, and September, 1918, issues concerning the Gyro-Electric Destroyer and how to help win the war with it.

Editor Electrical Experimenter:

I enclose herewith $.......... as my contribution towards building a model of your Gyro-Electric-Destroyer.

You are to build as large a model as the funds will permit and the money is to be used for the sole purpose of building this war machine. You agree to publish an exact account of all funds spent and all contributions are to be acknowledged thru the columns of the *Electrical Experimenter*.

You pledge yourself to construct the machine as quickly as possible and you will turn it over to the U. S. Government immediately upon its completion.

Name..

Address..

As a sign of the times, and merely to show what others think of the Gyro-Electric Destroyer, we reprint herewith the cover illustration of the famous French monthly *La Science et la Vie* (Science and Life).

Science et la Vie is the greatest and most widely read French popular scientific monthly. It is a really great publication, the current issue, for instance, numbering 192 pages. They choose for their cover illustration, which is printed in four colors, the Gyro-Elec-

(*Cont. on page* 389)

Autumnal Uses of the Electric Fan

By Grace T. Hadley

HERE are the latest directions for *drying fruits and vegetables* before an electric fan:

All the vegetables must be thoroly washed and dried and in the case of root vegetables pared thinly, then sliced as thin as possible and placed on cheese cloth over racks. Then start the fan. Have it at an angle of about 30 degrees so there may be a slightly upward current of air thru the racks.

Vegetables such as turnips, carrots, etc., if allowed to stand for about ten minutes (after slicing) in a 4 per cent. water solution (1 teaspoonful salt in 1 qt. water) will not discolor in the drying process.

Corn should be put into boiling water for—from five to ten minutes to set the milk before the cutting from the cob; then spread the cut corn upon the cheesecloth.

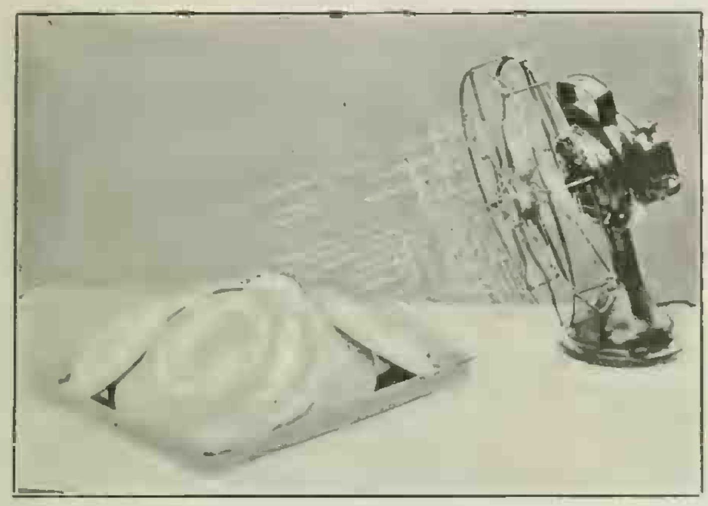
Green vegetables such as string beans and wax beans should be blanched in hot water, for from five to ten minutes before drying.

Fruits such as berries are merely thoroly washed then placed on racks to dry. These will take a little longer to dry because of the somewhat higher water content. Berries are dried enough if they do not stain the fingers when prest.

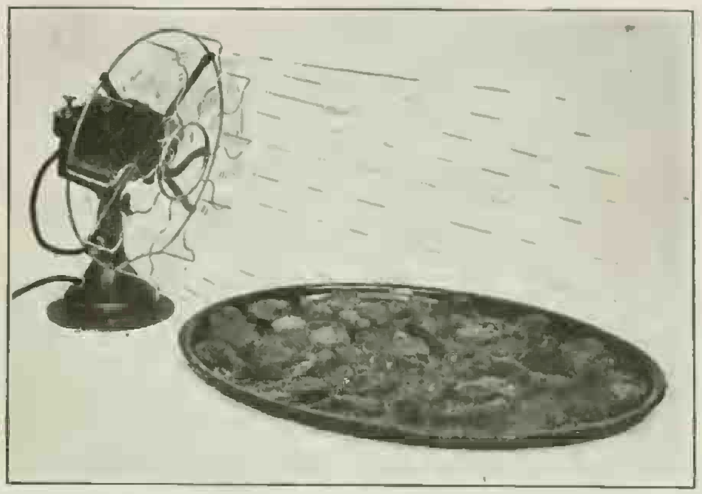
Other fruits and vegetables should have a pliable, leathery appearance when dry and should not be dried so long that they become brittle.

It is best not to pack and seal the dried products for several days, but keep them in open trays or pans covered with a clean cloth. If the products appear to be too moist they should be returned to the drying racks for a short time. Ability to judge accurately as to when fruit has reached the proper condition for removal from the drier can be gained only by experience. It should be so dry that it is impossible to press water out of the freshly cut ends of the pieces, yet not so dry that it will snap or crackle.

Two other practical uses for the electric fan in hot weather are illustrated herewith—the first, that of drying dishes by blowing a breeze over them and the second, cooling the woman-folks while they labor over the annual canning job.



Put the Electric Fan to Work—Make It Dry the Dishes For You—Madame. The Draft of Air Will Evaporate the Water Almost Instantly.



Now is the Time to Dry Those Apples, and Many Other Fruits—Let the Electric Fan Expedite the Work For You. The Cost is Very Small.

Canning Is An Unpleasant Job at Best—Especially in Small Kitchens. For One-half Cent An Hour An Electric Fan Will Keep You Cool.

As a symptom of the recent rapid development of Japan's commercial interests in Shanghai, Japanese lighting companies are now supplying a large proportion of the electric lamps for the city which were formerly imported chiefly from the General Electric Company in America. The fact is pointed out in the report of the Japanese consul-general at that point.

Splicing links and a unit made of a non-conducting material have been invented for insertion in electric light chains to insure that they are insulated.

AN ELECTRIFIED CAT.

A cat has been in the habit of sleeping on a rubber mat under a dynamo in Cleveland's power house, runs the yarn in a Cleveland paper. Somebody removed the mat and the cat slept on an iron plate. It didn't seem to hurt the cat, but her fur became so charged with electricity that ever since it has stood stiff on end like bristles of a hairbrush.

(Perhaps the cat's hair was scared stiff! Ed.)

The chief inventions used in the present war as distinguished from the Napoleonic wars are: Steamship, submarine, aircraft, high-power guns, smokeless powder, breech-loading guns, rapid-fire gun, revolver, automatic pistol, telephone, wireless telegraphy, automobile, poisonous gas. Yes, and German "Peace-Offensives!"

AIR MAIL PILOTS GO THRU THUNDER STORMS.

The air mail pilot is solving the problem of flying in all sorts of weather. Prior to the establishment of the Air Mail Service it was regarded as impracticable to make flights with airplanes during severe storms.

The practise of this daily service has shown that the mail can be carried thru the air in the teeth of a storm.

On three or four occasions the air mail pilots have encountered severe thunder and lightning, wind, hail, and rain without being stopt in their flight. No flight attempted in a storm has yet failed.

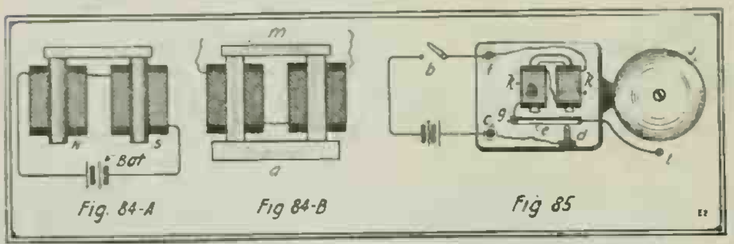
Recently Lieut. Stephen Bonsal from Philadelphia to Washington ran into a violent thunderstorm at Laurel, Md., at an altitude of 5,000 feet and proceeded on his way to the landing field in Washington without interruption. It was impossible to distinguish any landmarks in such torrents of rain. When he descended to a lower altitude for observation he was near the wireless towers at Radio, Va. To observers he appeared to drop out of the clouds from nowhere at an angle of 45° to a height of about 300 feet when he leveled the plane and made a perfect landing at Potomac Park in the midst of a torrent of rain. The plane arrived on schedule time, not being delayed by the storm. The propeller was slightly damaged by the pelting rain.

Lieut. Bonsal was not assisted by radio guide but depended entirely upon his compass and his judgment from familiarity with the route.

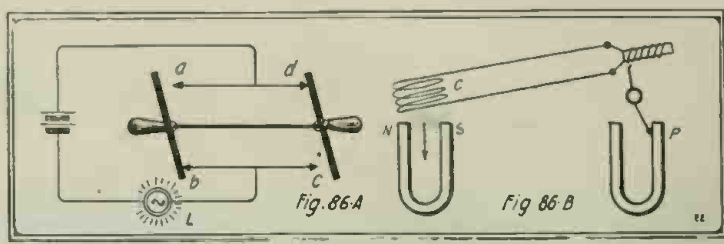
Experimental Physics

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

LESSON SIXTEEN



The Principle of the Electro-Magnet and How It Is Applied to the Electric Bell. The Electro-Magnet Comprises a Soft Iron Core Surrounded with Coils of Wire, Thru Which a Current Passes.



Experiment with Three-Way Switching in Lighting Circuit—Moving Switches to Alternate Position Lights Lamp. Fig. 86-B—Experiment of Moving a Coil in a Magnetic Field to Produce an E.M.F.

CURRENT ELECTRICITY (concluded)

EXPERIMENT 93

INSERT a piece of soft iron in the helix shown in Lesson 15, and allow the current to pass thru the helix. On testing the strength of the poles now (by bringing the helix near a compass or by picking up iron filings) we find a great increase in the magnetism. The iron core which was inserted has been magnetized by induction just as if it had been placed in the field of a permanent magnet; and now we have added to the magnetism of the helix the magnetism of the core, which accounts for the increase in strength. A helix with a core is called an *electro-magnet*, the commercial form being usually in horse-shoe form (see figure 84-A) in order to double the strength of the magnet. Figure 84-B shows the arrangement of the lines of force thru an electro-magnet *m*, and its armature *a* (piece of soft iron thru which the lines of force pass). The strength of an electro-magnet depends upon the *ampere-turns* (product of the amperes or amount of current, times the number of turns of wire in the helix). The importance of the electro-magnet in modern electricity cannot be over-estimated. One has but to recall its use in the bell, current measuring instruments, motor, dynamo, telephone, telegraph, induction coil, and an indefinite number of devices.

EXPERIMENT 94—The electric bell illustrates the use of the electro-magnet to produce an intermittent action. The construction is simple (see figure 85); *c* and *f* are binding posts, *d* a screw with platinum point, *e* a flat piece of spring steel, fastened to binding post *g*, and to a hammer consisting of hairpin with ball-bearing soldered to the end. *j* is gong, and *k* an electro-magnet consisting of two spools wound with magnet wire, two screws for cores and iron nail connecting the cores.

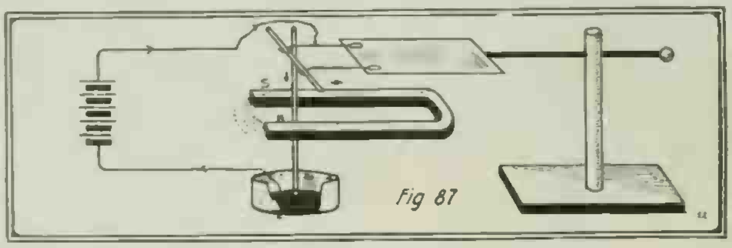
On closing the switch *b* (equivalent to pushing the button) current flows from battery to binding post *f*, from *f* thru connecting wire to the magnet, from the magnet to the binding post *g*, from *g* thru the spring steel to screw *d* and thence out thru binding post *c*. The passing of the current causes *k* to become magnetized, and *k* draws the spring steel toward it, thereby breaking the contact at the screw *d*. This causes the current to stop flowing; the magnet loses its magnetism and the spring of the steel causes it to snap back to the screw which closes the circuit again, making the current flow thru the magnet once more. These operations are repeated over and over again as long as switch *b* remains closed. Hence the hammer is alternately drawn to and pulled away from the gong, and the bell "rings".

EXPERIMENT 95—Cut in half a lead pencil having a large size lead. Shave off the wood from the lead; connect the leads thru a battery of about thirty volts, and separate the leads about an eighth of an inch. An arc will be formed similar to that of the commercial arc lamp, but of course not as bright. After a few minutes cut off the current and examine the leads. One will be found to be concave and the other convex. The concave is the positive and the convex the negative. (The polarity can be determined as suggested in Lesson 15). This is just as you might have expected; for the current is going from + to — has carried some of the carbon with it and deposited it on the other electrode. Try bringing the leads as close together as possible without their touching. *No arc will be formed unless the leads are first touched together.* If the leads are not touched together the resistance of the air prevents electricity of such low voltage from passing thru the gap however small it may be. But when the leads are first touched together and then drawn apart (the heat of the current while the leads are in contact vaporises the leads and fills the gap with carbon particles which offer but slight resistance to the passage of the current); the current now passes thru the gap and the hot particles glow. Using regular commercial carbons and the proper voltage (50 volts) an arc of great brilliancy is obtained. In the more up to date forms the carbons are impregnated with lime, magnesia, silica, or other minerals which give off a very brilliant light when heated to incandescence.

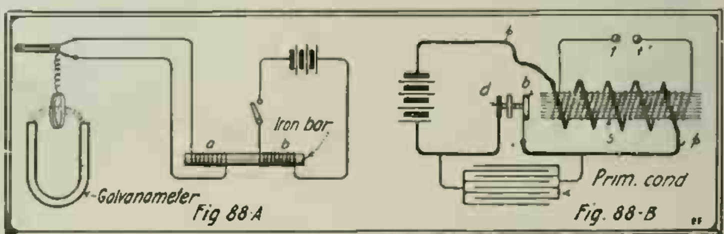
Figure 86-A, shows a three wire "hook-up" for controlling current from two different points. This hook-up is extensively used where it is desired to control a stairway light from each of two floors. *ab* and *cd* are single pole double throw switches (or the two button type). The middle wire is used as the neutral, and connections are made to the outside wires. If *b* and *d* are closed, the circuit is closed and current passes thru the lamp L. If person at the left wishes to extinguish the light he opens *b* and closes *a*—*b* and *c* now both being open, the circuit is open. The person at the right can open or close the circuit by similarly manipulating the switch *dc*. (The reader should try all possible combinations of the switches *ab* and *cd* and trace out the various paths of the current.)

EXPERIMENT 96—No doubt Oersted's discovery of the magnetic effect accompanying an electric current thru a conductor led to Sturgeon's discovery of the electro-magnet in 1825, six years later. Sturgeon's discovery in turn attracted the attention of physicists the world over, to the production of an electric current by means of a magnet (the electro-magnet being so much more powerful than the ordinary magnet). The year 1831 marked the beginning of modern electricity when Joseph Henry in America and Michael Faraday in Great Britain discovered independently and simultaneously the dynamo principle. Now electricity on a commercial scale for the production of light heat and power was possible. The principle is simple and can be easily understood without recourse to the intricacies of the modern dynamo. Wind a coil of about 500 turns of number 22 copper wire, with a diameter of about two inches. Connect this coil with a galvanometer or other current detecting device. A simple galvanometer can be made by suspending a coil of about 200 turns of number 30 copper wire between the poles of a horseshoe magnet. (See figure 86 B.) *Thrust the coil c down* over the S-pole of the magnet. The *deflection of the needle* P of the galvanometer will indicate that a current is passing thru the coil. If, how-

(*Continued on page* 427)



Experiment to Demonstrate the Principle of the Electric Motor, Showing That When an Electric Current Is Past Thru a Conductor In a Magnetic Field, a Motion of the Conductor Results.



An Interesting Experiment In Electro-Magnetic Induction, Fig. 88-A. At Right, the Component Parts of an Induction Coil, Fitted with Primary Condenser for Producing Sparks.

New Developments in Telephotography

By LeROY J. LEISHMAN

IN this, my second article on picture telegraphy to appear in the ELECTRICAL EXPERIMENTER, I shall explain another of my systems. This method reduces gravity, friction and inertia to a minimum and makes use of a new and very superior type of synchronizer. This system was frequently referred to in my previous article. See the December, 1917, issue of this journal.

Readers of the ELECTRICAL EXPERIMENTER are, no doubt, familiar with the cylinder phonograph arrangement for covering all parts of the picture in the same succession, and with the necessity for perfect synchronism to prevent distortion. A familiarity with these essentials will be taken for granted, and only the means for accomplishing the latter will be explained.

Let us first consider the sending of the picture. It is well known that selenium has the peculiar property of changing its electrical conductivity according to the intensity of light to which it is exposed. Selenium is therefore particularly adapted to form the "eye" that translates light and shade into corresponding intensities of an electrical current. Dr. Korn makes use of selenium in this regard, but in a way that differs considerably to my method. I have endeavored to make it unnecessary to have the sending cylinder in a dark box, and in so doing have also eliminated the necessity of using a film. A small selenium cell is placed in the back of a deep and comparatively large dark box. Lenses are arranged in front of the dark box and brought as close as possible to the sending cylinder. The purpose of this arrangement is to have only a very minute portion of the cylinder focused upon the cell. The picture to be transmitted is wrapt around the cylinder. On both sides of the dark box, very strong lights are placed to illuminate the picture. The cylinder has a threaded shaft, so that it advances as it revolves. This permits every part of the picture to be focused in turn upon the selenium cell, which varies the current according to the intensity of the reflected light. In this manner the picture is transmitted.

The receiving is equally novel. Light is not subject to the law of gravity and has no friction and no inertia. The electro-magnets at the receiving station therefore act directly upon a magnetically affected actinic ray. This beam of light may be polarized, a cathode ray, or, in fact, any ray upon which magnetism will exert its influence.

I shall first explain the polarized light arrangement for receiving. Unlike the sending cylinder, the receiving drum is inclosed in a dark box, close to the aperture of which is located an analyser thru which all light entering the box must pass. The light is polarized by Nicol prisms in line with the aperture of the dark box and the analyzer. Between these is placed an electro-magnet, thru the core of which the light passes. This apparatus may be adjusted to produce either a positive or a negative by arranging the prisms so that no light enters the dark box excepting when the magnet is energized, or vice versa, when it is not energized. The amount rotates in the plane of polarization. If a film is placed on the receiving drum and the magnet connected in series with the sending machine, very good pictures are obtained when the cylinders revolve in synchronism.

A cathode ray may be diverted from its path by a magnet, and the same thing is true of many other rays. Quite a variety of optical effects may be produced in a magnetic field, many of which lend themselves to the uses of telephotography because the effect of gravity and friction is not felt, and the inertia is nil compared with mechanical ways of receiving. In a rough manner, these rays may be used by causing them ordinarily to pass over an electromagnet thru the aperture of the dark box; and when the magnet is energized, the ray is either bent entirely away from the aperture or its effect materially lessened.

Of course, there is a little inertia in the selenium cell even tho connected with a Wheatstone bridge, and also in the magnet that controls the beam of light at the receiving end; but the further we get away from purely mechanical telephotography and the more nearly we approach the actual connections between light and electricity, the greater the speed.

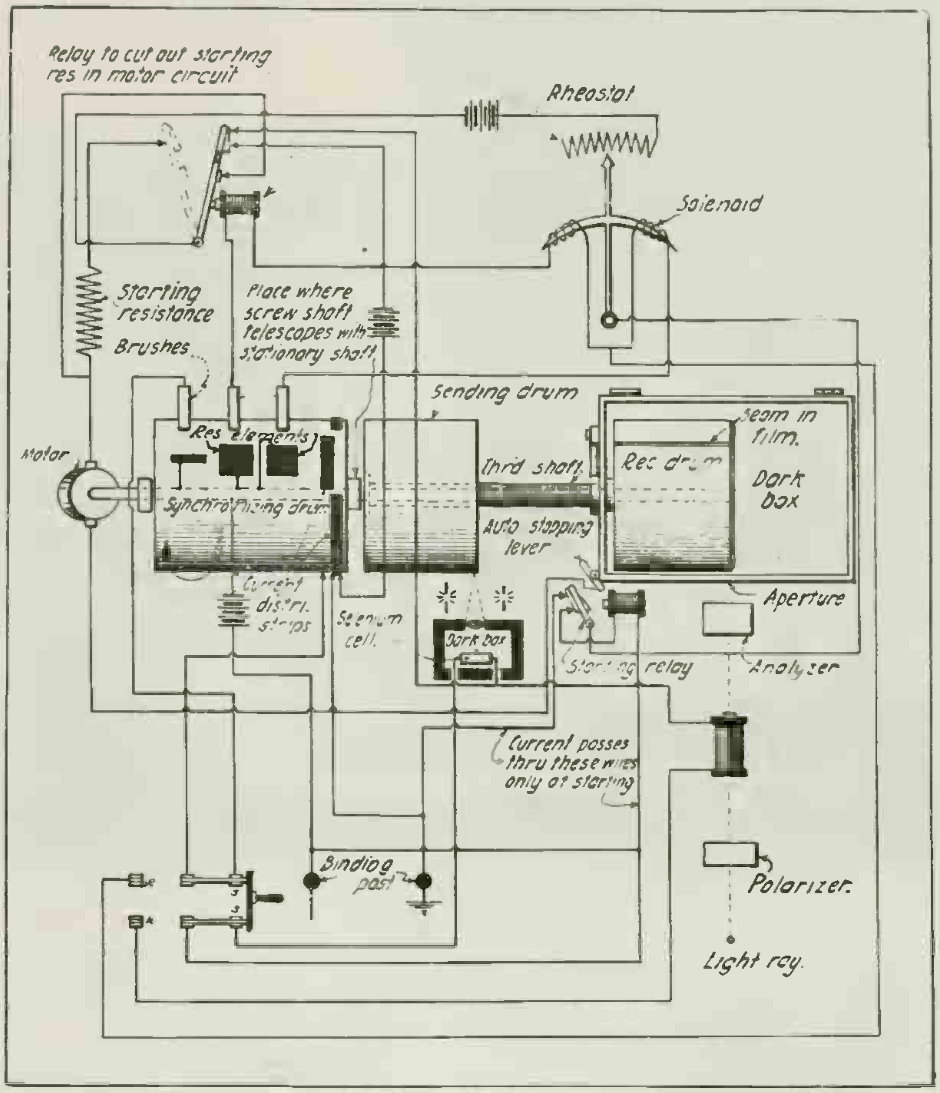
But in justice to the mechanical schemes for telegraphing pictures, let it be said that they work as fast as the *lag* in several hundred miles of wire will permit them.

Without synchronism, telephotography would be impossible. In my previous article, I explained a manually controlled synchronizer, and made reference to an automatic system. In connection with this system, I have arranged automatic starting and stopping features.

When the machines are not in operation, the starting relay on the receiver is connected direct to the binding posts, to which are attached the wires from the sending machines. The arm of this relay is held by gravity against a contact to effect this connection. The arm is then inclined about 15 degrees from the perpendicular. When the sending machine starts, the first impulse causes this relay to pull its arm against a different contact, against which it is also held by gravity, as the position is 15 degrees the other side of the perpendicular. This breaks the relay connection and starts the motor which operates the machine.

An important part of the synchronizer is

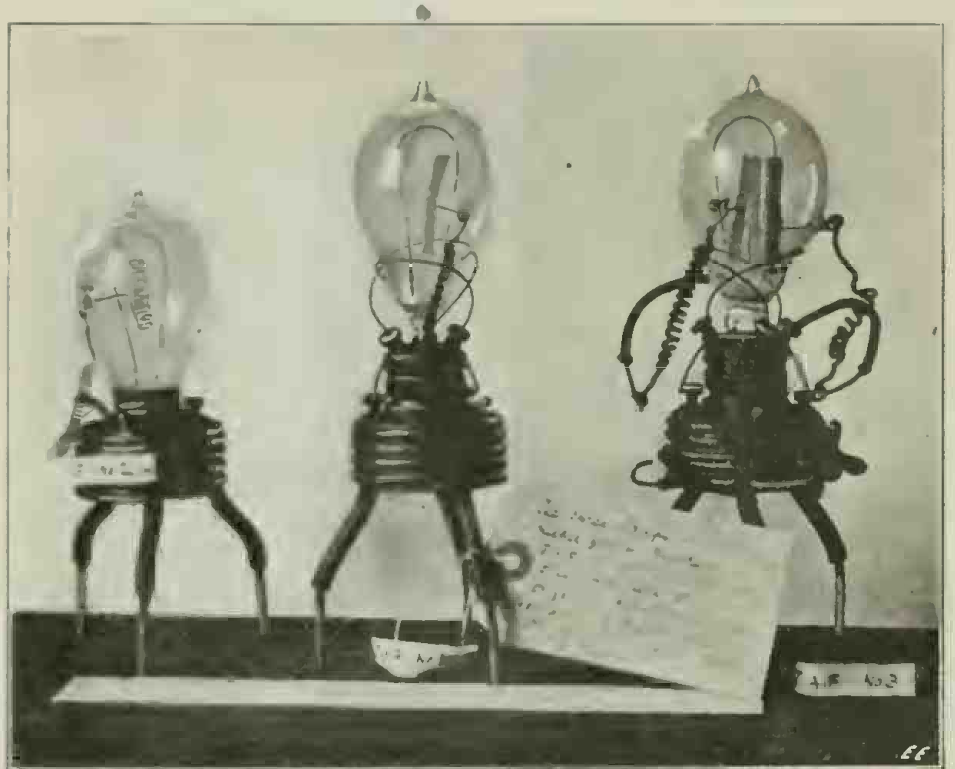
(*Continued on page* 414)



This Diagram Shows the Electrical Connections and Arrangement of the Various Apparatus in Mr. Leishman's Newest Telephotographic Instrument, Intended For Transmitting Pictures Over Telephone or Telegraph Wires. Among Other Interesting Departures the Inventor Makes Use of a Novel Polarized Light Ray, Which is Deflected by an Electro-Magnet.

Original "Valves" Used by Dr. J. A. Fleming

PROFESSOR J. A. FLEMING in 1904 was the first to apply the phenomena of thermionics to the rectification of alternating electric currents, whether of high or low frequency.* The device which he made to effect this may take one of several forms, some of the original ones of which are shown in the photograph herewith. It consists of an ordinary carbon filament incandescent lamp provided with a separate insulated electrode, in the shape of a flat or cylindrical metal plate, or another carbon filament, sealed into the bulb. When the carbon filament is rendered incandescent by a source of electric current it will be found that a single cell will pass a current thru the vacuous space between the insulated electrode and the hot filament provided that the negative pole of the cell is connected to the negative side of the filament. If the connections of the cell are reversed, practically no current passes, the small amount of current obtained being due to positive ions formed from the residual gas in the bulb. This is what we should expect from the fact that the hot filament is emitting negatively charged particles, and in order to draw these across the gas space to the cold electrode the latter must be raised to a positive potential with respect to some portion of the incandescent filament.


Historic Oscillation Valves Used by Dr. J. A. Fleming, F.R.S., in 1904.

The space between the cold and hot electrodes, therefore, possesses *unilateral conductivity*, and the arrangement acts as an "electrical valve", passing electric currents in one direction but not in the opposite direction. Fleming next found that this device could be used, on this principle, to convert either audio or radio frequency electric oscillations into unidirectional currents, which may then be detected by means of an ordinary galvanometer.

Fleming found later that greatly improved results were obtained when the valve was constructed with a *tungsten* filament and an insulated copper cylinder surrounding it. This is due to the fact that the tungsten can be raised to a much higher temperature than carbon without volatilisation and gives a much greater electronic emission, and this type of thermionic valve is almost universally constructed at the present time with either a tantalum or tungsten filament.

The next step in the evolution of the thermionic valve was made by Dr. Lee de Forest and consisted in the introduction of a third electrode into the evacuated bulb. Lee de Forest had been working on the simple rectifying valve containing a metal or carbon filament and one insulated electrode (already described) at practically the same time as Fleming, and his results were first described in a paper before the American Institute of Electrical Engineers in October, 1906. Considerable controversy has since then ensued as to the relative priority of the inventions of the Fleming valve and the "Audion", the name assigned to the valve by de Forest; but this has now been settled in favor of Fleming for the original valve, Lee de Forest having the credit of introducing another insulated electrode into the bulb, thereby transforming it from a rectifying valve into a kind of gas relay, having an amplifying effect on the received oscillations.—*Photo courtesy Wireless World.*

*See British Patent 24,850—1904.

AN UNUSUAL TYPE OF ELECTRON RELAY.

The hot filament rectifier or electron relay illustrated herewith is of rather unusual type, being encased in a perforated aluminum jacket, made from an individual egg boiler.

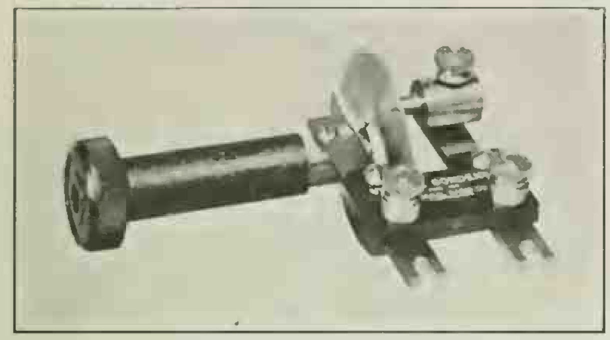
The advantage of the construction shown lies for the most part in the decrease of filament current required, due to the heat being retained by the metal covering.

Three connections are made to the inside of the bulb and the fourth to the outside shell.—*R. U. Clark, 3rd.*


Novel Electron Relay Encased in an Aluminum Egg Boiler Which Acts as a Heat Jacket, with a Reduction in the Filament Current Required.

New Developments in Radio Apparatus

THE type of radio frequency Hot-Wire Meter shown in Fig. 1 is of extremely low resistance and is designed to operate at a low temperature, thereby allowing a heavy overload without burning out as well as keeping the case from heating up. This low resistance insures a minimum of losses in the circuit. It is made in two models.



With This "Vernier Condenser" Shunted Across Any Standard Variable Condenser a Finely Graduated Capacity Is Attainable. This Instrument Makes a Laboratory Condenser of Any Variable Capacity. Fig. 3.

flush and full case type, measuring 3 inches in diameter. The meter is contained in a portable aluminum case suitable for laboratory uses. The expansion strip is of thin platinum and defies oxidation which gradually changes the readings of most instruments of this type. The steel shaft is supported by saffire bearings and a zero adjusting button on the front of the instrument allows instant calibrating of the pointer. The range of the meter varies from ¼ to 10 amperes. It is finished in satin black and all of the parts and movements are interchangeable.

The new radio frequency Decade Bridge (Fig. 2) is made up of resistances in suitable arrangement for bridge measurements adapted to the measuring of inductance, capacity and resistance at high frequencies, using a sine wave generator or oscillating vacuum tube, as well as to D. C. measurements. Its operation is identical to the Wheatstone bridge. In measuring capacity and inductance on this bridge, one arm of the bridge compensates for the resistance of the capacity or inductance under measurement as compared to that of the standard, thus giving an indication of the resistance as well as the capacity and inductance at the particular frequency employed. The bridge is mounted in a compact and convenient cabinet and arranged to eliminate losses at high frequencies. This bridge is accurate up to 1,500,000 cycles.

Telephone Transformer for Linking Up Audion Circuits, and Permitting of Various Ratios Between Primary and Secondary Being Readily Obtained. Fig. 4.

Fig. 3 illustrates the latest development in the form of a Vernier Condenser, which has been designed and adapted to give a closer variation of condenser capacities when shunted across the leads of any standard condenser. The two crescent shaped metal plates are made movable in two ways; they can be brought closer together or spaced further apart and they move in the same plane as the ordinary condenser plates in a variable rotary type. The long hard rubber handle minimizes body capacity to a practically nil degree, due to the nearly perfect insulation afforded by it.

The Telephone Transformer (Fig. 4) is designed to give a large field of variable inductance values and that represents its advantage over the old type of open-core telephone induction coil or Audion transformer now in use. It is substantially constructed and will stand rough usage. The eight binding posts on the front hard rubber panel make it very simple to connect into a circuit for any desired inductance ratio very readily. *Photos courtesy General Radio Co.*

THE GYRO-ELECTRIC DESTROYER.

(Continued from page 384)

tric Destroyer, pressure because the French scientific editors thought the machine feasible. The copy featuring the machine is the July 1918 issue and reached New York just as the September issue of the EXPERIMENTER had gone to press.

If the French scientists have faith in the Gyro-Electric Destroyer—and they surely ought to know—EXPERIMENTER readers should back up an America idea for all that it is worth. I firmly believe that the machine is thoroly practical and feasible.

And I am just as certain that if we had twenty of these machines in France just now with which to grind the Hun artillery into the ground, or by blowing it to pieces, the war would be ended much sooner. Deprive the Huns of their guns, and we will have them back to the Rhine in no time. This is a machine war—let's have the best machine. In the meanwhile—if you share this view with me—you might sign the subscription blank.

H. GERNSBACK.

Using a modified wireless receiving instrument, a French scientist has been able to detect thunder storms more than 300 miles distant.

PIPING UNDER SAYVILLE WIRELESS.

A Mineola contractor in the use of his steam traction trench digger has just completed an extensive underground piping system at the Sayville Wireless Station, which adds to the efficiency of this huge wireless plant, now such an important factor with the United States Government.

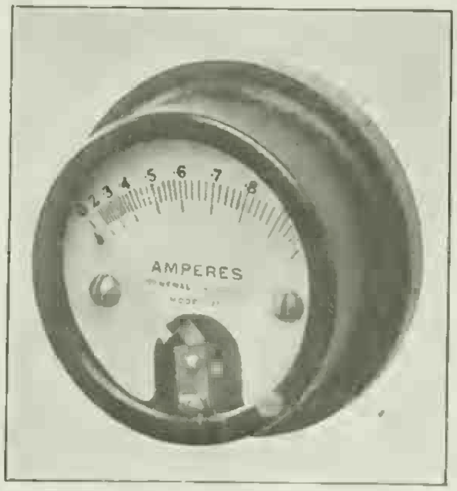
New Radio Frequency Decade Bridge Suitable for Measuring Inductance, Capacity and Resistance. Fig. 2.

U. S. SHIPS HEAR "HUN" RADIO TO U-BOATS.

Wireless operators on American and other ships crossing the Atlantic at night frequently "pick up" orders being sent by the German Admiralty to submarines at sea. The messages are in code, of course, and the submarines never acknowledge receipt of the orders, because if they did some warship of the enemy might get a clew as to the location of one or more of the undersea boats.

These messages to the submarines are from Nauen, a small town near Spandau, where Germany has its great wireless station. Electrical waves produced there will reach some 6,000 miles.

Nine towers are in use, the highest being 850 feet. Last year Nauen sent to the outside world almost $2,500,000 for the German government.

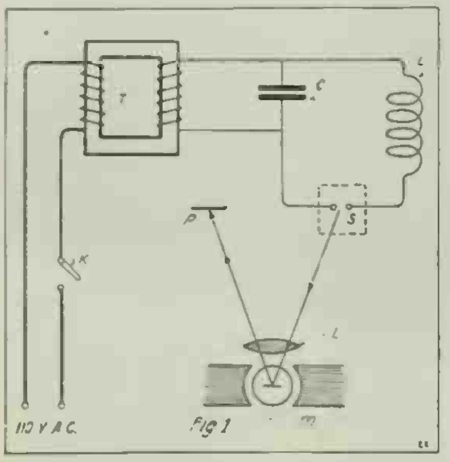


Recent Design of Hot-Wire Ammeter, Calibrated for Radio Frequency Measurements. It Possesses an Extremely Low Resistance, a Much Desired Quality in All Such Instruments. Fig. 1.

The Revolving Mirror and Spark Discharges

By PROF. LINDLEY PYLE, Professor of Physics, Washington University

IT is a matter of historic interest, especially to wireless enthusiasts, that an American physicist, Joseph Henry, first secured, in 1842, indirect experimental evidence of the oscillatory discharge of a Leyden jar; that Lord Kelvin, in 1855, made the mathematical prediction that the



Relative Position of Rotating Mirror "M" and Photographic Plate "P"; Spark at "S."

time elapsing during an oscillation is given by the now familiar equation, $T = 2\pi\sqrt{LC}$; that Feddersen, in 1857, obtained direct experimental evidence of the oscillations by examining the spark in a rotating mirror; and that Hertz, in 1887, showed experimentally that there is an accompanying electromagnetic wave propagated outward into space, thereby explaining certain puzzling experiments performed by earlier experimenters, and inaugurating the marvelous development of wireless telegraphy.

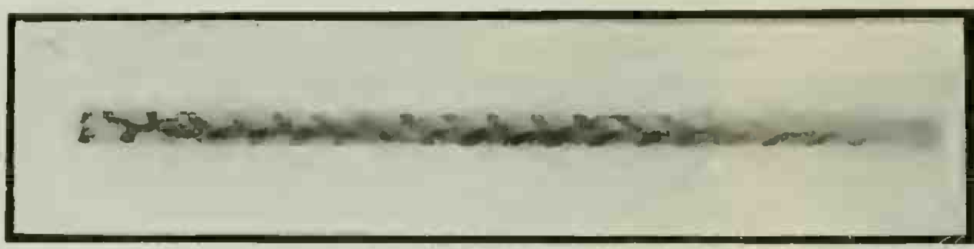


Fig. 3. Typical Oscillatory Spark Image Photographed With the Revolving Mirror by the Author.

The amateur electrical experimenter may easily repeat Feddersen's classic experiment and measure to his own intense satisfaction the number of to and fro surgings per second in the discharge of a condenser thru an inductance and low resistance. This number is, of course, the number of waves thrown off into space per second. Since in one second the wave motion travels out into space 186,000 miles, the wave length in miles is immediately found by dividing 186,000 by the *rate per second* at which the waves are produced.

Figure 1 shows the arrangement of the required apparatus. A small transformer, T, is used to charge a capacity (condenser), C, arranged so that discharges take place thru the inductance, L, across the spark gap, S. The spark gap device consists of two zinc rods thrust thru holes bored in the sides of a wooden box, the box completely enclosing the spark except on one side where a hole is cut (see dotted outline of box in Fig. 1). The box may be about six inches along its edges and the gap should be about one-eighth of an inch long. Light from the spark passes out thru the hole in the box, thence thru a lens, *l*, to a piece of good plate-glass mirror, m, from which it is reflected back thru the lens to a focus on a photographic plate at P. The mirror is fastened upon the projecting shaft of a small high-speed motor in the manner indicated in Fig. 2. (In fact, there are *two* mirrors.) Referring to figure 2, *w* is a piece of wood bored to fit tightly upon the motor shaft; *m* and *m* are two pieces of good quality plate-glass mirror fastened securely to the wood by red sealing wax. The lens should be bought at an optician's shop. Ask for a spectacle lens of *one diopter* focal power, i.e., one whose focal length is one meter, or 39.4 inches. It should not cost more than fifty cents when bought with the unfinished edges. The lens should be held in a stationary support facing the spark gap at a distance therefrom of 39.4 inches, with the motor driven mirrors as close as possible behind the lens (see Fig. 1). The faces of the mirrors should be as large as the face of the lens.

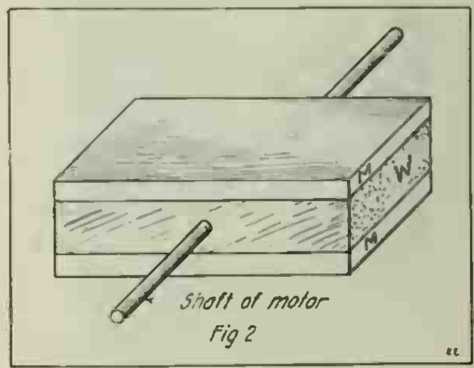
With the spark discharge in action (switch K closed) and the motor at rest, one should then be able to obtain a bright and sharp *image of the spark* upon a piece of white paper held at a point P at the side of, and close to, the spark-enclosing box. (It will be necessary to shift the position of the motor armature by hand until the beam of light reflected from a mirror falls in the right direction.) Move the armature slowly by hand and a number of *separate images* of spark discharges appear upon the white paper. Each separate image corresponds to the easily distinguishable separate crashes of noise coming from the spark gap and corresponds to the discharge phenomenon following each charging of the capacity C. We now proceed to show that when the armature rotates at high speed each of these separate patches of light will *itself* be found to be broken up into separate discharges, meaning that the discharging of the capacity C really consists of a *to and fro* surging of electricity across the spark gap,—each to and fro surging corresponding to an electromagnetic wave "shaken off" into surrounding space. The appearance of the discharge is then as reproduced in Figure 3. It can be seen directly on the white paper screen when the motor is at high speed but it is better to register the effect upon a photographic plate.

Darken the room or work at night in an unlighted room. Place a fresh and extra-rapid photographic plate in the position P, with the sensitive face pointed toward the lens. It is most convenient to put the plate into a regular plate holder, if one be available, and to draw the slide just previous to the exposure. Start the motor and when it has attained its highest speed close the switch in the primary circuit. Now watch the face of the exposed photo plate to see when the light of the spark falls upon it,—for it is obvious that only when the spinning mirrors happen to be in a certain position will they throw the light to the plate. Several records may be obtained upon the same plate provided it be *moved slowly sidewise* to avoid having a spark image fall upon the same part of the plate twice.

It is now plain that the box is placed around the spark gap so that there may be no fogging of the plate by stray light while exposure is being made. Shut off the spark and the motor, develop and fix the plate, and, if careful, you will have succeeded in taking a picture like that illustrated in figure 3.

The photograph reproduced in figure 3 was obtained by using 6 one-gallon Leyden jars connected in parallel to give the capacity C, and 8 turns of a helix of 12 inches diameter whose turns were one inch apart furnished the inductance L. In this case the photo plate was 58.7 inches from the lens and the motor was revolving at the rate of 3,764 revolutions per minute as measured by a speed counter. The speed at which the spot of light crost the photo plate may be casily calculated if it be recalled that when a reflected beam of light comes from a revolving mirror *the beam turns TWICE as fast as the mirror*. (For example if a looking glass receiving a sunbeam is turned thru 45° the reflected beam is turned thru 90°.) In the present case the beam of light coming from the lens is turning at the rate of *twice* 3,764 revolutions per minute, or 125.5 revolutions per second. Hence that part of the beam at a distance of 58.7 inches from the lens has a speed of 2 x 3.1416 x 58.7 x 125.5 = inches per second, or 46,280 inches per second, or 3,857 *feet per second*.

In other words, the spot of light from the spark crost the photo plate at a *speed much greater than that of a rifle bullet*. Furthermore, careful measurements on the photograph showed that there were 4.83 *complete to and fro electrical oscillations* recorded while the image of the spark made a trail *one inch long*. Whence the oscillations were taking place at the rate of 4.83 x 46,280 per second, or



Construction of Rotating Mirror, Comprising a Wooden Block "W," and Two Mirrors "M" and "M."

223,500 oscillations per second. The photograph shows that only about 20 oscillations took place before the energy of this particular discharge was dissipated, but meanwhile 20 wireless waves were thrown

(*Continued on page* 419)

The Einthoven Galvanometer

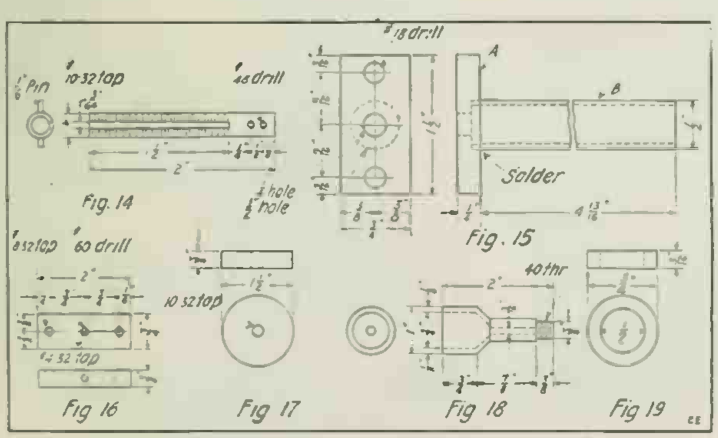
By SAMUEL D. COHEN

PART II.

THE next important thing is the telescopic apparatus, 13, 14. The frame for this is shown in Fig. 18. It is made from brass, and in this job it will be necessary to use a lathe and turn it down very accurately to the diameters given. The lens opening, which is three-quarters of an inch in diameter, will have to be bored out in order to produce a fine job. At the opposite end a three-eighths inch shank is turned and threaded with a No. 40 thread, and this is done on the lathe, as it is very difficult to obtain a die with this pitch, unless made to order. A double-concave lens three-quarters of an inch in diameter is inserted in each tube. These are firmly held in the seat by means of a brass washer, made as shown in Fig. 19. A flannel ring with dimensions equal to the metal washer should be inserted between the lens and telescope tube. Precaution must be taken in securing the lens. The lens can be procured at any opticians' shop at a nominal price. In purchasing the lens it is advisable to obtain those having a focal length of two inches, as this is the proper size for the tube. One of these tubes is used for viewing, while the second is used for admitting light to strike the wire.

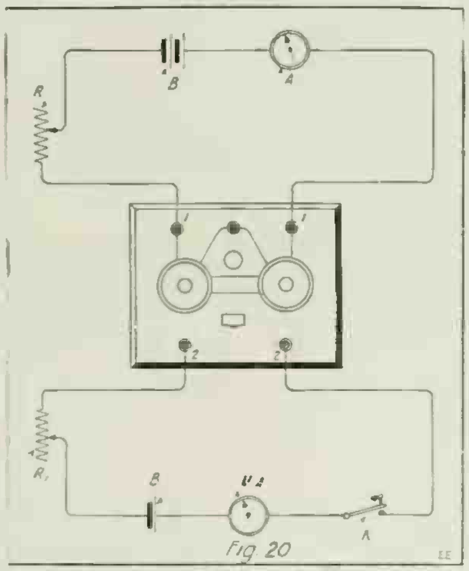
The wire or string is one of the most difficult parts that the constructor will have to obtain. This is a .002 mm. quartz fiber, the surface of which is silver-plated. This may be obtained from manufacturers of scientific measuring instruments. They are worth about $5.00 per string. However, if the amateur finds it difficult in obtaining the quartz, the writer has found that a *No.* 50 *copper wire* will give fairly good results. The difficulty with this wire is that its temperature coefficient is high in comparison with the quartz, and it requires constant adjustment with temperature changes. A piece of No. 18 wire is soldered to each end of the fine wires, so as to support it between the stationary and movable holders on the instrument. The tension is derived by turning the top tension knob.

As soon as the constructor has made all of the required parts, he should carefully assemble them as indicated in Fig. 4. Great care should be exercised to see that all parts fit properly, as the sensitivity of the whole device depends upon how accurately it is made. Three binding posts are placed in the rear of the base, those at the end are connected to each of the electro-magnets, while the central post is used to connect the series terminals of the coils. Two binding posts are stationed in the front two holes on the base and these are used to terminate the ends of the fine quartz or copper wire. This is done by connecting one terminal with the wire support, while the second is brought from the Bakelite insulating block screw, which has the lug with the solid flexible conductor. All of the wires should be soldered at all terminals so as to avoid excess resistances, as the currents traveling thru the quartz or copper wire are extremely minute in magnitude, and a slight increase in contact resistance would cause a sudden drop in amplitude, which would destroy the desired effect.



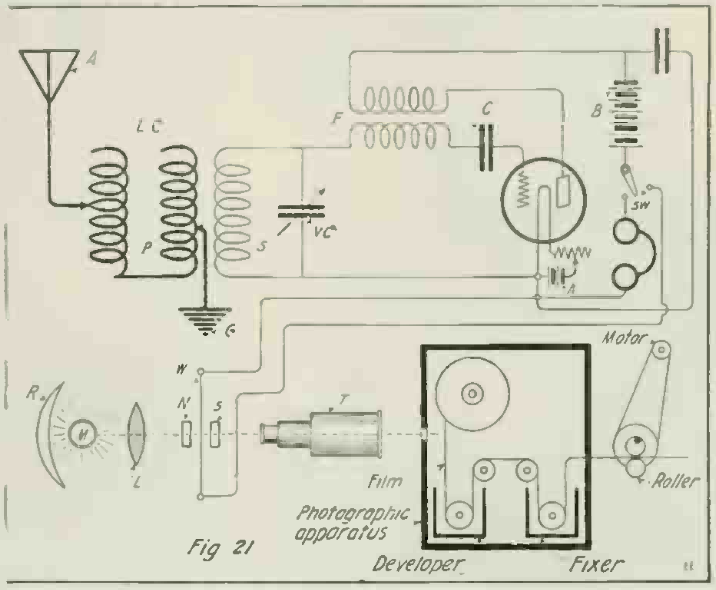
Details of Home-made String Galvanometer Parts.

Great care must be taken in adjusting and the following points will be found to give excellent



Connections For Calibrating String Galvanometers, Regulating Resistances, Etc.

results in adjusting the instrument as found by the author from actual experience. First, the instrument should be connected as indicated in Fig. 20 for adjustment. The two coils are connected in series with a six-volt storage battery, B; an ammeter, A; and a variable resistance, R. The string circuit has its terminals 2, 2, connected to a variable high resistance R_1 with a maximum range of 10,000 ohms and a very sensitive milliampere meter M.A. A key, K, is inserted in the



Radio Receiving Circuit Hooked Up With Einthoven String Galvanometer and Photographic Recorder. This System Was Used Commercially By the Federal Telegraph Company.

circuit and the maximum resistance is inserted at the beginning of the test. Having done this, the next thing is to see whether the string will be displaced when the current from the battery, B_1, is sent thru it, and maximum exciting current traveling thru the electro-magnet. This is noted by viewing thru one of the telescopes, while the other one is placed in the path of a strong ray of light and intermittently closing the key with a light tension on the string. If the string does not deflect the trouble lies with the improper connections of the electro-magnets giving two like polarites at their pole piece, poor electrical connections, or an open-circuit. This should be remedied by carefully tracing out the circuits. The former trouble can be overcome by testing the polarity of the pole pieces with the aid of a magnetic compass. If the trouble lies with the polarity, then reverse the leads from one of the electro-magnets.

To adjust to maximum sensitivity, proceed as follows: Close the string circuit key and adjust its resistance controller R_1, until the milliamperemeter reads nine-hundredths of one milliampere. Then obtain a projector lens and place it in such a position that if a beam of light from an incandescent lamp is placed before one of the telescopic tubes, that the string will be projected upon a white screen placed one meter away from the instrument. Adjust the lens so as to obtain a sharp image of the string on the screen. At the point of the string image, place thereon a metric system rule with its millimeter scale facing the string, and place so that the unit mark shall accurately coincide with the string image. Having all this performed, the next step is to slightly tighten the tension of the string, and with a minimum excitation current in the magnet field, close and open the key rapidly, and note the amount of deflection of the string image on the scale.

In order to detect when the galvanometer is most sensitive, the string must be displaced one millimeter on the scale with the original predetermined cur-

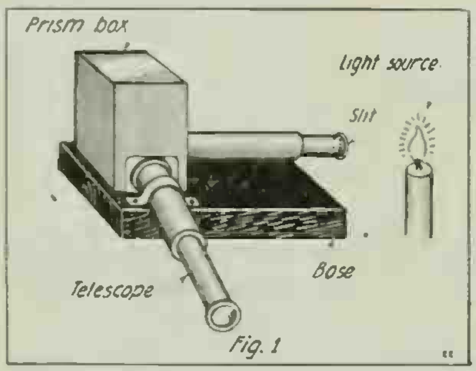
(*Continued on page* 425)

Spectroscopic Methods and Spectra

A SEQUEL TO "HOW TO BUILD A SPECTROSCOPE."

By D. S. BINNINGTON

BEFORE taking up the production of *Spectra*, it will be necessary to refer back to the previous article on this subject,—"How to Build a Spectroscope," which appeared in the August issue. The instrument described will perform a considerable amount of this work, but if this work is taken up systematically, as this kind of work should be, a few small additions to the instrument already described will be found convenient.



Set-up of Complete "Spectroscope," Showing Relative Position of Collimator Tube and Telescope, as well as Source of Light.

The chief of these is connected with the observation of the spectrum, namely the *Telescope*. The *Spectrum* can be observed by placing a reading glass against the spy-hole, which will magnify the spectrum sufficiently for general purposes, but for thoro work and good results a small telescope is a decided improvement. This need not be elaborate or expensive and does not need to be very powerful, one magnifying about 5 to 7 diameters and costing about one dollar, is very satisfactory.

The mounting of this telescope is shown in Fig. 1. The block of wood is adjusted so as to bring the lens of the telescope on a level with the spy-hole, which must be enlarged sidewise to allow of the telescope being moved. The telescope is fastened to this block by means of a strip of tin or copper, and the end of the telescope placed just inside the box which covers the prism, and *exactly horizontal with the prism*.

The exact angle between the prism and the *collimator* and telescope can only be secured by moving the prism till the *maximum spectrum* is obtained. The block to which the telescope is fixt should be fastened to the base *by one screw only*, so as to allow it to be moved sidewise as all the spectrum cannot be seen at once. If this addition of a telescope to the instrument is made, the instrument will need to be adjusted.

This is done as follows: Place a small mirror in place of the prism, so that any light past into the collimator is reflected into the telescope. Having previously focust the telescope on some distant object, place a *white light* in front of the slit, and slide the tube containing the slit (either in or out) till a distinct and clear image of the slit is seen in the telescope. Both the collimator and the telescope tubes should be marked with a line so that the instrument can be placed at these points when necessary. It should be noticed here that the collimator should not be moved from this position, but the telescope will need to be re-focust for each individual test in order to make the spectrum distinct and clear. If these directions have been followed carefully the instrument will be ready for use.

It would not be out of place here now to consider a little of the theory of the instrument, as this, if intelligently studied, will give the operator much more confidence in himself and a better understanding of the principles which underly the instrument. To do this, it will be necessary to go back to one of the first principles of *Optics*, which is that light of any description, when passing from a *rarer to a denser medium, does not travel in a straight line but is bent at an angle out of its path, i. e.*, it is said to be "REFRACTED." This is easily seen from FIG. 2.

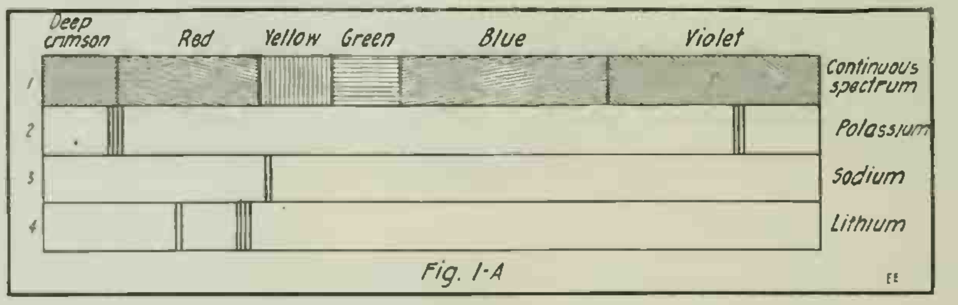
Now, light (by this is meant a primary color) has a definite *wave length*, by which is meant the length of the vibration of the ether which corresponds to the sensation of a definite color. In this respect, Red has the shortest wave length, and the other colors gradually increasing in wave length till violet is reached, which possesses the longest wave length *of the visible spectrum*. Beyond this, rays of still higher wave length, invisible to the eye, are known to exist. These are the ULTRA-VIOLET RAYS. The same is also true of the red end of the spectrum, in which waves of still shorter wave length than the red are known to exist. These are the INFRA-RED RAYS.

It will be useful to note here that the *red* rays are the *heat-carrying rays*, while the *violet* rays are the rays which produce *chemical action*, photography being due to the violet or *Actinic* rays.

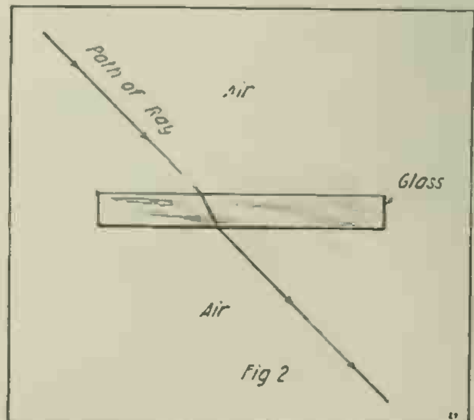
From the fact that these colors which make up white light each have a definite wave length, it can easily be seen that they are not all refracted alike. This is actually the case, and can be readily demonstrated by holding a reading glass outside its focus on a sheet of white paper. A *colored halo* will be seen around the edge. This is due to the varying refraction of the light, which is partially split up. When a prism is used in this fashion, the effect is intensified and a *spectrum* results.

SPECTRA are divided into two classes, (1) Spectra in which the colors form a continuous blend. This is a CONTINUOUS SPECTRUM, and is produced by incandescent *solids* such as the particles of carbon in oil or gas flames, or the filament of electric light. See Fig. 1-A. (2) Spectra in which the colors are isolated bands. This is BAND-SPECTRA, and is produced by an incandescent *VAPOR* or *gas*. In the following material, whenever a white light, or a continuous spectrum is needed, either gas (an ordinary burner or Welsbach), oil or electric light may be used. When a colorless flame is mentioned, a Bunsen burner is preferable, but an alcohol lamp with a *clean wick* can be used.

The methods of producing spectra: Class I. Methods in which gas, alcohol or gasoline is used to produce the spectra. Class 2. Methods in which electricity is used to produce the spectra.



Note the Two Classes of Spectra—the First the "Continuous Spectrum" and the Second the "Band-Spectra." The Latter Comprises Distinct Isolated Bands of Color as Shown.



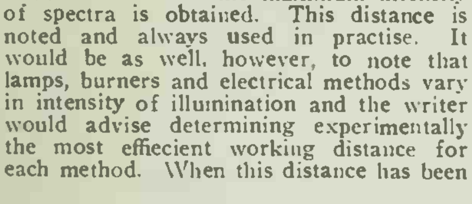
"Refraction"—the Principle of Optics Which Says That a Light Ray, When Passing from a Rarer to a Denser Medium, Is Bent out of Its Path, as When Passing thru Glass or Water.

Class 1 being the simplest will be taken up first. When using this method, however, it must be borne in mind that only those metals whose salts can be volatized at the temperature of the Bunsen flame can be used for this method. These metals are Sodium, Potassium, Barium, Strontium and Calcium, and the rarer metals, Rubidium and Caesium, and the extremely rare metals, Thallium, Indium and Gallium.

The wires used in this method are preferably of platinum, but a pure grade of iron wire (piano wire) can be used satisfactorily. If platinum is used, about 2 inches of No. 28 B. & S. gage is sufficient for each wire, but if iron is used about 3 to 4 inches of a slightly thicker wire should be used. The wires are mounted as shown in Fig. 3. A piece of glass tubing about 4 inches long and 3/16" diameter is drawn out to a jet, which is broken off and the wire inserted, the glass tube is now heated around the wire till it fuses onto it. The other end of the tube is heated in a flame till it closes. The free end of the wire is bent into a loop about 1/8 inch diamter. If platinum wire is used, two wires will be sufficient, but if iron is used about six should be made. Platinum wires are kept in a small bottle containing *chemically pure* hydrochloric acid. The glass handle of the wire should be pushed thru a hole in the cork. They are cleaned by first wiping off any loose matter with a piece of cloth and then dipt in hydrochloric acid and heated in the flame. This is repeated till *no color* is given to the flame.

If much work is planned, a stand to hold these wires when in use is desirable. This can be made easily as follows: Make a base of wood, about 2 inches square and ½ inch thick. Thru the center bore a *small* hole, thru which push a stiff pointed piece of steel wire (a hatpin with the head removed is just the thing). Then take a cork about 1 inch long, and push it on to the pin so that it can be moved but fits tightly. Bore a small hole in it to take the glass handle of the wire at right angles to the upright pin. The wire can then be moved up and down or around, and adjusted and held in the flame for any required length of time without any trouble. The finished stand is shown in Fig. 4.

The Spectrum is taken by this method as follows: First take a white light, and place it in front of the slit and about 12 inches away. Observe the spectrum and gradually move the lamp closer till a point is found at which the maximum intensity of spectra is obtained. This distance is noted and always used in practise. It would be as well, however, to note that lamps, burners and electrical methods vary in intensity of illumination and the writer would advise determining experimentally the most effecient working distance for each method. When this distance has been obtained, the thoroly cleaned wire is moistened with hydrochloric acid, dipt in the *powdered* salt, placed into the holder and heated in the flame. If much work is being done, it is advisable to darken the room, as this is easier on the eye.



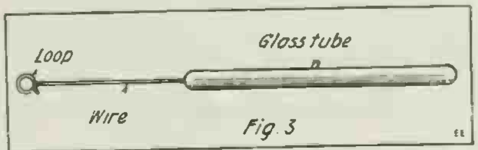
Stand for Holding Vaporizing Ring in Bunsen Flame for the Production of Spectra in Spectroscope.

When a spectrum is wanted for a considerable length of time, the following procedure can be adopted:—A small piece of asbestos wool is placed in a large test tube, covered with hydrochloric acid, and boiled; the acid is then decanted off, water added, shaken up well, the asbestos allowed to settle, and the water decanted off. The asbestos is then shaken out onto a piece of cheese-cloth, squeezed till dry, placed in the tube again, fresh acid added, and the process repeated. It should then be held in a twist of wire and heated in the flame for about 5 to 10 minutes. If it colors it at the end of this time, it should be again washed with acid and water. When clean it is twisted onto a clean wire about 5 to 6 inches long.

The material desired for the spectrum is dissolved in water to make a strong solution. The asbestos is dipt into this, and then gently heated till dry, and then again dipt into the solution and re-dried. Two drops of hydrochloric acid are dropt onto it, and it can then be placed into the flame. The spectrum thus produced will last a considerable time.

This method has one objection, however, and that is when the asbestos becomes red hot, it gives a *continuous spectrum*, but if the slit has been made narrow enough this will not cause any trouble.

Occasionally, a yellow sodium light is required. This can easiest be made by using an alcohol lamp and placing a *little* salt, or borax, on the wick. This will give a *yellow light* indefinitely.



Wire Loop and Handle Used to Volatize Various Metal Salts in the Bunsen Flame, for the Production of "Spectra" to be Studied in the Spectroscope.

The best salts to use in taking flame spectra are the chlorides or chlorates. If these can not be procured, however, the available salt is mixt to a thick paste with hydrochloric acid. This subject, however, will be treated of more fully further on. This about covers the field of one method of spectra-production. The next section to be taken up is:—

ELECTRICAL METHODS

Electrical methods can be sub-divided into into three general classes:—

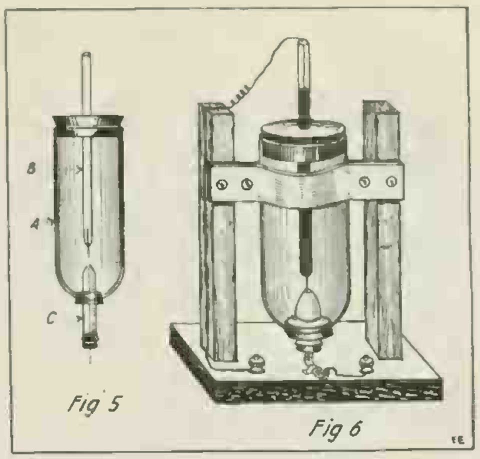
(1) Production of spectra of and in *gases*.

(2) Production of spectra of *liquids* or solutions.

(3) Production of spectra of *solids*.

Class No. 2 being the one most widely applied, will be considered first. In this method the material in the form of a solution is vaporized in the electric spark.

The apparatus requires an induction coil, giving not less than ¼ inch spark. Indeed the larger the spark the better will be the results obtained. The apparatus is shown in detail in Fig. 5. The glass cup "A" should be about 1" diameter and about 3 inches long. Test tubes can be purchased about 8" x 1", which when treated as below, make two excellent cups. The tube is cut about 3 inches from the bottom. This gives one good cup about 3" long and a piece of tube about 5" long. It is heated in the flame and worked with a large nail till the bottom is closed. This will eventually bring it to about the same length as the other.



Electrical Apparatus for Producing Spectra of Various Liquids—These are vaporized in the Electric Spark Provided by a ¼ Inch Spark Coil.

Of course as will be seen later on, a small bottle with its bottom cut off could be used, but the author would not advise this as the thickness of the glass will cut off some of the violet rays, besides distorting the image, while the apparatus made with a test tube is easier to make and will give far more satisfactory results.

A hole about ½" diameter must now be made into the bottom of the tube. This is done as follows:—Plug up the tube with a cork thru which passes a piece of glass tube connected to the mouth with a piece of rubber tubing. Heat about ¾" in the center of the bottom of the cup with a small flame, to bright redness, and then blow strongly into the tube. The bottom will then blow out. It should be carefully trimmed with a file till it is flush with the tube. The edges of this hole should now be heated in a small mouth-blowpipe flame till they fuse and assume a smooth appearance.

The next step requires about 3" of platinum wire. This can be obtained from any laboratory supply house. A six-inch piece of No. 28 B. & S. gage will cost about 75c and will make various pieces of apparatus. No. 32 B. & S. can be used and comes a little cheaper, but No. 28 is more satisfactory and will give better service.

The tube "B" is about 5 inches long and 3/16" internal bore. One end has sealed into it about 1 inch of platinum wire, so that about ¼" projects into tube. The tube "C" is the most important part of the apparatus, and the directions should be carefully followed. A piece of glass tubing about ¼" *internal diameter* is drawn out to a jet and cut off to about 1 inch over-all length. The large open end of the tube is smoothed in the flame, and the jet end is ground on a piece of moist emery cloth till it has an aperture not larger than 3/64" (between 1/32" and 1/16" is correct). The bottom of this tube is corked with a small piece of rubber thru which a small hole has been made. Thru this hole, the platinum wire (about two inches) is worked, so that when the rubber stopper is in place, the platinum wire is just in the end of the jet.

The position of this wire can always be adjusted by moving the rubber stopper slightly. About ½ inch or more of wire should project beyond the lower end of the cork. The whole arrangement is fastened into the tube "A" by a cork in the lower hole. The tube "B" is fastened into the tube by a large cork, which should have a slit cut in one side to allow gases to escape. The distance between the spark

(*Continued on page 427*)

Ohm's Law and A. C. Circuits

By ARNO A. KLUGE, Instructor in Radio, University of Nebraska

A SUBJECT that is usually rather hazy in the mind of the practical electrical man who has never had the opportunity of engineering training, is the application of Ohm's law to *alternating current* circuits. This may be traced to a total lack of literature of a concise nature on the matter, for in most text-books it is necessary to digest several chapters of non-essentials before the point is reached.

In alternating current practise we encounter three different kinds of paths or conductors of the current, and it is the method of computing their effective resistances in various combinations that this article has to deal with. The first kind is the simple straight wire, whose resistance, for low frequencies, at least, depends wholly upon its length, cross-section, and material. It must be clearly understood that this applies only to currents of *audio* frequencies, as from 25 to 500 cycles, since any conductor at *radio* frequencies possesses *appreciable capacity and inductance.*

The second and third cases of paths are the condenser and the inductance coil, designated as *capacity* and *inductance*, respectively. Seldom if ever do we find these cases in a circuit alone, but usually in combination with one or both of the other two. For example, an inductance coil always has *resistance* associated with it, since it is impossible to obtain a perfect conductor.

We can then make a table for the equivalent ohmic resistance of each of these types, from the data we find in text-books, as follows:

Type	Equivalent Ohmic Resistance
Simple	R, (Resistance of conductor)
Capacity	$\frac{1}{CP}$, (C = capacity in farads)
Inductance	LP, (L = inductance in henries)

In the above P represents the *reactance factor* of the current applied, being

$P = 2\pi n$ (where n = frequency in cycles)

The difference in the value of these resistances is due to the differing effect which they have upon the voltage and current of our power supply. A condenser in the circuit causes the current to *lead* the voltage, while an inductive resistance causes the current to *lag behind* the voltage, the maximum possible limit in either case being 90°, which represents a *zero power factor*, or a watt-less current. This is grafically shown by Fig. 1.

Applying Ohm's law to the case of a simple *non-inductive resistance*, we find that the current is given by the expression:

$$I = \frac{E}{R}$$

with which the reader is already familiar. This is represented in Case I, see diagrams.

Extending our formula to the case of a *pure capacity*, we have

$$\text{(Effective) } I = \frac{E}{1/CP} = ECP$$

or, the current which will flow in the circuit is the product of the voltage applied (voltage as measured by an A. C. voltmeter which gives the "effective value"), times the capacity (farads), and the reactance factor P. Case 2 shows this.

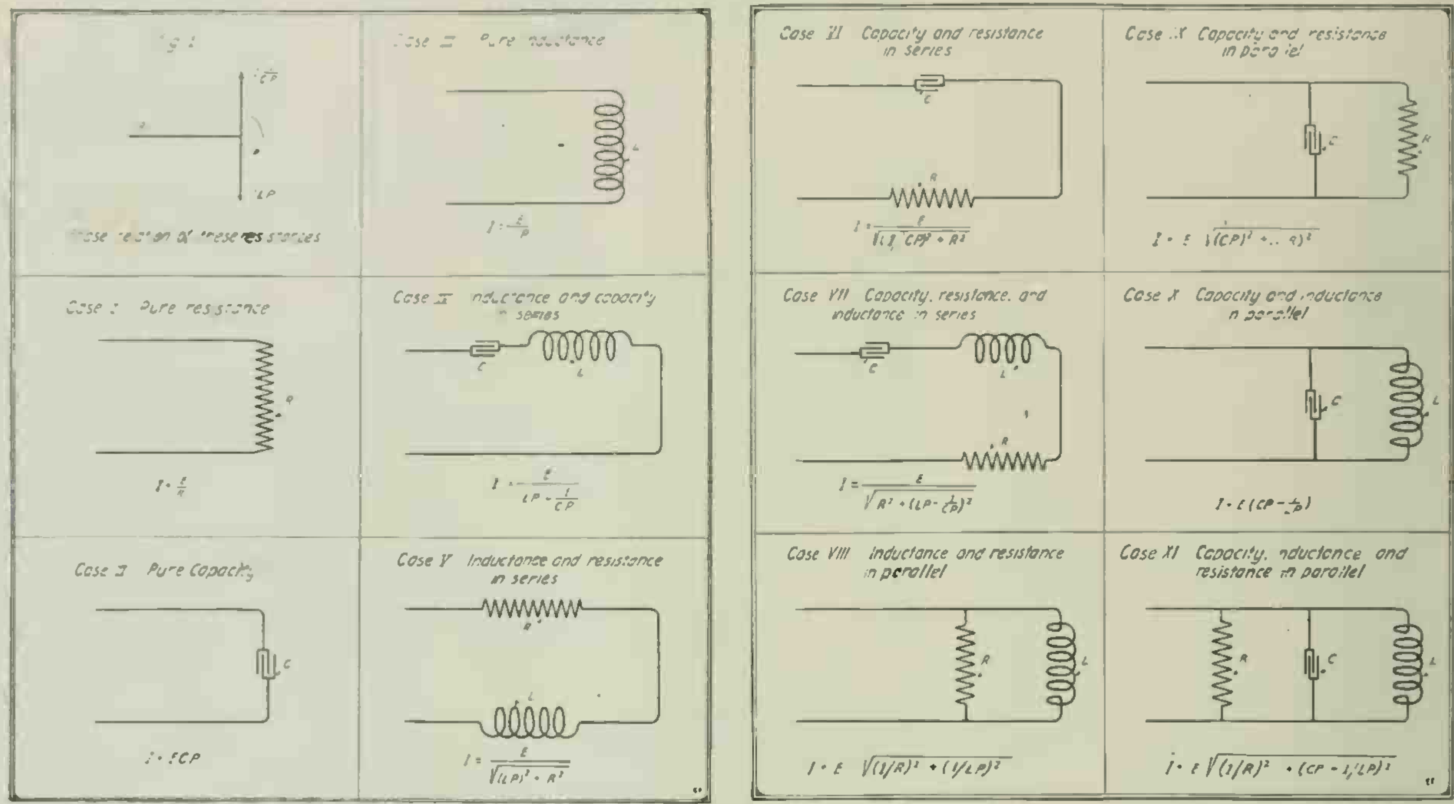
And for the case of a pure inductance, if such a thing were possible, we would then have

$$I = \frac{E}{LP}$$

as shown by Case 3.

In addition to these simpler ones, cases 4 to 11 illustrate various combinations of them, and by use of the formulae attached the student is enabled to calculate the current which will flow in any possible circuit. It should be borne in mind, however, that while these formulae will give the actual value of the current flowing in the circuit, we cannot then mutiply this amperage by the imprest E.M.F. and obtain the power consumption of the circuit in watts. The latter is wholly dependent upon the *power factor*, i.e., the per cent lag or lead of the current, and it will be necessary to multiply the product by this factor to obtain the true wattage consumption of our circuit.

The power factor of an A. C. circuit is found by dividing the *true watts* as read off from a compensated indicating watt-meter by the *apparent watts*, which latter term is the voltage resultant from multiplying the effective or indicated volts by the effective or indicated (or calculated) amperes. Some A. C. installations are fitted with a direct reading *power factor meter*.



Here Are the Various Alternating Current Circuits Encountered In Practise. These Combinations Include Different Combinations of Resistance, Inductance and Capacity, and the Simplified Forms of Ohm's Law Applicable to All of These Circuits Are Here Given. Cut out These Charts and Paste Them in Your Note-Book.

WOMEN INSTRUCT IN RADIO WORK.

Miss Baruch, daughter of Bernard Baruch of Glen Cove, Miss Chanler of Stony Brook and Miss Perrine of New York are instructing the men of the air service at Mitchel Field in radio work. There are twenty-five other women who are volunteering their services in instructing the men in both the English and French language. Special attention is given to the men who are not familiar with the English language, with especial reference to military terms.

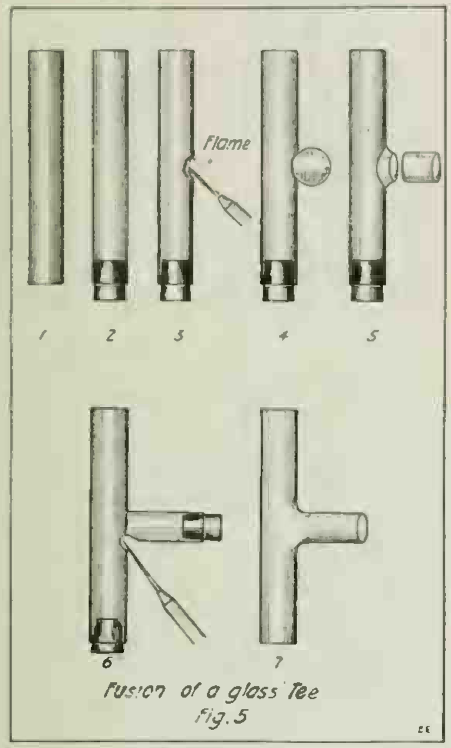
At one period no mail reached the miners of Spitzbergen for eight months, but they are now able to get the world's news twice a day by wireless telegraph.

The Manipulation of Glass Tubing in the Experimental Laboratory

By Prof. HERBERT E. METCALF

PART II

It is often necessary to fuse a small tube to a large one or to make other *end-to-end* fusions. Fusions are the hardest part of glass blowing and must be done carefully in order to produce satisfactory results. Many experimenters heat the ends of two pieces of glass in a flame and then stick them together only to find out that they will break apart upon the least provocation. A real fusion, properly done, will prove as strong as any other portion of the tubing. Heating the ends and sticking them together is the first part of the process, it is true, but the procedure extends beyond that. After the ends are stuck together they must *never be allowed to cool.* A cork is stuck in one of the ends and then a sharp needle-like flame from the blast lamp is directed at one side at the place where the two tubes join. This point will soon become white hot, the glass will run together and will bend in under the force of the flame. Removing the flame, blow very gently into the open end of the tube, thus bringing back the bent portion into its proper shape. At this point the glass is properly fused. This same procedure must be repeated all around the circumference of the fusion. When finished all points will be perfectly fused, with the two ends of each melted off smoothly one into the other: All this time the tube must not be allowed to cool. Therefore the work must be done rapidly and the joint must not be laid down until entirely finished. When the fusion is completed it must be gradually cooled in a yellow flame until *sooted.* It may then be laid on the asbestos mat to cool.



Successive Stages to be Followed in Fusing a Glass "Tee." It is Made of Two Pieces of Glass Tubing of Approximately the Same Sizes. It Looks Hard, But is Comparatively Simple When You Once Master the Trick of Handling Glass. Read Part I First by all Means.

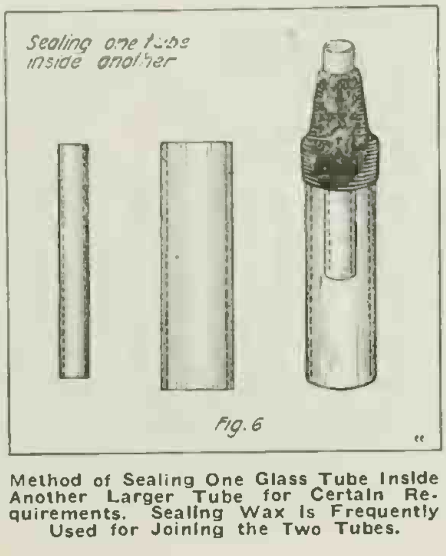
MAKING "T'S" AND "Y'S."

T's and Y's are only variations of the end-to-end fusion process. The principal difference, however, is in making the hole in the side of the glass tube, and the order of procedure in the more complicated pieces.

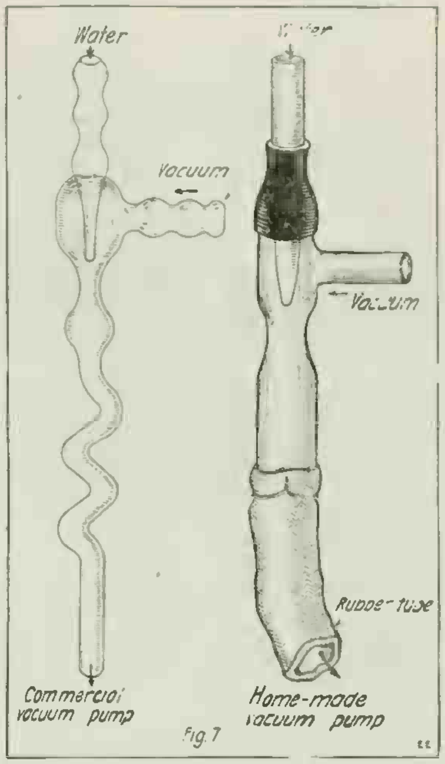
To make a hole in the side of a piece of glass tubing is a simple matter, but to make a hole of the proper size is much more difficult. First select the top bar of the "T" and direct a sharp, very fine needle-pointed flame at the place where the hole is to be, see Fig. 5. A cork having been placed in one end of the tube will enable the manipulator to blow out a small bubble on the side of the tube at the point which the blow pipe is heating *white hot.* Now the size of the resultant bubble will depend upon the area which is *white hot* and also upon the force with which the bubble is blown out: A few trials will soon give the knack of obtaining various sizes of holes. This bubble may then be broken with a file and the edges trimmed down, taking extreme care to leave a small lip to aid in fusion: The hole is now ready for the fusion. Heat the edges of the hole until they are sticky; heat the end of the piece to be fused on until it also is sticky, then stick them together with a slight rotary motion, being sure that no small air leak exists. If a leak is present it will prevent the effect of blowing in the tube.

As there are now two open ends, one of them must be plugged with a cork, leaving only one to blow into. The needle pointed flame is again brought into use and the joint fused by alternately melting in and blowing out the glass all around the circumference of the weld. The "T" must then be *sooted* thoroly and laid away to cool.

A few words about this all important *blowing* operation which forms a part of all glass tubing manipulation. It is so important it must be thoroly understood. Upon directing the needle-pointed flame on a portion of the circumference of two tubes at the point where fusion is to take place, the glass in a small spot, depending on the size of the flame, will become white hot and the edges will fuse or run together. But, at the same time the tube at this point will bend inward, and must be gotten back into shape. This is done by blowing gently into the open end of the tube just hard enough to get the hot portion of the tube back to its proper position. That is why corks have to be put in all but one opening, and that one left to blow thru. Now it is sometimes necessary to use pieces of tubing which are too short to be blown into without being burned. This may be avoided by attaching a small piece of rubber tubing to the open end of the glass tube and then blowing into the rubber tube. *Never blow into the tube while the flame touches the glass.*



Method of Sealing One Glass Tube Inside Another Larger Tube for Certain Requirements. Sealing Wax is Frequently Used for Joining the Two Tubes.



Duplicating a Commercial Glass Vacuum Pump (left) by Simple Home-Made Design (right). Former cost $2.50—"Made in Germany." Latter Cost 25 Cents and Works Just as well.

Having made a "T" it is a very simple matter to make a "Y". After the "T" has been fused, direct a larger flame so as to heat the entire tube in the neighborhood of the joint and then bend into the shape of a "Y".

Tubes with any number of side openings may be made: A cross may be made with one precaution. Proceed to make a "T", and then immediately start working on the other side without allowing the first joint to cool. This is to avoid re-heating and re-cooling a joint once made, as they are apt to crack.

MAKING CONSTRICTIONS IN GLASS TUBING

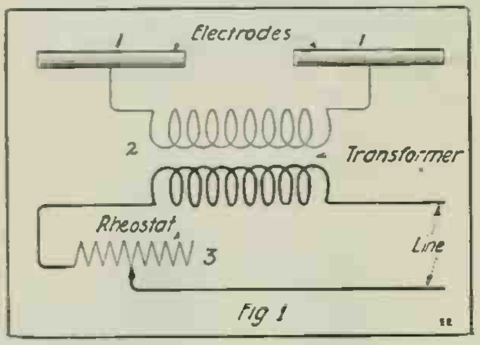
The ordinary way of making a *constriction* in a glass tube is to merely heat a portion of the tube and then draw the two ends apart until the required result is obtained.

(*Continued on page 422*)

Experimental Electric Furnaces

By JEROME S. MARCUS, B. Sc. (Chem. Eng.)

AN electric furnace is an apparatus for the production of high temperatures by electricity. The advantages of such an apparatus are—the direct application of heat to the material, thus eliminating excessive losses by conduction thru the walls of a containing vessel; the production of high temperature, usually above those obtainable from fuel in common uses; simple and accurate regulation, giving absolute control of a process and an economical use of power; and finally, with sources of water-power, a low operating cost.

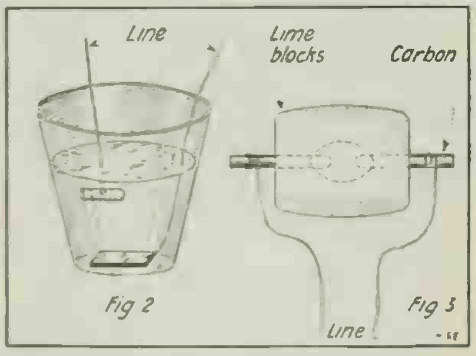


For the Resistance or Induction Type of Electric Furnace, a Step-up Transformer is Generally Necessary as a Higher Voltage Than That on Commercial Circuits is Required.

There are several types of electric furnaces in use. The general division are—the *Induction* type, and the *Resistance* type. The purpose of this article is to give the experimenter the simple construction details and operating principles of these furnaces.

Before going further, it is well to inform the operator of any of these devices to watch his fuses, as many will be blown without the proper regulation of the rheostat in Fig. 1. The experimenter will find that a transformer is not necessary for a small arc furnace, but in the case of the resistance or induction types a higher voltage than the ordinary lighting current is required for good results.

The author has found the simplest rheostat to be of the water-barrel type. A wooden pail is first filled with strong salt water. A metal plate in the bottom is attached to one lead, which is well insulated; a piece of rubber hose over the wire is excellent. To this other lead is soldered a metal electrode of any sort. The distance between the plate and the electrode regulates the current; the closer they are the less the resistance. The experimenter may fit up a support for his adjustable electrode to suit his convenience. Fig. 2.

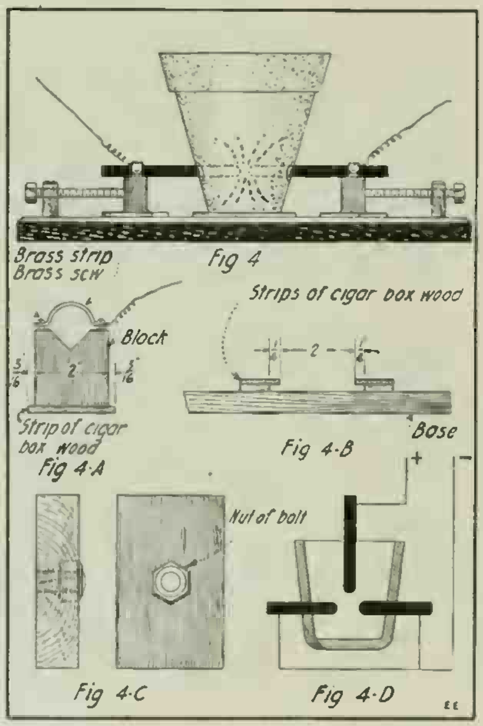


A Simple Water Rheostat For Regulating the Current Passing Thru the Electric Furnace, and a Small Furnace Constructed From Two Lime Blocks.

The arc furnace is by far the best for the amateur. It is the simplest and cheapest in construction, the easiest of operation and regulation, the most economical and is productive of higher temperature than the other types.

A furnace which will give practical results can be made from two blocks of slaked lime, hollowed out and grooved for two carbon electrodes, as shown. This apparatus can be run on the ordinary lighting current the same as an arc-light. To start the arc in operation the carbons are touched together and then drawn a small distance apart, giving a steady arc. The material to be melted is placed in the hollow beneath the arc. To stop the arc, the carbons are drawn far apart, thus breaking the arc. The use of a rheostat or "ballast" improves the steadiness of the arc. A transformer is not necessary as was stated before.

Since an electric arc between carbon wears down the postitive electrode, adjustment is frequently necessary in order to maintain the flow of current. One carbon should therefore be made loose in order to feed it in as required.



The Flower-pot Electric Furnace—a quickly Made Type For Experimental Work. Note the Three-Electrode Furnace at Fig. 4-D.

The above apparatus is not one that the experimenter cares to have as a permanent part of his laboratory. Below is given a description of a highly efficient furnace with which any experiment can be readily performed.

A clay flower pot is drilled to permit the carbon to pass thru, and is lined with fireclay or lime. The carbons are attached to wooden blocks, as shown. The pot is set on a board base with a circle of asbestos beneath. The adjustment of the carbon is made by means of threaded bolts moving the blocks in grooves. A single pole, single throw-knife switch may be mounted on the base. A clay cover is placed over the pot when in operation. The details are shown in Figs. 4 A, B and C. One inch wood is used for blocks and base.

A three-electrode arc furnace is shown in Fig. 4-D. The positive electrode only needs to be adjusted to keep the arc in the center of the chamber.

The adjustment of the electrodes is eliminated if water cooled metal ones are utilized in place of the carbon. These are more expensive to make, however, and unless carefully made soon come apart. A copper disc is welded or brazed on the end of a copper or brass tube. The cooling water is introduced thru a small metal pipe, see Fig. 5. An electrode can be made of iron pipe with a cap screwed on the end but is less efficient, owing to the high resistance of the iron.

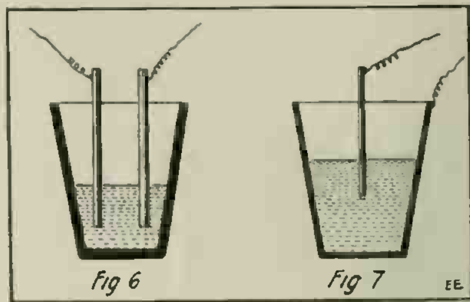
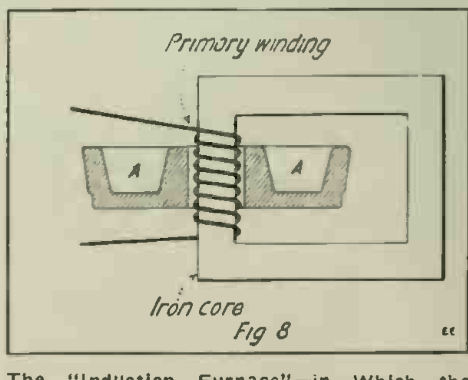


Fig. 6, Shows a Two-Electrode Resistance Furnace. Fig. 7, a Single Carbon Electrode Furnace Utilizing a Grafite or Fire-clay Lined Metal Crucible as the Second Electrode.

The resistance type of furnace depends on the resistance offered by the material to an electric current. for its source of heat. This form of furnace is the one used in the manufacture of carborundum, the smelting of ores, especially aluminum and in the refining of zinc.

The simplest resistance furnace consists of a flower pot or other clay container, in which the material is placed around two carbon electrodes, as shown in Fig. 6. Very often it is necessary to place a little granulated carbon between the electrodes to start the flow of current.

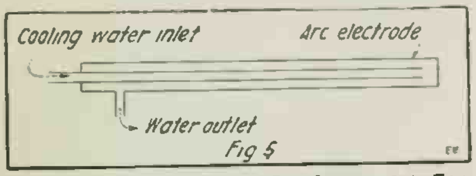
Another type of resistance furnace utilizes the container as one electrode. A grafite crucible is generally used, altho an iron pot lined with fire clay in which a large amount of carbon has been mixed, may be used for the lower temperatures. Only one connection is then made to the carbon electrodes, of which there may be one or several, depending on the size of the furnace, the other connection being made to the container itself. Higher voltages than 110 are best for this type of



The "Induction Furnace"—in Which the "Charge" Forms the Secondary Circuit at A-A. Current Is Transferred From the Primary Winding by Induction.

furnace, the amperage varying with the resistance offered by the material. The carborundum furnace at Niagara Falls runs on potentials as high as 22,000 volts.

The induction furnace (Fig. 8) is not a practical one for the experimenter. It requires some of the molten material to start it, and due to the high reactance resulting from the distance between the primary and



The "Arc Furnace," to Be Successful For Steady Work, Is Best Equipt With Hollow, Water Cooled Electrodes of the Design Shown.

secondary is uneconomical for a laboratory device. The induction furnace operates as a transformer, the secondary winding in this case being the "charge," which is contained in the circular channel A, and is heated by the secondary current. The amount of energy put into the secondary can be varied by varying the applied primary voltage.

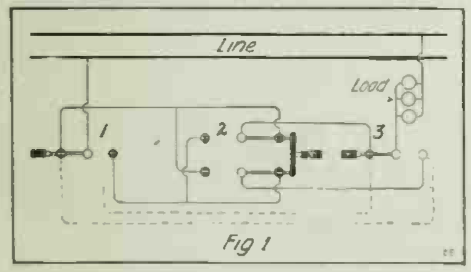
It is hoped that these few notes will prove useful to the electrical experimenter. There is a large number of unsolved problems concerning the behavior of various substances at high temperatures yet to be worked out, and the results of some experimenter's research may be, for all we can tell, of great commercial or scientific value.

TRICKS IN 3- AND 4-WAY LIGHT SWITCHING.

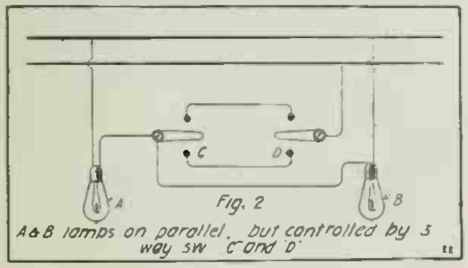
By Y. R. Mann

In the experimenter's laboratory it is often desirable to have control of current from two or more points. To accomplish this easily and at a low cost, battery type, porcelain base, knife switches may be substituted for the standard 3-way and 4-way push button switches. It must be remembered, however, that when the current is turned off by opening one of these switches (see Fig. 1) the blade must be thrown over to the opposite contact, so that the throwing of another blade will close the circuit again. In the standard snap and flush switches this operation is accomplished automatically by means of the spring.

The solid lines from switch to switch (Fig. 1) show the circuit as arranged for control from three points, using one double-pole and two single-pole, double-throw switches. The connections for control from two points are made by using only the



Circuits of a 3-Point Control For Electric Lights, using Standard Knife Switches.



Controlling Two Lamps, Connected on Parallel at Different Points, By Two 2-Point Battery Switches in Different Locations.

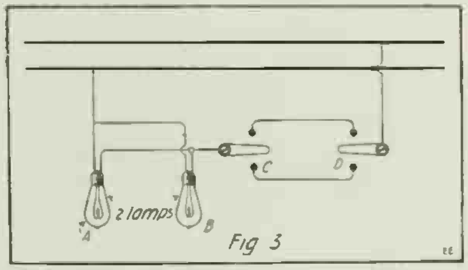
single-pole switches, connnected to the line and load as shown, and connected together as shown by the dotted lines.

Making a D. P. Switch from a 3-Way.—Any standard 3-way flush push-button switch may be changed to a double-pole switch by removing the contacts from one side (not one end) of the shell and transposing them. As in a 3-way push-button switch the contacts are arranged so that there is a high and a low one in each end of the shell, this change gives two high contacts in one end and two low ones in the other, making the switch either all on or all off at each consecutive push.

The strip of metal which bridges the "live" end of the 3-way must be removed or permanently disconnected. Line connection may be made to the point which has no screw by soldering the wire to it or by simply hooking the wire firmly and tightly in the unthreaded hole.

To change a double-pole flush push-button switch to a 3-way, reverse the above operation, bridging one end by a piece of wire and removing one screw from that end so that the "live" end can be readily distinguished.

3-Way Hook-Ups.—Fig. 2 shows two S. P. D. T. knife switches connected up to control two lamps in two rooms from two different locations. Fig. 3 illustrates two 3-way (or two S. P. D. T. knife switches) controlling two or more lamps, A, B, etc., in a group, the switches being placed in such positions as at the top and bottom of a stairway, etc.



Hook-up For Two 3-Way Switches to Control One or More Lamps A, B, Etc., In a Group, the Switches Being in Such Locations As At the Top and Bottom of a Stairway.

FILING SMALL HOLES.

It is often necessary to enlarge a hole thru a thick piece of metal by filing. If a very thin file is used, that will pass right thru the hole, there will be no risk of its getting jammed and snapping off with the end firmly imbedded in the work, as might happen if a stouter file were used that would only enter the hole for a portion of its length. On the other hand, only a limited amount of force can be exercised with safety when using a thin and delicate file, which makes the operation rather tedious. The best way is to select as strong as file as possible for the job, marking the safe limit to which it may enter the hole, and preventing it from going any further by slipping a small cork over the end. The file can then be used vigorously without any risk of striking.

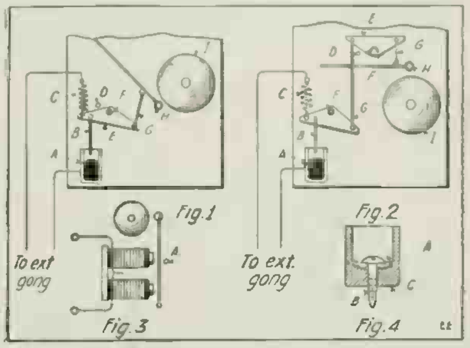
Contributed by H. J. GRAY.

AN EXTENSION GONG FOR A CLOCK.

In the sketch, A is a carbon cup holding mercury; B, a piece of No. 10 gage wire; C, a weak spring to raise B from cup; D, stop to prevent apparatus from turning out of position; E, piece of tin cut in triangular shape; F, pivot for tin triangle; G, cord or catgut connecting hammer with triangle; H, hammer, and I, the clock gong.

Figure 2 shows the arrangement if hammer is over gong and cannot operate as in Fig. 1. For the extension gong (Fig. 3) remove the vibrator from an old electric bell and connect as shown in diagram. D is a bumper for the armature.

In Figure 4, A is a rubber washer; B, brass screw, and C, carbon cup.



A "Mercury Switch" Rigged Up to Ring Extension Bells Whenever a Clock Strikes the Hour and Intermediate Periods.

I recently made an extension electric gong for a clock, so that it would strike whenever the clock struck, but I experienced trouble in getting good contacts in the clock. At first the contact was made by the hammer striking the gong, but this did not give satisfaction, so I devised an apparatus which is shown in diagrams, that worked with excellent success.

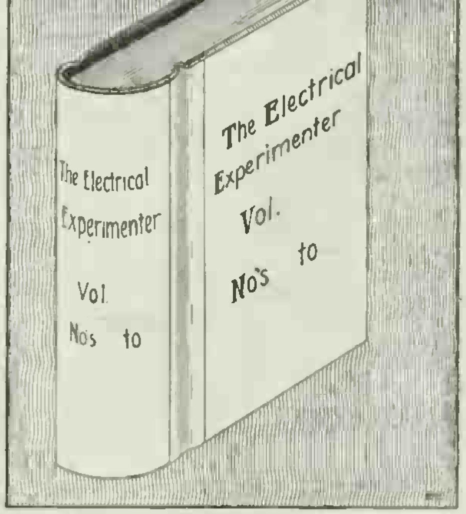
The carbon cup, A—which is mentioned in the diagrams—is easily made from a piece of a round carbon from an old battery. The holes are easily made in it with the use of an old pocket knife.

Contributed by CHAS. J. EDWARDS.

TITLING BOOKS

Many readers desire to title bound volumes of the *Electrical Experimenter*, or other magazines, or books which have been re-covered, etc. The usual method is to mark it in either black or white ink, according to the color of the covering. This method may be improved upon by applying a coat of transparent shellac over the lettering, and thus prevent the wording from becoming obliterated from hard usage or by being rubbed off with the fingers. When the lettering his dried, the shellac is applied, and allowed to dry thoroly before being used. It is advisable to apply one or more coats to the cover.

Contributed by
ALBERT W. WILSDON.



A Hint on Titling Bound Volumes of the "Electrical Experimenter" and Other Books.

Experimental Chemistry

By ALBERT W. WILSDON

Twenty-ninth Lesson

THE HALOGENS—CHLORIN (HISTORY)

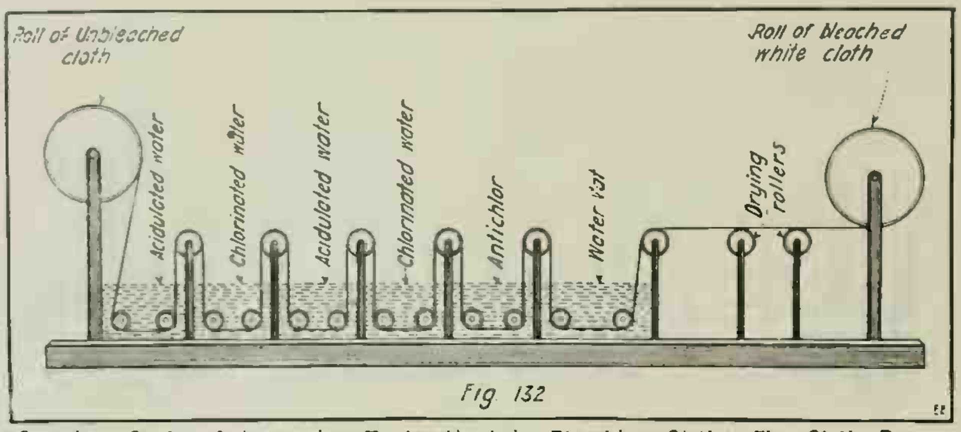


Fig 132

Complete Chain of Immersion Tanks Used in Bleaching Cloth. The Cloth Passes From Left to Right Thru the Acidulated and Chlorinated Water Vats Successively.

CHLORIN was first prepared by Scheele in 1774 while he was experimenting with "black magnesia" (an ore consisting largely of manganese dioxid) and hydrochloric acid, but it was not until 1801 that Davy first establisht its elementary character. Scheele called it "Dephlogistic Muriatic Acid". Berthollet named it "Oxidized Muriatic Acid", supposing it to be a compound, because he observed that its solution in water yielded muriatic (hydrochloric) acid and oxygen, when placed in sunlight. Davy applied the present name, chlorin, on account of its *greenish-yellow* color.

Fig. 133. Set-Up of Chemical Apparatus for Preparing Chlorin Gas From Hydrochloric Acid and Manganese Dioxid.

Gay-Lussac and Thenard demonstrated that one volume of it united with one volume of hydrogen to form hydrochloric acid.

OCCURRENCE.

Chlorin does not occur in the free state in nature as its affinities are too great. It is found abundantly in combination with sodium in the form of *sodium chlorid*, which is found in sea waters, inland lakes, and beds or deposits, from which it is dug like coal. It is also found combined with magnesium, which is a much smaller constituent of sea water than sodium, and which is also found in some mineral springs.

Preparation.—

(1) In the laboratory it is usually prepared by removing the hydrogen from hydrochloric acid with the aid of manganese dioxid. In this reaction the hydrogen taken from the acid unites with the oxygen of the manganese dioxid, according to the equation:—

$$4HCl + MnO_2 = MnCl_2 + 2H_2O + Cl_2$$

Chlorin has affinity for metals, and so half of it unites with the manganese present to form the compound *manganous chlorid* ($MnCl_2$). It might be expected that $MnCl_4 + 2H_2O$ would be the products, but one atom of manganese cannot hold more than two atoms of chlorin, and half the chlorin is thus set free, having nothing with which to combine, while all the oxygen goes to form water. You will observe that the valence of the manganese in the factors (to the left of the above equation) is 4, while in the products (to the right of the above equation), it is 2; or in other words, towards oxygen, manganese has a valence of 4, while towards chlorin its valence is 2. This is a reduction and oxidation, hydrochloric acid being the reducing agent, manganous chlorid the reduction product, and chlorin the oxidation product.

(2) It may be prepared by the *electrolysis* of hydrochloric acid or the chlorides by utilizing the electrolytic generator shown by Fig. 130 of this series, in the September issue of this journal. The principle involved is the decomposition of the acid, or chlorides, by means of an electric current,

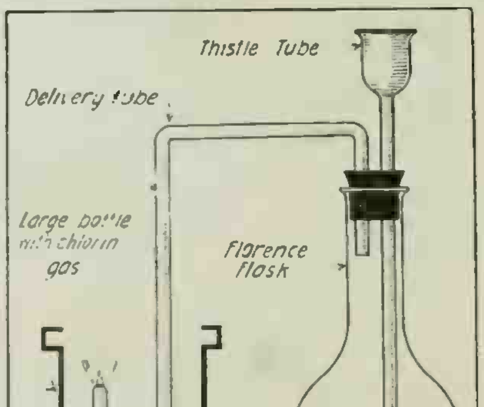


Fig. 135

Apparatus Used in Burning Hydrogen in Chlorin Gas Experiment.

in which the chlorin is liberated and collected at the anode, and the hydrogen or sodium (if sodium chlorid is used) collected at the cathode. In the various processes, many mechanical difficulties have been encountered in the form of secondary reactions taking place with the formation of sodium hypochlorit, chlorat and chlorid, due to the diffusion of the chlorin thru the solution, the reactions being:—

$$2NaCl = Na_2 + Cl_2$$
$$Na_2 + H_2O = 2NaOH + H_2$$
$$2NaOH + Cl_2 = NaClO + NaCl + H_2O$$
$$3NaClO = NaClO_3 + 2NaCl$$

Fig. 136. Apparatus for the Dry Collection of Chlorin Gas by the Displacement of Air. Height of Gas in Bottle is Seen by its Greenish Color.

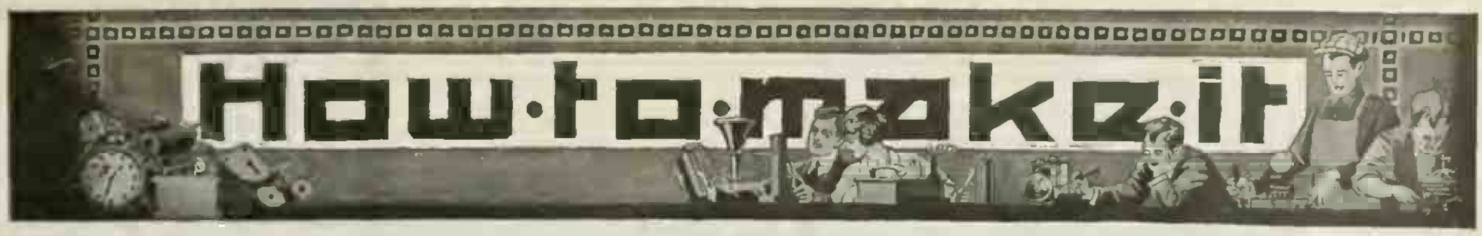
$$NaClO_3 + 3H_2 = NaCl_2 + 3H_2O$$

Numerous devices have been invented to overcome this difficulty. Probably the most successful has been the Castner-Kellner process, described in the November, 1917, issue and illustrated by Fig. 88 of the same issue.

(3) On the large scale chlorin is made by a method known as the Weldon process. The only difference between this method and the one first described above, namely that of acting on manganese dioxid with hydrochloric acid, consists in transforming the manganous chlorid into a compound that can be again treated with hydrochloric acid. The manganous chlorid was formerly wasted, and thus the cost of chlorin, when made into bleaching powders, etc., was considerable, caused by the necessity of using new manganese dioxid each time. By Weldon's method the manganous chlorid obtained is treated with calcium hydroxid (slaked lime, $Ca(OH)_2$), converting it into manganese dioxid, thus,

$$MnCl_2 + Ca(OH)_2 = Mn(OH)_2 + CaCl_2$$

(*Continued on page* 411)



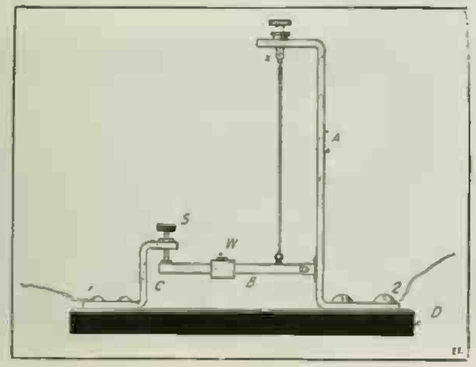
This department will award the following monthly prizes: First Prize, $3.00; Second Prize, $2.00; Third Prize, $1.00.

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 MAGNET-LESS BUZZER.

To make this buzzer, a piece of resistance wire, X, about 18 inches long is suspended from standard A. At its lower end it is connected to arm B which is hinged to A and insulated from it. W is a weight to regulate the tension of X. At C, on B, is soldered a contact. S is an adjustable contact screw which touches the contact at C. When current is applied at 2, it flows up standard A and down resistance wire, thru arm B and contacts to 1. The current heats the wire and it expands, letting down arm B, which breaks the circuit. Wire then cools and contracts, closing circuit again and wire again heats and cools, as long as current is applied.

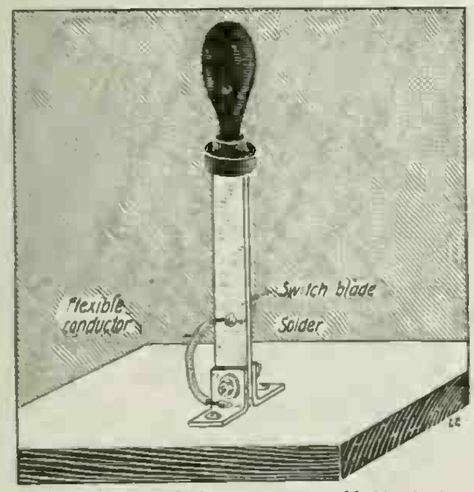


A Buzzer Without Magnet Coils—Sounds Impossible, Doesn't It? Well, This One Does the Trick.

Contributed by
T. R. WIESEMANN, JR.

HOW TO OIL KNIFE SWITCHES.

As oil is an insulator, it cannot be successfully used to make switches work easily of the ordinary blade and clip type, as the oil forms a film between the switch-post and switch-blade, thereby insulating one from the other. This may be overcome in the following manner:



To Make a Good Contact Thru Knife Switch Joints, Especially When Oiled, Solder a Flexible Lead to Both Hinge and Blade.

To the switch-post solder one end of a flexible conductor about two or three inches long. Solder the other end to the switch-blade. For this conductor drop-cord for electric lights will serve very efficiently.

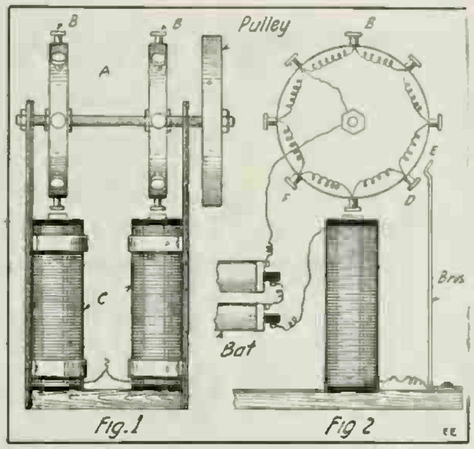
Contributed by
RICHARD J. ANDERSON.

SECOND PRIZE, $2.00

A SIMPLE BATTERY MOTOR FOR THE BOYS.

I am sending you a plan of an electric motor which I designed. The rotor is made of an old spool such as magnet wire comes on. On its circumference are set eight nails or screws on either side of the spool and these spaced evenly apart. One set of screws or nails is used for the commutator as shown in Fig. 2. This set of screws is connected to the shaft by wires as shown. When the screw D comes to brush E, F is drawn to the coil and so on. The connections are as follows: One terminal of battery is connected to the shaft by means of a brush, or by connecting a wire to the frame. The other terminal is connected to one side of coils, and the other terminal of coils is connected to brush E, Fig. 2.

Contributed by C. P. WALKER.



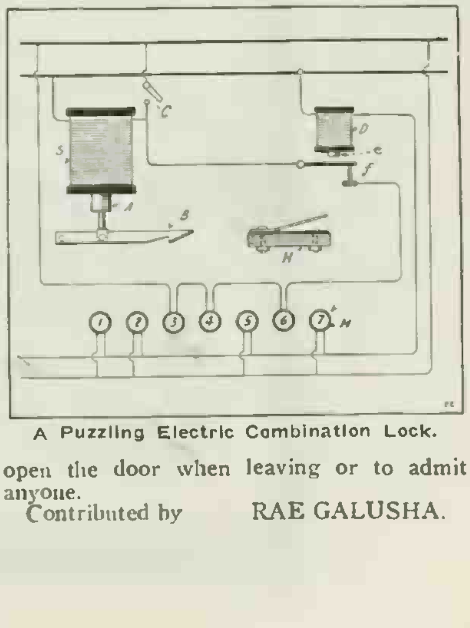
A Simple Form of Battery Motor Which Experimenters Will Find Interesting.

AN ELECTRIC "COMBINATION" DOOR LOCK.

The sketch shows a simple electric door lock attachment which any amateur electrician can make. It has been in use on my door for several months and has proven entirely satisfactory.

The solenoid "S," armature "A," and hook "B" are mounted on the casing of the door; inside the house of course. The row of push buttons "H" is placed outside of the door. The buttons 3, 4, and 6, are connected in series with the relay switch "f," which is normally closed, and the solenoid coil "S." Buttons, 1, 2, 5, and 7 are connected in multiple and the group in series with the relay switch magnet "D."

If buttons 3, 4 and 6 are prest, coil "S" is energized, raising the hook "B" which allows the door to be opened. However, if any other buttons are prest at the same time, then coil "D" opens the solenoid circuit at "F," and the door remains fastened. "C" is a switch placed inside the room to open the door when leaving or to admit anyone.



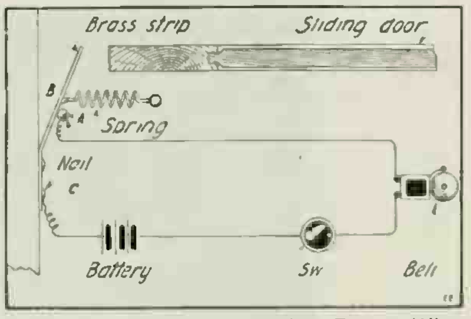
A Puzzling Electric Combination Lock.

Contributed by RAE GALUSHA.

THIRD PRIZE, $1.00

BURGLAR ALARM FOR A SLIDING DOOR.

This alarm has worked with success and I thought that someone else might wish to use it. The material consists of a strip of brass, a screen door spring, a long nail, an electric bell, switch and batteries. Fasten the strip of brass at one end on wall and bend it to shape shown in diagram. Drive nail in ceiling so that strip of brass will hit it when the door is open. Then fasten screen door spring so it will pull the brass strip against the nail "A." When the door is shut the brass strip is held away from the nail, but when it is open the brass strip touches the nail and closes the circuit, causing the bell to ring.



A Burglar Alarm For Sliding Doors—When the Doors Are Opened the Spring Hits the Nail, Closing the Bell Circuit.

Contributed by VIRGIL McELROY.

Electrical Engineer
Elec. Light and Power Supt
Hydroelectric Engineer
Telephone Engineer
Telegraph Engineer
Wireless Operator
Architect
Building Contractor
Civil Engineer
Structural Engineer
Mechanical Engineer
Shop Superintendent
Steam Engineer
Draftsman and Designer

Every Trade
Needed To

EUROPE is devastated. It must be rebuilt. And America must rebuild it. American brains, ingenuity, and inventive genius are going to supply war-torn Europe with new buildings, new factories, new machinery, new equipment of every description. In fact, there isn't one thing needed in the reconstruction of Europe that America won't supply. Can you grasp what that means?

The moment peace is declared America will begin the titanic task. No other country can do it. Think of what it will mean to America—to YOU and every ABLE man in the country. The task facing America will mean a decade or more of unparalleled prosperity—an era of COLOSSAL OPPORTUNITY for the TRAINED MAN. Earning power will be limited only by the lack of ability to DO THINGS. Every line of business will be worked to the limit. There can be no question about that, for the skilled workers of Europe have died by the hundreds of thousands. Now you see why training is so essential, and why every man not in the fighting line must prepare for the gigantic task facing America. The man with TRAINING will reap rich rewards.

Prepare Now For the Big Future

Don't sit on the sidelines when the big call for trained men comes. You don't have to. TRAIN and get into the game yourself. In six months you will be better fitted for the job you want than you are now. In a year you will have a strong grip on that job. In two years you can be an expert—a big money-maker. There will be a place for you no matter what your profession or age may be. There is time for you to get ready if you begin NOW. Trained men will be capable of earning salaries that will satisfy the most ambitious. And there will be a hundred or more openings for every man who can deliver the goods. There is no limit to the opportunities facing YOU and every man in the U. S.—*only the limit you place on yourself.*

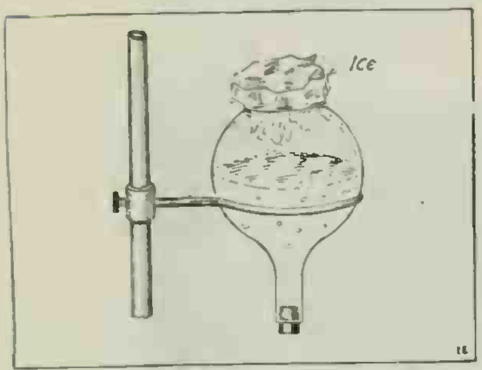
Results Follow If Training Leads

It needs a little backbone to study. It means devoting some part of your leisure hours to learning. But if you are man enough to do it, then the rewards are so sure—so certain—that the time you spend in home study will repay you a thousandfold. There is going to be a tidal wave of prosperity sweeping this country. It is beyond dispute. Are YOU going to ride on the crest of it, or will you be content to travel with the driftwood that follows it? IT IS UP TO YOU!

BOILING WATER WITH ICE.

This is an old, tho very curious and interesting experiment, calculated to mystify the uninitiated.

Obtain a Florence flask or glass distilling retort and fill it half full of water. Boil



If You Have Never Boiled Water With Ice, Here Is Your Chance! Next They Will Make Ice-Cream on the Gas-Range.

the water, and immediately on removing the flame, cork the flask tightly, and turn it upside down. As soon as the steam condenses it will form a partial vacuum over the water. It is well known that water boils in a vacuum at a much lower temperature than is required in the open air, and consequently, if the vacuum could be kept up, the water would boil long after it was removed from the source of heat. But as soon as steam is formed, it exerts a pressure on the water and stops the boiling.

If now we place a piece of ice on the top of the flask, the vapor or steam will be condensed, a vacuum will be formed and the water will commence to boil violently and will continue to do so until the temperature of the water in the flask falls below that at which water boils in a vacuum.

If the ice be removed before this occurs, the vapor will again form, press on the water and stop the boiling; but the boiling may be renewed by replacing the ice.

In performing this experiment, it is well to wrap the ice in flannel to avoid the dripping of the melted ice.

Contributed by V. H. TODD.

A FEW USEFUL INK FORMULAS.

Blue ink:

3 parts Prussian blue.
1 part Oxalic acid.
30 parts water.

When dissolved add 1 part of gum arabic.

Green ink: Sap green dissolved in very weak alum water.

A good ink eraser:

A. Oxalic acid mixed with citric acid may be used.
B. Equal parts of cream of tartar and citric acid in solution with water.

Inks that appear thru heat:

A. A weak solution of nitrat of copper; when heated it becomes (Red).
B. With a solution of sulfuric acid (Black).
C. With lemon, onion, leek, cabbage or milk and will be visible when paper is heated.
D. With a weak solution of nitrat of mercury (Black).

Invisible ink:

A. Write with pure dilute tincture of iron and develop with a blotter moistened with strong tea.
B. Linseed oil .... 1 part
Ammonia .... 20 parts
Water .... 100 parts
Mix well before using.

Vanishing ink:

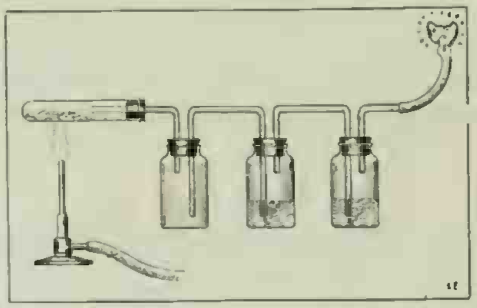
To make an ink black at the time but that will disappear in 24 hours: Boil nutgalls in alcohol, add copper sulfate and sal ammoniac, let cool and then dissolve a little gum in it.

Contributed by GEORGE JOHNSON.

HOW TO MAKE, USE, AND TEST COAL GAS.

A test tube is half filled with ground soft coal, packed loosely. The tube is heated and the gas allowed to pass thru a bottle filled with air. Anything left in this bottle will be coal tar. The gas is then past thru lime water. If any carbon dioxid is present, the lime water will become *milky*. The gas is then past thru the last jar containing red litmus solution. This will turn blue in the presence of ammonia.

From the last bottle, the gas may be allowed to flow thru a rubber tube in the end of which is a burner. The gas will



We Should Care Now If "It Goes Up!" We Will Make Our Own Gas and Laugh at the Consolidated!

burn with a yellow flame. Using a 6" x ¾" test tube, this flame will give about 1 candle-power.

Contributed by MORTON BERMANN.

"CHEMICAL SNOW."

Two parts Strontium Nitrat are first dissolved in 20 parts of water. Dissolve 2 parts Sodium Carbonat in 10 parts of water (heat may have to be used to dissolve it). Pour the second solution into the first. The result resembles a miniature snow storm.

Sodium Carbonat and Strontium Nitrat react, forming Sodium Nitrat and Strontium Carbonat. The latter is not soluble in water.

"Pouring Red, White and Blue from the Same Pitcher": Fill 3 glasses 2/3 full of water. In the first dissolve 1 measure of Ammonium Sulfocyanat. In the second 1 measure of Strontium Nitrat and in the third ½ measure of Sodium Ferrocyanid.

In the pitcher dissolve 3 measures of Ferric Ammonium Sulfat in 1/3 glassful of water. Pour a little of this into each glass. The first will turn red, the second white and the third blue.

Contributed by DUNBAR L. SHANKLIN.

SILVER-PLATING GLASS.

To silver-plate glass first have the glass clean. To clean it well wash it first with an alkali and then with distilled water.

Now dissolve 7.8 grammes of silver nitrat in 60 c.c of water and divide the solution in two equal portions. Dissolve also 3.11 grammes of Rochelle salt in 1180 c.c of water and heat the solution to the boiling point. Add to it gradually, so as not to stop the boiling, one of the portions of the silver solution, boil 10 minutes longer, cool and decant the clear liquid. To the other half of the silver solution add just sufficient ammonia water to dissolve the precipitat which is formed, or only leave a faint cloudiness; then add 360 c.c. of water and filter. Equal portions of these two solutions, when mixed and poured on glass, will deposit a brilliant coating of silver in about 10 minutes, depending on the temperature of the room.

The coating of silver should then be well washed, dried and varnished.

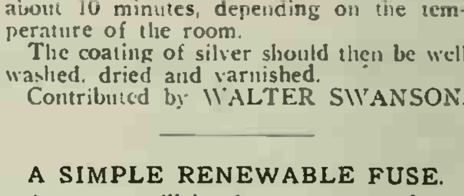
Contributed by WALTER SWANSON.

A SIMPLE RENEWABLE FUSE.

Amateurs utilizing large amounts of current usually have trouble with their fuses blowing out. A method that makes this occurrence less expensive is to make use of the so-called *renewable fuses*.

Cartridge fuses may easily be arranged so that new pieces of fuse wire may be put in very easily. A fuse of the proper size as regards the clips is obtained and the brass caps slit with a saw as shown in the illustration, thus cutting the ends of the caps into four pieces. The pointed ends are bent in and in this manner the caps are fastened permanently to the fiber tube. The asbestos filling is removed and the tube cleaned out.

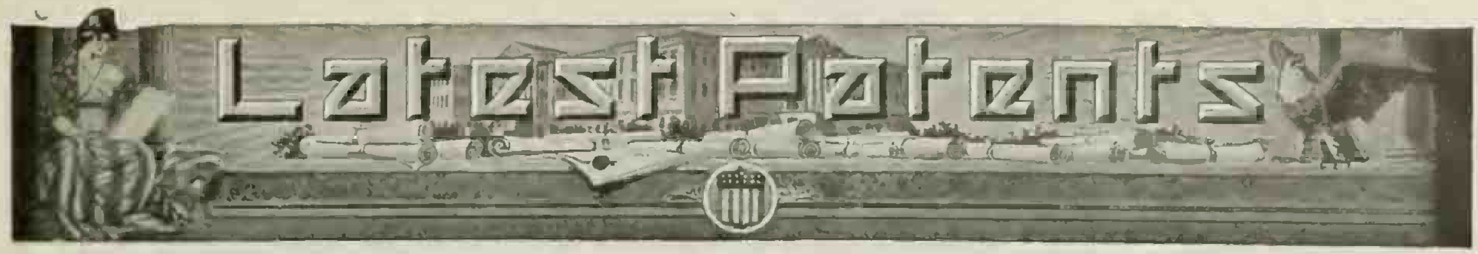
To renew such a fuse it is only necessary to run a length of wire of the proper size thru the tube and bend the ends of the wire around the ends of the tube, thus making connection to the brass caps. When the fuse blows the melted metal will not spatter, since it is confined by the tube. Corks



Look at All the W. S. S. You Can Buy, Making Your Own Fuses! T. W. B. Sure Has the Right War Saving Spirit. Send In Some More Money-Saving Devices Boys! Every Bit Helps.

may be placed in the ends of the tube to prevent undue splashing of the hot metal, but one of them should have a V-shapt slot cut in the side to act as a vent for the gases.

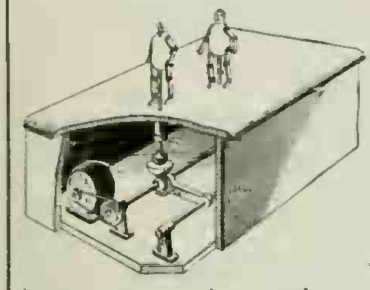
Contributed by THOS. W. BENSON.



Electric Figure Toy

(No. 1,272,304, issued to Elbert C. Owens.)

This invention refers to an improvement in that class of inventions

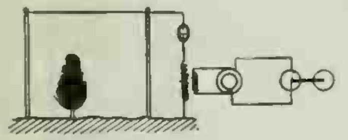


known as games and toys, and particularly to moving figure toys and advertising display features. The inventor makes use of two or more doll figures, arranged so that the electric motor drive within the cabinet will actuate the figures and cause them to take on lifelike movements, the limbs being suitably jointed for the purpose. Some of the features incorporated in this patent are a means for supporting and guiding the reciprocating rods in the dolls and other figures, and cushioning means for preventing noise while the device is in operation.

Electro-Agricultural Scheme

(No. 1,268,040, issued to Reginald A. Fessenden.)

Prof. Fessenden provides an elevated wire or series of wires above the plants as shown, and these are charged with a high potential current thru a rectifier and step-up transformer. An A.C. dynamo excites

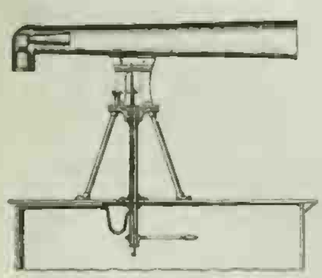


the transformer, the field of the alternator being connected to a rheostat, the arm of which is rotated by a motor. Thus the resistance of the dynamo field circuit is periodically increased and diminished during each revolution, and the rheostat is designed so as to give a strongly peaked wave form. He has found that a low frequency for such a current is preferable, even as low as once in five seconds, or even lower.

Electric Fog Horn

(No. 1,270,355, issued to Jesse A. Wright.)

An electric signaling horn useful for fog signaling and other requirements, and providing a means whereby the horn may be mounted upon the pilot house so that it can

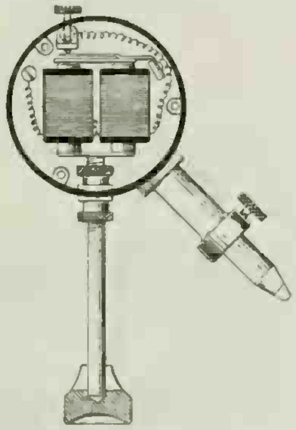


be rotated within the latter and locked in any of its adjusted positions. An electric siren such as used on autos but of larger size is mounted in the smaller end of the fog horn, and means are provided for maintaining the electrical connections to the siren motor as the fog horn is elevated or rotated thru different positions.

Electrical Percussor

(No. 1,266,945, issued to John Hickey.)

Physicians and surgeons make extensive use of the art of percussion in determining whether the body is sound and healthy, and also for diagnosing bone locations and dislocations, etc. Percussion is generally performed by striking the fingers on the portion of the body under examination, but a much more satisfactory means of establishing percussory sound waves is by means of

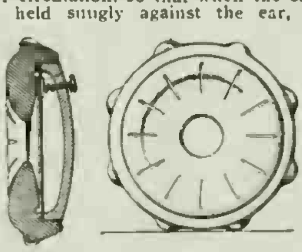


the electrical percussion apparatus here illustrated. The vibrations created by the vibrating buzzer are transmitted thru a rod and cup to the body.

Sound Reproducing Device

(No. 1,267,587, issued to Herman G. Pape.)

This invention provides a new form of ear cap for telephone receivers having a number of grooves or kerfs molded in the side facing against the ear, so as to allow free air circulation, so that when the cap is held snugly against the ear, it

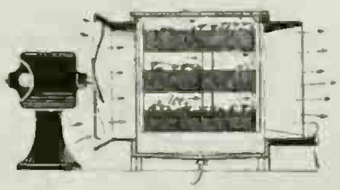


maintains communication between the outside air and the otherwise closed sound chamber within the cap. These kerfs prevent or dissipate pressure waves, due to the vibration of the diafram, which waves otherwise would be focust on the ear drum and cause the sounds to be muffled or indistinct, besides causing great strain on the ear drum. An adjustment screw with spring connection permits of modifying the vibration of the diafram. The cap also carries molded extensions around its perifery to prevent the receiver rolling off flat surfaces.

Ventilating Apparatus

(No. 1,270,352, issued to James A. Williams.)

This patent covers a unique ventilating, cooling and humidifying apparatus intended for use in theaters, restaurants and the household, and which will effectively circulate, cool and humidify the atmosphere at a small expense. The object of the invention here presented is to pro-

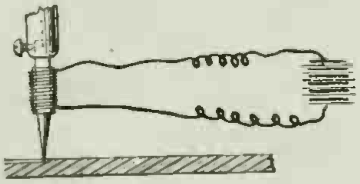


vide means for cooling the air which will so distribute the same thru the room, as to avoid the injurious effects of direct blasts or drafts of air usually caused by the ordinary electric fan. The inventor provides means for holding ice in the air tunnel, thru which an electric fan blows a draft of air, and the ice water is caught in a drip pan at the base of the apparatus, which is provided with an overflow outlet.

Electrical Phonograph Sound Recorder

(No. 1,271,684, issued to Victor Hugo Emerson.)

A scheme for producing phonograph sound records of the disc type and providing improved means for accomplishing this purpose by utilizing an electric heating coil applied to the needle of the master record machine on which the records are made. A source of electricity and a rheostat may be used so as to control the degree of heat applied to the needle very accurately. In applying this arrangement, the inventor uses a high degree of heat applied to the so-called "cutting stylus" while it

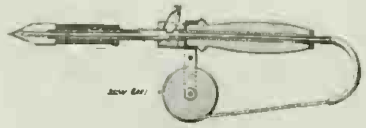


operates upon a record blank of suitable material, preferably a hard volatile composition for instance, xylonite (commercial celluloid). The needle is said to work best when brought to a red glow or to incandescence, and the stylus may be made of platinum or tungsten. This method seems much superior to the usual one in which the record is heated instead of the needle.

Self-Feeding Soldering Iron

(No. 1,268,877, issued to Harry A. Orme.)

Wire solder is used in the form of a reel, which can be snapt into place quickly, and this solder feeds thru the hollow handle and channel leading down thru the tip of the iron itself. A wrapping of asbestos is placed around the iron just ahead of the tip to prevent too much heat reaching the solder at this point and

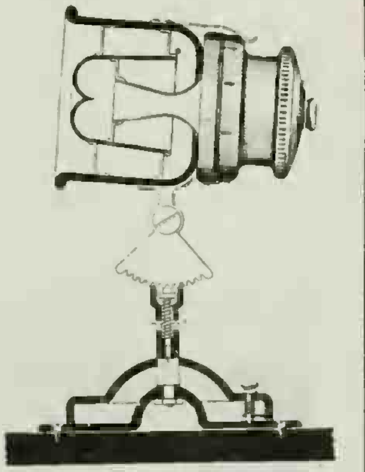


melting it. An ingenious feed lever, which can be worked by the thumb, is mounted on the front of the handle, this lever being spring actuated. The bottom of the lever bears against the solder and is toothed so as to push it forward a given amount with each movement of the lever.

Combined Telegraph and Telephone Receiver

(No. 1,270,861, issued to Herman G. Pape.)

This is a clever combination of telegraph and telephone receiver which may be used with an acoustic amplifier described by the inventor, and which should prove of considerable efficacy in telegraph offices where the sounders now in use make such a bedlam of noises. For telegraphy, the person using the new 'phone is the only one that receives the dot and dash signals. The electro-magnet actuating the device for telegraphy operates an armature at-

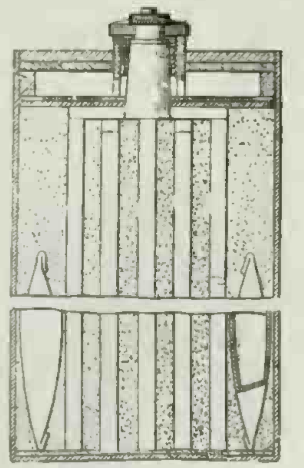


tached to a sound anvil, which latter strikes the diafram, resulting in a tap or click resembling that given by the standard Morse sounder. An adjustable buffer is set against the diafram or anvil to prevent continued vibration of the diafram and which permits only an instantaneous sound or vibration to be heard.

Dry Storage Battery

(No. 1,269,162, issued to Walter A. Crowdus.)

An improved form of dry storage



battery in which the electrolyte employed is non-flowing, and comprises suitable absorbent inert solid matter holding the liquid excitant which is distributed thru the solid mass. A specially devised gas vent and baffle is provided so that any gas produced by the battery can escape. A series of porous tubes are placed in the battery together with the plates, these tubes serving to hold any surplus of the liquid electrolyte which may seep thru their porous walls.

Copies of any of the above patents supplied at 10c. each

Our Amateur Laboratory Contest is open to all readers, whether subsribers 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

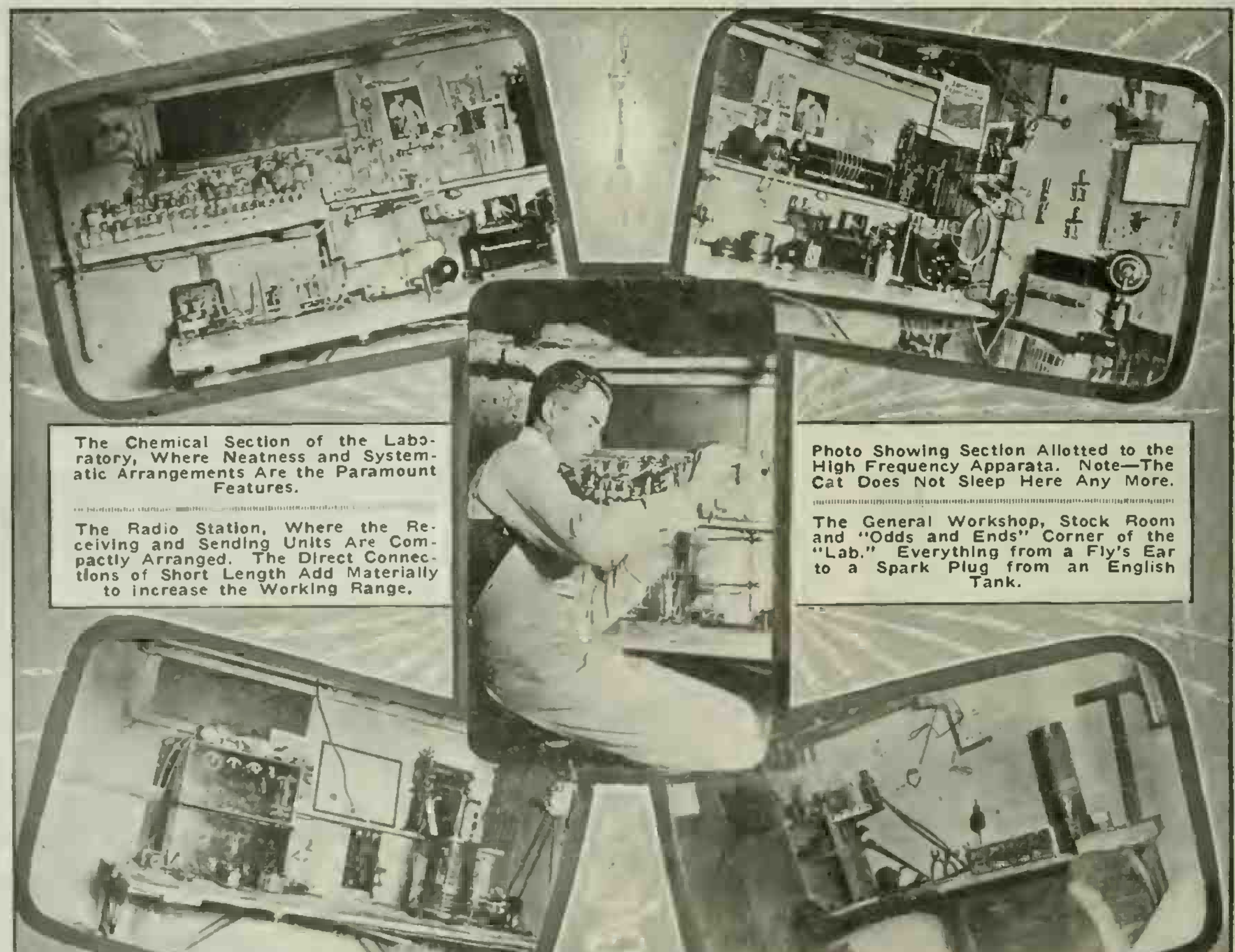
In this issue we publish some interesting facts with excellent photos, describing one Amateur Electrician's experimental laboratory. Now "Bugs" we want to publish a snappy one like it each month. Here's our proposition: Why not write up your "Electrical Lab., in not more than 500 words. Dress it up with several good, clear photographs. 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. Typewritten articles preferred. Address the Editor of this Department.

THIS MONTH'S $3.00 PRIZE WINNER—LAWRENCE C. ARMANTROUT, MATTOON, ILLINOIS

THE accompanying photos are views of my laboratory and (now extinct) Radio Station. My laboratory is combination, chemical and electrical, and the photos show most of the apparatus. I have about twenty-five pieces of electrical apparatus, such as Tesla and Oudin coils, 110-volt motors, spark coils, Leyden jars, generators, electrolytic-interrupter, step-down transformer, rheostats, tin foil condensers to 5 M.F. capacity, experimental arc, condensers for the spark coils, and 1 K.W. transformer, also condenser and rotary gap, which excite the 1 K.W. Tesla coil. The Chemical Laboratory consists of test tubes, thistle tubes, retort, delivery tubes, desiccator, hydrometer, Florence and Erlenmeyer flasks, crucible, chemists' scale, and sufficient other apparatus and chemicals for carrying on extensive experiments. I have carried on interesting experiments with home-made Geissler tubes, the construction of which was explained in the Experimenter sometime ago. I also have a couple of storage batteries and a short line telephone; and a drawing-board and drafting outfit for making structural designs, hook-ups and other drawings.

One of the photos shows my former radio station, with which I obtained excellent results, Albany, N. Y., being my record sending distance (about 900 miles). I think that the equipment needs no other descriptionn than that it is a 1 K.W. sending outfit and there are two regenerative, vacuum bulb detector cabinets for receiving, as well as auxiliary Crystaloi and crystal detectors.

Last but not least, is the work-shop in one end of my laboratory, "all dolled up" for a picture, in which I have a good stock of binding posts, contacts, machine screws, wood screws, bolts, nuts, magnet wire, springs, strip brass and copper and other "junk" that is usually found about a "mucker's" laboratory. The tools are coping saws, key saws, twist drills, hand drill, pliers and punches of different sizes, etc.



The Chemical Section of the Laboratory, Where Neatness and Systematic Arrangements Are the Paramount Features.

The Radio Station, Where the Receiving and Sending Units Are Compactly Arranged. The Direct Connections of Short Length Add Materially to Increase the Working Range.

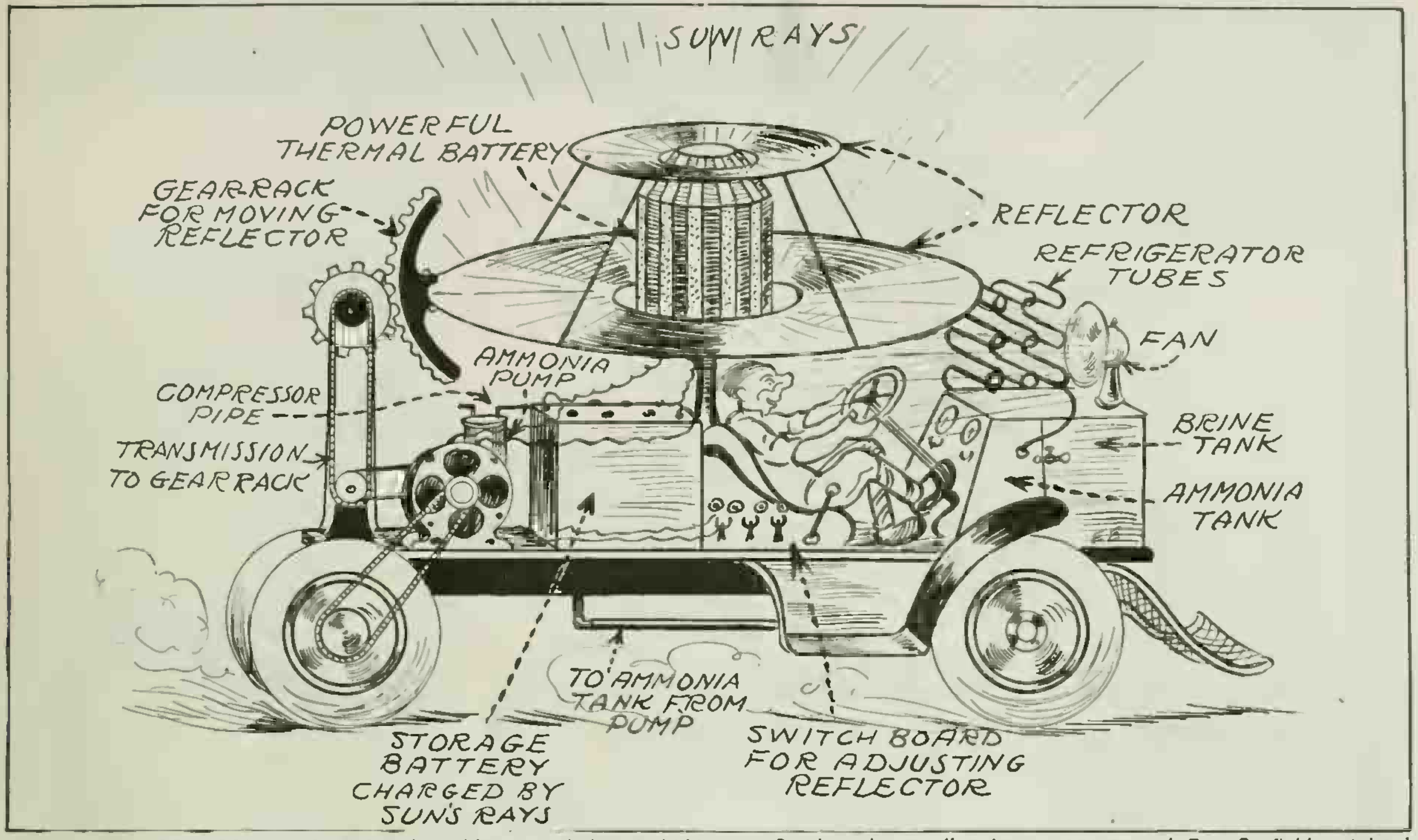
Photo Showing Section Allotted to the High Frequency Apparata. Note—The Cat Does Not Sleep Here Any More.

The General Workshop, Stock Room and "Odds and Ends" Corner of the "Lab." Everything from a Fly's Ear to a Spark Plug from an English Tank.

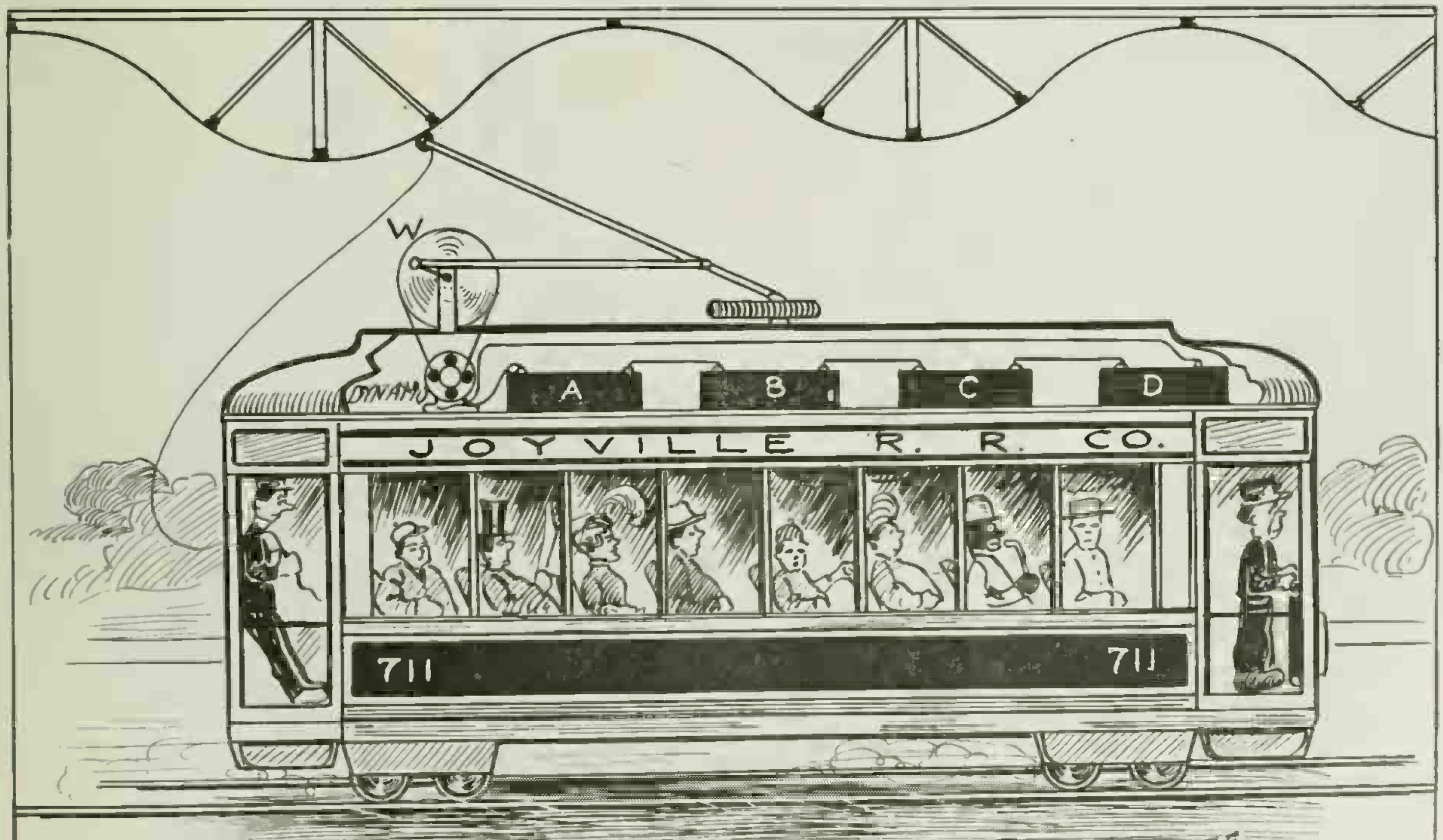
Phoney Patents

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 deffy 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 deffy as a lovesick bat. 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. SOLARMOBILE. Joy rides now being forbidden on Sundays in gasoline buzz wagons, and Doc Garfield not having clamped the lid as yet on the sun, your petitioner prays for letters Pat-ends on a sun-fliverette. This afore-abovementioned solarmobile by means of its reflector (which also shades the driver) collects free of charge the sun's rays, which striking the thermo-cells generate Juice, thence trickling into storage battery, drive fliverette motors. Compressor operates ice plant to cool driver when he gets his tire bill. The fan blows away his perspiration when he tries escaping the speed-cop. Inventor Kenneth Strickfaden, Paoli, Pa.



TROLLEY REGENARRATIVE SYSTEM. With blushing modisté I announce my revolusionizing inverted scenic-trolleyroad. Oncet started the trolley pole goes joyriding along the ups-and-downs track which is but a camou-full-flaged trolley wire. Due to its sinuous road it affects a 2-and-fro motion of the trolley pole. This is utilized to rotate wheel W which in turn turns one good turn into another, thus turning the pulley of dynamo which in turn interns the resultant juice into storage batteries A, B, C, D for the the duration of the war. The juice runs the trolley car, surplus current going into line to run other cars. Inventor Leslie E. Neville, Leonia, N. J.

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

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

BOOKS ON THE "ELECTRON."

(953) Oscar W. Ehrman, Portsmouth, Ohio, inquires:

Q. 1. For a good book treating on the "electron."

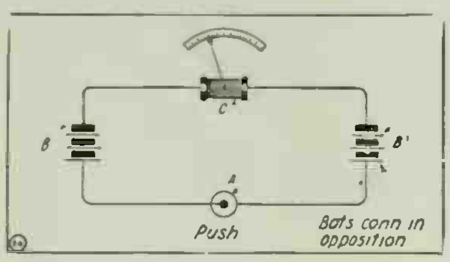
A. 1. With further reference to the editorial in the March number of the ELECTRICAL EXPERIMENTER entitled "Dormant Forces," you will undoubtedly find very interesting reading, in the new work by Professor Millikan, entitled "The Electron, Its Isolation and Measurement." Our Book Department can supply it at $1.60 prepaid.

Also you will find some very interesting reading along this line in the April, 1918, issue of the ELECTRICAL EXPERIMENTER.

DIFFERENTIAL BATTERY CURRENTS.

(954) A. Hering, Brooklyn, N. Y., wishes to know:

Q. 1. How to detect differential battery currents in circuits where cells are connected in opposition.



Showing How a Sensitive Galvanometer is Connected Up to Indicate Any Differential Battery Current.

A. 1. It is possible to detect such a current when the push button is closed by inserting a very sensitive galvanometer at the place marked "C" in your diagram, for then and as the case always is with dry cells or storage batteries there is invariably a very small current flowing in one direction which is equal to the algebraic sum of the currents of the batteries, and the direction of this resulting current is the direction of the greater current, which is, by the way, very small. A very sensitive telephone receiver should be able to detect this minute current, while the type of galvanometer used can be of the D'Arsonval type.

DO RADIO WAVES AFFECT TELEPHONE CIRCUITS?

(955) Howard N. Hess, Ansted, W. Va., asks several interesting wireless questions:

A. 1. The reason you can receive a message without a ground is because in your case you have a typical *counter-poise* aerial. As far as is known, telephone circuits are not affected by the radio waves, unless the stations happen to be in very close proximity to the telephone lines, and therefore you have experienced nothing unusual relative to the reception of telephone messages.

A. 2. The reason for the elimination of static disturbances is due to the use of the variable condenser which has the property of cutting out these disturbances to some extent without altering the intensity of the received signals to any degree. The uses to which you put the two switches are very good ones, and produce effects of equivalent value to that of a series condenser, in which case the wave length is always shortened.

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.

CAN SELENIUM CELLS OF DEFINITE RESISTANCE BE MADE?

(956) Ray N. Coffman, Newark, Ohio, asks among other questions concerning selenium cells, if it is possible to build them with a definite, known resistance.

A. 1. Relative to the least intensity of light which will cause the resistance of a selenium cell of the Fritts or Hammer type to be lowered to its smallest value, we would say that when either of these types of cells are subjected to light rays, their resistance is decreased considerably. In making a selenium cell it is very hard to ascertain what this ratio of resistance will be. An idea of the degrees of the resistance of some of these cells can be gotten from the fact that several cells have been constructed having a ratio of 200 to 1. The amount of current that will pass when a pressure of 12 volts is subjected to the cell can be computed by Ohm's Law, in the usual manner.

Suppose the resistance of a cell in the dark is 10,000 ohms and 500 in the light, then by Ohm's Law the current in the dark is equal to

$$I = \frac{E}{R} = \frac{12}{10{,}000} = .0012 \text{ Ampere.}$$

The amount of current flowing in a circuit when the light is on is equal to

$$I = \frac{E}{R} = \frac{12}{500} = .024 \text{ Ampere}$$

The resistance of the relay, if used, must, of course, be added to the cell resistance in making this calculation. Yes, an electrical current can be successfully broken 4,050 times per second, in fact Dr. Nikola Tesla has invented a machine for successfully making 50,000 breaks per second. A description of this machine has been given in the February, 1917, issue of the ELECTRICAL EXPERIMENTER.

ST. ELMO'S FIRE.

(957) Gordon Jones, Jr., Cordele, Ga., inquires of the Oracle:

Q. 1. What is St. Elmo's Fire?

A. 1. "St. Elmo's Fire" is the phenomenon which takes place when the atmosphere is abundantly charged with electricity. It usually appears as a brilliant light on the top of ships' masts, the points of metallic objects and other conductors from which a silent discharge usually passes. The phenomenon is most common during thunder storms and in some instances, the appearance resembles sheets of flame extending several feet in length.

We would refer your particularly to an interesting article on atmosphereic electricity in the July and August, 1917, issues of this Journal.

WHAT IS "LAUGHING GAS"?

(958) Patrick MacCourt, Medicine Hat,

(*Continued on page* 408)

THE ORACLE.

(*Continued from page 406*)

Q. 1. What is "laughing gas"?

A. 1. Nitrous Oxid is commonly called *laughing gas*. It is a colorless gas with a slightly sweet taste and produces unconsciousness. It is produced in the following manner: Ammonium nitrat is heated and as the nitrat melts it soon begins to decompose with effervescence. Great care must be taken in regulating the heat, otherwise an explosion may occur.

Q. 2. What is the meaning of *Analgesia?*

A. 2. Relative to the statement appearing in a certain weekly paper, we believe that said statement is in error because the word *analgesia* is defined as "the insensibility to pain in any part of the body." However, as to the method of removing hair so that no pain at all is felt, we would say that such methods are dealt with under the subject of *cataphoresis*. This subject of cataphoresis is the art of localizing the use of drugs by electrolysis so that no pain is felt in that part where it is applied. We refer you to the book entitled "Cataphoresis" by W. J. Morton, which can be procured from our Book Department for $2.50. We do not know of any case where X-rays have been used for removing superfluous hair.

MOVIE TRICKS EXPOSED.

(*Continued from page 371*)

as clear and simple as the result is mystifying and complex. The action is obtained by the process illustrated in Fig. 7. In scenes Nos. 1, 2, 3 and 4, the usual process of motion picture photography is followed. When the director determines that it is time for His Satanic Majesty to dissolve into space, he calls "Stop" at the split between scenes 4 and 5, marked X. The camera man stops the camera, Monsieur Satan leaves the scene; Jack, the stage hand, sets a smoke bomb, as shown in scene 5, on the place where Satan stood and lights the fuse. The camera immediately is started again and the ensuing explosion is filmed. After this film has been developed the printer, who makes the thousands of duplicates or positive films from the master or negative film for general distribution to show houses thruout the States, cuts out scene No. 5, and places scenes Nos. 6, 7 and 8 over scenes 2, 3 and 4 and prints them in that position. The result attained is to have Satan gesticulate and instantly a smoke screen starts from his feet and envelops him entirely. When this smoke has cleared away, lo! and behold, you find that the Kaiser's Ally has also "cleared out".

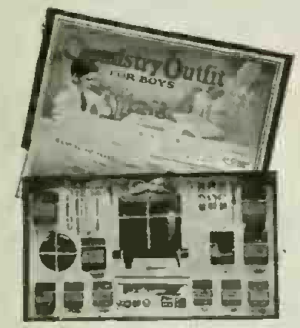
Figure 8 shows how it was possible by using the Bray system of animated drawings, to show the action of a commercial *adding machine*. This operation would normally be impossible to visualize with the naked eye. Therefore it can be readily seen that with the new process it is possible to photograph and understand thoroly the operation of the heretofore unphotographable.

The production of an animated cartoon is made by a very tedious method, extending over a considerable period of time. The artist makes a pencil sketch of the cartoon that he wishes to have photographed and this is placed under a very thin sheet of celluloid having a thickness of about 1/5,000 of an inch; and possessing a marked degree of transparency. The second operation is to trace this pencil sketch onto the celluloid sheet permanently with drawing ink. One drawing is made showing the background, which in Fig. 6 is a room, showing chairs, pictures and two doors. Upon this background sheet is

(*Continued on page 411*)

GILBERT

Chemical and Electrical Outfits
Telegraph, Telephone and Wireless Sets



THE wonders of electricity and chemistry—the things that have made the reputation of Edison, Bell, Marconi and other great men—can be learned by the boy who has a Gilbert telephone, telegraph or wireless set, or an electrical or chemical outfit.

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MOVIE TRICKS EXPOSED

(*Continued from page 408*)

placed the drawing of the subject on a separate piece of celluloid; then it is photographed. Each succeeding action of the figure is accomplished by making a separate celluloid drawing showing the figure that is to move placed in a new position. In this way progressive action is eventually accomplisht. Each new move is photographed by the camera man. In the case where a figure remains passive but where a part of the figure moves, such as an arm, the figure is drawn on a celluloid sheet and is made armless. Each successive move that it is desired to have the arm make, is then drawn on another piece and placed upon the armless figure in its proper position.

EXPERIMENTAL CHEMISTRY.

(*Continued from page 398*)

Upon introducing a blast of air into the heated mixture the oxygen present gives *Calcium Manganit* ($CaMnO_3$)

$$Ca(OH)_2 + Mn(OH_2) + O = CaMnO_3 + 2H_2O$$

This manganit is acted upon by hydrochloric acid.

$$CaMnO_3 + 6HCl = CaCl_2 + MnCl_2 + 3H_2O + 2Cl$$

By this process the manganese, which is the costly ingredient, can be used again and again. The oxygen of the air together with steam, is forced into the mixture of hydroxides and water.

(4) By heating a mixture of 5 parts of manganese dioxid, 4 parts of sodium chlorid, and a mixture of 12 parts of sulphuric acid with 6 parts water:—

$$MnO_2 + 2NaCl + 2H_2SO_4 = MnSO_4 + Na_2SO_4 + 2H_2O + Cl_2$$

Manganous Sulfate

(5) By heating a mixture of potassium bichromat and concentrated hydrochloric acid,

$$K_2Cr_2O_7 + 14HCl = Cr_2Cl_6 + 2KCl + 7H_2O + 3Cl_2$$

Potassium Bichromat — Chromic Chlorid

(6) By adding hydrochloric acid to bleaching powder or hypochlorites.

$$Ca(OCl)ClCaO + 4HCl = 2CaCl_2 + 4H_2O + Cl_2$$

Bleaching Powder — Calcium Chlorid

$$HClO + HCl = H_2O + Cl_2$$

(7) The Deacon Process is based upon the oxidation of hydrochloric acid gas by the oxygen of the air, over pieces of brick which have been saturated with copper chlorid and heated to about 440 degrees Centigrad. In outline, the reaction is:—

$$2HCl + O = H_2O + Cl_2$$

It is presumed that the copper chlorid acts as a *catalytic* agent in the liberation of a portion of its chlorin, and withdrawal of it from the hydrochloric acid, thru the influence of the oxygen of the air.

Properties: Physical:—

1. Chlorin is a *yellowish-green gas*, of a suffocating and stifling odor, and when inhaled, exerts a corrosive action on the mucous membranes of the air passages. It is irrespirable and intensely poisonous, *death* resulting from inhaling it in quantity. The "Huns" are reported as using this fiendish gas to check the advancing drives of the "Allies" in the present World War, and it is a foregone conclusion that no other civilized nation would stoop to such a vile means of not only killing, but severely impairing the respiratory organs of their opponents.

(2) It has a vapor density of 33.45, nearly 2.5 times as heavy as air, and thus may be readily collected by displacement, the height to which the vessel is filled being noted by the color of the gas. It is quite soluble in water, at 0 degrees one volume of water dissolves 1.5 volumes of chlorin; at 10 degree—three volumes.

When past into ice water, chlorin forms a greenish crystalline mass called *chlorin hydrate* ($Cl_2 + 8H_2O$).

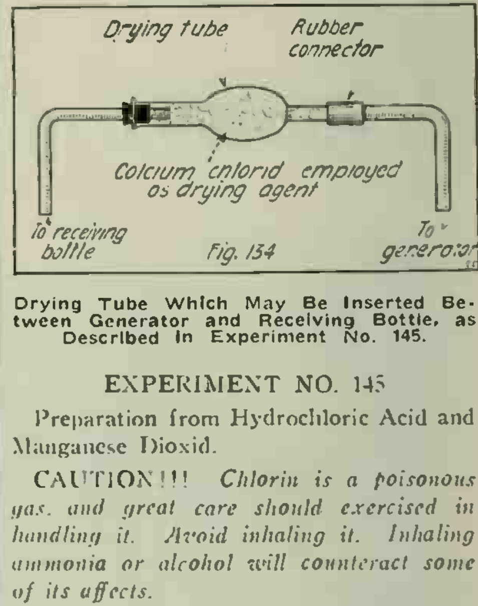
3. It can be liquefied at —40 degrees and boils at —33.6 degrees.

4. It solidifies at —102 degrees.

Chlorin is now commercially supplied as a comprest liquid in steel cylinders.

BLEACHING

Cotton goods are bleached by causing long rolls of the cloth to pass thru successive vats, the first, third, fifth, etc., of which contain water acidulated with sulfuric acid; the second, fourth, etc., contain a solution of bleaching powder. A very little acid is left with the water on the cloth as it passes thru the first vat. This acid liberates chlorin from the bleaching powder in the second, and the chlorin partially whitens the cloth. In the successive vats the same operation is repeated till the fabric is of the desired color. To remove any remaining chlorin which might injure the fabric, the cloth is past thru an antichlor of sodium thiosulfate (commonly known in photography as "Hypo") then thru a vat of water to wash it, and finally over hot rollers to dry. Fig. 132 depicts a two-vat bleacher.



Drying Tube Which May Be Inserted Between Generator and Receiving Bottle, as Described in Experiment No. 145.

EXPERIMENT NO. 145

Preparation from Hydrochloric Acid and Manganese Dioxid.

CAUTION!!! *Chlorin is a poisonous gas, and great care should exercised in handling it. Avoid inhaling it. Inhaling ammonia or alcohol will counteract some of its affects.*

Put 10 grams of manganese dioxid (the granular is preferable to the powder in this experiment), into a Florence or Erlenmeyer flask and make the connections as shown in Fig. 133. Run the thistle tube thru a two-hole rubber stopper, and run a short right-angle connector to the receiving bottle as shown. A drying tube of the form shown in Fig. 134 may be inserted between the right angle connector from the flask to the delivery in the receiving bottle. If this dryer is used it should be filled with calcium chlorid, which dries the gas as it passes thru. Set the flask on the ring stand or tripod over gauze or asbestos, and apply only a moderate heat, first pouring in thru the thistle 25 or 30 cc. of hydrochloric acid and rotating the flask so as to mix the solid and liquid. As the experiment progresses it may be necessary to add more of the reagents, especially the acid (if the gas escaping becomes white), shaking the contents of the flask in each case. Watch the action in the generator and flask, and have other bottles to replace the first as soon as it is full, or a little before, which can be told by the color. Collect three or four bottles, covering each with a glass plate. Test the action of the gas towards combustion, by thrusting a lighted splint into the flask.

EXPERIMENT NO. 146.

Prepare a hydrogen generator and cause the hydrogen to be liberated by permitting hydrochloric acid to act upon zinc. Use only a small quantity of zinc and have some water in the flask, then introduce the acid in small quantity thru the thistle tube.

Instead of collecting it under water as we did in our experiments with hydrogen (December, 1916, Lesson) bend a delivery tube as shown in Fig. 135, with a small opening at the end and reaching nearly to the bottom of a large bottle. When hydrogen is escaping quite freely, test it for air by applying a lighted splint, and when all the air is expelled, ignite the hydrogen at the capillary.

(To be continued)

WHY NOT ELECTRICITY FROM THE OCEAN?

(Continued from page 377)

To those who have not experimented with a float mounted on such a body of water as to give it appreciable power whenever waves were produced, such as on rivers, lakes, or perhaps on the ocean shore, it is probably a little difficult to perceive that such a power plant as this will develop any really appreciable amount of energy. The reader may form a good idea as to just how much power even a small wave will give by an instance which the author noted not long ago. In this case, the float (on the shore) measured about ten by twenty feet and was used as a launch landing on a river a mile wide. Whenever one of the steamboats plying this river past at a distance of half a mile, i.e., in midstream, the waves created from the side-wheels of the boat were sufficient, when they reached the shore, to oscillate the float (on which rested one end of a fairly long and heavy gang plank) with surprising power, and to give an idea of just how powerful this action was, it can be stated that with four people, weighing about six hundred pounds in the aggregate, the float was thrown rapidly up and down on its guide poles a distance of about four feet, much as if it had been merely an egg shell resting on the water. By comparison it is easy to see that the ocean waves, which are much more powerful on the average, would exert an infinitely greater power. In the case of the float just cited, the work expended by the waves amounted to 2,400 foot-pounds or considerable over one foot-ton. The float was capable of lifting a much greater weight than that mentioned, but this will serve as a practical example to show the great power possest by a moving body of water.

For further details see Transactions of the American Society Mechanical Engineers, XIII, 438 and Kent's Mechanical Engineer's Hand-book, 1916 Edition. Also see article entitled "Electric Power from Ocean Waves" in the February, 1917, issue of this journal.

AN ELECTRIC SPEED AND DIRECTION INDICATOR FOR TRANS-ATLANTIC 'PLANES.

(Continued from page 375)

that the floating log being pulled thru the water would have to be periodically hauled aboard the aeroplane so as to read its dials. Several minutes would be consumed undoubtedly in hauling up the log and taking its reading, and some authorities have mentioned that this might cause an error as great as two per cent, owing to the time during which the log was out of the water, and the exact distance flown over would not then be recorded by the mechanism.

The drawing herewith shows the simple arrangement of electrical apparatus involved in an aeroplane log such as we propose, and which is, moreover, thoroly feasible, for similar apparatus has been used for a considerable number of years in recording the speed of engines, boats, automobiles, electric dynamos, motors, etc. In brief, its action is based upon the fact that the voltage of a dynamo is proportional to its speed, and the more we increase the speed, the more voltage do we get, and thus all that is necessary in order to read the speed of a machine in revolutions per minute, or other specific terms, is to properly calibrate the apparatus so that the galvanometer or voltmeter connected to the wires leading from the dynamo reads over a scale calibrated in *miles per hour*, or revolutions per minute, etc. If the aeroplane is flying in a calm or in a wind which is parallel to the direction in which the aeroplane is pointed, or the reverse, then the log will tow directly astern. Should the wind blow from either side, or the other as the accompanying diagrams show, and its direction from the aeroplane will be exactly the reverse of the direction in which the aeroplane is moving over the water, as becomes apparent. In other words, the aeroplane would be swept sidewise and the degree of its departure from its course would be at once indicated by the angular position of the wire leading to the log, i.e., the log, owing to the fact that it was gript by the water and not affected by the wind, would always lag off at one side, and that side would be the one from which the wind was blowing.

It would, moreover, not be necessary for the aeroplane pilot to be continually looking behind to ascertain the angle of the "log line" with his craft, altho the relative position of the log could be determined in this way at any time, even at night when it is dark, by virtue of the small electric bull's-eye attached to the front of the log, as here shown. In practise the long line is simply attached to a lever mounted on the aeroplane so as to cause an indicator needle to move in the cock-pit.

NEW DEVELOPMENTS IN TELE-PHOTOGRAPHY.

(*Continued from page* 387)

a drum of non-conducting material, preferably on the same shaft as the sending and receiving cylinders. On this drum, in longitudinal alignment, are a very thin strip of copper or other conducting material and two resistance elements. All of these are electrically connected to the shaft. The current to these resistance strips is supplied from opposite sides, the purpose of which will be obvious later. Three brushes—one for the copper strip, and the other two for the resistance elements—are arranged so as to make contact with these as the drum revolves.

When sending a picture, the thin copper strip is connected thru the shaft to one outgoing wire; and the brush is connected in series with several batteries and the other outgoing wire. This connection causes a heavy current to be sent to the receiving machine whenever the copper strip and the brush make contact; that is, once every revolution.

Now let us go back to the receiving machine at the point where we left it. Now that the starting relay no longer short-circuits the incoming current, the said current is permitted to pass to the synchronizer or to the picture receiving apparatus, as the case may be.

The two resistance elements on the synchronizing drum are used in receiving; and if their connections are born in mind, it will readily be seen that if the heavy impulse from the sending machine is received when the brushes are in exact centers of said resistance members, the current in the two brushes will be equal; but if the brushes are either above or below center at this time, there is a differential effect in the current—that is, the current is heavy in one and light in the other, this effect becoming greater the further the brushes are from center.

The synchronizing impulse is necessarily heavy to distinguish it from the picture transmitting current. This being the case, it is imperative to provide some means to keep the heavy current from entering the circuit that receives the picture, as it would burn out the magnets. The seams of the picture are arranged to come in line with the synchronizing strips on the non-conducting drum, so that the heavy impulse is never received when the picture itself is being transmitted, but while the seam is passing. It is, of course, necessary to have the synchronizing impulse received when the brushes at the receiving machine are passing over the resistance pieces; but for the sake of clearness this will be explained later and must be taken for granted for the present. Supposing, then, that this current always comes when the brushes and synchronizing strips make contact, it is easy to arrange other contacts and brushes so that the entire current passes into the synchronizing circuit while this part of the cylinder is passing, and so that the current at all other times passes into the circuit that receives the picture proper. So long as the cylinders are revolving in synchronism, this means can be relied upon to distribute the two currents into their proper circuits; but until synchronism is establisht, at the beginning of a transmission, another arrangement accomplishes the purpose.

This system operates in conjunction with the means for getting the resistance strips to pass beneath the brushes when the synchronizing impulse is received.

The principal part of the mechanism is another gravity relay. In its first position, this serves to connect the motor with its source of current thru a circuit containing considerable resistance. This causes the motor to run slower than the one on the transmitting instrument. This being the case, the heavy impulse is finally received (and it takes only a few seconds—seldom more than ten revolutions) when the resistance elements are under the brushes. The current is now permitted to flow from the brush thru the coils of the relay, which throws the gravity arm, causing the resistance in the motor connections to be short-circuited, so that the motor then runs at the approximate speed of the motor of the transmitting machine.

Until the relay is operated, by the presence of a current in the synchronizing circuit, the circuit that sends the picture remains open. This is necessary to keep the coils for the lighter current from being burnt out, as the currents cannot be distributed until the brushes and resistance elements are in contact when the synchronizing impulse comes in. As soon as this relationship is establisht, the relay, which operates only under the heavy impulse, causes the picture transmitting circuit to be closed. This relay performs the twofold purpose of closing this circuit and of short-circuiting the resistance that is in series with the motor.

It has already been explained that the current is equal in the two brushes that touch the resistance strips, providing the current is received when they are at cen-

(*Continued on page* 419)

CYCLOPEDIA OF APPLIED ELECTRICITY, in seven volumes, 3,000 pages, 7 x 10 inches, 2,600 illustrations, full page plates, diagrams, etc., with many tables and formulas. Cross-indexed for quick reference, bound in half morocco. Publisht by American Technical Society, Chicago, Ill., 1917. Price, $19.80.

This exhaustive Cyclopedia of Applied Electricity covers a very wide field of electrical engineering as the reader will perceive by glancing at the contents of the various volumes as outlined below. The general style of the treatment is such that anyone with an understanding of the English language and with an ordinary grammar school education can readily learn from these books the successive problems involved in the application of electricity to telegraphy, electric lights and power distribution, wireless telegraphy, electric welding, etc., etc.

Volume one covers the elements of electrical study and starts off with the principles of the magnet and magnetic induction. The style of treatment by the authors of these books, all of whom are well-known instructors in well-known universities and colleges, is very clear, and the illustrations are particularly well made and arranged so that the layman or young student can gain a true idea in every case of just how a certain experiment or test is to be properly made. Wherever possible, photographs are used liberally to show the commercial instruments and apparatus, and by so blending the theoretical study and the necessary diagrams with photographs of actual commercial apparatus the student or general reader cannot fail to gain a thoro idea of each instrument described and just how it operates. Volume one continues with the study of static electricity, primary cells, the principles of the telegraph and telephone, the principle of the electric current, the application of Ohm's law to both series and parallel circuits, etc. Considerable space is devoted to the requirements of the Fire Underwriters in installing electrical apparatus, and the wiring of the various approved types of installation of this nature are well illustrated by means of photographs and diagrams where necessary. Another section deals with electrical measurements and covers the use and operation of such instruments as standard cells, resistance units, electrolytic instruments, hot wire measuring instruments, galvanometers, electro-dynamometers, the Kelvin balance, wattmeters, electro-static voltmeters, frequency meters, power-factor meters, the Wheatstone bridge for measuring resistances, the Megger, the potentiometer, etc. The following chapter takes up the method of making tests on D. C. as well as A. C. circuits, and also in polyphase circuits. The mercury motor watt-hour meter and ampere-hour meter are described and illustrated, also the testing of watt-hour meters and the method of reading integrating watt-hour meters. At the end of the volume there appears a number of review questions which will give the student a good idea of how the various problems are worked out.

Volume two takes up dynamo-electric machinery. The first part of this volume deals with the laws of electro-magnetism, especially as they are related to dynamos and motors, and gradually the student is educated by easy stages to the well-known laws of the magnetic circuit. The elements of armature winding are clearly explained with many excellent illustrations and the process of commutation is made particularly clear by means of numerous special drawings. A very complete study of the design of a continuous current generator of one hundred and fifty kilowatts output is given, together with every detail and calculation for the proportioning of the mechanical and electrical parts of the machine down to the last bolt. This section will appeal particularly to those interested in dynamo design, as it includes numerous tables giving data on various designs of dynamos from one kilowatt output up to several hundred kilowatts. Another chapter deals with the various types of generators and motors, and this chapter is illustrated with numerous photographs of all of the standard types of machines and all well-known commercial makes, so that the student will quickly recognize each respective type of motor or generator when he sees it for the first time after studying the text. The latter part deals with alternating current generators and motors and a number of questions are appended at the end of the volume for the student to work out, which cover the text matter studied in the various chapters.

Volume three takes up the study of the direct current motor in detail, also the management of dynamos and motors including their inspection and maintenance as well as the testing out of motor and dynamo troubles on the job. This volume also takes up the principles of electric lighting.

(Continued on page 418)

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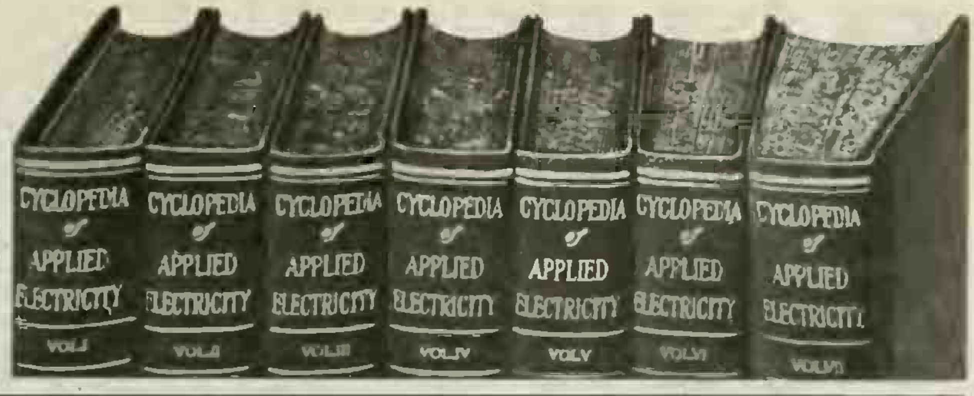

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BOOK REVIEW.

(*Continued from page 416*)

The opening section on direct current motors is up to date, and is very clearly illustrated by numerous diagrams showing how the starting boxes and speed controllers are connected up to series, shunt and compound-wound machines. Numerous excellent illustrations are inserted thruout the work, showing both large and small commercial applications of the electric motor, all of which tend to broaden the mind of the student and to thoroly familiarize him with the appearance and technical arrangement of belts, chains, etc., in industrial plants. One of the sections deals with motor-driven machinery, and shows how motors are applied to various types of machines, and some excellent tables are given of the horsepower required for driving these various sizes and types of machines. The section on motor and dynamo trouble is well systematized and arranged so that the reader can quickly find the various remedies for any certain trouble. The section on electric lighting is very complete and opens with the history of the incandescent lamp. The various forms of incandescent lamps are described, and all of the latest important factors in electrical illumination are taken up in detail with numerous diagrams and photographs of the lamps as well as the comparative effects obtained. Electrical train lighting systems are discust as well as electric head-light systems, with complete wiring diagrams. The measurement of candlepower is well explained and a very interesting final chapter covers isolated lighting plants such as those found in surburban homes.

Volume four covers alternating current machinery, and in this one book all of the essential principles of alternating currents are combined, as well as the principles of the various types of alternating current machinery. The manner of explaining the various intricate problems encountered in alternating current circuits is highly commendable, and the student or general reader will find no difficulty in rapidly mastering the fundamental principles outlined on this subject, which is usually considered quite difficult even by college students who have the aid of expert teachers. The various phenomena of alternating current circuits and machinery are clearly and also completely explained without the application of higher mathematics, and therefore the student of electrical matters will find this one volume particularly valuable and instructive if he happens to be one of that great army of knowledge seekers, who has not had a college education. Anyone with an understanding of the laws of geometry and algebra can readily learn the principles of alternating currents from this excellent treatise. A chapter is devoted to the rotary converter and the method of changing the direct current dynamo into a rotary converter by attaching suitable contact rings to the D. C. commutator. A lengthy description is given of the induction motor and the theory of its operation, also the various relations between the operation of the induction motor and the synchronous motor.

Volume five treats on power transmission, and it includes the theoretical and practical considerations in designing both direct and alternating current transmission circuits. The section on the design and calculation of A. C. transmission lines is very clear, and numerous tables containing the necessary factors to be used in the formulas applying to the work are included in the text. Such practical problems as underground construction are taken up and various arrangements of the transformers are described in detail, also the advantages and disadvantages of these different arrangements. The section on electrical railways is written in a very interesting manner, and is very ably illustrated. Detail drawings are given of the various types of electric railway cars, and railway motors of the latest type are included in this treatment. Other features treated on are lighting and heating systems for electric railways, electric railway power plants and their operating characteristics, electrical transmission systems for railways, track construction, electric locomotives, etc. At the close of this volume a very interesting description is given together with detail drawings of the latest trackless trolley utilizing a double-contact trolley wheel, and a section is also devoted to self-propelled railway cars of the gas-electric type.

Volume six. Power stations and applied electrochemistry are here discust. This book deals with electric power stations of various types and the elementary principles of power station design are given in a simple manner, so that the student can quickly progress thru the various studies leading up to the design of a complete station. The first chapter takes up in detail the various factors governing the most desirable location of a power station, and shows the method whereby this is calculated so that the station will be as near as possible, all things considered, to the center of the electrical load. The text then proceeds with the design of power plant, chimneys, arrangement of boilers, etc., and also the installation of water turbines where waterpower is to be utilized. Part of this volume is devoted to various types of electrical switchboards for power stations, and the necessary instruments to be used on these boards for various sizes of plants. It is regrettable that the section on water wheels and water turbines is not larger, as hydro-electric plants are the coming thing and are being developed more and more every day. Considerable space is devoted to the study of storage batteries including their relation to central station operation, where they are used to carry the peak of the day's load, etc. The complete manner in which the storage battery is explained and illustrated is very good indeed. The Edison storage battery is described in detail. Storage battery charging systems are covered very completely. The closing section of this volume treats of applied electro-chemistry, and it covers such interesting and absorbing topics as the fixation of atmospheric nitrogen, electrical fume and smoke precipitation, electrical ozonizers, electric furnaces, the manufacture of aluminum, the electrical production of oxygen and hydrogen commercially for industrial and balloon requirements, the manufacture of chlorin and caustic soda, the manufacture of hydro-chlorites, electro-plating on non-conducting surfaces, such as glass, etc.

Volume seven. Telegraphy, both wire and wireless, electrical elevators, electric heating and welding are the subjects treated in the seventh and concluding volume of the Cyclopedia. This volume treats in the first chapter on modern land and submarine telegraphy, and the subject is very well handled indeed. The various types of telegraph circuits are discust in a clear manner, and all of the different instruments used on the circuits are illustrated both by diagrammatic illustrations and half-tone cuts of the actual instruments. The various forms of telegraph repeater circuits are given, and a section is devoted to the latest development in telegraphy, the typewriter key-board printing telegraph, such as the "Morkrum system." The various types of multiplex printing telegraphs including the well-known Bordot system are illustrated and described as well as automatic and high speed telegraph transmitting and receiving systems. The section on cable telegraphy is well written, altho it is somewhat brief in scope. The next section deals with wireless telegraphy and the basic principles on which this branch of science rests are clearly explained. This section will give the student a good idea of the general principles of wireless telegraphy, but it is more historical in its treatment than anything else. The closing chapter of the wireless section treats on wireless telephony, and explains the principle of the Bell photophone, as well as the earlier systems used by Ernst Ruhmer and A. F. Collins, including the arc system of Poulsen. The section on elevators is made of extreme practical value.

THE REVOLVING MIRROR AND SPARK DISCHARGES.

(*Continued from page* 390)

off into space. Had the oscillations continued for one second, 223,500 waves would have been produced and they would have been stretched out over a distance of 186,000 miles. In other words each of the 20 waves actually produced was 186,000 ÷ 223,500 = length in miles or 0.832 mile, or 1,465 yards. A wave-meter brought near the helix would read 1,465 yards wave length if correctly calibrated.

NEW DEVELOPMENTS IN TELE-PHOTOGRAPHY.

(*Continued from page* 414)

ter; and that the differential effect increases the further they are from center, one brush having the greater current above center, and the other brush the greater when below center. Each brush is connected with a solenoid, into the centers of which protrude the horn-shaped arms of a rocker that pivots on a friction bearing. A hand on this rocker forms the contact on a sliding contact rheostat in series with the motor. As long as the machines are running in synchronism, the current in the solenoids balances the rocker arm so that the current to the motor is steady; but as soon as there is a slight deviation in the synchronism, there is a change of current in the solenoids which pulls the rocker arm to one side or the other, thereby moving the rheostat contact so as to give the motor more current if it is too slow, or less current if it is too fast. This system of synchronizing is positive, and because of the resistance strips and the differential circuits, a very slight change causes the apparatus to respond.

When the picture has been received, the cylinders continue to revolve until they have advanced far enough to strike the arm of the starting relay and throw it to its original position, breaking the motor circuit and stopping the machine.

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 addrest to "Patent Advice" cannot be answered by mail free of charge. Such inquiries are publisht here for the benefit of all readers. If the idea is thought to be of importance, we make it a rule not to divulge details, in order to protect the inventor as far as it is possible to do so.

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

Readers' attention is called to the fact that due to the great amount of letters to this department it is quite impossible to answer them all thru these columns. The inquiries answered in this issue date as far back as May, and if readers wish speedy service they should carefully note the announcement appearing in the preceding paragraph.

Loose Leaf Device.

(261) L. Mac Neil, Mansfield, Mass., writes us as follows: "As you know there are many styles of loose leaf books on the market, and most of them have to have a special paper that is supplied by the same people that put out the books. Because of the rings in the book, this paper has to be punched before it leaves the factory. A man could buy a paper punch for each kind of loose leaf book he has in his office, but it would cost too much, and take up too much time to punch all the pages for the books.

My idea is to have an adjustable paper punch. It would be about twelve inches long, have at least six dies, that could be spaced any distance apart, inside of the twelve inches. With this punch a man could have as much paper as he wanted cut to the size of his book, and punch the sheets as he used them. Will you kindly give me your advice in this matter.

A. device of this kind is not patentable. Unless there were entirely new features connected with this die, you could not obtain a patent on the same. Just by making a punch die adjustable does not make it patentable.

Projector.

(262) C. Reginald Wilson, Loosville, Pa., has an idea which concerns a twelve-inch shell to be fired from a cannon. It contains a central cylinder shape, which he proposes to fill with nitro-glycerin, while another ring-shaped partition contains poison gas. The idea is that when the shell explodes the nitro-glycerin would force the gas out. Our advice on this is asked.

A. The idea is entirely impossible. Nitro-glycerin is one of those explosives which detonate violently under concussion, consequently, before the shell would leave the cannon it would most certainly explode from the shock alone and incidentally burst the cannon. The chemical, gas-poison shells, which are now being used at the front, make use of a certain explosive which open up the shell, forcing the gas out. Usually a very small amount of explosive is used for this purpose. There is, of course, nothing new in an idea of this kind.

Rubber Stamp.

(263) Don Collier, Mountain Grove, Mo., says, "Noticing some Boy Scouts with a first-class emblem and merit badge after their signature. I thought of having a stamp with movable figures like the dating hand ruber stamps used in offices, but instead of having the figures or numbers, I propose using the Scout Emblems and merit badges. Is such an idea patentable?

A. This is decidely not patentable; just because you use the Boy Scouts' insignias instead of figures or letters does not make an idea patentable. Otherwise, it is a good idea.

There are many good ideas on which people have made a lot of money which cannot be patented. It is not always the patent that counts.

ADVICE

H. GERNSBACK

Testing Device.

(264) Clarence N. George, Portsmouth, N. H., has developed a very ingenious scheme for testing out telephone wires.

It has been found that many times it was necessary to run a number of circuits between two points where it was not practical to run a lead cable. These wires are all of the same color and it becomes necessary to test each pair before they can be connected to the proper lines and a branch exchange switchboard. The method usually practised is to station a man at one end of the wires with a test telephone and have another man at the opposite end with a test phone and dry cells. In this way the right pairs are picked out.

A. The idea which our correspondent advances is a very ingenious one and more or less simple. We are sorry we have not available space to show the entire device, but we are certain that our correspondent's apparatus can be patented. We advise him to get into touch with a patent attorney.

Combination Device.

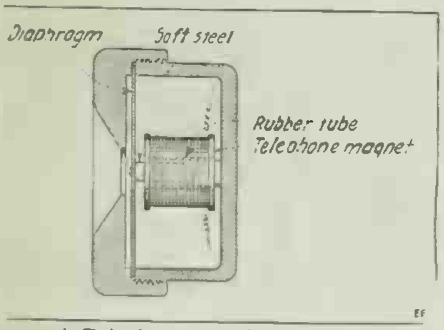
(265) W. R. Charles, Knob Noster, Mo., shows a sketch which embodies a combination tool for pocket use, comprising a gas tank key, a small screwdriver, a bottle opener, owner's name and a hole which serves to put on the key ring. Our advice is asked.

A. We see nothing fundamentally new in this device. It seems to us we have seen something similar before.

Telephone Receiver.

(266) Benson Freeman, Jr., Atlanta, Ga., submits a telephone receiver working on the principle of a suction coil, as the illustration shows. Instead of having an electro magnet in the shell of the receiver, this receiver has a rubber tube 1/16 of an inch in thickness, the inside being hollow, wound in the usual manner. The diafram is like the ordinary one except for the fact that in the center a piece of soft iron or steel 3/16 of an inch thick and ¾ of an inch in length fits into the hollow space in the rubber tube. Do we think that a patent might be secured on this receiver?

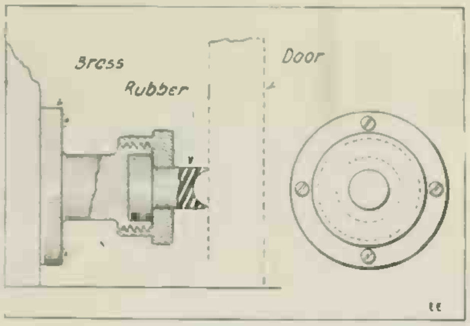
A. This is a very old idea and has been described over twenty years ago. This is the principle of the so-called "Thompson" Receiver, and the trouble with it is that on account of the diafram not being permitted to swing free, it is somewhat less sensitive than receivers that are not so encumbered.



Proposed Telephone Receiver with Solenoid and Movable Iron Core Attached to Diafram.

Door Stop.

(267) Enos M. Johnston, Binghamton, N. Y., submits an idea of a combination door stop and holder. The frame is made of brass with a soft rubber cylinder on one end. This cylinder has a cup-shaped depression as shown. As the door is prest against this piece of rubber, it forces the air out of the cup and, therefore, makes a partial



Combination Door Stop and Holder of Suction Type.

vacuum, holding the door firmly. The device can be fastened on the floor or against the wall. The door can be disengaged with a quick jerking pull. Is the idea patentable?

A. This is indeed a very good idea and we are certain that a good patent can be secured. We should think there would be a good demand for a device of this sort, providing the article can be made to function surely in every instant.

We have found, however, that the one trouble with suction cups of this kind is, that unless they are large they will not function well unless they are wetted, but perhaps by making our correspondent's cup-shaped rubber piece about two inches in diameter this could be overcome. Very pure soft rubber would have to be used also as otherwise age and constant use will deteriorate it too quickly.

Dynamometer.

(268) Isaac Weiss, Brooklyn, N. Y., says: "I have an idea of a Dynamometer and Efficiency Instrument, which I know will work and believe it practical. I would like to know thru the columns of your magazine whether or not there is any demand or field for such an instrument.

"The object of the invention is to provide a new type of dynamometer in which the power being transmitted thru shafting is measured without the power being absorbed by or transmitted thru the dynamometer. Its use is to test the amount of power each machine in a large plant is using, and to find the most efficient speed to run machines. This information, I believe, is of great value in the daily operation of large plants using great quantities of power.

"I have met the requirements of such instruments in producing a portable, direct-reading dynamometer of large capacity which occupies very little room on the shaft to be tested, takes a small amount of time to set in position for testing, and does not require the shutdown of any machine for testing."

A. If our correspondent has really produced such an instrument we should think that there would be quite a demand for the same. Not knowing the full details we, of course, cannot give an intelligent answer, but would refer our correspondent to one of the patent attorneys.

Tail Lamp.

(267) John Hare, Sheridan, Ind., writes: "Would an automobile tail-light made in the form of a cross, to represent the Red Cross, be a good selling Auto Novelty? The light to be about three inches in width and length and one and three-quarter inches in thickness."

A. We are afraid that while this is a good idea, the authorities would not sanction the use of a Red Cross emblem of this kind on private vehicles. We think it would be apt to make for confusion, but this is merely our idea. Otherwise, we have no fault to find but we doubt if a patent can be obtained.

THE MANIPULATION OF GLASS TUBING.

(*Continued from page* 395)

This may be all right and may give the required result functionally, but not mechanically, as any one who has handled a tube with such a constriction knows. It breaks very easily. The problem is to make such a constriction and have it as strong as the original tube. It may be done very simply. Put the length of glass in a blow-pipe flame so that a portion about one inch wide is heated. Rotate the tube constantly to obtain an even distribution of heat and while rotating gently push the tube TOGETHER instead of drawing it apart. This will cause the walls at this point to thicken. When the walls are quite thick, much thicker than the original walls, gently and firmly draw the tube out, and the resulting constriction will have walls fully as thick, or even thicker than the original tube.

ENLARGING THE DIAMETER OF A TUBE.

It is not so easy to enlarge a tube and keep the walls heavy at the same time. It is better to use heavy tubing and not make the enlargement too big. The entire success of blowing an enlargement lies in the heating of the tube. If one side of the tube is hotter than the other, naturally the enlargement will be one sided. Also the enlargement must have a gentle continuous pressure from the mouth and must be made in one operation. If you blow too strongly into the tube, a hole will be blown clear thru the side, thus spoiling the operation. With only one blow pipe it is impossible to heat both sides at once so that if an enlargement is put back into a flame after once made, one side is sure to melt before the rest of it is heated, thus spoiling the symmetry of the bulb.

Heat the tube as for a constriction, then when *white hot* remove from the flame and blow with a steady pressure on the open end, rotating the tube all the while. If you do not rotate the tube while blowing the force of gravity alone will make the resultant enlargement lop-sided.

SEALING LIQUIDS IN GLASS.

Making ampoules is a process many an experimenter has had trouble with. The process is not hard after the procedure is learned. The first thing to do is to get everything ready as it is a very easy matter to run thru a lot of ampoules at once, doing one step at a time. This will save many minutes, as there will be no waiting for the glass to cool.

Cut a series of tubes slightly longer than the length desired. After they are cut one end should be sealed in a flame and put aside. Next draw out the other end of each so that a tube with an opening of about one to two millimeters in diameter is on the end of each ampoule. Each ampoule will now be composed of the main portion which is to form the finished container, a narrow tube, and then a short untouched piece of tubing, which was used to hang on to while drawing out the tube. (See illustrations in Part I.)

The ampoules may now be filled with the desired liquid. This is done by using a fine hypodermic needle and syringe and inserting the needle point all the way down into the ampoule. But most experimenters do not happen to have a long needled hypodermic around their laboratory. So one is quickly made by drawing out a piece of tubing which will be small enough to reach into the ampoule and then fitting a rubber pipette bulb on the other end.

After the ampoules have been filled about three-fourths full they are sealed off by rapidly passing the narrow tube thru a very hot flame. The sides of this tube are very thin and will melt together almost instantly, and even tho the ampoule be filled with an inflammable or volatile liquid, the sealing will take place so quickly that there will be no trouble in sealing the tube without heating the contents. One thing which must be observed, however, is that the ampoules must be kept in an upright position until the seal is cool, otherwise the *cold liquid* coming in contact with the *hot glass* will surely crack it. When cool the ampoules may be scratched with a file near the seal and put away until wanted. When it is wished to open one of them the tip may be broken at the file mark, and its contents extracted.

USES OF SEALING WAX IN GLASS TUBING MANIPULATION.

Sealing wax is very valuable in working with glass tubing, as if applied correctly it will stick to glass firmly. In case of pieces of apparatus where one tube is to be sealed inside another, it is especially valuable as it is almost impossible for anyone but an experienced glass blower to seal one tube inside another. So it is necessary to use sealing wax to accomplish the same result. (See Fig. 6.) It has many disadvantages for chemical laboratories as there are numerous liquids which would dissolve it and render it useless. But for many purposes it is invaluable and should always be on the glass blowing bench.

DUPLICATION OF COMMERCIAL ARTICLES.

When the need for a certain article made from glass comes up in the laboratory, do not buy it until you have carefully studied it and decide that you cannot possibly duplicate its yourself. Commercial catalogs are invaluable for the purpose of giving the construction of many of these pieces of apparatus. With a little study you will find that most of the articles illustrated may be home-made with very little trouble. To illustrate the point, I built a Meinke water jet vacuum pump, adapting the design to fit my raw materials, using the illustration in a catalog of a large supply house as a guide. There were a number of changes, it is true, and it did not look as pretty, but when I came to calibrate the vacuum in terms of millimeters of mercury I found that I could exceed the vacuum claimed by the supply house. (See Fig. 7.) I now have both, and the home-made pump besides costing less than 25 cents is stronger and works better than the "made in Germany" product, which cost $2.50. Try it

(*Continued on page* 425)

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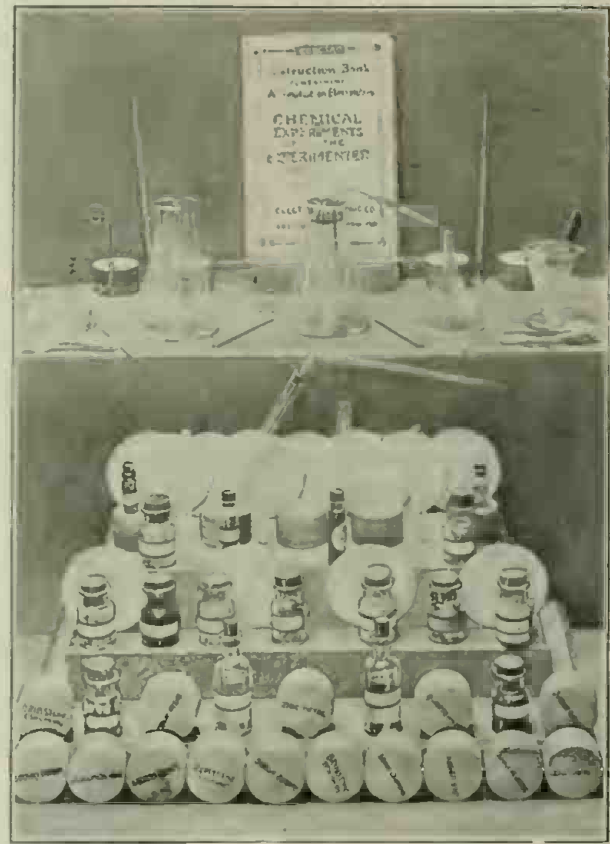

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Sodium Carbonate	Sodium Sulphate	Ammonium Aqua	Iodine
Sodium Borate	Sodium Chloride	Calcium Chloride	Mercury, Metallic
Sodium Sulphite	Calcium Sulphate	Chloride of Zinc	Tin, Metallic
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THE MANIPULATION OF GLASS TUBING.

(*Continued from page 423*)

and see, and after a little practise you will be able to fit up your laboratory with glass apparatus made in America, by yourself, which often is better and cheaper than the average commercial product.

(*Conclusion.*)

THE EINTHOVEN GALVANOMETER.

(*Continued from page 391*)

rent flowing thru it. In order to obtain this deflection, it will be necessary to carefully regulate the tension of the string and the intensity of the field flux, which is controlled by adjusting the current flow therein with the aid of the rheostat, R. This requires a great deal of patience and care until the instrument is finally adjusted to this sensitivity. It will be found that the string will be deflected a maximum at a given magnet flux intensity, and if the current is further increased until the supersaturation of the cores takes place, the sensitivity of the instrument is decreased greatly; so it is advisable to take precaution in adjusting the current flow in the exciting electro-magnets. It was also found that as soon as the tension of the string was altered at a given magnetic flux adjustment, that its sensitivity was impaired. Therefore, every time the tension of the string is varied, a corresponding change of the magnetic field is necessary in order to keep the instrument at a maximum sensitivity point.

The Einthoven galvanometer was utilized with great success in conjunction with radio-communication for recording received signals. It is the only instrument ever devised for receiving directly telegraphic messages sent by radio at speeds ranging from sixty to one hundred words per minute. This is accomplisht by photographing the impulses received by the galvanometer string, which are projected upon a moving photographic film. The arrangement shown in Fig. 21 is used to accomplish this. The standard radio receiving circuit for the reception of continuous long wave lengths is used, since the undamped transmitters with high speed automatic keys are utilized for the purpose. A is the antenna connected to the primary of the induction coupler L C, and back thru the ground, G. The secondary S, of the inductive coupler is shunted with a variable condenser, V C, and linked to a vacuum tube detector A, the grid and wing circuits being electromagnetically coupled to each other by means of the feed-back circuit, F. This is done to make the tube regenerative, thus receiving the undamped oscillations from the distant transmitter by beat reception. The audio-frequency circuit contains the telephone receivers, T, and the Einthoven galvanometer, each of which may be used by merely throwing switch, S. W., in the respective contacts.

To record or photograph the incoming signals, the operator has but to listen to the telephone receiver, and as soon as he receives the proper transmitting station, he switches S W to the galvanometer terminal which causes the string W to be displaced in accordance with the signals. Thus the string images are projected thru the magnifying and projecting telescope, T, to the moving film contained in a perfectly light-proof box. The light is derived from an incandescent electric lamp L, with a reflector, R. This light is then condensed to a single beam by means of a condensing lens, L, and then permitted to fall on the string, W. The developing and fixing mixtures are placed in the lower compartment of the photographic container, and as the film is moved at a constant and definite

(*Continued on page 427*)

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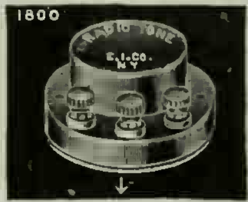

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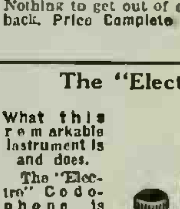

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THE EINTHOVEN GALVANOMETER.

(*Continued from page 425*)

velocity by two rollers driven by a motor, the photographer portion of the film is developed and fixt, and its message translated at the moment of its leaving the fixing tank. The process is very rapid and it is the only means utilized by the large radio companies, especially those having a great deal of traffic.

Not only is this instrument utilized in radio work, but it has played the most important rôle in the art of transmitting photographs over electrical circuits. It may be mentioned that whenever a very sensitive galvanometer is wanted, especially for recording high periodicity impulses, the Einthoven galvanometer is the only one that will meet the requirements.

(*Conclusion*)

SPECTROSCOPIC METHODS AND THE PRODUCTION OF SPECTRA.

(*Continued from page 393*)

points should be as large as the spark will permit.

The apparatus can be easily and handsomely mounted by the arrangement shown in Fig. 6. The two wood uprights are screwed on from underneath. The tube is held by two bands of tin or copper. These are clamped to the tube by means of two small bolts and the ends screwed to the uprights. The electrical connections are made by pouring some mercury into the tube "B", and filling the tube "X", which is glass, bent and fastened to the board by a strip of metal. Into one end leads the platinum wire from "C", and into the other the lead in.

If the apparatus is intended to be connected direct to the spark coil, the wires from the coil may be directly inserted into the mercury in the two tubes, but it is better to fix two binding posts in the base and connect the coil to these. In this case the wires leading from the binding posts to the mercury should be iron, as copper will amalgamate with the mercury and cause trouble.

The apparatus is now ready for use. A solution of the substance to be examined is placed into "A", preferably with a pipette, till it is just about level with the jet in tube "C". The current is now turned on. The liquid is drawn by the capillary attraction of the glass to the jet, and each spark vaporizes a tiny portion.

Both the level of the solution, the hole in the jet, and the position of the platinum wire may have to be adjusted before the apparatus will work satisfactorily. The chief advantages of this method are:—(1) Ease of working. (2) Small amounts of material can be used. (3) Many materials that will not vaporize in the Bunsen flame will vaporize in the spark, and also many materials that give a spectrum in the Bunsen, in the higher temperature of the spark will give many more lines. (4) The supply is practically inexhaustible.

(*See Part II in the November issue.*)

EXPERIMENTAL PHYSICS.

(*Continued from page 386*)

ever, the coil is held stationary over the magnet pole no deflection will be observed, i.e., no current flows. If the coil is *drawn up* past the pole the needle will deflect in an *opposite direction*. If we alternately *thrust down* and *draw up* the coil it is obvious that an *alternating current* will result. By use of a commutator this current can be converted into direct current (the commutator is a device for reversing the current alternately when each change in direction occurs; the two reversals being equivalent to no reversal at all). We may now add to Oersted's discovery, the dynamo principle that *when a conductor moves in a magnetic field so as to cut the lines of force of the field, a current is induced in the conductor.* The right-hand three-finger rule is an excellent guide for determining the direction of the induced current. *Bend the thumb and the first two fingers of the right hand at right angles to each other. Point the thumb in the direction of the motion of the conductor, the first finger in the direction of the field of the magnet; then the central finger indicates the direction of the current.* In the modern dynamo, of course, instead of hand power, steam or water power is belted to the dynamo to give the motion and also rotary motion being much simpler and possessing other advantages, the coil is turned continuously rather than thrust up and down. However, the principle is the same and the three-finger rule applies equally well.

EXPERIMENT 97—If a current is past thru a dynamo its armature revolves and we now have a motor. The last experiment can be slightly modified to show the motor principle. Suspend a heavy copper wire so that it is free to swing in a plane perpendicular to the field of a horseshoe magnet. Let the lower end of the wire dip into a dish of mercury. Connect a battery of about 20 volts to the top of the wire and to the mercury as in figure 87. When the circuit is closed the wire will be found to move (swing to the right). Just as might have been expected,—*when a current passes thru a conductor in a magnetic field a motion of the conductor results.* If now we substitute left for right we have the left-hand (three-finger) rule which enables us to predict the direction in which the conductor is going to move. Otherwise the rule reads identically with the right-hand three-finger rule. (These rules are also called the dynamo and motor rules respectively.)

EXPERIMENT 98—Wind about 500 turns of number 28 insulated copper wire around one end of a soft iron core and connect to a galvanometer such as was used in experiment 96. Wrap about the same number of turns about another portion of the core and connect to a battery of several cells. When the circuit is closed the deflection of the galvanometer will indicate the passage of a current thru the coil *a* in spite of the fact that the batteries are not in the circuit of *a*. When the circuit is opened, an equal but *opposite deflection* will indicate the flowing of an equal current in the *opposite* direction. This experiment illustrates the principle of the *induction coil* and the *transformer*. The coil *b* is called the primary and the coil *a* the secondary. Causing the lines of force to appear inside of *a* (magnetising the space inside of *a*) caused an induced current to flow thru the coil. Demagnetisation induces a current also. Stated more compactly and correctly, *any change in the lines of force which thread a coil produces an induced current in the coil.* In the alternating current transformer, the number of lines of force changes because the magnetising force is always changing. In the direct current transformer (induction coil) the number of lines of force changes because of the action of an electro-magnetic interrupter of the form described in experiment 94.

In figure 88-B, *c* denotes a soft iron core composed of a bundle of sofe iron wires; *p* is a primary coil wrapt around this core and consists of about 200 turns of number 16 insulated copper wire; connected to the battery circuit by contact point on the end of screw *d*, a secondary coil *s* wrapt around the primary and consisting of about 50,000 turns of number 36 insulated copper wire connected to the terminal point (spark gap) *t* and *t'*; and a spring hammer *b* for making and breaking the primary circuit. Just as in the case of the bell an intermittent current passes thru the primary, hence inducing a current in the secondary. The rate at which the lines of force are cut determines the voltage of the current; also since the number of turns of the secondary is so much greater than that of the primary, the effect is similar to having the same number of turns but more lines of force cut, and hence the induced voltage is tremendously greater than that passing in the primary circuit.

The subject of electricity is a vast one and because of its great commercial value is by far the most important division of Physics. In devoting only three lessons to it the author had to omit details and discuss only the fundamental of the fundamentals. His hope is that a desire for further light on the subject has been awakened in the reader.

(To be continued.)

POPULAR ASTRONOMY.

(Continued from page 383)

to be considerably less than our own, is familiar to every one. A second theory upheld convincingly by Prof. W. H. Pickering is the one of aerial deposition. The more prominent canals, according to this theory, are marshy strips of vegetation, lying in the path of water-ladened air currents blowing from the vicinity of the melting polar cap toward the equatorial regions and depositing moisture along their paths during the Martian night. The absence of dense clouds in the planet's atmosphere and the amount of detail visible in the surface markings at a distance that is never less than thirty-five million miles show that the atmosphere of Mars is very rare. The daily range of temperature must therefore be very great, the days being extremely hot and the nights extremely cold. Much moisture would, therefore, be deposited at night.

In regard to the appearance of the broader and more conspicuous canals, that are comparatively few in number, Prof. Lowell stated that ninety per cent of them were either straight lines or followed the arcs of great circles, while Prof. Pickering declares that many of them are quite distinctly curved and attributes this curvature to the deflection of the air currents that feed the canals or marshes, due partly to friction with the atmosphere and partly to the effect of the rotation of the planet on its axis. He computes from the radius of curvature of several of these canals at a recent opposition the velocity of the storms that feed them and arrives at a value for the minimum pressure of the atmosphere of 7.5 inches of mercury or less than one-quarter of a terrestrial atmosphere. The corresponding temperature of boiling water on Mars he, therefore, finds to be 150°F.

It has also been noted in past oppositions of Mars that certain canals occasionally shift their positions noticeably both in latitude and longitude by the amount of several hundred miles.

A number of observers of the broader canals have criticised their representation as fine, straight lines, artificial in appearance, claiming that they appear rather—to use the words of one observer—as "soft streams of dusky material with frequent condensations."

(Continued on page 430)

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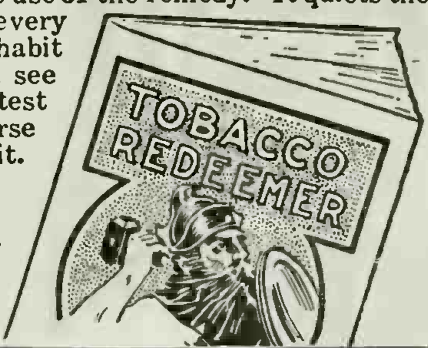

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POPULAR ASTRONOMY.

(*Continued from page 428*)

In addition to these larger canals there have been seen by a number of observers a secondary type of canal which always appears late in the Martian summer and then occurs in great numbers. More than five hundred of these canals have been seen and mapt at the Lowell Observatory but the question of their origin is still unsettled. They differ from the larger canals in being extremely narrow, straight and uniform in appearance. It is yet to be decided whether they are artificial, as has been claimed by some observers, or an optical illusion, as is claimed by others, or whether they mark the course of accidental or local storms.

Some interesting observations made at the opposition of Mars that occurred this year have been given in Prof. Pickering's Twentieth Report on Mars. It is there noted that during the Martian summer just past the desert regions distinctly changed color from reddish to corn color. The permanency of the change showed it was not due to clouds but was a surface change due to the presence of moisture in the atmosphere and the resulting growth of vegetation. The only color that could partly neutralize the reddish tinge of the deserts is green.

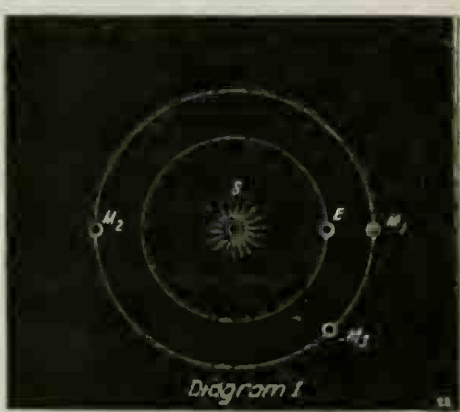

Diagram I—Scale One Hundred Million Miles to the Inch. In the Above Diagram the Inner Circle Represents the Earth's Orbit and the Outer Circle the Orbit of Mars Projected on the Plane of the Earth's Orbit. This Projected Orbit of Mars Differs Very Little from the True Orbit, Since the Inclination of the Plane of Mars' Orbit to the Ecliptic, or Plane of the Earth's Orbit, Is Less Than Two Degrees. The Eccentricities of the Two Orbits, Being Small, Are Neglected and the Orbits are Represented as Circles with the Mean Distances of the Planets from the Sun as Radii.
Mars Is in OPPOSITION When the Sun S, Earth E, and Projected Position of Mars M, Are in a Straight Line in the Position SEM, the Earth Being Between the Sun and Mars. The Planet Is Then Visible Thruout the Night and Is on the Meridian at Midnight.
When Mars Is at M_2 and the Three Are in the Position ESM_2 with the Sun Between the Earth and Mars, the Planet Is in CONJUNCTION with the Sun and Invisible Because It Is on the Day Side of the Earth and Lost in the Sun's Rays.
When Mars Is at M_3 the Lines SE and M_3E Make a Right Angle at E, and Mars Is in QUADRATURE with the Sun. There Are Two Positions in Its Orbit in Which It Is in Quadrature. It Is Then on the Meridian Either at Sunset or Sunrise, According to Whether It Is East or West of the Sun. At Quadrature the Disk of Mars Is Slightly Gibbons Resembling the Phase of the Moon Within Two or Three Days of Full, Due to the Fact That We Then See a Small Portion of the Unilluminated Portion of Its Surface.

The most conspicuous dark, marshy tract not connected with polar regions, the Syrtis Major, showed decided changes in form and color at this opposition due to flooding with water from the melting polar cap. At times it appeared decidedly blue, due to the presence of large quantities of water, at other times it was covered partly by cloud and at one time was observed to recede northward six hundred miles in six days.

Darkening of certain portions of the desert tracts hourly were also noted at this opposition and attributed to the warming and thawing of the ground with the increasing warmth of the sun's rays, the darkening being most noticeable in the Martian's afternoon. It was concluded from this that the ground frequently freezes at night and thaws out during the day. Tropical frosts appear to be quite the usual thing on Mars and two were directly observed at this opposition. Three temporary increases in the size of the melting north polar cap were also recorded this year, due to heavy snow storms at the north pole. The polar cap in the winter season frequently extends 35° from the pole, but at the height of the summer season it has a diameter of only four hundred miles or so and on rare occasions almost, if not quite, disappears.

Whatever may be one's opinion as to the reality or unreality of the canal system the evidence that Mars possesses air and water seems to be beyond dispute and therefore we are justified in assuming that both animal and vegetable life may exist upon this interesting planet.

The comparative ages of Mars and the earth are unknown. It is generally believed that Mars is more advanced in age and development than our planet, due to its smaller size, which would cause it to cool off and form a surface crust earlier.

Mars has one-seventh of the volume and about one-tenth of the mass of the earth. Its surface gravity is thirty-eight per cent of that of our own planet and a body weighing one hundred pounds on the earth would weigh only thirty-eight pounds on Mars. As a result of these facts the Martians are sometimes pictured as creatures of great size and agility, far more advanced in evolution than the human race. We must remember, however, that nothing whatever could be known concerning the inhabitants of the planet Mars. If life exists on Mars it must be adapted to its environment, which is probably affected by many factors that make it very dissimilar to our environment.

To speculate concerning the nature and characteristics of the Martians is very fascinating, but will not lead to any definite or satisfactory result and serves no purpose except to exercise our powers of imagination.

(*Next installment will appear in November issue.*)

THE ARTILLERY BARRAGE—HOW IT WORKS.

(*Continued from page* 368)

rage is lifted another twenty-five yards out, and so it advances as the illustrated time-table herewith shows—twenty-five yards at the end of each minute. At 3.01 P. M. when the barrage has lifted to a distance of fifty yards in front of the trenches, the first wave of doughboys go "over the top", with bayonets fixt and belts loaded with hand grenades. The advancing barrage is lifted, the specified increment exactly at the end of each pre-arranged interval (say one minute), and not gradually or during the one minute interval. This is done so that the infantry officers know just how far their men shall advance *by the watch*. In other words, they know that at the end of a minute, the barrage will have lifted another twenty-five yards, and their men can then crawl forward that distance; at the end of another minute the barrage will have lifted another twenty-five yards and the men can then proceed forward again for this distance; they then hold the new position until another minute has elapsed, when the barrage will have again lifted the specified increment, et cetera.

Looking at the barrage time-table once more, we see that C in stage 1, represents the searching barrage, B represents the standing barrage which pounds the enemy trenches constantly, even while the creeping barrage A is lifting or going forward, and finally we have the fourth stage of the maneuver, or the enemy counter barrage at stage six. In stage four, the second wave of "Yanks" is shown forming, while German troops are being brought forward to the front line trench from underground dug-outs, galleries and supporting trenches to strengthen the front line trench, and also to replace the heavy casualties occasioned by the standing barrage shell-fire.

"Treat 'Em Ruff Boys" is the only line that fits in stage five, when the Yanks come to grips with the Huns in their own trenches. Here the standing and creeping barrages combine and advance to the rear of the German trenches so as to prevent their retreat, and also the bringing up of reserve troops and supplies, as much as possible. At stage six, the enemy artillery gets in a good lick with a counter barrage and this is liable to happen at any point in the previous stages, all depending on the strategical tactics followed by the enemy commander (the counter barrage is indicated by the curved line of iron crosses) but, of course, the shells fired by the Teuton guns are not quite so elaborate in shape; ask "Sammy"—he knows. The effect of the counter barrage is sometimes quite disastrous, unless the storming troops can dig in and make use of the underground galleries and dug-outs which they have captured until their own guns can silence the counter-barrage artillery, which may be several miles in the rear in some cases and well camouflaged. Another effect of the counter-barrage is to prevent the bringing up of more than one or two waves of attacking infantry.

It was found, however, that even as effective as the barrage proved, there were still loop-holes by which the "Boche" could make his escape. For instance, he awakened to the fact that if he could withstand the shell-fire until the barrage had reached and past his own front trench, that he could then scamper around the "side" ends of the barrage "fire-curtain", and thus escape to his second or third line trenches and dug-outs. But the Allied artillery experts soon got on to this cunning maneuver, and now they make use of what is termed in artillery parlance a "box barrage." This is shown in the accompanying illustration, and as will be seen, a number of the barrage cannon are employed at certain intervals to create a *cut-off wall of shell fire*, as at A, A.

Some of the wonders and mysteries of modern artillery barrage fire are unmasked in a very excellent lecture recently given before the Washington Academy of Sciences by Major-General John Headlam in charge of the British Artillery Mission in this country. General Headlam in his lecture, which was entitled "Developments in Artillery During the War", treats on many important and highly interesting features of present day artillery practise, and in line with the foregoing discussion, he has considerable to say considering the how and why of barrage fire, particularly as related to regular artillery bombardments and the general factors related thereto, such as the methods of observation, the manner of allowing for loss in range due to multifarious factors such as wind velocity, humidity, air pressure, gun erosion, etc., etc.

The accompanying battle-field panorama shows in a vivid manner the general arrangement for carying out an artillery barrage and the outstanding features of such an offensive, notably the numerous and highly diversified means of gathering the important information essential to insure the hair-line accuracy demanded in such an artillery operation.

In the first place it is interesting to note that the artillery, even for carrying out a barrage offensive, is not always situated as far back from the front line trenches as we are wont to imagine, for as General Headlam says,—"But, as a matter of fact, just as this war has seen the revival of hand-to-hand fighting with the bayonet and the rifle butt, so it has seen guns pushed into closer ranges. On many occasions I have known individual field guns put within *two hundred yards* of the enemy's trenches.

With time, ingenuity and courage, a gun can be gotten almost anywhere, and the effect of its fire at such ranges is very marked while its presence affords immense encouragement to the infantry. One case I may mention, where a gun had to be brought up over the open, and it was moved at night under a canopy like a dignitary of the church in high festivities. The gunners who carried the canopy were trained to drop it on the gun whenever a "flare" went up. This gun fired its *one hundred rounds at a range of seventy yards in nine minutes;* completely destroying its objective, and the detachment then, strictly against orders, joined in the assult."

General Headlam covers a number of interesting points, and then comes to the *accuracy of fire.* "Accuracy of fire," he says, "is, of course, the first essential to success in the artillery. First, we must have a good position or emplacement for the gun, and next we must exercise great care in storing and alloting ammunition. The powder and fuses must be protected from the weather, and this entails much labor and constant care. Guns, cartridges and fuses are made in *lots* and no *adjustment* can quite get over the differences between these. Therefore, every effort is made to keep lots together. One of the things that must be observed by the artilleryman is the weight of the shell, and the various lots of shells are carefully examined, checked and marked for weight.

"The next thing the artilleryman has to think of is the *age of his gun,* or rather how hard it has lived, for as a gun *wears,* its accuracy and its range fall off. The former cannot be calculated, tho it must be allowed for; the latter can, and the loss of muzzle velocity in each gun must be found and allowed for. This is what we call *calibration,* and it has to be repeated with each propellant—and in a howitzer with each charge. These problems are usually carried out on the front, because we prefer whenever possible, that every shell should have at any rate a chance of killing a German. To enable it to be done the topographical sections provide the gun batteries with maps, carefully mounted so as to avoid errors due to shrinkage or warping, and showing accurately not only the positions of the guns and observation stations, but also such datum points as may be desired inside the enemy's lines."

Then we have *the error of the day.* "Having by the various means known to artillery science, found the errors of the guns, a battery commander has next to think of the *error of the day,* or rather, of the *moment*", says General Headlam. "He must ascertain and allow for the height of the barometer, the temperature of the air, the temperature of the charge, and the force and direction of the wind for a given time of flight, and here he has to depend on his scientific friend "Meteor" in the nearest meteorlogical observation station, who sends to him every few hours cryptic telegrams giving above all-essential facts.

Altho when written in book form the directions and calculations to be performed and carried out by artillery officers seem really quite methodical and well settled, yet they are not always so easy to apply in the field by any means, and also they are sometimes fraught with considerable danger, especially where tests are being made with actual shots from the guns and with the observers located in shell holes or front line trenches. General Headlam mentions the fact that one of his best battery commanders was killed by a shell from his own battery while he was conducting the fire from a trench and from which he had cleared the infantry. This occurs now and then for the reason that the artillery officer or gunner has misjudged his *fire*

(*Continued on page* 435)

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THE ARTILLERY BARRAGE — HOW IT WORKS.

(*Continued from page 433*)

zone for all of the shells from a series of rounds *fired at the same time and elevation* will *not* fall on the same spot, but will cover a rectangle varying in size with the gun and the range.

Not only is the artillery officer confronted with an amazing amount of mathematical calculations to be performed almost instantaneously, as well as very accurately, but he must see to it that his arrangements for the observation of shell fire is complete, and moreover thoroly effective. It seems, of course, very difficult to maintain the observation points, especially where these are in the form of aerial observers suspended from balloons, as shown in the accompanying illustration, or where the observers are in aeroplanes—for the enemy, especially in a heavy counter offensive, has an irritating habit of "dropping" these observation planes and balloons (blimps, as they are called) with a well directed shell or spray of shells.

In most cases artillery observation officers are sent forward with advancing infantry, and also observers are stationed near the front line trenches in shell holes or other advantageous points. The aeroplane observers communicate their findings by *wireless* to earth. A radio station, of the dug-out or portable auto-truck type, picks up the message flashed thru the air from the soaring plane several thousand feet above the earth, and communicates the range figures and changes in range immediately to the battery commanders by telephone. Communication lines are all handled under the supervision of the Signal Corps, and these lines of communication must be maintained in constant working order at all times and at all hazards, especially when a battle is in progress. The observation balloons or blimps, have a telephone wire running down along their anchoring cable, by means of which the balloon observer communicates his findings to earth and thence to the battery commander thru the field telephone switchboards, etc.

But we are not thru yet with the refinements that the artillery officer has worked out for the control of modern shell-fire. We next find the *flash-spotter* and *sound-ranger*. As General Headlam points out in his lecture,—"In the liberally equipt observatories of the *flash-spotters*, the burst of every round may be accurately recorded by the inter-sections of three widely separated observers, and instantly transmitted to the plotting stations. There, too, will be registered the position of any gun that is foolish enough to open fire from an insufficiently masked position when the clouds are dark behind it. Then comes the *sound-ranger*, who, with his delicate instruments, registers the discharge of the enemy's gun.

One of the latest developments in artillery is the "aerial barrage", which comes within the realm of anti-aircraft gunnery. This is one of the most remarkable and as yet not very well-known branches of gunnery, and one in which there is a great opportunity for students of such work. It has often been said that it takes approximately a thousand shells to bring down or "bag" an enemy 'plane, even at a fairly low height, and then in most cases, the 'plane does not come down after all. But as General Headlam says,—"If you think that the results obtained have been small, that with all the expenditure of time and material devoted to it, the proportion of aeroplanes brought to 'bag' is insignificant, you must remember the difficulties of the task. *An aeroplane covers more than half a mile while the shell is in the air*, and I leave it to the sportsmen among you to say how many ducks they would pick up under such conditions."

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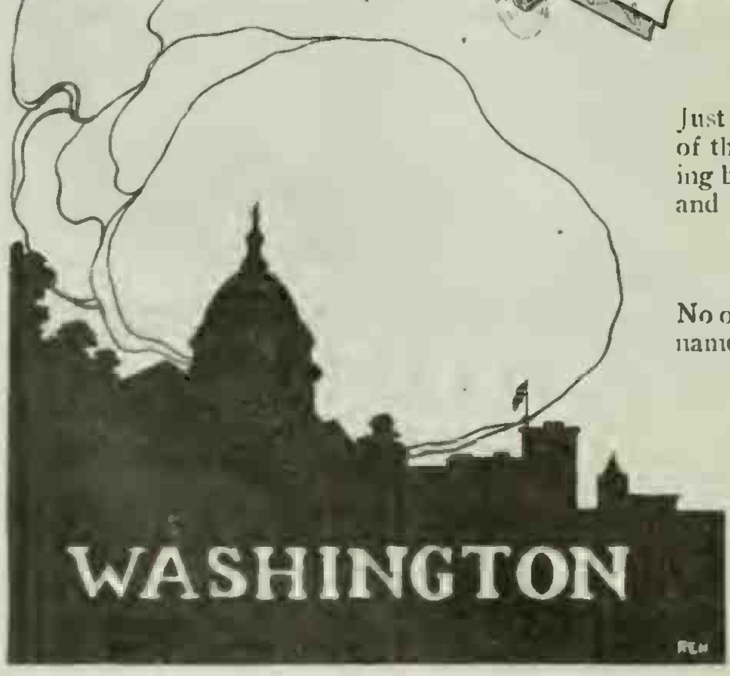

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Remember, the U. S. Postal Laws protect you. No one can "do" or cheat you. Of 3,495 "ads" published in these columns during the past five years, only twelve complaints were reported to us, and each one was adjusted to the full satisfaction of the complainant.

The rates are: *Five cents per word* (name and address to be counted.) *Remittance must accompany all orders.* No advertisement for less than 50c accepted. We reserve the right to refuse any advertisement which we consider misleading or objectionable. Dealers' advertising accepted in Opportunity Ad-let columns only. Advertisements for the Nov. issue should reach us not later than Sept. 22.

OVER 100,000 CIRCULATION GUARANTEED, A. B. C. AUDIT

179 Marcy Ave., Brooklyn, N. Y.
August 22, 1918.

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